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PANORAMA

ICT practitioner skills and training solutions at sub-degree and vocational level in Europe

Guidelines for ICT training and curriculum development

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A. Willi Petersen
Carsten Wehmeyer

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Preface

This study is part of a series of four studies launched by Cedefop in late 2002 under the project ICT platform. A working party, set up to accompany these studies, comprised some 20 eminent experts and expert bodies in the field. This ICT workshop has met three times since its constitution and has the task of advising Cedefop on the approach to, and content of, the surveys and on questions linked to ICT skills supply and curriculum development in general. Links were also established by Cedefop to parallel developments in the European Commission and especially to the e-skills forum and e-Europe action programme launched under the Danish Presidency. The workshop also relates to other important activities of DG Education and Culture on E-Learning. The contractors were invited, on the basis of their former experience and additional surveys, to edit a text of around 50 pages (without annexes) on the subject indicated in the introduction below.

These four studies are now available individually and will be combined in a synthesis report expected to be ready by the end of 2003.

In parallel to the studies, Cedefop cosponsored a workshop in the framework of European standardisation activities (CEN/ISSS). This was intended to validate the outcomes of the work of the Career Space Consortium, published by Cedefop in 2001 and 2002 (www.career-space.com) on ICT profiles and curricula aimed at university level skills and IT practitioner higher education.

Once this validation is concluded (anticipated at the end of 2003) the same procedure will be used to validate the outcomes of these four Cedefop studies (see also the virtual community under http://cedefop.communityzero.com/cen-ict, set up by Cedefop on this issue).

Werner Herrmann, Senior Advisor to Cedefop's Director

Burkart Sellin, Principal Administrator and Project Manager

1. Executive summary

In recent years the spread and dynamic of information and communications technologies (ICT) across Europe have been steadily increasing. Today the importance of ICT for the EU economy and throughout business, services, domestic and leisure is obvious. ICT developments are changing society to an 'information society' and new opportunities and challenges in all areas of work and life have arisen. In particular, this applies to ICT work itself.

ICT practitioners, highly skilled staff, are needed to manage business and work processes in both the core ICT sector and in industries using ICT. To understand, produce and use the new information and communications technology, (computers, networks, internet, new hard- and software applications, e-commerce, fixed and mobile telecommunications, consumer electronic devices, digital cameras and television, etc.) there is a widespread need to possess a range of ICT competences. This, in turn, makes demands on the various provisions of higher education (HE) and vocational education and training (VET) as well as requiring tailored offers for continuing vocational education and training (CVT) and lifelong learning (LLL).

The situation regarding ICT practitioner supply and demand varies across Europe. The state of development of the ICT economy and of the national systems of higher education (HE) and VET affect this situation both in qualitative and quantitative terms. However, recent worldwide problems with the new economy have contributed to more reasonable discussion on the outstanding demand and the problems of the ICT labour market. The situation must be judged from a qualitative viewpoint, namely that the supply of ICT practitioner qualifications in total still does not meet ICT skill requirements. Therefore, to improve the current situation, and to narrow the ICT qualification mismatch, there is a need for more and better qualified ICT practitioners in all European countries.

The Career Space Industry Consortium of major European ICT companies has described the operational background and the wide range of needs in relation to ICT skills at higher education or degree levels (CSC, 2001). The consortium also published a study on curriculum guidelines, which were compiled in cooperation with different organisations, the education sector and a number of universities and technological training institutes across Europe. The work on recommendations on core generic ICT skills profiles and the design of ICT courses offers information and suggestions to universities about the needs of the ICT sector and the ways in which the ICT qualification mismatch might be reduced (CSC, 2001; CSC/Cedefop, 2001a/b).

In addition to the Career Space results, the present study is specifically concerned with the ICT practitioner skills and training solutions at sub-degree vocational level in Europe. The study was launched in October 2002 with the objective of analysing the specific need for ICT skills and practitioners at sub-degree levels in the ICT and user sectors, especially in SMEs. Corresponding to the needs of ICT skills and skill profiles, further guidelines should be developed for ICT curricula at sub-degree levels and recommendations made for the design of

vocational training courses. Such curriculum guidelines and recommendations should also relate to the ICT skills and profiles at degree levels developed by the Career Space Consortium's working party.

Investigation and analysis to determine current ICT industry needs at sub-degree skill levels is mainly based on two empirical studies. The first is the Leonardo da Vinci II project European qualification strategies in information and communications technology (EUQuaSIT), which includes surveys and case studies in companies. The project was carried out in cooperation with partners in five European countries. The second is a national study carried out by *biat* to evaluate new vocational ICT training profiles in Germany, using investigations, case studies and expert interviews on ICT business and work structures, contents and requirements. Additional results from secondary analyses allowed the overall research method and approach of the investigation to be based on interaction of demand and supply of ICT practitioners.

ICT employment: demand from ICT and user industries and supply of practitioners at different skill levels

To support ICT development and the competitiveness of enterprises, and therefore the European economy as a whole, it is necessary to have a balance between demand for and supply of ICT practitioners. This is important for the ICT sector itself and for all ICT user sectors, which today includes virtually all sectors. This study presents findings on ICT practitioner supply and demand from quantitative and qualitative points of view, with detail of shortage, gap and mismatch. The study and training solutions currently existing and needed in Europe and specific European countries respectively are also examined.

In this context, a first important fact is the total number of ICT practitioners employed in Europe. Different studies suggest that this figure is approximately 3 700 000 (*biat,* 2001; EUQuaSIT, 2002; CEPIS, 2002). This includes practitioners in the ICT sector itself and in user sectors at all skill levels, and is approximately 2.5 % of total employment in Europe (total labour force is approximately 160 million). In comparison the USA has a proportion of approximately 2.8 % (total labour force is approximately 140 million). The employment split in Europe is 40 % (approximately 1 500 000) in the ICT sector and 60 % (approximately 2 200 000) in the ICT user sectors, though the proportions vary between European countries and regions according to the economic situation. This figure of 60% for ICT user sectors is virtually identical to the situation in the USA (NSSB, 2002, p. 11).

Projections of current and future demand for ICT practitioners depend on ICT business and general future economic development. Forecasts, assumptions and scenarios of this demand in Europe and in each European country have indicated a change resulting from problems in the 'new economy' worldwide over the last three years. Company responses on employment are important in suggesting that ICT staff levels in approximately 60 % of ICT and ICT user companies in Europe will not change in the short and mid-term. In the ICT sector and small enterprises, more than 30 % expect higher ICT staff levels in the near future.

Based on summarised study results, calculations and a realistic assumption of no more than 5 % per annum ICT staff growth over the coming years, total new demand for ICT

practitioners in Europe – including replacement demand – will be around 230 000 ICT practitioners per year. Projecting these figures to the year 2010 gives a total number of 5 100 000 ICT practitioners for Europe.

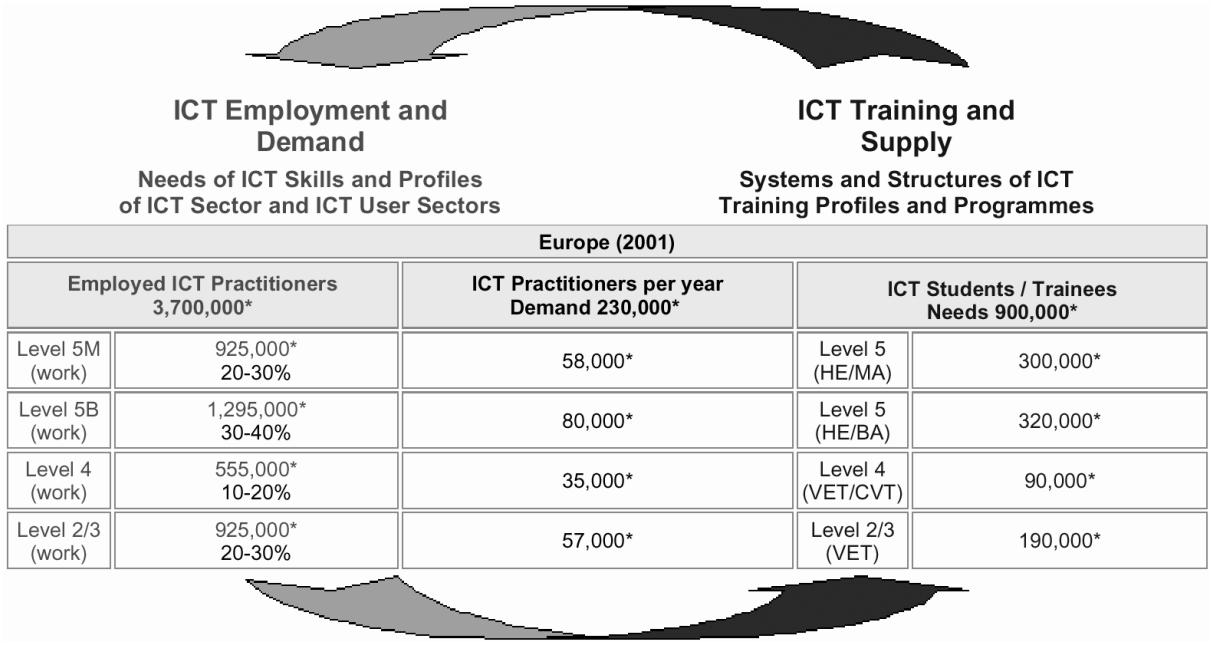
It is more difficult to assess current and future shortage of ICT practitioners because this demands information on current and future demand in relation to supply. The results from the company survey show that the shortage of ICT practitioners is currently quite limited. They paint quite a positive picture of the ICT labour market in Europe, with the supply of practitioners mostly estimated by the companies as being 'fair' and only some 15 % suggesting it is 'bad'. There are minor variations between European countries. This contrasts with the previous forecasts of a huge shortage of ICT practitioners in Europe, predicted by some as a 1.6 million shortage by 2004 (IDC, 2001).

Any forecast of an ICT practitioner gap has to be based on realistic numbers for the foreseeable supply of ICT practitioners, which are neither easy to find nor available for all European countries. This is particularly so in respect of the need to divide the supply of ICT practitioners into different qualification levels. In addition, there is also a need to ascertain the division of ICT employment and demand for ICT practitioners at different skill levels.

As shown in the figure, ICT employment in Europe indicates that between 50 % and 70 % of all ICT practitioners work, and have an ICT qualification, at degree level, with the remainder having an ICT qualification at sub-degree level. The actual number depends mainly on the relevant country and further on the sector. For example, ICT employment at degree and sub-degree levels in Germany is 50 % and 50 %, in the Netherlands 60 % and 40 % and in Portugal 70 % and 30 %. Figure 1 also indicates ICT employment and demand at the degree and sub-degree levels for Europe.

Because we do not really know how many ICT students and trainees we have in total, or at each level, today in Europe, the figure shows only the estimated number of students and trainees needed at each qualification level to meet the presumed demand per year. Taking into account the average duration of ICT training programmes, and also a drop-out rate, there is a total need for approximately 900 000 ICT students and trainees. This picture is complicated by the fact that, approximately five years ago, the numbers were too low in most European countries but increased demand for ICT practitioners has led to an increase in ICT students and trainees. However, the company surveys indicate supply of ICT practitioners is 'fair'.

Figure 1: ICT employment and demand at different levels in relation to the needed ICT students/trainees in Europe



ICT Employment and Demand Needs of ICT Skills and Profiles of ICT Sector and ICT User Sectors		ICT Training and Supply Systems and Structures of ICT Training Profiles and Programmes		
Europe (2001)				
Employed ICT Practitioners 3,700,000*		ICT Practitioners per year Demand 230,000*	ICT Students / Trainees Needs 900,000*	
Level 5M (work)	925,000* 20-30%	58,000*	Level 5 (HE/MA)	300,000*
Level 5B (work)	1,295,000* 30-40%	80,000*	Level 5 (HE/BA)	320,000*
Level 4 (work)	555,000* 10-20%	35,000*	Level 4 (VET/CVT)	90,000*
Level 2/3 (work)	925,000* 20-30%	57,000*	Level 2/3 (VET)	190,000*

*Source: CEPIS, 2002; *biat, 2001; EUQuaSIT, 2002*

In consideration of the slow-down in economic development and the current employment situation, the results of the company evaluation indicate that:

(a) the demand for ICT practitioners is being met quantitatively by the supply;

(b) the numbers of ICT students and trainees are possibly sufficient to improve the balance in the ICT labour market;

(c) a supply-demand gap is only apparent at BA degree level and at sub-degree level 4.

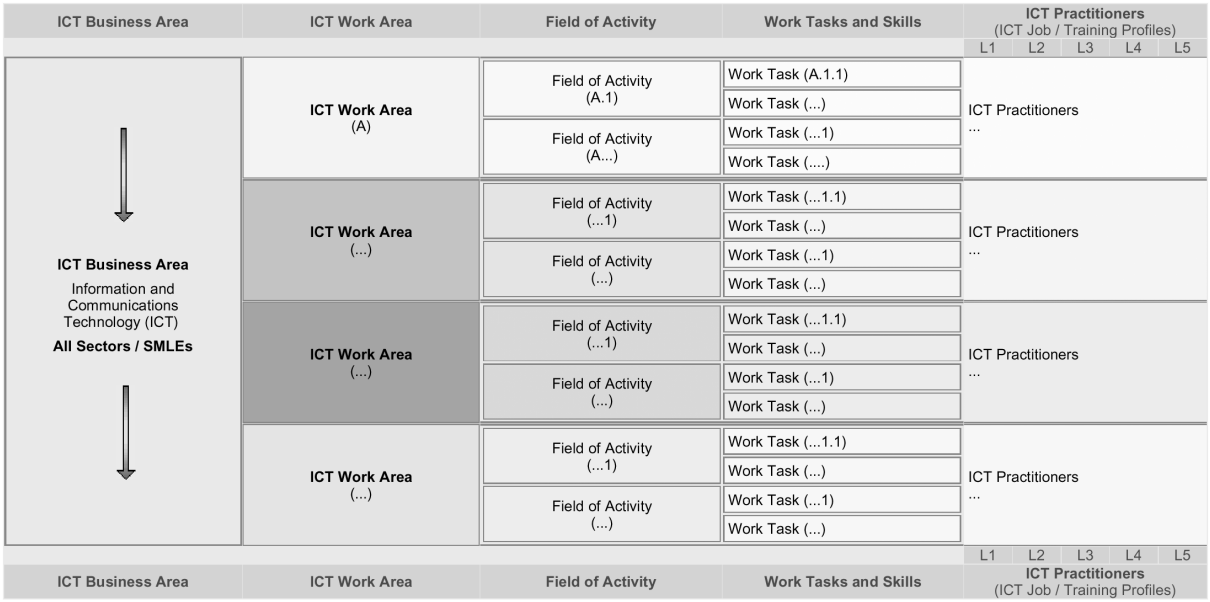
However, reality depends on various developments (such as career choice patterns) and this analysis reflects industry need for ICT skills and practitioners from a quantitative perspective.

ICT work and skill needs at different sub-degree levels and a structure for generic work area oriented ICT skills profiles

The findings on European industry's needs for ICT skills and practitioners is mainly based on case studies of the types of ICT business processes in ICT and user companies of all sizes. Existing ICT training profiles and CVT demand for special ICT qualifications are other indicators of ICT skill needs.

To identify ICT work and skills in the broad ICT business area, a common model structure of ICT business and work areas, fields of activities and ICT work tasks – called GAHFA (*Geschäftsprozess – Arbeitsprozesse – Handlungs-Felder – Arbeitsaufgaben*) – was used in the case studies.

Figure 2: The 'GAHFA' model structure



The results show that ICT operations – and therefore work and skills – differ in structure and content depending on the sector and the core business of a company. However, the findings of the case studies allow a first step in abstracting all ICT business processes to a list of relevant ICT business and technology (sub-)areas, such as:

(a) information systems,

(b) IT applications and services,

(c) communications systems,

(d) CT applications and services,

(e) internet and intranet systems and applications,

(f) networks systems and solutions,

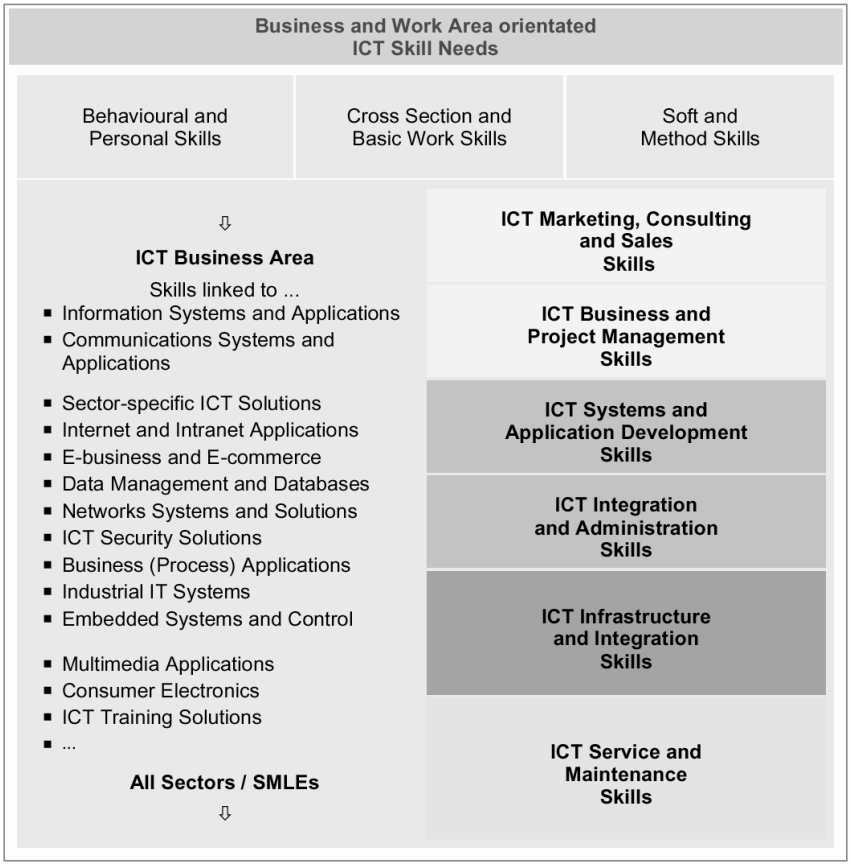
(g) multimedia systems and applications.

Nevertheless, all ICT business and technology (sub-)areas can ultimately be understood as one broad ICT business area. In a second step, focusing on the workflow structures of ICT work processes, there are similarities of ICT work criteria which allow aggregation to a single structure of six generic ICT work areas. The contents and structure of the six ICT work areas depend on the actual ICT business process and link to one of the different business and technology areas but the structure is also a feature of the size of the company and its organisation (departments, hierarchies, etc.). On the whole, however, the six generic ICT work areas cover the majority of European ICT business and work processes and indicate their ICT skill needs (see figure below).

The results also show that in each ICT work area there are ICT practitioners at all levels and, for instance in ICT systems and application development, there are needs for ICT skills. In

this instance they are at all degree (L5M, L5B) and sub-degree levels (L4, L3, L2), apart from sub-degree level 1. For ICT skill needs in general, the case studies indicate that ICT work requirements and skill needs are currently covered by different ICT job profiles, depending on the company, and different European ICT training profiles.

Figure 3: Structure of the business and work area oriented ICT skill needs in general



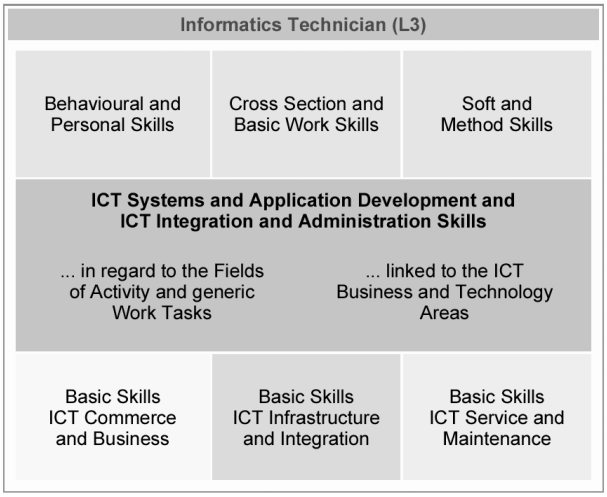
In addition to general ICT skills, the case studies reveal in each work area a structure of typical fields of activity, each of which contains certain generic ICT work tasks as the basis for a detailed framework of ICT skill needs. The case study investigations concentrated on tasks carried out by practitioners mainly with ICT job and training profiles at sub-degree skill levels, highlighting for each ICT work area the structures and contents of ICT skill needs at this level. In combination with the company surveys, industry ICT skill needs can be aggregated to 14 generic work area oriented ICT skills profiles at the three sub-degree levels:

Table 1: Structure of the 14 generic work area oriented ICT skills profiles at sub-degree levels

level 2 (L2)	level 3 (L3)	level 4 (L4)
- ICT business assistant - informatics assistant - ICT systems assistant - ICT service assistant	- ICT business technician - informatics technician - ICT systems technician - ICT service technician	- ICT commerce specialist - ICT business specialist - informatics specialist - ICT administration specialist - ICT systems specialist - ICT service specialist

The structure of the specific skills profile for an informatics technician (L3) is shown in Figure 4. The primary part of the profile is the skills kernel associated with the fields of activity and generic ICT work tasks and the various business and technology areas in which the work tasks take place. A set of complementary basic skills, such as behavioural and personal skills, is also needed, again depending on the actual work tasks and the skill level. Ultimately all ICT business work areas are related to each other and ICT practitioners need fundamental skills that cover the entire ICT business spectrum. An ICT skills profile, therefore, also covers cross work area ICT skills expressed by the other three groups of generic ICT work areas. Detailed examples of the generic work area oriented ICT skills profile are described in the report on work areas and sub-degree levels.

Figure 4: Generic work area oriented ICT skills profile: informatics technician at sub-degree level 3



These generic work area oriented ICT skills profiles can be seen as both a definition and qualitative description of current ICT skill needs, and hence practitioner needs, across Europe,

particularly for small and medium size enterprises. In addition, they can act as a basis for developing new European ICT curricula for training profiles at the three sub-degree levels.

ICT curriculum development guidelines and recommendations for new European training solutions

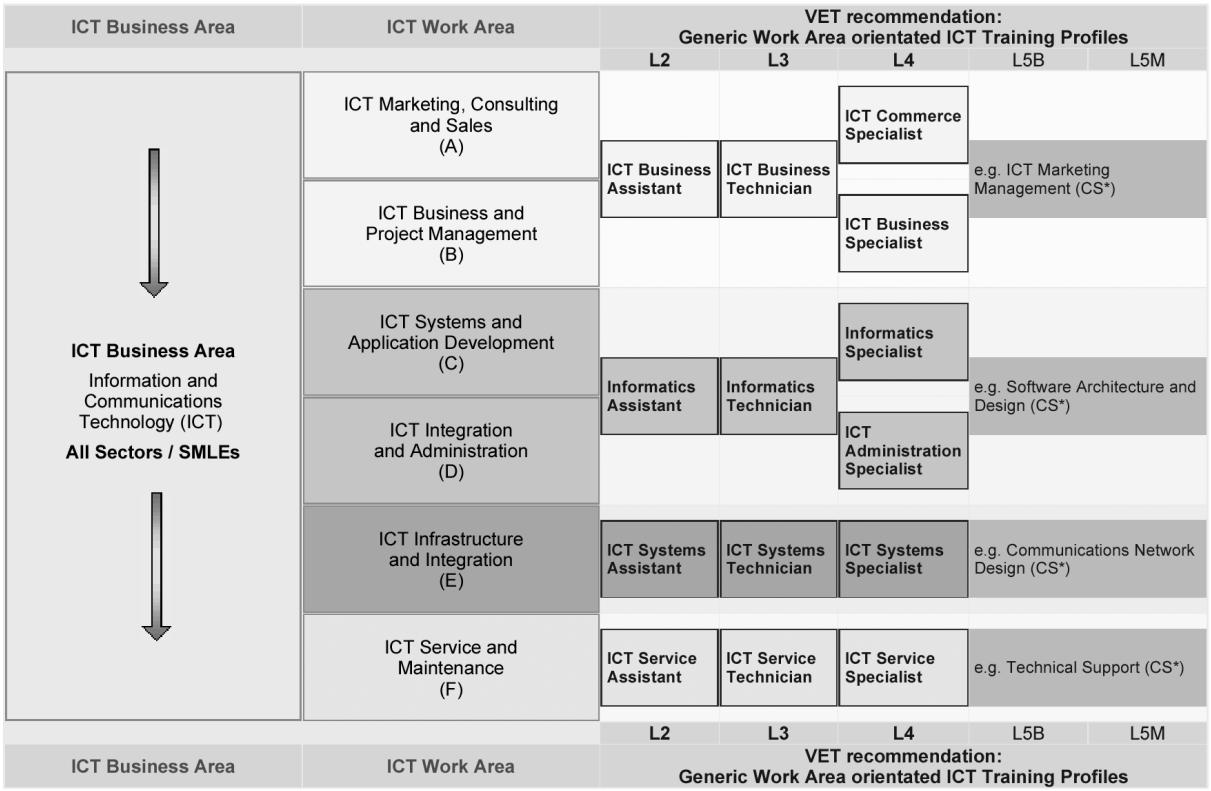
There are currently a variety of different European ICT curricula reflecting profile skill levels, the number of profiles at each level and study content. However, there are also major similarities in the didactics and design of ICT curricula, with a similar approach in terms of aims and contents; this mainly arises from the increasingly global nature of developments and activities. Training outcomes and qualifications also have similarities, as seen in the fact that ICT practitioners in different countries are able to carry out the same work tasks in a comparable way. Furthermore, skill needs are based on a broad ICT business area with an extensively common and international structure of ICT work areas, fields of activity and ICT work tasks.

The company evaluation of ICT training profiles clarifies company needs in terms of the extent to which each ICT training profile meets anticipated skill needs. The results indicate a mismatch between training goals and contents, as well as illustrating examples of good and bad practice. Even though there is certainly no single way to develop ICT curricula, examples of good practice show various structures, goals and contents related to the work area oriented ICT skills profiles. By contrast, the curricula which still separate ICT business, informatics (software) and electronics (hardware) skills and contents do not meet the work area oriented skill needs. Given the support of a large number of companies for common European standards for ICT training profiles and curricula, there is a strong motivation to improve common European curriculum design at sub-degree levels with greater work orientation direction based on corresponding ICT training profiles.

To improve the balance between ICT employment and ICT vocational education and training, the curricula and profile structure need to be designed in accordance with the skill needs and contents of ICT work areas. However, based on the identified ICT skill needs and contents a didactic and pedagogic reflection is necessary for the decision on an appropriate range and depth of competences of the ICT qualification profiles and curricula. From a European perspective it seems appropriate to make the structure of the 14 generic work area oriented ICT skills profiles the basis and framework for new European generic work area oriented ICT training profiles at sub-degree levels (see figure below).

This is possible because the work and training levels use the same level structure. As with the skills profiles, new European generic work area oriented ICT training profiles are designed with reference to the skill needs and contents of the ICT work areas and not to a specific sector, technology or business area. That means the number of profiles, and the content and competence delimitations of each, focus initially on one or two work areas and a specific work tasks sample and only afterwards on business and technology areas in their diversity.

Figure 5: Structure of the 14 generic work area oriented ICT training profiles at sub-degree levels



* Generic ICT skills profiles examples at degree level of Career Space

The profile and curriculum approach with high equivalence of generic ICT skills profiles and level structures is also important to the outcomes in terms of the qualifications of each ICT training profile. The skill needs as described and defined in each generic ICT skills profile should be the outcomes of each generic work area oriented ICT training profile in terms of qualifications.

Basing curriculum development on the outcomes helps to detail the structures and contents of skill needs described in the generic ICT skills profiles. The skill structure of all profiles, at each level, is basically identical, with three main skill fields being:

(a) behavioural and personal skills, cross section and basic work skills, soft and method skills,

(b) ICT practitioner skills (kernel work area oriented profile skills),

(c) cross work area ICT skills (complementary to kernel work area).

Addressing these identical skills and contents structures, and therefore the qualification outcomes of the ICT training profiles, the basis of curriculum development can be described in a common curriculum model as a qualification framework of 'work area oriented ICT curriculum' for all sub-degree levels. This curriculum model has a framework of three main qualification and content fields and a recommendation for its coverage:

(a) basic qualifications (15 %): behavioural and personal qualifications, cross section and basic work qualifications, soft and method qualifications;

(b) ICT practitioner qualifications (~70 %): covering all kernel work area oriented profile qualifications;

(c) basic ICT work area qualifications (~15 %): covering basic ICT qualifications of all other work areas complementary to the kernel work area of each ICT skills profile.

In respect of the qualification outcomes and structure of the 14 generic work area oriented ICT training profiles, one recommendation is to define a corresponding structure of vocational training programmes by specifying the duration indicated in three models. These models show a hierarchical structure and combination of two and three year ICT vocational training programmes with a more or less open learning organisation and different options of mutual recognition of certificates or examinations.

The curricula need structure and definition of learning units, consequently recommended and defined as work area oriented ICT learning modules. Each learning unit orients to the description and requirement of the work areas and is part of a didactic module set that constitutes each training programme. This also includes a recommendation that ICT vocational training programmes be valued in terms of credit points (CP).

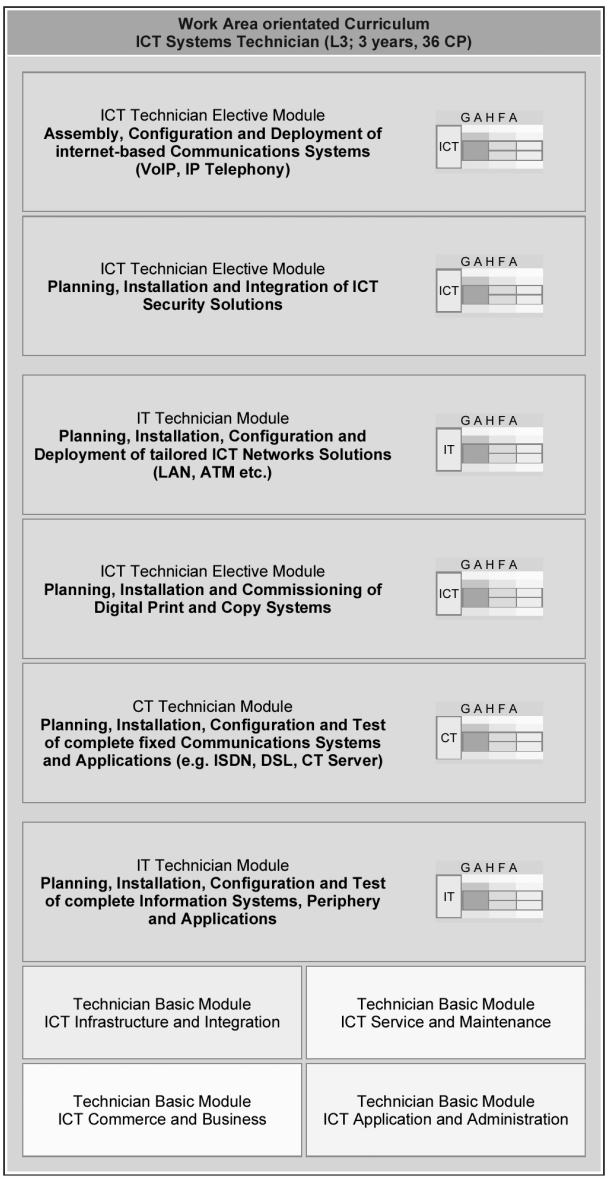
The didactic concepts of the curricula for ICT assistants and ICT technicians are similar insofar as each programme begins with four learning modules that cover basic competences and knowledge of an ICT business process as a whole (see Figure 6). However, the recommendation is that all assistant, technician and specialist modules have an identical structure and that the contents of each set relates to each ICT training profile, the qualifications in regard to work area(s) and their specific fields of activity and generic work tasks. They should also relate to the profile level. Additionally, each work area oriented module should consider the fields of activity and generic work tasks and the qualifications linked to each specific business and technology area. Whereas two (three for technicians) modules of these sets are mandatory, linked to the two main business and technology areas of information systems, applications and services (IT) and (tele)communications systems, applications and services (CT), the other modules are elective. These are also linked to one specific business and technology area but, due to the breadth of the ICT business area, this area can be chosen from the open list of ICT business and technology (sub-) areas.

The mandatory and elective modules in each training programme cover the kernel ICT qualifications and include integrated basic qualifications, e.g. behavioural, cross section and method qualifications. The specific guidelines for ICT technician and specialist curricula foresee an open number of so-called add-on modules that are additionally supposed to cover specific competences within the training programmes, e.g. specific product, technology or field of activity ICT competences.

The duration of the ICT practitioner modules for ICT assistant and most technician curricula is four months. Two elective modules of the ICT technician curricula and all modules of the

ICT specialist curricula have a duration of six months. According to the training profile level and the module duration, the value of each of these modules ranges from two credit points to six credit points. The sum of the credit points of each training programme is therefore different. The total value of all curricula at level 2 is 12 credit points, at level 3 is 36 credit points and at level 4 is 24 credit points.

Figure 6: ICT Systems Technician curriculum at level 3



Incorporating these curriculum guidelines, the report provides a complete structure for all 14 generic work area oriented ICT training profiles with their curriculum and module sets. This, in turn, can be interpreted as a framework for the development of new European ICT training profiles and curricula at vocational sub-degree levels.

The basis for developing the curricula are outcomes as sets of qualifications defined by the generic work area oriented ICT skills profiles rather than a knowledge list of subjects, scientific disciplines and technology areas. However, these outcomes have to be defined precisely and in detail regarding each curriculum, with detail of the modules as the basis for further matters such as entry requirements, assessment and certification. Another method of approaching entry requirements is using ICT vocational training programmes. VET normally starts at sub-degree level two or three. For these levels the entry requirements are education and qualifications of a general nature. ICT vocational training programmes at level 4 normally build on a programme at level 3. Therefore, the entry requirements for VET level 4 can be described by the outcomes of the ICT training profiles at sub-degree level 3.

Other possibilities in this context can be left more open by using the recommendations of valuing and assessment in addition to corresponding certification of the ICT training profiles and modules outcomes. With certificates for profiles and modules awarded according to credit points and based on examinations, there are various options for mutual recognition. These can be used between and for each profile and outcomes level respectively, as well as to set up individual entry requirements for a new intergradation between the sub-degree and degree level. Other mutual recognition methods, such as valuing non-formal prior learning by external exam or product and vendor specific certifications in the broad ICT business areas, are also possibly more effective on an outcomes basis in comparison to the proper ICT training profiles and modules outcomes.

In the other options for mutual recognition it must be emphasised that the work area oriented ICT profiles and curricula focus strictly on outcomes and that these outcomes have a clearly defined sub-degree level.

It must be stressed that ICT curricula at sub-degree level are greatly dependent for qualifying on vocational education. Therefore, in the absence of a preliminary provision of one European qualifying concept, qualifying processes should be like the curricula and modules themselves, based on a work oriented didactic concept with a combination of theoretical and practical training.

The ICT curricula and their modular structure also provide a didactic orientation for course design; courses should be organised on a work oriented didactic basis and not in subject structures. Also, the learning process should be designed and implemented with a work, and problem, orientation. To carry out the courses and moderate the learning processes in this didactical sense, teachers and trainers must have competences in, and experience and knowledge of, ICT work processes. Training institutions should establish quality control and evaluation for VET programmes, based on each specific qualifying concept and course design aspect.

Curriculum development guidelines have been described for the 14 generic work area oriented ICT training profiles at vocational levels and their module sets. The elaboration of the learning modules is an important further step. However, aspects such as the number and

structure of the new ICT training profiles and the recommended sets of learning modules still need to be accepted in broad European discussion before this happens.

The comparison of the recommendations on ICT needs and the relevant conclusions for the ICT situation in Europe are complementary to those of the Career Space results on ICT curriculum guidelines and the generic ICT skill profiles at degree level. However, there is one significant difference, namely the more subject oriented generic ICT skill profiles at the degree level of Career Space and the more business and work area oriented ICT skills profiles at sub-degree levels described in this report. In consequence each curriculum structure is based more on subject or on business and work process oriented contents. Although the advantages and disadvantages for the didactics and the learning and qualification processes have not yet been addressed, the differences certainly do not allow a simple transfer ICT skills profiles and curriculum development guidelines from one model to another.

2. Introduction

At the Lisbon European Council in March 2000 the European Union, in response to the challenges of globalisation and the information society, set out a strategic objective for the coming decade. This involves becoming 'the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.' Correspondingly, in the Copenhagen Declaration, the European Ministers of Vocational Education and Training, and the European Commission, state: 'The development of high quality vocational education and training is a crucial and integral part of this strategy, notably in terms of promoting social inclusion, cohesion, mobility, employability and competitiveness' (The Copenhagen Declaration, Nov. 2002, p.1).

Dynamic changes in information and communications technology (ICT) such as the internet and e-commerce effect the entire economic structure in Europe. To shape future developments in computer related work, ICT companies and those of ICT user sectors need qualified ICT practitioners. For various reasons appropriate ICT specialists are not easy to find in the labour market, and this only partly depends on the overall situation of the labour market. One major cause, however, is a deficit of transparency and a mismatch of ICT working and qualification structures and related training profiles: 'On the one hand, there is a shortage of jobs and training places in certain business sectors and regions, while, on the other hand, a certain number of jobs and training places are not being filled in other regions and future-oriented sectors' (BMBF, 2002). In a European perspective of open labour markets, employment and qualification, more transparency and knowledge is needed: 'Concerning the environment for training, skills and knowledge acquisition, strategies are needed to improve the transparency of qualification structures and possibilities for mobility' (Cedefop, 2001d, p. 16).

ICT now affects almost any domain of human activity: from technical to social areas, from military to commercial. This is simply the result of the material concerned: information. Hence any human activity could (eventually) benefit from information technology. In the first phase information technology (IT) was used in economic and technical domains to process large amounts of data quickly and accurately. The second phase focused on the efficiency of target system running, either in a direct way (process optimisation) or an indirect way (decision support and expert systems). The third phase reversed the direction of interaction between IT&C and targeted domains. In this, information technology shapes the target domain, as in the case of e-business, e-learning, e-culture. The third phase required mass combined ICT qualifications, with differing degrees of intensity, and from this point on, education and labour needed tailored ICT training profiles. It also led to changes in the boundaries between ICT practitioners and various categories of ICT users.

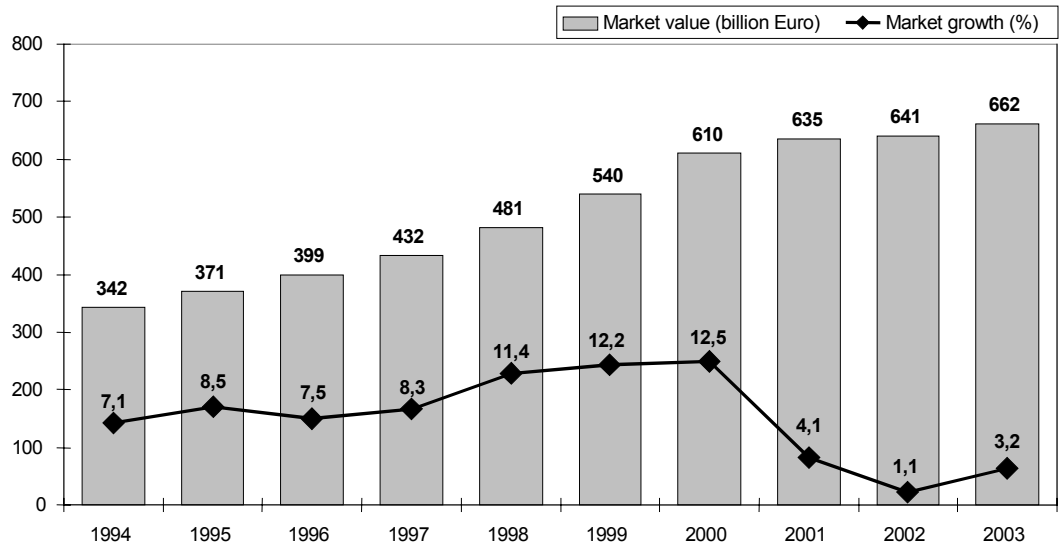
The following section focuses on the situation of the ICT industry, taking into account the skill and training needs in ICT business areas of companies in the user industries. Specific information is chiefly available from three European countries, Germany, the Netherlands and

Portugal. Where feasible, information from other European countries or all (western) Europe has been taken into account.

2.1. Situation of the ICT market and ICT development and applications in Europe

Information and communications technology (ICT) plays a major role in the globalisation of the economy and, at the same time, creates prospects for the development of future technology and the modernisation of products and services. The use of different types of ICT is one of the most significant features of today's business. ICT support tools are computers and data processing equipment, means for building computer systems, digital (tele)communications equipment, software products and (global) services connected with the delivery of software, communications products and services, selected forms of technology for the manufacture of electronic parts, multimedia products and related services. The Internet has already fundamentally changed the way today's businesses operate and will continue to do so in the future. ICT promotes prospects for economic growth and also results in the creation of jobs for highly skilled personnel. The ICT market has grown significantly throughout the last ten years, even though the rate of growth declined at the beginning of 21st century (see Figure 7).

Figure 7: Development of the western European ICT-Market, 1994-2003



Source: EITO Update 2002 in cooperation with IDC

'The ICT market has been strongly impacted by the economic slowdown, even if the various markets have been affected at a different level, more in the hardware segments, less in software and services, more in the Nordic countries and Germany, less in southern Europe. The western European ICT market amounted to EUR 643 billion in 2001 or some 7.5 % of GDP. The IT market (including office equipment, electronic data processing and datacom equipment, software, and services) was some EUR 324 billion, while the telecommunications

market accounted for some EUR 318 billion. Overall the ICT market in western Europe grew only by (some) 5.1 % in 2001 (compared to 11.0 % forecast in the EITO 2001). In the IT area, growth was mainly driven by investments in software applications and related services, especially in the e-business area. However, most hardware investments have been postponed with strong implications for total ICT spending growth. In the telecommunications area, investments in equipment have been falling since the beginning of 2001. However, telecommunications services continued to grow, even if at a more moderate pace compared to previous years' (EITO, 2002, p. 53f.).

The ICT market situation in Germany, the Netherlands and Portugal can be expressed as follows:

(a) in Germany the deteriorating economic situation had a negative impact on IT investments. The German IT market grew by some 1.2 % in 2001. The telecommunication market grew by 4.7 % in 2001;

(b) in the Netherlands IT spending was up 4.0 % in 2001. After buoyant growth in 2000, the Netherlands telecommunications market grew by 5.9 % in 2001;

(c) in Portugal IT spending was up 4.8 % in 2001. The telecommunications market in Portugal grew by 8.0 % in 2001.

(EITO, 2002, p. 56 et seq.) ([1]).

To characterise the ICT market in more detail, it is useful to have background information on ICT development and extent, covering aspects such as:

(a) number of computers in business and domestic situations;

(b) internet users (network and home users) and number of internet domains and hosts;

(c) e-commerce sites and volume of e-business;

(d) use and penetration of mobile communications.

According to various surveys in 2001, the number of PCs in use worldwide topped 600 million units; there were over 551 million computers-in-use at year-end 2000. The USA has the largest number of PCs in use with 175 million at year-end 2001. Western Europe is close to the USA now with 158 million PCs (CIA, 2001). Germany, the Netherlands and Portugal have a proportion of between 20 and 40 PCs per 100 inhabitants whereas the proportion of countries like the Czech Republic and Romania is under 10 PCs per 100 inhabitants (EITO, 2002, p. 81).

([1]) There is also more information available on the ICT market trends of other western European countries such as Spain, France and the UK.

The number of internet users world-wide surpassed 530 million in 2001 from 400 million at year-end 2000 and less than 200 million Internet users at year-end 1998. This number will continue to grow strongly in the next five years. Most of the growth is in Asia, Latin America and parts of Europe (CIA, 2001). The USA had over 150 million Internet users or about 30 % of the total at year-end 2001. At the end of 2001 there were some 120 million internet users in Europe all together. Following figures of the European Commission for 2000, about 30 % of private households in EU Member States are connected to the internet. In addition, 70 % of SMEs ware connected to the internet and approximately 40 % have their own web site (ECIN, 2002).

In Germany the number of internet users in 2001 increased to approximately 20 million people, or about 25 % of the population. About 15 million had internet access from home. In the Netherlands the rate is extremely high compared with the rest of Europe, at about 50 % of its population. For Portugal the proportion is about 20 % in total and about 50 % for users between 15 and 19 years of age. An increasing proportion of Internet users will be using wireless devices such as web-enabled cell phones and PDAs to go online in the next two years. These wireless devices will be supplemental to PC Internet access for most users in developed countries. In countries with low internet penetration, many wireless Internet devices will often be the sole Internet access devices (CIA, 2001).

ICT suppliers already offer distributors and suppliers the opportunity to order products over the Internet. The amount of money spent though e-commerce in the world rose by 68 % between 2000 and 2001. Worldwide, e-commerce expenditure reached more than 600 billion in 2001 and is expected to pass 1 000 billion in 2002 (NFO, 2002, p. 273 et seq.). European spending was anticipated as almost EUR 70 billion via internet and online commerce. The growth was large in all regions but the factors behind this growth vary from one region to another. In European electronic commerce, Germany is responsible for 27.5 %, the Netherlands for 4.5 % and Portugal for 1.9 %. In this field the single currency will lead to an increase in transparency, improved competition and a better supply for online customers. During the last year the volume of e-commerce transactions has grown but people seem to be more cautious about data security, for instance when paying online with credit cards. For the vast majority of European countries there is more to do in order to improve the e-commerce climate, especially in legislation.

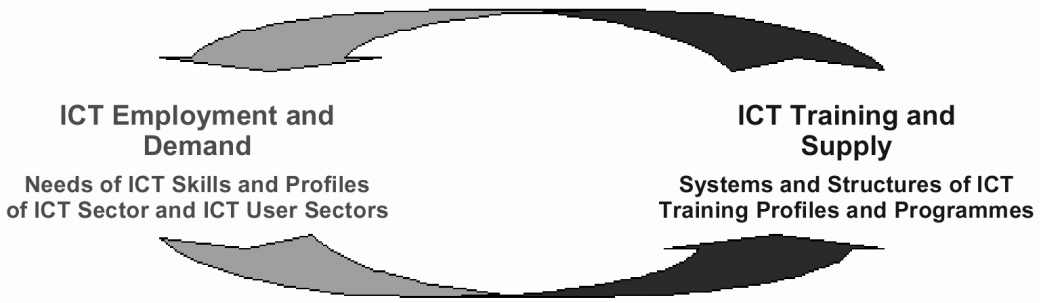
The increase in the number of mobile phones has been enormous over the last five years. Penetration in Germany, the Netherlands and Portugal in 2001 was already approaching 70 % of the total population. In 1997 less than 10 % of the people used mobile phones in these countries (ETO, 1997).

2.2. ICT employment and demand in Europe and interaction with ICT training and supply

Without doubt, the slow-down in the ICT economy has had an impact on the development of ICT labour markets in Europe and elsewhere in the world. The situation of the 'new economy' worldwide has caused an increase in discussion of the ICT practitioner supply/demand gap. However, the demand for ICT practitioners needs to be assessed particularly from a qualitative viewpoint, namely that the supply of ICT programmes and training profiles may not sufficiently meet the ICT practitioner and skill needs expressed by companies. And it is always true that the rapid changes in ICT applications and business and work processes requirements lead to substantial changes in practitioner skills required. Therefore, adequately skilled ICT practitioners are constantly in demand in all European countries and it is one of the major present and future challenges not only to react to this demand but also to provide a tailored framework of ICT programmes and training profiles at different levels.

For clarification of this context, it is necessary to identify developments in ICT business and work areas, against the background of different ICT market segments, and relate them to employment and skill needs and ICT programmes and training profiles. The following figure illustrates this relationship and the interaction between the two, showing that the employment needs of the ICT and user sectors has an influence on the ICT training and supply. The skill needs are an important basis for curriculum consideration at all levels, independent of each European education system. From a separate perspective, ICT training and supply have an influence on ICT work and the potential for employment, which means that education has an important role to play in supporting companies using developing technology and competences.

Figure 8: Interaction between the ICT employment and demand and ICT training and supply



The following table provides an overview of ICT employment, skills and qualification terms used for this report. Discussions throughout the production of the report indicated different understandings and definitions of, for instance, the term ICT practitioner. The use of the term ICT profile on its own has proven particularly problematic and is avoided in this report. Only combinations such as ICT skills profile or ICT training (qualification) profile offer clarification.

Table 2: ICT terms used for this report

Definition and understanding of ICT terms	
ICT practitioner	ICT practitioners are understood as ICT experts (professionals and associate professionals or skilled workers and assistants) who work in the ICT industry or in user industries primarily on ICT concepts, systems and applications. The term generally also covers those who have just finished a study or training programme (alumni: graduates, degree and sub-degree holder, diploma or certificate holder, etc.) so that ICT Practitioners exist at all skill and qualification levels.
ICT professional	In the occupational context a professional is often understood as someone with a higher education degree such as MA, BA or university diploma or doctor, lawyer, architect, etc. Therefore, the term ICT professional is normally understood as ICT practitioner with a higher education at degree level. But in general a 'professional qualification' as described in the 'Directive ... on the recognition of professional qualifications' can be understood and defined in regard to all established 'five levels of professional qualification' (CEC, 2002a, Article 11, 13). However, for this report the term ICT professional itself is avoided as far as possible.
ICT staff/ICT workforce	The state of employed ICT practitioners in an enterprise, company or organisation of the ICT and user sectors.
ICT employment	Summarises all employed ICT practitioners in enterprises, companies or organisations of the ICT and user sectors. Another frequent understanding is: summarises all employed ICT practitioners and all other employed workers only in enterprises and companies of the ICT sector.
ICT occupation	Covers a range of ICT work and tasks to be described on an occupational basis.
ICT job profile	Covers the main purpose, responsibilities and work tasks of a certain ICT work and activity area. A job profile is described for working purposes. An ICT job title is the specific denomination for an ICT job profile.
ICT skills profile	Describes the essential and desirable skills (and knowledge) needed to fulfil the main purpose, responsibilities and work tasks described in an ICT job profile.
Generic ICT skills profile	Summarises and defines ICT skill profiles based on broad criteria such as common work and job areas (CSC/Cedefop, 2002).
ICT qualification (profile)	An ICT qualification or a set of ICT qualifications within an ICT qualification profile is like a general qualification 'defined as a formal recognition of a standard or a set of standards expressed by a certificate, diploma or other evidence. It is delivered when it has been made clear, through an assessment process, that standards are achieved. A

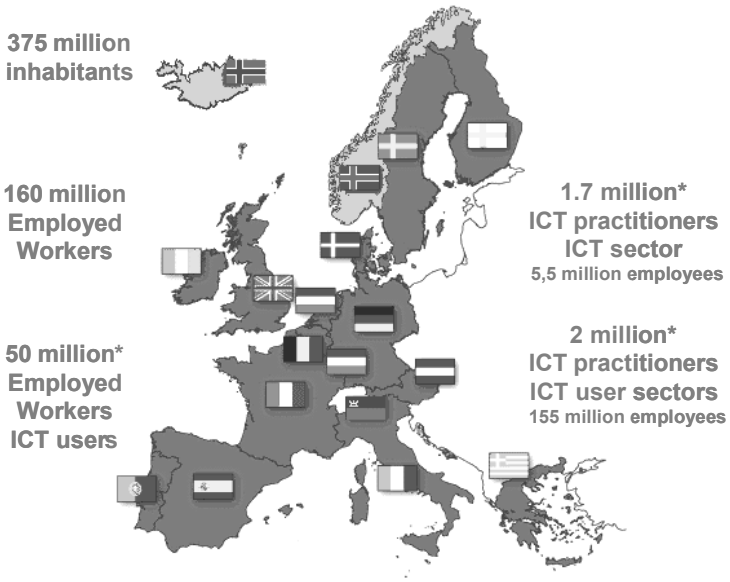
	qualification indicates that a person acquired a certificate, either through work experience or after having successfully completed a course or programme, entitling this person to obtain a diploma or some other form of official recognition of value to the labour market or to further education' (Cedefop, 2001b, p.7). An ICT qualification can also be understood as the attestation of ICT competences or evidence of formal ICT training and within a 'General system for recognition of evidence of training' and as for the 'five levels of professional qualification it is described as ICT professional qualification at different levels (CEC, 2002a, Article 11, 13).
ICT training profile	An ICT training profile describes a recognised set of ICT qualifications or competences as well as training objectives and contents, e.g. initial training profile, further training profile, academic training profile. Normally the profile is defined by a minimum of formal training duration and as a recognition of a professional qualification or competence standard at a certain level expressed by a certificate, diploma or other evidence.
ICT programme	An ICT programme normally describes the ICT curriculum of an ICT training profile as basis, for example, of a formal training at VET sub-degree level or of a study and course at bachelor or master level.

While it is possible to summarise quantitative results from different survey sources, each survey carries different understandings and definitions of the terms ICT, ICT employment and, especially, ICT practitioner, as well as of the delimitation of their ICT work contents. For example, the understanding of IT practitioners in the CEPIS report (CEPIS, 2002, p. 34 et seq.), using the ISCO classification is:

- IT practitioners (computing professionals ISCO 213) 'conduct research, plan, develop and improve computer based information systems, software and related concepts, develop principles and operational methods as well as to maintain ... 'systems ... ensuring integrity and security of data';
- IT practitioners (computer associate professionals ISCO 312) 'provide assistance to users …, control and operate computers and peripheral equipment and carry out limited programming tasks connected with the installation and maintenance of computer hardware and software'.

This analysis of ICT employment, therefore, represents only core IT technical staff and omits other employed ICT practitioners such as communications and electronics engineers, IT managers, etc. (CEPIS, 2002, p. 37). However, adopting the understanding of ICT practitioners described above, the following figure, drawn from different investigations, offers as an overview of current European ICT employment.

Figure 9: ICT employment and number of ICT practitioners in western Europe



*Source: *biat 2001; EUQuaSIT 2002; OECD 2000; CEPIS 2002* with appraisement

This figure shows a total number of 3.7 million ICT practitioners and their distribution between the ICT sector and ICT user sectors. The large group of approximately 50 million ICT users can be understood as employed workers whose main job is not ICT, but who use ICT – often very considerably – in their work. This group has been increasing every year and it is sometimes difficult to find a reasonable delimitation to ICT practitioners at low level. Table 3 shows their distribution of ICT employment in three countries:

Table 3: Split of ICT employment between IT (ISCO) and ICT practitioners at all skills levels as well as between ICT and user sectors

	IT practitioners (ISCO 213)	IT practitioners (ISCO 312)	IT practitioners (ISCO 213+312)	ICT practitioners at all levels (esp. communications and other practitioners)	ICT practitioners (Total)	ICT practitioners (ICT sector)	ICT practitioners (ICT user sectors)
Germany	295 500	256 600	552 100	250 000*	800 000* (2.4 %)	300 000*	500 000*
The Netherlands	125 600	123 300	248 900	31 000*	280 000* (5 %)	110 000*	170 000*
Portugal	6 000	29 600	35 600	25 000*	60 000* (1.3 %)	24 000*	36 000*
...	...	...	...	...	...	...	...
Europe 2000	...	...	2 443 000	...	3 700 000* (2.5 %)	1 700 000*	2 000 000*

*Source: CEPIS, 2002, page 38, 42; *biat, 2001, EUQuaSIT, 2002* with rounding, estimation.

Further results on European ICT employment are shown more in detail in the report and are related to skill needs. However, one initial, and important, aspect of ICT training and supply has to be addressed at the outset. This concerns the distribution of ICT employment in relation to required skill levels, which in turn demands consideration of qualifications and training levels. Information on this aspect is difficult to find for most European countries and for Europe as a whole, a consequence of the lack of a classification or framework with Europe-wide recognition. Those systems which are used in many reports tend to have different purposes, such as occupation statistics or sector or company based standard salary groups, with specific definitions of the work and skill levels. In such systems it is not unusual to have definitions ranging between four and eight skill levels. There are difficulties with ICT occupations because they are fairly new and the transfer of common definitions is not always easy. Also, ICT work and skill contents change continually. There is a need, therefore, to find a practical method of relating a skills level framework to ICT employment.

There is the same lack of a system or framework of ICT qualification and training levels. Various discussions and publications, for instance commissioned by Cedefop (Cedefop, 2001a/b/c) or the National Qualifications Authority of Ireland (NQA, 2002), indicate the problem through the extensive range of definitions of qualification and training levels. There certainly is a need for a broadly recognised European qualification level framework as a precondition and reference, for example, for international comparisons, improvement of mutual recognition of diplomas, vocational certificates, more transparency and harmonisation of qualifications or a better recognition of non-formal learning and qualifications in Europe. And the question is also not new as shown by the 1985 Council Decision on the comparability of vocational training qualifications between the Member States of the European Community (European Communities, 1985). In line with this decision, the description of VET qualifications and occupations should cover a number of aspects in close cooperation with the Member States and the organisations of workers and employers at Community level. These are quoted in the document as:

(a) selection of the relevant occupations or groups of occupations;

(b) drawing up mutually agreed Community job descriptions for those occupations or groups of occupations;

(c) matching the vocational training qualifications recognised in the various Member States with those job descriptions;

(d) establishing tables incorporating information on:

  (i) the SEDOC and national classification codes;

  (ii) the level of vocational training;

  (iii) for each Member State, the vocational title and corresponding vocational training qualifications;

  (iv) the organisations and institutions responsible for dispensing vocational training;

(v) the authorities and organisations competent to issue or to validate diplomas, certificates, or other documents certifying that vocational training has been acquired;

(e) publication of the mutually agreed Community job descriptions and the comparative tables in the Official Journal of the European Communities;

(f) establishment, within the meaning of Article 4 (3), of a standard information sheet for each occupation or group of occupations, to be published in the Official Journal of the European Communities;

(g) dissemination of information on the established comparabilities to all appropriate bodies at national, regional and local levels, as well as throughout the occupational sectors concerned.

This action could be supported by the creation of a Community-wide database, if experience suggests a need. (European Communities, 1985).

While this proposal from the Council Decision of 1985 is still current, a new European Commission Directive from 2002 describes, and aims to apply conditions for recognition of, five levels of professional qualification (CEC, 2002a, Article 11, 13). In this context the 1999 Bologna Declaration on establishing a European system of higher education by 2010 is also partly relevant because this declaration includes a European understanding and definition of professional qualifications at higher education level (CRE, 2000).

Against the background of different European work, occupation, skill and qualification level frameworks it seems desirable to create a framework for ICT qualification and training levels based on a common understanding found in many European countries (see the following sections, for instance the level framework in the Netherlands). At the same time, a framework of ICT work and skill levels must be established in a similar manner. This combination framework is possible because of the congruence of qualifications and skills in theory and practice; for example, ICT practitioners with qualifications at degree level normally work in ICT work areas in which skills at degree level are required.

In practice, as shown in the figure below, the level framework describes the two degree levels 5M and 5B and the three sub-degree levels 4, 3 and 2 which all are relevant in respect of ICT qualifications and ICT skills. As with the definition and understanding of ICT terms, this level framework of ICT qualifications and ICT skills is also important and is used in this report.

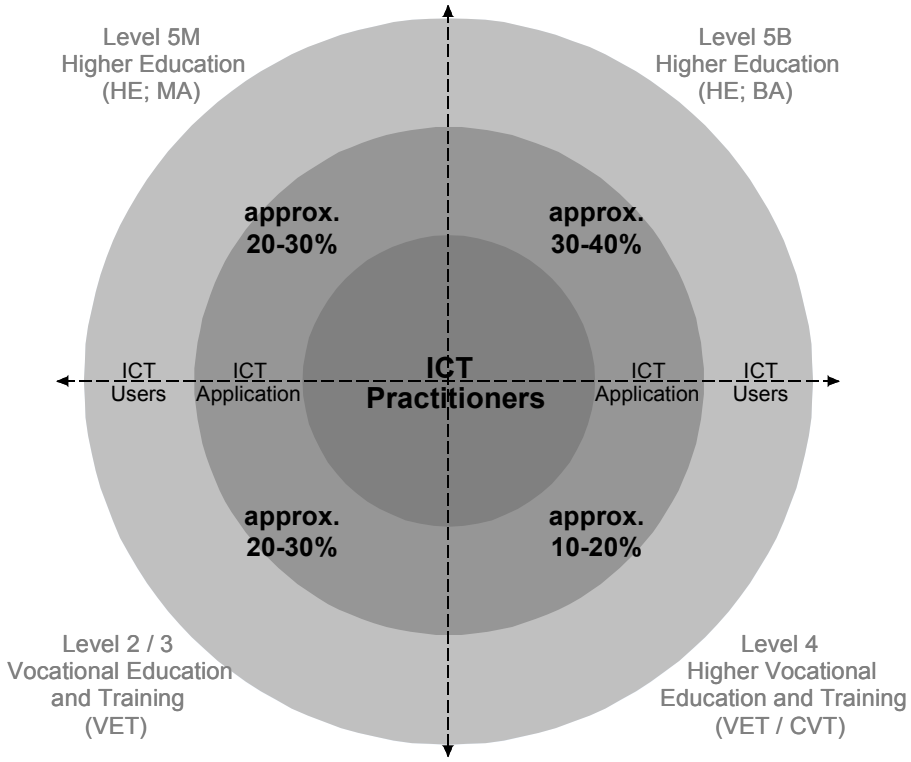
Figure 10: Framework of combined ICT work and skill levels and ICT qualification and training levels

ICT employment and demand Needs of ICT skills and profiles of ICT sector and ICT user sectors		ICT training and supply Systems and structures of ICT training profiles and programmes	
ICT work and skill levels		**ICT qualification and training levels**	
Level 5M (work)	ICT work which skills required at degree level 5M. ... generally leads to an autonomously pursued vocational activity - as an employee or as self-employed person - entailing a mastery of the scientific bases of the occupation. The qualifications required for engaging in a vocational activity may be integrated at these various levels.**	Level 5M (MA)	ICT qualification and study profile at higher education university level. Following the Bologna Declaration (1999) the academic courses cover graduate studies and lead to master or second cycle or doctorate degrees. Access to the second cycle shall require successful completion of first cycle studies (cf. CSC / Cedefop 2001b, p.34). ... corresponds to training at higher education level and of a minimum duration of four years. (Level 5)*
Level 5B (work)	ICT work which skills required at degree level 5B. ... generally leads to an autonomously pursued vocational activity - as an employee or as self-employed person - entailing a bachelor of the scientific bases of the occupation. The qualifications required for engaging in a vocational activity may be integrated at these various levels.**	Level 5B (BA)	ICT qualification and study profile at higher education level. Following the Bologna Declaration (2000) the courses cover undergraduate studies and lead to bachelor or first cycle degrees already relevant to the European labour market (cf. CSC / Cedefop 2001b, p.34). Depending on the national qualification system it starts after the completion of (specialised) upper secondary education or based on a qualification at VET level 4. ... corresponds to a course of training at higher or university level and of a duration of at least three years and less than four years. (Level 4) *
Level 4 (work)	ICT work which skills required at sub-degree level 4. ... covers a higher level of knowledge and of capabilities. It does not generally require mastery of the scientific bases of the various areas concerned. Such capabilities and knowledge make it possible in a generally autonomous or in an independent way to assume design and/or management and/or administrative responsibilities.**	Level 4 (VET/CVT)	ICT qualification and training profile at higher vocational education and training level. Depending on the national qualification system it starts after the completion of (upper) secondary education or based on a qualification at level 3. The ICT training normally provides specialised qualifications. ... corresponds to a course of training at higher or university level and of a duration of at least three years and less than four years.*
Level 3 (work)	ICT work which skills required at sub-degree level 3. ... involves a greater fund of theoretical and practical knowledge than level 2. Activity involves chiefly technical or administrative work which can be performed independently and/or entail executive and coordination duties.**	Level 3 (VET)	ICT qualification and training profile at vocational education and training level. Depending on the national qualification system it starts after the completion of secondary education or based on a qualification at level 2. The ICT training provides a broad basis of qualifications. ... corresponds to training at post-secondary level and of a duration of at least one year and less than three years.*
Level 2 (work)	ICT work which skills required at sub-degree level 2. ... corresponds to a level where the holder is fully qualified to engage in a specific activity, with the capacity to use the instruments and techniques relating thereto. This activity involves chiefly the performance of work which may be independent within the limits of the relevant techniques.**	Level 2 (VET)	ICT qualification and training profile at vocational education and training level. It starts after the completion or is part of secondary education. The ICT training provides a first basis of qualifications. ... corresponds to training at secondary level, of a professional nature or general in character, supplemented by a professional course.*

Source: *COM (2002) 119 final, CEC 2002a, Article 11, 13; ** European Communities 1985

Because the investigations and studies – carried out by *biat* and within the EUQuaSIT project – used this level framework, differentiated quantitative observations on ICT employment with regard to work and skill levels can be presented in a figure. The results on the basis of three European countries show that around 20-30 % of the ICT employees work at level 5M and 30-40 % at level 5B and they have qualifications at degree or higher education level 5M (HE/MA) or 5B (HE/BA) respectively. At sub-degree levels the results show that 10-20 % of ICT employees work at level 4 and 20-30 % at levels 3 and 2; they have qualifications at sub-degree or VET levels 4, 3 or 2. This means that between 30 % and 50 % of the total 3 700 000 ICT practitioners employed in Europe work and have qualifications at sub-degree levels 4, 3 or 2. More than half of the ICT practitioners in Europe, with variations between countries, normally work and have qualifications at degree or higher education level.

Figure 11: Split of ICT employment in regard to the work and skill levels and their ICT qualification and training level in western Europe



Source: biat, 2001, EUQuaSIT, 2002

These results are of crucial importance to ICT training and supply. ICT training profiles and programmes in each European country need to provide an adequate supply of ICT practitioners related to the ICT employment needs, in both quantitative and qualitative aspects. The systems and structures of education in Europe are very different and therefore the supply of ICT training profiles and programmes in each European country is different. This applies to all the training levels described above, as proved by the EUQuaSIT project which

analysed ICT training and supply in five European countries with the aim of producing European qualification and training profiles for ICT practitioners. The results (see http://www.euquasit.net) show that European ICT training and supply depend on national education systems (see sections below) which meet ICT needs from their different ICT training profiles and programmes. But there is a question over how well each national ICT training system answers the challenges of European developments and supplies the enormous breadth of ICT business and work areas without any skills mismatch. Initial findings on this, based on a company survey, can be found in the EUQuaSIT project and are outlined along with recommendations on curriculum guidelines and European training solutions in the within the following sections.

2.3. ICT training and supply at sub-degree VET levels in European countries

European education and training systems are challenged by the development of the ICT market; ICT training profiles and programmes may be failing to meet company practitioner and skill needs. The following section describes the current situation in relation to VET structures, existing ICT training profiles and curricula at sub-degree levels in relation to profile skill levels, the number of ICT training profiles at each level and the main subjects of ICT qualification from three countries involved in the EUQuaSIT project, namely Germany, the Netherlands and Portugal (EUQuaSIT, 2002).

2.3.1. ICT training profiles and VET qualification concepts in Germany

Even though there is no comprehensive framework classifying vocational qualifications, the organisation and delivery of vocational education and training (VET) in Germany can be divided into three subsystems and corresponding qualification levels:

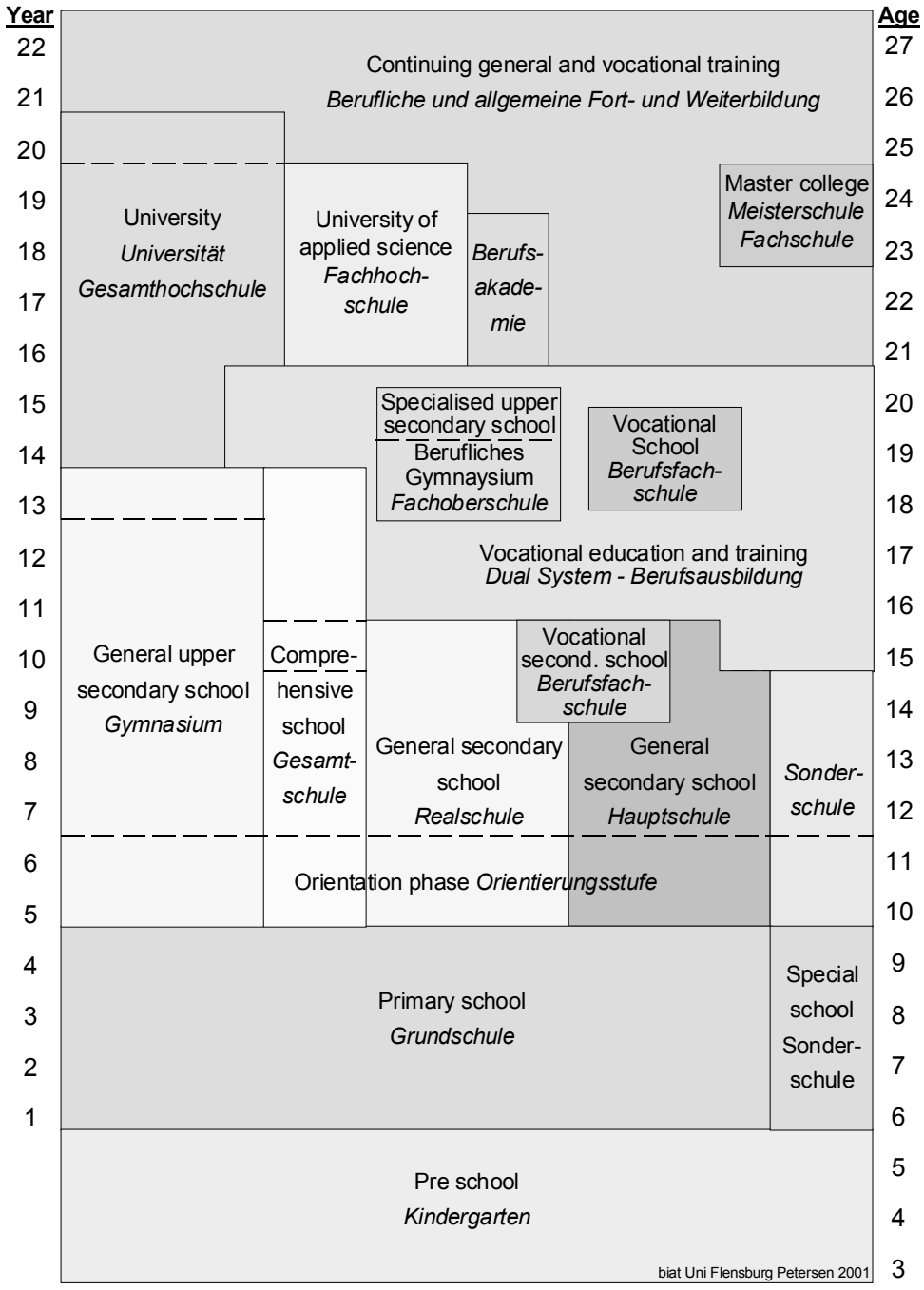
(a) school-based initial vocational education and training profiles (*Schulische Assistentenberufe*) in a vocational school (*Berufsfachschule*), for this report VET level 2;

(b) apprenticeship initial vocational education and training profiles (*Ausbildungsberufe* in the dual system), for this report VET level 3;

(c) further/higher vocational education and training profiles (*Fort- und Weiterbildungsberufe* in the *Meisterschule* and *Fachschule*) → for this report VET (CVT) level 4.

The classification of these three subsystems into general and vocational education and training is further indicated in Figure 12.

Figure 12: Basic structure of the general education and vocational education and training system in Germany

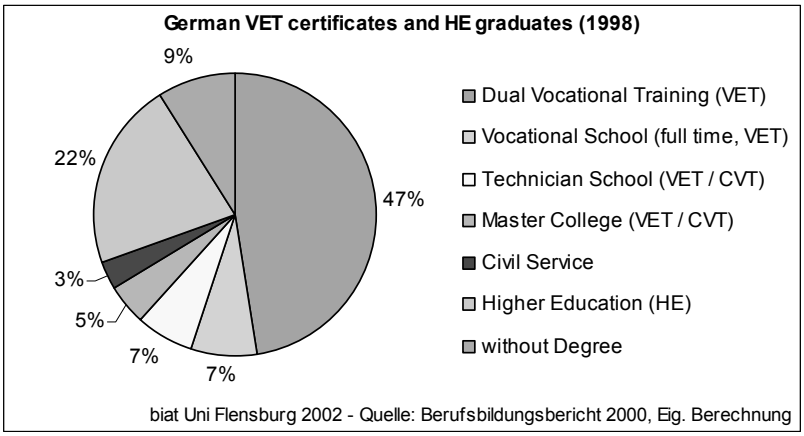


Source: EUQuaSIT, 2002, p. 22

The figures presented indicate the dominance of the dual vocational education and training in Germany that provides almost half of the skilled personnel for the labour market. Full-time vocational qualifications regulated by the federal states (*Länder*) constitute 7 % of recognised qualifications. Based on these pathways of initial qualification there are another 7 % and 5 % attending a technician school and a master college respectively. One fifth in 1998 finished a

degree in higher education. One tenth of the youngsters did not have an official (vocational) education degree at all.

Figure 13: Allocation of VET certificates and HE graduates in Germany



For each of the three VET subsystems there is a number of different training profiles in information and communications technology (ICT). The following paragraphs provide some ICT oriented information on the developments and regulations of vocational education and training in Germany.

2.3.1.1. School-based initial vocational education and training (specialised vocational schools)

Initial vocational education and training at specialised vocational schools leads to (full) state recognised qualification entitled *Assistentenberufe* (assistants), as well as other forms such as basic vocational training in a specific occupational field that can be credited to trainees if they enter dual apprentice training. These training profiles are provided by specialised vocational schools (*Berufsfachschulen*) offering mainly two-year courses. German legislation determines that full-time school based VET is governed by the federal states. However, there are general agreements and framework curricula issued by the conference of *Länder* Ministers of Education and Cultural Affairs' (KMK) signed by all federal state ministers of education ensuring comparable syllabi and the recognition of qualifications (KMK, 2002a). For this report, assistant training profiles are classified at qualification level 2.

Assistant ICT training profiles have existed since the beginning of the 1980s. There are more business/economy oriented ICT training profiles (e.g. assistant for business informatics, business assistant for data processing) as well as the more informatics and technical oriented ones (e.g. technical assistant for informatics, technical assistant for data processing, etc.) (KMK, 2002b ; KMK, 1999).

Table 4 ICT training profiles at VET level 2 in Germany

level 2		
• Assistant for business informatics • Business assistant for data processing • Technical assistant for informatics	• Technical assistant for production informatics • Technical assistant for data processing	• Technical assistant for data processing • ICT assistant • Assistant for automation and computer technology

School based VET profiles are quantitatively less important than the apprenticeship VET, a factor that has relevance for ICT. Nevertheless, they have a specific and additional relevance for both providing training places for youngsters in those regions where apprenticeship places are rare and for qualifying skilled staff at a certain qualification level. Figures from 1998 indicate that approximately 13 000 assistant-level students visited a specialised vocational school (from approximately 6 000 at the beginning of the 1990s). According to the official VET report of the German government, about 10 000 students were training for a qualification either as technical assistant for informatics or assistant for business informatics (BMBF, 2000, p. 80 et seq.). The more business/economy oriented ICT training profiles constitute two thirds of all ICT assistant training profiles with the more informatics and technically oriented ICT profiles providing the other third.

2.3.1.2. Apprenticeship initial vocational education and training (dual system)

Apprenticeship training in Germany, known as initial vocational training within the dual system, is the most important pathway to a recognised VET qualification. The main organisational feature is the dualism of on-the-job training taking place in a company, based on a contract, and classes in a vocational school. The occupations are regulated nationally based on the vocational training act of 1969 (*Berufsbildungsgesetz*). Students usually begin apprenticeship after general secondary school at the age 15 or 16 years. In some domains, such as banking and insurance as well as ICT, almost 50 % of the apprentices have *Abitur* (general upper secondary school) and begin their initial vocational training at the age of 18 or 19 years as an alternative to university education. In many of these cases the apprenticeship only takes two years instead of three.

At VET level 3 there are various recognised ICT occupational training profiles available within the dual training system. The first two dual ICT occupations, mathematical technical assistant (MTA) and data processing specialist, were launched in 1966 and 1969 respectively. The MTA still exists whereas the latter was revised and replaced in 1997 by new recognised ICT training profiles. Additionally, there is a revision of some dual ICT training profiles

taking place in 2003, namely in relation to the revision of the recognised occupations in the vocational field of electrical engineering and electronics:

- telecommunications facility electronics technician is becoming electronics technician (trade);
- communication electronics technician is becoming informatics systems technician (industry).

However, the development in ICT vocational education and training within the dual system was fundamentally influenced by four newly recognised ICT occupations in 1997: IT system electronics; information technology specialist; IT system support specialist; and information technology officer. Information technology specialist is divided into the main training fields of application development and system integration. Based on new training regulations the four profiles also have a new qualification structure of common occupational qualifications, covering 18 months and thus half of the training, and specific occupational ICT qualifications. The aim of the new training concept is to produce ICT practitioners who are similarly proficient as businessmen, technicians, service providers, organisers and client consultants (Schwarz, 2000, p. 99).

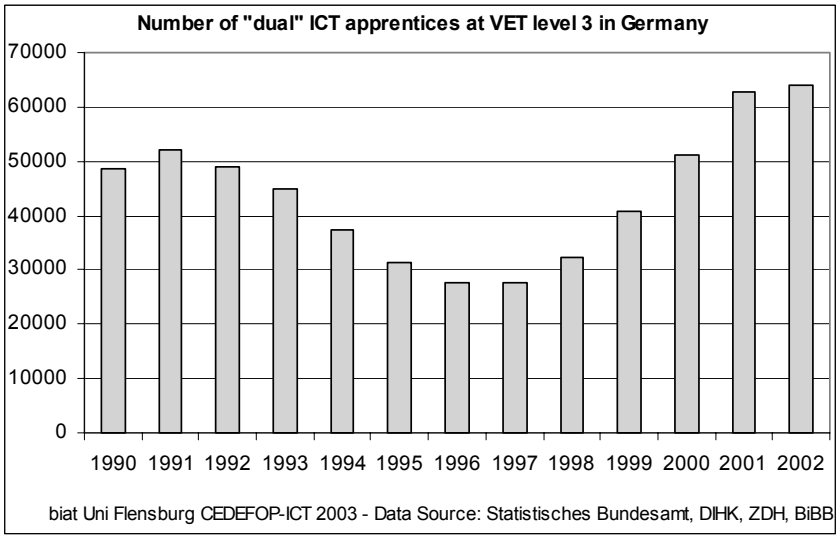
Table 5: ICT training profiles at VET level 3 in Germany

level 3		
• IT system support specialist • Information technology specialist in application development • Mathematical technical assistant	• Information technology specialist in system integration • Information technology officer • IT system electronics	• Information electronics • Telecommunications facility electronic technician • Communication electronic technician

However, companies are not universally able to put in place the new training regulations and concepts. Problems occur, for instance, in fulfilling the full extent of required training contents. Vocational schools as the dual training partner are faced with challenges such as implementing the new curriculum structure and content as well as the ICT work process orientation (*biat*, Petersen, Wehmeyer, 2001).

As indicated in the figure, the ICT training profiles launched in 1997 have been benefited from the ICT boom of the 1990s and led to a remarkable increase in apprenticeship places, reaching more than 60 000 in all ICT training profiles. However, the economic slow-down in the ICT sector can also be recognised in the number of new ICT traineeships which was decreasing in 2002 after the five year boom.

Figure 14: Development of ICT apprentices at VET level 3 in Germany



The broad range of ICT training profiles at VET levels 3 and 2 in Germany has a significant influence on the supply of ICT practitioners. However, skilled work in ICT requires a certain level of qualification. This is seen in the high entrance level of ICT trainees and apprentices even at VET level 3 within the dual VET system in Germany, where the proportion of ICT trainees with university entrance qualifications (*Abitur*, A-levels) in some training programmes is above 50 % (*biat*, Petersen, Wehmeyer, 2001, p. 64). Therefore access to these ICT training profiles and occupations has been limited and training entrance proves to be a tough goal for youngsters with normal secondary school exams. In fact, the majority of companies state that the upper secondary school exam is required in order to make sure the apprentices eventually achieve the objectives of ICT qualification (ibid., p. 66). Very often youngsters with lower general school exams need to start school-based training which limits occupational mobility.

The situation of VET delivery is of importance for continuing vocational training (CVT). It constitutes a basis for further training activities which are briefly described in the following paragraphs.

2.3.1.3. Further/higher vocational education and training profiles

Further and higher vocational education and training profiles in Germany can have qualifications regulated at either national or federal state level. The following possibilities exist at VET (CVT) qualification level 4: state certified business managers and technicians (technical vocational school); master craftsman (trade); specialist for data processing (industry, trade); new ICT professional; and specialist training profiles.

A precondition for these training courses (or examinations) is a recognised and appropriate initial VET qualification plus certain work experience in the subject area. Therefore this type

of vocational qualification is understood as a kind of continuing vocational training (CVT) leading to a higher qualification VET level to be summarised at level 4. In contrast with lifelong learning (LLL) courses these VET (CVT) programmes have a duration of 12 to 36 months.

In the first group, current ICT training profiles called state certified business managers and technicians, regulated at federal state level, range from more business oriented subjects (e.g. business manager in business informatics) to informatics/data processing (e.g. technician in data processing technology) and ICT engineering competences (e.g. state certified technician in data systems technology).

Table 6: ICT training profiles at VET (CVT) level 4 in Germany

level 4		
• Business manager in data processing and organisation • Business manager in business informatics • Specialist for data processing – business information Technology (IHK) • Coordinators (new specialist profiles) • Advisors (new specialist profiles)	• State certified informatics • Technician data processing technology • Technician data systems technology • Software developers (new specialist profiles) • Solution developers (new specialist profiles) • Administrators (new specialist profiles)	• Technician in technical informatics • Technician in information- and communications technology • Technician in radio communication • Technicians (new specialist profiles) • Master (craftsman) information technology • Master (craftsman) TC electronic technician • ICT service advisor (new specialist profile)

The position of master (craftsman) has a fairly long tradition in Germany. In ICT there are currently two training profiles available, namely master (craftsman) telecommunication facility electronic technician and master (craftsman) information technology.

In addition, the chambers of industry and commerce and chambers of trade offer vocational training that can partly be defined at qualification level 4.

The latest development in further VET profiles and occupations in ICT is the system of 'IT professional and specialist profiles' (see http://www.apo-it.de or http://www.kib-net.de). Since 2002 there are two more strategic and four operative IT professional profiles available within this new qualification framework. These qualifications are based on national

examination regulations (following the Vocational Training Act of 1969). There are also 29 new ICT specialist profiles at VET/CVT level 4 available in six thematic groups: software developers; coordinators; consultants; technicians; administrators; and advisors. The training is supposed to be fully integrated into a concrete work and project process. A specialist is certified, not according to national regulations but by an accredited certification body when a project or major part of it has been completed and documented and fulfilled the criteria described in a reference project. The certification of similar work process competences is also possible. Finally, the candidates need to pass a test based on a one hour 'expert talk'.

2.3.1.4. Lifelong Learning (LLL, CVT) delivery in Germany

Germany has a differentiated system of lifelong learning, with various organisational structures and forms of funding related to the functions, objectives and contents of the training. Providers of LLL/CVT offers are companies, private and public organisations, chambers of trade and industry, business educational foundations, trade union further training foundations, institutions of higher education with courses for those in employment, etc. Large companies usually operate their own continuing training departments, responsible for planning, implementing and evaluating continuing training and personnel development.

Approximately 266 200 people took part in LLL and retraining programmes promoted by the Federal Labour Office in 1997. However, based on year 2000 data there were 46 500 LLL measures in ICT funded by the government, about 17 000 of which are part of retraining and approximately 30 000 of a LLL nature. In addition, the federal states provide funding on business and market oriented continuing and further ICT qualification in close cooperation with companies from the ICT sector (BMBF, 2001, p. 40).

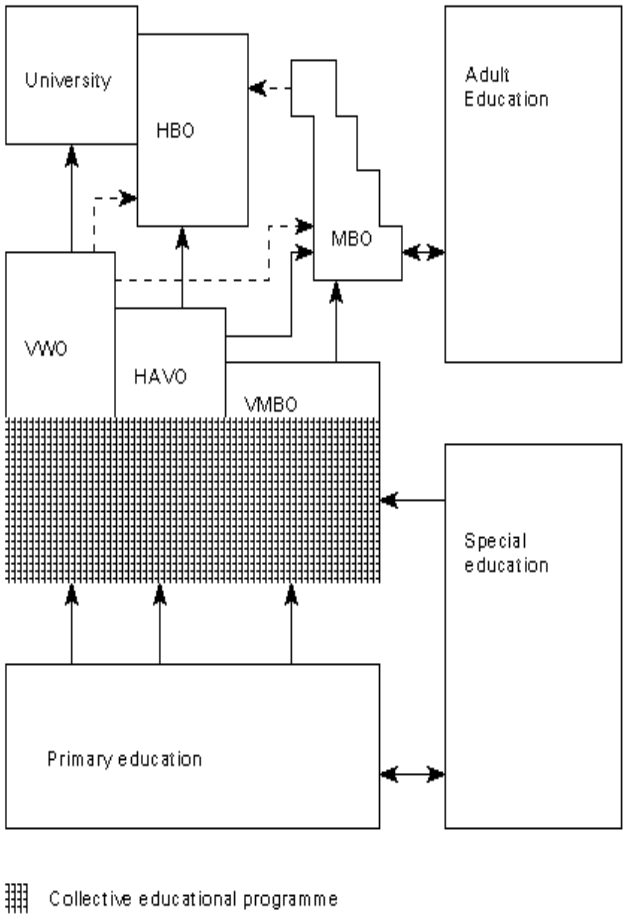
However, the biggest LLL market is of a private nature and utilised by companies or based on the personal commitment of ICT practitioners. The main providers of training are large LLL/CVT organisations that sometimes combine their ICT training business with ICT consulting activities. Also, increasing numbers of vendors offer training specific product courses through their own training departments, outsourced ICT training branches or the above mentioned LLL/CVT organisations.

2.3.2. ICT training profiles and VET qualification concepts in the Netherlands

Initial vocational training (IVT) in the Netherlands is part of initial degree education. It is intended as a final phase of initial education and prepares young people to enter the labour market as vocational trainees. Depending on the type of diploma obtained or the level achieved in the preceding phase, a student may continue to senior secondary vocational education (MBO), higher professional education (HBO), or to university education (WO). The intent is that all students will leave the initial system with a vocational qualification recognised by the government.

Senior secondary vocational education (MBO) has a structure that corresponds to the various business sectors. Training programmes are provided within the engineering and technology, agriculture, economics, personal and social services and health care sectors. The MBO programmes prepare students for national qualifications that are recognised by the government. All qualifications are integrated into a qualification structure (see classification below).

Figure 15: Basic structure of the general and vocational education and training system in the Netherlands



Source: EUQuaSIT, 2002, p. 34

In total, MBO offers some 500 different training programmes. The total number of qualifications to be granted has been subsumed in a qualification structure. MBO training programmes are mainly provided by regional training centres (ROCs) and agricultural training centres (AOCs). Training programmes are offered at four levels and have different duration. The levels were derived from the European Council Decision of 16 July 1985 (SEDOC

classification) ([2]). The following schedule summarises the levels, duration and educational tracks of MBO programmes:

Table 7: Duration and educational tracks of MBO programmes

level	***duration***	***educational tracks***
level 1: assistant training	one year	vocational training or vocational guidance track
level 2: basic vocational training	three years (two years after completing the assistant training)	vocational training or vocational guidance track
level 3: practitioner training	four years (two years after completing the training for basic vocational training)	vocational training or vocational guidance track
level 4: middle management training	four years	vocational training or vocational guidance track
level 4: specialist training	two years (training only available after completing training for trade practitioners)	vocational guidance track

(a) courses at assistant level (*assistentopleiding*) (level 1) equip students to perform simple executive tasks. These courses are intended for those who are not able to obtain a basic qualification (level 2) but can thus obtain a certificate nonetheless;

(b) basic vocational training (*basisberoepsopleiding*) (level 2) prepares students to perform executive tasks at a slightly higher level. The diploma awarded at this level is equivalent to a basic qualification, which is the minimum qualification that everyone should have;

(c) holders of a practitioner training (*vakopleiding*) diploma (level 3) are able to carry out tasks completely independently. They must also be able to account for their actions to colleagues and monitor and supervise the application of standard procedures by others;

(d) the fourth level, i.e. middle-management or specialist (*specialistenopleiding*) training (level 4), prepares students to carry out tasks completely independently, combined with the ability to perform a broad range of tasks or specialisation in a particular field. Students must also demonstrate that they possess non-job-specific skills, such as tactical and strategic thinking, and can expect to take up posts in which they have hierarchical, formal and organisational responsibilities.

Most training programmes can be followed according to two different educational tracks. The student can choose between an educational track in which the primary emphasis is on learning at school (the vocational training track) or an educational track with an emphasis on learning on-the-job (the vocational guidance track). In the vocational training track, practical training will take up between 20 % and 60 % of the course and in the vocational guidance track, practical training will take up more than 60 % of the course.

([2]) European Communities: Council Decision of 16 July 1985 on the comparability of vocational training qualifications between the Member States of the European Community

The exit qualifications indicate in abstract terms what is expected of the students at each of the levels (including what they have to do to obtain partial qualifications (*deelkwalificaties* [3]) along the way). Employers, teachers and students will then know what knowledge and skills are required and what is on offer. It is up to the institutions how they organise their teaching. They are free to devise their programmes for the courses they offer on the basis of the exit qualifications.

All courses within the qualification structure are entered in the central register of vocational courses (CREBO). This register records which institutions provide which courses, what the exit qualifications are, which learning pathway is involved and which of the partial qualifications awarded are subject to external validation. It also indicates which courses the government funds and which institutions are authorised to validate examinations. Anyone who wishes may consult the register to find out what courses are on offer and how they fit into the qualification structure.

Students can take different courses consecutively, the diploma for one course serving to gain entry to the next. All the courses have a certain recognisable scope. The range of courses can be made more or less detailed for each specific sector of employment or group of sectors. Narrow, highly job-specific courses are not accorded a separate place within the system. Consequently, not every industry or occupational field will have courses at all four levels. ICT-courses are available at levels 2, 3 and 4, although the numbers are limited at levels 2 and 3. At level 1 there are no courses available leading to a professional ICT qualification as understood in this report.

From a quantitative point of view, VET at qualification levels 3 and 2 in ICT is not so important in the Netherlands. There are all together nine ICT training profiles. Apart from the profile assistant administrator ICT, the focus of these craftsman profiles is on communications technology, ICT service and industrial electronics and applications.

Table 8: ICT training profiles at VET level 2 and level 3 in the Netherlands

level 2		
Craftsman communication-installations	Craftsman communications networks	ICT service worker Craftsman industrial electronics
level 3		
Assistant administrator ICT First craftsman communications networks	First craftsman communication-installations	First craftsman electronics and instrumentation First craftsman industrial electronics

([3]) *deelkwalificaties*: partial qualifications. The exit qualifications in senior secondary vocational education (mbo) indicate the knowledge and skills that students are expected to acquire. Examination syllabuses are based on the exit qualifications and are divided into modules, each of which leads to a partial qualification. Each partial qualification is deemed to form a separate unit in terms of practitioner practice or transfer onward to further or higher education. Under the old system of MBO (i.e. prior to August 1997), partial qualifications were referred to as credit units.

Each course includes practical training in the occupation concerned. This is provided on the basis of a contract between the institution, the student and the company or organisation providing the placement. The contract sets out the rights and obligations of each party, including provisions on the number of training-hours to be provided, arrangements for supervision of the student, which part of the exit qualifications must be satisfied by the student in the course of his or her practical training, and how the latter is to be assessed.

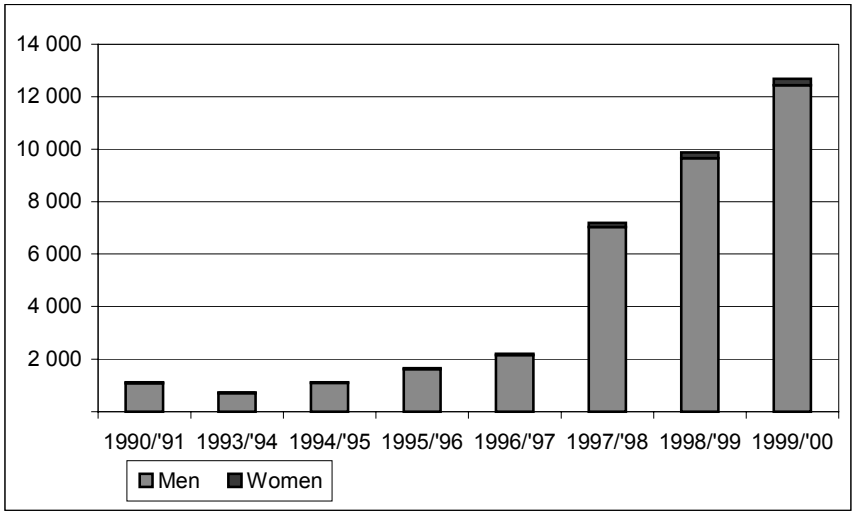
Table 9 provides the ICT training profiles available at VET qualification level 4. The listing indicates that the ICT training profiles at this qualification level represent the range of ICT areas covering administration, multimedia management, software development and administration, network administration, telecommunications and electronics engineering.

Table 9: ICT training profiles at VET level 4 in the Netherlands

level 4		
Middle management employee administrator ICT	Developer software applications	Middle management employee automation electronics
Middle management employee IT media production	Administrator software applications	Middle management employee automation energy engineering
Middle management employee multimedia designer	Network administrator	Middle management employee computer interface engineering
	Technician communications systems (TCS)	Technician electrical industrial plants
	Telecommunications and ICT engineer	

Figure 16 indicates the development of the number of students in 4-year technical studies at VET level 4. The number of students that followed full-time training in ICT has grown enormously the last five years. From 1996/1997 to 1999/2000 the number of students grew by more then 500 %. There was growth in each technical profile. Most of the training profiles were newly introduced in the school-year 1996/1997.

Figure 16: Number of students/trainees in technical ICT training profiles at VET level 4



At the heart of the qualification structure introduced by the Adult and Vocational Education Act (WEB) lie the exit qualifications. These describe the qualities in terms of knowledge, understanding, skills and, where applicable, practitioner attitude, which those completing the course should possess with a view to their future career and role in society and which, in some cases, are necessary for entry to further or higher education. The exit qualifications are divided into a number of partial qualifications. Each partial qualification represents a combination of exit qualifications which is deemed to form a separate unit in terms of practitioner practice in the field concerned. Students who complete the whole course successfully are awarded a diploma. A certificate is awarded for each partial qualification (*deelkwalificaties*) obtained. The national vocational education bodies formulate the exit qualifications for each sector of employment, group of sectors or occupational group, which are then finalised by the Minister of Education, Culture and Science.

2.3.2.1. Lifelong Learning (LLL) delivery in the Netherlands

In the Netherlands lifelong learning (LLL) includes all full-time and part-time learning activities available to people who have left initial education, are no longer subject to compulsory education, and wish to improve their position in the labour market through this qualification route. These people have a broad range of courses to choose from. In the Netherlands, continuing training programmes are not arranged in a cohesive system. Instead, they exist as a conglomerate of numerous activities provided by various institutions. In the Netherlands, LLL is often described on the basis of combinations of legal arrangements, objectives, providers, target groups, sponsors, and/or according to the division of responsibilities. Dutch continuing vocational training has the following dimensions:

(a) participants: job seekers, entrepreneurs and employees;

(b) LLL qualification providers: providers of courses which prepare students for qualifications from the initial degree programme or for supplemental, non-recognised qualifications;

(c) funding: the government and/or the relevant business sector and/or the employer and/or the participant.

Because there is no coherent system of continuing vocational education and training in the Netherlands it is very difficult to produce information on the numbers of certificates awarded. Also, the fact that most studies are provided by private (commercial) organisations, which are not obliged to provide information on the numbers of students, makes it impossible to produce this information.

In the Netherlands, there are very few facilities in continuing vocational training specifically for special target groups. For CVT, the rule is that everyone must follow training programmes as much as possible within the existing facilities. There are three exceptions to this:

(a) vocational schools for women and women returnees;

(b) courses offered by five specialised institutes for people with a handicap (mostly for people who have developed a handicap later in life;

(c) training of recent immigrants (*nieuwkomers*) takes place in the context of the naturalisation scheme for recent immigrants.

2.3.3. ICT training profiles and VET qualification concepts in Portugal

Since the earlier 1970s new disciplines related to information and communications technologies (ICT) have been introduced to Portuguese education. Initially, those disciplines were only introduced in university courses, in particular in engineering and management. Later, new computer curricula were included in secondary education (recurrent and vocational training). Currently (starting 2001/2002) educational reform will introduce new ICT training programmes and curricula at all levels of the Portuguese education system. The VET subsystems in Portugal can be divided as follows:

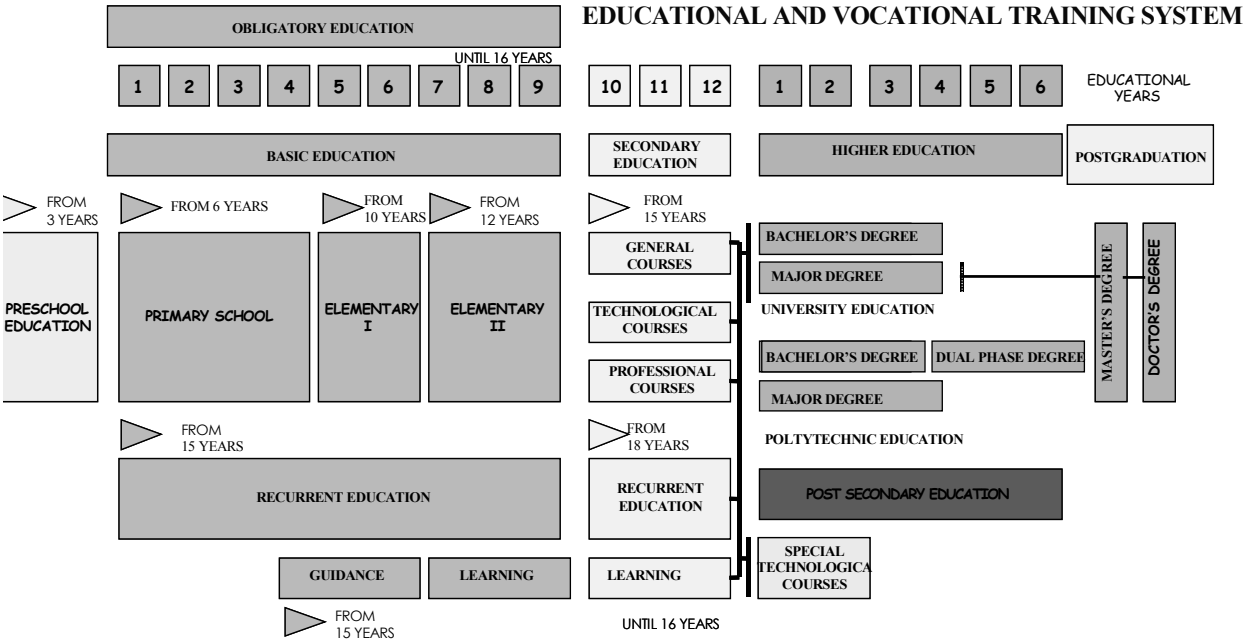
- secondary courses (recurrent and vocational education) equate to VET level 3 and 4;
- professional ICT training courses (professional schools) equate to VET level 4;
- IEFP learning system (apprenticeship courses) equate to VET level 2, 3 and 4

Vocational training within the scope of ICT is a vast sector and its analysis is difficult. There are numerous private organisations that promote periodic and systematic training in those domains. In the last few years, there have been numerous training initiatives at several levels of intervention. Secondary education has a duration of three years (corresponding to the 10, 11 and 12 scholar years). It is organised in accordance with different courses that may be oriented towards specific areas of knowledge and active working life (e.g. technological ICT courses) or for further development of studies (general courses). Educational curricula for the

secondary education sector have, for almost every group of study, a discipline entitled Introduction to new information technologies.

Vocational education and training in professional schools (professional courses) is a special type of education, an alternative to regular education. These schools, established in 1989, aim to train intermediate level technicians and belong to a network of private education institutions (at the initiative of local governments, professional associations, etc.). The State has also funded these institutions, through the creation of professional schools covering areas not covered by the existing network. All schools are under the responsibility (at pedagogic, scientific and operational level) of the Ministry of Education. These courses have a duration of three school years, presented in a modular form with variable duration, and are organised according to education and qualification levels (up to the highest level).

Figure 17: Basic structure of the general and vocational education and training system in Portugal



Explicative Comments:

- Basic Education includes 9 years of compulsory education. It's formed by 4 primary school years, followed by 2 elementary I years and 3 elementary II years.
- Recurrent Education is part time general and technical education for students who abandoned studies and for adults.
- General Courses belong to secondary education leading mainly to following studies.
- Technological Courses belong to secondary education leading to work life.
- Professional Courses have a professional/vocational nature.
- Learning – these courses are attended by students aged between 14 and 25 years, duration 1 to 3 years.
- Special Technological Courses 1 to 3 years according to part or full time education and/or access education (students from General Courses have to previously join in a Technical Course for additional professional level 3 qualifications).

Source: EUQuaSIT, 2002, p. 47

The working plans for professional courses include a sociocultural training component which is common to all courses, a scientific training component which is common to all courses from the same training area, and components of technical training, practical training, arts training and technological training which depend on the type of course and which must not cover more than 50 % of the course working plan. It is also mandatory that all courses have a training period in a real working environment (probation period). The successful conclusion of a professional course provides a qualification level and the right to professional certification at level 4 (in accordance with European Union procedures).

Besides the training programmes described, there is a whole range of initiatives belonging to the Institute for the Employment and Vocational Training (IEFP) in cooperation with various training centres, under direct and indirect management. The training programmes provided by the IEFP are known as the learning system. This system is quite similar to the one described for the professional schools and is also oriented towards complementing standard education. In ICT, this system includes training corresponding to levels 2 and 3, which is equivalent to the 9 and 12 school years, and it is regarded as a vocational education training (VET). Enrolment is based on the 6 and 9 school years, respectively, for courses at levels 2, 3 and 4. The system includes informatics/computer technician and network technician courses. At VET qualification level 3 and 2 we find ICT training profiles such as database management and data processing assistant. Another focus is on technical and maintenance activities, e.g. for PCs, networks and other equipment (see below).

Table 10: ICT training profiles at VET level 2 and level 3 in Portugal

level 2		
Data processing assistant	Informatics assistant technician Informatics/computer operator	Network (PCs) maintenance technician Assistant technician equipment maintenance
level 3		
Database management – micro systems Informatics technician Multimedia systems Programmer	Advanced applications operator CAD operator Data processing technician	Network maintenance technician Hardware technician

Looking at concrete ICT training profiles at level 4 available in Portuguese VET (mainly secondary ICT courses) one primary focus is on applications analysis and developing (programming). In addition, there are more technically oriented ICT training profiles such as applications technician, data analyst and network technician.

Table 11: ICT training profiles at VET level 4 in Portugal

level 4		
Database management – mainframe	Informatics applications analyst	Maintenance applications technician
Data processing management	Informatics applications Programmer	Industrial design CAD 3D specialist
Mainframe applications programmer	Data analyst	Micro network management and installation technician
	Multimedia applications operator	

From a quantitative point of view there are some 12 000 students enrolled in computer technological courses within secondary education. Since 1996, there has been no increase in demand for this course, and a reduction in the number of enrolments was registered. It should also be noted that educational curricula have undergone essential alterations to keep up with technological development, to promote the acquisition of proper skills and to contribute to the continuous development of students by preparing them with the knowledge needed for entering more advanced levels of scientific and technical studies.

Quantitative analysis of the IEFP learning system for the period between 1995 and 1999 shows appreciable impact since 1997, since when it has registered enormous growth. The overall number of trainees involved in the several courses in 1999, with particular emphasis on the computer technician courses – at levels 3 and 4 – was around 2 000. The IEFP learning system has the necessary conditions for providing the labour market with a relevant number of qualified technicians with similar qualifications as the ones provided by normal secondary education courses in computer technologies.

VET in ICT in Portugal does not have, up to now, equivalent significance when compared with higher education degrees. Most ICT practitioners have higher education degrees. However, the current VET system has sufficient ICT training availability in this domain, mainly from the quantitative point of view.

2.3.3.1. Lifelong Learning (LLL) delivery in Portugal

Overall, the framework for lifelong learning (LLL) in Portugal in ICT is quite positive and, in accordance with data provided by IEFP, will register further growth within the next couple of years. In order to address this trend, IEFP has been developing a number of initiatives that will contribute to increasing current supply. Efforts have focused on rehabilitating current installations, building new facilities and increasing the number of available trainers.

The growth registered within the last five years extends to all regions and almost every level of training. Nevertheless, the growth for specific professional training is not as relevant as that

registered for other courses that allow access to certification and professional outcomes. This situation may be due to the fact that most of the time working practitioners have, within their organisation, further access to training and specialisation opportunities and do not have the need to attend the training programmes offered by IEFP. Hence, the applicants that seek certifications with professional outcomes are, mainly, unemployed and persons looking for a better practitioner position.

3. Industry need for ICT skills and practitioners: demand and supply

Developments in information and communication technologies (ICT) and the wide range of ICT applications have changed the demand for ICT practitioners in recent years. Ensuring a well-balanced relationship between ICT practitioner demand and supply is increasingly important, both quantitatively and qualitatively. This balance affects the competitiveness of enterprises in the ICT sector itself and also industries across all sectors, ICT users, and therefore the European economy as a whole.

In addition, enterprises need ICT practitioners with different skills and qualification levels, with a specific division obvious between degree and sub-degree/vocational levels. Using analyses, evolution studies and some forecasts the following section aims to identify the requirement for ICT skills and associated skills profiles, both in number and in type.

3.1. Work oriented research and study approach

A number of surveys and empirical analyses have been carried out for this report. First are surveys and case studies among ICT companies ICT users in selected European countries: Germany, the Netherlands and Portugal. The aims of this research are to examine ICT employment and the demand for ICT practitioners with a focus on quantitative and qualitative needs in terms of programmes, main contents, range of skills and knowledge, etc., anticipating certain occupational/professional profiles and skill levels.

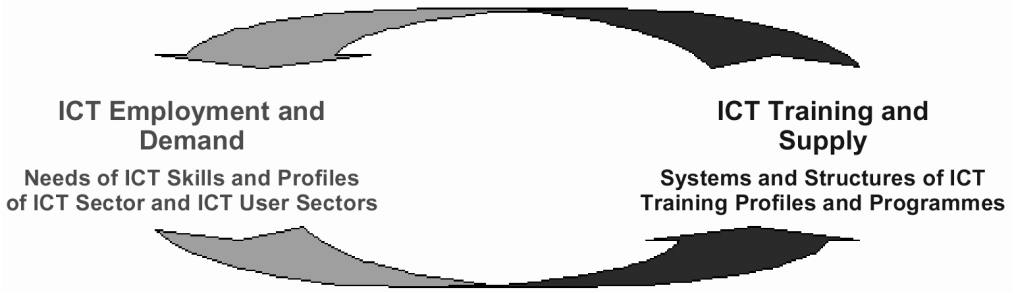
This has been complemented by examination of current ICT training and qualification profiles, including the supply of ICT practitioners in the same selected European countries, with the aim of evaluating and comparing ICT training profiles in Europe at degree and sub-degree levels (VET, CVT and HE). The focus here is on programmes, occupational/professional profiles, targets, main contents, range of skills and knowledge, etc., numbers of ICT students and trainees and expected supply of ICT practitioners.

Finally there is an evaluation of demand and supply, and any consequent gap or mismatch, of ICT practitioner skills and ICT training solutions.

These surveys and empirical analyses derived mainly from two research projects and studies. The first is the European Leonardo da Vinci II project European Qualification strategies in information and communications technology (EUQuaSIT), which includes company surveys and case studies. The project was carried out in cooperation with partners in five European countries. The secondly is a national study carried out by *biat* to evaluate new vocational ICT training profiles in Germany. This covered investigations, case studies and expert interviews on ICT business and work structures, contents and requirements. By using additional results

of secondary analyses, the overall research approach was to focus on the interaction of the demand and supply of ICT practitioners (see below).

Figure 18: Interaction and investigation of the employment, demand and supply of ICT practitioners



This research into ICT employment and skill needs is neither limited to the industries and companies of the ICT sector nor exclusively to large enterprises. The survey sample includes all industries and companies, and so covers small and medium sized enterprises (SMEs) and relevant ICT user sectors. As indicated in Table 12, three selected ICT user sectors have also been the subject of specific studies commissioned by Cedefop on IT practitioner skills and training solutions, namely the automotive industry, finance and banking and the graphic/media industry.

Table 12: Study approach to an adequate sample of all industries and SMEs of the ICT and user sectors

ICT sector (ICT supplier companies) Small-, Medium-, Large-Enterprises / Companies / Organisations	
Information Technology I(C)T HW / SW / Networks	**Communications Technology (I)CT** HW / SW / Networks (fixed, radio)
Information and Communications Technology ICT HW / SW / Information Networks / Communication Networks (fixed, radio)	

ICT user sectors (ICT user companies) Small-, Medium-, Large-Enterprises / Companies / Organisations					
Automotive Industry	**Financing and Banking**	**Graphic/Media industry**	Electrical, Electronics Industry	Metal Industry	Print-, Wood-, Paper Industry
Chemical Industry	Food Industry	Insurance	Wholesale and Retail Trade	Services	Government, Public Administration
Energy Supply	Construction	Transport, Distribution and Logistics	Health and Human Services	Tourism and Leisure Industry	others

3.2. ICT practitioner demand and supply at different skill levels

The total number of ICT practitioners at all skill levels in Europe is some 3 700 000 (*biat,* 2001; EUQuaSIT, 2002; CEPIS, 2002). The number of information technology (IT) practitioners (ISCO 213 and 312; excluding ICT business or computer sales staff or electronics or communications engineers, etc.) is estimated at 2 500 000 (CEPIS, 2002, p. 35). The total number of ICT practitioners in Germany is some 800 000, in the Netherlands 280 000 and in Portugal 60 000. The ICT practitioner proportion of total employment in individual European countries varies between 1 % and 5 % and depends on the relevant economic situation and infrastructure. The average percentage in Europe is approximately 2.5 % of a total labour force of approximately 160 million. This is similar to the USA which has approximately 2.8 % of a total labour force of 140 million.

Figures for Europe show that 40 % of ICT practitioners are employed by ICT (supply) companies and 60 % are employed by ICT users. Allowing for regional differences in European countries, this is also similar to the USA. An ITAA report (ITAA, 2000) indicates that approximately 60 % of ICT workers in the USA are employed in non-ICT industries (NSSB, 2002, p. 11).

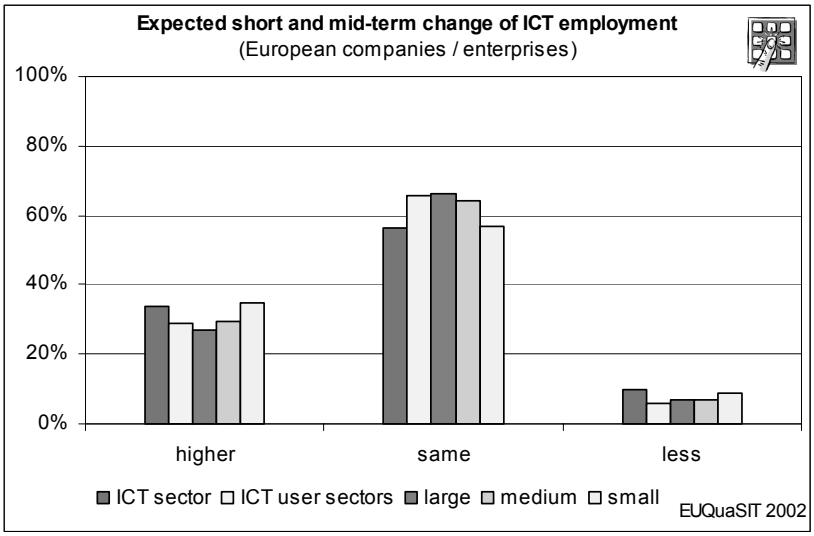
Table 13: Employment and needs of ICT practitioners in Europe 2000-10

	ICT practitioners 2000	ICT practitioners (ICT sector)	ICT practitioners (user sectors)	...	ICT practitioners (demand per year)	...	ICT practitioners 2010
Germany	**800,000*** (2,4%)	300,000*	500,000*	...	**50,000***	...	**1,100,000***
Netherlands	**280,000*** (5%)	110,000*	170,000*	...	**15,000***	...	**370,000***
Portugal	**60,000*** (1,3%)	24,000*	36,000*	...	**4,000***	...	**85,000***
...	...	...	...	...	...	...	...
Europe	**3,700,000*** (2,5%)	1,500,000*	2,200,000*	...	**230,000***	...	**5,100,000***
USA	*3,900,000** (2,8%)*	*1,600,000***	*2,300,000***	...	***?***	...	***?***

Source: CEPIS, 2002; *biat, 2001; EUQuaSIT, 2002; **NSSB, 2002, p.p. 8, 26, 27 with additional estimation

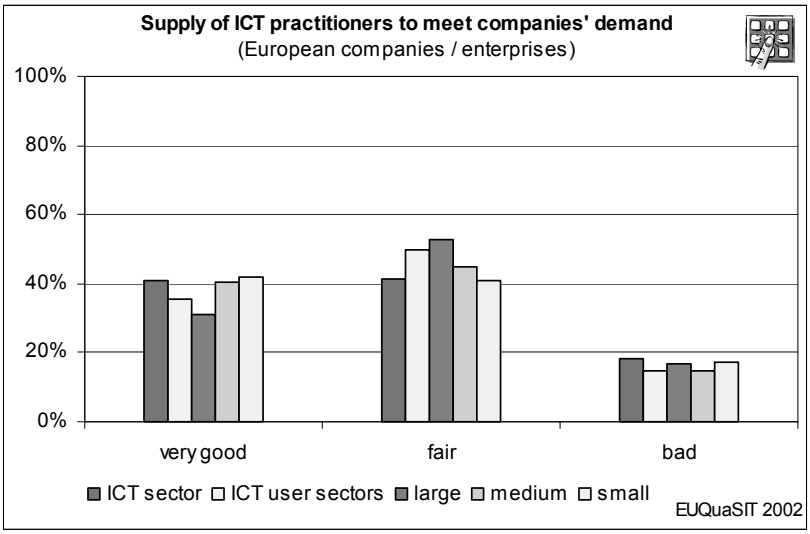
Based on recent developments in the ICT business and labour market, different forecasts and scenarios about future demand for ICT practitioners are possible. However, such forecasts depend very much on future economic development. Current survey results show, for the short and mid-term perspective, no changes in levels of ICT employment in approximately 60 % of the ICT and user sectors in Europe. However, more than 30 % of the ICT sector and small enterprises anticipate higher ICT employment in the near future (see below).

Figure 19: Change in ICT employment in European companies/enterprises in the near future



This suggests that ICT employment growth over the coming years can be calculated at not more than 5 % per year. The previous forecasts of a huge shortage of ICT practitioners in Europe, e.g. the predicted 1.6 million gap by 2004 (IDC, 2001, quoted in CSC/Cedefop, 2001a, p. 5) lack credibility today. The survey results suggest that the supply of ICT practitioners in Europe is mostly estimated by companies as 'fair' (see below). Of course, there are differences between European countries, e.g. a significantly better situation in the Netherlands compared to Germany and Portugal.

Figure 20: Companies evaluation of how the supply meets the demand of ICT practitioners



The total demand for ICT practitioners in Europe – including replacement demand – can be estimated at 230 000 per year. This is based on *biat* study results, substantiated by the EUQuaSIT surveys and further shared calculations. Based on current employment, demand in Germany is estimated at 50 000, in the Netherlands at 15 000 and in Portugal at 4 000 per year. Assuming a steady development up to 2010, total employment of 5 100 000 ICT practitioners in Europe seems to be a realistic projection (see table above).

Additional information on ICT practitioner demand and supply relates to different skill levels in various hierarchical structures and work organisations. Work oriented models of skill levels exist, with a certain diversity of interpretation in various contexts across the EU. European, national or company level models with a structure from four to eight or even more work and skill levels are not unusual. For example, Skills framework for the information age (SFIA) used a matrix with seven levels (e-skills NTO 2001). One example from a German company used work and skill descriptions at eight levels, corresponding to wages of the ICT staff employed, for internal ICT employment grading. Vocational education and training systems across Europe offer different models and frameworks for qualification levels, which are the basis for achieving greater transparency and harmonisation and improving mutual recognition.

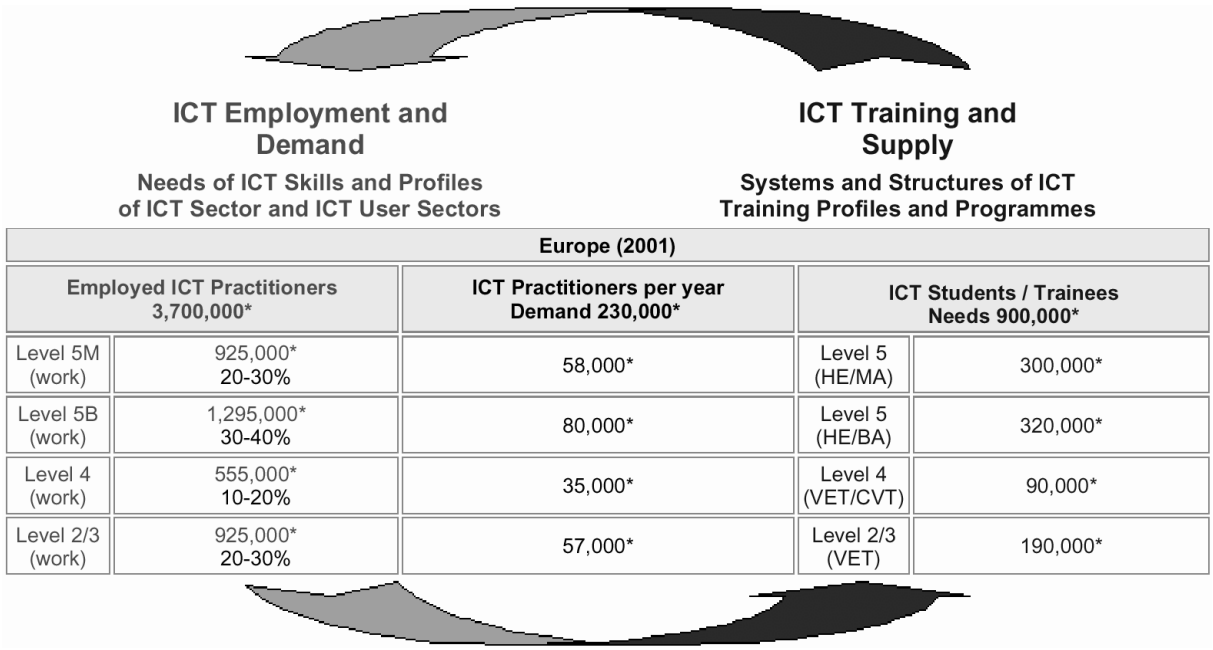
There is an obvious interaction between employment and education, yet it proves impossible to establish a generally accepted coordination of skill level models and qualification frameworks because of the different European systems of employment and education. We know that in few cases, if any, do non-formally qualified practitioners carry out the same work tasks as their formally qualified colleagues and there is a high correlation between work skills and the qualifications or training levels of practitioners. Therefore, it seems logical, considering already existing ICT training and qualification profiles, to use a framework for training and qualification levels similar to the framework of the work and skill levels of ICT practitioners. Given the framework that uses degree levels 5M and 5B and sub-degree levels 4, 3 and 2, it is possible to assess ICT employment, and also skill needs, in the same way. This approach allows ICT employment and industry needs to be used for direct comparison between ICT practitioner demand and supply.

From a qualitative viewpoint, however, even this approach is insufficient, requiring expansion of the sort in the company evaluation of ICT training profiles and the case studies described below. For the moment, however, the analysis is limited to quantitative aspects.

The analysis initially shows a simple split, with 60 % of all employed ICT practitioners having an ICT qualification at degree level and 40 % having a qualification at sub-degree level. The actual figure varies according to the country, the sector and, to a certain degree, specific ICT practitioner demand and supply. For example the figures for Germany are 50 % and 50 %, for the Netherlands 60 % and 40 % and for Portugal 70 % and 30 %. The proportion of ICT practitioners who work at degree or sub-degree levels and do not have a formal ICT qualification degree (ICT training profile) is approximately 5 % to15 %. However, as a result of special ICT qualification initiatives and programmes, this figure has decreased in recent years (*biat,* 2001; EUQuaSIT, 2002).

Further subdivision shows a proportion of 20-30 % at level 5M (HE/MA) and 30-40 % at level 5B (HE/BA). For the sub-degree levels the figures are 10-20 % at level 4 (VET/CVT) and 20-30 % at levels 3 and 2 (VET). Figure 21 shows the approximate numbers of ICT practitioners at each work and qualification level among Europe's 3 700 000 ICT practitioners. It also shows how the estimated 230 000 additional ICT practitioners required per year are split between each level.

Figure 21: ICT employment and demand at different levels in relation to the needed ICT Students/Trainees in Europe



Europe (2001)				
Employed ICT Practitioners 3,700,000*		ICT Practitioners per year Demand 230,000*	ICT Students / Trainees Needs 900,000*	
Level 5M (work)	925,000* 20-30%	58,000*	Level 5 (HE/MA)	300,000*
Level 5B (work)	1,295,000* 30-40%	80,000*	Level 5 (HE/BA)	320,000*
Level 4 (work)	555,000* 10-20%	35,000*	Level 4 (VET/CVT)	90,000*
Level 2/3 (work)	925,000* 20-30%	57,000*	Level 2/3 (VET)	190,000*

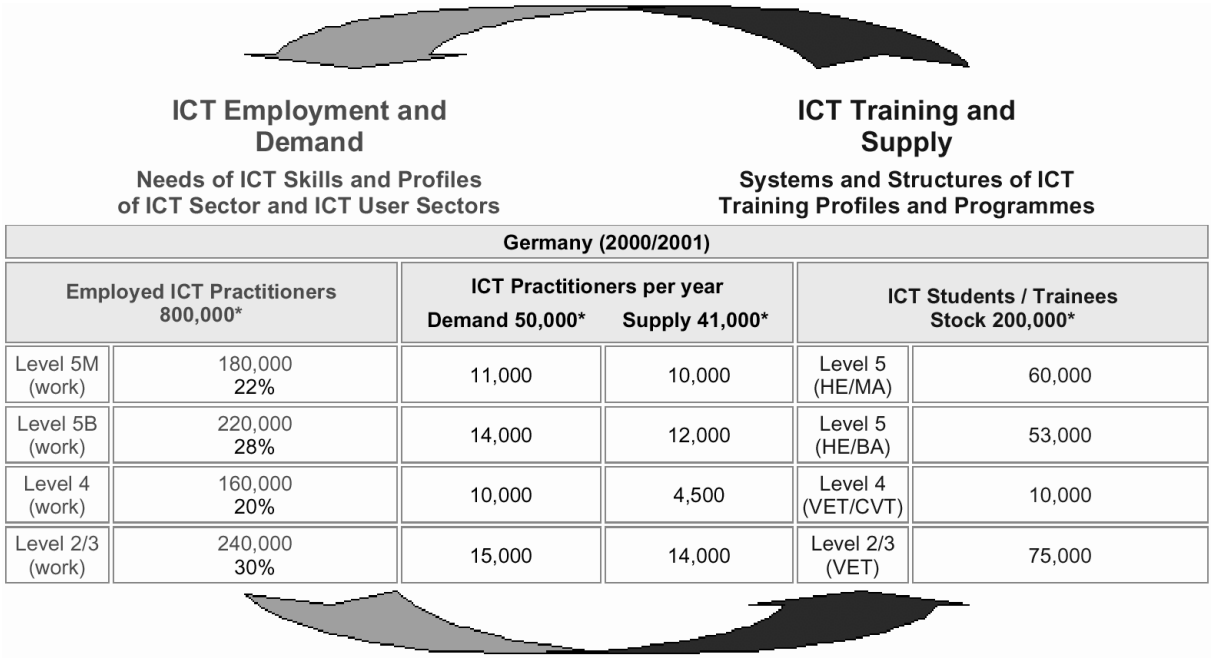
Source: CEPIS, 2002; **biat,* 2001; EUQuaSIT, 2002

The estimated demand for ICT practitioners, each year and by level, indicates the need for ICT students and trainees. In total, allowing for the average duration of existing ICT programmes and training and also a drop-out rate, some 900 000 ICT students and trainees are needed each year in Europe. Examination by level shows, for example, a need for some 35 000 ICT practitioners per year at level 4 which, in turn, indicates a needs for approximately 90 000 ICT trainees.

Exact numbers of ICT students in total or at each level today in Europe are not available. In most European countries five years ago the numbers were too low but during recent years the numbers of ICT students and trainees has increased to meet the increased demand for ICT practitioners.

With economic slow-down and company evaluation indicating that the numerical demand for ICT practitioners is being met by the supply, there may be sufficient ICT students to ensure balance in the ICT labour market. However, this situation can be affected by a variety of developments (such as career choice patterns) and is only a statement of quantitative demand.

Figure 22: ICT employment and demand at different levels in relation to the supply of ICT practitioners and the stock of ICT students/trainees in Germany



Germany (2000/2001)					
Employed ICT Practitioners 800,000*		ICT Practitioners per year Demand 50,000*	Supply 41,000*	ICT Students / Trainees Stock 200,000*	
Level 5M (work)	180,000 22%	11,000	10,000	Level 5 (HE/MA)	60,000
Level 5B (work)	220,000 28%	14,000	12,000	Level 5 (HE/BA)	53,000
Level 4 (work)	160,000 20%	10,000	4,500	Level 4 (VET/CVT)	10,000
Level 2/3 (work)	240,000 30%	15,000	14,000	Level 2/3 (VET)	75,000

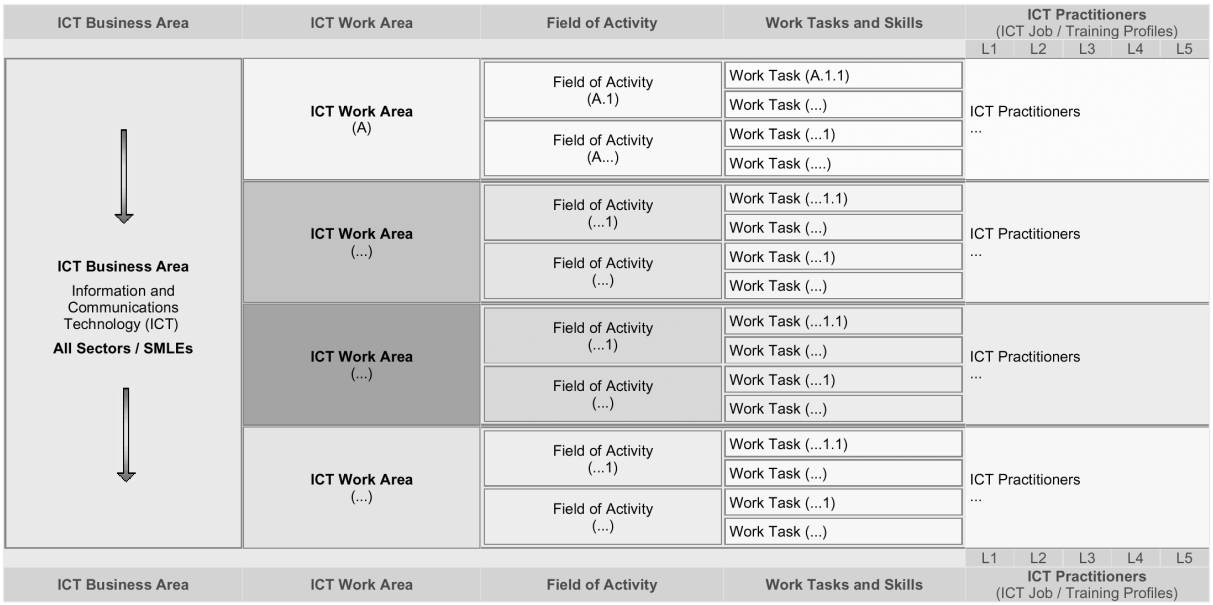
*Source: *biat, 2001; EUQuaSIT, 2002*

Actual numbers of ICT students in Germany may illustrate the trend in Europe. ICT students have been increasing in recent years, e.g. up to approximately 50 000 trainees in four new ICT occupations at level 3 launched in 1997. Figure 22 shows that the supply of students will almost meet the demand for practitioners at all levels in Germany apart from level 4.

3.3. ICT work and needs at different skill levels and a company evaluation of ICT training profiles

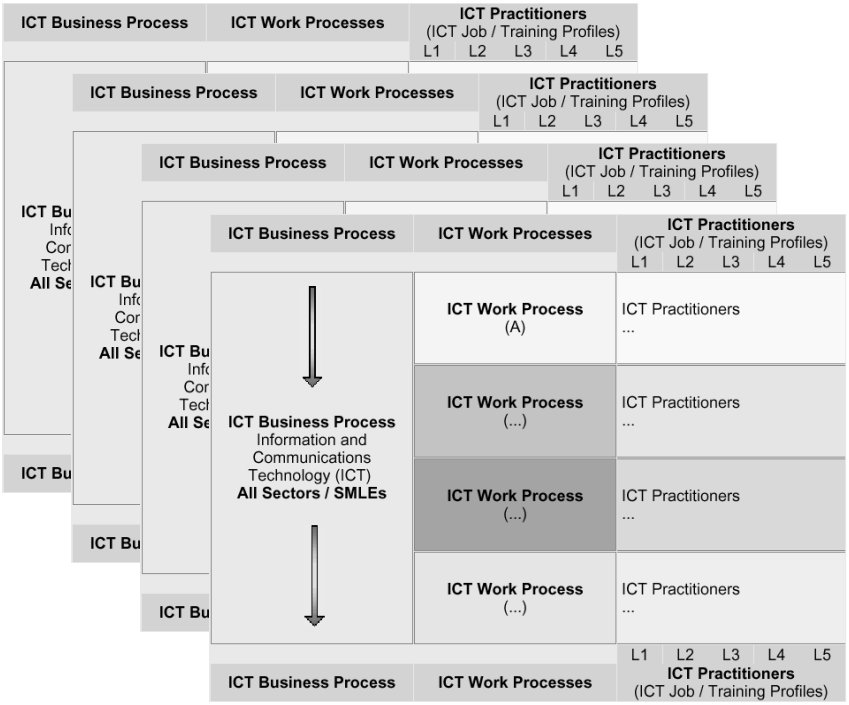
In order to investigate European industry needs for ICT skills and practitioners and ICT training solutions from a qualitative point of view, a work oriented approach was used to combine the surveys and case studies described earlier (see Section 2.1.). The main objective was to detail ICT business in general in relation to typical work areas, fields of activities and work tasks. This included analysis to determine the skills needed by ICT practitioners to work in specific areas and to carry out specific tasks. Based on a model structure of ICT business and work areas, and with the knowledge that practitioners work at different levels within each area, the analysis aimed to evaluate job and (qualification) training profiles of the practitioners (see below). The essence of the approach is that detailed ICT work and job descriptions, in combination with a company evaluation of ICT training profiles, will help determine qualitative industry needs for ICT skills and ICT training solutions in Europe.

Figure 23: Model structure of ICT business area with ICT work areas, fields of activities and ICT work tasks including the ICT practitioners who carry out the work tasks



Ensuring an adequate sample, case studies from the ICT and user sectors in Germany, the Netherlands and Portugal are first of all used to identify and describe ICT business in general with all its work areas, fields of activities and tasks. According to the research concept, the case study results of many different concrete 'ICT business processes' investigated in the companies are the basis of this identification and aggregation.

Figure 24: ICT business processes investigated in the European company case studies



The same approach to the case studies was used with companies of all sizes. It can be itemised as follows:

(a) identification and description of typical ICT business processes as the ICT business area of the company (all companies/all sectors):

  (i) type and content of respective ICT business process (production, service, technology, application, customer, etc.);

(b) for one real ICT business process in the company, identification and description of all ICT work processes (work flow) and ICT practitioners (see the common work oriented model structure above):

  (i) structure and content of all ICT work processes (broad ICT work areas);

  (ii) all ICT practitioners involved in each ICT work process;

(c) for each ICT work process, identification and description of all phases of activity and work tasks, practitioners involved with their job and training profiles at different levels:

  (i) structure and content of all phases of activity of each ICT work process,

  (ii) structure and content of all ICT work tasks of each phase of activity,

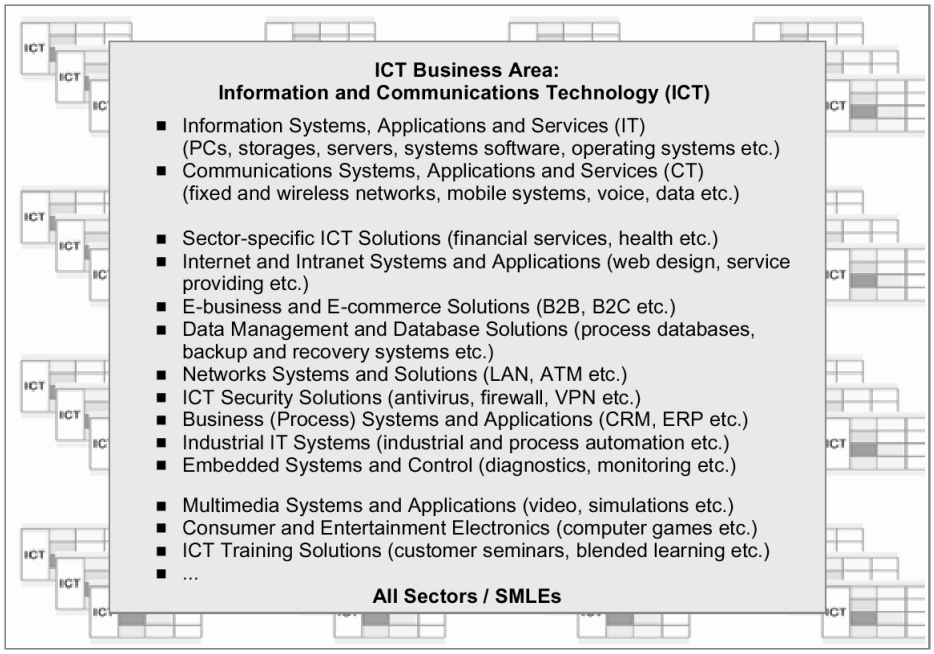
  (iii) all ICT practitioners involved carrying out work tasks and description of skill needs, main contents, range of knowledge, etc. and their ICT job and training profiles (especially at sub-degree and vocational skill levels).

3.3.1. Case study results on general skill needs within the ICT business and work areas

The broad business area of information and communications technology (ICT) in Europe differs substantially in structure and content. In addition, as the investigations of ICT business processes within the case studies have indicated, the broad business area has different sub-areas. These depend on the sector (ICT supplier or user) and the core and main ICT business of the companies, e.g. information systems, applications and services, communications systems, applications and services, and multimedia applications.

Nevertheless, as the findings of case studies show, all ICT business processes can be based on specific ICT work and technology criteria, which can be abstracted to a list of relevant ICT business and technology areas (see Figure 25).

Figure 25: List of relevant ICT business and technology (sub-)areas



In addition to this list of relevant ICT business and technology areas which can be understood as one broad ICT business area, the case studies illustrate, in line with ICT business process, a variety different contents and structures of ICT work processes. The contents of the ICT work processes are closely linked to specific ICT business process. However, despite their variety, these processes show similarities – particularly in terms of work criteria – which allow aggregation into six generic ICT work areas (see Figure 26):

(a) two with more economic technical orientation (shown in yellow);

(b) two with more informatics/communications technical orientation (shown in blue);

(c) one with more technical informatics/communications and infrastructure orientation (shown in red);

(d) one with more ICT service orientation contents (shown in green).

These six ICT work areas represent the different contents and structures of ICT work processes for businesses in the ICT sector and ICT users alike. In practice, the contents and structure of the six ICT work areas depend on each real ICT business process and on the different business and technology areas respectively (see the list). They are also affected by:

- the size of the company (small, medium, large);
- the company organisation (department structure, hierarchies, etc.).

For instance, ICT marketing, consulting and sales is chiefly relevant in ICT supply companies. Also the number and structure of work areas in large enterprises is normally higher and more detailed than in small enterprises. However, it is possible to see an initial direction in

determining industry's ICT skill needs and practitioners in the structure of these six generic work areas.

Within this context, and based on practitioner work and their ICT job and training profiles, the case studies indicate that in each work area there is a need for ICT skills at all degree and sub-degree levels. An exception occurs at sub-degree level 1, which is absent from the ICT work areas. Normally, ICT practitioners with job and training profiles at different levels work together in teams.

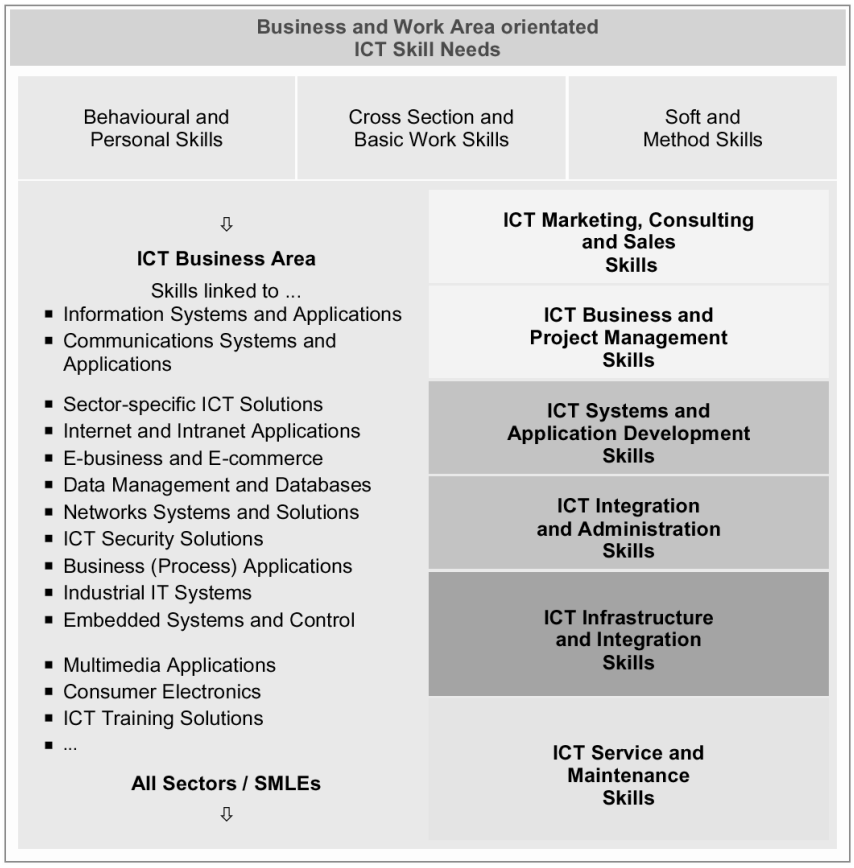
ICT job and training analysed by level and country (e.g. L2, L3 and D (Germany), NL (Netherlands), P (Portugal)) also show that currently the ICT requirements and skill needs vary according to the company while training profiles vary according to the country.

Figure 26: The ICT business area with the structure of six generic ICT work areas and involved ICT practitioners stating their ICT job and training profiles at degree and sub-degree levels

ICT Business Area	ICT Work Area	ICT Practitioners (ICT Job / Training Profiles) L2	L3	L4	L5B	L5M
ICT Business Area ▪ Information Systems and Applications ▪ Communications Systems and Applications ▪ Sector-specific ICT Solutions ▪ Internet and Intranet Applications ▪ E-business and E-commerce ▪ Data Management and Databases ▪ Networks Systems and Solutions ▪ ICT Security Solutions ▪ Business (Process) Applications ▪ Industrial IT Systems ▪ Embedded Systems and Control ▪ Multimedia Applications ▪ Consumer Electronics ▪ ICT Training Solutions ▪ ... **All Sectors / SMLEs**	**ICT Marketing, Consulting and Sales** (A)	e.g. ICT Consultant / Informatics and Economics (L5M NL) e.g. Product Manager / Information and Management (L5M P) e.g. Services Marketing Manager / Computer Science Economy and Business (L5B D) e.g. Key Account Manager / Business Administration Informatics (L5B NL)				
	ICT Business and Project Management (B)	e.g. Sales Account Manager / IT Sales Advisor (L4 D) e.g. Middle Management Employee Administrator ICT (L4 NL) e.g. Office Manager / Database Management - Micro Systems (L3 P) e.g. Marketing Technician / IT System Support Specialist (L3 D) e.g. Business Assistant / Assistant for Business Informatics (L2 D)				
	ICT Systems and Application Development (C)	e.g. Software Architect / Informatics (L5M P) e.g. Java Developer / Computer Science / Informatics (L5M D) e.g. Senior Support Engineer / Higher Informatics (L5B NL) e.g. Multimedia Programmer / Informatics Multimedia (L5B D) e.g. Database Developer / Developer Software Applications (L4 NL)				
	ICT Integration and Administration (D)	e.g. Test Analyst / Informatics Applications Programmer (L4 P) e.g. Systems Supporter / Assistant Administrator ICT (L3 NL) e.g. ICT Systems Developer / Information Technology Specialist in Application Development (L3 D) e.g. VBA Programmer / Technical Assistant for Informatics (L2 D)				
	ICT Infrastructure and Integration (E)	e.g. Hardware Design Engineer / Electrical Engineering (L5M NL) e.g. Data Network Designer / Computer Science Engineering (L5B D) e.g. Interfaces Engineer / Telecommunications and ICT Engineer (L4 NL) e.g. Networks Technician / IT System Electronics (L3 D) e.g. Systems Operator / Informatics Assistant Technician (L2 P)				
	ICT Service and Maintenance (F)	e.g. Service Analyst / Technical Informatics / Computer Techniques (TI/TC) (L5M NL) e.g. TC Systems Tester / Telecommunications and Electronics (L5B P) e.g. ICT Service Manager / Master Information Technology (L4 D) e.g. Networks Fitter / Network (PC's) Maintenance Technicians (L3 P) e.g. Service Assistant / ICT Service Worker (L2 NL)				
		L2	L3	L4	L5B	L5M
ICT Business Area	ICT Work Area	ICT Practitioners (ICT Job / Training Profiles)				

These initial analysis results provide further information on ICT skill requirements in general, as shown in Figure 27.

Figure 27: Structure and categories of the business and work area oriented ICT skill needs in general



The skills of each generic ICT work area are specified below.

3.3.1.1. ICT marketing, consulting and sales skills

ICT marketing, consulting and sales is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. It applies to both the ICT industry and to companies of the ICT user industries (a key description being profit centre organisation). Successful marketing and sales of ICT products and services requires fundamental analyses of external and internal market and customer needs. Following various consultations, these requirements need to be translated into services and products that answer specific customer needs while providing benefits to the own company or department at the same time. These combinations of business and technical tasks ask for specific skills that justify the elaboration and delimitation of a generic ICT work area and corresponding skills at different levels.

3.3.1.2. ICT business and project management skills

ICT business and project management also combines business and ICT skills ensuring the work flow success of an ICT project and business process. Within a wide range of project

activities and responsibilities, business and project oriented ICT practitioners at different skill levels closely collaborate with internal and external ICT experts, providers and customers to ensure that customer business needs are met when developing and deploying infrastructure and software ICT solutions and services. Business oriented ICT practitioners constitute the crucial interface between the customer and primary ICT specialists and technicians. A common goal of business and technically oriented ICT practitioners is a clear description of the business requirements within the technical specification of the ICT solution to be developed. In shared responsibility, business and technically oriented ICT practitioners organise and implement applied support, training and instructions to the customer.

3.3.1.3. ICT systems and application development skills

ICT systems and application development covers far more than individual programming or coding. In this work area, practitioners at different skill levels work in development teams that design, realise, update, test and document ICT systems and software applications. The work is carried out based on comprehensive analyses and descriptions of ICT systems and applications needed by the market, a specific sector or a specific (internal or external) customer. In practice, contacts with the project manager and ICT business and technical practitioners within or outside the company are important. In the daily work processes, the transfer of technical and business requirements into a consistent data processing specification is crucial for the final success of ICT systems and application development process. Primary criteria for software solutions are reliability and usability. Furthermore, the work as part of a team often runs under time constraints and must be constantly well communicated and documented. The customer and users often need applied support, training and instructions.

3.3.1.4. ICT integration and administration skills

After the development of ICT systems and applications, these need to be professionally integrated, deployed, administered, optimised, supported, etc., depending on the platform the applications run on. ICT integration and administration teams configure, integrate, maintain and administer newly developed or already running systems and software applications. The work is carried out based on comprehensive analyses and descriptions of systems environments essential to final success in integration and deployment. In daily work processes, contacts with the project manager and ICT business and developers within or outside the company are important. The customer and users often need applied (help desk) support, training and instruction. As part of the (continuing and often contracted) technical support, systems and applications are optimised and upgraded, and troubleshooting needs to be coordinated and problems resolved at different levels.

3.3.1.5. ICT infrastructure and integration skills

ICT infrastructure and integration work covers the planning, integration, modification and installation of the wide range of different systems, devices, telecommunications, networks, etc., summarised as ICT infrastructure. The work is carried out based on problem oriented

analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. In practice, contacts with customers, project managers and ICT business and systems development practitioners within or outside the company are important. To realise the projects or project parts, and depending on the skill and responsibility level, ICT infrastructure practitioners need to consider aspects such as cost effectiveness, expandability and upgradeability, reliability, security, etc. The integration of standard, specific and innovative solutions (e.g. software applications, wireless network and telecommunication solutions, web-based infrastructure) is part of this work. The work, sometimes as part of a team, often runs under time constraints and must be constantly well communicated and documented. The customer and users often need applied support, training and instructions.

3.3.1.6. ICT service and maintenance skills

ICT service and maintenance primarily concerns analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft- and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to concrete technical problems, ICT service practitioners need to communicate well with customers, users and colleagues. As part of the service and maintenance, ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

Additional skills

By including the main contents and overall tasks within the six generic ICT work areas it becomes obvious that additional skills are also required. The need for these skills depends on the type and contents of the work. Such skills can be labelled ‘basic skills’ and summarised in three categories as listed below:

(a) behavioural and personal skills: flexibility, self learning, motivation and commitment, stress resistance and emotion, responsibility, managing risks, decision-making, negotiation, initiative and attention, persuasiveness, professional attitude (business or technical orientation and interests);

(b) cross section and basic work skills: quality awareness, commercial and market awareness, entrepreneurship, customer orientation and relationship, company and business organisation, work and project organisation, work safety and health protection, labour law and data privacy, environmental and resource awareness;

(c) soft and method skills: communication and moderation, languages and culture, collaboration and interaction, teamwork and mentoring, conflict and consensus, creative and innovation, analytical and reasoning, problem analysis and solving, strategy, conception and planning, context and causal connection thinking, information handling, documentation and presentation.

3.3.2. Case studies on skill needs at sub-degree levels: additional evaluation of ICT training profiles

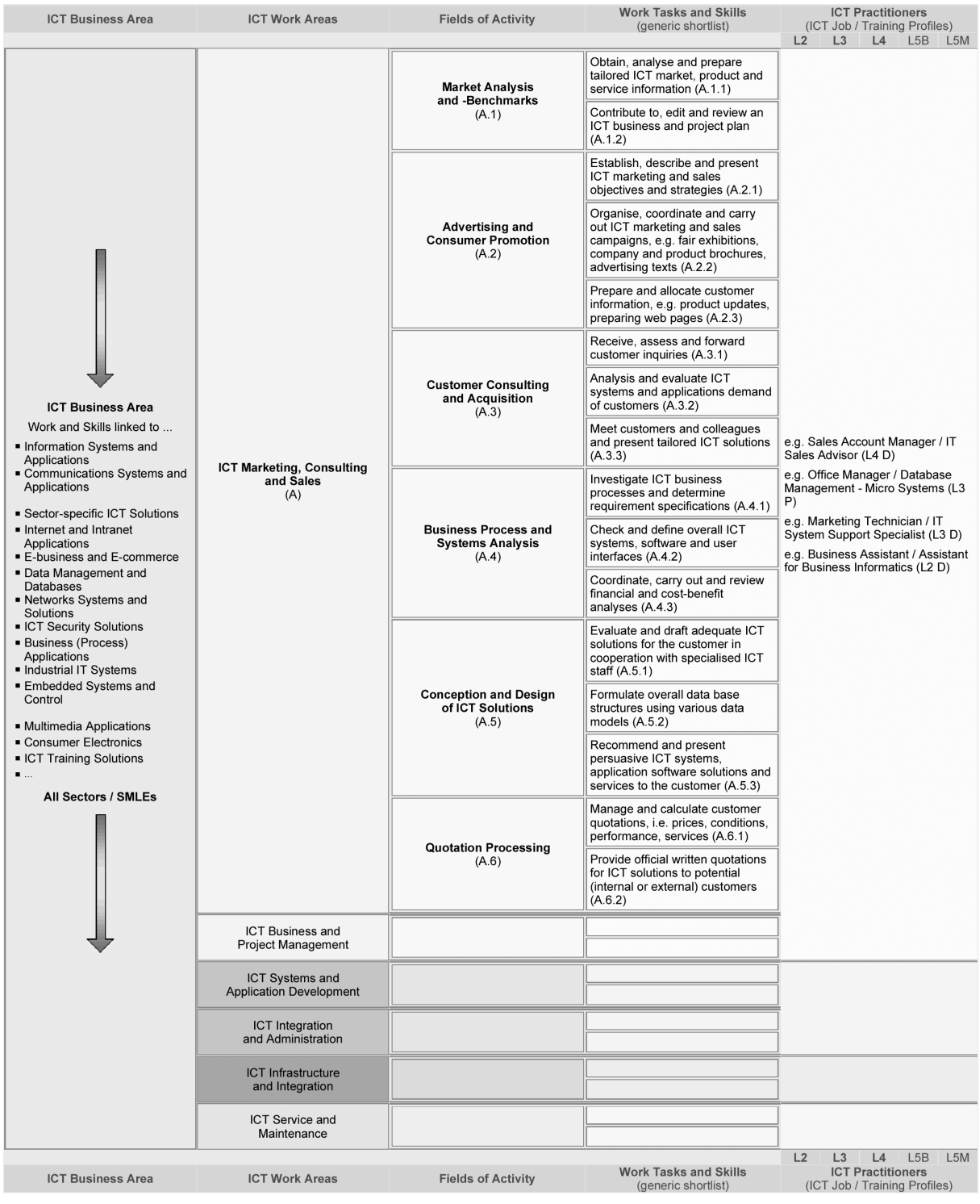
The third step in the case study concept allowed each ICT work process to be further subdivided into a number of phases of activity and each phase of activity into a certain number of ICT work tasks. In turn, the contents and structures of phases of activity can be aggregated into a structure of typical fields of activities. Similarly, all work tasks in each field of activity can be summarised into a structure of generic ICT work tasks. Just as ICT work areas constitute the basis for the overall framework of required ICT skills, these generic ICT work tasks are the basis for detailed work oriented sets of ICT skill needs.

ICT practitioners of different skill levels work together in teams. Equally, ICT work areas and fields of activities involve work tasks at all skill levels. However, the detailed case study investigations concentrated especially on ICT work tasks at sub-degree skill levels and input from practitioners with job and training profiles at sub-degree skill levels. Because the levels and contents of ICT work tasks are directly connected with the detail of ICT skill needs at sub-degree level, they have a specific importance for training profiles in each ICT work area. In addition, company evaluation of current ICT training profiles is also relevant to determining skill needs. If there is no, or very little, demand for an ICT training profile this indicates a mismatch between skills training and company skill needs. High demand indicates skill needs more or less as delivered by the ICT training skills and profiles. It is the combination of different analyses, therefore, that feeds recommendations on ICT training profile revision or demand for new generic ICT skill profiles based on industry needs. The following description of identified skill needs is presented separately for each of the six generic ICT work areas. This approach has been chosen because of the diversity of the findings and to guarantee an appropriate overview. However, since, in reality, ICT work areas are linked to each other – as are the tasks and skill needs – each detailed description includes a work oriented overview of all ICT work areas.

3.3.2.1. ICT marketing, consulting and sales

The case study results indicate within the work area ICT marketing, consulting and sales there are six ICT fields of activity and 16 work tasks and skills at sub-degree levels (see figure below). Each field of activity includes a generic shortlist of work tasks and skills at sub-degree levels (except for level 1), i.e. tasks mainly carried out by ICT practitioners with job and training profiles at sub-degree skill levels 2, 3 or 4 (L2, L3, L4).

Figure 28: ICT marketing, consulting and sales: work area, fields of activity and ICT work tasks and skills



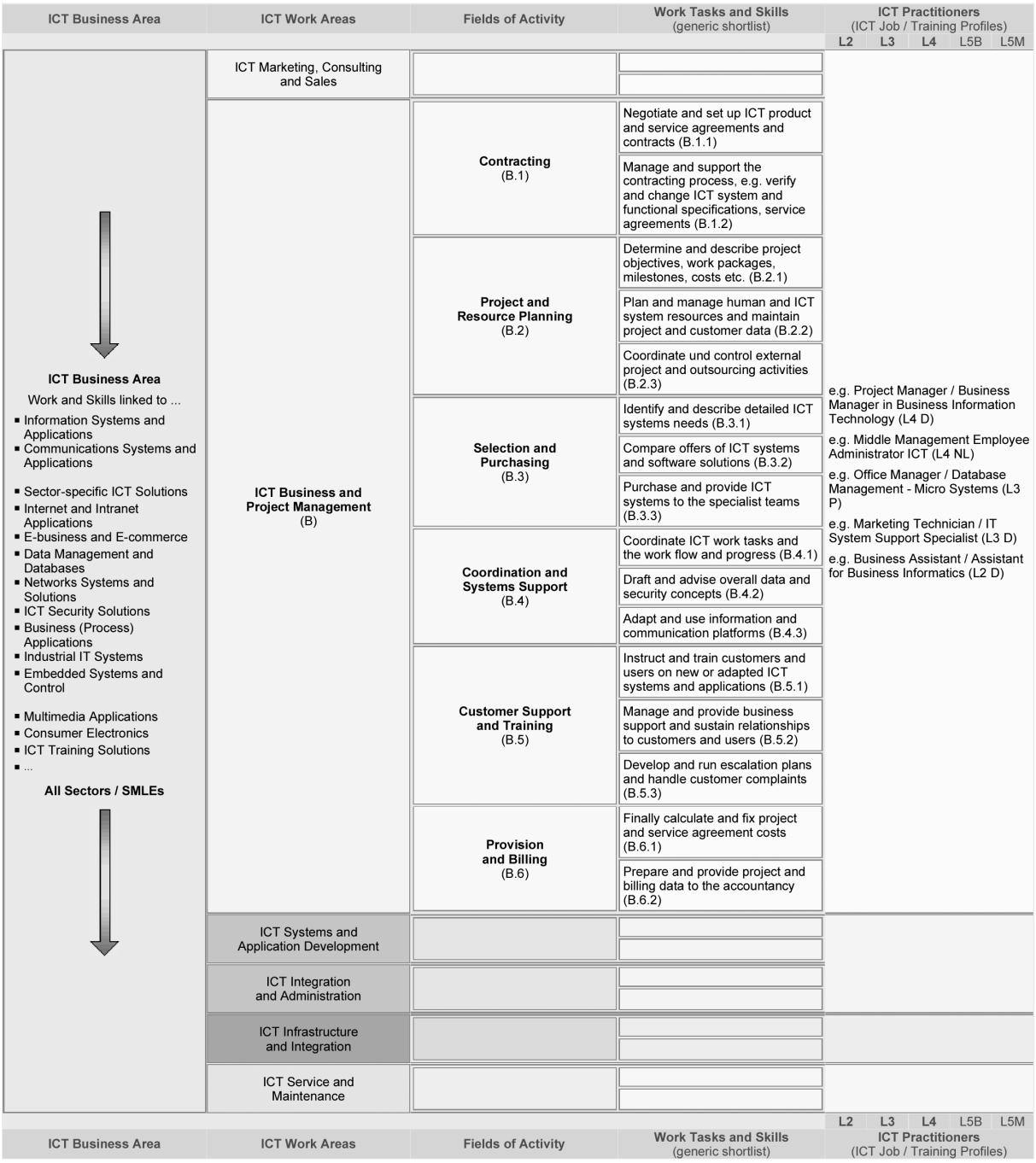
All the tasks and skill requirements have an economic technical orientation (denoted by yellow in the figure). The titles of the job profiles indicate which kind of ICT skills profiles are relevant for companies. The actual work requirement, and hence required skills, depends on factors such as content, level of responsibility and work organisation. For example, the task

‘Obtain, analyse and prepare tailored ICT market, product and service information’ covers more or less all sub-degree skill levels (L2, L3 and L4) while the task ‘Establish, describe and present ICT marketing and sales objectives and strategies’ covers mainly skill level 4 (L4). This ICT work area links economic and technical contents closely with the following one, so that should also be described before summarising skill needs for the two.

3.3.2.2. ICT business and project management

The case study results indicate that within the work area ICT business and project management there are six ICT fields of activity and 16 work tasks and skills at sub-degree levels (see figure below).

Figure 29: ICT business and project management: work area, fields of activity and ICT work tasks and skills



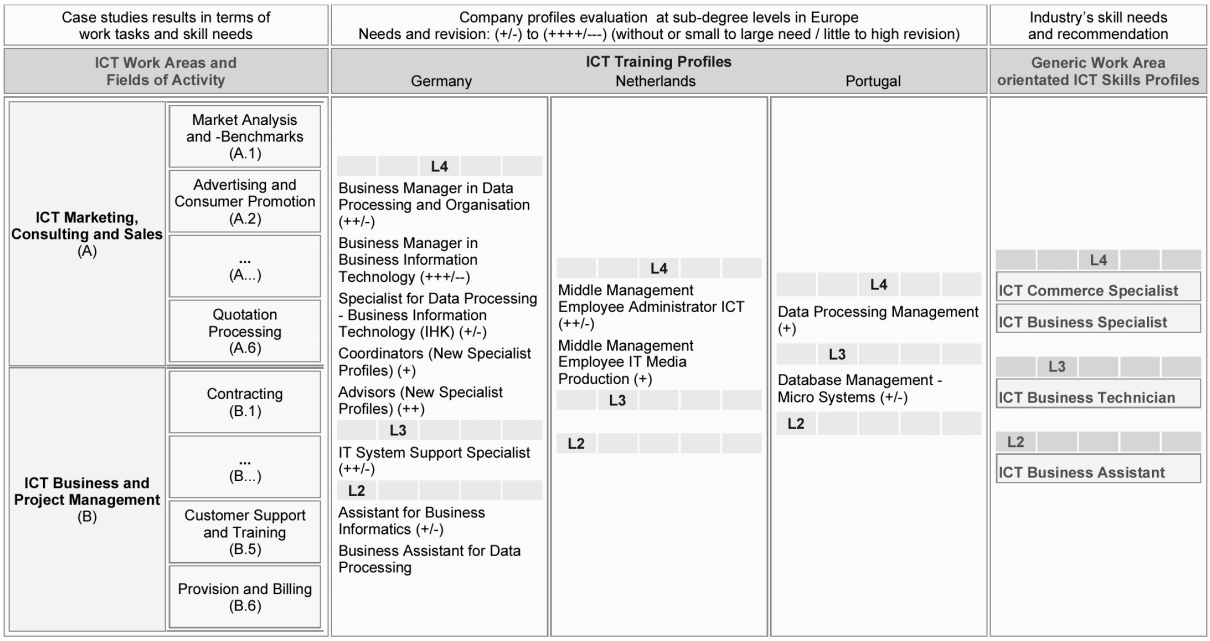
As with the previous area, each field of activity includes a generic shortlist of work tasks and skills at sub-degree levels, mainly carried out by ICT practitioners with job and training profiles at sub-degree skill levels 2, 3 or 4 (L2, L3, L4), but, again, omitting level 1. All tasks and skill contents have an economic technical orientation.

Examples of tasks include 'Manage and support the contracting process, e.g. verify and change ICT system and functional specifications, service agreements' skill levels 2 and 3 (L2

and L3) and ‘Coordinate and control external project and outsourcing activities’ or ‘Draft and advise overall data and security concepts’ covering skill level 4 (L4).

The job and training profiles of practitioners in both the areas with an economic technical orientation are comparable. The next question is to what extent these two work areas assist in producing an adequate structure for ICT skill needs in general, and also whether they match the needs identified in the ICT training skills and profiles evaluation.

Figure 30: Needs and recommendations for four economic technical orientation skills profiles at sub-degree levels

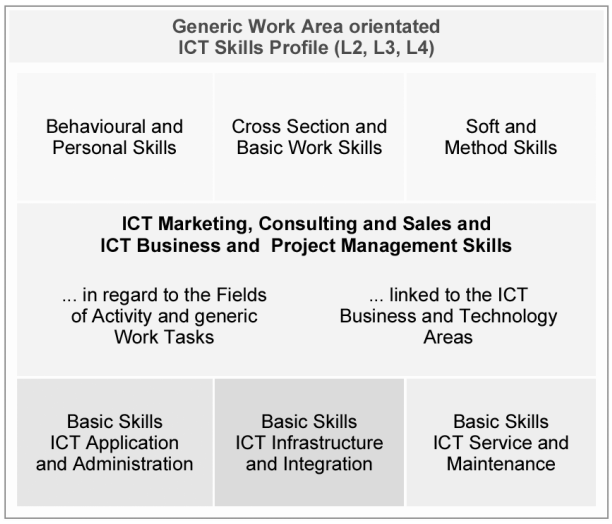


The company evaluation results provide a sample of training profiles with an economic technical orientation at sub-degree level in specific European countries. At first the results show that the numbers of current and relevant ICT training profiles for both ICT work areas differ significantly between countries. Each training profile is analysed according to company requirements and the need for revision, summarised in the table in a range ‘without or small to large need’ (+++) to ‘without or little to high revision (necessity)’ (---). These results add to the understanding of ICT skill needs insofar as, for example, the skills of the German ICT training profile IT system support specialist are generally required (++) by industry and the skills and contents are widely accepted but need a little revision (-).

The results of the various analyses can be transferred and integrated into a structure of four generic and work area oriented ICT skills profiles at sub-degree level. The recommendation is for two profiles at level 4 and one profile each at levels 3 and 2. The varying depth of the required skills and knowledge for these four generic work area oriented ICT skills profiles can be described in the following general profile and skill structure.

The primary part of the skills profile is the work area oriented 'skills kernel' relating to the fields of activity and generic ICT work tasks. This is the fundamental feature of the description and the skills described in the fields of activity and generic work tasks are directly linked to the ICT business and technology areas (see below). Furthermore, a set of complementary basic skills such as behavioural and personal skills is also needed to meet the work requirements in these generic ICT work areas, varying according to specific work tasks and skill levels. Ultimately, practitioners need some overall understanding of ICT business and work processes as a whole and thus basic skills in all work areas of the ICT business area. An ICT skills profile correspondingly also covers cross work area ICT skills expressed by the other three groups of generic ICT work areas. These basic skills also depend on specific work requirements and skill level.

Figure 31: Structure of the economic technical ICT skills profiles at sub-degree levels



One example of the business technical ICT skill needs is the generic work area oriented ICT skills profile ICT commerce specialist at sub-degree level 4. The major work area oriented skills of this profile cover 14 generic ICT work tasks in all the six fields of activity. The following descriptions also include basic skills.

Table 14: Generic work area oriented ICT skills profile: ICT commerce specialist at sub-degree level 4

1. Generic work area oriented ICT skills profile

ICT commerce specialist (L4)

2. Examples of job titles and training profiles (country)

- Sales account manager
- IT sales advisor (D)

3. Work and profile description

ICT marketing, consulting and sales is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. At first sight this generic ICT work area seem to apply to the ICT industry only but, for instance, structural changes in companies of the ICT user industries (key description: profit centre organisation) leads to consideration of such work areas. Increasingly 'internal' customers of ICT departments (e.g. in banks, insurance companies, industry departments such as accounting, production etc.) have the same requirements as external customers of their ICT suppliers; the provision of advice and guidance on how to support their business processes through the effective use of ICT products and services. Therefore, this work area covers external as well as internal processes in the ICT and ICT user industries.

The successful marketing and sales of ICT products and services requires fundamental analyses of external and internal market and customer needs. The most important step, however, is to translate these requirements into services and products that answer specific customer needs while providing benefits to the own company or department at the same time. The common goal of more business and technically oriented ICT practitioners is a clear description of the business requirements within the technical specification of the ICT solution to be developed. These combinations of business and technical tasks ask for specific skills and competences, justifying the elaboration and delimitation of the two generic ICT work areas and corresponding skills profiles at different skill levels.

ICT business specialists working in ICT marketing, consulting and sales' are responsible process 'chain links' guaranteeing work flow success from the very first steps, such as ICT market analysis and benchmarks to the quotation processing of ICT services. Within these different phases of activity and responsibilities, ICT business specialists closely collaborate with internal and external ICT experts, providers and customers in order to ensure that customers' business needs are met when developing and deploying infrastructure and software ICT solutions and services. Business oriented ICT practitioners constitute the crucial 'interface' between the customer and primary ICT specialists and technicians.

4. Behavioural and personal skills, cross section and basic work skills, soft and method skills

Behavioural and personal skills
- Flexibility
- Stress resistance and emotion
- Responsibility
- Managing risks
- Decision making
- Negotiation
- Influence and persuasiveness
- Professional attitude (business or technical orientation and interests)

Cross section and basic work skills
- Quality awareness
- Commercial and market awareness
- Entrepreneurship
- Customer orientation and relationship
- Company and business organisation
- Work and project organisation
- Work safety and health protection
- Labour law and data privacy
- Environmental and resource awareness

Soft and method skills
- Communication and moderation
- Languages and culture
- Collaboration and interaction
- Teamwork and mentoring
- Conflict and consensus
- Creative and innovation
- Problem analysis and solving
- Strategy, conception and planning
- Documentation and presentation

5. ICT marketing, consulting and sales specialist skills

in regard to the fields of activity and generic work tasks

- Market analysis and benchmarks
  - obtain, analyse and prepare tailored ICT market, product and service information
  - contribute to, edit and review an ICT business and project plan
- Advertising and consumer promotion
  - establish, describe and present ICT marketing and sales objectives and strategies (e.g. strategic planning, e-marketing and e-sales, network marketing and sales, direct marketing and sales)
  - organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts
- Customer consulting and acquisition
  - receive, assess and forward customer inquiries
  - analyse and evaluate ICT systems and applications demand of customers
  - meet customers, colleagues and present ICT solutions
- Business process and systems analysis
  - investigate ICT business processes and determine requirement specifications

... linked to the ICT business and technology areas

- Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
- Sector-specific ICT solutions (financial services, health etc.)
- Internet and intranet systems and applications (web design, service providing etc.)
- e-business and e-commerce solutions (B2B, B2C etc.)
- Data management and database solutions (process databases, backup and recovery systems etc.)
- Networks systems and solutions (LAN, ATM etc.)
- ICT security solutions (antivirus, firewall, VPN etc.)
- Business (process) systems and applications (CRM, ERP etc.)
- Industrial IT systems (industrial and process automation etc.)
- Embedded systems and control (diagnostics, monitoring etc.)

- coordinate, carry out and review financial and cost-benefit analyses

- Conception and design of ICT solutions
  - evaluate and draft adequate ICT solutions for the customer in cooperation with specialised ICT staff
  - formulate overall data base structures using various data models
  - recommend and present persuasive ICT systems, application software solutions and services to the customer
- Quotation processing
  - manage and calculate customer quotations, i.e. prices, conditions, performance, services
  - provide official written quotations for ICT solutions to potential (internal or external) customers

- Multimedia systems and applications (video, simulations etc.)
- Consumer and entertainment electronics (computer games etc.)
- ICT training solutions (customer seminars, blended learning etc.)
- ...

6. Cross work area basic ICT skills

Basic skills ICT application and administration

- Differentiate and describe the architecture of ICT systems and software solutions (e.g. client-server, mainframes, web services)
- Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL, case tools)
- Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems)
- Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, C, C++, Java, Cobol, JSP, JavaScript, ABAP, HTML, XML)
- Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL)

Basic skills ICT infrastructure and integration

- Provide, install and upgrade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)
- Differentiate and describe appropriate interface bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)
- Differentiate and describe ICT infrastructure and networks structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)
- Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)
- Arrange the delivery of ICT systems and infrastructure solutions

Basic skills ICT service and maintenance

- Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)
- Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues)
- Handle and relay customer complaints
- Update and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)
- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)
- Differentiate ICT Test and measurement instruments, analysers and software (e.g. Cable, EMV, ISDN, ATM, GRPS, LAN , WLAN, VOIP)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, ICT commerce specialists working in ICT marketing, consulting and sales must be aware of the need for lifelong learning (LLL) both, in terms of more informatics and technology subjects but chiefly economic technical aspects like market developments and trends. Based on some years work and project experience as an ICT commerce specialist, the next stage of a career in the work area ICT marketing, consulting and sales is described in the relevant ICT skill profiles at degree level 5B, e.g. Career Space. This role, for instance, involves more responsible consulting and strategic work, e.g. marketing and sales strategies, product management, external product promotion.

3.3.2.3. ICT systems and application development

The case studies indicate that within this work area there are six ICT fields of activity and 19 work tasks and skills at sub-degree levels (see Figure 32).

Figure 32: ICT systems and application development: work area, fields of activity and ICT work tasks and skills

ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M
ICT Business Area Work and Skills linked to ... ▪ Information Systems and Applications ▪ Communications Systems and Applications ▪ Sector-specific ICT Solutions ▪ Internet and Intranet Applications ▪ E-business and E-commerce ▪ Data Management and Databases ▪ Networks Systems and Solutions ▪ ICT Security Solutions ▪ Business (Process) Applications ▪ Industrial IT Systems ▪ Embedded Systems and Control ▪ Multimedia Applications ▪ Consumer Electronics ▪ ICT Training Solutions ▪ ... **All Sectors / SMLEs**	ICT Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development (C)	**Requirement Analysis and Consulting** (C.1)	Investigate and review ICT systems and application requirements of the client and users (C.1.1)	e.g. Database Developer / Developer Software Applications (L4 NL) e.g. Test Analyst / Informatics Applications Programmer (L4 P) e.g. Software Developer / Information Technology Specialist in Application Development (L3 D) e.g. ICT Systems Developer / Informatics Technician (L3 P) e.g. VBA Programmer / Technical Assistant for Informatics (L2 D)
			Determine and specify concrete hardware and software needs (C.1.2)	
			Recommend an adequate and tailored ICT solution to the customer (C.1.3)	
			Write (parts of) the technical, ICT system and functional specification (C.1.4)	
		Work- and Project Planning (C.2)	Manage and specify own work and project priorities using project management tools (C.2.1)	
			Accompany, monitor and lead the development process of the ICT solution and ensure progress, quality, configuration management etc. (C.2.2)	
			Test, choose and set up software and systems development tools (C.2.3)	
		Design and Conception (C.3)	Define and design of the ICT systems and software architecture and distribution (e.g. Client/Server, Mainframe, CORBA) considering latest research results (C.3.1)	
			Analyse and define objects, frameworks, basic software classes, systems components, interfaces etc. (C.3.2)	
			Create and specify concepts, prototyping, data structures, access, data base models etc. (C.3.3)	
			Determine and describe software units, methods, attributes, modules, I/O-parameters etc. (C.3.4)	
		Programming and Implementation (C.4)	Code, adapt and document systems and software applications, e.g. in 3GL and with 4GL development tools (C.4.1)	
			Implement data base connection as well as web and e-commerce applications (C.4.2)	
			Version and register new software and database applications (C.4.3)	
		Testing and Release (C.5)	Develop and coordinate test procedures and cases (C.5.1)	
			Run, interpret and document ICT systems and software tests by using various test tools, methods and data (C.5.2)	
			Give change instructions and run debugging (C.5.3)	
		Documentation (C.6)	Write (parts of) the installation and user instructions and ICT systems and application manuals (C.6.1)	
			Document the work following overall and company standards, e.g. info and help centre, change management (C.6.2)	
	ICT Integration and Administration			
	ICT Infrastructure and Integration			
	ICT Service and Maintenance			
ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M

Each field of activity includes a generic shortlist of work tasks and skills at sub-degree levels (except for level 1) with tasks and skill content detail being oriented to informatics/communications. The titles of the ICT job profiles indicate which kind of ICT skills profiles are relevant for companies. The actual work requirement, and hence the required skills, depends on factors such as content, level of responsibility and work organisation. For example, the major task 'Code, adapt and document systems and software applications, e.g. in 3GL and with 4GL development tools' within the implementation phases includes work and requirements at more or less all sub-degree skill levels (L2, L3 and L4). In contrast, the task 'Develop and coordinate test procedures and cases' includes work and requirements mainly at skill level 4 (L4).

This ICT work area focuses on informatics/communications technical contents as does the following one, so that should also be described before finishing and summarising the results on the skill needs for these two ICT work areas.

3.3.2.4. ICT integration and administration

The case studies indicate that within this work area are six ICT fields of activity and 20 work tasks and skills at sub-degree levels (see Figure 33).

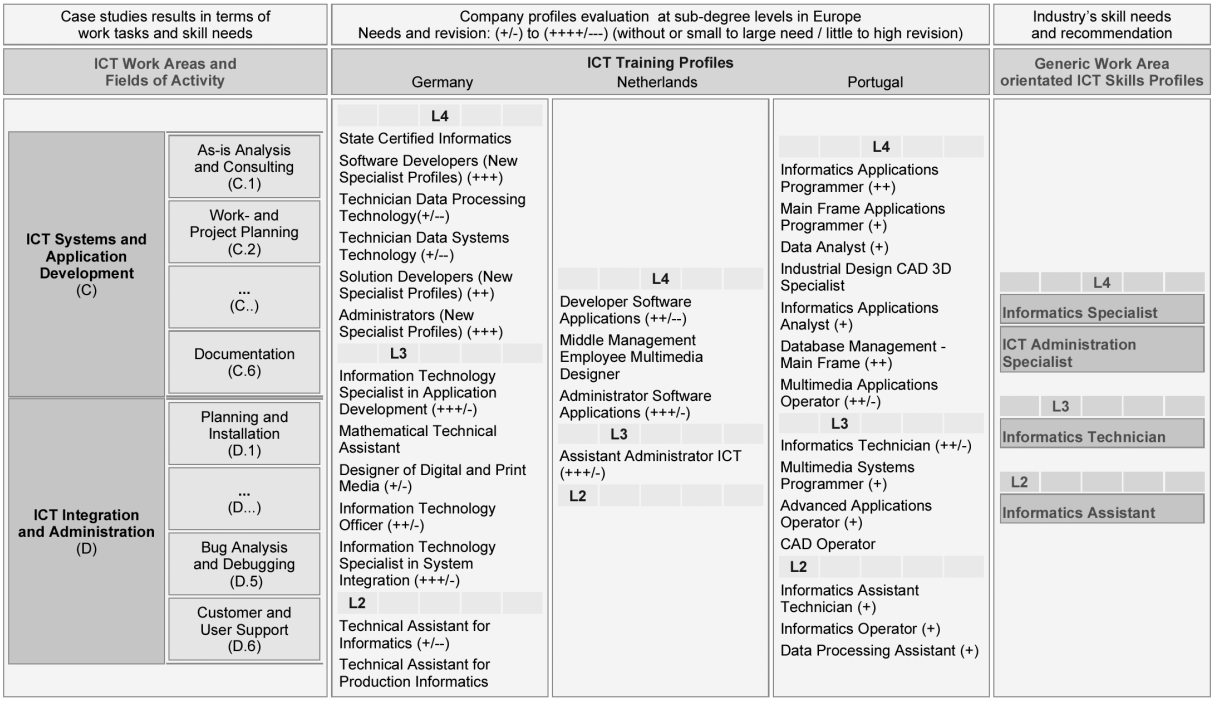
Each field of activity includes a generic shortlist of work tasks and skills at sub-degree levels (except for level 1) with tasks and skill contents oriented to ICT integration and administration. After ICT systems and applications are developed they need to be professionally integrated, deployed, administered, optimised, supported, etc., depending on the platform the applications run on. Examples of job profiles indicate that more administration and support ICT skills profiles are relevant in this work area. The level of each ICT work task requirement, and hence required skills, depends on factors such as content, level of responsibility and work organisation. For example, the task 'Optimise and actualise ICT systems, e.g. hardware, operating system, libraries' within the administration phases includes work and requirements at more or less all sub-degree skill levels (L2, L3 and L4). In contrast, the task 'Manage and run software distribution, remote configuration, data archiving, retrieving and reorganisation' includes work and requirements mainly at skill level 4 (L4) and the task 'Arranging ICT system and software security' primarily requires skills at level 3 (L3).

Figure 33: ICT integration and administration: work area, fields of activity and ICT work tasks and skills

ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M
ICT Business Area Work and Skills linked to ... ▪ Information Systems and Applications ▪ Communications Systems and Applications ▪ Sector-specific ICT Solutions ▪ Internet and Intranet Applications ▪ E-business and E-commerce ▪ Data Management and Databases ▪ Networks Systems and Solutions ▪ ICT Security Solutions ▪ Business (Process) Applications ▪ Industrial IT Systems ▪ Embedded Systems and Control ▪ Multimedia Applications ▪ Consumer Electronics ▪ ICT Training Solutions ▪ ... **All Sectors / SMLEs**	ICT Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development			
	ICT Integration and Administration (D)	**Planning and Installation** (D.1)	Advise the ICT systems and software development teams and customers on systems and software installation and operation (D.1.1)	
			Assemble and test ICT systems, e.g. hardware, operating system, drivers (D.1.2)	
			Clarify and describe hardware and software requirements for the installation and integration of ICT systems and applications (D.1.3)	
			Plan and prepare automatic software installations (D.1.4)	
			Manual and automatic installation and adaptation of operating systems, data bases and application software (D.1.5)	
		Integration and Configuration (D.2)	Control compatibility between devices and ICT systems (D.2.1)	
			Check and adapt installation and configuration parameters to new and real circumstances (D.2.2)	
			Implement communication software and ensuring data mining and exchange (D.2.3)	e.g. Database Administrator / Administrator Software Applications (L4 NL)
			Plan and set up systems parameters and user administration (D.2.4)	e.g. Test Analyst / Informatics Applications Programmer (L4 P)
		ICT Training and Instruction (D.3)	Elaborate and edit training and instruction material (D.3.1)	e.g. Software Developer / Information Technology Specialist in Application Development (L3 D)
			Plan and run tailored training and instruction for customers and users (D.3.2)	e.g. ICT Systems Supporter / Assistant Administrator ICT (L3 P)
			Evaluate training measures and suggest improvements (D.3.3)	e.g. Application Supporter / Data Processing Assistant (L2 P)
		System Administration and Optimisation (D.4)	Optimise and actualise ICT systems, e.g. hardware, operating system, libraries (D.4.1)	
			Arrange and guarantee ICT system and software security and data backup and restore (D.4.2)	
			Manage and run software distribution, remote configuration, data archiving, retrieving and reorganisation (D.4.3)	
		Bug Analysis and Debugging (D.5)	Receive, interpret and forward ICT systems and application problems (D.5.1)	
			Localise and remove bugs personally or coordinate external support (D.5.2)	
		Customer and User Support (D.6)	Organise and improve customer and user support (D.6.1)	
			Support the calculation and billing of ICT administration and services (D.6.2)	
			Manage and run remote and on site customer and (end-)user support (D.6.3)	
	ICT Infrastructure and Integration			
	ICT Service and Maintenance			
ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M

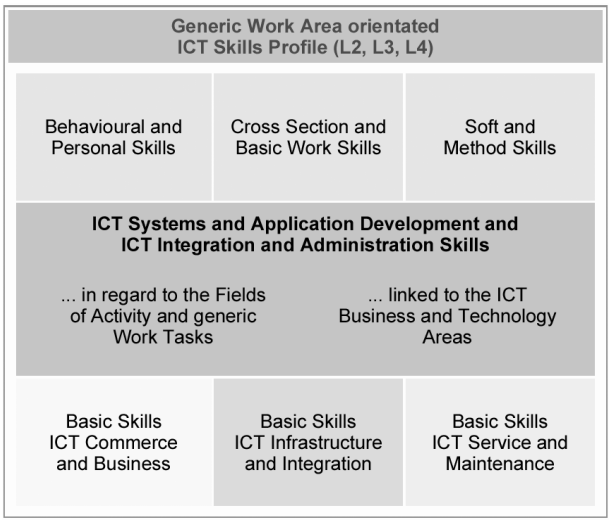
Practitioner job and training profiles in these two informatics/communications technically oriented ICT work areas are comparable. As with the commerce and business skills profiles, the question is to what extent these identify ICT skill needs in general and also whether they match the ICT training skills and profiles evaluation results. The company survey on current ICT training profiles comprises a significant sample of more informatics/communications technically oriented profiles at sub-degree levels in specific European countries. For instance, at skill level 4 there are ICT training profiles ranging from software analysis and development to administration in all countries. There is also a wide range of ICT training profiles in these work areas at skill levels 3 and 2 in Germany and Portugal, but little in the Netherlands (see Figure 34). The survey results on company needs and the necessity for revision indicate, for instance, a significant need but also little revision in relation to profiles such as 'administrator software applications (+++/-)' at level 4 in the Netherlands and 'information technology specialist in application development' at level 3 in Germany.

Figure 34: Needs and recommendations for four informatics/communications technical skills profiles at sub-degree levels



The case study results, in terms of work tasks and skills, together with the company evaluation of current training profiles, indicate skill needs for the two informatics/communications technically oriented ICT work areas. The results can also be integrated into a structure of four generic and work area oriented ICT skills profiles. The specific recommendation for ICT skill needs is two profiles at level 4 and one each at levels 3 and 2. The varying depth of the required skills and knowledge for these four generic work area oriented ICT skills profiles can be described in the following general profile and skill structure.

Figure 35: Structure of the informatics/communications technical ICT skills profiles at sub-degree levels



One example of the informatics/communications technical ICT skill needs, the profile informatics technician at sub-degree level 3, is described below in detail. The major work area oriented skills of this profile cover 30 generic ICT work tasks in all the 12 fields of activity. As with all generic ICT skills profiles, there is also a need for basic skills.

Table 15: ICT skills profile informatics technician at sub-degree level 3

1. Generic work area oriented ICT skills profile

Informatics technician (L3)

2. Examples of job titles and training profiles (country)

- Software developer
- ICT systems developer
- Information technology specialist in application development (D)
- Informatics technician (P)

3. Work and profile description

ICT systems and application development and ICT integration and support are comprehensive work areas covering far more than just individual programming or coding. In these work areas informatics technicians work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using existing modelling and engineering methods, development tools and languages, (O).D.B.M.S. ((object-oriented) database management system) etc. Depending on the specific ICT business area, the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications etc.

The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer. Informatics technicians take over responsible parts in this work, usually as self-organised team members. In practices, permanent contacts to the project and team manager and ICT business and technical practitioners within or outside the company are important, e.g. ICT consultants, ICT infrastructure practitioners, research groups etc.

In the daily work processes the transfer of the technical and business requirements to be clearly defined in the 'technical specification' into a consistent 'data processing specification' is crucial for the final success of ICT systems and application development as well as the final integration and deployment process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented. Ultimately, the customer and users often need applied (help desk) support, training and instructions. As part of the (continuous and often contracted) technical support systems and applications are optimised and upgraded and troubleshooting need to coordinated and problems resolved.

4. Behavioural and personal skills, cross section and basic work skills, soft and method skills

Behavioural and personal skills	Cross section and basic work skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Self learning	▪ Commercial and market awareness	▪ Languages and culture
▪ Motivation and commitment	▪ Entrepreneurship	▪ Collaboration and interaction
▪ Stress resistance and emotion	▪ Customer orientation and relationship	▪ Teamwork
▪ Responsibility	▪ Company and business organisation	▪ Creative and innovation
▪ Decision-making	▪ Work organisation	▪ Analytical and reasoning
▪ Initiative and attention	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Professional attitude (business or technical orientation and interests)	▪ Labour law and data privacy	▪ Context and causal connection thinking
	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT systems and application development and ICT integration and administration technician skills

in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas
▪ Requirement analysis and consulting - investigate and review ICT systems and application requirements of the client and users - determine and specify concrete hardware and software needs - recommend an adequate and tailored ICT solution to the customer - write (parts of) the technical, ICT system and functional specification ▪ Work- and project planning - manage and specify own work and project priorities using project management tools - test, choose and set up software and systems development tools ▪ Design and conception - create and specify concepts, prototyping, data structures, access, data base models etc. - determine and describe software units, methods, attributes, modules, I/O-parameters etc. ▪ Programming and implementation - code, adapt and document systems and software applications, e.g. in 3GL and with 4GL development tools - implement data base connection as well as web and e-commerce applications	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.) ▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.) ▪ Sector-specific ICT solutions (financial services, health etc.) ▪ Internet and intranet systems and applications (web design, service providing etc.) ▪ e-business and e-commerce solutions (B2B, B2C etc.) ▪ Data management and database solutions (process databases, backup and recovery systems etc.) ▪ Networks systems and solutions (LAN, ATM etc.) ▪ ICT security solutions (antivirus, firewall, VPN etc.) ▪ Business (process) systems and applications (CRM, ERP etc.) ▪ Industrial IT systems (industrial and process automation etc.) ▪ Embedded systems and control (diagnostics, monitoring etc.) ▪ Multimedia systems and applications (video, simulations etc.)

- version and register new software and database applications
- Testing and release
  - run, interpret and document ICT systems and software tests by using various test tools, methods and data
  - give change instructions and run debugging
- Documentation
  - write (parts of) the installation and user instructions and ICT systems and application manuals
  - document the work following overall and company standards, e.g. info and help centre, change management
- Planning and installation
  - assemble and test ICT systems, e.g. hardware, operating system, drivers
  - clarify and describe hardware and software requirements for the installation and integration of ICT systems and applications
  - manual and automatic installation and adaptation of operating systems, data bases and application software
- Integration and configuration
  - control compatibility between devices and ICT systems
  - check and adapt installation and configuration parameters to new and real circumstances
  - implement communication software and ensuring data mining and exchange
  - plan and set up systems parameters and user administration
- ICT Training and instruction
  - elaborate and edit training and instruction material
  - plan and run tailored training and instruction for customers and users
- System administration and optimisation
  - optimise and actualise ICT systems, e.g. hardware, operating system, libraries
  - arrange and guarantee ICT system and software security and data backup and restore
- Bug analysis and debugging
  - receive, interpret and forward ICT systems and application problems
  - localise and remove bugs personally or coordinate external support
- Customer and user support
  - support the calculation and billing of ICT administration and services
  - manage and run remote and on site customer and (end-)user support

- Consumer and entertainment electronics (computer games etc.)
- ICT training solutions (customer seminars, blended learning etc.)
- …

6. Cross work area basic ICT skills

Basic skills ICT commerce and business

- Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)
- Describe the impact of innovative ICT developments and trends (e.g. hardware, software, internet, services)
- Collaborate within customers quotations, consulting, contracting and project processing
- Self-responsible and project related support of customers and users
- Provide project data for invoicing and accountancy

Basic skills ICT infrastructure and integration

- Provide, install and upgrade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)
- Differentiate and describe appropriate interface bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)
- Differentiate and describe ICT infrastructure and networks structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)
- Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)

Basic skills ICT service and maintenance

- Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)
- Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues)
- Handle and relay customer complaints
- Update and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)
- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities
Due to the rapid developments and changes in technologies, methods and process organisation, informatics technicians must be aware of the need for lifelong learning (LLL) both, in terms of primary informatics and technology subjects and overall aspects such as ICT business process and market developments and trends. Based on some years work and project experience as an informatics technician next stage of a career in the work area ICT systems and application development and ICT integration and support is described in the ICT skill profiles informatics specialist and ICT administration specialist at sub-degree level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

3.3.2.5. ICT infrastructure an integration

The case studies indicate that within this work area are six ICT fields of activity and 19 work tasks and skills at sub-degree levels (see Figure 36).

The work tasks and skill contents within the six fields of activity at the three sub-degree levels are focused on technical and organisational aspects of the entire ICT infrastructure, including its installation, integration and configuration. Titles of ICT job profiles indicate the skills profiles that are relevant to companies and in specific European countries. The actual work requirement, and hence required skills, depends on factors such as content, level of responsibility and work organisation. For example, the task 'Receive, assess and forward new customer orders' within the first phases includes work and requirements at more or less all sub-degree skill levels (L2, L3 and L4), though dependent on the customer. The task 'Blueprint and determine ICT systems and network solutions and adaptations' includes work and requirements mainly at skill level 4 (L4).

Figure 36: ICT infrastructure and integration: work area, fields of activity and ICT work tasks and skills

ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M
ICT Business Area Work and Skills linked to ... ▪ Information Systems and Applications ▪ Communications Systems and Applications ▪ Sector-specific ICT Solutions ▪ Internet and Intranet Applications ▪ E-business and E-commerce ▪ Data Management and Databases ▪ Networks Systems and Solutions ▪ ICT Security Solutions ▪ Business (Process) Applications ▪ Industrial IT Systems ▪ Embedded Systems and Control ▪ Multimedia Applications ▪ Consumer Electronics ▪ ICT Training Solutions ▪ ... **All Sectors / SMLEs**	ICT Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development			
	ICT Integration and Administration			
	ICT Infrastructure and Integration (E)	**Customer Consulting** (E.1)	Advise and influence colleagues and customers on new or extended ICT infrastructure solutions (E.1.1)	e.g. Interfaces Engineer / Telecommunications and ICT Engineer (L4 NL) e.g. Networks Technician / IT System Electronics (L3 D) e.g. Systems Operator / Informatics Assistant Technician (L2 P)
			Determine, specify and describe technical requirements (E.1.2)	
			Write (parts of) the ICT infrastructure and functional specification (E.1.3)	
		Task Adoption and Work Planning (E.2)	Receive, assess and forward new customer orders (E.2.1)	
			Arrange the time schedule and coordinate work tasks (E.2.2)	
			Clarify work order details with colleagues and the customer (E.2.3)	
		ICT Systems Planning and Installation Preparation (E.3)	Ensure, select and use latest ICT product and service information and requirements, also in foreign languages (E.3.1)	
			Blueprint and determine ICT systems and network solutions and adaptations (E.3.2)	
			Develop and present an ICT systems integration and security concept (E.3.3)	
			Plan, test and document new ICT systems and prototypes in test and real operating environments (E.3.4)	
			Order and dispose installation material (E.3.5)	
		Installation, Integration and Configuration (E.4)	Install and up-grade ICT systems and networks devices and components (E.4.1)	
			Manual and automatic installation and configuration of operating systems, applications and communication software etc. (E.4.2)	
			Plan and ensure ergonomics, interoperability, power supply and security of installed ICT infrastructure, applications and data (E.4.3)	
			Decommission and recycle old ICT infrastructure (E.4.4)	
		Commissioning and Documentation (E.5)	Test and verify requested function of installed and integrated ICT systems (E.5.1)	
			Prepare and compile ICT systems and installation documentations (E.5.2)	
		Delivery, Instruction and Finalising (E.6)	Deliver installed and integrated ICT systems and instruct and train ICT support staff and users (E.6.1)	
			Document the work, e.g. working hours, used material, resources, problems (E.6.2)	
			Provide project and billing data to the manager and accountancy (E.6.3)	
	ICT Service and Maintenance			
ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M

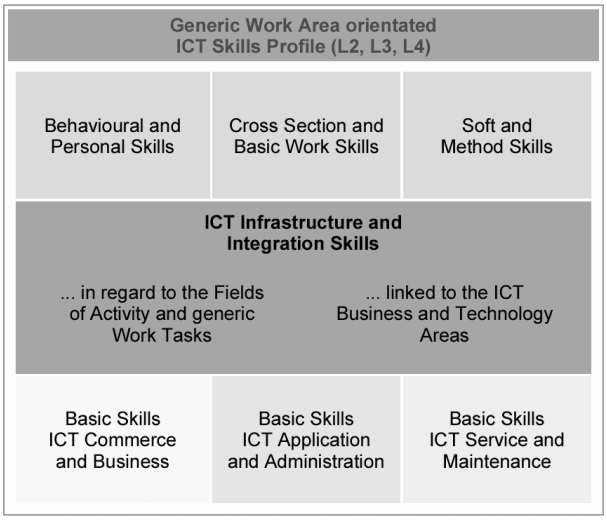
ICT practitioner job and training profiles oriented to technical and infrastructure matters are partly comparable but also have differences. Analysis, therefore, is important not just for ICT skill needs in general, but also in the context of the skills profiles evaluation. The company survey comprises a significant sample of technical and ICT infrastructure oriented ICT training profiles at sub-degree levels in specific European countries. For instance, at skill level 4 there are four ICT training profiles available in Germany and the Netherlands focusing on technical aspects such as informatics, telecommunications or specific problems such as computer interfaces. There are two ICT training profiles each at skill levels 3 and 2 in these countries, whereas in Portugal the number of profiles is less (see Figure 37). The survey results on company needs and the necessity for revision indicate, for example, a medium level need but also necessity for revision of profiles such as 'technician in technical informatics (++/--) or technician communication systems (TCS) (++/--)' at level 4 in Germany and the Netherlands, or 'IT system electronics (++/-)' at level 3 in Germany.

Figure 37: Needs and recommendation for three infrastructure and integration skills profiles at sub-degree levels

Case studies results in terms of work tasks and skill needs		Company profiles evaluation at sub-degree levels in Europe Needs and revision: (+/-) to (++++/----) (without or small to large need / little to high revision)			Industry's skill needs and recommendation
ICT Work Areas and Fields of Activity		ICT Training Profiles Germany	Netherlands	Portugal	Generic Work Area orientated ICT Skills Profiles
ICT Infrastructure and Integration (E)	Customer Consulting (E.1)				
	Task Adoption and Work Planning (E.2)				
	ICT Systems Planning and Installation Preparation (E.3)	L4 Technician in Technical Informatics (++/--) Technician in Information- and Communications Technology (+/-) Technician in Radio Communication Technicians (New Specialist Profiles) (+) L3 IT System Electronics (++/-) Communication Electronic Technician (+/-) L2 Technical Assistant for Data Processing (+/-) Information and Communications Technology Assistant (+/--)	L4 Technician Communications Systems (TCS) (++/--) Telecommunications and ICT Engineer (++/-) Middle Management Employee Computer Interface Engineering (++/--) Technician Electrical Industrial Plants L3 First Craftsman Communications Networks First Craftsman Communication Installations (+/-) L2 Craftsman Communications Networks (+) Craftsman Communication Installations (+/-)	L4 Micro Network Management and Installation Technician (++) L3 Data Processing Technician (+) Hardware Technician (+) L2	L4 ICT Systems Specialist L3 ICT Systems Technician L2 ICT Systems Assistant
	Installation, Integration and Configuration (E.4)				
	Testing and Documentation (E.5)				
	Delivery, Instruction and Finalising (E.6)				

The case study results in terms of tasks and skills, together with the company evaluations on the current training profiles, indicate industry's skill needs in the generic work area ICT infrastructure and integration. The results can be integrated into a structure of three generic work area oriented ICT skills profiles, with a specific recommendation for one ICT skills profile at each sub-degree level. The varying depth of the required skills and knowledge for these three generic work area oriented ICT skills profiles can be described in the following general profile and skill structure.

Figure 38: Structure of the infrastructure and integration ICT skills profiles at sub-degree levels



One example of ICT infrastructure and integration skill needs, the generic work area oriented skills profile ICT systems assistant at sub-degree level 2, is described in detail below. The work area oriented skills of this profile cover 12 generic ICT work tasks in all the six fields of activity. As with all generic ICT skills profiles, the following descriptions also look at basic skills.

Table 16: ICT skills profile ICT systems assistant at sub-degree level 2

1. Generic work area oriented ICT skills profile

ICT systems assistant (L2)

2. Examples of job titles and training profiles (country)

- Systems operator
- Informatics assistant technician (P)

3. Work and profile description

ICT infrastructure and integration work covers the planning, integration, modification and installation of the wide range of different ICT systems, devices, telecommunications, networks etc., summarised as ICT infrastructure. The work is carried out based on problem oriented analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. ICT systems assistants use these information for the description of what is needed in concrete cases. For this contacts to customers, project managers and ICT business and systems development practitioners within or outside the company may have some importance but may not be carried out by assistants. However, for the realisation and integration of ICT infrastructure solutions such as networks or telecommunications, ICT systems assistants need to consider aspects such as reliability, cost effectiveness, upgradeability etc. The integration of standard solutions (e.g. software applications, wireless network and telecommunication solutions, web-based infrastructure) is part of this work. The work, sometimes as part of a team, must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions.

4. Behavioural and personal skills, cross section and basic work skills, soft and method skills

Behavioural and personal skills	Cross section and basic work skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Self learning	▪ Customer orientation and relationship	▪ Languages and culture
▪ Motivation and commitment	▪ Company and business organisation	▪ Collaboration and interaction
▪ Responsibility	▪ Work safety and health protection	▪ Teamwork
▪ Initiative and attention	▪ Labour law and data privacy	▪ Creative and innovation
▪ Professional attitude (business or technical orientation and interests)	▪ Environmental and resource awareness	▪ Problem analysis and solving ▪ Documentation and presentation

5. ICT infrastructure and integration assistant skills

in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas
▪ Customer consulting - determine, specify and describe technical requirements ▪ Task adoption and work planning - receive, assess and forward new customer orders - clarify work order details with colleagues and the customer ▪ ICT systems planning and installation preparation - ensure, select and use latest ICT product and service information and requirements, also in foreign languages - plan, test and document new ICT systems and prototypes in test and real operating environments - order and dispose installation material ▪ Installation, integration and configuration - install and up-grade ICT systems and networks devices and components - manual and automatic installation and configuration of operating systems, applications and communication software etc. - decommission and recycle old ICT infrastructure ▪ Commissioning and documentation - test and verify requested function of installed and integrated ICT systems ▪ Delivery, instruction and finalising - document the work, e.g. working hours, used material, resources, problems - provide project and billing data to the manager and accountancy	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.) ▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.) ▪ Sector-specific ICT solutions (financial services, health etc.) ▪ Internet and intranet systems and applications (web design, service providing etc.) ▪ e-business and e-commerce solutions (B2B, B2C etc.) ▪ Data management and database solutions (process databases, backup and recovery systems etc.) ▪ Networks systems and solutions (LAN, ATM etc.) ▪ ICT security solutions (antivirus, firewall, VPN etc.) ▪ Business (process) systems and applications (CRM, ERP etc.) ▪ Industrial IT systems (industrial and process automation etc.) ▪ Embedded systems and control (diagnostics, monitoring etc.) ▪ Multimedia systems and applications (video, simulations etc.) ▪ Consumer and entertainment electronics (computer games etc.) ▪ ICT training solutions (customer seminars, blended learning etc.) ▪ ...

6. Cross work area basic ICT skills

Basic skills ICT commerce and business	Basic skills ICT application and administration	Basic skills ICT service and maintenance
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Provide project data for the invoicing and accountancy	▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, C, JSP, JavaScript, HTML, XML)	▪ Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Update and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, ICT systems assistants must be aware of the need for lifelong learning (LLL) both, in terms of primary ICT and technology subjects as well as overall aspects such as ICT business process and market developments and trends. As an ICT systems assistant, the next stage of a career in the work area ICT infrastructure and integration is described in the ICT skill profiles ICT systems technician at sub-degree level 3. This role, on the one hand, involves more self organised and responsible project work and, on the other hand, the integration of more specific ICT infrastructures and systems, e.g. in the fields of printing systems, mobile communications systems, audio and video systems, ICT security systems.

3.3.2.6. ICT service and maintenance

The case studies indicate that within this work area are six ICT fields of activity and 17 work tasks and skills at sub-degree levels (see figure below).

The work tasks and skill contents within the six fields of activity at the three sub-degree levels focus on the technical and organisational aspects of ICT service and maintenance. Titles of ICT job and training profiles such as ‘Networks fitter/(PC's) maintenance technician’ indicate the relevance of ICT skills profiles to companies and specific European countries.

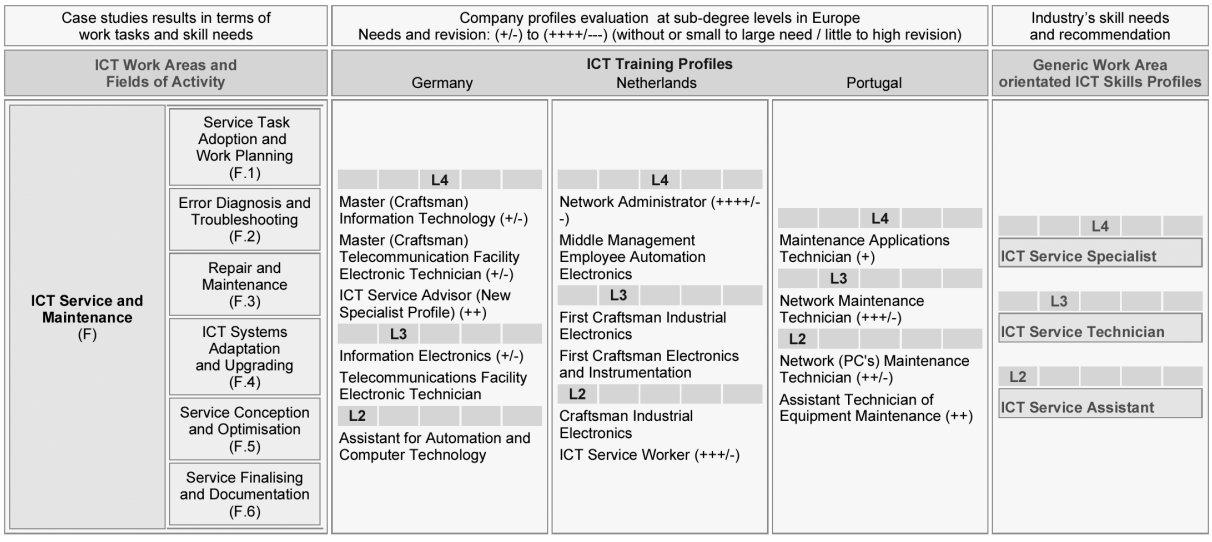
Figure 39: ICT service and maintenance: work area, fields of activity and ICT work tasks and skills

ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M
ICT Business Area Work and Skills linked to ... ▪ Information Systems and Applications ▪ Communications Systems and Applications ▪ Sector-specific ICT Solutions ▪ Internet and Intranet Applications ▪ E-business and E-commerce ▪ Data Management and Databases ▪ Networks Systems and Solutions ▪ ICT Security Solutions ▪ Business (Process) Applications ▪ Industrial IT Systems ▪ Embedded Systems and Control ▪ Multimedia Applications ▪ Consumer Electronics ▪ ICT Training Solutions ▪ ... **All Sectors / SMLEs**	ICT Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development			
	ICT Integration and Administration			
	ICT Infrastructure and Integration			
	ICT Service and Maintenance (F)	**Service Management and Work Planning** (F.1)	Receive, interpret and confirm customer ICT service orders (F.1.1)	e.g. ICT Service Manager / Master Information Technology (L4 D) e.g. Networks Fitter / Network (PC's) Maintenance Technician (L3 P) e.g. Service Assistant / ICT Service Worker (L2 NL)
			Check and assess service level agreements and advise colleagues and customers on ICT service possibilities (F.1.2)	
			Coordinate and provide service information and tasks, e.g. service platforms, time schedule, support level, escalation plan etc. (F.1.3)	
		Error Diagnosis and Troubleshooting (F.2)	Ensure, select and use latest ICT product and service information and manuals, also in foreign languages (F.2.1)	
			Narrow and interpret ICT systems and infrastructure problems (F.2.2)	
			Select and run test and diagnosis systems and software tools (F.2.3)	
		Repair and Maintenance (F.3)	Remove defects and ensure safety and security, e.g. exchange hardware, configure systems components (F.3.1)	
			Maintain ICT systems and infrastructure, e.g. PCs, networks, telecommunication systems, digital printing, copy systems (F.3.2)	
		System Management and Upgrading (F.4)	Investigate and assess ICT systems and process performance as well as configuration and security (F.4.1)	
			Upgrade and modify ICT infrastructure and systems, e.g. new systems software, drivers, firmware etc. (F.4.2)	
			Recommend and optimise ICT applications, e.g. office products, database systems (F.4.3)	
		Service Conception and Optimisation (F.5)	Analyse and implement ICT service and escalation concepts and platforms using various methods and sources (F.5.1)	
			Assess and document the quality and organisational effectiveness of company ICT service structures, support levels and action (F.5.2)	
			Suggest potential ICT service and maintenance improvements of the company (F.5.3)	
		Service Finalising and Documentation (F.6)	Instruct ICT support staff and users on new systems, safety, security, application changes, potential problems etc. (F.6.1)	
			Report and document service work tasks, e.g. working hours, material, resources, problems (F.6.2)	
			Provide service and billing data to the manager and accountancy (E.6.3)	
ICT Business Area	ICT Work Areas	Fields of Activity	Work Tasks and Skills (generic shortlist)	ICT Practitioners (ICT Job / Training Profiles) L2 L3 L4 L5B L5M

The requirements of each ICT work task, and the skills needed, depend mainly on the concrete contents, level of service responsibility and work organisation. For example, the task 'Select and run test and diagnosis systems and software tools' includes work and requirements at all sub-degree skill levels 2, 3 and 4 (L2, L3, L4). In contrast, the task 'Analyse and implement ICT service and escalation concepts and platforms using various methods and sources' includes work and requirements mainly at skill level 4 (L4).

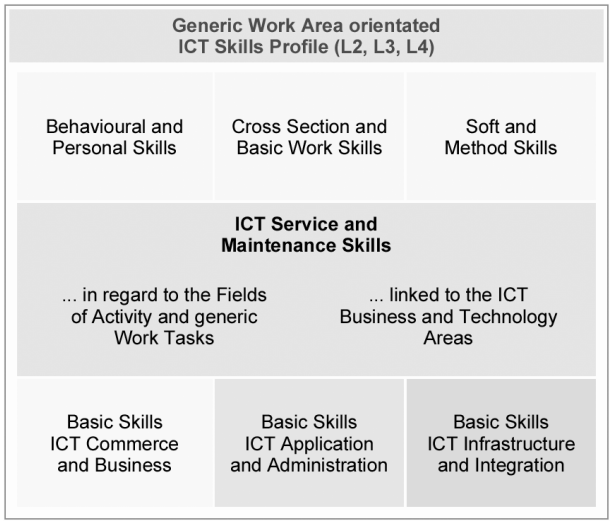
The examples of practitioner job and training profiles show some common major technical trends, e.g. networks, telecommunications. This makes the analysis not only of high importance for ICT skill needs in general, but also in terms of the training skills and profiles survey results which cover all sub-degree levels in the specified European countries. For instance at skill level 4 there are three ICT training profiles in Germany and two in the Netherlands. There are one or two ICT training profiles at skill levels 3 and 2 in these countries (see Figure 40). The survey results on company requirements and the need for revision indicate, for instance, a large need but also the necessity of revision of profiles like 'Network administrator (++++/--)' at level 4 in the Netherlands, or 'Network maintenance technician (+++/-)' at level 3 in Portugal.

Figure 40: Needs and recommendation for three service and maintenance skills profiles at sub-degree levels



Together, the case study assessment of work tasks and skills and the company survey results on current ICT training profiles constitute industry's skill needs in the generic work area ICT service and maintenance. The results can be integrated into a structure of three skills profiles, with a specific recommendation for one profile at each sub-degree level. The varying depth of the required skills and knowledge for these three generic work area oriented ICT skills profiles can be described in the following general profile and skill structure.

Figure 41: Structure of the service and maintenance ICT skills profiles at sub-degree levels



One example of the ICT service and maintenance skills profiles, ICT service technician at sub-degree level 3, is described below. The major work area oriented skills of this profile cover 13 generic ICT work tasks in all the six fields of activity. As with all generic ICT skills profiles, the following descriptions also look at basic skills.

Table 17: ICT skills profile ICT service technician at sub-degree level 3

1. Generic work area oriented ICT skills profile

ICT service technician (L3)

2. Examples of job titles and training profiles (country)

- Networks fitter
- Network (PC's) maintenance technicians (P)

3. Work and profile description

ICT service and maintenance primarily concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft- and hardware based expert and diagnosis tools. In order to narrow the faults down to the specific technical problem, ICT service practitioners need to communicate well with customers, users and colleagues. As part of the service and maintenance, they must be able to discuss possibilities of optimising and upgrading existing ICT systems.

4. Behavioural and personal skills, cross section and basic work skills, soft and method skills

Behavioural and personal skills

- Flexibility
- Self learning
- Motivation and commitment
- Stress resistance and emotion
- Responsibility
- Decision-making
- Initiative and attention
- Professional attitude (business or technical orientation and interests)

Cross section and basic work skills

- Quality awareness
- Commercial and market awareness
- Entrepreneurship
- Customer orientation and relationship
- Company/business organisation
- Work organisation
- Work safety and health protection
- Labour law and data privacy
- Environmental and resource awareness

Soft and method skills

- Communication
- Languages and culture
- Collaboration and interaction
- Teamwork
- Creative and innovation
- Analytical and reasoning
- Problem analysis and solving
- Context and causal connection thinking
- Documentation and presentation

5. ICT service and maintenance technician skills

in regard to the fields of activity and generic work tasks

- Service task adoption and work planning
  - receive, interpret and confirm customer ICT service orders
  - coordinate and provide service information and tasks, e.g. service platforms, time schedule, support level, escalation plan etc.
- Troubleshooting and test diagnosis
  - ensure, select and use latest ICT product and service information and manuals, also in foreign languages
  - narrow and interpret ICT systems and infrastructure problems
  - select and run test and diagnosis systems and software tools
- Repair and maintenance
  - remove defects and ensure safety and security, e.g. exchange hardware, configure systems components
  - maintain ICT systems and infrastructure, e.g. PCs, networks, telecommunication systems, digital printing, copy systems
- System management and upgrading
  - upgrade and modify ICT infrastructure and systems, e.g. new systems software, drivers, firmware etc.
  - Recommend and optimise ICT applications, e.g. office products, database systems
- Service conception and optimisation
  - suggest potential ICT service and maintenance improvements of the company
- Service finalising and documentation
  - instruct ICT support staff and users on new systems, safety, security, application changes, potential problems etc.
  - Report and document service work tasks, e.g. working hours, material, resources, problems
  - Provide service and billing data to the manager and accountancy

... linked to the ICT business and technology areas

- Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
- Sector-specific ICT solutions (financial services, health etc.)
- Internet and intranet systems and applications (web design, service providing etc.)
- e-business and e-commerce solutions (B2B, B2C etc.)
- Data management and database solutions (process databases, backup and recovery systems etc.)
- Networks systems and solutions (LAN, ATM etc.)
- ICT security solutions (antivirus, firewall, VPN etc.)
- Business (process) systems and applications (CRM, ERP etc.)
- Industrial IT systems (industrial and process automation etc.)
- Embedded systems and control (diagnostics, monitoring etc.)
- Multimedia systems and applications (video, simulations etc.)
- Consumer and entertainment electronics (computer games etc.)
- ICT training solutions (customer seminars, blended learning etc.)
- …

6. Cross work area basic ICT skills

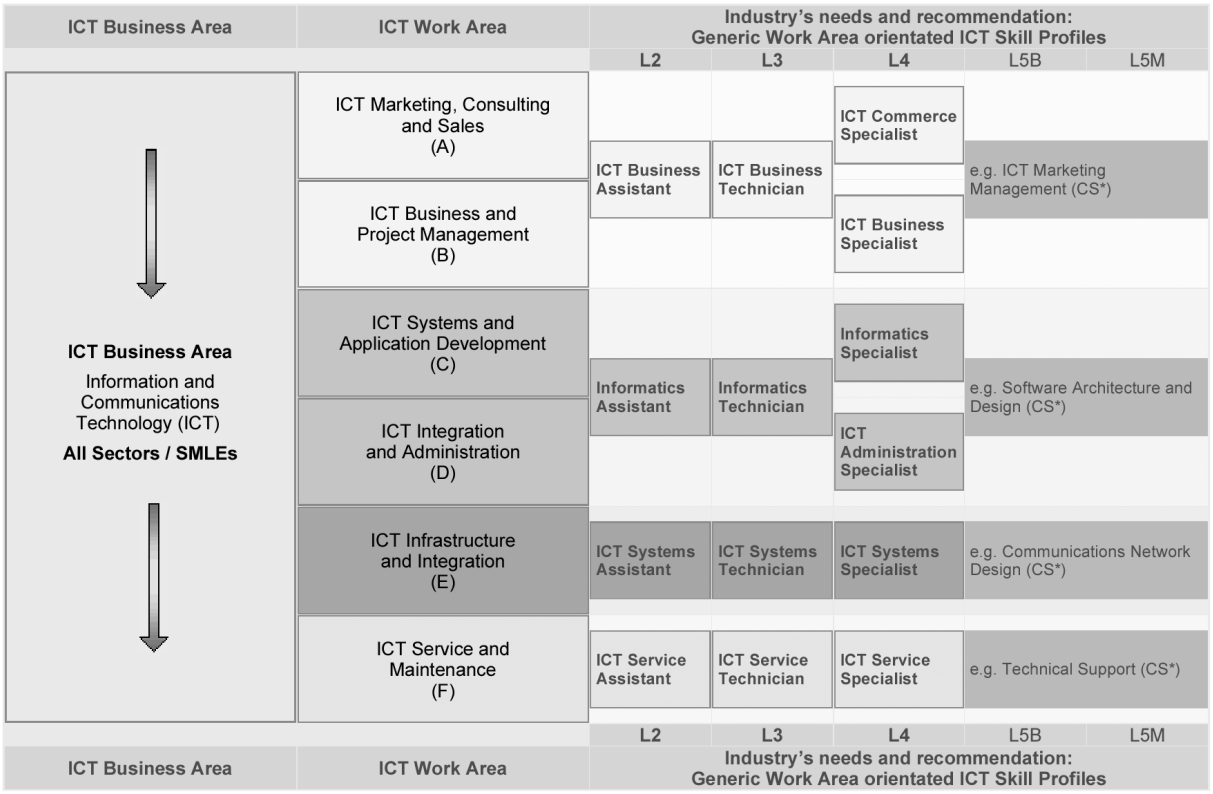
Basic skills ICT commerce and business	Basic skills ICT application and administration	Basic skills ICT infrastructure and integration
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Describe the impact of innovative ICT developments and trends (e.g. hardware, software, internet, services) ▪ Collaborate on customer quotations, consulting, contracting and project processing ▪ Self-responsible and project related support of customers and users ▪ Provide project data for invoicing and accountancy	▪ Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL, case tools) ▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, C, C++, Java, Cobol, JSP, JavaScript, HTML, XML) ▪ Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL)	▪ Provide, install and upgrade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe appropriate interface bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and networks structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, ICT service technicians must be aware of the need for lifelong learning (LLL) both, in terms of primary ICT service and technology subjects and overall aspects such as ICT business process and market developments and trends. Based on some years work and project experience as an ICT service technician, the next stage of a career in the work area ICT service and maintenance is described in the ICT skills profiles ICT service specialist at sub-degree level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the service and maintenance of more specific ICT systems, e.g. in the fields of ICT systems and network administration, mobile systems helpdesk and support, ICT application and user training, ICT troubleshooting and recovery.

The following table summarises the structure of the 14 generic work area oriented ICT skills profiles at the three sub-degree levels, complementary to the generic ICT skills profiles at degree level (see examples).

Figure 42: Structure of the 14 generic work area oriented ICT skills profiles at sub-degree levels



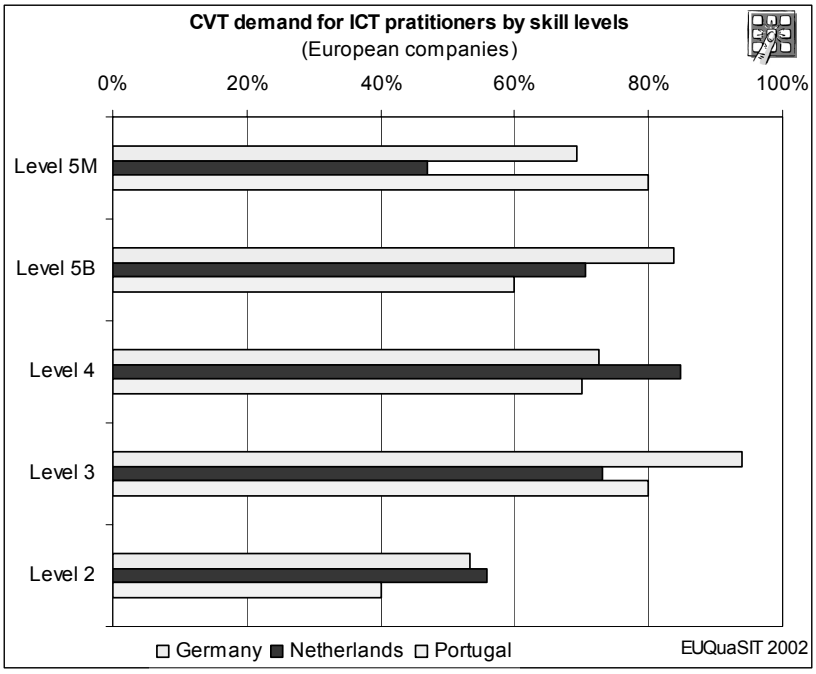
** Generic ICT skills profiles examples at degree level of Career Space*

The analysis can be regarded as a definition and qualitative description of current ICT skill and profile needs at sub-degree levels. Furthermore, it can be taken as a recommendation to use the 14 generic work area oriented ICT skills profiles as a basis for developing new European ICT curricula for training profiles at the three sub-degree levels.

3.4. CVT demand as a further indicator of industry's ICT skill needs

Industry's current and mid-term demand for continuing vocational education and training (CVT) for ICT practitioners is a further indicator for determining ICT skills needs at different sub-degree and degree levels. According to the results of the EUQuaSIT investigations, European companies have a need for CVT for ICT practitioners at all skill levels. Even though total demand is slightly lower at sub-degree level 2, the proportion of Dutch companies is higher at this level than, for instance, at degree level 5M. In Germany, companies see the biggest need at level 3 and degree level 5B. Dutch companies identify greatest demand at level 4 whereas in Portugal the need is at levels 5M and 3.

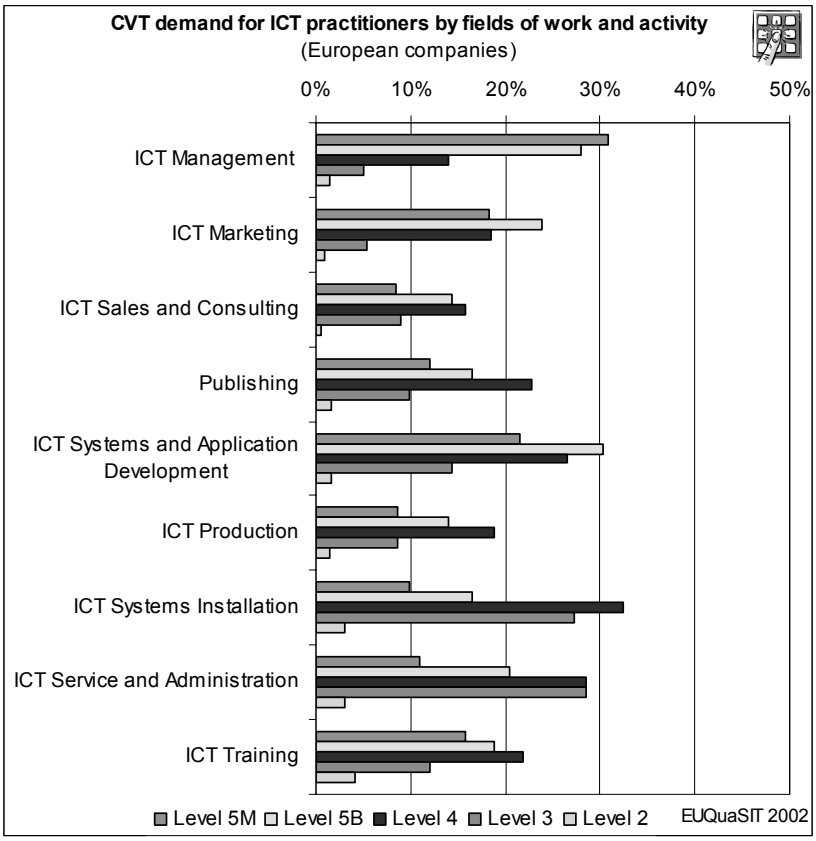
Figure 43: CVT demand for ICT practitioners at different skill levels in European companies



Looking in more detail, CVT demand at the various skill levels differs according to the contents of the fields of ICT work. The biggest CVT demand for ICT practitioners at sub-degree levels is indicated in systems installation and in service and administration, as well as in ICT systems and application development. Companies also see a certain CVT demand for practitioners at sub-degree skill levels in the more economic and technically oriented fields of work, chiefly at level 4, e.g. marketing and sales and consulting. Figure 44 indicates that CVT courses focusing on ICT management mainly require ICT practitioners at degree level qualification, but also at sub-degree level 4.

The supply of CVT courses for ICT practitioners in the region is given the most positive appraisal by Dutch companies. More than 70 % say the supply is adequate and tailored to their needs. In Germany and Portugal more than 60 % state that there is a complete and tailored offer. However, some 30-40 % of the companies also state that the supply of CVT courses is inadequate and has to be improved and adapted to industry's ICT skill needs. Companies within the ICT sector criticise inadequate supply and demand improvement more often than ICT user companies of all sizes. Major problems identified are the level and range of ICT course contents and the competences of teachers and trainers.

Figure 44: CVT needs for ICT practitioners in different work areas



The main reason for high demand for CVT is developments in ICT and the changes in applications which modify and increase the skill requirements of practitioners. Another reason is perhaps that the study and training programmes and ICT training profiles do not cover ICT skill needs as a whole. Therefore it is important that company CVT demand is in line with the ICT skill needs represented by the generic work area oriented ICT skills profiles described above. For example, demand for ICT service and administration for ICT practitioners at levels 3 and 4 is related to the generic work area oriented ICT skills profiles ICT service technician at level 3 and ICT administration specialist at level 4.

3.5. Special needs of certain target groups

The European Commission states that 'special interventions may be needed to promote the skills and mobility of those who are at a disadvantage in the labour market' (CEC 2002c, p. 8). As well as handicapped people, foreign workers and ethnic minorities this also concerns gender aspects, since females are significantly underrepresented in ICT training and work practice. The empirical results from the EUQuaSIT survey display an average female proportion in European ICT training of approximately 20 % and an even lower figure for ICT practitioners in companies. In the more economic and technically oriented ICT training profiles, the proportion of females is higher than in more technical informatics and

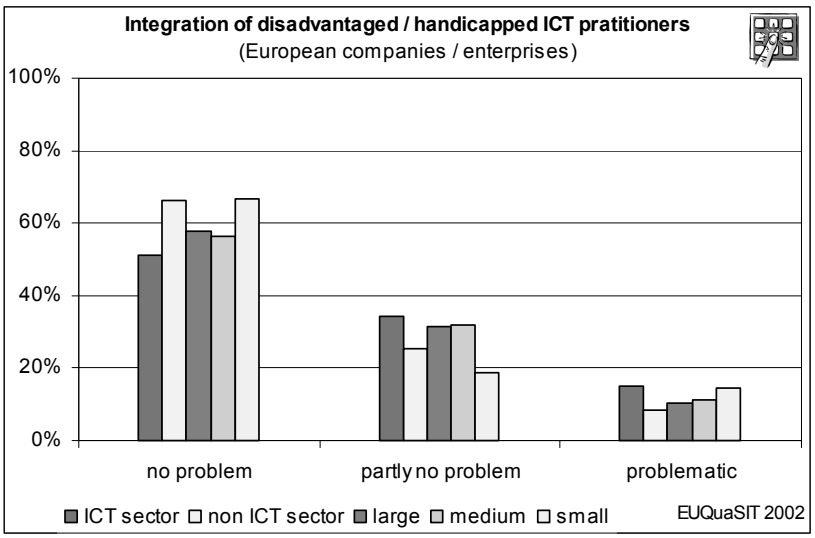
communications oriented profiles. It is interesting that many European companies see a good proportion of males and females as important in the ICT business.

However, with regard to specific ICT skill needs it is not possible to identify easily – if at all – any differences between males and females. The only question worth discussing is what measures and initiatives can be successfully implemented to increase the proportion of females in ICT training and employment. Corresponding aspects were partly investigated in the EUQuaSIT study.

Special ICT initiatives, programmes, projects, etc., for promoting and increasing female participation in ICT training are very rare in training institutions. Fewer than 20 % of the training providers in Europe offer ICT qualification with a special focus on females or organise special ICT training with female teachers and trainers. However, about half of these training institutions have experienced that ICT training especially addressing females or with females as teachers and trainers have a good chance of success.

A second group, perhaps even more important in discussion of special skill and training needs, are handicapped people. From the companies' point of view the integration, inclusion and transition of disadvantaged or handicapped ICT practitioners into employment is no, or little, problem (see below). This is true for small, medium and large enterprises. As few as 15 % of ICT companies state that this can sometimes be problematic but most of them declare this depends on different factors such as the work area and the degree of handicap. The areas of ICT application and systems development and test or user support (helpdesk) are ones where many companies see good opportunities to employ physically handicapped people.

Figure 45: Company experience with the integration of disadvantaged/handicapped ICT practitioners



Many training institutions in Europe also do not see major problems with regard to the integration of disadvantaged and handicapped people into ICT education and training. Only a small proportion of about 20 % of the training providers in Germany and the Netherlands think this is problematic.

In general, vocational education and training should be open to all learners irrespective of any difficulties or disabilities. Governing bodies, companies and training providers have a clear responsibility for ensuring that discrimination on these grounds does not take place and that a student or trainee with disadvantages or disabilities is no less favourably treated than any other student. However, training concepts and practice may need to be adapted for certain target groups to reduce disparities in access to the labour market. This adds to the challenge of developing an information society chiefly through the influence of ICT business and practitioners.

4. ICT curriculum development guidelines and new European training solutions

Currently there are many different European curricula for ICT study and vocational training programmes at more or less all levels, including provision at each national school curriculum level. The importance of ICT research and development, of production, installation and implementation is matched by the need to understand and use ICT in private and work areas in an elaborated and critical way. While ICT curricula across Europe show major similarities in didactics and design, the goals and structures of the national education, vocational and study systems are different. However, the curricula often share aims and contents because ICT is not a national matter; it is a global technology and business, as is seen from the computers, the internet, networks, mobile phones, etc., that it uses. Also, ICT businesses are increasingly international in scope and structure. The globalisation of ICT affects business management, research and development fields and the shop floor level, and because of the internationalisation of so many aspects, ICT work today is impossible without competence in the English language.

These aspects, especially in regard to ICT work at sub-degree levels in Europe, have been confirmed by the case study investigations of ICT skill needs in enterprises both of the ICT sector and ICT users. Company surveys of the demand for ICT practitioners and the evaluation of existing ICT training profiles (almost 500 companies were involved in the Europe-wide research), and skill needs at sub-degree levels are based on a broad business area with an extensively common and international structure of work areas, fields of activity and tasks. This enabled summary and harmonisation into 14 generic work area oriented ICT skills profiles.

This, in turn, is a good basis for outlining development guidelines for new European ICT curricula. However, further basic knowledge and evaluation of current ICT curricula are necessary to determine in detail the mismatch in existing ICT training and qualification profiles. To meet today's big challenges, we need totally new didactic concepts for new ICT curricula that will be broadly accepted in Europe. Tailored concepts and recommendations are also important for vocational education and further training (VET/CVT) programmes and for the design of ICT courses including additional aspects such as outcomes definitions, entry requirements, assessment and certification, quality control and the specific qualifying processes.

4.1. Current ICT training profiles and curricula in vocational education and training

Evaluation of existing ICT training profiles and curricula at sub-degree and VET levels indicates differences in European countries with regard to profile skill levels, the number of

ICT training profiles at each level and the main subjects of ICT qualification. It is, therefore, very difficult to compare ICT training profiles, or only possible at an abstract level as comparison studies of VET systems confirm. There are differences in individual curricula, as shown in detail by the EUQuaSIT Leonardo project, e.g. in regard to the goals, contents, method or duration of the ICT training, as the curriculum elements focus on the profiles and skill levels structures. Nevertheless, there are many similarities in specific goals, contents and methods. This is equally the case with outcomes and ICT qualifications, given the fact that ICT practitioners in Germany or the Netherlands are able, after training, to carry out the same work tasks in a comparable manner.

The company evaluation of ICT training profiles has been important in highlighting needs and possible revisions. Comparing ICT training profiles to skill needs in general helps identify any mismatch with regard to training goals and contents and also illustrates curriculum good or bad practice. The results of the evaluation, with particular reference to Germany, the Netherlands and Portugal, can be summarised as follows.

The curricula for 'modern' ICT training profiles, i.e. launched or updated in recent years, are often relevant as examples of good practice. To a great extent they meet the skill needs and contents indicated by the generic work area oriented ICT skills profiles; this is true of the four new ICT training profiles at level 3 and new work process oriented further ICT specialist profiles at level 4 in Germany, the new BCP ICT training profiles in the Netherlands, and the new professional ICT training profiles at vocational levels in Portugal.

There are problems where the curricula for modern ICT training profiles and older ones exist in parallel and partly overlap in skills and contents. However, this result also applies to a degree with some of the newer ICT training profiles.

The curricula for ICT training profiles that meet the skill needs and contents presented by the generic ICT skills profiles only to a lesser degree, still often separate ICT skills and contents, for instance in IT and CT. The current ICT training profiles at VET levels 2 and 3 – for example, telecommunication facility electronic technician and mathematical technical assistant in Germany or craftsman communications networks in the Netherlands – are examples of this.

Curricula which still separate ICT business, informatics (software) and electronics (hardware) skills and contents do not meet work area oriented skill needs. These curricula are mostly subject or scientific discipline oriented with little or no integrated or combined structure and contents, e.g. in Germany, technician in radio communication or, in Portugal, software analyst.

Curricula with a general mismatch hardly consider work area oriented skills and contents or cross section and basic work skills. These tend to be subject or scientific discipline oriented and include virtually no business, customer and application oriented contents, work process and quality management contents or overall subject contents,

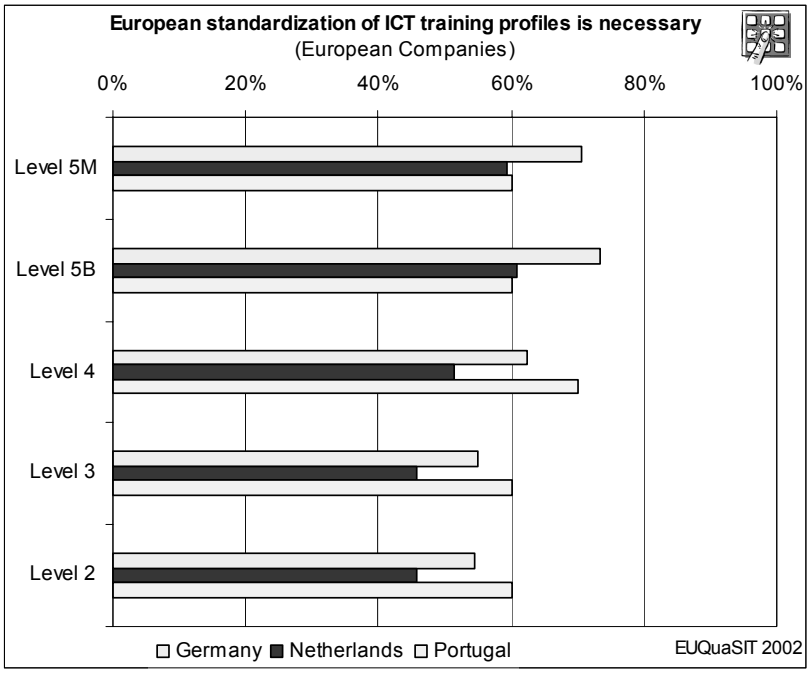
Finally, other curricula with a mismatch often place too much stress on basic skills. They have predominantly scientific and engineering theory contents, such as computer and technology

science, and mathematics oriented contents and, at the same time, too little emphasis on work, customer and application oriented contents.

The picture from the evaluation, therefore, is mixed. On the one hand there are ICT curricula that may be regarded as examples of good practice, offering solutions related to the work area oriented ICT skills profiles wherefore there is no single way to develop the curriculum. On the other hand there are problems and different maladjustments of curricula, with some indications to improve the common curriculum design.

Many companies support the need for common European standards for ICT training profiles and curricula, with varying proportions in each country giving an average of more than 50 % across Europe. The number of Dutch companies supporting such action is lower than in Germany or Portugal, especially for the profiles at the three sub-degree levels. Divided by qualification levels, the outcomes indicate that the higher the level of qualification, the higher is the proportion of companies stating that such European initiatives are needed. For higher education degrees, between 60 and 80 % of the companies want European standardisation of ICT training profiles. For the VET profiles at levels 3 and 2 the proportion is slightly lower and 50 % of the companies would rather 'save national standards' of ICT training and qualification. One primary reason for this is probably a lack of mutual European trust in what concerns strategies and concepts of a common way to Europe-wide accepted skills, training and curriculum frameworks. However, saving national standards does not necessarily mean that common European vocational curriculum concepts and frameworks cannot be taken into account for national and regional action.

Figure 46: Company evaluation of a European standardisation of ICT training profiles



Together the results offer didactic orientations and further information on training profiles, goals, contents, methods, etc., that are useful for the guidelines and recommendations for new European ICT training profiles and curricula.

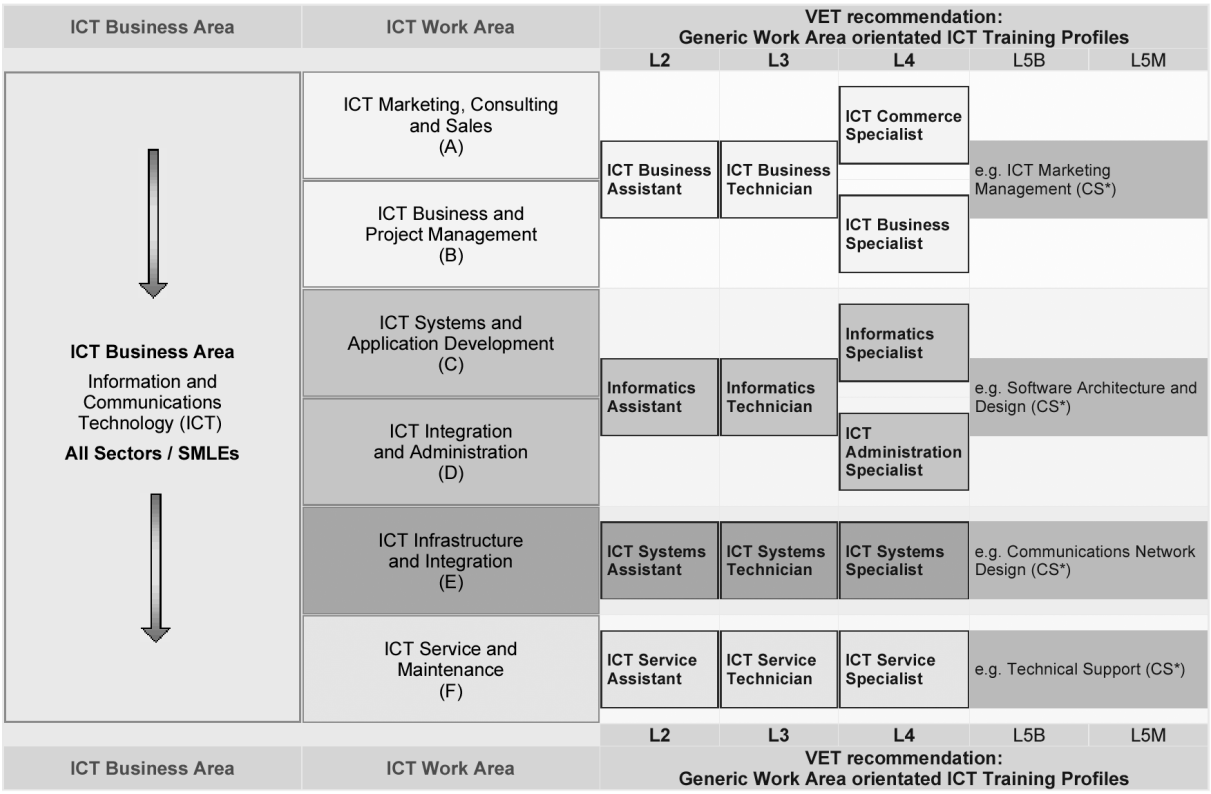
4.2. ICT curricula at sub-degree levels: structure of ICT training profiles and qualifications outcomes

Designing curricula demands reference to the horizontal and vertical profile structure of training and qualification profiles. With regard to the need for ICT skills and practitioners, one aspect of the vertical structure that is clear is the need for profiles at degree and sub-degree level, particularly at levels 4, 3 and 2. As the existing profile diversity has already shown, demands in terms of the horizontal profile structure at each sub-degree qualification level are complex. We need good reasons and an adequate approach to determine the right number of profiles, their delimitations and sets of qualifications. In general terms, these decisions can either be more related to subjects, scientific disciplines and technology areas, to a vocational pedagogic and education view, or to the skill needs and contents of work areas. As shown by current European ICT training profiles, there is no single way to meet the needs of ICT work and provide ideal ICT competences for different people. However, taking account of mismatches and the desire to improve the balance between ICT employment and relevant vocational education and training, the curriculum and profile approach should clearly be designed with reference to current and prospective skill needs of ICT work areas. At the same time, for all ICT training profiles, the concrete business and technology contents also require a didactic reflection of the appropriate range and depth of skill needs.

The composition of the 14 generic work area oriented ICT skills profiles has already been considered in this sense (see Section 3.3.2.). Consequently the structure of ICT training profiles, and hence professional qualification profiles, must have reference in the 14 generic work area oriented ICT skills profiles to current and prospective needed skills and contents of ICT work at sub-degree levels. From an open European perspective, without preliminary consideration of a national VET system, the recommendation is that the structure of the 14 generic work area oriented ICT skills profiles is the basis of the framework for 14 new European generic work area oriented ICT training profiles at sub-degree levels with:

- four ICT training profiles at level 2;
- four ICT training profiles at level 3;
- six ICT training profiles at level 4 (see below).

Figure 47: Structure of the 14 'Generic work area oriented ICT training profiles' at sub-degree levels



* Generic ICT skills profiles examples at degree level of Career Space

Allocating structure to these 14 generic work area oriented ICT training profiles is possible because of the definition of a simple combined level framework (see Section 2.2.), so that work and training levels share the same level structure (see also below in terms of outcomes). As with the ICT skills profiles, the number and structure of the training profiles is designed with strong reference to skill structures and work areas and not, for example, to a specific sector, technology or business area. This basic profile and curriculum decision is one of the main reasons that the number of ICT training profiles at sub-degree levels is not very high. Another reason is the new European basic principle of 'lean occupation', stressing the idea of less and open ICT training profiles in a work area rather than too many specific ICT training profiles, e.g. for each specific business and technology area like databases, networks, internet, sector specific software, etc.

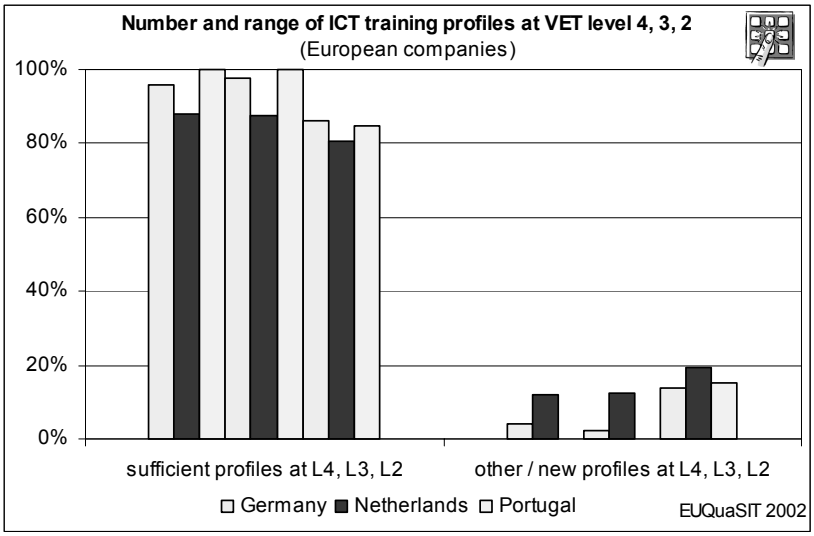
The number and detail of profiles at qualification level 2 need to be further explained because ICT business and technology areas do not directly indicate a need nor have many people ICT training profiles in mind at this level. But the survey of industry needs for ICT skills and practitioners suggests a demand at this level as does the existence of ICT training profiles at level 2 in certain European countries and their acceptance within companies. In fact, the results collected also show that there is not a particularly high demand at this level. Nevertheless the allocation of four ICT training profiles at level 2 is part of the recommended profile framework as a whole.

In contrast, the number and detail of profiles at qualification level 3 are more in evidence within work but the number is not very high. The reason, as with all ICT training profiles, is that each profile is initially oriented to one or two work areas and a skill profile specific sample of work tasks, and only then linked to specific business and technology areas in their diversity. Therefore, it is not unusual to have a double or triple number of the profiles by using another profile and curriculum orientation. For example, instead of one ICT systems technician it would also be possible to define:

- an IT systems technician,
- a CT systems technician,
- a network technician,
- an ICT bank systems technician.

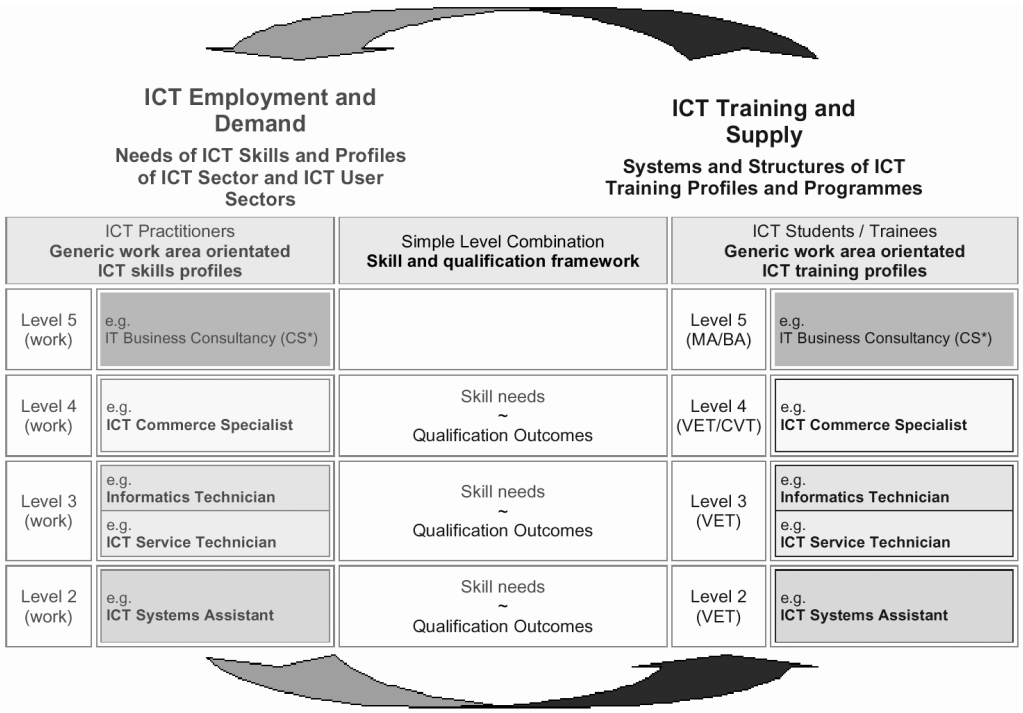
A further profile orientation is a specialisation in which the profile structure is oriented in detail to the work areas and the fields of activity. As shown with the recommended structure and delimitation of the six ICT training profiles at level 4, this orientation leads to a higher number of profiles but, also as shown by the results of the existing ICT training profile diversity in Europe, the problem is not too few profiles: it is defining ICT training and qualification profiles with a clear structure broadly accepted by industries. The results of the company surveys indicate that the number of current ICT training profiles at all levels in Europe is sufficient, according to the majority of companies in Germany, the Netherlands and Portugal (see Figure 48). Only for sub-degree level 2 do a certain number of companies state that other or new ICT training profiles are needed. These results are strongly linked to the company results on the need to revise some current ICT training profiles. Thus, all results support the recommended profile framework and especially the number and horizontal and vertical structure of the new 14 European generic work area oriented ICT training profiles.

Figure 48: Company evaluation of numbers of the current ICT training profiles at levels 4, 3 and 2 in European countries



As a next step, the basis of the profile framework can be examined in relation to curriculum questions, initially with regard to outcomes in terms of the qualifications of each ICT training profile.

Figure 49: Level and profile framework with skill needs and qualification outcomes



* Generic ICT skills profiles examples at degree level of Career Space

The skill needs as defined in each generic ICT skills profile can be interpreted as the outcomes of each generic work area oriented ICT training profile in terms of qualifications. In this context, the structures and skills contents of the ICT skills profiles are the basis for the structures and contents of the qualifications as the outcomes of the ICT training profiles (see above).

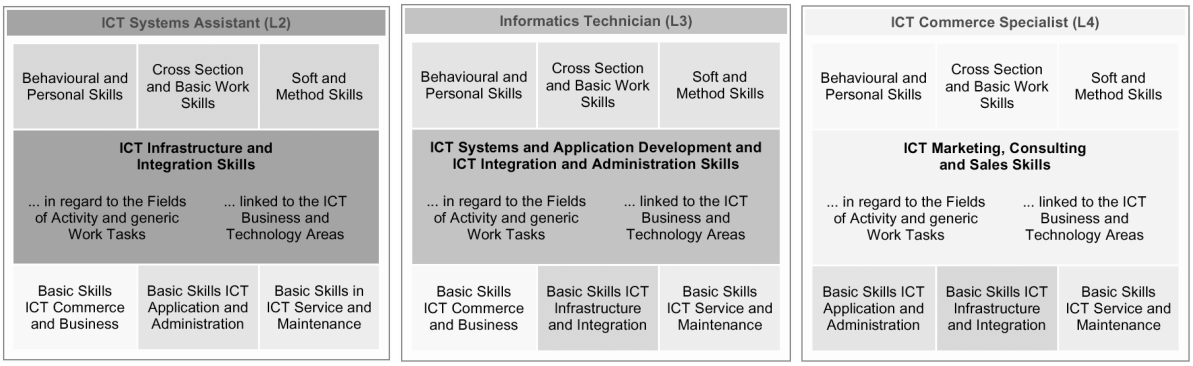
The identified structures and contents of the skill needs and generic work area oriented ICT skills profiles are relevant to ICT curriculum development and VET programmes. As seen with the ICT skills profiles and the profiles at each level, the skill structure of all profiles is basically identical with three main skill fields:

(a) behavioural and personal skills, cross section and basic work skills, soft and method skills;

(b) ICT practitioner skills (kernel work area oriented profile skills);

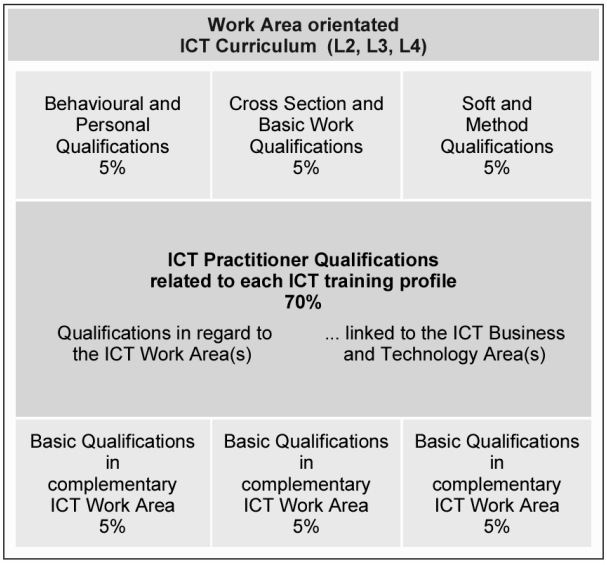
(c) cross work area ICT skills (complementary to kernel work area).

Figure 50: Identical skill structure of the generic work area oriented ICT skills profiles at sub-degree level



Following this delineation of skills, and also qualification outcomes with their structure and contents of the ICT training profiles, the basis of ICT curriculum development can be described in a common curriculum model as a qualification framework of work area oriented ICT curriculum for all sub-degree levels.

Figure 51: Qualification framework of the work area oriented ICT curriculum for all sub-degree levels



This curriculum model illustrates a framework of three main qualification and content fields that depend on level for the breadth and depth of their qualifications. Each qualification field also shows the qualification and content structure in detail, which includes, from didactic reflection of practitioner needs, a recommendation of the (quantitative) curriculum extent, e.g. ICT practitioner qualifications cover 70 % of the curriculum (see Figure 51).

The first qualification field of the ICT curriculum covers behavioural and personal qualifications (~5 %) which include: flexibility, self learning, motivation and commitment, stress resistance and emotion, responsibility, managing risks, decision making, negotiation, initiative and attention, persuasiveness, professional attitude (business or technical orientation and interests).

It also covers cross section and basic work qualifications (~5 %) which include: quality awareness, commercial and market awareness, entrepreneurship, customer orientation and relationship, company and business organisation, work and project organisation, work safety and health protection, labour law and data privacy, environmental and resource awareness.

As a final element, it covers soft and method qualifications (~5 %) which include: communication and moderation, languages and culture, collaboration and interaction, teamwork and mentoring, conflict and consensus, creative and innovation, analytical and reasoning, problem analysis and solving, strategy, conception and planning, context and causal connection thinking, information handling, documentation and presentation.

In a didactic sense, it is important for the ICT curriculum model in general, and therefore the qualifications, that the separate qualification and content fields and categories show a common structure only at this level. For instance this structure is not the direct basis for designing courses or learning processes. Behavioural and personal qualifications in particular,

and cross section and basic work qualifications, should not and cannot be taught in isolation from other qualifications, e.g. the next qualification field. For example, motivation and commitment or self learning competence cannot be taught without contents and depend on the didactical and methodological concepts of the training as a whole. Also customer orientation, environmental and resource awareness or work and project organisation competence must be integrated and linked to business and technology contents. All soft and method qualifications such as communication and moderation or information handling, documentation and presentation must have, in the same way, a relation to the other qualifications and contents.

The qualification and content field ICT practitioner qualifications (~70 %) covers all kernel work area oriented profile qualifications. This means all ICT qualifications and contents of one or more ICT work areas are specifically related to each ICT skills profile (see structure of the 14 generic work area oriented ICT skills profiles). For example, for the informatics specialist at level 4, all ICT qualifications permit work in all fields of activity and performing work tasks at level 4 of the ICT work area ICT systems and application development. Very important to the structure and contents of these ICT professional qualifications is, therefore, their relevance to the work areas or detail of work processes, phases of activity and work tasks and their link to the ICT business and technology areas.

The last qualification and content field of basic ICT work area qualifications (~15 %) covers basic ICT qualifications of all other work areas complementary to the kernel work area of each ICT skills profile. For example, an ICT systems technician, in addition to ICT professional qualifications, must also have basic qualifications in ICT commerce and business or ICT application and administration. With these basic qualifications the ICT curriculum ensures that all ICT practitioners have overall knowledge and an understanding of the business and work processes as a whole. This not only supports teamwork but is also a certain precondition for qualified work in a specific work area such as service and maintenance.

The model of work area oriented ICT curriculum with these three main qualification fields is the common basis of the following guidelines for the development of new ICT curricula at sub-degree levels.

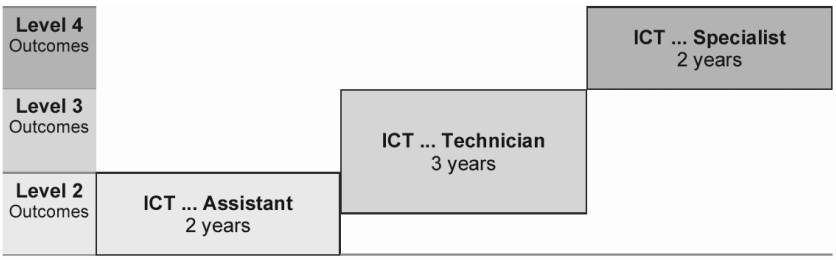
4.3. Guidelines for developing new European ICT curricula at sub-degree levels

Guidelines for the development of curricula normally need to say for which learning institution or place, learning and qualifying concept and for which profile and qualification level, subject or course the curriculum is specifically intended. The recommendation of the 14 generic work area oriented ICT training profiles and their profile and level structure is one of the first relevant decisions. Also very important is the definition of the outcomes of the ICT training profiles. But apart from such decisions, the choice of learning institution and place, learning path and the way in which qualification outcomes can concretely be achieved is basically open. In the same sense the following guidelines include recommendations for

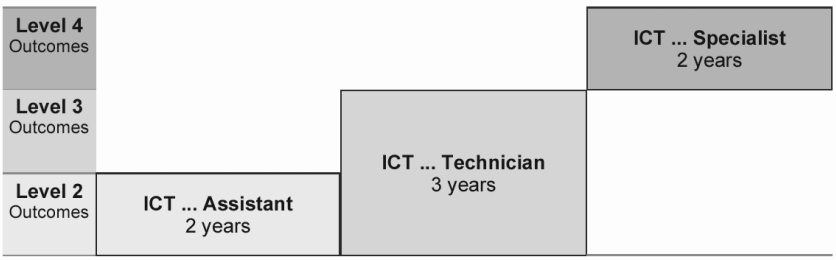
developing curricula without any preliminary decisions in this direction. Therefore, the curricula can be the basis for different learning institutions and places or qualifying concepts such as focus on school or work based training, apprenticeship concepts, etc.

One recommendation for the curriculum guidelines is to define a structure of ICT vocational training programmes corresponding to the 14 generic work area oriented ICT training profiles by specifying the duration as indicated in the following models. These models show a hierarchical structure and combination of two and three years ICT vocational training programmes with a more or less open learning organisation and different options for mutual recognition of certificates or examinations. Questions of entry requirements and valuing non-formal prior learning are also more or less open and depend on the chosen model and further curriculum recommendations.

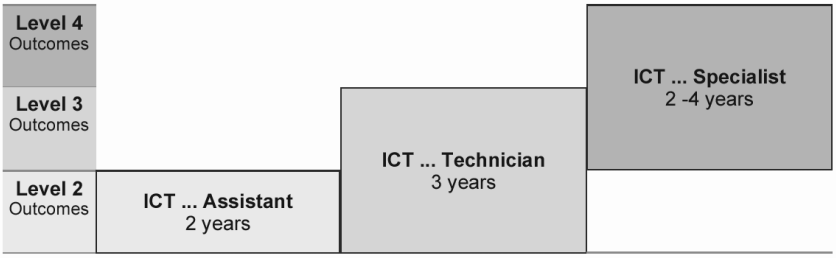
Figure 52: Feasible models for the structure and duration of ICT vocational training programmes



Model 1: Structure and duration of ICT vocational training programmes according the level structure of the ICT training profiles



Model 2: Structure and duration of ICT vocational training programmes according the level structure of the ICT training profiles



Model 3: Structure and duration of ICT vocational training programmes according the level structure of the ICT training profiles

The curricula, in terms of the two or three year training programmes, need a structure and definition of learning units which are defined as work area oriented ICT learning modules. This name and structure have been chosen because the qualifications and contents of each learning unit are geared to the description of the work areas; also each learning unit – like a module – is part of a didactic module set that constitutes each ICT training programme. The

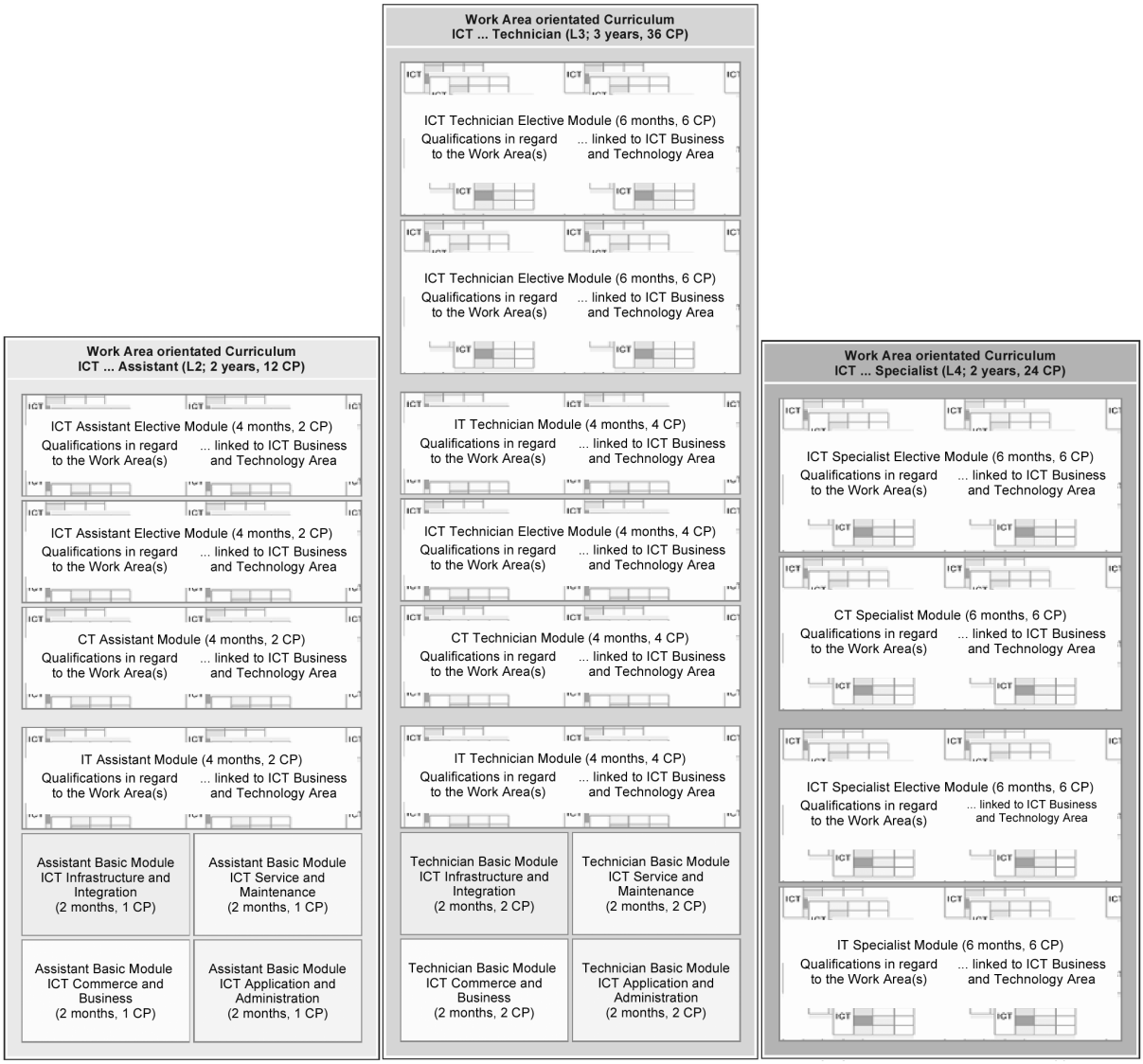
module structure and sets show the following level variants, including a recommendation for valuing the ICT vocational training programmes in terms of credit points (CP):

Table 18: Sets of work area oriented ICT learning modules

ICT assistant curriculum (L2; 2 years, 12 CP) - set of assistant basic modules - set of assistant modules - set of assistant elective modules	ICT technician curriculum (L3; 3 years, 36 CP) - set of technician basic modules - set of technician modules - set of technician elective modules - set of technician add-on modules	ICT specialist curriculum (L4; 2 years, 24 CP) - set of specialist modules - set of specialist elective modules - set of specialist add-on modules

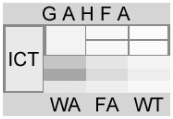
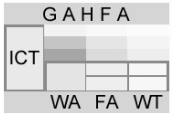
Corresponding with the model of work area oriented ICT curricula for all sub-degree levels described above, and based on didactic reflections of the qualification outcomes, these sets of learning modules can be defined in more detail for the ICT assistant curricula at level 2, the ICT technician curricula at level 3 and the ICT specialist curricula at level 4 as seen in Figure 53.

Figure 53: ICT assistant, technician and specialist curricula with set of work area oriented learning modules



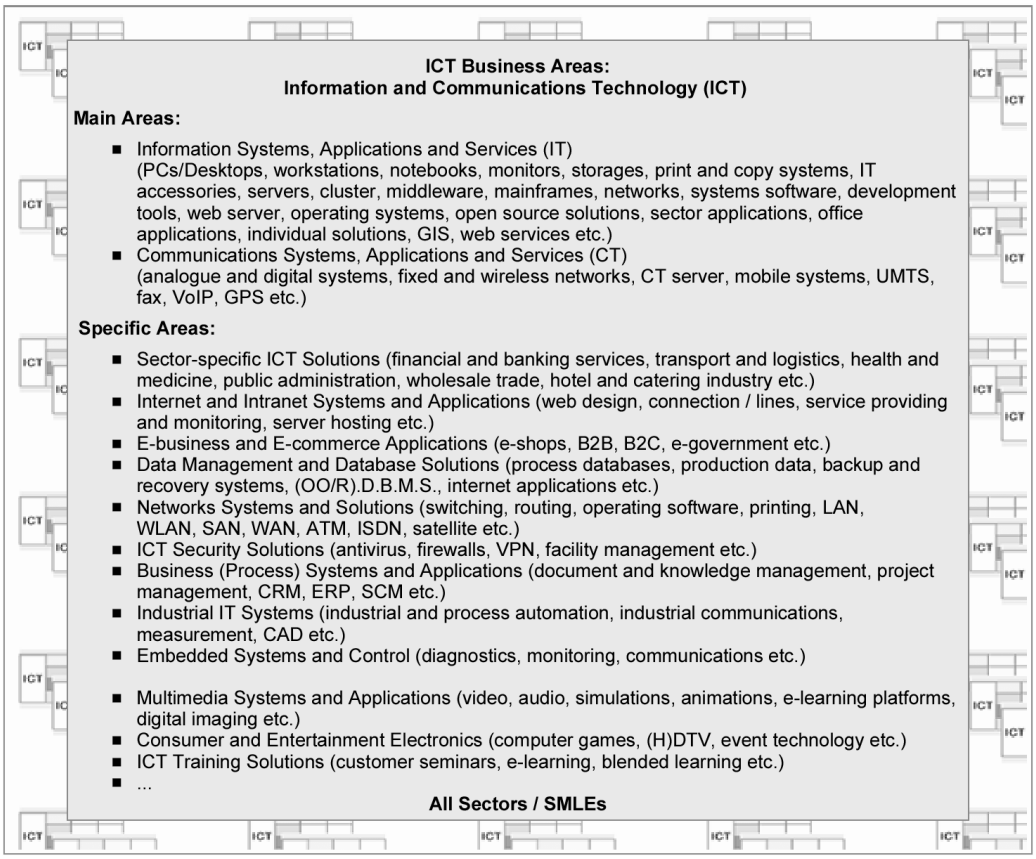
The didactic concept for the curricula for ICT assistants and ICT technicians is similar in that that each programme begins with four learning modules that cover basic qualifications and knowledge of an ICT business process as a whole. Normally trainees can start with the work area oriented learning module ICT commerce and business via the modules of ICT application and administration and ICT infrastructure and integration, up to the module ICT service and maintenance, progressively achieving an overview with basic qualifications and knowledge of all ICT work areas. These modules, therefore, provide a work and subject oriented basis for the acquisition of the formative ICT professional qualifications and include integrated basic qualifications such as behavioural and personal competences. The duration of each basic module is assessed at two months and the value of each assistant basic module is one credit point (CP) and of each technician basic module two credit points (CP).

All the following assistant, technician and, additionally, specialist modules have an identical structure. The content of each set depends initially on each ICT training profile, respectively the qualifications in regard to the adequate ICT work area(s) and their specific fields of activity and generic work tasks. The profile level also has an influence, as seen below.

Modules of ICT business profiles in regard to ...	ICT commerce and business work area(s) (WA) and their specific fields of activity (FA) and generic work tasks (WT)	
Modules of informatics profiles in regard to ...	ICT application and administration work area(s) (WA) and their specific fields of activity (FA) and generic work tasks (WT)	
Modules of ICT systems profiles in regard to ...	ICT infrastructure and integration work area (WA) and their specific fields of activity (FA) and generic work tasks (WT)	
Modules of ICT service profiles in regard to ...	ICT service and maintenance work area (WA) and their specific fields of activity (FA) and generic work tasks (WT)	

On a second level, each module includes, within the fields of activity and generic work tasks, qualifications and contents linked to one specific business and technology area which can be extracted from the broader area of information and communications technology (ICT). Whereas two (for the technicians, three) modules of these sets are mandatory ICT modules linked to the two main business and technology areas of information systems, applications and services (IT) and (tele-)communications systems, applications and services (CT), the others are elective ICT modules. These elective modules are also linked to one specific business and technology area, but due to the breadth of the ICT business area this area can be chosen from the open list (see Figure 54), e.g. sector-specific ICT solutions, internet and e-commerce applications and administration or networks systems and solutions.

Figure 54: List of main and specific ICT business and technology areas as a basis for mandatory and elective module contents



The selection of the elective module contents within each set of modules and profile curriculum depends on two primary criteria:

(a) the business and technology areas covered by, and available in, a company or training institution (keyword: feasibility);

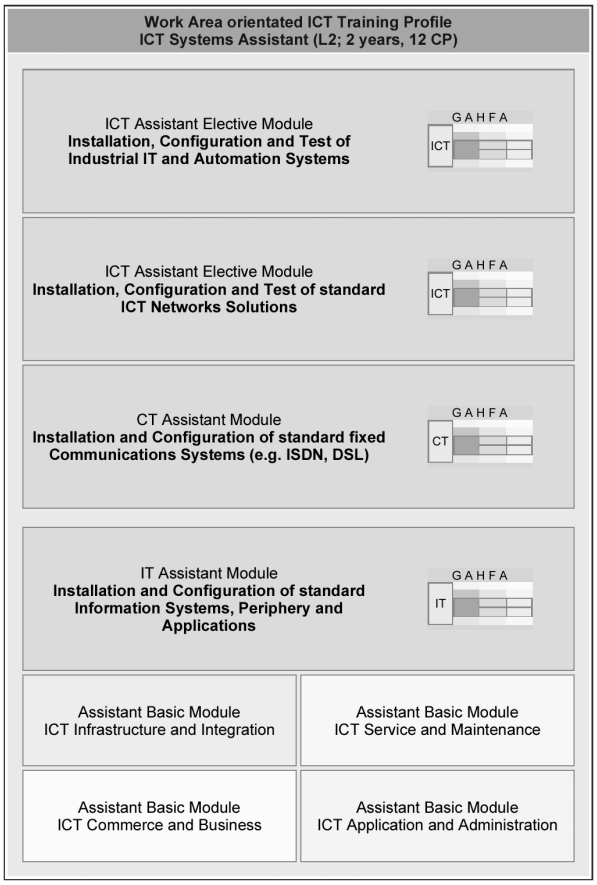
(b) distinction between, and relevance to, the two main business and technology areas IT and CT (keyword: diversity).

The mandatory and elective ICT modules in each training programme particularly cover the kernel ICT professional qualifications and include – as do all modules – integrated basic qualifications, e.g. behavioural, cross section and method competences. The specific guidelines for the ICT technician and specialist curricula also foresee an open number of add-on modules to cover particular qualifications within the training programmes, e.g. specific product, technology or field of activity ICT qualifications.

ICT practitioner modules, plus those for the ICT assistant and most of the ICT technician curricula, are of four months' duration. Two elective modules of the ICT technician curricula and all modules of the ICT specialist curricula have a duration of six months. They value from two credit points to six credit points each dependent on the training profile level and the module duration. The summation of the credit points of each training programme is, therefore,

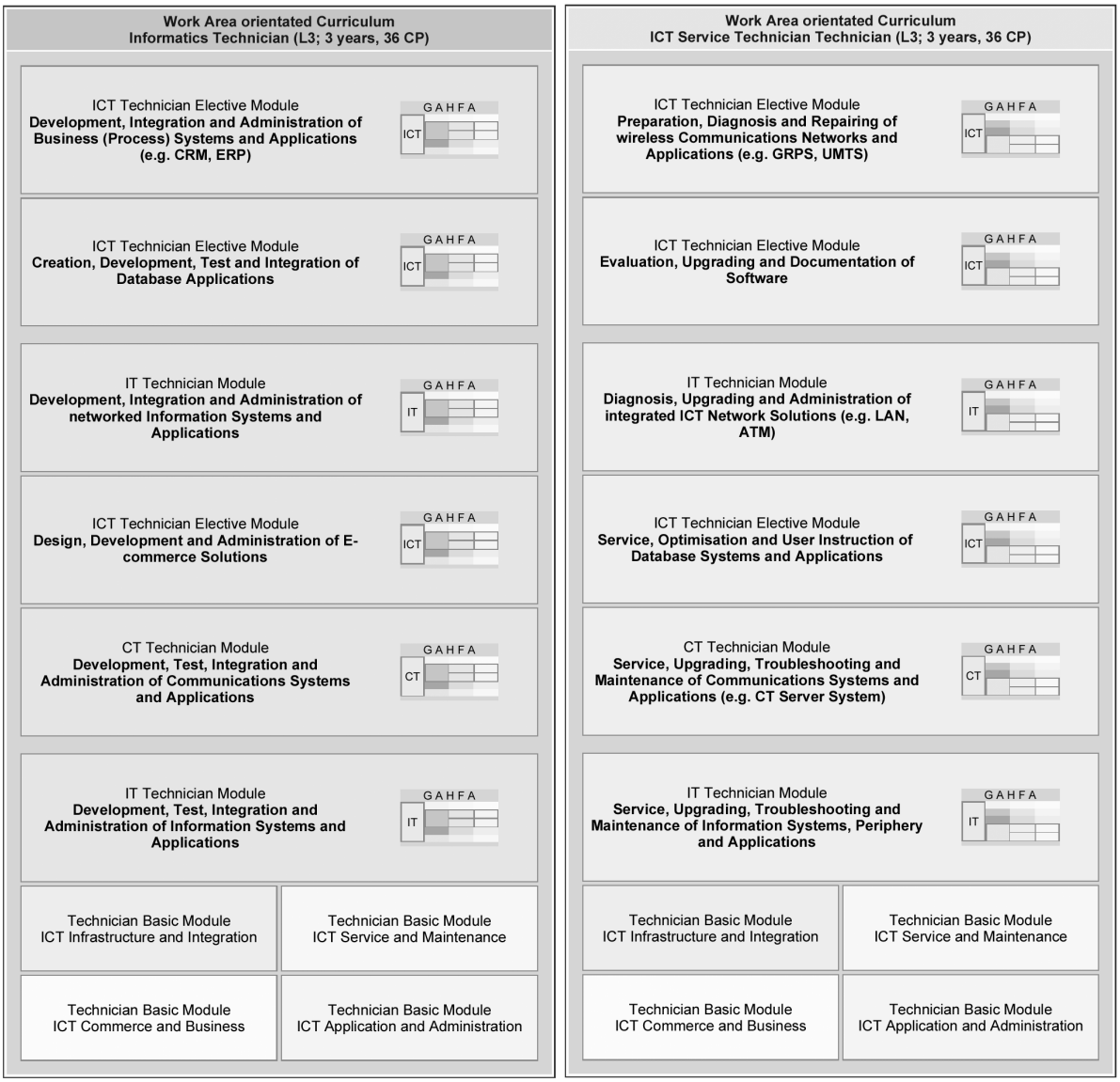
also different and, as shown in Figures 55 and 56, the total value of all curricula at level 2 is 12 credit points, at level 3 is 36 credit points and at level 4 is 24 credit points.

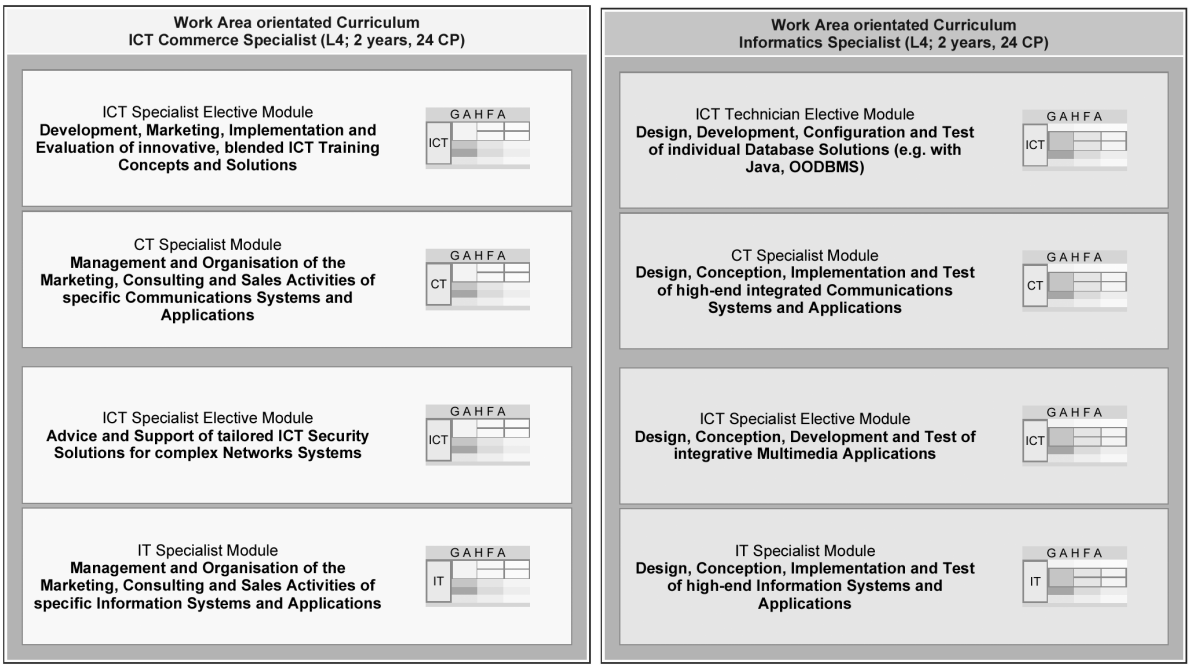
Figure 55: Informatics assistant and ICT systems assistant curriculum at level 2



Using these curriculum guidelines, the six examples illustrate the potential to develop the curricula with reference to the 14 ICT training profiles at sub-degree levels. The six examples cover ICT training profiles at all levels and for all generic ICT work areas, with two ICT curricula each at levels 2, 3 and 4.

Figure 56: ICT curricula at levels 3 and 4





Figures 57 to 60 summarise the complete structure of all 14 generic work area oriented ICT training profiles in the corresponding work area(s) with their curriculum and module sets at sub-degree levels.

Figure 57: Structure of the more economic technically oriented generic work area oriented ICT training profiles with their curricula and module sets at sub-degree levels

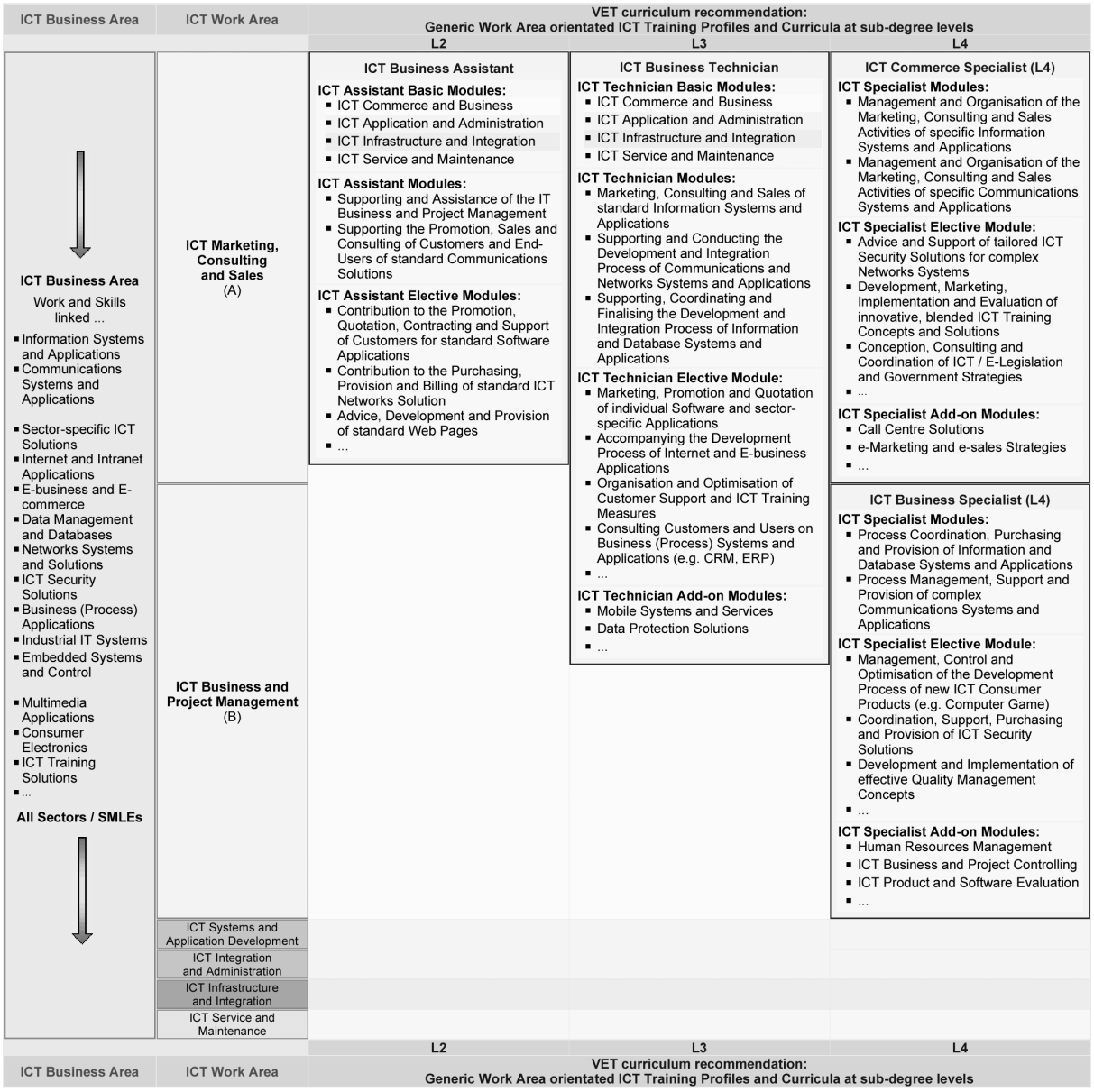


Figure 58: More informatics/communications technical oriented generic work area oriented ICT training profiles with curricula and module sets at sub-degree levels

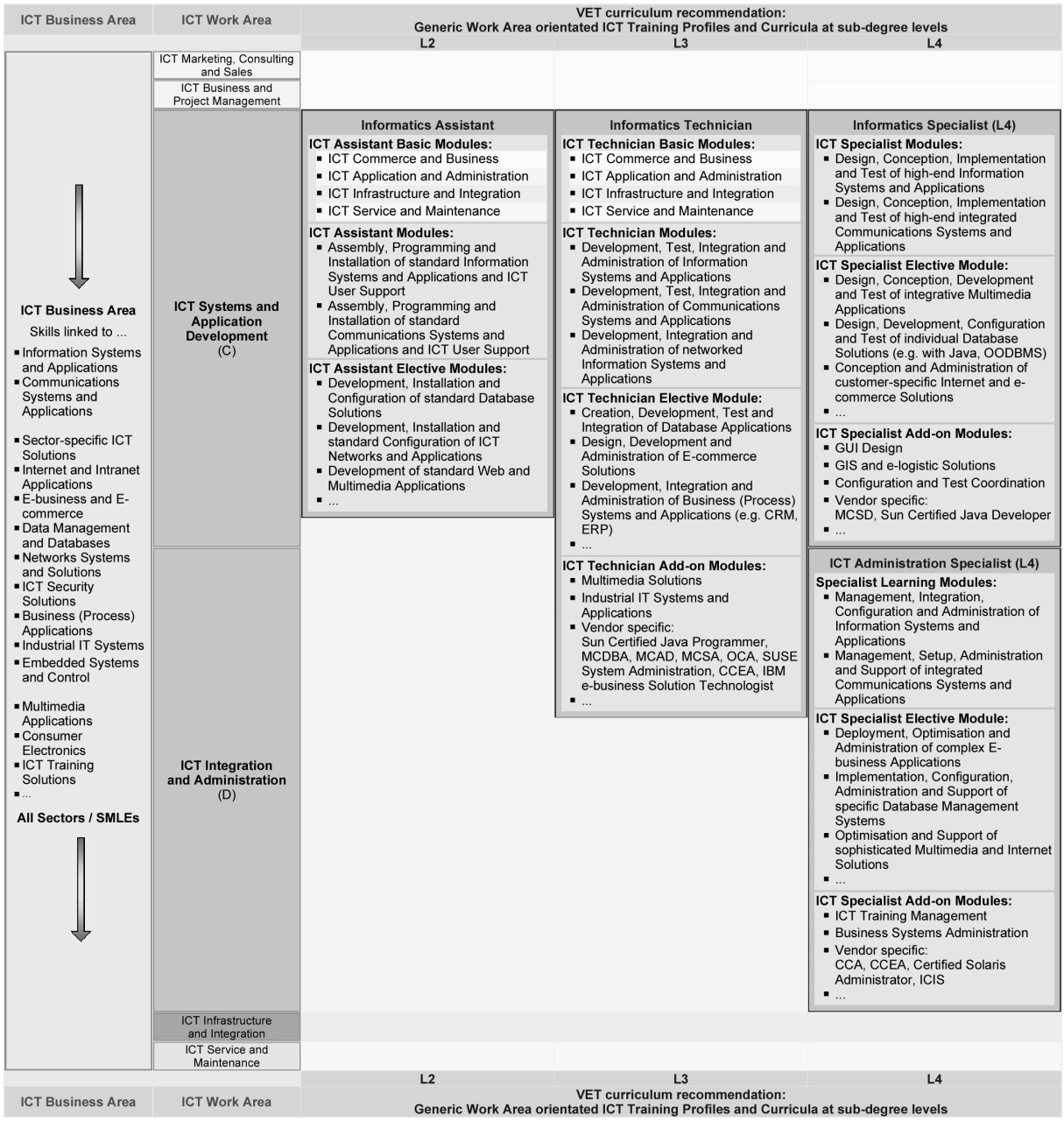


Figure 59: Technical informatics oriented generic work area oriented ICT training profiles and curricula

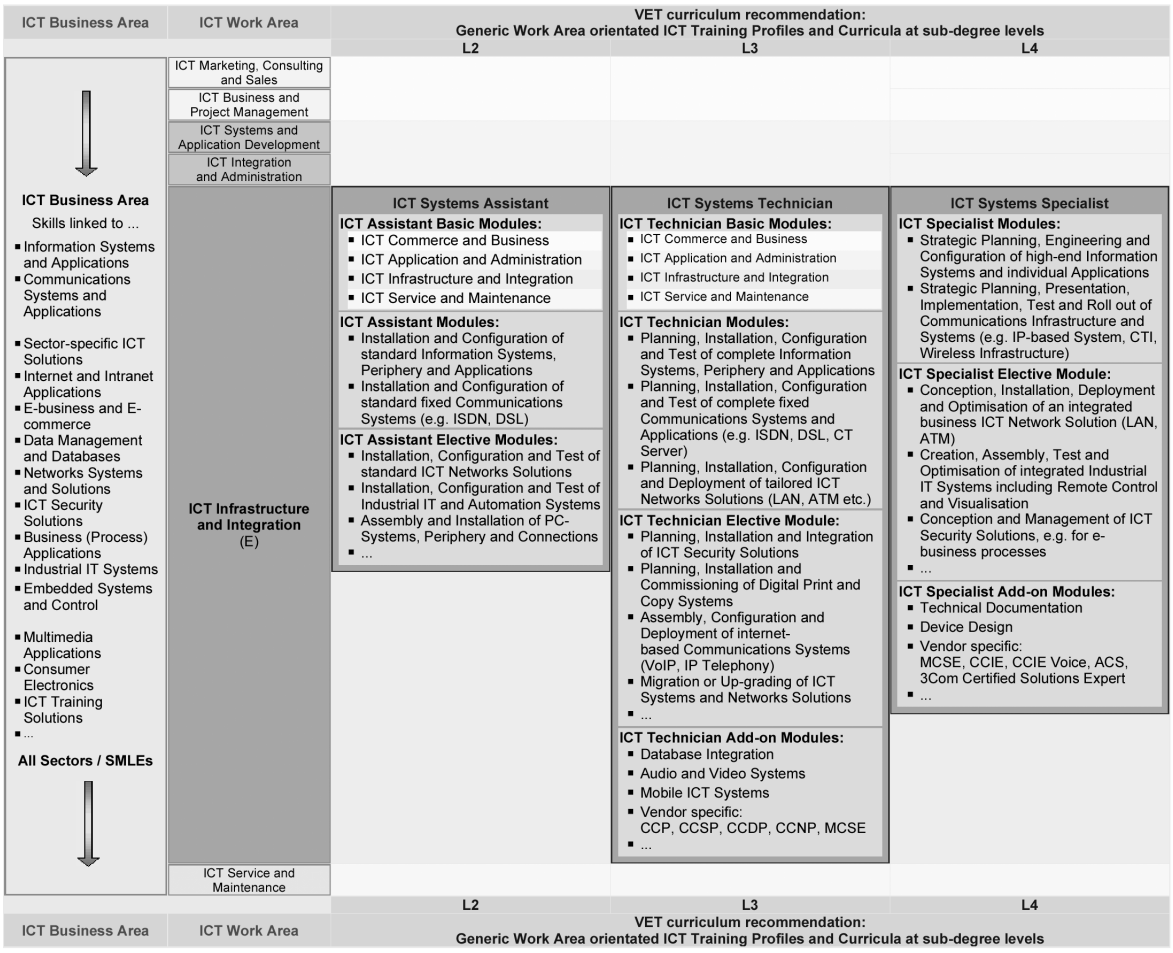
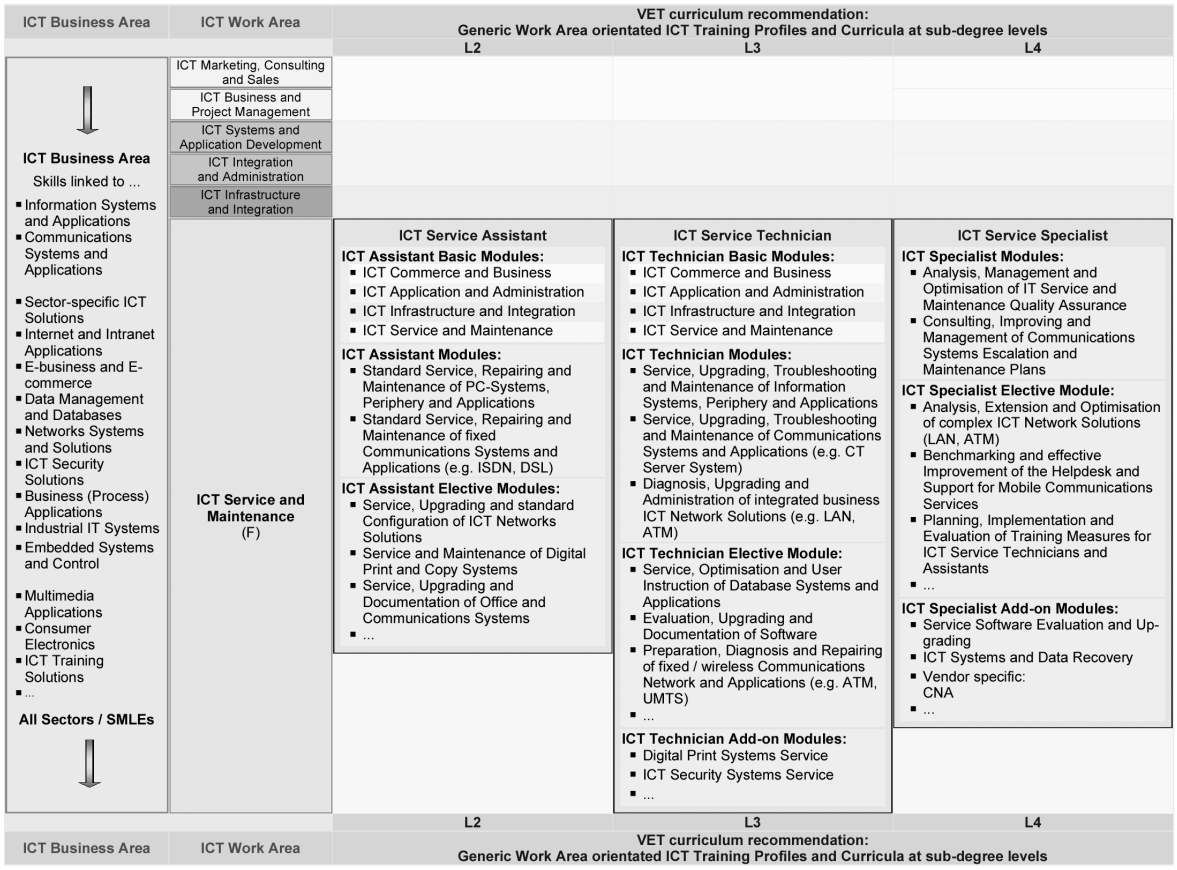


Figure 60: ICT service oriented generic work area oriented ICT training profiles and curricula



These curriculum recommendations for the 14 generic work area oriented ICT training profiles at vocational sub-degree levels and their module sets detail the curriculum development guidelines to a certain extent. This provides a framework and basis for the development of new European ICT training profiles and curricula at sub-degree vocational levels. The elaboration of the learning modules is an important further step but the number and structure of the new ICT training profiles, and the recommended sets of learning modules, must first be accepted in the course of a broad European discussion. Also important in this context, especially from the point of view of acceptance, are the following recommendations with regard to specific aspects such as entry requirements, assessment and certification, qualifying processes and design of courses.

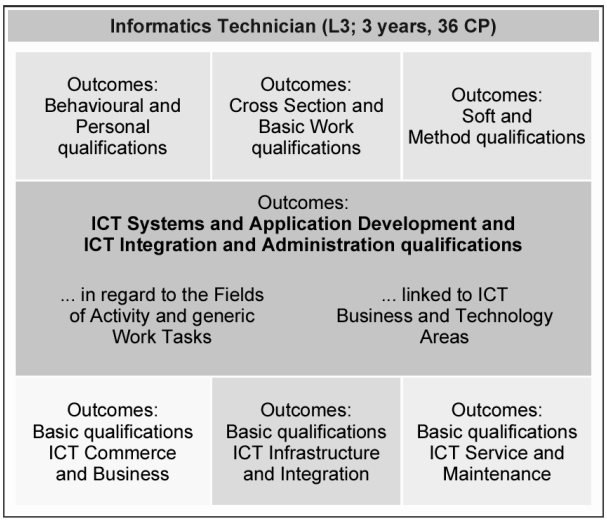
4.4. Further specific recommendations

4.4.1. Outcomes definitions

The aim of ICT vocational education is to produce a skilled worker with sub-degree ICT qualifications and abilities that qualify him or her to work in different areas and fields of activity and to carry out a range of ICT work tasks. The ICT training profiles and curriculum development guidelines emphasise the importance of qualification levels and profiles meeting the needs of the different ICT work area and labour market requirements. The sub-degree ICT qualifications and the structure and definitions of the 14 ICT training profiles have already been described in such a way that outcomes definitions have strong relevance to the needed skills and profiles within the ICT and user sectors (see Section 4.2.).

Correspondingly, the outcomes as sets of qualifications defined by the generic work area oriented ICT skills profiles are the basis for developing the curricula of ICT training profiles, rather than simply a knowledge list of subjects, scientific disciplines and technology areas. To adjust the outcomes continuously and keep the curricula up-to-date in order to increase the employability of skilled ICT workers, skill needs within the ICT and user sectors should also be evaluated continuously, e.g. through surveys and company case studies. Understanding curriculum development, therefore, is a continuing process. However, curricula outcomes have to be defined precisely in each case and specifically for the modules as the relevant basis for aspects such as entry requirements, assessment and certification. For example, the qualifications and contents structure of the defined outcomes of an informatics technician at level 3 can be described as follows:

Figure 61: Qualifications and contents structure of defined outcomes of the Informatics technician at sub-degree level 3



The detail of defined outcomes for one learning module for this position is as follows:

Figure 62: Defined outcomes of one work area oriented ICT Technician elective module

The outcomes of the ICT training profiles at sub-degree levels 2, 3 and 4 in combination with the duration of the accompanying ICT vocational training programme are one basis for setting up entry requirements. Another orientation is given by the three models with a hierarchic structure and combination of the 2 and 3 years ICT vocational training programmes (see Section 2.3.). Vocational education and training normally starts at sub-degree levels 2 or 3. For these levels the entry requirements are education and qualifications in general, which trainees have acquired through the secondary education up to the age of 16 years. The ICT vocational training programmes at level 4 normally build on a programme at level 3. Therefore, the entry requirements of VET level 4 can be described by the outcomes of the ICT training profiles at sub-degree level 3.

4.4.2. Assessment and certification

Other possibilities of entry and intergradation can be basically open, using the recommendations of valuing and assessment as well as corresponding certification of the ICT training profiles and modules outcomes. The recommended outcomes value in terms of credit points (CP) of the ICT assistant curricula is 12 CP, of the ICT technician curricula 36 CP and of the ICT specialist curricula 24 CP. The outcomes value of the modules differs depending

on the profile level and the learning module duration (see example above and Section 4.3.). With certificates for the profiles and modules according to the credit points and based on examinations, there are various options of mutual recognition between profiles and outcomes respectively, as well as to establish individual entry requirements. For example certification for ICT assistant outcomes can be recognised with 12 CP for profiles at level 3, while ICT technician outcomes can be recognised with 36 CP for the profiles at level 4.

As a new intergradation between the sub-degree and degree level, the certification for ICT specialist outcomes (which include ICT Technician outcomes) can be recognised with 60 CP (36 CP + 24 CP) for profiles at a first cycle degree, e.g. BA level (= 180 CP). Other mutual recognitions, such as valuing non-formal prior learning by external exam or product and vendor specific certifications in the broad ICT business areas, are also possibly more effective on an outcomes basis. With orientation to the list of main and specific ICT business and technology areas as a basis for mandatory and elective module contents described above, the following list indicates product and vendor specific ICT certification diversity:

Table 19: Examples of choice of product and vendor specific ICT certifications

- **Information systems, applications and services e.g.:**

  Compaq: ACT – Accredited Compaq Technical, ASE – Accredited Systems Engineer;
  IBM: CDA – Certified Developer Associate, CD – Certified Developer, CS – Certified Specialist, CSE – Certified Solutions Expert, CATE – Certified Advanced Technical Expert;
  Hewlett-Packard: Open View, HP UX;
  Microsoft: MCP – Microsoft Certified Professional, MCSE – Microsoft Certified Systems Engineer, MCSA – Microsoft Certified Systems Administrators, MCAD – Microsoft Certified Application Developer, MCSD – Microsoft Certified Solution Developer;
  Intel: ICIS – Intel Certified Integration Specialist, ICSC – Intel Certified Solutions Consultant;
  Citrix: CCA – Citrix Certified Administrator, CCEA – Citrix Certified Enterprise Administrator, CCIA – Citrix Certified Integration Architect;
  S.u.S.E.: Basic Course, System Administration, Internet Access;
  Sun: Certified Solaris Administrator, Sun Certified Java Programmer, Sun Certified Java Developer;
  ...
  CompTIA: A+, Server+, Linux+, IT-Projekt+;
  ICCP: ACP – Associate Computing Professional, CCP – Certified Computing Professional;
  LPIC – Linux systems administration, OSAC – Open Source Desktop Applications;

- **Communications systems, applications and services, e.g.:**

  Cisco: CCIE Communications and Services, CCIE Voice (over IP);
  Avaya: ACA – Avaya Certified Associate, ACS – Avaya Certified Specialist, ACE – Avaya Certified Expert;

- **Internet and intranet systems and applications, e.g.:**

  Cisco: CCIP – Cisco Certified Internetwork Professional;
  Novell: CIP – Certified Internet Professional;
  ...
  CompTIA: I-Net+;

- **e-business and e-commerce applications, e.g.:**

  IBM: Certified for e-business Solution Advisor, Certified for e-business Solution Designer, Certified for e-business Solution Technologist, Certified E-Commerce Consultant;
  Intel: ICeS – Intel Certified e-Business Specialist;

- **Data management and database solutions, e.g.:**

  Oracle: OCA – Oracle9i Database Administrator Certified Associate , OCP – Oracle9i Database

Administrator Certified Professional, OCM – Oracle9i Database Administrator Certified Master;
Sybase: SCA – Sybase Certified Associate, Sybase Certified Professional;
Informix: Database Specialist for Informix Online Dynamic Server, System Administrator for Informix Online Dynamic Server;
Microsoft: MCDBA – Microsoft Certified Database Administrators (on Microsoft SQL Server 2000);

- **Networks systems and solutions, e.g.:**

  3Com: 3COM Certified Solutions Associate (Training), 3Com Certified Solutions Expert, MNS – Master of Network Science;
  Cisco: CCDA – Cisco Certified Design Associate, CCNA – Cisco Certified Network Associate, CCDP – Cisco Certified Design Professional, CCNP –Cisco Certified Network Professional, CCIE – Cisco Certified Internetwork Expert, CCIE Routing and Switching;
  Novell: CNA – Certified Novell Administrator, CNE – Certified Novell Engineer, Master CNE, CDE – Certified Directory Engineer;
  Nortel Networks: NNCDS – Design Specialist, NNCFS – Field Specialist, NNCSS – Support Specialist, NNCDE – Design Expert, NNCSE – Support Expert, NNCA – Architect;
  ...
  CompTIA: Network+;

- **ICT security solutions**

  Microsoft: MCSA Security, MCSE Security;
  Cisco: CCSP – Cisco Certified Security Professional, CCIE Security;
  ...
  CompTIA: Security+;
  ISC2: SSCP – Systems Security Certified Practitioner, CISSP – Certified Information System Security Professional;

- **Business (process) systems and applications, e.g.:**

  SAP: R/3-Modules: Human Resources, CRM, ERP, etc.;
  Baan: Certified Baan Consultant;
  Lotus: CLS – Certified Lotus Specialist, CLP – Certified Lotus Professional, CLP Principal;
  ...
  CompTIA: e-Biz+;

- **Industrial IT systems, e.g.:**

National instruments: Certified LabVIEW Developer, Certified TestStand Developer, Certified Architect, Certified Professional Instructor;

- **Multimedia systems and applications, e.g.:**

  Macromedia: MMCP – Macromedia Certified Professional, Macromedia Director;
  Silicon Graphics: IRIX;
  Adobe: ACE – Adobe Certified Expert, Adobe Advanced Skills Courses;
  Quark: QuarkXPress Standard, QuarkXPress Advanced;
  ...
  CompTIA: CDIA+;

- **ICT training solutions, e.g.:**

  Microsoft: MCT – Microsoft Certified Trainers;
  ...
  CompTIA: CTT+

Looking at all opportunities for mutual recognition, it must be stressed that work area oriented ICT profiles and curricula focus strictly on outcomes and that these outcomes have a clearly defined sub-degree level. The outcomes are, therefore, not only the basis of the recommendation for ICT profiles and curricula and mutual recognition but also of all

processes of quality control such as qualifying and examination, design of courses and, ultimately, curriculum evaluation as a whole.

4.4.3. Qualifying processes

The proposed ICT curricula described the vocational education process with a structure and sequence of modules which can be understood as the basis for designing the qualifying and examination processes and courses. Whereas ICT curricula at degree level are normally located within higher education at universities, at sub-degree level learning processes and training places and concepts are more open and depend more on vocational education. Consequently, recommendations for designing qualifying processes and courses have to consider the possibilities of the different institutions and qualifying concepts including school based training, apprenticeship training, training courses in rotation of work or work process based and practical training. But because the ICT curricula and their modular structure can act as a common basis for different learning places and qualifying concepts, the general recommendation is that in the absence of one European qualifying concept, the qualifying processes should be like the curricula and modules, based on a work oriented didactic concept with a mix or combination of theoretical and practical training.

Experience shows that exclusively subject or theory oriented concepts do not really meet ICT skill needs. At the same time, practical training alone is not enough to understand complex ICT business and work processes and to carry out ICT work tasks in a professional way. Training concepts such as apprenticeships (e.g. in Germany, the Netherlands) or modern apprenticeships (e.g. in Great Britain) or the production school concepts from this point of view are good-practice examples of didactic orientation.

4.4.4. Course design

ICT curricula and their modular structure provide a didactic orientation for course design and so the recommendation is similar. Theory or practice courses should be organised according to work oriented didactic concepts and not in subject structures such as algorithms and complexity, operating systems, programming languages, architecture and computing, software engineering, computational science and numerical methods, etc. Also the learning process should be designed and implemented to be work, and therefore problem, oriented. This requires a focus on sequences and skill needs in regard to the fields of activity and work tasks of the ICT work processes. To carry out the courses and moderate the learning processes in this didactical sense, teachers and trainers must have some qualification in, and experience and knowledge of, ICT work processes. This is perhaps one of the biggest problems for ICT training and one reason why many other traditional concepts are more common and widespread.

4.4.5. Quality control and evaluation process

Training institutions should set up a quality control and evaluation process for VET programmes, based on each specific qualifying concept and course design decision. The collected results can be used for the further improvement of ICT curricula, programmes and concepts. The examination process results can also be used, as these not only evaluate the trainees' achievements but also the curriculum and qualifying concepts. In the context of quality control and evaluation, it is also important to get feedback from industry and the trainees who have finished the VET programmes by assessing the new work area oriented ICT qualifications and evaluating how well the ICT training profiles and programmes matched the outcome objectives and the requirements of the job. For example, as partly shown by the EUQuaSIT project described earlier, first evaluation experience can be used on how to shape further quality control and evaluation processes.

5. Cooperation in Initial VET and continuing training at European level

5.1. Enhancing mutual understanding and transparency of ICT skills and qualifications in Europe

Under the principle of subsidiarity every Member State of the European Union still retains full responsibility for the content of teaching and the organisation of its own education and training. However, people increasingly need to be able to follow more individualised learning and work pathways which may take them between different levels of education and training, different occupations and sectors, as well as between countries (The Copenhagen Declaration, Nov. 2002). Corresponding actions have been trying to tackle aspects such as mobility, exchanges, transparency and recognition of qualifications, definition and use of reference levels and qualification system structures, cooperation in areas like accreditation/certification and the validation of non-formal prior learning. The latest developments include the Europass-Training developed by the EU, Cedefop activities like the network of reference and expertise, the establishment of virtual communities and the service to the social partners and the social dialogue (for more details see on http://www.cedefop.gr).

European policy actions on vocational education and training aim at higher occupational and geographical mobility of labour forces. Despite several initiatives trying to improve the mobility of skilled workers, there are still big differences between political (theoretical) vision and social (practical) reality. The EU is actually characterised by low levels of occupational and geographic mobility, especially at skilled worker level and particularly between, but also within, member states. What intensifies this perception of lack of mobility is an increasingly knowledge-based and service-sector economy in which occupational mobility is essential for adapting to structural changes (CEC, 2002c, p. 7-9). Therefore, the corporate and economic potential of ICT as typically service driven is directly threatened by low mobility of ICT practitioners.

One of the major preconditions for mobility is to set up frameworks that improve transparency in European employment and training strategies and action. The European Commission's Action Plan for skills and mobility highlights three fundamental challenges (CEC, 2002c, p. 4):

(a) first, there is the challenge of inadequate occupational mobility, showing up the need to adapt education and training more effectively to the labour market, to boost lifelong learning and skills acquisition (particularly skills in information and communication technologies - ICT), and to improve systems to recognise qualifications and competences.

(b) second, low levels of geographic mobility within and between Member States suggest that the benefits of the internal market are not yet fully explored, for example in terms of

dealing with skills bottlenecks or labour market imbalances. Many obstacles to mobility still exist, including deficiencies in language skills, etc.

(c) finally, deficiencies in access to and the quality of information on mobility and individual sectors deter many people from considering a job move or particular career choice.

In this context it is a key challenge to enhance mutual trust in relation to European VET and CVT structures and frameworks. The developed ICT skills and qualification concepts of the report are described in this view in the following paragraphs.

5.2. European ICT skills, training and curriculum frameworks as a precondition for cooperation and transparency

In order to improve the structural relationship between ICT education and training and the ICT labour market, it is crucial to have a clear picture of actual skill requirements in companies and of training profiles in the relevant business and work areas. The processes for developing a mutual platform for a European dimension in vocational education and training can be summarised under the widely accepted term 'transparency' and have already been discussed and implemented in this report with special regard to ICT:

- investigation of ICT employment, demand from ICT and user industries, and the supply of ICT practitioners at all skill levels;
- investigation of ICT skill needs in European companies and qualification structures and existing ICT training profiles at sub-degree vocational levels in European countries;
- conception and implementation of three sub-degree ICT skill and qualification levels (L4, L3, L2) as a reference and framework for the definition and delimitation of ICT skills and training profiles and ICT curriculum development guidelines.

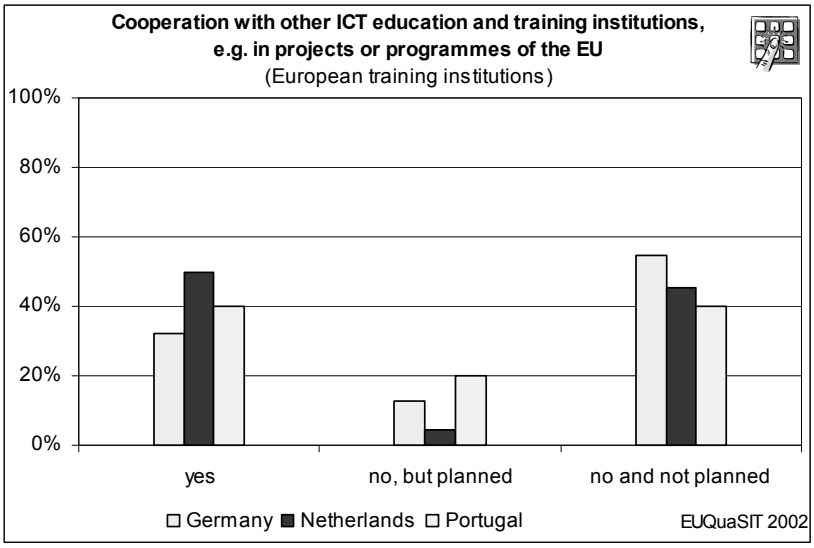
These results are in line with the need for 'new types of skills profiles to be developed to enable enterprises to provide relevant training to their employees, with account being taken of the needs and circumstances of SMEs. The development of ICT and e-Business skills profiles in particular is needed to help ease shortages in ICT occupations and sectors' (CEC, 2002c, p. 8). The primary advantage of clarifying industry's ICT skill needs from a business and work process perspective is the potential to establish business and work area oriented competence structures to help reduce the mismatch between industry's skill needs and current and future training programmes and qualification certificates. This work area oriented approach provides new perspectives for the development of common European training concepts and actions as well as the identification, assessment, legislation and recognition of non-formal (or informal) learning which takes place outside formal learning, e.g. at work or voluntary activities, every day (see Cedefop, Bjornavold, 2000). A lack of recognition of non-formal learning by employers and educational institutions can be a significant barrier to occupational mobility, whether within or between Member States (CEC, 2002c, p. 9). For instance, companies looking for ICT practitioners have been coping with a situation where formally qualified staff

were not easy to find in the labour market while many ICT workers qualified in other domains have been asking for a recognition of their non-formal ICT skills.

5.3. Cooperation of European ICT training institutions

One concrete level of cooperation in vocational education and training is that between ICT training institutions, e.g. in projects or programmes of the EU. In the context of the need for European understanding of ICT training profiles and curricula at different levels and in CVT, it is of value if national training providers cooperate with ICT education and training institutions in other countries. The EUQuaSIT survey indicates that approximately half of the ICT training institutions in the Netherlands and Portugal actually do, or at least plan to, cooperate with training providers in other European countries. In Germany the percentage is significantly lower and more than 50 % of the training institutions responded that no activities in this direction are currently carried out or planned.

Figure 63: European cooperation among ICT training institutions



One of the major problems is still the transparency and comparison of vocational skills and qualifications at sub-degree levels across Europe. A closer connection and dialogue between ICT employment (demand) and ICT training (supply) provides a basis for improving the concepts, provision and recognition of qualifications and competences, and therefore enhances occupational and geographical mobility in Europe.

6. Conclusions and recommended actions

The report provides quantitative and qualitative data on European ICT employment, the demand for and supply of ICT practitioners, and the ICT skills needs of the ICT and user sectors. Despite a primary focus on the skill and practitioner needs of ICT industries, the information also covers the needs of ICT user industries as well as enterprises of all sizes. Detailed case study results are presented on the specific ICT skill needs at sub-degree levels using a business area model of six generic work areas with associated fields of activity and work tasks; these are supported by European company evaluation results of actual ICT training profiles. The analyses and conclusions lead to a structure of 14 generic work area oriented ICT skills profiles.

Each of these skills profiles represents detailed skill needs at a specific sub-degree level and indicates, at the same time, the skills mismatch as regards existing ICT training profiles. The skills profiles provide, based on a work oriented didactic approach, the basis for an innovative framework of 14 European generic work area oriented ICT training profiles at sub-degree levels. In relation to this framework, and according to defined outcomes within three main qualification categories, the report also presents curriculum guidelines and recommends European training solutions for ICT practitioners focusing on the three vocational qualification levels 4, 3 and 2. The new ICT training profiles are further described through a didactic set of work area oriented ICT learning modules and a recommendation of valuing the ICT vocational training programmes in terms of credit points with corresponding conclusions regarding entry requirements, assessment and certification, the qualifying processes and design of courses.

The forthcoming challenge for means, programmes and actions, both at European and national level, is now the broad acceptance and successful implementation and evaluation of the common (reference) frameworks for ICT profiles, qualifications and credits and thus the establishment and acceptance of joint European occupational and professional ICT qualification standards. It has already been mentioned in the report that the results, such as the number and structure of the new ICT training profiles, the curriculum recommendations or the defined sets of learning modules, still need to be tested in European discussion and cooperation. However, some further concrete actions and tasks can be concluded and recommended:

(a) to monitor the European ICT labour market concerning the supply of and demand for ICT practitioners based on common occupation indicators such as a mutual understanding of ICT employment, workforce and job and skill levels;

(b) to investigate and assess continuously the skill and qualification needs of ICT practitioners based on quantitative, qualitative and comparative analyses such as company surveys, case studies and the evaluation of ICT training profiles and curricula in the sense of continuous curriculum development;

(c) to organise and administrate broad European cooperation (voluntary networks, public-private partnerships) of responsible education and labour ministries, VET and certification boards and committees, social partners, training providers and VET advisors and researchers willing to implement and evaluate the new ICT curriculum guidelines and training solutions in the scope of comprehensive pilot projects;

(d) to ensure greater transparency through systematic information, comparison and guidance on present European ICT training profiles and qualifications;

(e) to elaborate and implement the ICT learning modules and the design of courses based on skill needs in regard to the fields of activity and work tasks of ICT work processes;

(f) to monitor and evaluate the implementation of the developed modular vocational curriculum structure in various training institutions and companies;

(g) to ensure European recognition of the ICT qualification standards and certificates in order to provide greater transparency and mobility across Europe for skilled workers (e.g. ICT Euro-Pass , the Red Seal Program in Canada, http://www.hrdc-drhc.gc.ca/hrib/hrp-prh/redseal/english/index_e.shtml);

(h) to install joint methods and instruments for skills assessment and quality control;

(i) to discuss and draft recommendations for tailored ICT and didactic qualification concepts for teachers and trainers;

(j) to value and accredit vendor or product specific ICT certifications, prior non-formal learning and to help improve companies' own training provision.

It is hoped that the results presented support the mutual understanding, definition, recognition and implementation of European ICT skills, curriculum and training standards. For this we finally propose further and broader surveys on the ICT skill needs of, and adequate curriculum and training solutions for, ICT practitioners with special focus on vocational levels and in a representative sample of European countries. A first pilot project, e.g. in Germany, Greece, the Netherlands, Portugal, and the UK could gather experience in implementing the presented frameworks and solutions. However, the final synthesis report will summarise the results of all four studies within this Cedefop activity including the primary ICT industry and the three user industries automotive, financing and banking and the graphic/media industry and will provide further conclusions and recommendations on the subject.

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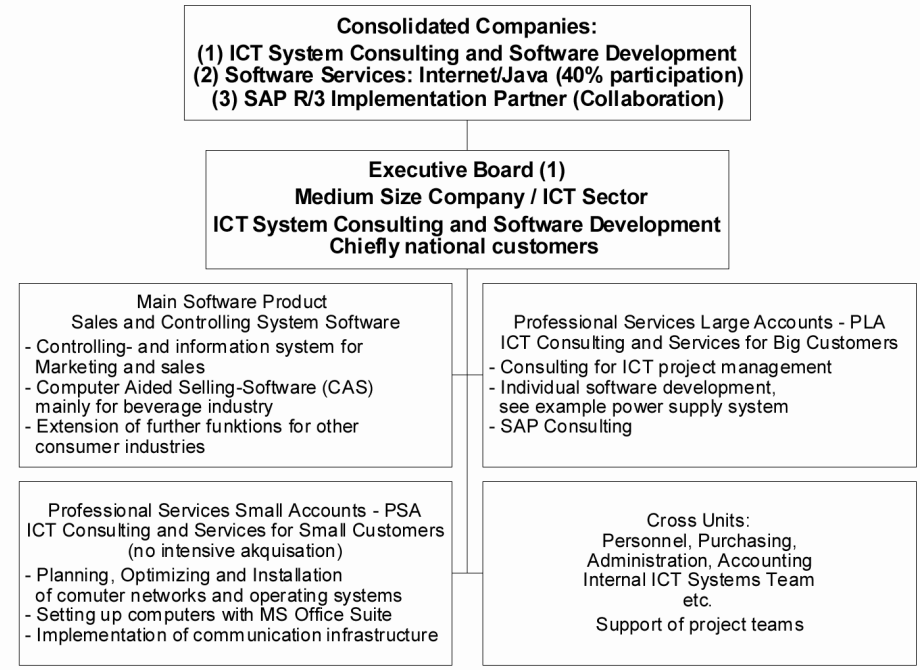
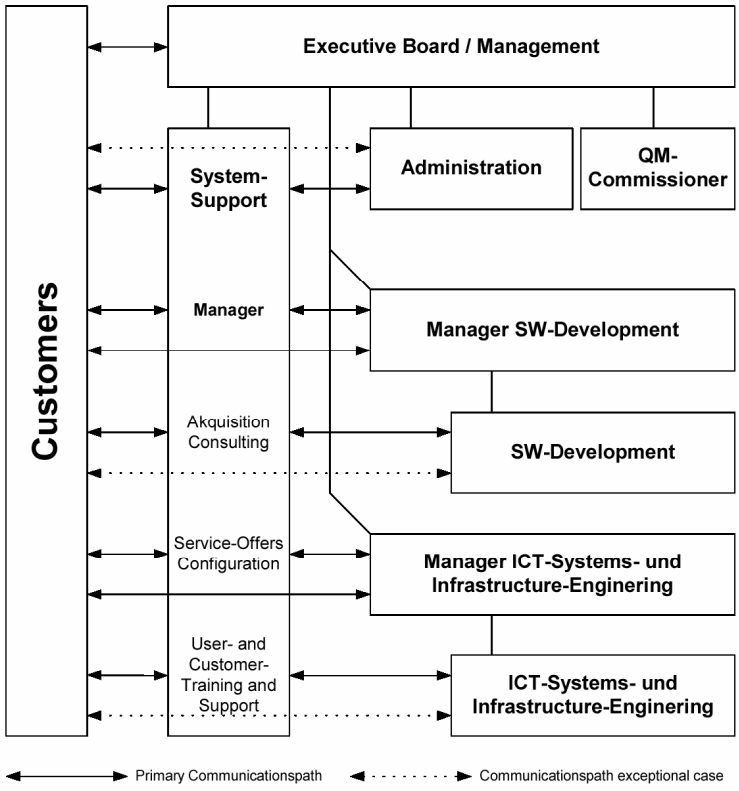
8. Annex: case study examples

8.1. Case study in an ICT systems and software company

Company	IT Systems Consulting and Support and Software Development
Sector	ICT Sector
Size of Company	Medium Sized Company
No. of ICT practitioners	app. 40
Structure of ICT staff / workforce	ICT practitioner group Level 5M (University degree) app. 20 % ICT practitioner group Level 5B (University of applied science degree) app. 40 % ICT practitioner group VET Level 4 app. 10 % ICT practitioner group VET Level 3 app. 30 %
Organisational structure of the company	
ICT Business Process 1	Further development, sales and implementation of the own "Sales and Controlling System Software" for large and medium size companies
ICT Business Process 2	Project management and individual software development for the administration of bond flotation of a large bank in Frankfurt
ICT Business Process 3	Project and main frame system support of a producer for printing machines, e.g. software development and support of the PL/1 systems
ICT Business Process 4	Prototyping, customizing und interface development for SAP R/3 (SAP-Consulting) in close collaboration with an affiliated company (SAP R/3 Implementation partner)
ICT Business Process 5	Planning, installation und implementation of a computer networks and corresponding PC work stations for a medium size electronics company (3000qm area)
ICT Business Process 6	**Development of a client-server based software for the data administration of German wide high voltage power supply system**

ICT work processes	Phases of activity	Work tasks	ICT practitioners			
			L2	L3	L4	L5
Coordination with customer and design of the technical specification (A)	Analysis of customer requirements and design of the technical specification (A.1)	Coordinate and prepare customer meetings (A.1.1)	Sales Manager (Dipl.-Kfm., L5B) Project Manager (Data Processing-Officer, L3) External ICT Consultant (Dipl.-Inf., L 5M)			
		Define and describe technical requirements and specifications (A.1.2)				
		Examine the realisation for the software concept (A.1.3)				
	Project management, contract and customer support (A.2)	Prepare and finalise the project contract (A.2.1)				
		Manage and coordinate the project (A.2.2)				
		Business support of the customer (A.2.3)				
Design of the software concept and framework (B)	Design of the object orientated data model (framework) (B.1)	Design of the basic software classes (B.1.1)	Framework-Developer (Dipl.-Inf., L 5M) Project Manager (Data Processing-Officer, L3) SW-Developer (Dipl.-Inf., L 5M) SW-Developer (Data Processing-Officer, L 3)			
		Develop the database concept (B.1.2)				
	Choice of the software development tools (B.2)	Organise and prepare project and systems information (B.2.1)				
		Test relevant software development tools (B.2.2)				
Development of the software applications (C)	Planning of tasks (C.1)	Arrange team meetings for the allocation of work tasks (C.1.1)	Framework-Developer (Dipl.-Inf., L 5M) Project Manager (Data Processing-Officer, L 3) SW-Developer (Dipl.-Inf., L 5M) SW-Developer (Data Processing-Officer, L 3) Apprentice (Information Technology Specialist, L 3)			
		Asses integration tools and configure technical infrastructure (C.1.2)				
	Realisation and programming of the software applications (C.2)	Design and specify software parts (C.2.1)				
		Develop software applications in Centura SAL (C.2.2)				
		Version software modules (C2.3)				
		Program and code Import-/Export Interfaces in Centura SAL (C.2.4)				
	Development of high efficient software modules in 3GL (C.3)	Describe demand of high efficient software modules (C.3.1)				
		Program and code of high efficient software modules in C++ (C.3.2)				
	Tests during software development process (C.4)	Develop test procedures and programmes (C.4.1)				
		Carry out software tests and code analyses (C.4.2)				
		Debug and implement software units (C.4.3)				
	Development and implementation of the database (C.5)	Graphical design of database structures and entities (C.5.1)				
		Implement the SQL database under Oracle (C.5.2)				
Implementation, final test phase of software parts and customer support (D)	Integration and configuration of the finished applications (D.1)	Coordinate the integration of software into the ICT system (D.1.1)	Sales Manager (Dipl.-Kfm., L 5B) Project Manager (Data Processing-Officer, L 3) External Consultant (Dipl.-Inf., L 5M) SW-Developer (Dipl.-Inf., L 5M) SW-Developer (Data Processing-Officer, L 3)			
		Configure the software applications remotely and at the customer's (D.1.2)				
	Real application tests at the customer system (D.2)	Define and describe boundary cases for the systems tests (D.2.1)				
		Run software tests at the customer's (D.2.2)				
	Support of the customer (D.3)	Instruct the systems supporter and the users at the customer's (D.3.1)				
		Permanent support and advise of the customer (D.3.2)				
		Advise the customer on potential extensions (D.3.3)				
			L2	L3	L4	L5
ICT work processes	Phases of activity	Work tasks	ICT practitioners			

8.2. Example of a case study in a ICT systems and software company

Company	ICT Systems Vendor chiefly in sector-specific Software Development	
Sector	ICT Sector	
Size of Company	Medium Sized Company	
No. of ICT practitioners	20	
Structure of ICT staff / workforce	ICT practitioner group Level 5M (University degree)	app. 50 %
	ICT practitioner group Level 5B (University of applied science degree)	app. 10 %
	ICT practitioner group VET Level 4	app. 10 %
	ICT practitioner group VET Level 3 / 2	app. 30 %
Organisational structure of the company		
ICT Business Process 1	New and further development (up-grading) of the own sector-specific software product	
ICT Business Process 2	Contracting and update-service of new and further software versions via remote data transmission or at the customer	
ICT Business Process 3	**Supply of Companies' Sector-specific Software Application including Consulting, Hard- and Software Adaptation and Delivery**	

ICT work processes	Phases of activity	Work tasks	ICT practitioners				
			L1	L2	L3	L4	L5
Customer consulting and contracting (A)	Acquisition of a new customer (A.1)	Arrange a sector-specific ICT fair exhibition (A.1.1)	Head of Department Systems Support (Dipl.-Forestry, L 5M) System Supporter (Data Processing Technician, L 3) Trainee (IT System Support Specialist, L 3) Technician (Communication Electronic Technician, L 3)				
		Design and assemble of the fair stand and the systems and applications to be presented (A.1.2)					
		Recommend company specific ICT systems solutions to potential customers (A.1.3)					
		Carry out and assess the fair in the post-processing (A.1.4)					
	Customer consulting and quotation processing (A.2)	Individually consult the customer regarding the optimisation of the operation and systems management (A.2.1)					
		Coordinate and plan the purchase order (A.2.2)					
		Prepare and deliver an official quotation to the customer (A.2.3)					
	Contracting (A.3)	Prepare the specific contract draft (A.3.1)					
		Provide technical consulting to the customer (A.3.2)					
		Direct and undergo the contract processing and finalising with the customer (A.3.3)					
		Execute final adaptations and changes to the contract (A.3.4)					
Provision of ICT infrastructure and systems (B)	Hardware assembly (B.1)	Identify and fix needed hardware performance (B.1.1)	Technician (Communication Electronic Technician, L 3) Trainee (IT System Electronics, L 3)				
		Purchase hardware systems (B.1.2)					
		Prepare and set up ICT systems components (B.1.3)					
	Set up of ICT systems and networks software (B.2)	Install and configure systems software (B.2.1)					
		Install and configure networks operating system (B.2.2)					
	Set up of communication software (B.3)	Select relevant communication software (B.3.1)					
		Install and configure communication software (B.3.2)					
	ICT systems and hardware delivery (B.4)	Plan and coordinate the systems and hardware delivery (B.4.1)					
		Set up the systems and infrastructure at the customer's (B.4.2)					
		Finally inspect the systems and document the work tasks (B.4.3)					
Adaptation and implementation of the customer software (C)	Adaptation of the sector-specific software to customer specifications (C.1)	Define and describe customer requirements to the applications (C.1.1)	SW-Developer (Computer Science Economy and Business (BA), L 5B) System Supporter (Data Processing Technician, L 3)				
		Adapt and implement software applications and units (C.1.2)					
		Document and version of the changes (C.1.3)					
	Set up of the sector-specific software at the customer's site (C.2)	Install and configure the software applications at the customer's site (C.2.1)					
		Test and acceptance of the software performance (C.2.2)					
Software and systems provision and project finalising (D)	Instructing the systems users (D.1)	Coordinate the user instruction (D.1.1)	System Supporter (Data Processing Technician, L 3) Head of Department Systems Support (Dipl.- Forestry, L 5M)				
		Carry out and evaluate the user training (D.1.2)					
	Accounting and billing (D.2)	Account the project work and systems performed (D.2.1)					
		Document the performances and customer information in the company database (D.2.2)					

Service and maintenance (E)	Service management (E.1)	Coordinate the customer service on the basis of the contract (E.1.1)	Head of Department Systems Support (Dipl.- Forestry, L 5M) System Supporter (Data Processing Technician, L 3)				
		Propose new service offers to the customer (E.1.2)					
	Troubleshooting (E.2)	Receive and interpret systems or application problems of customer (E.2.1)					
		Remove defects remotely or at the customer's (E.2.2)					
			L1	L2	L3	L4	L5
ICT work processes	**Phases of activity**	**Work tasks**	**ICT practitioners**				

Cedefop (European Centre for the Development of Vocational Training)

ICT practitioner skills and training solutions at sub-degree and vocational level in Europe
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A. Willi Petersen
Carsten Wehmeyer

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In recent years the spread and dynamic of information and communications technologies (ICT) across Europe have been steadily increasing. Today the high importance of ICT for the EU economy and business, services, domestic and leisure activities is obvious. ICT developments have created an 'information society' with consequential new possibilities and challenges in all areas of work and life. This is especially true of ICT work itself.

ICT practitioners – skilled and highly skilled ICT staff – are needed to manage business and work processes in both the core ICT sector and in ICT user industries. To understand, produce and use the new information and communications technology (computers, networks, the Internet, new hard- and software applications, e-commerce, fixed and mobile telecommunications, consumer electronic devices, digital cameras and television, etc.) increasingly demands a wide range of ICT competences and skills. This is one of four studies which Cedefop launched in support of the e-Europe programme and e-skills forum set up by the European Commission in 2003, covering three user industries (automotive, banking and financing, media and graphic arts) and the ICT manufacturing industry. The focus of the last of these is on subdegree level skills and training issues.

PANORAMA

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