Cedefop Programme:
IT Practitioner Skills and Curricula

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

Framework and guidelines for new ICT training profiles and curriculum development

(Final Report - July 2003)

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Forword

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1 Executive Summary

In recent years the spread and dynamic of information and communications technologies (ICT) in all European countries have been steadily increasing. Today the high importance of ICT for the EU economy and all areas including business, services, domestic and leisure is obvious. ICT developments have changed the society to an "information society" and new possibilities as well as challenges in all areas of work and life have been arisen, in particular in ICT work areas itself.

ICT practitioners as the skilled and highly skilled ICT staff are necessary to manage business and work processes in both, in the core ICT sector and in all (ICT-) user industries. To understand, produce and use the new Information and Communications Technology, like computers, networks, internet, new hard- and software applications, e-commerce, fixed and mobile telecommunications, consumer electronic devices, digital cameras and television etc., all people must increasingly possess and master a wide range of ICT competences and skills. The main source and fundament of all ICT practitioners are the various provisions of higher education (HE) and vocational education and training (VET) as well as tailored offers for continuing vocational education and training (CVT) and lifelong learning (LLL) respectively.

In regard to the needs of ICT practitioners the situation of the supply and demand in the European countries varies. Depending on the state of development of the “ICT economy” and of the national systems of higher education (HE) and VET the situation differs both in qualitative and quantitative aspects. However, the recent “new economy” problems world wide have been leading to the fact, that the discussion with regard to the outstanding demand and the problems of the ICT labour market has become more reasonable. The situation of the ICT practitioners needs has to be regarded particularly under qualitative aspects, namely that the supply of ICT practitioner qualifications altogether still does not sufficiently meet the ICT skill requirements. Therefore, to improve the current situation and to narrow the ICT qualification mismatch there is a need of more and better qualified ICT practitioners in all European countries.

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

In addition to the Career Space results the subject of 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 industry’s needs of ICT skills and practitioners at sub-degree levels in the ICT and user

sectors and especially including SMEs. Corresponding to the needs of ICT skills and skill profiles there should be further developed guidelines for ICT curricula at sub-degree levels and recommendations for the design of vocational training courses. In the general perspective of the ICT skill needs and situation in Europe curriculum guidelines and recommendations should be also carried out in comparison and complementary to the ICT skills and profiles at degree levels developed by the Career Space Consortium's working party.

The results of the analyses and investigations to find out the current ICT industry needs at sub-degree skill levels is mainly based on two empirical studies. Firstly, the European Leonardo da Vinci II project entitled "European Qualification Strategies in Information and Communications Technology (EUQuaSIT)", that includes company questionings and case studies in companies. The project has been carried out in cooperation with partners in five European countries. Secondly, a national study carried out by biat in order to evaluate new vocational ICT training profiles in Germany that 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 method and approach of the investigation based on the interaction of the demand and supply of ICT practitioners.

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

To support the ICT development and the competitiveness of enterprises and therefore the European economy as a whole a well-balanced relationship between the demand and supply of ICT practitioners is important for the ICT sector and all ICT user sectors which today more or less includes all sectors. An adequate supply of ICT practitioners at different qualification levels is therefore a very important precondition for the potential of enterprises, companies and organisations across all sectors. Findings on the situation of the demand and supply of ICT practitioners are insofar relevant under quantitative and qualitative aspects and in detail for all questions of the shortage, gap and mismatch as well as the existing and needed study and training solutions in Europe and the European countries respectively.

In this context a first important result is the total number of the employed ICT practitioners in Europe which according to different studies can be summarised to approximately 3,700,000 (cf. biat 2001, EUQuaSIT 2002 and CEPIS 2002). This total number includes the ICT practitioners in the ICT and user sectors and at all skill levels and is app. 2.5% of the total employment in Europe (total labour force app. 160 million). In comparison, for instance, the USA has a proportion of app. 2.8% (total labour force app. 140 million). The ICT practitioner proportion in split of the ICT employment between the "ICT and User sectors" in Europe is:

- **40% of ICT practitioners (app. 1,500,000) are employed in the ICT sector and**
- **60% of ICT practitioners (app. 2,200,000) are employed in the ICT user sectors.**

These proportions vary in European countries and depend on the economic situation and regions. And again, compared to the ICT employment in the USA it is interesting that also app. 60% of ICT practitioners are employed in non-ICT industries (NSSB 2002, page 11).

The next results to the relevant question of the current and future demand of ICT practitioners - of course - strongly depend on the ICT business and overall future economic development. Forecasts, assumptions and scenarios of this demand in Europe and in each European country

have shown this relation that has certainly changed according the "new economy" problems world wide especially in the last three years. Insofar actual company questioning results on the ICT employment are important which have indicated that the ICT staff in app. 60% of ICT and ICT user companies in Europe will not change in a short and mid-term. Otherwise especially in the ICT sector and small enterprises there are more than 30% expecting higher ICT staff in the near future. Therefore based on summarised study results, shared calculations and a realistic assumption with not more than 5% p.a. of the ICT staff growth in the next years:

- **the total demand of ICT practitioners in Europe - including the replacement demand - can be roughly estimated with some 230,000 ICT practitioners per year.**

In consideration of these annual demand and a corresponding development until the year 2010 a total number of 5,100,000 ICT practitioners for Europe seems to be a reasonable estimation. More difficult in this context are the results and assumptions in regard to the current and future shortage of ICT practitioners because these depend on the estimated numbers of the actual and future demand and at the same time the supply of ICT practitioners and therefore of the gap of ICT practitioners. In this context the actual company questioning results further show that the shortage of ICT practitioners is currently not very big. The results confirm in detail that the ICT labour market in Europe is actually not really bad either, because the supply of ICT practitioners is mostly estimated by the companies as being "fair" and only some 15% assess the supply as being “bad”. There are minor differences between European countries. With the background of this results even less realistic today are the "old" numbers of a huge shortage of ICT practitioners in Europe, e.g. the predicted 1.6 million shortage by 2004 (IDC 2001).

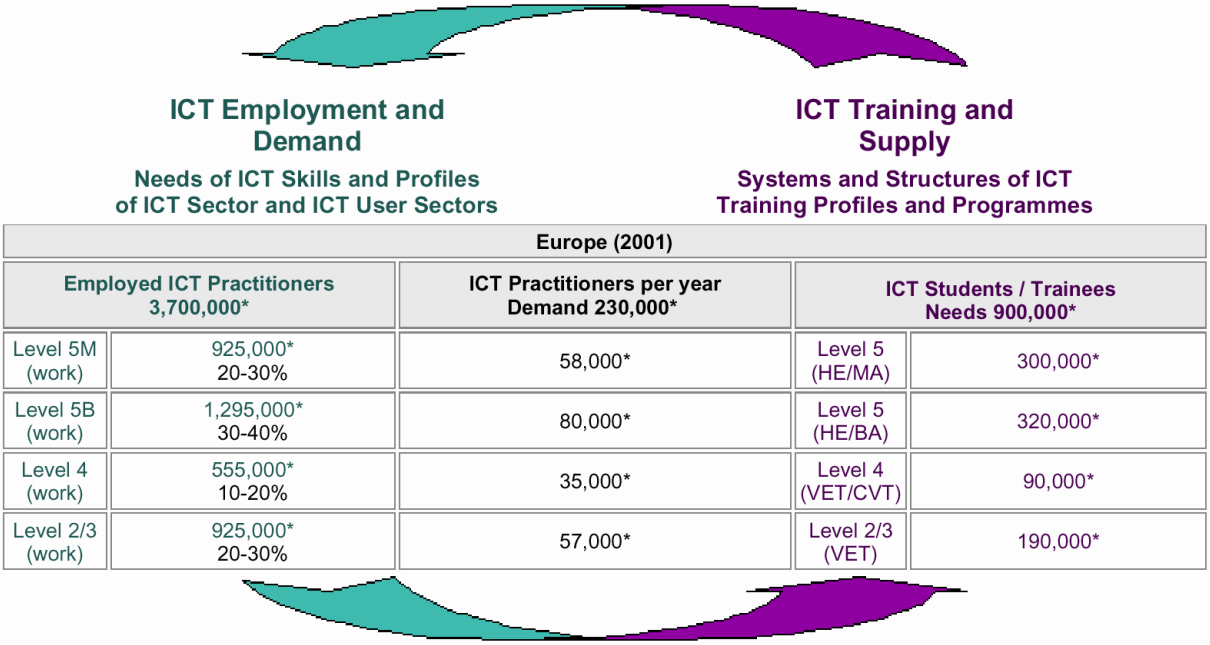
But all results and assumptions of the gap of ICT practitioners based on realistic numbers of the foreseeable supply of ICT practitioners which is neither easy to find nor available for all European countries. These particularly in what concerns the needed split in the supply of ICT practitioners at the different qualification levels. Furthermore one condition are results and findings on the split of the ICT employment and demand of the ICT practitioners at the different skill levels too.

As shown in the figure and according to different studies one result on the split of the ICT employment in Europe can be summarised to a relevant finding of this report:

- **between app. 50% to 70% of all employed ICT practitioners work and have an ICT qualification at degree level and**
- **between app. 30% to 50% of all employed ICT practitioners work and have an ICT qualification at sub-degree level.**

The concrete relation depends mainly on the respective country and further on the sector. For example the relation between the ICT employment at degree and sub-degree levels in Germany is 50% to 50%, in the Netherlands 60% to 40% and in Portugal 70% to 30%. The figure further indicates in detail the relative and absolute allocation of the 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 and therefore realistic numbers of the supply of ICT practitioners are not available, the figure shows according to the presumed demand per year only the estimated needed number of students and train-

ees at each qualification level. For instance and with consideration of an average duration of ICT programmes and trainings and also a drop out rate there is a total need of 900,000 est. ICT students and trainees in Europe. But in regard to this needs and as we know for most of the European countries, app. five years ago the numbers were too low. Otherwise we also know, that due to the increased demand of ICT practitioners during recent years the numbers of ICT students and trainees has also increased in the most European countries. However, as actual company questioning results indicate too, the situation of the ICT labour market in Europe is actually not too bad and the supply of ICT practitioners is mostly estimated by the companies as being "fair".



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*

fig. 1-1: ICT employment and demand at different levels in relation to the needed ICT Students / Trainees in Europe (cf. CEPIS 2002; *biat 2001; EUQuaSIT 2002)

In conjunction with the slow-down of the economic development and the actual employment situation the European results of the company evaluation indicate that:

- **the demand of ICT practitioners is quantitatively being met by the supply,**
- **the numbers of ICT students and trainees are possibly sufficient in order to improve the balance on the ICT labour market and**
- **a certain gap of ICT practitioners is only recognisable at BA degree level and at sub-degree level 4.**

For all this, one should keep clearly in mind, that reality depends on various developments (e.g. also career choice behaviour) and this was “only” a statement of the industry needs of ICT skills and practitioners under quantitative aspects.

ICT work and skill needs at different sub-degree levels and a structure of "Generic work area orientated ICT skills profiles"

The qualitative results of the industry’s needs of ICT skills and practitioners in Europe mainly base on investigations and analyses in form of case studies of the ICT business processes variety in the ICT and user industries as well as small, medium and large enterprises (SMLEs).

Results of the existing ICT training profiles and the CVT demand of special ICT qualifications are other indicators of the ICT skill needs.

In order to identify the ICT work and skills in the broad ICT business area a common model structure of ICT business and work areas (WA), fields of activities (FA) and ICT work tasks (WT) - called "GAHFA" - was used and proved by the case studies.

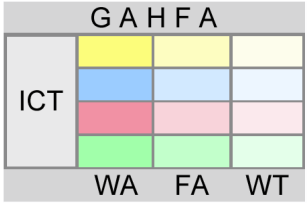


fig. 1-2: The “GAHFA” model structure

The results show on the one hand that the broad ICT business area in Europe and therefore the ICT work and skills - of course - differ in structures and contents depending on the sector and the core and main ICT business of a company. On the other hand the findings of the case studies allow in a first step to abstract all ICT business processes to a list of relevant ICT business and technology (sub-)areas, e.g. Information Systems, Applications and Services (IT), Communications Systems, Applications and Services (CT), Internet and Intranet Systems and Applications, Networks Systems and Solutions, Multimedia Systems and Applications etc. (see the list below). Nevertheless all ICT business and technology (sub-)areas can eventually be understood as one broad ICT business area. In a second step and especially the workflow structures of the "ICT Work Processes" show similarities which allow - based on common ICT work criteria - to aggregate and conclude the different structures of "ICT Work Processes" to one structure of six generic ICT work areas. These six ICT work areas represent the different contents and structures of "ICT Work Processes" for SMLEs in the ICT sector and ICT user sectors in a generic form. The contents and structure of the six ICT work areas depend on each real ICT business process and show in detail a cross link to one of the different business and technology areas respectively. But especially the structure of the six generic ICT work areas depends additionally on the size of the company (S, M or L) and the company organisation (department structure, hierarchies etc.). On the whole and as a first relevant analysis result for the general questions of the industry’s ICT skill needs and practitioners the broad ICT business area with the structure of six generic ICT work areas covers in a common sense the majority of the "ICT Business and Work Processes" in European small, medium and large enterprises and organisations and show their ICT skill needs in a common sense (see figure below).

The ICT work analysis results show furthermore that in each ICT work area there are ICT practitioners at all level involved and in each ICT work area for instance in the work area "ICT Systems and Application Development" therefore are needs of ICT skills at all degree (L5M, L5B) and sub-degree levels (L4, L3, L2), apart from sub-degree level 1. For the ICT skill needs in general the case studies indicate that the ICT work requirements and skill needs are currently covered by different ICT job profiles depending on the company and different European ICT training profiles.

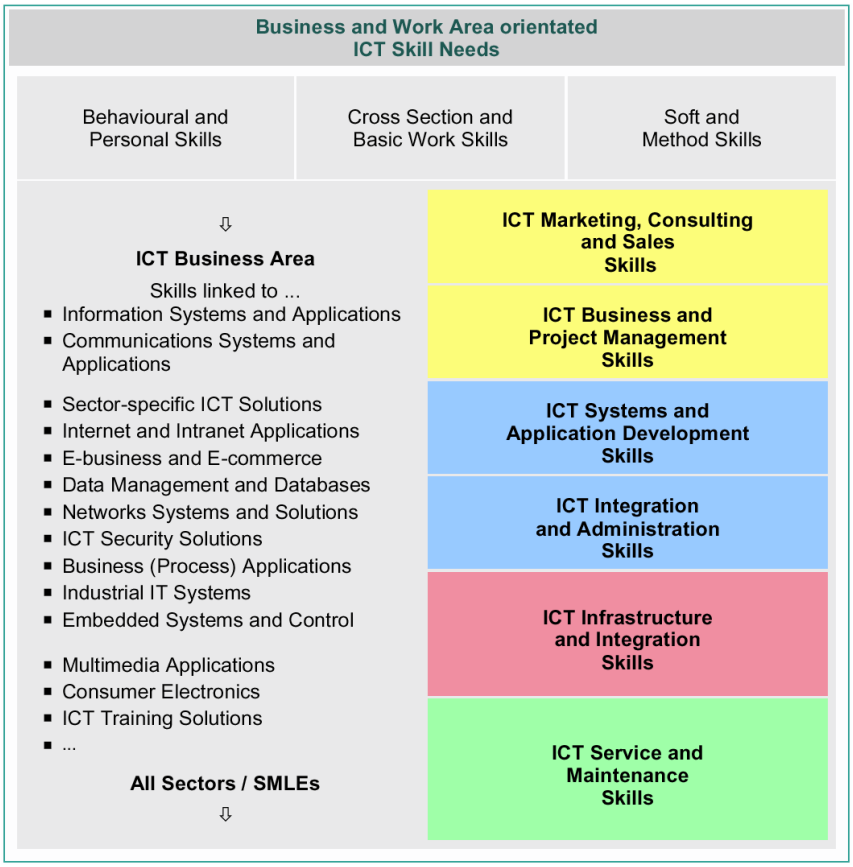


fig. 1-3: Structure of the business and work area orientated ICT skill needs in general

In addition to ICT skills in general the case studies show to each ICT work area a summarised structure of typical fields of activity and to each field of activity a certain number of generic ICT work tasks which are the broad empirical fundament for a framework of the ICT skill needs in detail. According to the case study concept the investigations concentrate especially within the fields of activity on ICT work tasks at sub-degree skill levels respectively on tasks carried out by ICT practitioners mainly with ICT job and training profiles at sub-degree skill levels. In this assignment the results show in regard to each ICT work area especially the structures and contents of the ICT skill needs at sub-degree levels. In further combination of these results with company evaluation results of the current ICT training profiles based on the European questioning the industry's ICT skill needs can be aggregated and concluded to the structure of 14 "Generic work area orientated ICT skills profiles" at the three 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

fig. 1-4: Structure of the fourteen "Generic work area orientated ICT skills profiles" at sub-degree levels

Each of these generic work area orientated ICT skills profiles represents in detail the skill needs at the specific sub-degree level and according to the ICT work areas and specific tasks. The skills profile "Informatics Technician" (L3) is shown in its structure in the picture below.

Primary part is the work area orientated "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 concretely take place. Furthermore, a set of complementary basic skills like the behavioural and personal skills is also needed, depending on the concrete work tasks and the skill level. Eventually in the ICT business area all work areas are related to each other and ICT practitioners need some fundamental skills of the entire ICT business area. Therefore an ICT skills profile covers also cross work area ICT skills expressed by the other three groups of generic ICT work areas. Detailed examples of the generic work area orientated ICT skills profile are described in the report for all work areas and sub-degree levels.

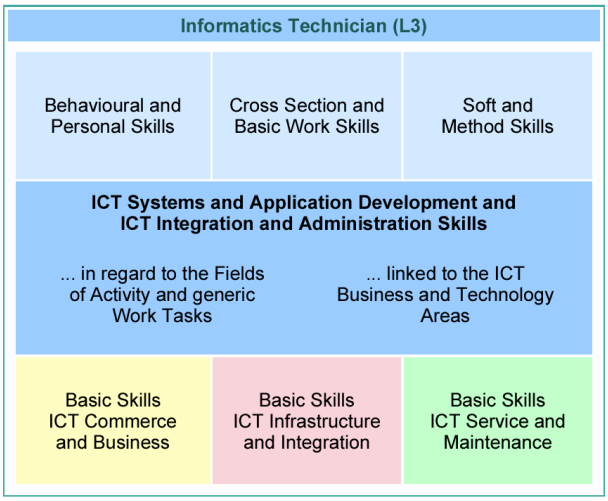


fig. 1-5: Generic work area orientated ICT skills profile: "Informatics Technician" at sub-degree level 3

The results on the ICT work and needs at sub-degree skill levels in terms of these "Generic work area orientated ICT skills profiles" can be at first understood as a definition and qualitative description of the current ICT skill and profile needs. The ICT skills profiles cover industry's needs of ICT skills and practitioners of the ICT and user sectors in Europe - in particular of small and medium enterprises too. Secondly and because these generic ICT skills profiles ought to decrease the mismatch in regard to the existing ICT training profiles the results can be understood as a recommendation to use the 14 "Generic work area orientated ICT skills profiles" as a fundament to develop new European ICT curricula for training profiles at the three sub-degree levels.

ICT curriculum development guidelines and recommendations for new European training solutions

In European countries there are currently different ICT curricula for ICT study and vocational training programmes at more or less all levels, e.g. with regard to the profiles skill levels, the number of ICT profiles at each level and the main subjects of ICT qualification. Nevertheless ICT curricula in European countries also show major similarities in what concerns the didactics and design and - chiefly due to increasing global and international developments and activities - the ICT curricula often base on the same approach in terms of aims and contents. Insofar the outcomes and ICT qualifications to be achieved contain a wide range of similarities, for instance just proven by the fact that the ICT practitioners after the ICT training, e.g. in Germany or Netherlands, are able to carry out in a comparable qualified way the same ICT work tasks. Furthermore the ICT skill needs at all skill levels of the European ICT and user

sectors base 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 European company evaluation of the ICT training profiles and therefore of the ICT curricula further clarifies company's needs of each ICT training profile respectively to what extent a profile meets the ICT skill needs in general. The results indicate especially under revision aspects a mismatch in regard to the ICT training goals and contents. Beside using these results to find out the skill needs and profile structures, among other things, the curriculum evaluation results indicate examples of "good and bad practice". Even though there is certainly no single way to develop ICT curricula, the examples of "good practice" show various structures, goals and contents related to the work area orientated ICT skills profiles, whereas the curricula which still partially but strongly separate ICT business, informatics (software) and electronics (hardware) skills and contents do not meet the work area orientated skill needs. Supported by a majority of companies who see the necessity of common European standards for ICT training profiles and curricula the results all together motivate to improve the common European curriculum design at sub-degree levels in a more work orientated direction based on corresponding ICT training profiles.

Considering the evaluation results and in order to improve the balance between the ICT employment and the ICT vocational education and training systems the curricula and profile structure need to be designed in strong reference to the skill needs and contents of the ICT work areas. Of course, all curricula and profiles subjects or concrete business and technology contents require a didactic reflection of the appropriate range and depth of competences too. In an open European sense without a preliminary curriculum decision of a national VET system the recommendation and appointment is:

- **the structure of the fourteen "Generic work area orientated ICT skills profiles" is the fundament and framework for the new European "Generic work area orientated ICT training profiles" at sub-degree levels (see figure below).**

This profile and curriculum appointment with a high equivalent and equation of the "Generic ICT skills profiles" and level structures is especially possible, because the work and training levels base on the same level structure. Like the skills profiles the number and structure of these new fourteen European "Generic work area orientated ICT training profiles" are insofar designed in strong reference to the structure of the skill needs and contents of the ICT work areas and not, for example, to a specific sector, technology or business area. That means the profile numbers at each sub-degree level and the content and competence delimitations of each ICT training profile is oriented in a first line to one or two work areas and a specific work tasks sample and only in a second line to the concrete business and technology areas in their diversity.

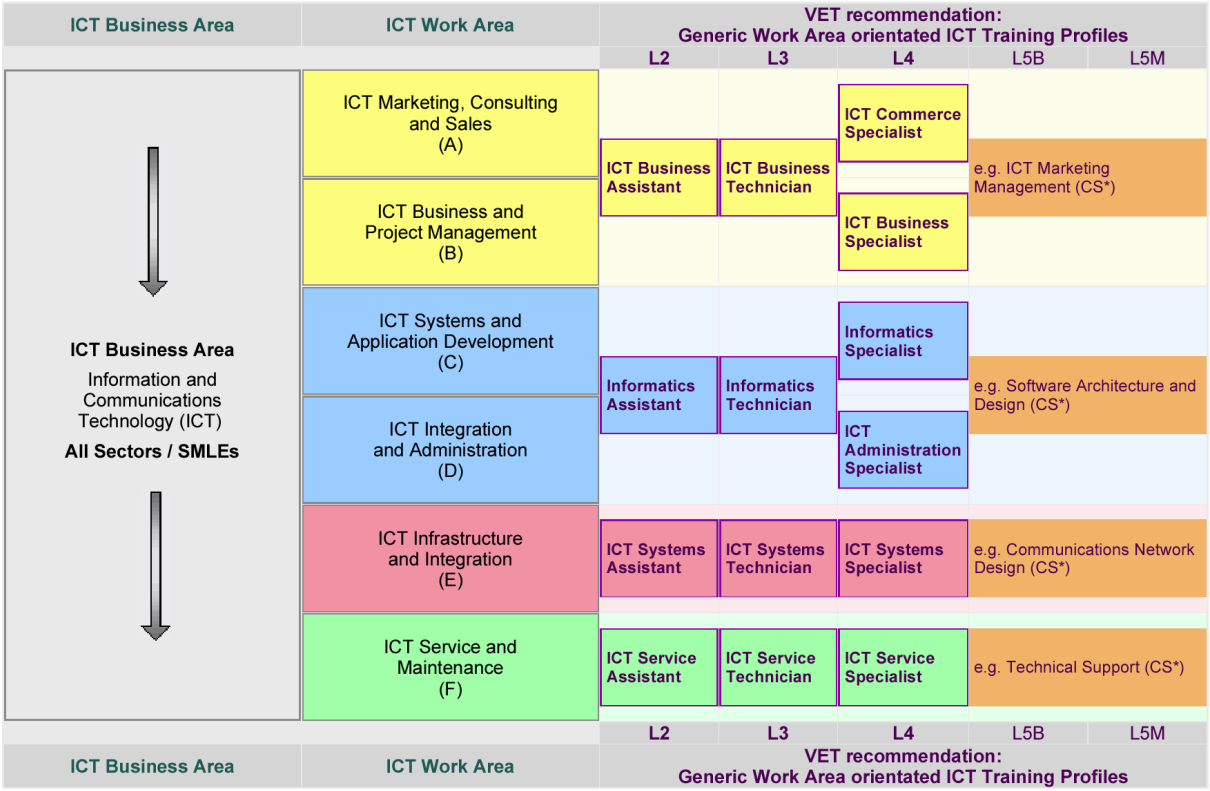


fig. 1-6: Structure of the fourteen "Generic work area orientated ICT training profiles" at sub-degree levels (* Generic ICT skills profiles examples at degree level of Career Space)

In a further curriculum step the profile and curriculum approach with a high equivalent of the "Generic ICT skills profiles" and level structures is also important in regard 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" can be understood as the outcomes of each "Generic work area orientated ICT training profile" in terms of qualifications. Correspondingly the answer in general is

- **the structures and contents of the skills of the "ICT skills profiles" are the fundament of the structures and contents of the qualifications as the "Outcomes" of the "ICT training profiles"**

Furthermore, the outcomes as a fundament for the curriculum development also in detail consider the structures and contents of skill needs described in the generic ICT skills profiles. As shown for each ICT skills profile and the profiles at each level the skill structure of all profiles is basically identical with three main skill fields as follows:

- **Behavioural and Personal Skills, Cross Section and Basic Work Skills, Soft and Method Skills,**
- **ICT Practitioner Skills (kernel work area orientated profile skills),**
- **Cross Work Area ICT Skills (complementary to kernel work area).**

In respect of these identical skills and contents structure and therefore the qualification outcomes of the ICT training profiles the basis of all ICT curriculum development can be described in a common curriculum model as a qualification framework of **"Work Area orientated ICT Curriculum"** for all sub-degree levels. This curriculum model shows a framework

of three main qualification and content fields and a recommendation of its (quantitative) curriculum extent:

- **Basic Qualifications (15%)**: Behavioural and Personal Qualifications, Cross Section and Basic Work Qualifications, Soft and Method Qualifications
- **ICT Practitioner Qualifications (~70%)**, that cover all kernel work area orientated profile qualifications
- **Basic ICT Work Area Qualifications (~15%)**, that cover 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 level structure of the fourteen "Generic work area orientated ICT training profiles" it is one recommendation of the curriculum guidelines to define a corresponding structure of ICT vocational training programmes by specifying the duration as indicated in three models. These models show a hierarchical structure and combination of 2 and 3 years ICT vocational training programmes with a more or less open learning organisation and different options of mutual recognition of certificates or examinations.

The curricula furthermore need a structure and definition of learning units which are consequently recommended and defined as "Work area orientated ICT learning modules". Each learning unit orients to the description and justification of the work areas and is - like a module - part of a didactic module set that constitutes each ICT training programme. This also includes a recommendation of valuing the ICT vocational training programmes in terms of credit points (CP):

The didactic concepts of the curricula for the ICT Assistants and the ICT Technicians is more or less similar insofar that each programme begins with four learning modules that cover basic competences and knowledge of an ICT business process as a whole (see figure below). But the recommendation is that all "Assistants", "Technicians" and in the same way all "Specialists" modules have an identical structure and the contents of each set depends in a first line 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 and further - of course - on the profile level. In a second line each work area orientated module considers within the fields of activity and generic work tasks at the same time qualifications linked to one specific business and technology area which can be extracted from the wide business area of information and communications technology (ICT). Whereas two and for the "Technicians" three modules of these sets are mandatory "ICT Modules" linked to the two overall and main business and technology areas "Information Systems, Applications and Services" (IT) and "(Tele-)Communications Systems, Applications and Services" (CT) the other modules 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 of ICT business and technology (sub-)areas.

The mandatory and elective "ICT Modules" in each training programme complete and cover especially the "kernel" ICT qualifications and include - as all modules - integrated basic qualifications, e.g. behavioural, cross section and method qualifications. And the guidelines particular for the ICT Technician and Specialist curricula furthermore foresee an open number of so-entitled "ICT Add-on Modules" that are additionally supposed to cover specific compe-

tences within the training programmes, e.g. specific product, technology or field of activity ICT competences.

Regarding the duration of the ICT practitioner modules those for the ICT Assistant and most of the ICT Technician curricula have 4 months. Two elective modules of the ICT Technician curricula and all modules of the ICT Specialist curricula have a duration of 6 months training. The value in a range from 2 credit points to 6 credit points of each of these modules depend on the training profile level and the module duration. The summation of the credit points of each training programme is therefore also different and the total value of all curricula at level 2 is 12 credit points, at level 3 36 credit points and at level 4 24 credit points.

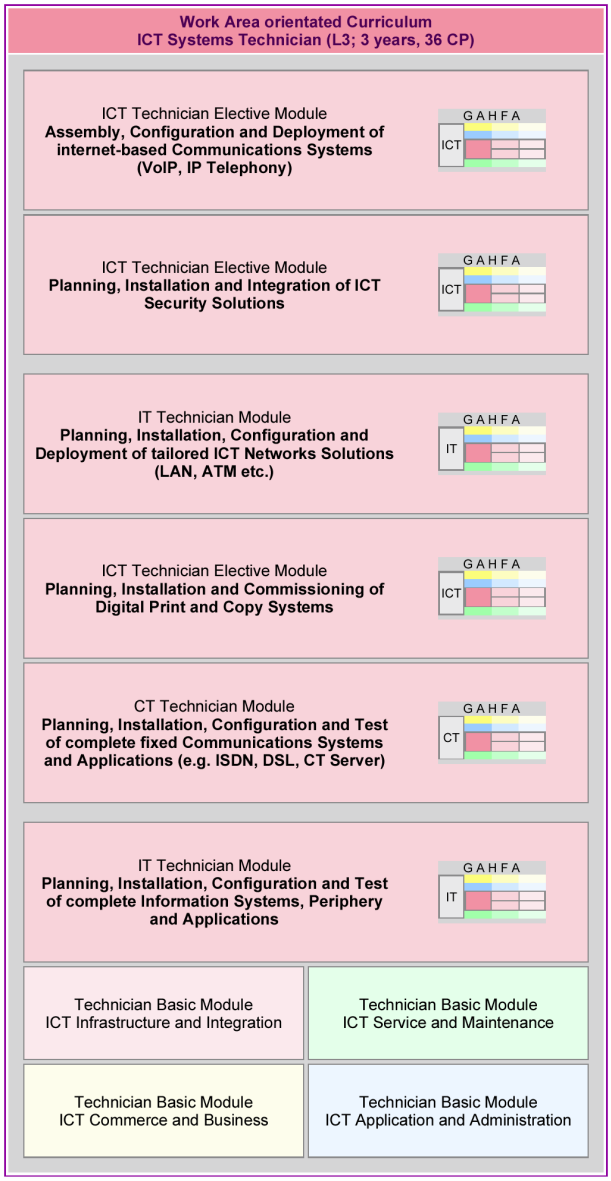


fig. 1-7: ICT Systems Technician curriculum at level 3

By using these curriculum guidelines the report contains the complete and assigned structure of all fourteen "Generic work area orientated ICT training profiles" with their curriculum and module sets to be understood as a framework and fundament for the development of new European ICT training profiles and curricula at vocational sub-degree levels.

The basis for developing the curricula of ICT training profiles are the outcomes as sets of qualifications defined by the generic work area orientated ICT skills profiles and required to exercise ICT work at sub-degree levels rather than a knowledge list of subjects, scientific disciplines and technology areas. On the other hand the outcomes of the curricula have to be defined precisely and in detail regarding each curriculum and for instance concrete for the modules as the relevant basis for further questions like the entry requirements, assessment and certification etc. Another orientation to set up entry requirements is given by the model and system of ICT vocational training programmes. VET normally starts at sub-degree level 2 or 3. For these levels the entry requirements are education and qualifications in general. 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.

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

In the sense of all feasibilities of mutual recognition it needs to be underlined too, that the work area orientated ICT profiles and curricula strictly focus on outcomes and that these outcomes have a clearly defined sub-degree level.

With regard to the qualifying processes it needs to be stressed that the ICT curricula at sub-degree level in regard to learning or training places and concepts are more or less open and strongly depend on the vocational education system and there is correspondingly only one recommendation to be given in general:

- **without a preliminary provision of one European qualifying concept the qualifying processes should be like the curricula and modules itself based on a work orientated didactic concept with a mix or combination of theoretical and practical training.**

For the design of courses the ICT curricula and their structure of modules provide also a didactic orientation and thus the courses should be organised on a work orientated didactic concept and not in subject structures. Also the learning process should be designed and implemented work and therefore problem orientated. That means, the sequences and skill needs in regard to the fields of activity and work tasks of the ICT work processes are the orientation and basis to reflect the content structure and method and also the media for designing courses and the learning processes. To carry out the courses and moderate the learning processes in this didactical sense one implication and relevant condition is that the teachers and trainers must have certain experience, competences and knowledge of the ICT work processes. For the

VET programmes based on each specific qualifying concept and course design decision the training institutions ought to set up a quality control and evaluation process.

With these curriculum recommendations for the fourteen "Generic work area orientated ICT training profiles" at vocational levels and their module sets the curriculum development guidelines have been described to a certain extent including aspects for their implementation. The elaboration of the learning modules is one of the important further steps. But, however, certainly the results like the number and structure of the new ICT training profiles and the recommended sets of learning modules still need to be accepted before in the course of a broad European discussion.

Complementary to the Career Space results of the ICT curriculum guidelines and the generic ICT skill profiles at degree level the comparison of the recommendations show in regard to ICT needs and the relevant conclusions for the ICT situation in Europe a good harmony. But in a general perspective there is one significant difference, namely the more subject orientated generic ICT skill profiles at the degree level of Career Space and the more business and work area orientated ICT skills profiles at sub-degree levels described in this report. In the result this means that each curriculum of the modules in the comparable structure likewise based on more subject or more business and work process orientated contents. However, the advantages and disadvantages for the didactics and the learning and qualification process have not been addressed yet, but the differences certainly do not allow to simply transfer the developed 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 its new strategic objective for the coming decade, viz.: "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 internet and e-commerce effect the entire economical structure in Europe. To actively 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 on the labour market, and this only partly depends on the overall situation on 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). As mentioned above especially in a European perspective of open labour markets, employment and qualification more transparency and knowledge is needed as follows: "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 is now spread in almost any domain of human activity - from technical to social areas, from military to commercial domains. This is simply due to the matter under concern - information; hence any human activity could (eventually) benefit from information technology. In the first phase information technology (IT) was involved in economical and technical domains to process large amount of data quickly and accurately, but rarely to increase efficiency. The second phase focused on efficiency of target system running - in direct way (process optimisation) or in indirect way (decision support and expert systems). The third phase reversed the direction of interaction between IT&C and targeted domains, namely information technology shapes the target do-main - as it is the case of e-business, e-learning, e-culture. The third phase requires mass combined ICT qualifications, more or less intense, and from this point on, the education along with job and labour market need tailored ICT training profiles; it also leads to changes on borders between ICT practitioners and various categories of ICT users.

The following paragraphs focuses on the situation of the ICT industry taking into account the skill and training needs in ICT business areas of companies of the user industries. Special outcomes are chiefly available from three European countries, namely Germany, Netherlands and Portugal. Where available and feasible information from other European countries or entire (western) Europe have been taken into account.

2.1 Situation of the ICT Market and the 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 modernization of products and services. The use of all the different types of ICT is one of the most significant features of today's business. The tools of supporting ICT 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. Furthermore the Internet has already fundamentally changed the way today's businesses operations and will continue to do so in the future. ICT on the one hand promotes prospects for economic growth, on the other hand we see the creation of jobs for highly skilled personnel. The ICT market all together has permanently grown throughout the last ten years, even though the growth was not that massive any longer at the beginning of 21st century (see fig. 2-1).

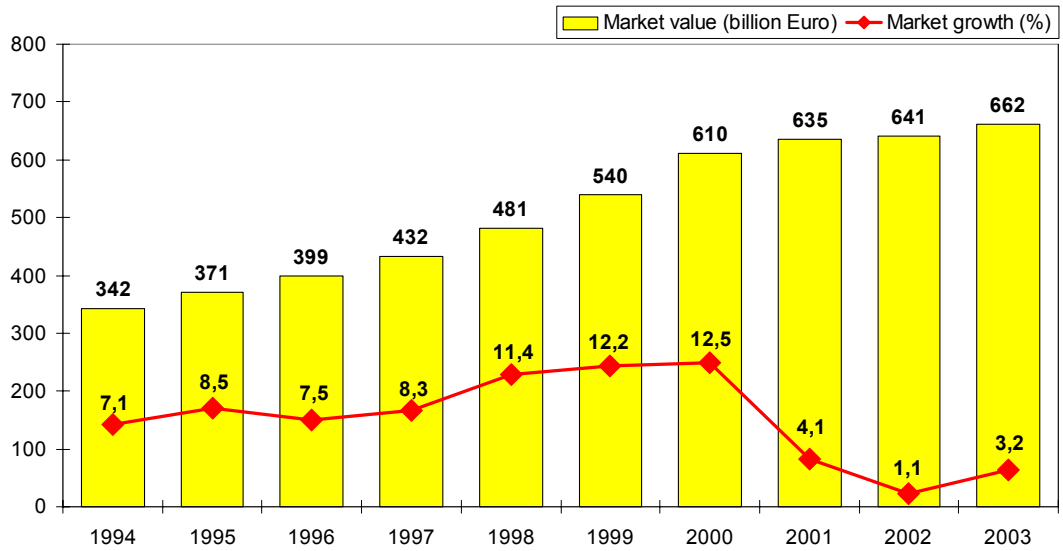


fig. 2-1: Development of the Western European ICT-Market, 1994-2003
(Source: EITO Update 2002 in cooperation with IDC)

"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 € 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 € 324 billion, while the telecommunications market accounted for some € 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 ser-

vices continued to grow, even if at a more moderate pace compared to previous years" (EITO 2002. p. 53 f.).

The ICT market situation in specific European countries for example can be expressed for Germany, the Netherlands and Portugal as follows:

- in Germany the slow-downed 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;
- in the Netherlands IT spending was up 4.0 % in 2001. After buoyant growth in 2000, Netherlands telecommunications market grew by 5.9 % in 2001;
- in Portugal IT spending was up 4.8 % in 2001. The telecommunications market in Portugal grew by 8.0 % in 2001 (cf. EITO 2002. p. 56 et seq.). ([1])

To characterise the ICT market in more detail some background information about the ICT development and extend are relevant with aspects and topics like:

- Number of computers etc. in business and private areas,
- internet users (network and home users) and number of internet domains and hosts,
- e-commerce sites and volume of e-business,
- use and penetration of mobile communication.

According to various surveys in 2001 the worldwide number of PCs in use 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 a number of 158 million PCs (CIA 2001). Germany, the Netherlands and Portugal e.g. 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.

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 coming from 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 there are about 30% of private households of the European Union member states that are connected to the internet. In addition there are 70% of SMEs who are connected to the internet and app. 40% have their own web-site (ECIN 2002).

For Germany e.g. the number of internet users in 2001 has increased to app. 20 million people which was about 25% of the population. About 15 million had internet access from home. In the Netherlands compared with Europe the rate is extremely high with about 50% of its population. For Portugal the proportion is about 20% all together and about 50% for the users between 15 and 19 years of age. An increasing portion of Internet users will be using wireless devices such as web-enabled cell phones and PDAs to go online. Therefore wireless devices

[1] There are also more information available on the ICT market trends of other Western European countries like France, Spain, UK etc.

become a major way to access the Internet in the next two years. The 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 Internet access devices (CIA 2001).

ICT Suppliers already offer to distributors and suppliers the possibility 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 the e-commerce expenditures reached more than 600 billion in 2001 and are expected to overcome 1000 billion in 2002. In Europe people were supposed to spend almost 70 billion Euro via internet and online commerce respectively. The growth was large in all regions but the factors behind this growth depend from one region to another. For the electronic commerce of Western Europe, Germany is responsible for 27.5%, Netherlands for 4.5% and Portugal for 1.9%. In this field the unique Euro currency will lead to a raise of transparency, higher 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 as far as aspects of data security are concerned, for instance the payments 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.

In regard to the mobile communications market the change of the number of mobile phones has been enormously throughout the last 5 years. The penetration for example in Germany, the Netherlands and Portugal already in 2001was nearly 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 the interaction to ICT training and supply

Without doubt, the actual slow-down of ICT economy's growth has had impact on the development of the ICT labour markets in Europe and elsewhere in the world. The situation of the "new economy" world wide has been leading to the fact, that the discussion with regard to the ICT practitioner demand and gap became more reasonable. However, the demand of ICT practitioners needs to be regarded particularly under qualitative aspects, namely that the supply of ICT programmes and training profiles altogether may still not sufficiently meet the ICT practitioner and skill needs expressed by the companies. And it is always true that the permanent and rapid changes of ICT offers and applications as well as ICT business and work processes requirements lead to substantial changes of the ICT practitioner skills required in regard to the wide range of ICT work areas. Therefore adequately skilled ICT practitioners are requested in all European countries permanently and for any country throughout Europe it is one of the major present and future challenges not only to react to the demand and needs but also to support the development and to provide a tailored framework of ICT programmes and training profiles at different levels.

For questions in this context, for instance to have dates and facts in detail and more clear, it is the main task to identify the developments of the ICT and user sectors concerning the ICT business and work areas on the background of the different ICT market segments and applica-

tions described above and bring them into a relationship to the ICT employment and skill needs and the systems and structures of ICT programmes and training profiles. Used as the research approach at the same time in this report the following figure illustrate this relationship in the specific interaction form because there is no determinism. That means that the ICT employment and demand of the ICT and user sectors - of course and comprehensible - have an influence on the ICT training and supply. Concrete the skill needs are an important fundament to curriculum questions at all levels, independent of each European education system. Otherwise it is also comprehensible that the ICT training and supply have a certain influence on the ICT work and the possibilities of employment which is in the sense of autonomous education especially of importance to support companies based on prospective technology and behaviour competences.

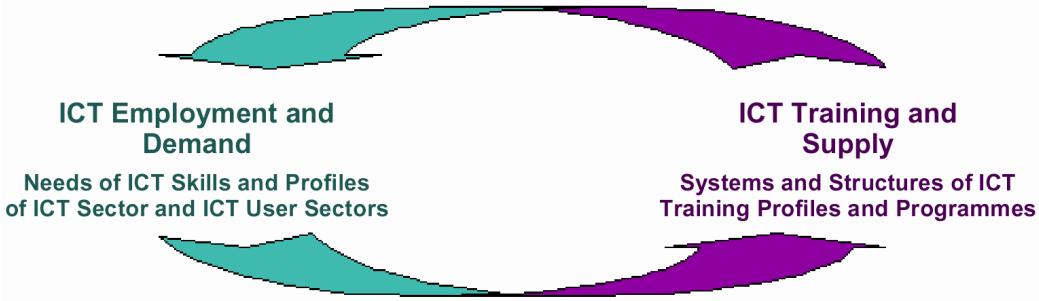


fig. 2-2: Interaction between the ICT employment and demand and ICT training and supply

The following table provides an overview of ICT employment, skills and qualification terms used for this report. All the discussions throughout the edition process of the report have indicated different understandings and definitions of what is understood, for instance, by the term ICT practitioner and the delimitation to what is meant by ICT practitioner and so on. Furthermore, especially the usage of the term “ICT profile” on its own has been proven problematic and is being avoided for this report. Only combinations like “ICT skills profile” or “ICT training (qualification) profile” prove clarification.

Definition and understanding of ICT terms	
ICT Practitioner	ICT Practitioners are understood as ICT experts (professionals and associate professionals or skilled workers and assistants) which work in the ICT industry or in user industries primarily on ICT concepts, systems and applications. The term generally covers also ICT Practitioners who just finished a study or training programme (alumni: graduates, degree and sub-degree holder, diploma or certificate holder etc.) and therefore ICT Practitioners at all skill and qualification levels.
ICT Professional	In the occupational context a "professional" is often understood as someone with a higher education degree like 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" (cf. 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 understanding often 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 (cf. CSC / Cedefop 2002).
ICT Qualification (Profile)	A "ICT Qualification" or a set of ICT qualifications within an "ICT Qualification Profile" is like a "qualification" in general "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" (cf. Cedefop 2001b, p.7). Further on an "ICT Qualification" can 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 like for the "five levels of professional qualification are established" it is described as "ICT Professional Qualification" at different levels (cf. 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 Occupation	ICT Practitioners are understood as ICT experts (professionals and associate professionals or skilled workers and assistants) which work in the ICT industry or in user industries primarily on ICT concepts, systems and applications. The term generally covers therefore ICT Practitioners at all skill and qualification levels.
ICT Employment	In the occupational context a "professional" is often understood as someone with a higher education degree like 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" (cf. 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 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.

fig. 2-3: ICT terms which mainly important and used for this report

Overall a first view at the European ICT employment and demand summarises some quantitative results of different survey sources. Of course behind each single survey result there are different understandings and definitions of the term ICT and ICT employment and especially of the term ICT practitioner and of the delimitation of their ICT work contents. For example the understanding of "IT practitioners" in the CEPIS report by 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” (cf. CEPIS 2002, p. 34 et seq.).

The respective CEPIS report results of the "ICT employment" therefore represent "only" the “core” of IT technical staff and not all other employed ICT practitioners especially communications and practitioners like electronics engineers, IT managers etc. (cf. CEPIS 2002, p. 37). Nonetheless and by using the understanding of "ICT practitioners" described above, the fol-

lowing figure represents the summarised result of different investigations as an overview and good orientation of the current European ICT employment.

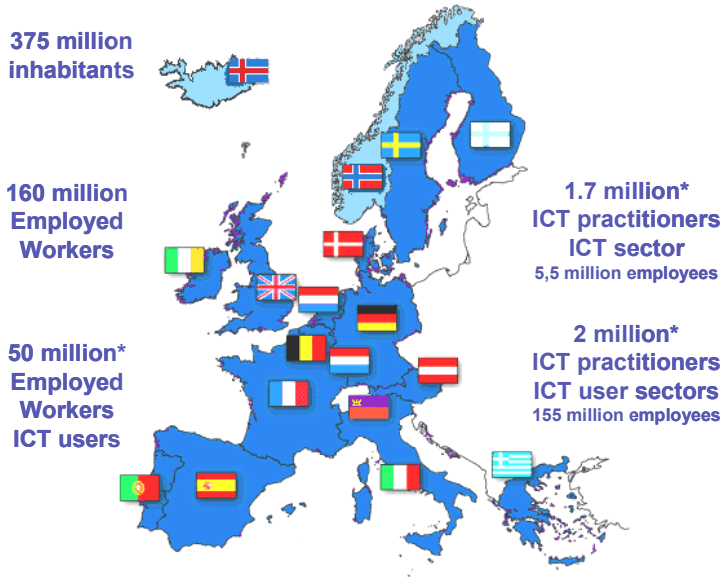


fig. 2-4: ICT employment and number of ICT practitioners in Western Europe (cf. *biat 2001; EUQuaSIT 2002; OECD 2000; CEPIS 2002 with appraisement)

The ICT employment figure shows in detail the total number of 3.7 million ICT practitioners and the distribution of the ICT staff in the ICT sector and ICT user sectors and further their relation to the entirety of employed workers. The large group of approximately 50 million ICT users can be understood as employed workers which main job is not ICT, but who use ICT - often very considerably - in their work. This group has been increasing every year and in some cases it is sometimes difficult to find a reasonable delimitation to ICT practitioners at low level. In addition to these numbers of the European ICT employment the next table shows their distribution for instance in three countries:

	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*
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***

fig. 2-5: Split of ICT employment between IT (ISCO) and ICT practitioners at all skills levels as well as between ICT and user sectors (cf. CEPIS 2002, page 38, 42; *biat 2001, EUQuaSIT 2002 with rounding, estimation)

Further results and findings of the European ICT employment are shown more in detail in the report and cohesive to questions of the demand and skill needs. But one ICT employment and skill needs aspect in respect of the interaction and the questions of the ICT training and supply is already here and introductory important. This aspect ask for the split and distributions of the ICT employment in regard to the work and skill levels which in the same time are relevant

for questions of the qualification and training levels. But quantitative results to this aspect have been a long time not available and difficult to find for most European countries and therefore for Europe as a whole. One main and common reason is that there is really not a work and skill level system, classification or framework which has a nation or European wide recognition and which is easy to use for the split of employment. The work and skill level systems which are in practice and use in many reports are those in regard to the different purpose like occupation statistics or sector or company based standard salary groups specific understandings and definitions of the work and skill levels. Insofar national or company level systems and structures with specific definitions of for instance four up to eight and even more work and skill levels are not unusual. For the ICT occupation areas it is perhaps partly more difficult because these areas are more or less new in this direction and the transfer of common definitions is not always easy and possible and the ICT work and skill contents change permanently. An open question therefore is to find a practical answer to which level framework and basis the level split of the ICT employment can be orientated.

But considering the interaction to the systems of ICT training and supply it needs to be constituted too that the same problems to a system or framework of qualification and training levels in Europe exists. There is also not really a European reference framework for qualification and training levels which currently finds a broad recognition. The discussions and various publications for instance commissioned by Cedefop (cf. Cedefop 2001a/b/c) or the National Qualifications Authority of Ireland (cf. NQA 2002) only show the problems and a large bandwidth of understandings and definitions of the qualification and training levels. But the question is not the necessity of a broad recognised European qualification level framework as a primary precondition for example for international comparisons, improvement of mutual recognition of diplomas, vocational certificates, more transparency and harmonisation of qualification 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 (cf. European Communities 1985). Following this decision the description of VET qualifications and occupations should cover the following aspects in close cooperation with the Member States and the organisations of workers and employers at Community level:

- "selection of the relevant occupations or groups of occupations;
- drawing up mutually agreed Community job descriptions for the occupations or groups of occupations referred to in the first indent;
- matching the vocational training qualifications recognized in the various Member States with the job descriptions referred to in the second indent;
- establishing tables incorporating information on:
  a) the SEDOC and national classification codes;
  b) the level of vocational training;
  c) for each Member State, the vocational title and corresponding vocational training qualifications;
  d) the organizations and institutions responsible for dispensing vocational training;

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

- publication of the mutually agreed Community job descriptions and the comparative tables in the Official Journal of the European Communities;
- 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;
- 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 data base, if experience shows the need for such a base.” (European Communities 1985).

On the one hand this proposal of the quoted Council Decision from 1985 is still up-to-date. On the other hand a new Directive of the European Commission published 2002 exists wherewith in regard to the purpose of applying "Conditions for recognition" ... "five levels of professional qualification are established" and described (cf. CEC 2002a, Article 11, 13). In this context the “Bologna Declaration” on a “European system of higher education” (ESHE) by 2010 from 1999 is partly also relevant because this declaration includes a European understanding and definition of professional qualifications at higher education level (cf. CRE 2000).

Against the background of different European work, occupation, skill and qualification level frameworks one solution is to find a practical answer to the questions above to, namely to set up first a framework for ICT qualification and training levels which considers a very common VET level understanding and which is currently spread and recognised in many European countries (see the following chapters for instance the level framework in the Netherlands). Very close to this ICT level framework a framework of the ICT work and skill levels could be secondly defined and set up nearly in the same way. The main reason for this simple combination framework is a high congruence of qualifications and skills in theory and practice and because, for example, ICT practitioners with qualifications at degree level normally and in the most cases work in a ICT work area in which skills at degree level are required. Concrete and 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 the ICT employment and the ICT training. For the ICT training the two degree level 5M(aster) and 5B(achelor) label the higher education at “mastery” university level (Master Degree, University Graduate Degree or Diploma or even Second Cycle Degree SCD) and the shorter higher education at "bachelor" level (Bachelor Degree, University of Applied Science Degree or Diploma or First Cycle Degree FCD). Following the EU Directive the highest possible vocational education qualification can be defined at level 4 and allow the access to higher education. For the ICT training therefore the three sub-degree levels label the vocational education and training (VET) at qualification level 4, 3 and 2. Like the definition and the understanding of ICT terms this level framework of ICT employment and ICT training is also important and used for this report.

	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.*

fig. 2-6: Framework of combined ICT work and skill levels and ICT qualification and training levels (*cf. COM (2002) 119 final, CEC 2002a, Article 11, 13; **cf. European Communities 1985)

Because the investigations and studies - carried out by biat and within the EUQuaSIT project - used a framework like this, differentiated quantitative results of the ICT employment in regard to the work and skill levels can now be presented in a figure. The results on the basis of five European countries show that a proportion of 20-30% of the ICT employment work at level 5M and 30-40% at level 5B and have qualifications at degree or higher education level 5M (HE/MA) or 5B (HE/BA) respectively. And for the sub-degree levels the results show that a proportion of 10-20% of the ICT employment work at level 4 and 20-30% at level 3 and 2 respectively have qualifications at sub-degree or VET level 4, 3 or 2. That means in a range between 30% to 50% of the total 3,700,000 employed ICT practitioners in Europe work and have qualifications at sub-degree level 4, 3 or 2. Otherwise and altogether but still depending on the country more than half of the ICT practitioners in Europe normally work and have qualifications at degree or higher education level.

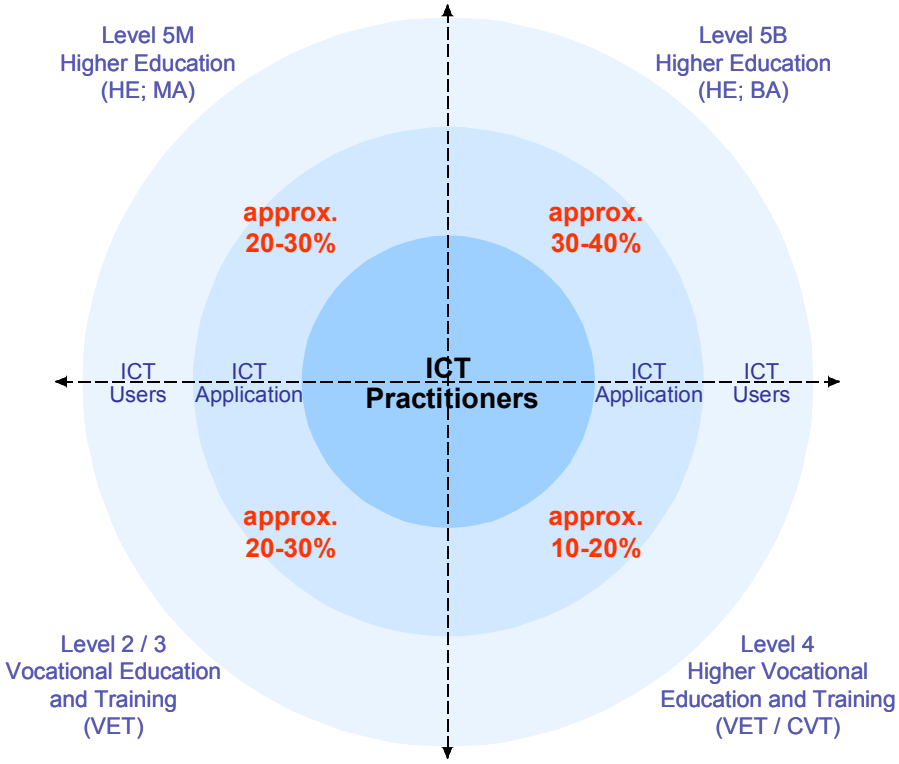


fig. 2-7: Split of the ICT employment in regard to the work and skill levels and their ICT qualification and training level in Western Europe (cf. biat 2001, EUQuaSIT 2002)

Particularly these quantitative results on the ICT employment in regard to the ICT qualification and training levels are of crucial importance in their interaction to the questions of the ICT training and supply. The systems and structures of ICT training profiles and programmes in each European country need to provide an adequate supply of ICT practitioners related to the ICT employment demand and needs both, under quantitative and qualitative aspects. As everybody knows the systems and structures of education in Europe are partly very different and therefore - of course - also the supply of ICT training profiles and programmes in each European country is different. And this in orientation to the ICT qualification and training levels described above at each qualification level. This is proved for instance within the EUQuaSIT project which analysed the ICT training and supply of five European countries and further aims at finding, evaluating, comparing and, last but not least, presenting European

qualification and training profiles of the “ICT Practitioners”. The selected results available and implemented in an internet based solution (see http://www.euquasit.net) show exemplary that the European ICT training and supply depends on each national education system (see chapters below) and that this can cover and meet the ICT demand and needs using different structures of ICT training profiles and programmes. But one question is, how well each national ICT training supply answer the challenges of the European wide developments and requirements of the enormous breadth of ICT business and work areas under quantitative and qualitative aspects ("without" gap and skills mismatch respectively). First empirical findings in this direction and based on a company questioning will be presented within the EUQuaSIT project and in the outlined recommendations of curriculum guidelines and European training solutions of this report within the next chapters.

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

As mentioned above and described on the basis of the relation to ICT employment and demand, European education and training systems are challenged by the ICT market and technical development, among other things. One assumption was that the supply of ICT training profiles and programmes altogether may still not sufficiently meet the ICT practitioner and skill needs expressed by the companies. As a background, the following paragraphs exemplarily and shortly describe the actual situation in what concerns VET structures, existing ICT training profiles and curricula at sub-degree levels with regard to the profiles 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 (cf. EUQuaSIT 2002).

2.3.1 ICT training profiles and VET qualification concepts in Germany

Even though there is no comprehensive level framework classifying vocational qualifications the organisation and delivery of vocational education and training (VET) in Germany can be divided in three subsystems and corresponding qualification levels as used for this report:

- School based initial vocational education and training profiles (“Schulische Assistentenberufe” in a Vocational School (Berufsfachschule)) → for this report VET Level 2
- Apprenticeship initial vocational education and training profiles (“Ausbildungsberufe” in the Dual System) → for this report VET Level 3
- 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 the overall and vocational education and training system is further indicated in the figure below:

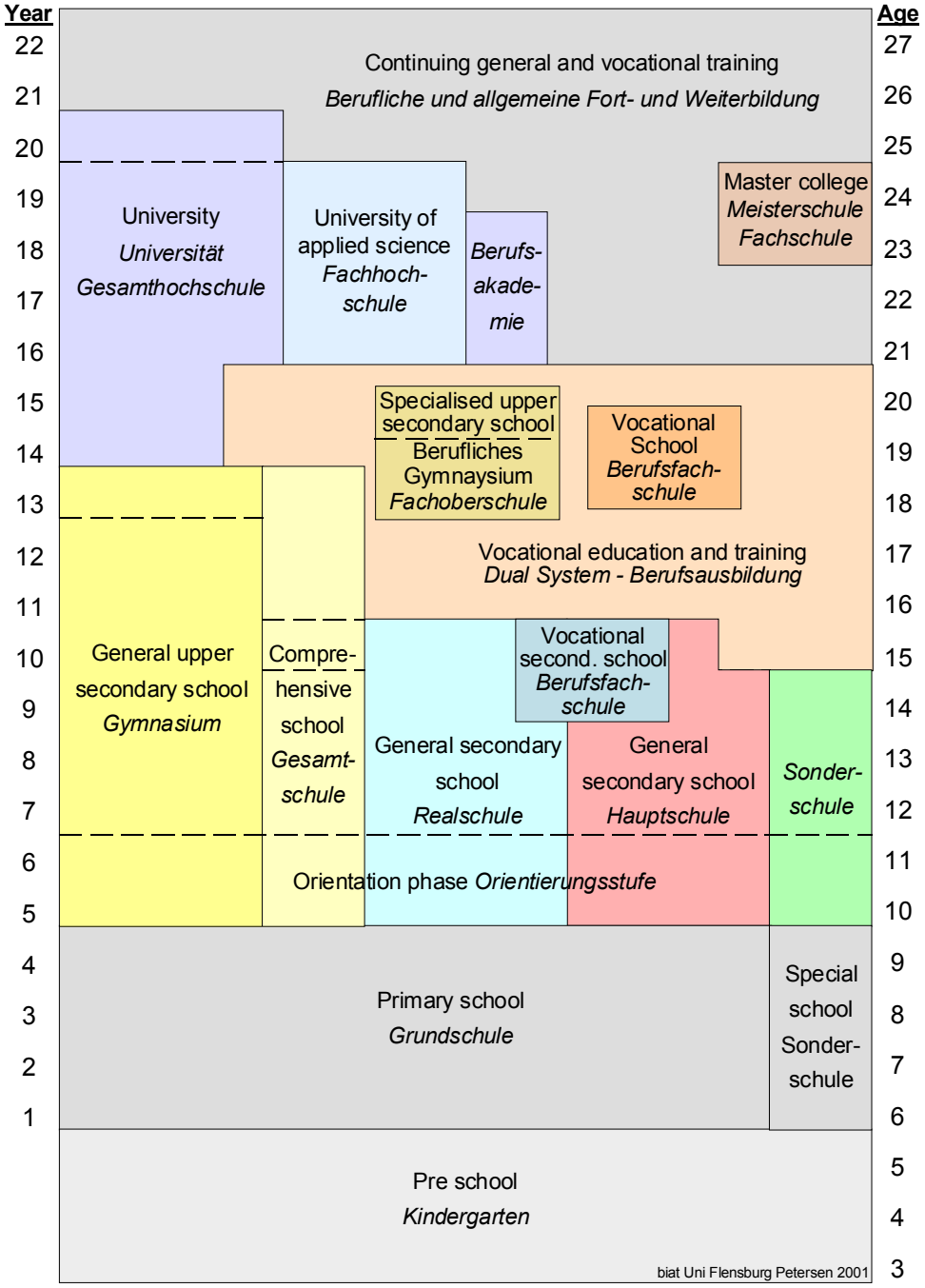


fig. 2-8: Basic structure of the general education and vocational education and training system in Germany (cf. EUQuaSIT 2002, p. 22)

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 (in all domains and occupations). 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% respectively undergoing 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.

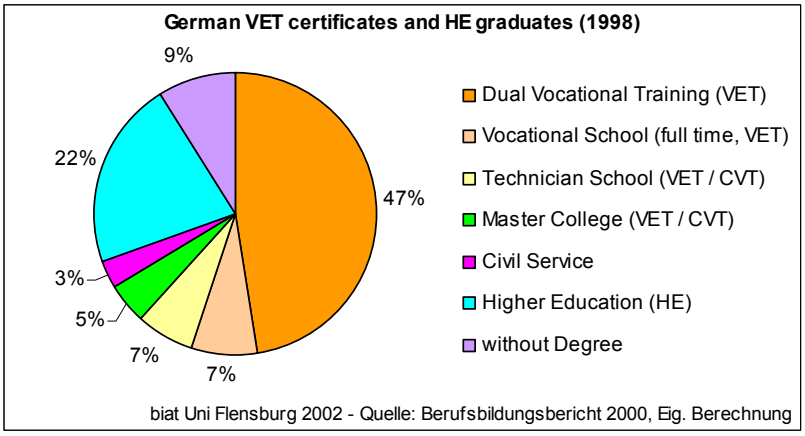


fig. 2-9: Allocation of VET certificates and HE graduates in Germany

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

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)", beside other forms like basic vocational training in a specific occupational field that can be credited to trainees if they enter the dual apprentice training. These training profiles are provided by specialised vocational schools (Berufsfachschulen) offering averaged two-year courses. Due to German legislation 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.org) signed by all federal state ministers of education ensuring comparable syllabi and the recognition of qualifications (cf. KMK 2002a). For this report "Assistant" training profiles are classified at qualification level 2.

Concrete Assistant ICT training profiles exists since the beginning of the 1980s. There are more business / economical orientated ICT training profiles (e.g. Assistant for Business Informatics, Business Assistant for Data Processing) as well as the more informatics and technical orientated ones (e.g. Technical Assistant for Informatics, Technical Assistant for Data Processing etc.) (cf. KMK 2002b ; cf. KMK 1999).

ICT training profiles at VET Level 2 in Germany		
• 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

As mentioned above and also appropriate for ICT, school based VET profiles are quantitatively less important than the apprenticeship VET but have, nevertheless, surely a noticeable and additional relevance for both providing training places for youngsters in those regions where apprenticeship places are rare and qualifying skilled staff at a certain qualification level. Figures from 1998 indicate that app. 13,000 "Assistant"-students visited a specialised vocational school (from app. 6,000 at the beginning of 1990s). Following the official VET

report of the German government about 10,000 of the students were going for a qualification either as "Technical Assistant for Informatics" or "Assistant for Business Informatics" (BMBF 2000, S 80 ff.). For all ICT Assistant training profiles the more business / economical orientated ICT training profiles constitute two thirds of the students and the more informatics and technical orientated ICT training profiles correspondingly one third.

Apprenticeship initial vocational education and training (Dual System)

In Germany the apprenticeship training 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 the classes in a vocational school. The occupations are regulated nationwide based on the "Vocational Training Act of 1969 (Berufsbildungsgesetz)". The youngsters usually begin the apprenticeship based on own commitment and application after the general secondary school at the age 15 or 16 years. In some domains like 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 instead of three years.

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 → Electronics Technician (Trade),
- Communication Electronics Technician → Informatics Systems Technician (Industry).

However, the development in ICT vocational education and training within the dual system was fundamentally influenced by four new recognised ICT occupations in 1997, namely IT System Electronics, Information Technology Specialist, IT System Support Specialist and Information Technology Officer. The "Information Technology Specialist" is divided into the main training fields "Application Development" and "System Integration". Based on new training regulations the four profiles also have a new qualification structure of common occupational qualifications covering all together 18 months and thus half of the training, and specific occupational ICT qualifications. The aim of the new training concept is to produce lCT practitioners who are likewise proficient as businessmen, technicians, service providers, organizers and client consultants (cf. Schwarz, 2000, p. 99).

ICT training profiles at VET Level 3 in Germany		
• 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 realize the new training regulations and concepts. Problems for instance occur in fulfilling and realising the width and depth of demanded

training contents. Furthermore the vocational schools as the “dual training partner” are faced with challenges like implementing the new curriculum structure and content as well as the ICT work process orientation (cf. biat, Petersen, Wehmeyer, 2001).

As indicated in the fig. the ICT training profiles launched in 1997 have been benefited from the “ICT boom” in the 1990s and led to a remarkable increase of 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 years boom.

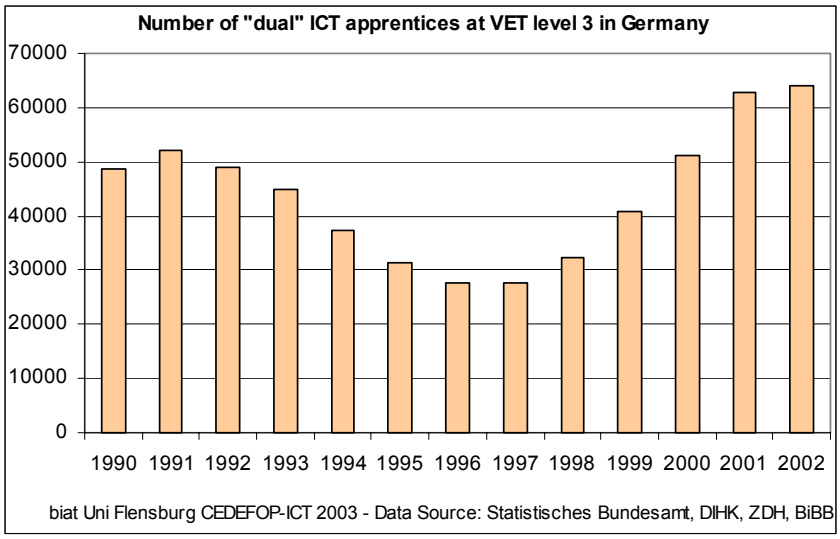


fig. 2-10: Development of ICT apprentices at VET level 3 in Germany

All together it can be constituted that there is a broad range of ICT training profiles at VET level 3 and 2 in Germany. These have a significant position in supplying ICT practitioners. However, skilled work in the field of ICT requires a certain level of qualification. This is proven, for instance, by the high entrance degree of ICT trainees and apprentices even at VET level 3, e.g. within the dual VET system in Germany, where the proportion of ICT trainees with university entrance degree (Abitur, A-levels) in some training programmes is above 50% (cf. 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 trainings which in Germany limits the occupational mobility.

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

Further / higher vocational education and training profiles

Further and higher vocational education and training profiles in Germany can be either national or federal state level regulated qualifications. The following possibilities at VET (CVT) qualification level 4 can be divided: 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.

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 distinction to lifelong learning (LLL) courses these VET (CVT) programmes have a duration of 12 - 36 months.

For the first group current ICT training profiles entitled "State Certified Business Manager and Technicians", which are federal state level regulated qualifications, range from more business orientated 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).

ICT training profiles at VET (CVT) Level 4 in Germany		
• 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)

Especially the "Master (Craftsman)" have a fairly long tradition in Germany. In the field of ICT there are currently two training profiles available, namely Master (Craftsman) Telecommunication Facility Electronic Technician and Master (Craftsman) Information Technology.

In addition to training profiles like technician and master (craftsman) programmes especially the chambers of industry and commerce as well as trade offer vocational training that can partly be defined at qualification level 4 as well.

The latest development of further VET profiles and occupations in the field of ICT is the system of "IT Professional and Specialist Profiles" (see http://www.apo-it.de or http://www.kibnet.de). Since 2002 there are two more strategic and four operative "IT Professional" profiles available within this new qualification framework. These qualifications are certified based on national examination regulations (following the Vocational Training Act of 1969). In a flexible and open system there are also 29 new "ICT Specialist" profiles at VET / CVT level 4 available in six thematic groups since 2002: 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 based on national regulations but by an accredited certification body when a project or major part of project in the subject area has been completed and documented and fulfilled the standards and criteria described in a reference projects. The certification of indicated similar work process competences is also possible. Finally the candidates need to pass a one hour "expert talk".

Lifelong Learning (LLL, CVT) delivery in Germany

Germany has a differentiated system of lifelong learning, with various organizational structures and forms of funding related to the functions, objectives and contents of the training. Normally are the most important providers of. Providers for 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 of continuing training and personnel development.

Approximately 266,200 people all together took part in LLL and retraining programmes promoted by the Federal Labour Office in 1997. However, based on newer official figures of the Federal Labour Office in the year 2000 there were 46,500 LLL measures in ICT funded by the government. About 17,000 of which are part of retraining and app. 30,000 of LLL nature. On top of that the federal states provide additional funding on business and market orientated continuing and further ICT qualification in close cooperation with companies from the ICT sector (cf. BMBF 2001, p. 40).

However, the biggest LLL-market is of private nature and utilised by companies or based on personal commitment of ICT practitioners. Providers of training are first of all large LLL / CVT organisations that sometimes combine their ICT training business with ICT consulting activities. Secondly more and more ICT vendors offer training specific product courses through 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 beginning vocational trainee. 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).

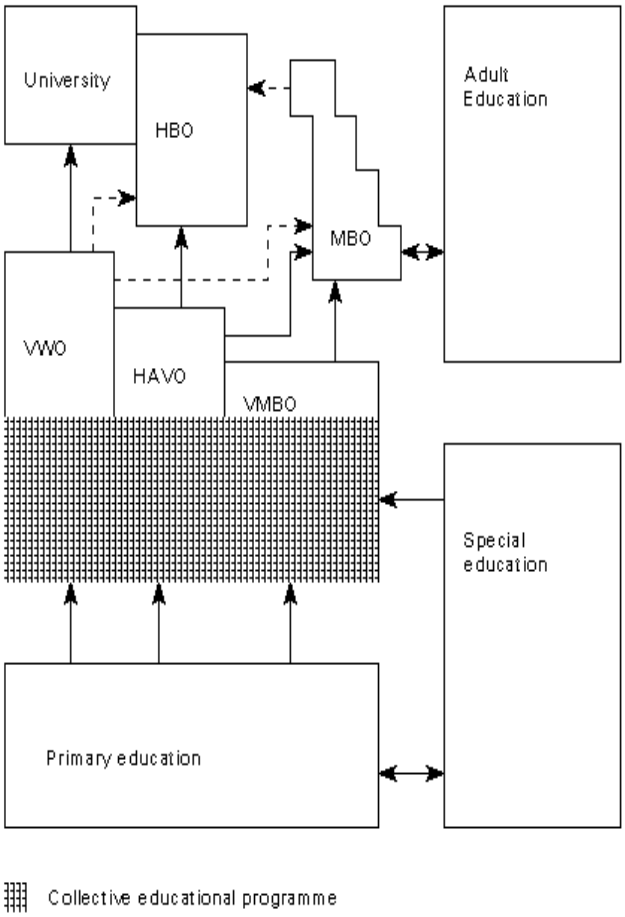


fig. 2-11: Basic structure of the general and vocational education and training system in the Netherlands (cf. EUQuaSIT 2002, p. 34)

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.

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

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

- 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.
- 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.
- 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.
- 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 lies 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.

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. Con-

[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.

sequently, not every industry or occupational field will have courses at all four levels. ICT-courses are available at the level 2, 3 and 4, although the numbers are limited at levels 2 and 3. At level 1 in a low definition 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 level 3 and 2 in the field of ICT is not so important in the Netherlands. There are all together nine ICT training profiles available. Apart from the profile "Assistant Administrator ICT" the focus of these craftsman profiles is on communications technology, ICT service and industrial electronics and applications.

ICT training profiles at VET Level 3 in the Netherlands		
• Assistant Administrator ICT • First Craftsman Communications Networks	• First Craftsman Communication-installations	• First Craftsman Electronics and Instrumentation • First Craftsman Industrial Electronics
ICT training profiles at VET Level 2 in the Netherlands		
• Craftsman Communication-Installations	• Craftsman Communications Networks	• ICT Service Worker • Craftsman Industrial Electronics

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.

The table below further on 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 ICT administration, multimedia management, software development and administration, network administration, telecommunications and electronics engineering.

ICT training profiles at VET Level 4 in the Netherlands		
• Middle Management Employee Administrator ICT • Middle Management Employee IT Media Production • Middle Management Employee Multimedia Designer	• Developer Software Applications • Administrator Software Applications • Network Administrator • Technician Communications Systems (TCS) • Telecommunications and ICT Engineer	• Middle Management Employee Automation Electronics • Middle Management Employee Automation Energy Engineering • Middle Management Employee Computer Interface Engineering • Technician Electrical Industrial Plants

In fig. 2-12 the development of the number of students in 4-year technical studies at VET level 4 is indicated. The number of students that followed full-time training in ICT has grown enormous the last five years. From the year 1996/1997 till 1999/2000 the number of students grew with more then 500%. The number of students grew for each technical profile. Most of the training profiles are newly introduced in the school-year 1996/1997.

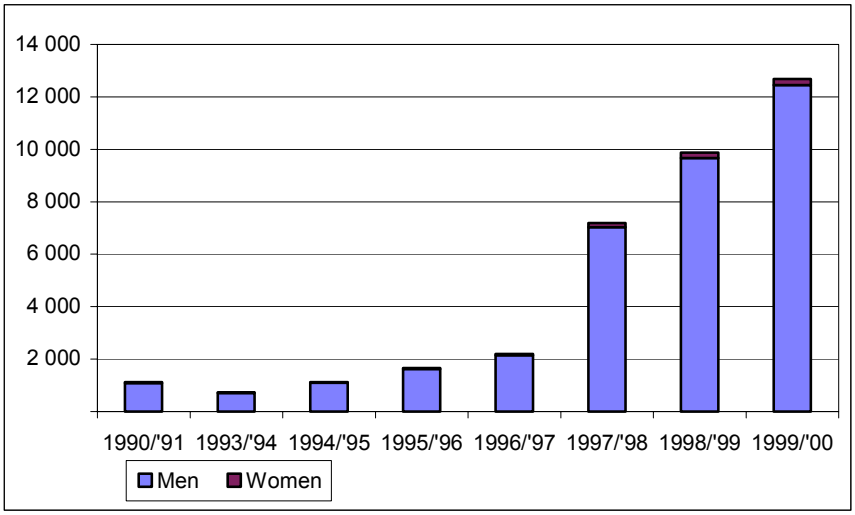


fig. 2-12: Number of students / trainees in technical ICT training profiles at VET level 4

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 up 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.

Lifelong Learning (LLL, CVT) delivery in the Netherlands

In the Netherlands lifelong learning (CVT, LLL) includes all full-time and part-time learning activities available to people who have left the initial education system, 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. The Dutch continuing vocational training has the following dimensions:

- Participants: job seekers, entrepreneurs and employees;
- CVT (LLL) qualification providers: providers of courses which prepare students for qualifications from the initial degree programme or for supplemental, non-recognised qualifications;
- 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 numbers of certificates awarded. Also the fact that most studies are being 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:

- Vocational Schools for women and women returnees;
- Courses offered by five specialised institutes for people with a handicap (mostly for people who have developed a handicap later in life;
- 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

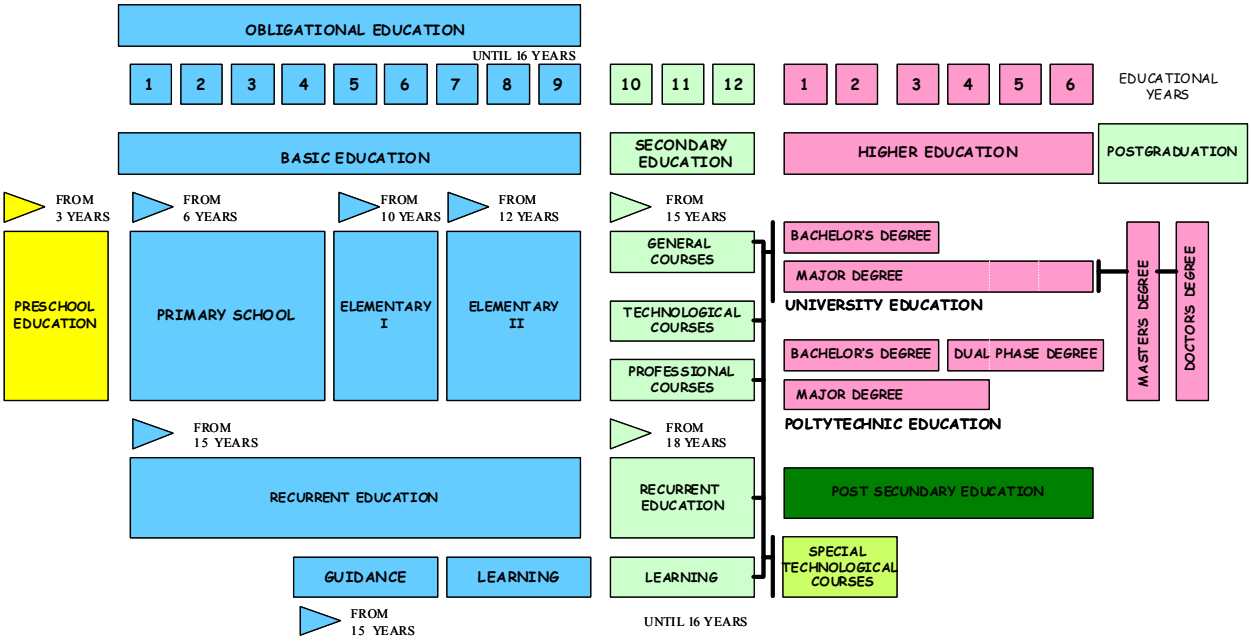
Since the earlier 1970's new disciplines related to the information and communications technologies (ICT) have been introduced to the Portuguese educational system. Initially, those disciplines were only introduced in the university courses, in particular in the fields of Engineering and Management. Later on, new computer curricula were included in the secondary education (recurrent and vocational training). Currently (starting 2001/2002) a new educational reform is going to proceed with the introduction of a 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) → VET level 3 and 4
- Professional ICT training courses (Professional Schools) → VET Level 4
- IEFP Learning System (Apprenticeship Courses) → 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. First of all the Secondary Education has a duration of 3 years (corresponding to the 10º, 11º and 12º scholar years). It is organised in accordance with the different courses that may be oriented towards specific areas of knowledge and the active working life (e.g. technological ICT courses) or for the further development of studies (general courses). The educational curricula for the secondary education sector have for almost every group of study a discipline entitled introduction to the new information technologies.

Secondly, vocational education and training in Professional Schools (Professional Courses) is a special type of scholar education, in alternative to the "regular" education system. The professional schools, established in 1989, aim at the training of intermediate level technicians and belong to a network of private education institutions (by initiative of local governments, professional associations, etc.). The State has also being funding these institutions, namely through the creation of professional schools for 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 3 school years, presented in a modular form with variable duration each, and are organised according with the education and qualification levels (up to the highest level).



Explicative Comments:

- Basic Education includes the 9 years of compulsory education. It's form by 4 primary school years, follows 2 elementary I years and 3 elementary II years.
- Recurrent Education is part time general and technical education for students abandoned studies and also for adults.
- General Courses belong to secondary education leading mainly to following studies.
- Technological Courses belong to secondary education guiding to work life.
- Professional Courses have a professional/vocational nature.
- Learning – These courses are attended by students 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 qualification).

fig. 2-13: Basic structure of the general and vocational education and training system in the Netherlands (cf. EUQuaSIT 2002, p. 47)

The working plans for the professional courses include a socio-cultural training component which is common to all courses, a scientifically 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 that must not cover more than 50% of the course working plan. It is also mandatory that all courses have a training period in real working environment (probation period). The successful conclusion of a professional course provides a qualification level and the right to a professional certification at level 4 (in accordance with the European Union procedures).

Besides the described training programmes, there is a whole range of initiatives belonging to the Institute for the Employment and Vocational Training (IEFP) in co-operation with the 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 the stan-

dard education system. In the field of ICT, this system includes training corresponding to levels 2 and 3, which is equivalent to the 9º and 12º school years, and it is regarded as a Vocational Education Training (VET). The enrolment is based on the 6º and 9º school years, respectively for courses of the levels 2, 3 and 4. The system included the "Informatics / Computer Technician" and "Network Technician" courses. At VET qualification level 3 and 2 we find ICT training profiles like Database Management and Data Processing Assistant. Another focus is on technical and maintenance activities, e.g. for PCs, networks and other equipment (see below).

ICT training profiles at VET Level 3 in Portugal		
• Database Management - Micro Systems • Informatics Technician • Multimedia Systems Programmer	• Advanced Applications Operator • CAD Operator • Data Processing Technician	• Network Maintenance Technician • Hardware Technician
ICT training profiles at VET Level 2 in Portugal		
• Data Processing Assistant	• Informatics Assistant Technician • Informatics / Computer Operator	• Network (PCs) Maintenance Technician • Assistant Technician Equipment Maintenance

Looking at concrete ICT training profiles at level 4 available in the Portuguese VET system (mainly secondary ICT courses) one primary focus is on applications analysis and developing (programming). Furthermore there are more technical orientated ICT training profiles like Applications Technician, Data Analyst and Network Technician.

ICT training profiles at VET Level 4 in Portugal		
• Database Management - Main Frame • Data Processing Management • Main Frame Applications Programmer	• Informatics Applications Analyst • Informatics Applications Programmer • Data Analyst • Multimedia Applications Operator	• Maintenance Applications Technician • Industrial Design CAD 3D Specialist • Micro Network Management and Installation Technician

From a quantitative point of view there are some 12,000 students enrolled in computer technological courses within secondary education. Since 1996, there was no increase in the demand for this course, and a decrease was even registered in the number of enrolment (10º). It is also mandatory to refer that the educational curricula have been suffering some needed alterations in order to keep-up with the technological development, to promote the acquisition of proper skills and to contribute for the continuous development of students namely by preparing them with the knowledge needed for entering more advanced levels of scientifically and technical studies.

As mentioned above the IEFP Learning System is included in the vocational and education training (VET) component and its quantitative analysis for the period between 1995 and 1999 shows appreciable impact since 1997 and have since then registered an enormous growth. The overall number of trainees involved in the several courses in 1999, with particular emphasis for the Computer Technician courses - at level 3 and 4 - was around 2,000. We should mention that 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 the "normal" secondary education courses in computer technologies.

All together VET in the field of ICT in Portugal surely does not have, up to now, that significance compared to higher education degrees. Most of the ICT practitioners have higher education degrees. Based on the analysis of recent statistical data, we could mention that Portugal still needs further developments in the field of ICT vocational education in order to achieve the level of development already achieved by other European countries. However, the current VET system has sufficient ICT training availability in this domain, mainly from the quantitative point of view.

Lifelong Learning (LLL, CVT) delivery in Portugal

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

The growth registered within the last 5 years is extensive to all regions and the almost every level of training. Nevertheless, the growth for the specific professional training is not as relevant as the one registered for other courses that allow access to certification and professional outcomes. This situation may be due to the fact that most of the times the working practitioners have, within their organisation further access to training and specialisation opportunities and do not have the need to attend the training programs 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's Needs of ICT Skills and Practitioners - Analysis of the Demand and Supply

The developments of information and communication technologies (ICT) and the wide range of ICT applications have rapidly changed and increased the needs of ICT practitioners in recent years. Today a well-balanced relationship between the demand and supply of ICT practitioners is more and more important under quantitative as well as qualitative aspects. All questions with regard to the demand and supply are not only important for the competitiveness of enterprises in the ICT sector. Today an adequate stock of skilled ICT practitioners is also a very important condition for the potential of industries across all sectors, summarised as "ICT user sectors", and therefore the European economy as a whole. Another point in the context of demand and supply of ICT practitioners is, that all enterprises need ICT practitioners with different skills and qualification levels. Following the structure of the employment and demand in the ICT and user industries the need of ICT practitioners can be differed especially between degree and sub-degree / vocational levels. On the whole it is very relevant for growth, competitiveness and employment in all ICT business, production and services areas to have a sufficient number of people skilled in managing, distributing, developing and deploying ICT. Based on analyses, evolution studies and partly forecasts of the needs of the dynamic ICT and user industries in Europe the answers below show and identify the requirements of ICT skills and ICT skills profiles under quantitative and qualitative aspects.

3.1 Work oriented research and study approach and the investigation basis of the data collections and needs analyses

In order to investigate and clarify industry's needs of ICT practitioner skills and training solutions in Europe the following surveys and empirical analyses were carried out for this report:

- Questioning and case studies in the industries and companies of the ICT sector and ICT user sectors in selected European countries (especially in Germany, Netherlands and Portugal)
  Aims and contents of the surveys and studies:
  ICT employment and demand of ICT practitioners with focus of the quantitative and qualitative needs in terms of programmes, main contents, range of skills and knowledge etc. anticipating certain occupational / professional profiles and skill levels;
- Analyses and evaluation of current ICT training and qualification profiles including the supply of ICT practitioners in selected European countries (especially in Germany, Netherlands and Portugal)
  Aims and contents of the analyses:
  Evaluation and comparison of ICT training profiles in Europe at degree and sub-degree levels (VET, CVT and HE) in terms of programmes, occupational / professional profiles, targets, main contents, range of skills and knowledge etc. and numbers of ICT students and trainees and expected supply of ICT practitioners;

- Evaluation of the demand and supply and the gap and mismatch of ICT practitioner skills and ICT training solutions.

These surveys and empirical analyses have been carried out particularly in two research projects and studies. Firstly, the European Leonardo da Vinci II project entitled "European Qualification Strategies in Information and Communications Technology (EUQuaSIT)", that includes company questionings and case studies in companies. The project has been carried out in cooperation with partners in five European countries. Secondly, a national study carried out by biat in order to evaluate new vocational ICT training profiles in Germany that 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 method and approach of the investigation based on the interaction of the demand and supply of ICT practitioners (see below).

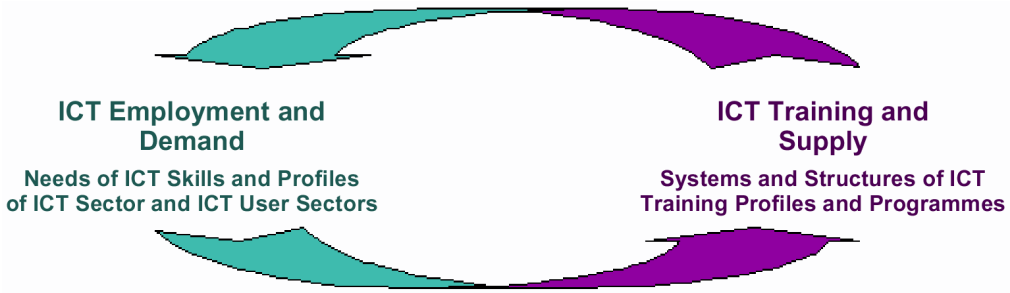


fig. 3-1: Interaction and investigation of the employment, demand and supply of ICT practitioners

It needs to be stressed, that all investigations, questionings and case studies on ICT employment and skill needs are neither limited to the industry's and companies of the ICT sector nor exclusively to large enterprises. The sample of the surveys includes all industry's and companies and thus particularly also an adequate composition of small and medium sized enterprises (SMEs) and relevant "ICT user sectors". As indicated in the figure below, three selected "ICT user sectors" have also been subject of specific studies commissioned by Cedefop on IT practitioner skills and training solutions, namely the Automotive industry, Financing and Banking and the Graphic/Media industry.

ICT sector (ICT supplier companies)					
Information Technology I(C)T HW / SW / Networks			**Communications Technology (I)CT** HW / SW / Networks (fixed, radio)		
ICT user sectors (ICT "user" organisations)					
Automotive Industry	Electrical Industry	Metal Industry	Chemical Industry	Energy Supply	Manufacturing, Construction
Financing and Banking	Insurance	Transport, Distribution and Logistics	Health and Human Services	Wholesale and Retail Trade	Hotel and Catering Industry
Graphic/Media industry	Print-, Wood-, Paper Industry	Services	Government, Public Administration	Education and Training	Tourism and Leisure Industry
...	...	Trade / Craft	Others	...	...
Enterprises / Companies / Organisations					
Small		**Medium**		**Large**	

fig. 3-2: Study approach of an adequate sample of all industries and SMEs of the ICT and user sectors

3.2 Quantitative results on the ICT employment and demand of the ICT and user industries and the supply of ICT practitioners at different skill levels

According to the questions of the demand and needs of ICT employment in Europe first of all a couple of quantitative results are relevant. The total number of the employed ICT practitioners at all skill levels in Europe is some 3,700,000 (cf. biat 2001, EUQuaSIT 2002 and CEPIS 2002). The specific proportion of employed Information Technology (IT) Practitioners (ISCO 213 and 312; e.g. not included ICT Business or Computer Sales Staff or Electronics or Communications Engineers etc.) is estimated some 2,500,000 (cf. CEPIS 2002, p. 35). The total number of employed ICT practitioners e.g. in Germany is some 800,000, in the Netherlands 280,000 and in Portugal 60,000. The ICT practitioner proportion of the total employment in European countries varies between 1 and 5% and depends on the economic situation and infrastructure. The average percentage in Europe is app. 2,5% (total labour force app. 160 million). The ICT practitioner proportion of the total employment is similar to the USA with app. 2,8% (total labour force 140 million).

The split of all employed ICT practitioners between "ICT and User sectors" in Europe shows the following proportions:

- **40% of ICT practitioners are employed by ICT (Supply) Companies and**
- **60% of ICT practitioners are employed by ICT User Organizations.**

Apart from regional differences in European countries the overall comparison to the ICT workforce in the USA is interesting, too. An ITAA report (ITAA, 2000) also indicated that approximately 60% of ICT workers in the USA are employed in non-ICT industries (NSSB 2002, page 11).

	ICT Practitioners 2000	ICT Practi-tioners (ICT sector)	ICT Practi-tioners (User sec-tors)	...	ICT Practitio-ners (Demand per year)	...	ICT Practitio-ners 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***	...	**?**	...	**?**

fig. 3-3: Employment and needs of ICT practitioners in Europe 2000 to 2010 (cf. CEPIS 2002; *biat 2001, EUQuaSIT 2002; **NSSB 2002, page 8, 26, 27 with rough estimation)

Based upon recent developments of the ICT business and labour market different forecasts and scenarios about the future demand of ICT practitioners are possible. However, such appraisements strongly depend on the future economic development. Actual questioning results show in short and mid-term perspective no changes of the ICT employment in approximately

60% of all industry's and companies of the ICT and user sectors in Europe. In detail, however, especially in ICT sector and small enterprises there are more than 30% expecting higher ICT employment in the near future (see below).

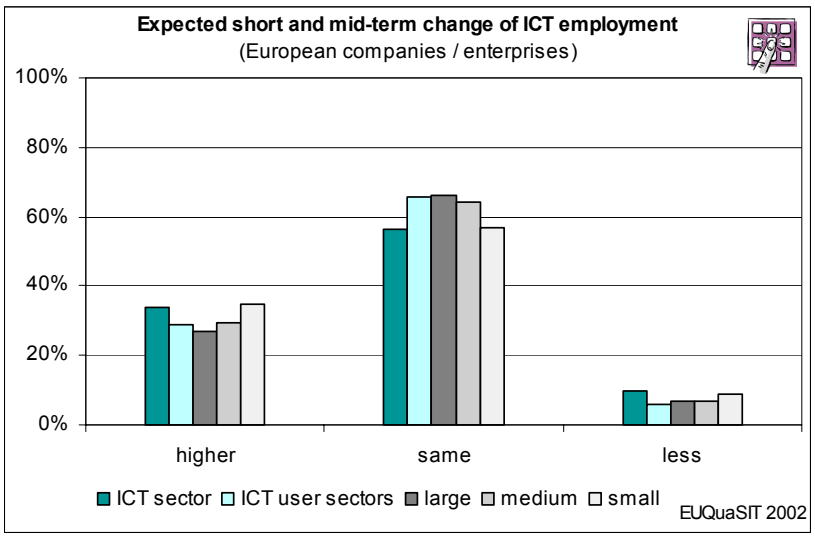


fig. 3-4: Change of ICT employment in European companies / enterprises in the near future

With the results forecasts or assumptions of ICT employment growth in the next years can be calculated with not more than 5% p.a.. Therefore, less realistic today are the "old" numbers of a huge quantitative gap of ICT practitioners in Europe, e.g. the predicted 1.6 million gap by 2004 (IDC 2001, quoted in CSC/Cedefop 2001a, p. 5). However, as the questioning results indicate too, the situation of the ICT labour market in Europe is actually not too bad and the supply of ICT practitioners is mostly estimated by the companies as being "fair" (see below). Of course there are differences between European countries, e.g. a significant better situation in the Netherlands compared to Germany and Portugal.

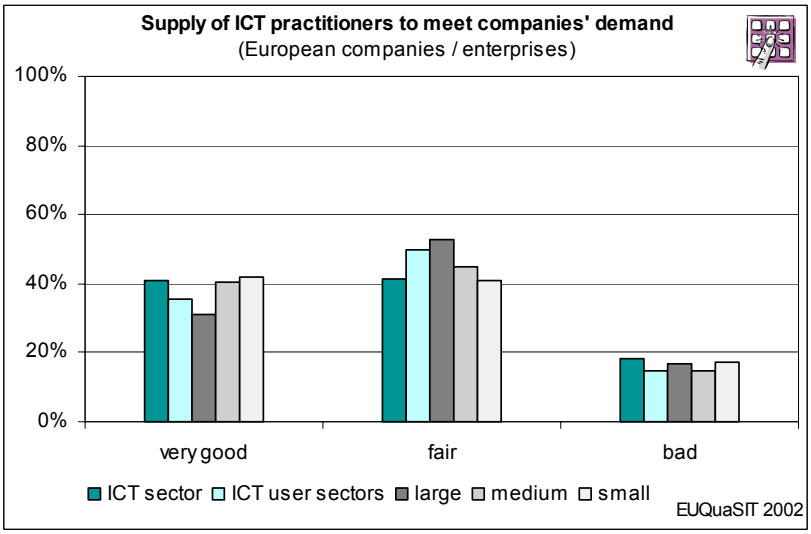


fig. 3-5: Companies evaluation of how the supply meets the demand of ICT practitioners

Based on the results the total demand of ICT practitioners in Europe - including the replacement demand - can be roughly estimated with some 230,000 ICT practitioners per year. This finding is based on biat study results and were proved by the EUQuaSIT questioning results and further shared calculations. Corresponding to their respective ICT employment the de-

mand in Germany is 50,000, in Netherlands 15,000 and in Portugal 4,000 ICT practitioners per year. In consideration of these annual needs and a corresponding development until the year 2010 for Europe a total employment of 5,100,000 ICT practitioners seems to be a realistic and reasonable estimation (see table above).

Further quantitative results of the ICT employment and the industry's needs and demand are relevant in regard to the skill levels of the ICT practitioners. The research approach for these findings based as a whole on the interaction between the demand and supply of ICT practitioners. In correspondence to the specific subject of this report it is of primary importance that basically in all industry's the ICT practitioners work and operate at different skill levels and in various hierarchical structures and work organisations. Work orientated models of skill levels or stages with a certain diversity of interpretation are discussed and used in various contexts especially in the EU and single European countries. European, national or company level models with a structure between four up to eight and even more work and skill levels are absolutely not unusual. For example, "Skills Framework for the Information Age" (SFIA) used a matrix with seven levels (e-skills NTO 2001) or in practice companies, e.g. a German company, used for internal ICT employment grading work and skill descriptions of eight levels, often corresponding to wages of the employed ICT staff. Otherwise from the vocational education and training systems point of view and as described in chapter 2.2 and 2.3 in Europe and European countries there are also different models and frameworks for qualification levels. These models and frameworks are important preconditions to achieve more transparency and harmonization and improve the mutual recognition in Europe e.g. of ICT training profiles at different qualification levels.

In a common sense now we know there is an interaction of the structure and contents between the systems of employment and education. Even so it is impossible to establish a generally accepted combination and coordination of the skill level models and qualification frameworks, namely for particularly reasons of the different European systems of employment and education. However, we also know that in not even little cases non-formally qualified practitioners carry out the same work and work tasks as their formally qualified colleagues with for instance bachelor degree. But on the other hand what we also know is that normally and in the most cases there is a high dependence and correspondence between the work skills and qualifications or training levels of the ICT practitioners. Therefore in a simple combination and in reference more to already existing ICT training and qualification profiles one possibility and solution is to use a framework for training and qualification levels in nearly the same way as a framework of the work and skill levels of ICT practitioners. That means, by using the framework for ICT training and qualification levels as described in chapter 2.2 with the degree levels 5M and 5B and the sub-degree levels 4, 3 and 2 the focus of all research questions is to split the ICT employment and also the demand and skill needs in regard to this levels. The advantage of this approach is that the quantitative results of the ICT employment and the industry's needs can be directly used for comparing the demand and supply of ICT practitioners, because both based on the same framework and level structure.

Under qualitative aspects, however, the described approach and framework is insufficient and requires an expansion especially to the qualitative ICT demand and supply like prepared with the companies evaluation of the ICT training profiles and the case studies described below.

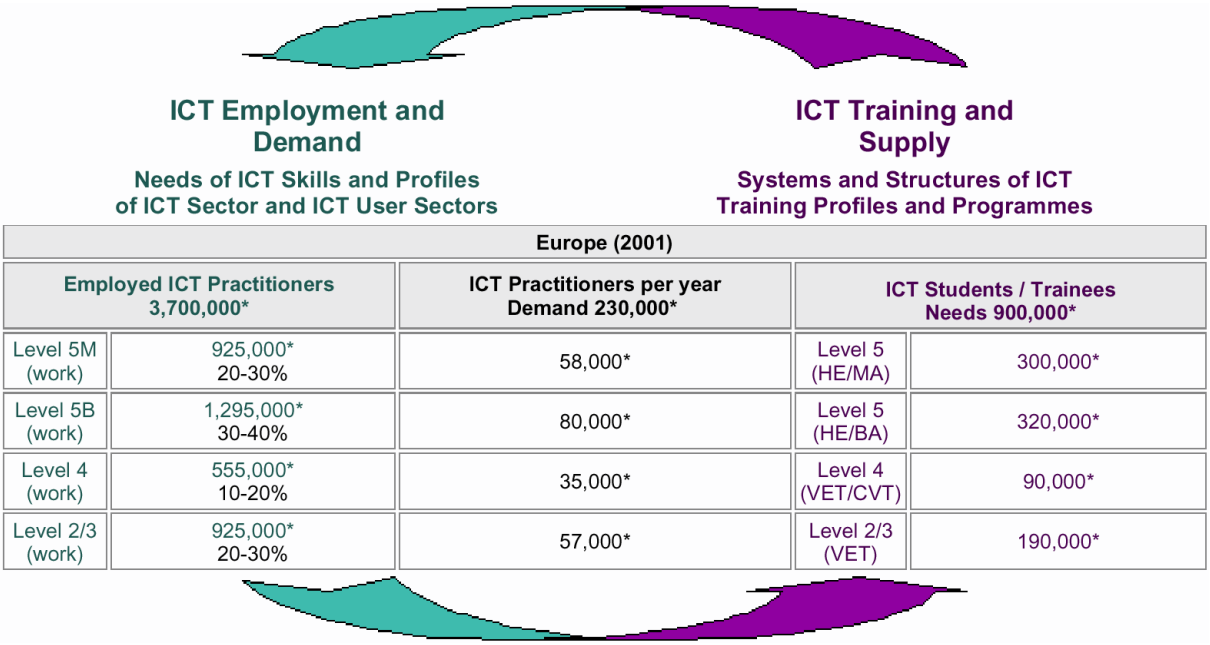
The following results in this sub-chapter are limited to the quantitative aspects, whereas the dates of the needed supply do not contain qualitative statements either.

The results first of all show an interesting cognition using a simple split of all employed ICT practitioners between degree and sub-degree levels:

- **60% of all employed ICT practitioners work and have an ICT qualification at degree level and**
- **40% of all employed ICT practitioners work and have an ICT qualification at sub-degree level.**

The concrete relation mainly depends on the respective country, on the sector and to a certain degree on the respective specific demand and supply of ICT practitioners of the companies and countries. For example the relation between the ICT employment at degree and sub-degree levels in Germany is 50% to 50%, in the Netherlands 60% to 40% and in Portugal 70% to 30%. The proportion of all employed ICT practitioners who work at degree or sub-degree levels and do not have a formal ICT qualification degree (ICT training profile) is approximately between 5% and 15%. But due to special ICT qualification initiatives and programmes the proportion clearly decreased in recent years (cf. biat 2001; EUQuaSIT 2002).

The further allocation of the employed ICT practitioners within the degree work and qualification levels shows a proportion of 20-30% at level 5M (HE/MA) and 30-40% at level 5B (HE/BA). And for the sub-degree levels the findings are 10-20% at level 4 (VET/CVT) and 20-30% at level 3 and 2 (VET). Based on this allocation and on the basis of the total 3,700,000 employed ICT practitioners in Europe the table below shows the approximate numbers of ICT practitioners at each work and qualification level. Regarding the total quantitative needs of approx. 230,000 ICT practitioners per year in Europe the table below shows in the same way and linked to the split of the ICT employment the approximate demand of ICT practitioners at each level (see below).



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*

fig. 3-6: ICT employment and demand at different levels in relation to the needed ICT Students / Trainees in Europe (cf. CEPIS 2002; *biat 2001; EUQuaSIT 2002)

According to the presumed demand of ICT practitioners per year and level and therefore of the needed supply is it possible to indicate the number of needed ICT students and trainees. In total and with consideration of an average duration of existing ICT programmes and trainings and also a drop out rate there is a total need of some 900,000 ICT students and trainees in Europe. In the same way and in relation to the different duration of the ICT programmes or trainings at each level the table shows the according numbers of the needed ICT students and trainees. For example to meet the quantitative need of some 35,000 ICT practitioners per year at level 4 the according needs of ICT trainees at level 4 is app. 90,000 in Europe.

Exact numbers are not available to answer the question, how many ICT students and trainees we have in total or at each level today in Europe. As we know for most of the European countries, app. five years ago the numbers were too low. But as we know too, according the increased demand of ICT practitioners during recent years the numbers of ICT students and trainees has also increased in the most European countries.

In conjunction with the slow-down of the economic development and the actual employment situation supported by the above presented figures of the companies evaluation indicating that the demand of ICT practitioners is quantitatively being met by the supply, the numbers of ICT students and trainees are possibly sufficient in order to meet the demand or to improve the balance on the ICT labour market. For all this one should keep clearly in mind, that all depends on various developments (e.g. also career choice behaviour) and is only a statement of the demand and needs under quantitative aspects.

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

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

fig. 3-7: ICT employment and demand at different levels in relation to the supply of ICT practitioners and the stock of ICT Students / Trainees in Germany (*biat 2001; EUQuaSIT 2002)

The realistic numbers of ICT students and trainees for instance in Germany prove in detail the trend in Europe. The numbers of ICT students and trainees have been increasing in recent years, e.g. up to app. 50,000 trainees only in four new ICT occupations at level 3 launched in 1997. The table below indicates based on the rounded stock of ICT students and trainees and

the presumed supply of ICT practitioners that the supply will almost meet the demand at all levels, e.g. in Germany apart from level 4.

3.3 Qualitative results on the ICT work and needs at different skill levels and a company evaluation of ICT training profiles

In order to investigate industry's needs of ICT skills and practitioners and ICT training solutions in Europe from a qualitative point of view a work oriented approach combined the questioning and case studies described above (see chapter 3.1). The main objective is to identify the broad ICT business area in a common sense with all typical ICT work areas, fields of activities and ICT work tasks including the analysis to find out the necessary skills of the ICT practitioners to work in the ICT work areas and to carry out the work tasks. Based on an appropriately developed model structure of ICT business and work areas and with the knowledge that ICT practitioners in Europe work at different levels within each ICT work area the analysis aims at the respective evaluation of ICT job and (qualification) training profiles of the ICT practitioners as well (see below). Therefore to the work oriented research approach belongs the thesis that detailed ICT work and job descriptions in combination with a company evaluation of ICT training profiles are the fundament to find out the qualitative industry needs of ICT skills and ICT training solutions in Europe.

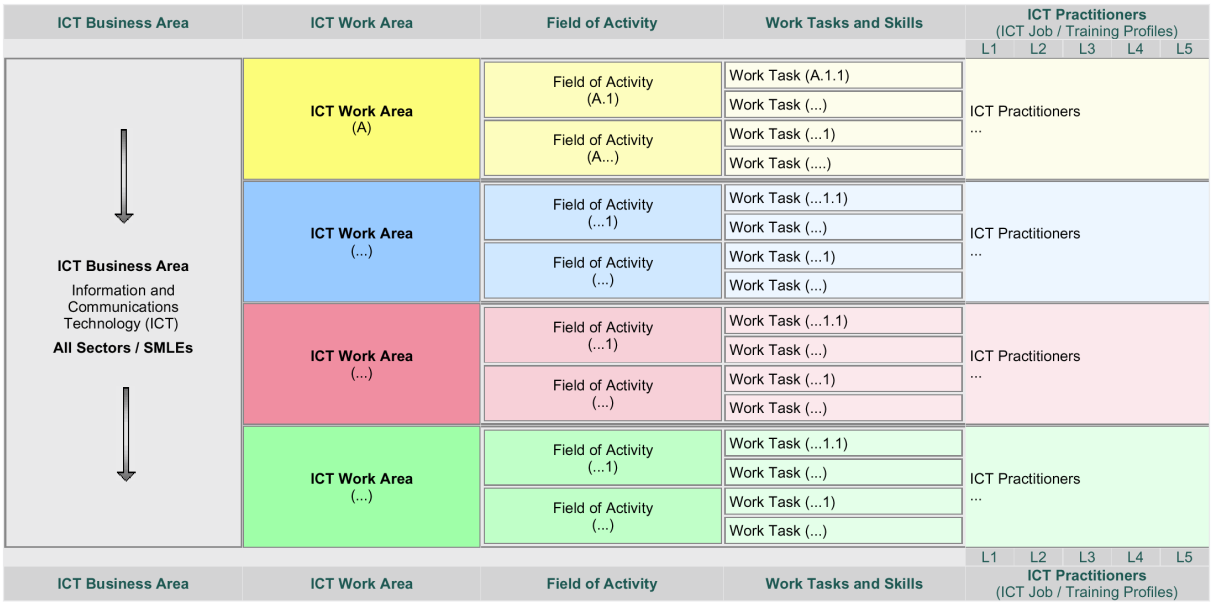


fig. 3-8: Model structure of ICT business area with ICT work areas, fields of activities and ICT work tasks including the ICT practitioners who carry out the work tasks

Within a scope of an adequate sample and composition the case studies in different industries and companies of the ICT and user sectors in Europe (especially in Germany, Netherlands and Portugal) are first of all used to identify and describe the common ICT business area with all typical ICT work areas, fields of activities and ICT work tasks. According to the concept of the case studies many and in any European case study different and concrete "ICT Business

Processes" generate the basis of this identification as well as the methodological background of aggregation.

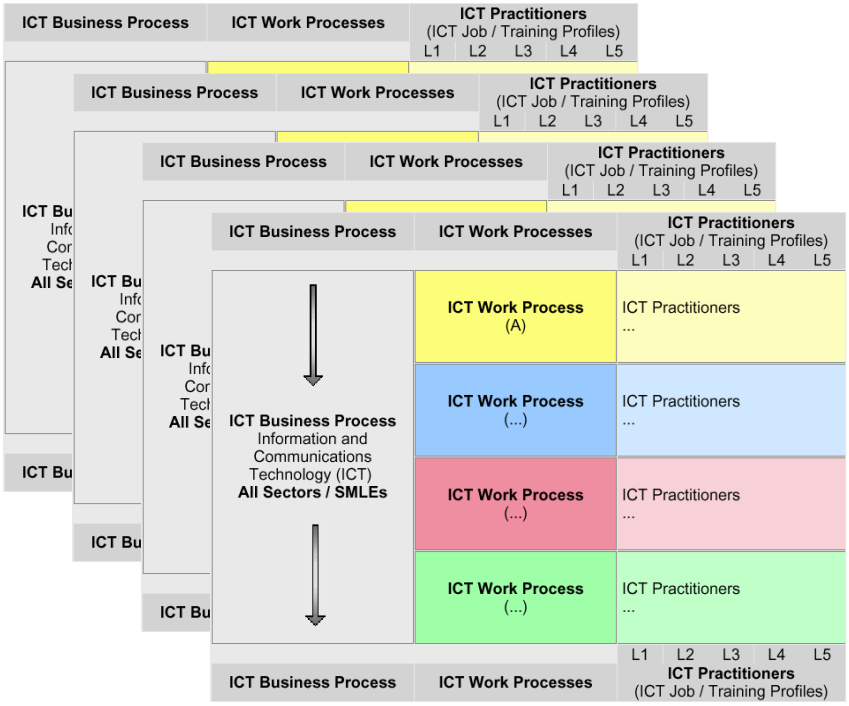


fig. 3-9: "ICT Business Processes" variety are the subject matter of empirical investigations in the European company case studies

To carry out the case studies the following steps of the concept are used in the same way, e.g. within small, medium and large companies:

Concept of the case studies for analysing the ICT business processes and skill needs in European companies of the ICT and user sectors:

- first step of the case study: identification and description of typical ICT business processes as the ICT business area of the company (SMLEs / All Sectors):
  - type and content of respective ICT business process (production, service, technology, application, customer etc.),
- second step of the case study: for one real ICT business process in the company identification and description of all ICT work processes (work flow) and involved ICT practitioners (see the common work oriented model structure above):
  - structure and content of all ICT work processes (broad ICT work areas),
  - all involved ICT practitioners of each ICT work process,
- third step of the case study: for each ICT work process identification and description of all phases of activity and work tasks and involved ICT practitioners with their ICT job and training profiles at different levels:
  - structure and content of all phases of activity of each ICT work process,
  - structure and content of all ICT work tasks of each phase of activity,
  - all involved ICT practitioners carrying out the ICT 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 studies results on the skill needs in general within the ICT business and work areas

The broad and wide business area of information and communications technology (ICT) in Europe - of course - differs substantially in structures and contents and as the investigations of "ICT Business Processes" within the case studies have been indicating too, the real broad ICT business area has different (sub-)areas and these especially 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,
  - multimedia applications etc.

Nevertheless and despite the enormous breadth of ICT the findings of case studies allow - by comparing the ICT business process diversity in the SMLEs and the ICT sector and ICT user sectors - that all ICT business processes can be based on specific ICT work and technology criteria abstracted to a list of relevant ICT business and technology areas (see below).

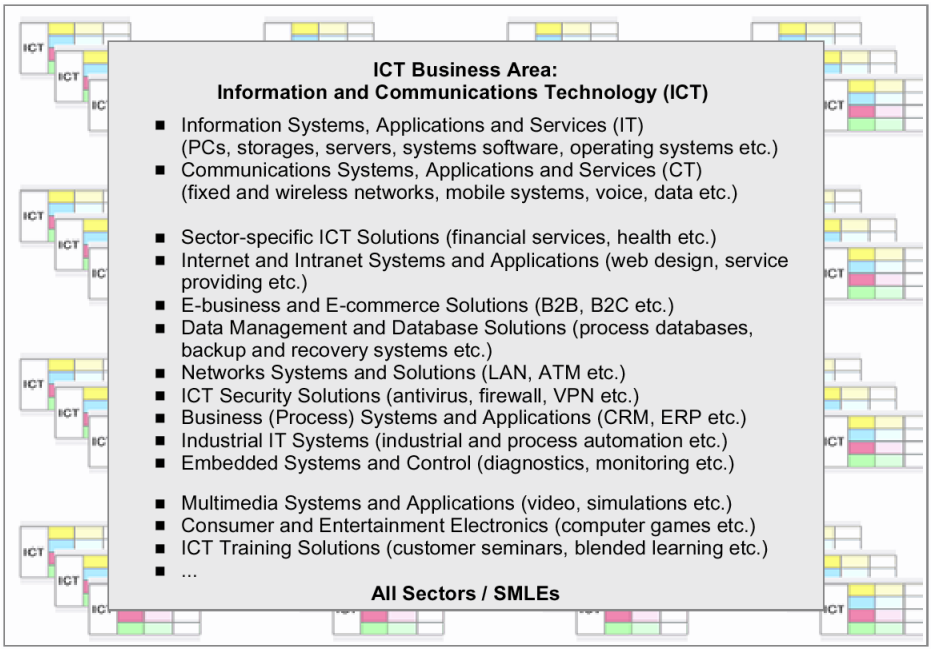


fig. 3-10: List of relevant ICT Business and Technology (sub-)Areas

In addition to this list of relevant ICT business and technology (sub-)areas which can be understood as one broad ICT business area the case studies indicate within the second investigation step and according to the ICT business process variety different contents and structures of "ICT Work Processes". The concrete contents of the "ICT Work Processes" show on the one hand a crosslink to the specific ICT business process. On the other hand and despite the variety of business processes the contents and especially the workflow structures of the "ICT Work Processes" show similarities which allow - based on common ICT work criteria - to aggregate and conclude the different structures of "ICT Work Processes" to one structure of six generic ICT work areas (see figure below):

- **two ICT work areas with more economic technical oriented contents** (in figure yellow colour),
- **two ICT work areas with more informatics / communications technical oriented contents** (in figure blue colour),
- **one ICT work area with more technical informatics / communications and infrastructure oriented contents** (in figure red colour) and
- **one ICT work area with more ICT service oriented contents** (in figure green colour).

These six ICT work areas represent the different contents and structures of "ICT Work Processes" for SMLEs in the ICT sector and ICT user sectors in a generic form. Nevertheless, of course and l ike the broad ICT business area above 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). But especially the structure of the six generic ICT work areas depends additionally on:

- **the size of the company (S, M or L) and / or**
- **the company organisation (department structure, hierarchies etc.).**

For instance, the contents and work area "ICT Marketing, Consulting and Sales" is chiefly relevant in ICT supply companies or the number and structure of the ICT work areas in large enterprises is normally higher and more detailed than in small enterprises. But on the whole and as one first relevant analysis result for the general questions of the industry's ICT skill needs and practitioners the broad ICT business area with the structure of six generic ICT work areas covers in a common sense the majority of the "ICT Business and Work Processes" in European small, medium and large enterprises and organisations.

In the context of these ICT work analysis results the case studies furthermore include some first qualitative results on the industry's needs of ICT skills and ICT skill levels. According the broad ICT business area with the structure of six generic ICT work areas of course not very detailed at this stage, but for the employed and needed ICT practitioners in each work area the case studies indicate based on the practitioner work and their ICT job and training profiles that

- **in each ICT work area there are needs of ICT skills at all degree and sub-degree levels.**

As some examples to each ICT work area show in the figure, ICT practitioners with ICT job and training profiles at all levels work - normally in a team - together. An exception is sub-degree level 1, because there are neither work, nor needs at this level in any of the ICT work areas. The examples of ICT job and training profiles by stating the level and country (e.g. L2, L3 and D Germany, NL Netherlands, P Portugal) show furthermore that currently the ICT requirements and skill needs covered by different ICT job profiles depend on the company and covered by different ICT training profiles depend on the European country.

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)

fig. 3-11: 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

All these first findings and analysis results based on the ICT business and technology areas and the six generic ICT work areas include further qualitative results on the needed ICT skills in general. The content structures of the needed ICT skills and required overall and cross section skills which are already in evidence for all involved ICT practitioners can be described in an abstract form and in a framework as follows:

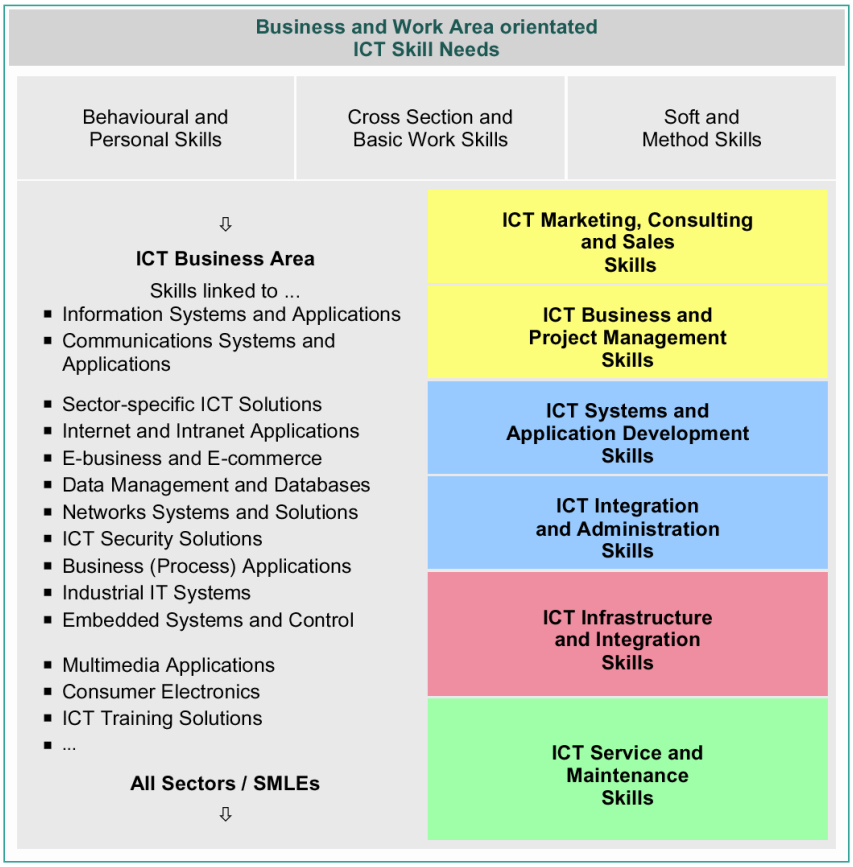


fig. 3-12: Structure of the business and work area orientated ICT skill needs in general

Within this framework and structure of the ICT skill needs in general the skills of each generic ICT work area can be furthermore specified and described as follows:

- **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 (keyword: 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 combination of business and technical tasks ask for specific skills justifying the elaboration and delimitation of a generic ICT work area and corresponding skills at different levels.

- **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 orientated ICT practitioners at different skill levels 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. All together business orientated ICT practitioners constitute the crucial "interface" between the customer and primary ICT special-

ists and technicians. Common goal of more business and technical orientated ICT practitioners is a clear description of the business requirements within the "technical specification" of the ICT solution to be developed. In shared responsibility more business and technical orientated ICT practitioners organise and implement applied support, training and instructions to the customer.

- **ICT Systems and Application Development skills:**

"ICT Systems and Application Development" covers far more than just mere individual programming or coding. In this work area ICT 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 what ICT systems and applications are needed by the market, a specific sector or a specific (internal or external) customer. In practise contacts to the project manager and ICT business and technical practitioners within our without the company are important. In the daily work processes the transfer of the technical and business requirements into a consistent "data processing specification" is crucial for the final success of the ICT systems and application development 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 and documented. Eventually, the customer and its users often need applied support, training and instructions.

- **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 new developed or already running systems and software applications. The work is carried out based on comprehensive analyses and descriptions of needed or existing systems environments to be finally successful in the integration and deployment process. In daily work processes contacts to the project manager and ICT business and developers within our without the company are important. Eventually, the customer and its users often need applied (Help Desk) support, training and instructions. As part of the (continuing and often contracted) technical support, systems and applications are optimised and up-graded and trouble-shooting need to be coordinated and problems resolved at different levels.

- **ICT Infrastructure and Integration skills:**

"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 orientated 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 practise contacts to customers, project managers and ICT business and systems development practitioners within our without the company are important. For the realisation of the projects or project parts and depending on the skill and responsibility level ICT infrastructure practitioners need to consider aspects like cost effectiveness, expandability and upgradeability, reliability, security etc. The integration of standard, specific and innovative solutions (e.g. software applications, wireless net-

work 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. Eventually, the customer and its users often need applied support, training and instructions.

- **ICT Service and Maintenance skills:**

"ICT Service and Maintenance" primary 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, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to well communicate with customers, users and colleagues. As part of the service and maintenance the ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

By inducting the main contents and overall tasks within the six generic ICT work areas it becomes obvious that further skills than just ICT skills are also required. The need of these skills directly depends on the type and contents of the work task. Such skills can be interpreted as "basic skills" and summarised in three categories as listed below:

- **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);

- **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, 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 results on the skill needs at sub-degree levels within the ICT fields of activity and work tasks in detail and additional evaluation results of ICT training profiles

According to the third step of the case study concept and within the model structure of ICT business and work areas as shown above the outcomes at first indicate and prove that each ICT work process can be further structured in a number of "Phases of Activity" and each phase of activity in a certain number of "ICT Work Tasks". Therefore and comparable to the aggregation and conclusion process of identical "ICT Work Processes" to an ICT work area the contents and structures of phases of activity can be aggregated and concluded to a struc-

ture of typical fields of activities. In the same way and based on all case studies results of the ICT work analyses in detail all work tasks of each field of activity can be commonly summarised to a structure of generic ICT work tasks. Just like the ICT work areas constitute the fundament for the overall framework of needed ICT skills in general, now these generic ICT work tasks are the fundament for work oriented sets of ICT skill needs in detail.

As we know, in all ICT work areas and fields of activity ICT practitioners at different skill levels work together in a (temporary) team. Insofar there are basically in all ICT work areas and fields of activities concrete ICT work tasks at all skill levels too. But according to the concept then detailed case study investigations concentrate especially within the fields of activity on ICT work tasks at sub-degree skill levels and respectively on tasks carried out by ICT practitioners mainly with ICT job and training profiles at sub-degree skill levels. In this assignment and because the levels and contents of the ICT work tasks are directly connected with the ICT skill needs at sub-degree levels in detail, the tasks and skill needs have furthermore and in the view of company's needs a specific importance for the structure and skills of the ICT training profiles of in each ICT work area involved ICT practitioners and in general. That means, in addition and compared to the case study results the company evaluation results of the current ICT training profiles based on the European questioning are also relevant to find out industry's skill needs. For example, if there is no or very little demand of an ICT training profile this indicates a mismatch between the ICT training skills and company skill needs. Otherwise, a high demand indicates or proves skill needs more or less as delivered by the ICT training skills and profiles. In combination of all results therefore questions and recommendations of ICT training profiles revision or of new generic ICT skill profiles allow answers based on a broad empirical fundament of industry's ICT skill needs.Oriented at the six generic ICT work areas the following description of all detailed results and skill needs is separated presented for each ICT work area. This form is chosen because of the great diversity of the findings and to guarantee the overview. However, since in real "ICT Business Processes" the ICT work areas are linked to each other - as also the tasks and skill needs are - each detailed description includes a work oriented overview of all ICT work areas.

Oriented at the six generic ICT work areas the following description of all detailed results and skill needs is separated presented for each ICT work area. This form is chosen because of the great diversity of the findings and to guarantee the overview. However, since in real "ICT Business Processes" the ICT work areas are linked to each other - as also the tasks and skill needs are - each detailed description includes a work oriented overview of all ICT work areas.

Work area "ICT Marketing, Consulting and Sales": fields of activity and ICT work tasks and skills at sub-degree levels

The case study results indicate within the work area "ICT Marketing, Consulting and Sales"

- 6 ICT fields of activity and
- 16 work tasks and skills at sub-degree levels (see figure below).

On the whole to each field of activity belongs a generic shortlist of work tasks and skills at sub-degree levels (except for level 1) and thus tasks mainly carried out by ICT practitioners with ICT job and training profiles at sub-degree skill levels 2, 3 or 4 (L2, L3, L4).

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** (A)	**Market Analysis and -Benchmarks** (A.1)	Obtain, analyse and prepare tailored ICT market, product and service information (A.1.1)	e.g. Sales Account Manager / IT Sales Advisor (L4 D) 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)
			Contribute to, edit and review an ICT business and project plan (A.1.2)	
		Advertising and Consumer Promotion (A.2)	Establish, describe and present ICT marketing and sales objectives and strategies (A.2.1)	
			Organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts (A.2.2)	
			Prepare and allocate customer information, e.g. product updates, preparing web pages (A.2.3)	
		Customer Consulting and Acquisition (A.3)	Receive, assess and forward customer inquiries (A.3.1)	
			Analysis and evaluate ICT systems and applications demand of customers (A.3.2)	
			Meet customers and colleagues and present tailored ICT solutions (A.3.3)	
		Business Process and Systems Analysis (A.4)	Investigate ICT business processes and determine requirement specifications (A.4.1)	
			Check and define overall ICT systems, software and user interfaces (A.4.2)	
			Coordinate, carry out and review financial and cost-benefit analyses (A.4.3)	
		Conception and Design of ICT Solutions (A.5)	Evaluate and draft adequate ICT solutions for the customer in cooperation with specialised ICT staff (A.5.1)	
			Formulate overall data base structures using various data models (A.5.2)	
			Recommend and present persuasive ICT systems, application software solutions and services to the customer (A.5.3)	
		Quotation Processing (A.6)	Manage and calculate customer quotations, i.e. prices, conditions, performance, services (A.6.1)	
			Provide official written quotations for ICT solutions to potential (internal or external) customers (A.6.2)	
	ICT Business and Project Management			
	ICT Systems and Application Development			
	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

fig. 3-13: ICT Marketing, Consulting and Sales: work area, fields of activity and ICT work tasks and skills

All tasks and skill contents are in detail more economic technical oriented (in figure yellow colour). Examples of titles of the ICT job and training profiles provide in the same assignment an impression which kind of ICT skills profiles are relevant in this ICT work area in the companies and European countries. The level of each ICT work task requirement and therefore of the needed skills depend in detail chiefly on the concrete contents, level of responsibility and work organisation, e.g. the task "Obtain, analyse and prepare tailored ICT market, product and service information" includes work and requirements more or less at all sub-degree skill lev-

els (L2, L3 and L4) and the task "Establish, describe and present ICT marketing and sales objectives and strategies" includes work and requirements mainly at skill level 4 (L4). Because this ICT work area links economic and technical contents close to the subsequent work area that one should also be described before finishing and summarising the results on the skill needs for these economic and technical ICT work areas.

Work area "ICT Business and Project Management": fields of activity and ICT work tasks and skills at sub-degree levels

Within the work area "ICT Business and Project Management" the case study results indicate

- 6 ICT fields of activity and
- 16 work tasks and skills at sub-degree levels (see figure below).

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			e.g. Project Manager / Business Manager in Business Information Technology (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 Business and Project Management (B)	Contracting (B.1)	Negotiate and set up ICT product and service agreements and contracts (B.1.1)	
			Manage and support the contracting process, e.g. verify and change ICT system and functional specifications, service agreements (B.1.2)	
		Project and Resource Planning (B.2)	Determine and describe project objectives, work packages, milestones, costs etc. (B.2.1)	
			Plan and manage human and ICT system resources and maintain project and customer data (B.2.2)	
			Coordinate und control external project and outsourcing activities (B.2.3)	
		Selection and Purchasing (B.3)	Identify and describe detailed ICT systems needs (B.3.1)	
			Compare offers of ICT systems and software solutions (B.3.2)	
			Purchase and provide ICT systems to the specialist teams (B.3.3)	
		Coordination and Systems Support (B.4)	Coordinate ICT work tasks and the work flow and progress (B.4.1)	
			Draft and advise overall data and security concepts (B.4.2)	
			Adapt and use information and communication platforms (B.4.3)	
		Customer Support and Training (B.5)	Instruct and train customers and users on new or adapted ICT systems and applications (B.5.1)	
			Manage and provide business support and sustain relationships to customers and users (B.5.2)	
			Develop and run escalation plans and handle customer complaints (B.5.3)	
		Provision and Billing (B.6)	Finally calculate and fix project and service agreement costs (B.6.1)	
			Prepare and provide project and billing data to the accountancy (B.6.2)	
	ICT Systems and Application Development			
	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)	L2 L3 L4 L5B L5M ICT Practitioners (ICT Job / Training Profiles)

fig. 3-14: ICT Business and Project Management: work area, fields of activity and ICT work tasks and skills

Like above, to each field of activity belongs a generic shortlist of work tasks and skills at sub-degree levels respectively tasks mainly carried out by ICT practitioners with ICT job and training profiles at sub-degree skill level 2, 3 or 4 (L2, L3, L4), again except level 1. And in detail all tasks and skill contents are similarly more economic technical oriented (in figure thus the same yellow colour).

In the same way the level of each ICT work task and therefore of the needed skills depend in detail chiefly on the concrete contents, level of responsibility and work organisation, e.g. the task "Manage and support the contracting process, e.g. verify and change ICT system and functional specifications, service agreements" includes work and requirements more at skill levels 2 and 3 (L2 and L3) and the task "Coordinate und control external project and outsourcing activities)" or "Draft and advise overall data and security concepts" includes work and requirements mainly at skill level 4 (L4).

In regard to the involved ICT practitioners the examples of their ICT job and training profiles in both more economic technical oriented ICT work areas show more or less comparable profiles. Questions, how far all results and skill needs of these two ICT work areas can be summarised are thereby not only of high importance for an adequate structure and set of the ICT skill needs in general, but likewise in the context of the ICT training skills and profiles evaluation results. As described above, based on the European questioning the company evaluation of the current ICT training profiles for both ICT work areas complementary to the case studies results are also relevant to ascertain industry's skill needs.

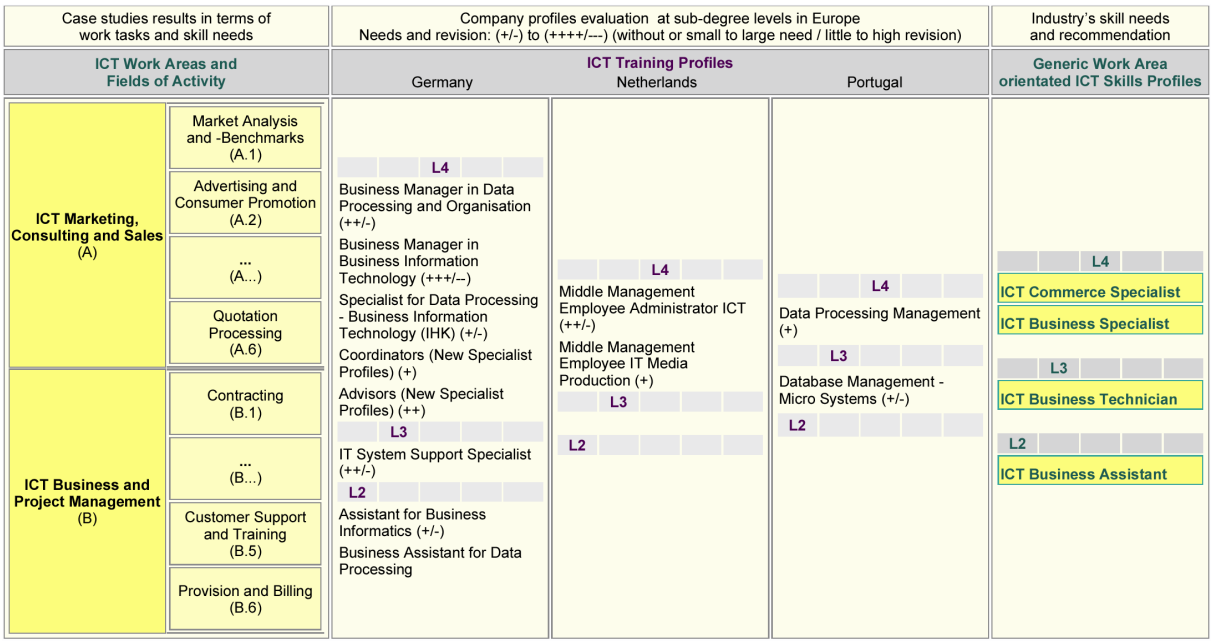


fig. 3-15: Needs and recommendation of four economic technical "Generic Work Area orientated ICT Skills Profiles" at sub-degree levels

The company evaluation results on the current ICT training profiles comprises an adequate sample of more economic technical oriented ICT training profiles at sub-degree levels of European countries. At first the results show that the numbers of current and relevant ICT training profiles for both ICT work areas in European countries differs significantly (see table below). Under the aspects of companies' needs and the necessity of revision the evaluation provides a result for each ICT training profile, in the table summarised in terms and range

"without or small to large need" (+++) and "without or little to high revision (necessity)" (---). These results enrich the ICT skill need questions insofar as, for example, the skills of the German ICT training profile "IT System Support Specialist" are required (++) at large by the industry and the skills and contents are widely accepted but need a "little revision" (-).

All case study results in terms of work tasks and skills and in addition the company evaluation results on the current ICT training profiles contain the industry's ICT skill needs of the two more economic technical oriented ICT work areas. The results can be transferred and integrated into an adequate structure of four generic and work area orientated ICT skills profiles at sub-degree levels. The concrete recommendation representing the ICT skill needs is two profiles at level 4 and one skills profile each at level 3 and 2. In difference of the width and depth of the needed skills and knowledge these four generic work area orientated ICT skills profiles can be described in the following general profile and skill structure.

Primary part of the skills profile is the work area orientated "skills kernel" in regard to the "Fields of Activity" and "generic ICT Work Tasks" of the work area(s). As it is the fundamental feature of the work area orientated description of tasks and skills these are needed in various business and technology areas specific to the company business. Therefore, in general the skills described in the fields of activity and generic work tasks are linked to the ICT business and technology areas (see below). Furthermore, to meet the work requirements and skill needs in these generic ICT work areas a set of complementary basic skills like the behavioural and personal skills is also needed, as already described above, depending on the concrete work tasks and the skill level. Eventually ICT practitioners need some overall understanding of the 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 covers also cross work area ICT skills expressed by the other three groups of generic ICT work areas. These basic skills also depend on the concrete work requirements and skill level.

fig. 3-16: Structure of the economic technical ICT skills profiles at sub-degree levels

In detail and only as one example of the business technical ICT skill needs the generic work area orientated ICT skills profile "ICT Commerce Specialist" at sub-degree level 4 is described subsequently. The major work area orientated skills of this profile cover 14 generic

ICT work tasks in all the six fields of activity. Furthermore and as for all generic ICT skills profiles the following descriptions look at basic skills, too.

1. Generic Work Area orientated 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 (keyword: Profit Centre Organisation) lead to a strengthened consideration of such work areas. Increasingly "internal" customers of ICT departments (e.g. in banks, insurance companies, industry departments like accounting, production etc.) have the same requirements as external customers have of their ICT suppliers in what concerns 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 customers needs while providing benefits to the own company or department at the same time. Common goal of more business and technical orientated ICT practitioners is a clear description of the business requirements within the "technical specification" of the ICT solution to be developed. These combination 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" guarantying the work flow success from the very first steps like "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. All together business orientated 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
  - Analysis and evaluate ICT systems and applications

... 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

demand of customers
- Meet customers, colleagues and present ICT solutions

- Business Process and Systems Analysis
  - Investigate ICT business processes and determine requirement specifications
  - 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

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 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 Up-grade 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
- Up-date 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 of 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 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.

fig. 3-17: Generic work area orientated ICT skills profile: "ICT Commerce Specialist" at sub-degree level 4

Work area "ICT Systems and Application Development": fields of activity and ICT work tasks and skills at sub-degree levels

The case studies results indicate within this work area:

- 6 ICT fields of activity and
- 19 work tasks and skills at sub-degree levels (see figure below).

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)	L2 L3 L4 L5B L5M ICT Practitioners (ICT Job / Training Profiles)

fig. 3-18: ICT Systems and Application Development: work area, fields of activity and ICT work tasks and skills

On the whole to each field of activity belongs a generic shortlist of work tasks and skills at sub-degree levels (except for level 1) and thus tasks and skill contents are in detail more informatics / communications technical oriented. Examples of titles of the ICT job and training profiles indicate which kind of ICT skills profiles are relevant in this ICT work area in the companies and European countries. The level of each ICT work task requirement and therefore of the needed skills depend in detail chiefly on the concrete contents, level of responsibility and work organisation, e.g. 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 more or less at all sub-degree skill levels (L2, L3 and L4). The task "Develop and coordinate test procedures and cases" includes work and requirements mainly at skill level 4 (L4).

Because this ICT work area focuses on informatics / communications technical contents like the subsequent work area that one should also be described before finishing and summarising the results on the skill needs for these "blue" ICT work areas.

Work area "ICT Integration and Administration": fields of activity and ICT work tasks and skills at sub-degree levels

The case studies results indicate within this work area:

- 6 ICT fields of activity and
- 20 work tasks and skills at sub-degree levels (see figure below).

On the whole to each field of activity belongs a generic shortlist of work tasks and skills at sub-degree levels(except for level 1) and thus tasks and skill contents are in detail more "ICT Integration and Administration" oriented. 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. Examples of titles of the ICT job and training profiles indicate that more administration and support ICT skills profiles are relevant in this ICT work area in the companies and partly European countries. The level of each ICT work task requirement and therefore of the needed skills depend in detail chiefly on the concrete contents, level of responsibility and work organisation, e.g. the major task "Optimise and actualise ICT systems, e.g. hardware, operating system, libraries" within the administration phases includes work and requirements more or less at all sub-degree skill levels (L2, L3 and L4). The task "Manage and run software distribution, remote configuration, data archiveing, retrieving and reorganisation" includes work and requirements mainly at skill level 4 (L4) and the task "Arranging ICT system and software security" requires primarily skills level 3 (L3).

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 Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development			
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 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)	e.g. Database Administrator / Administrator 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 Supporter / Assistant Administrator ICT (L3 P) e.g. Application Supporter / Data Processing Assistant (L2 P)
			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)	
			Plan and set up systems parameters and user administration (D.2.4)	
		ICT Training and Instruction (D.3)	Elaborate and edit training and instruction material (D.3.1)	
			Plan and run tailored training and instruction for customers and users (D.3.2)	
			Evaluate training measures and suggest improvements (D.3.3)	
		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

fig. 3-19: ICT Integration and Administration: work area, fields of activity and ICT work tasks and skills

In regard to the involved ICT practitioners the examples of their ICT job and training profiles in the two more informatics / communications technical oriented ICT work areas show comparable profiles. As for the more commerce and business ICT skills profiles questions con-

cerning the summary are thereby not only of high importance for an adequate structure and set of the ICT skill needs in general, but likewise in the context of the ICT training skills and profiles evaluation results. The company evaluation results on the current ICT training profiles comprises a significant sample of more informatics / communications technical oriented ICT training profiles at sub-degree levels of European countries. For instance at skill level 4 there are ICT training profiles available in all countries ranging from software analysis and development to administration. There is also a wide range of ICT training profiles in these work areas at skill level 3 and 2 in Germany and Portugal, but little in the Netherlands (see table below). The evaluation results on companies' needs and the necessity of revision indicate for instance a large need but also little revision of profiles like "Administrator Software Applications (+++/-)" at level 4 in the Netherlands or "Information Technology Specialist in Application Development" at level 3 in Germany.

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 Systems and Application Development (C)	As-is Analysis and Consulting (C.1)	L4 State Certified Informatics Software Developers (New Specialist Profiles) (+++) Technician Data Processing Technology(+/--) Technician Data Systems Technology (+/--) Solution Developers (New Specialist Profiles) (++) Administrators (New Specialist Profiles) (+++)	L4 Developer Software Applications (++/--) Middle Management Employee Multimedia Designer Administrator Software Applications (+++/-)	L4 Informatics Applications Programmer (++) Main Frame Applications Programmer (+) Data Analyst (+) Industrial Design CAD 3D Specialist Informatics Applications Analyst (+) Database Management - Main Frame (++) Multimedia Applications Operator (++/-)	L4 Informatics Specialist ICT Administration Specialist
	Work- and Project Planning (C.2)	L3 Information Technology Specialist in Application Development (+++/-) Mathematical Technical Assistant Designer of Digital and Print Media (+/-) Information Technology Officer (++/-) Information Technology Specialist in System Integration (+++/-)	L3 Assistant Administrator ICT (+++/-)	L3 Informatics Technician (++/-) Multimedia Systems Programmer (+) Advanced Applications Operator (+) CAD Operator	L3 Informatics Technician
	... (C..)	L2 Technical Assistant for Informatics (+/--) Technical Assistant for Production Informatics	L2	L2 Informatics Assistant Technician (+) Informatics Operator (+) Data Processing Assistant (+)	L2 Informatics Assistant
	Documentation (C.6)				
ICT Integration and Administration (D)	Planning and Installation (D.1)				
	... (D...)				
	Bug Analysis and Debugging (D.5)				
	Customer and User Support (D.6)				

fig. 3-20: Needs and recommendation of four informatics / communications technical "Generic Work Area orientated ICT Skills Profiles" at sub-degree levels

All case study results in terms of work tasks and skills and in addition the company evaluation results on the current ICT training profiles constitute the industry's ICT skill needs of the two more informatics / communications technical oriented ICT work areas. The results can also be transferred and integrated into an adequate structure of four generic and work area orientated ICT skills profiles. The concrete recommendation representing the ICT skill needs is two profiles at level 4 and one skills profile each at level 3 and 2. In difference of the width and depth of the needed skills and knowledge these four generic work area orientated ICT skills profiles can be described in the following general profile and skill structure for the informatics / communications technical oriented ICT work areas.

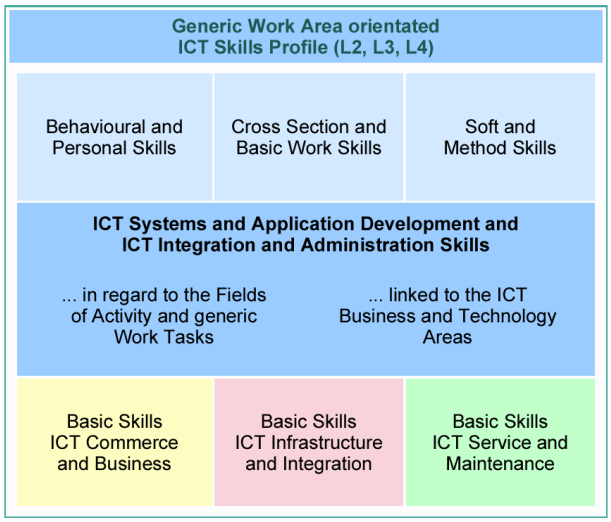


fig. 3-21: Structure of the informatics / communications technical ICT skills profiles at sub-degree levels

In detail and only as one example of the informatics / communications technical ICT skill needs the generic work area orientated ICT skills profile "Informatics Technician" at sub-degree level 3 is described subsequently. The major work area orientated skills of this profile cover 30 generic ICT work tasks in all the 12 fields of activity. Furthermore and as for all generic ICT skills profiles the following descriptions look at basic skills, too.

1. Generic Work Area orientated 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 mere 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-orientated) database management system) etc. Depending on the real 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 practise permanent contacts to the project and team manager and ICT business and technical practitioners within our without 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. Eventually, the customer and its 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 up-graded 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
- Flexibility
- Self Learning
- Motivation and Commitment
- Stress Resistant and Emotion
- Responsibility
- Decision Making
- Initiative and Attention
- Professional Attitude (Business or

Cross Section and Basic Work Skills
- Quality Awareness
- Commercial and Market Awareness
- Entrepreneurship
- Customer Orientation and Relationship
- Company and Business Organisation
- Work Organisation
- Work Safety and Health Protection

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

Technical Orientation and Interests)	▪ Labour Law and Data Privacy ▪ Environmental and Resource Awareness	Thinking ▪ 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 - 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	▪ 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.) ▪ ...

- 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

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 the Invoicing and Accountancy

Basic Skills ICT Infrastructure and Integration

- Provide, Install and Up-grade 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
- Up-date 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 of lifelong learning (LLL) both, in terms of primary informatics and technology subjects as well as overall aspects like 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.

fig. 3-22: Generic work area orientated ICT skills profile: "Informatics Technician" at sub-degree level 3

Work area "ICT Infrastructure and Integration": fields of activity and ICT work tasks and skills at sub-degree levels

The case studies results indicate within this work area:

- 6 ICT fields of activity and
- 19 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 are focusing on more technical and organisational aspects of the entire ICT infrastructure and its installation, integration and configuration. Examples of titles of the ICT job and training profiles indicate which kind of ICT skills profiles are relevant in this ICT work area in the companies and European countries. The level of each ICT work task requirement and therefore of the needed skills depend in detail chiefly on the concrete contents, level of responsibility and work organisation, e.g. the task "Receive, assess and forward new customer orders" within the first phases includes work and requirements more or less at all sub-degree skill levels (L2, L3 and L4), but nevertheless still depending 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).

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

fig. 3-23: ICT Infrastructure and Integration: work area, fields of activity and ICT work tasks and skills

In regard to the involved ICT practitioners the examples of their ICT job and training profiles in the more technical and ICT infrastructure oriented ICT work area show partly comparable but also different profiles. Questions concerning the synopsis are thereby not only of high importance for an adequate structure and set of the ICT skill needs in general, but likewise in the context of the ICT training skills and profiles evaluation results. The company evaluation results comprises a significant sample of technical and ICT infrastructure oriented ICT training profiles at sub-degree levels of European countries. For instance at skill level 4 there are four ICT training profiles available in Germany and the Netherlands focusing on technical aspects like more informatics, more telecommunications or specific problems like computer interfaces. There are two ICT training profiles each at skill level 3 and 2 in these countries, whereas in Portugal the number of profiles is less (see table below). The evaluation results on companies' needs and the necessity of revision indicate for instance a medium need but also necessity of revision of profiles like "Technician in Technical Informatics (++/--) or Technician Communications Systems (TCS) (++/--)" at level 4 in Germany and the Netherlands respectively, or "IT System Electronics (++/-)" at level 3 in Germany.

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) Installation, Integration and Configuration (E.4) Testing and Documentation (E.5) Delivery, Instruction and Finalising (E.6)	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

fig. 3-24: Needs and recommendation of three ICT infrastructure and integration "Generic Work Area orientated ICT Skills Profiles" at sub-degree levels

All case study results in terms of work tasks and skills and in addition the company evaluation results on the current ICT training profiles constitute the industry's ICT skill needs in the generic work area "ICT Infrastructure and Integration". The results can be transferred and integrated into an adequate structure of three generic and work area orientated ICT skills profiles. The concrete recommendation representing the ICT skill needs is one ICT skills profile at each sub-degree level. In difference of the width and depth of the needed skills and knowledge these three generic work area orientated ICT skills profiles can be described in the following general profile and skill structure.

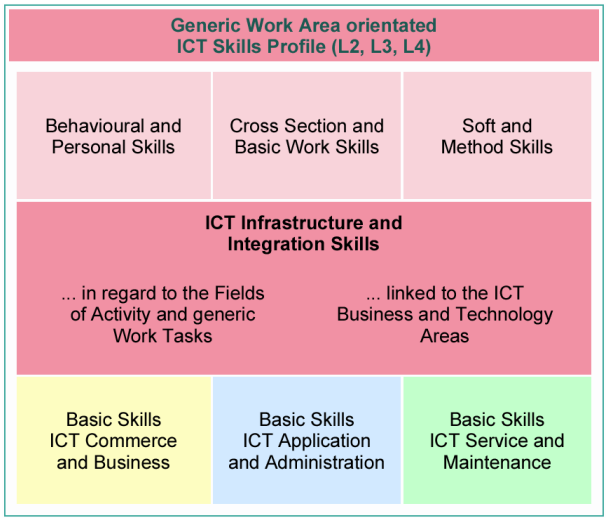


fig. 3-25: Structure of the infrastructure and integration ICT skills profiles at sub-degree levels

In detail and only as one example of the "ICT Infrastructure and Integration" skill needs the generic work area orientated ICT skills profile "ICT Systems Assistant" at sub-degree level 2 is described subsequently. The major work area orientated skills of this profile cover 12 generic ICT work tasks in all the six fields of activity. Furthermore and as for all generic ICT skills profiles the following descriptions look at basic skills, too.

1. Generic Work Area orientated 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 orientated 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 our without the company can partly be important, but may not in any case carried out by Assistants. However, for the realisation and integration of ICT infrastructure solutions like networks or telecommunications ICT Systems Assistants need to consider aspects like 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
- Flexibility
- Self Learning
- Motivation and Commitment
- Responsibility
- Initiative and Attention
- Professional Attitude (Business or Technical Orientation and Interests)

Cross Section and Basic Work Skills
- Quality Awareness
- Customer Orientation and Relationship
- Company and Business 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
- 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
- Customer Consulting
  - Determine, specify and describe technical requirements
- Task Adoption and Work Planning

... linked to the ICT Business and Technology Areas
- Information Systems, Applications and Services (IT) (PCs, storages, servers, systems software, operating systems etc.)

- 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

- 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
- 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

Basic Skills ICT Application and Administration
- 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)

Basic Skills ICT Service and Maintenance
- Describe Support and Communication Channels (e.g. customers, business partners, suppliers, colleagues)
- Up-date 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 of lifelong learning (LLL) both, in terms of primary ICT and technology subjects as well as overall aspects like ICT business process and market developments and trends. As an ICT Systems Assistant 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.

fig. 3-26: Generic work area orientated ICT skills profile: " ICT Systems Assistant" at sub-degree level 2

Work area "ICT Service and Maintenance": fields of activity and ICT work tasks and skills at sub-degree levels

The case studies results indicate within this work area:

- 6 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 are focusing on more technical and organisational aspects of the entire ICT Service and Maintenance. Examples of titles of the ICT job and training profiles like "Networks Fitter / (PC's) Maintenance Technician" indicate which kind of ICT skills profiles are relevant in this ICT work area in the companies and European countries.

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 Marketing, Consulting and Sales			
	ICT Business and Project Management			
	ICT Systems and Application Development			
	ICT Integration and Administration			
	ICT Infrastructure and Integration			
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 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

fig. 3-27: ICT Service and Maintenance: work area, fields of activity and ICT work tasks and skills

The level of each ICT work task requirement and therefore of the needed skills depend in detail chiefly on the concrete contents, level of service responsibility and work organisation, e.g.

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). 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).

In regard to the involved ICT practitioners the examples of their ICT job and training profiles in the ICT service oriented work area show some common major technical trends, e.g. networks, telecommunications. Questions concerning the synopsis are thereby not only of high importance for an adequate structure and set of the ICT skill needs in general, but likewise in the context of the ICT training skills and profiles evaluation results. The company evaluation results comprises ICT service oriented ICT training profiles at all sub-degree levels in the 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 level 3 and 2 in these countries (see table below). The evaluation results on companies' needs and the necessity of 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.

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 Service and Maintenance (F)	Service Task Adoption and Work Planning (F.1)	L4 Master (Craftsman) Information Technology (+/-) Master (Craftsman) Telecommunication Facility Electronic Technician (+/-) ICT Service Advisor (New Specialist Profile) (++)	L4 Network Administrator (++++/--) Middle Management Employee Automation Electronics	L4 Maintenance Applications Technician (+)	L4 ICT Service Specialist
	Error Diagnosis and Troubleshooting (F.2)	L3 Information Electronics (+/-) Telecommunications Facility Electronic Technician	L3 First Craftsman Industrial Electronics First Craftsman Electronics and Instrumentation	L3 Network Maintenance Technician (+++/-)	L3 ICT Service Technician
	Repair and Maintenance (F.3)	L2 Assistant for Automation and Computer Technology	L2 Craftsman Industrial Electronics ICT Service Worker (+++/-)	L2 Network (PC's) Maintenance Technician (++/-) Assistant Technician of Equipment Maintenance (++)	L2 ICT Service Assistant
	ICT Systems Adaptation and Upgrading (F.4)				
	Service Conception and Optimisation (F.5)				
	Service Finalising and Documentation (F.6)				

fig. 3-28: Needs and recommendation of three ICT service and maintenance "Generic Work Area orientated ICT Skills Profiles" at sub-degree levels

All case study results in terms of work tasks and skills and in addition the company evaluation results on the current ICT training profiles constitute the industry's ICT skill needs in the generic work area "ICT Service and Maintenance". The results can also be transferred and integrated into an adequate structure of three generic and work area orientated ICT skills profiles. The concrete recommendation representing the ICT skill needs is one ICT skills profile at each sub-degree level. In difference of the width and depth of the needed skills and knowledge these three generic work area orientated ICT skills profiles can be described in the following general profile and skill structure.

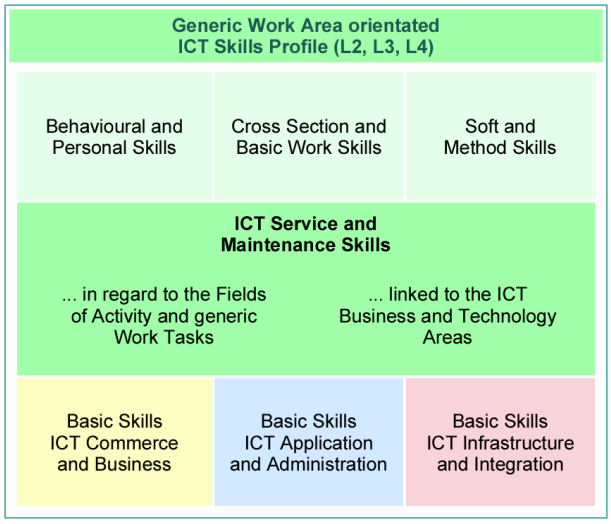


fig. 3-29: Structure of the service and maintenance ICT skills profiles at sub-degree levels

In detail and only as one example of the "ICT Service and Maintenance" skill needs the generic work area orientated ICT skills profile "ICT Service Technician" at sub-degree level 3 is described subsequently. The major work area orientated skills of this profile cover 13 generic ICT work tasks in all the six fields of activity. Furthermore and as for all generic ICT skills profiles the following descriptions look at basic skills, too.

1. Generic Work Area orientated 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" primary 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, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to well communicate with customers, users and colleagues. As part of the service and maintenance the ICT practitioners must be able to propose 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 Resistant and Emotion
- Responsibility
- Decision Making
- Initiative and Attention
- Professional Attitude

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,

... 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)

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

(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

- 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 the Invoicing and Accountancy

Basic Skills ICT Application and Administration

- 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)

Basic Skills ICT Infrastructure and Integration

- Provide, Install and Up-grade 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 of lifelong learning (LLL) both, in terms of primary ICT service and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience as an ICT Service Technician 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.

fig. 3-30: Generic work area orientated ICT skills profile: "ICT Service Technician" at sub-degree level 3

The following table summarises the results in what concerns the structure of the 14 "Generic work area orientated ICT skills profiles" at the three sub-degree levels and complementary to the "Generic ICT skills profiles" at degree level (see examples).

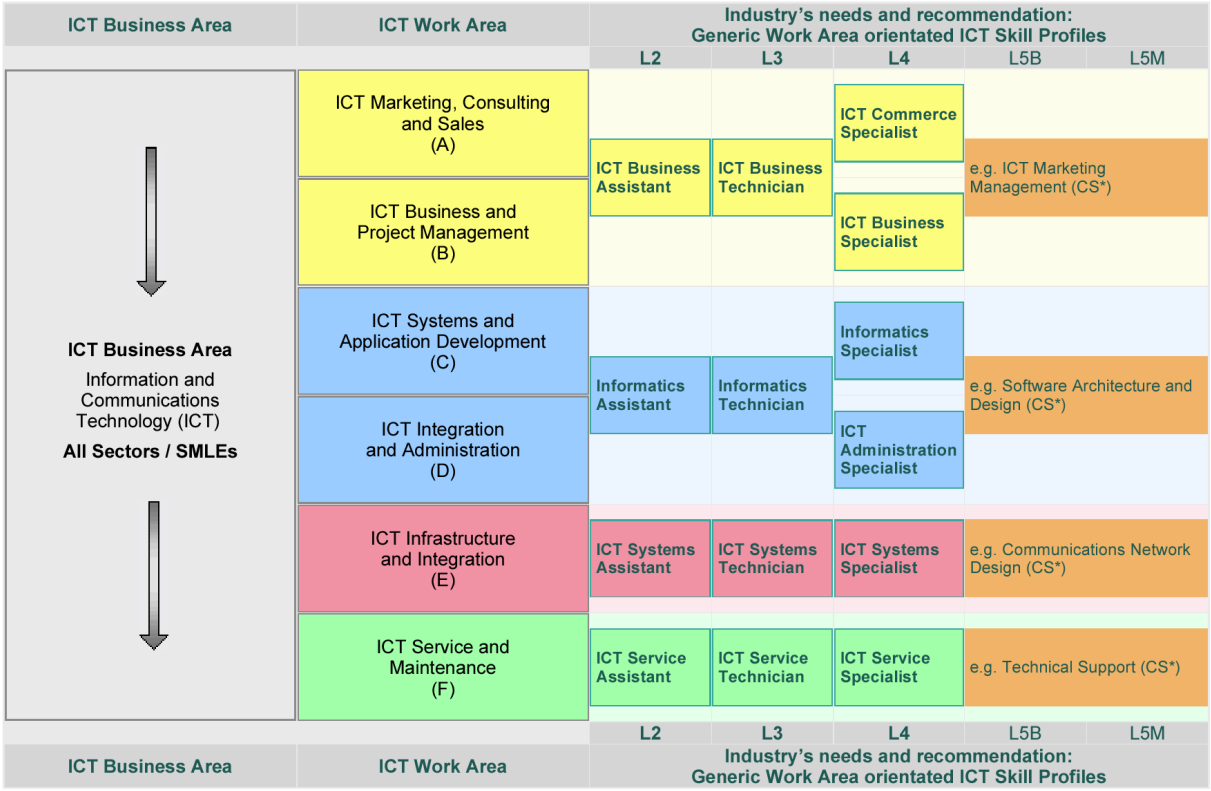


fig. 3-31: Structure of the fourteen "Generic work area orientated ICT skills profiles" at sub-degree levels (* Generic ICT skills profiles examples at degree level of Career Space)

The results on the ICT work and needs at sub-degree skill levels in terms of these "Generic work area orientated ICT skills profiles" can be at first understood as a definition and qualitative description of the current ICT skill and profile needs. The ICT skills profiles cover the industry's needs of ICT skills and practitioners of the ICT and user sectors in Europe - in particular of small and medium enterprises too. Secondly and because these generic ICT skills profiles ought to decrease the mismatch in regard to the existing ICT training profiles the results can be understood as a recommendation to use the 14 "Generic work area orientated ICT skills profiles" as a fundament to develop 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 actual and mid-term demand of continuing vocational education and training (CVT) for their ICT practitioners has been a further indicator for the determination of the ICT skills needs at different sub-degree and degree levels. Following the results of the EUQuaSIT investigations, first of all European companies see a CVT demand for ICT practitioners at all skill levels. Even though the demand is all together slightly lower at sub-degree level 2, in particular the proportion of Dutch companies is higher at this level than for instance at degree level 5M. In Germany the companies see the biggest demand of CVT for ICT practitioners at level 3 and degree level 5B. The Dutch companies answer the biggest CVT demand for level 4 whereas in Portugal most companies see the CVT demand at level 5M and level 3.

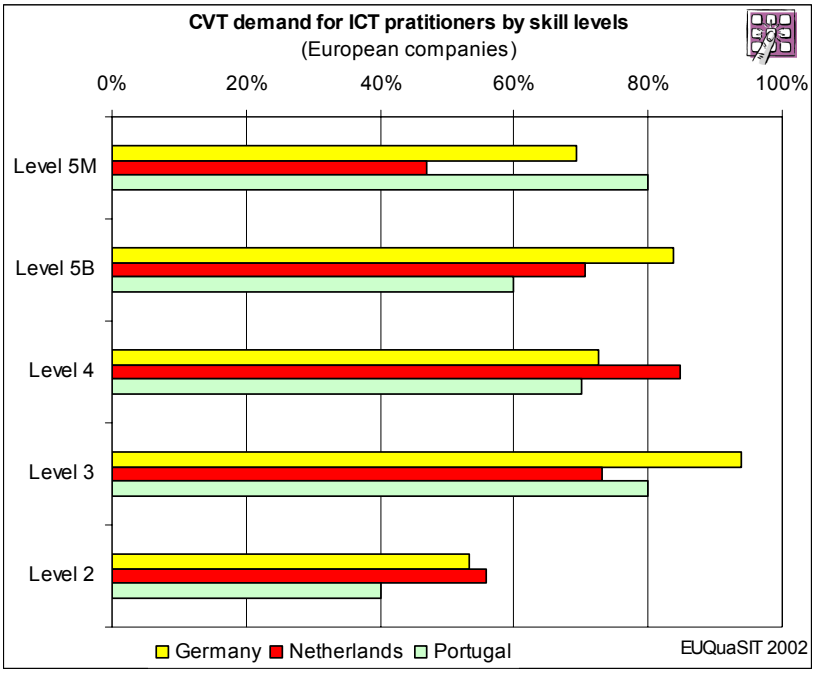


fig. 3-32: CVT demand for ICT practitioners at different skill levels in European companies

Looking in more detail, the CVT demand at the skill levels differs depending on the contents of the fields of ICT work and activity, too. The biggest CVT demand for ICT practitioners at sub-degree levels is indicated in the field of work and activity "ICT Systems Installation" and "ICT Service and Administration", as well as in the field "ICT Systems and Application Development". Companies also see a certain CVT demand for ICT practitioners at sub-degree skill levels in the more economic technical orientated fields of work and activity and here chiefly at level 4, e.g. "ICT Marketing" and "ICT Sales and Consulting". The diagram below furthermore specifies that CVT courses focusing on "ICT Management" are mainly asked for ICT practitioners at degree level qualification, but also for those at sub-degree level 4.

The supply of CVT courses for ICT practitioners in the region is best estimated by Dutch companies. More than 70% declare the supply is adequate and tailored to their needs. In Germany and Portugal also the majority of more than 60% states there is a complete and tailored offer all together. On the other hand there is also a percentage of 30-40% of the companies stating that the supply of CVT courses is inadequate and has to be improved and adapted to industry's ICT skill needs. These results, on the one hand, apply for small, medium and large companies likewise. On the other hand companies of the ICT sector more often than those of the ICT user sectors criticize an inadequate supply and state the need of improvement. According to the companies, major problems are the level and range of ICT contents of the CVT courses as well as the competences of the teachers and trainers.

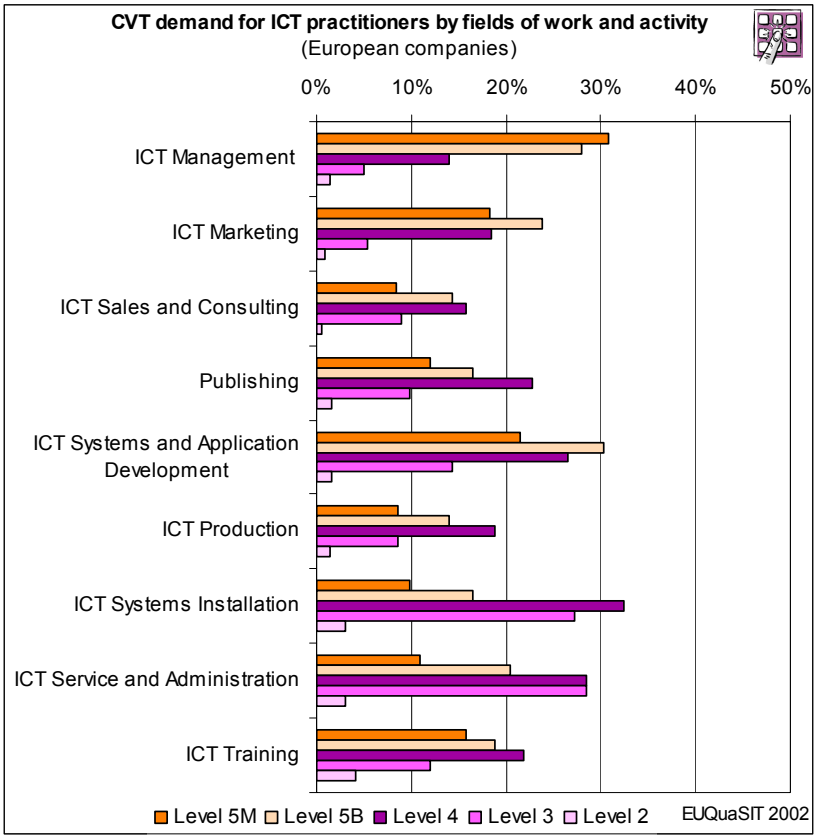


fig. 3-33: CVT needs for ICT practitioners in different work areas

A normal reason of special industry ICT skill needs indicated by the CVT demand of the companies are the ICT developments and the rapid changes of ICT applications which modify and increase the skill requirements of the ICT practitioners in each time. Another reason is perhaps that the study and training programmes and ICT training profiles do not cover the ICT skill needs as a whole. Therefore it is not unimportant that the CVT demand of the companies compared with the ICT skill needs represented by the generic work area orientated ICT skills profiles described above have a high congruence. For example the respectable CVT demand in the fields of work and activity "ICT Service and Administration" for ICT practitioners at level 3 and 4 has been considered for example by the generic work area orientated ICT skills profiles "ICT Service Technician" at level 3 and by the "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). Beside handicapped people, foreign workers and ethnic minorities this discussion unfortunately still also concerns gender aspects, since females are significantly underrepresented for instance in the ICT training and work practice. The empirical results from the EUQuaSIT survey display an average female proportion in European ICT training of app. 20% and even lower amongst ICT practitioners in the companies. In the more economic technical orientated ICT training profiles the proportion of females is higher than in more technical informatics

and communications orientated profiles. It is interesting with regard to the importance of gender diversity that many European companies state a good proportion of males and females is important in ICT business and work processes.

However, in what concerns special ICT skill needs we cannot easily - if at all - identity any differences between males and females. The only question worthwhile to discuss is, which measures and initiatives can be successfully implemented to increase the proportion of females in ICT training and employment. Because the proportion of females is already rather low in ICT training courses, corresponding aspects were partly investigated in the EUQuaSIT study.

Special ICT initiatives, programmes, projects etc., however, in order to promote and increase the female proportion in ICT training are very rare in training institutions. Only up to 20% of the training providers in Europe offer ICT qualification with special addressing to females or organise special ICT training with females as teachers and trainers. Nonetheless, about half of these training institutions have made the experience that ICT training especially addressing females or with females as teachers and trainers have a good change of success.

A second group perhaps even more important to be considered in the 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 at least partly no problem (see below). This result is true for small, medium and large enterprises. There is only some 15% of companies for instance of the ICT industry stating this can sometimes be problematic but most of them declare this depends on different factors like the work area and the degree of the handicap. Especially in the area of "ICT Application and Systems Development and Test" or "User Support (Helpdesk)" many companies see good chances to employ physically handicapped people.

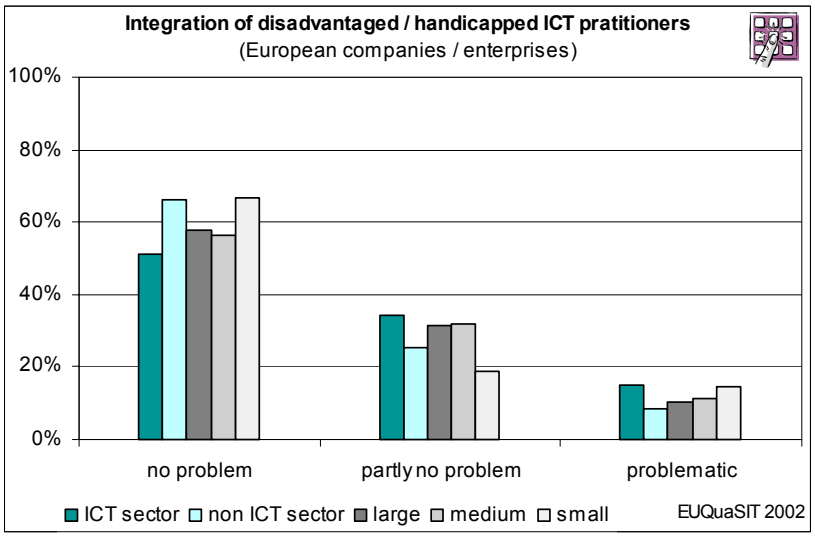


fig. 3-34: Companies' experience with the integration of disadvantaged / handicapped ICT practitioners

In regard to the experience with ICT education and training focusing on the integration of disadvantaged and handicapped people also many training institutions in Europe do not see bigger problems in this context. Only a small proportion of about 20% of the training providers for example 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 thus a student or trainee with disadvantages or disabilities is less favourably treated than any other student, on the contrary. However, in qualification and training concepts and practice special needs of certain target groups may need to be considered in order to reduce disparities in access to the labour market. This surely becomes even more a challenge towards the development of a information society chiefly influenced by ICT business and practitioners itself.

4 ICT Curriculum Development Guidelines and New European Training Solutions

In European countries there are currently of course a lot of different ICT curricula for ICT study and vocational training programmes at more or less all levels. This also includes the provision at each national school curriculum level with different opportunities and ICT programmes for all pupils to learn and to achieve qualifications in the field of ICT. Research and development in the fields of ICT and to produce, install and make ICT happen is in the new information society important today as is, correspondingly, to understand and use ICT in private and work areas in an elaborated and critical way. As ICT curricula in European countries, on the one hand, show major similarities in what concerns the didactics and design, different are the goals and structures of the national education, vocational and study systems. On the other hand, the ICT curricula often base on the same approach in terms of aims and contents, because ICT is not a national affair, ICT is a global technology and business simply made evident looking at computers, internet, networks, mobile phones etc. This is also proved more and more in all ICT business and work areas in the increasing number of international companies and enterprises. The globalisation of ICT affects the business management, the research and development fields and the concrete shop floor level, because the ICT research and development, hardware and software production and components become more and more international, so that work today in ICT without competences in the English language is impossible.

These aspects and with special focus on the ICT work at sub-degree levels in European countries have been widely approved by the case study investigations of the ICT skill needs in small, medium, and large enterprises (SMLEs) of the ICT sector and ICT user sectors. As furthermore shown by the company questioning results on the demand and needs of ICT practitioners and the evaluation of existing ICT training profiles (almost 500 companies were involved in the European wide questionings), the ICT skill needs at sub-degree levels of the European ICT and user sectors base on a broad ICT business area with an extensively common and international structure of ICT work areas, fields of activity and ICT work tasks. As a main result, the findings and contents diversity could be summarised and harmonised to fourteen "Generic work area orientated ICT skills profiles".

In order to outline development guidelines for new European ICT curricula this main result of the industry's needs therefore is a good and broad empirical fundament. But apart from the result of the generic work area orientated ICT skills profiles further basic knowledge and evaluation results of the current ICT curriculum are necessary, because the mismatch of the existing ICT training and qualification profiles in detail is also one basis. Nevertheless, for the big challenges we need altogether new and good ideas and didactic concepts to have right answers for new ICT curricula that will be broadly accepted in Europe. In the same way 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 specific aspects like outcomes definitions, entry requirements, assessment and certification, quality control and the concrete qualifying processes.

4.1 Situation and evaluation of current ICT training profiles and curricula in vocational education and training

As already described above in the context of detecting the ICT skill needs, the evaluation of existing ICT training profiles and curricula at sub-degree and VET levels indicates a couple of differences in European countries with regard to the profiles 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 the ICT training profiles or rather only possible at an abstract level as likewise comparison studies of VET systems confirm. The differences on the basis of each ICT curricula, especially as the results of the EUQuaSIT Leonardo project verify in detail, e.g. in regard to the goals, contents, method or duration of the ICT training, of course are more or less the same, because the curriculum elements tend to the profiles and skill levels structures. Nevertheless and of course, there are many accordances of the concrete goals, contents and methods. Insofar the outcomes and ICT qualifications to be achieved contain a wide range of similarities, for instance just proven by the fact that the ICT practitioners after the ICT training e.g. in Germany or Netherlands are able to deal and carry out in a comparable qualified way the same ICT work tasks.

The European company evaluation of the ICT training profiles and therefore of the ICT curricula has been highly important under aspects of the needs and revision. First of all, the evaluation results include the company needs of each ICT training profile respectively to what extent the profile meets the ICT skill needs in general. Secondly the results indicate especially under revision aspects a mismatch in regard to the ICT training goals and contents. Beside using these results to find out the needs and profile structure presented by the fourteen "Generic work area orientated ICT skills profiles", among other things, the evaluation results can be in the same context further interpreted as a mismatch to a certain extent and findings of the current ICT curricula e.g. in terms of curriculum examples of "good or bad practice".

In this sense and in relation of the current curricula of ICT training profiles - here e.g. especially in Germany, Netherlands and Portugal - and the generic work area orientated ICT skills profiles the evaluation results can be summarised as follows:

- the curricula of "modern" ICT training profiles, launched or updated in the last years, are often relevant as curriculum examples of "good practice". To a high percentage they meet the skill needs and contents presented by the generic work area orientated ICT skills profiles, e.g. in Germany the four new ICT training profiles at level 3 and new work process orientated further ICT specialist profiles at level 4 or in the Netherlands the new BCP ICT training profiles or also in Portugal the new professional ICT training profiles at vocational levels,
- beside the curricula of "modern" ICT training profiles the problems are that often the "old" ICT training profiles further and parallel exist and in this context the corresponding ICT curricula and training profiles partly overlap significantly in skills and contents, but, however, this result partly applies to some new ICT training profiles as well,
- the curricula of ICT training profiles that meet the skill needs and contents presented by the generic ICT skills profiles only to a lower degree, still often split and separate the

ICT skills and contents for instance in IT and CT, especially current ICT training profiles at VET level 2 and 3, e.g. in Germany "Telecommunication Facility Electronic Technician" and "Mathematical Technical Assistant" or in Netherlands "Craftsman Communications Networks",

- the curricula which still partially but strongly split and separate ICT business, informatics (software) and electronics (hardware) skills and contents do not meet the work area orientated skill needs. These curricula are mostly strong subject or scientific discipline orientated without enough or none integrated or combined structure and contents, e.g. in Germany "Technician in Radio Communication" or in Portugal " Software Analyst",
- other curricula with a mismatch in general hardly consider any work area orientated skills and contents or cross section and basic work skills. These curricula also mostly strong subject or scientific discipline orientated and hardly include for instance business, customer and application orientated contents, work process and quality management contents or overall subject contents,
- and finally other curricula with a mismatch often stress too much the basic skills with predominantly scientific base and engineering theory contents like computer and technology science and mathematics orientated contents and, at the same time, too little basic skills with work, customer and application orientated contents.

On the one hand the results and findings of the current ICT curricula at sub-degree levels in relation to the skill needs presented by the generic work area orientated ICT skills profiles evidence that in European countries a couple of ICT curricula exist that may be named as curriculum examples of "good practice". These curricula show various solutions related to the work area orientated ICT skills profiles wherefore there is no single way to develop the curriculum. On the other hand the results show problems and different maladjustments of the ICT curricula with indications to improve the common curriculum design.

In this context it is of interest that many companies support the necessity of common European standards for ICT training profiles and curricula. In little dependency of the level an average of more than 50% of the companies state that a European standardisation of ICT training profiles is urgently necessary. 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 the qualification levels the outcomes indicate that the higher the level of qualification, the higher is the proportion of companies stating there are such European initiatives needed. For the higher education degrees between 60 and 80% of the companies stress the importance of a European standardisation of ICT training profiles. For the VET profiles at level 3 an 2 the proportion is slightly lower and there is correspondingly another 50% of the companies who rather would "save national standards" of ICT training and qualification. One primary reason for this appraisal can probably be seen in a lack of mutual European trust in what concerns strategies and concepts of a common way to European 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.

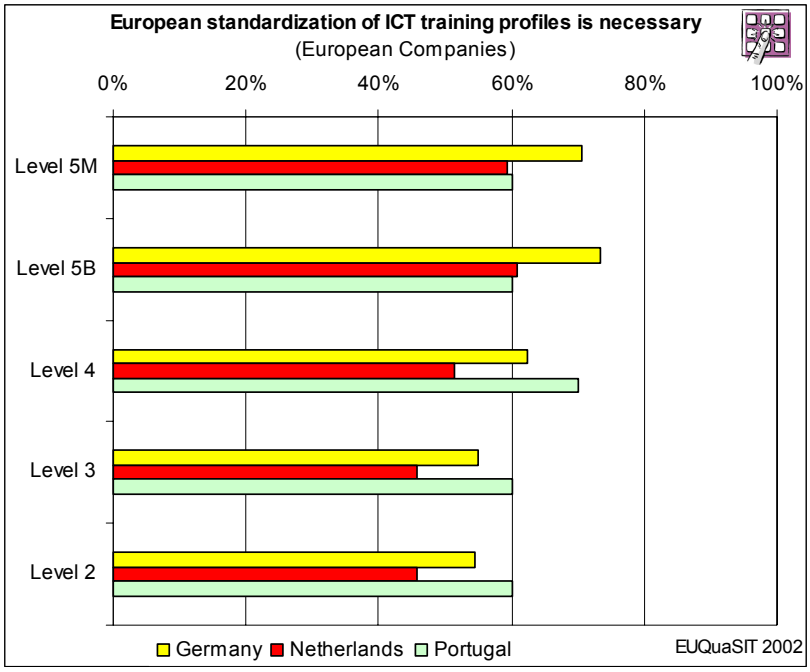


fig. 4-1: Company evaluation of a European standardisation of ICT training profiles

All together the findings include didactic orientations and further information concerning training profiles, goals, contents, methods etc. that are useful for the guidelines and recommendations for new European ICT training profiles and curricula.

4.2 Model for work area orientated ICT curricula at sub-degree levels - Structure of ICT training profiles and their outcomes in terms of qualifications

The design of curricula in general need at first answers and decisions on the "horizontal and vertical" profile structure of the training and qualification profiles. With regard to the industry's needs of ICT skills and practitioners and the challenges for the design of new and broad accepted European ICT curricula one answer and decision of the "vertical" structure is fairly clear, we need profiles at degree and sub-degree professional qualification level and here especially at sub-degree level we need training profiles at level 4, 3 and 2. Like the existing profile diversity has already shown too, the answer and decision of the "horizontal" profile structure of the ICT training profiles at each sub-degree qualification level is not easy. We need good reasons and an adequate curriculum approach for the decision of the right profile number and the delimitations of the profiles and their sets of qualifications. Without explaining the entire diversity of theories for curriculum approaches and profile development, these answers and decisions can basically either be more in reference to the subjects, scientific disciplines and technology areas or more in reference to a vocational pedagogic and education view or more in reference to the skill needs and contents of work areas. As shown by the current European ICT training profiles there is not only one single way to cover and meet the needs of the ICT work and to ideally provide ICT competences for different people. But mainly in regard to the mismatches and to improve the balance between the ICT employment

and the ICT vocational education and training systems the answer and decision for the curriculum and profile approach is clear, namely that the curricula and profile structure need to be designed in reference to the current and prospective skill needs of the ICT work areas. Of course, for all ICT training profiles and curricula the subjects or concrete business and technology contents require a didactic reflection of the appropriate range and depth of the skill needs and qualifications too.

The composition of the fourteen "Generic work area orientated ICT skills profiles" is already thought in this sense and especially their "horizontal and vertical" profile and level structure insofar is the relevant basis for the according curriculum decision of the profile numbers and the delimitations of the ICT training profiles between and at each sub-degree level (see chapter 3.3.2). Consequently the "horizontal and vertical" structure of the ICT training profiles and therefore the professional qualification profiles have to bear their primary reference in the fourteen "Generic work area orientated ICT skills profiles" respectively the current and prospective needed skills and contents of the ICT work at sub-degree levels. And in an open European sense without a preliminary curriculum decision of a national VET system the recommendation and appointment is:

- **the structure of the fourteen "Generic work area orientated ICT skills profiles" is the fundament of the framework for fourteen new European "Generic work area orientated ICT training profiles" at sub-degree levels with**
- **four ICT training profiles at level 2,**
- **four ICT training profiles at level 3 and**
- **six ICT training profiles at level 4 (see below).**

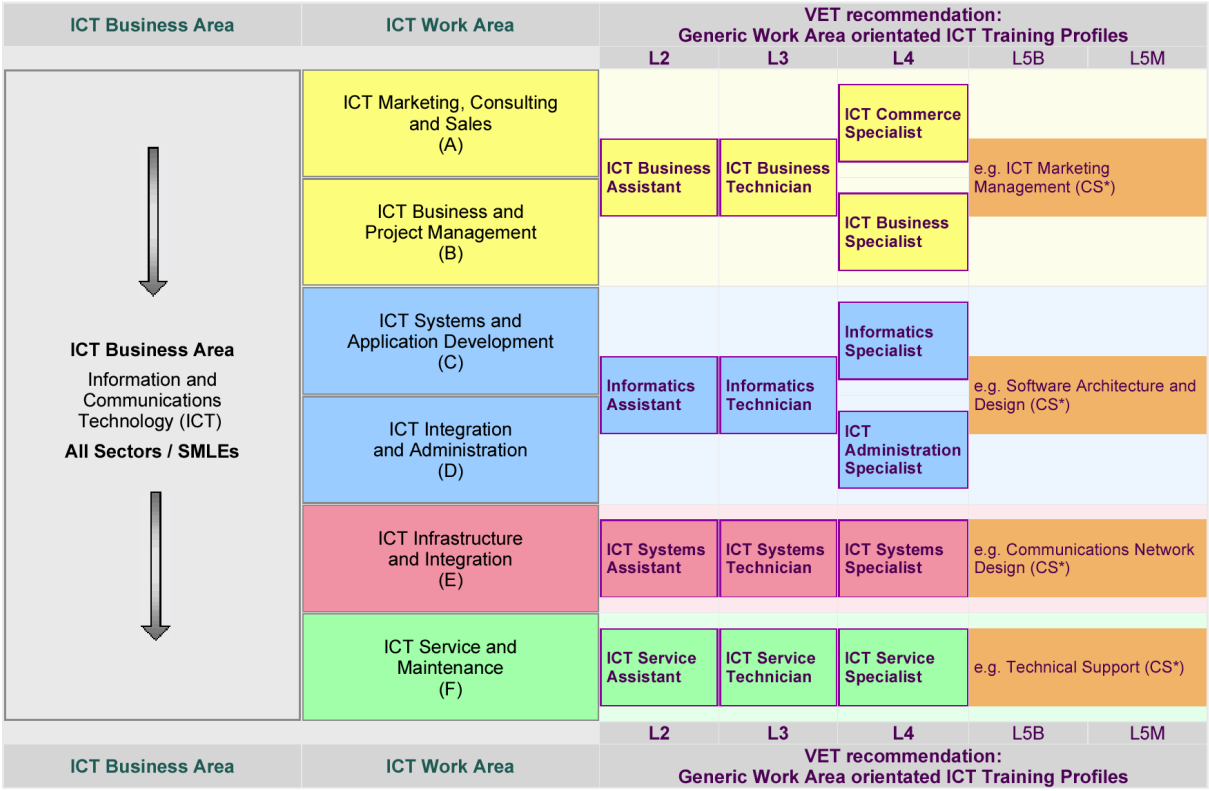


fig. 4-2: Structure of the fourteen "Generic work area orientated ICT training profiles" at sub-degree levels (* Generic ICT skills profiles examples at degree level of Career Space)

The appointment of the structure of these fourteen "Generic work area orientated ICT training profiles" is especially possible, because, by definition of a simple combined level framework as described above (see chapter 2.2), the work and training levels base on the same level structure (see also subsequent for the outcomes). Like the ICT skills profiles the number and structure of the ICT training profiles is insofar designed in strong reference to the skill structures and the ICT 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 all ICT training profiles at sub-degree levels is not very high. Another reason follows the new European basic principle of "lean occupation".

Otherwise especially the profiles and profile number at qualification level 2 need to be further explained because the complex work of the ICT business and technology areas neither directly show their need and demand nor have many people ICT training profiles at this level often in their mind. But the results of the industry's needs of ICT skills and practitioners indicate a need and demand at this skill and qualification level as well as does the existence of ICT training profiles at level 2 in European countries and their acceptance in the companies. In fact, the gleaned results also show that there is not a very high demand at this level. Nevertheless the appointment of the four ICT training profiles at level 2 belongs to the recommended profile framework as a whole.

In contrast the ICT training profiles and profile number and delimitation at qualification level 3 are more in evidence but, anyway, the number is not very high. The reason is like for all ICT training profiles that each profile in a first line is oriented to one or two work areas and a skill profile specific sample of work tasks and only in a second line the profile is linked to the concrete business and technology areas in their diversity. Therefore it is in general not difficult 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 is thinkable to define

- an "IT Systems Technician",
- a "CT Systems Technician",
- a "Network Technician" or
- an "ICT Bank Systems Technician" etc.

A further profile orientation is according to the overall structure of the ICT work areas a specialisation in which the profile structure is more oriented in detail at the work areas and the fields of activity. And as shown with the recommended structure and delimitation of the six ICT training profiles at level 4 this profile orientation correspondingly leads to a higher number of profiles. But and again in general and as shown by the results of the existing ICT training profile diversity in Europe the problem is not too few profiles rather than defining ICT training and qualification profiles with a clear structure broadly accepted by the industries. In this context especially the results of the company questionings indicate that the number of current ICT training profiles at all levels in the European countries is sufficient following the vast majority of companies e.g. in Germany, the Netherlands and Portugal (see figure). Only for sub-degree level 2 a certain number of companies state that other or new ICT training profiles are needed. These results are strongly linked to the company results of the needs and necessity of revising some current ICT training profiles. Thus, all results support the recom-

mended profile framework and especially the number and "horizontal and vertical" structure of the new fourteen European "Generic work area orientated ICT training profiles".

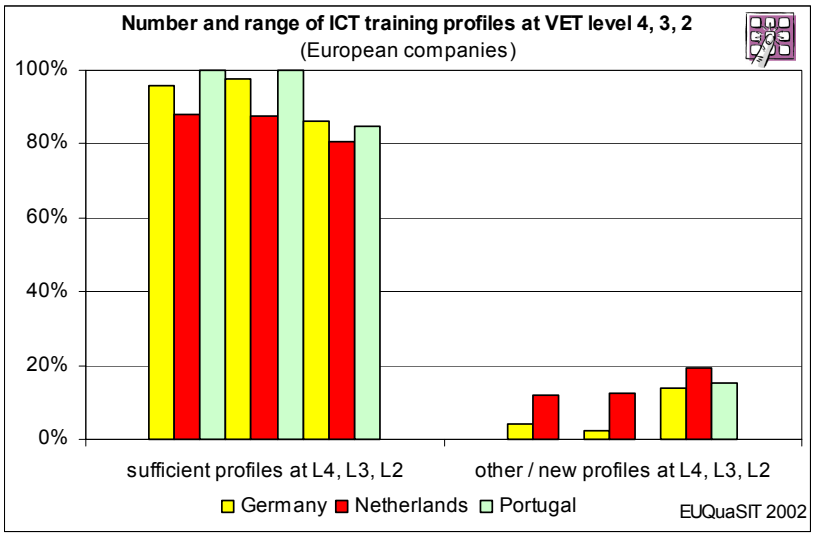


fig. 4-3: Company evaluation of numbers of the current ICT training profiles at level 4, 3 and 2 in European countries

In a next step the basis of the profile framework with a high equivalent and equation of the "Generic ICT skills profiles" and level structures is also important for all curriculum questions and at first in regard to the "Outcomes" in terms of the qualifications of each ICT training profile.

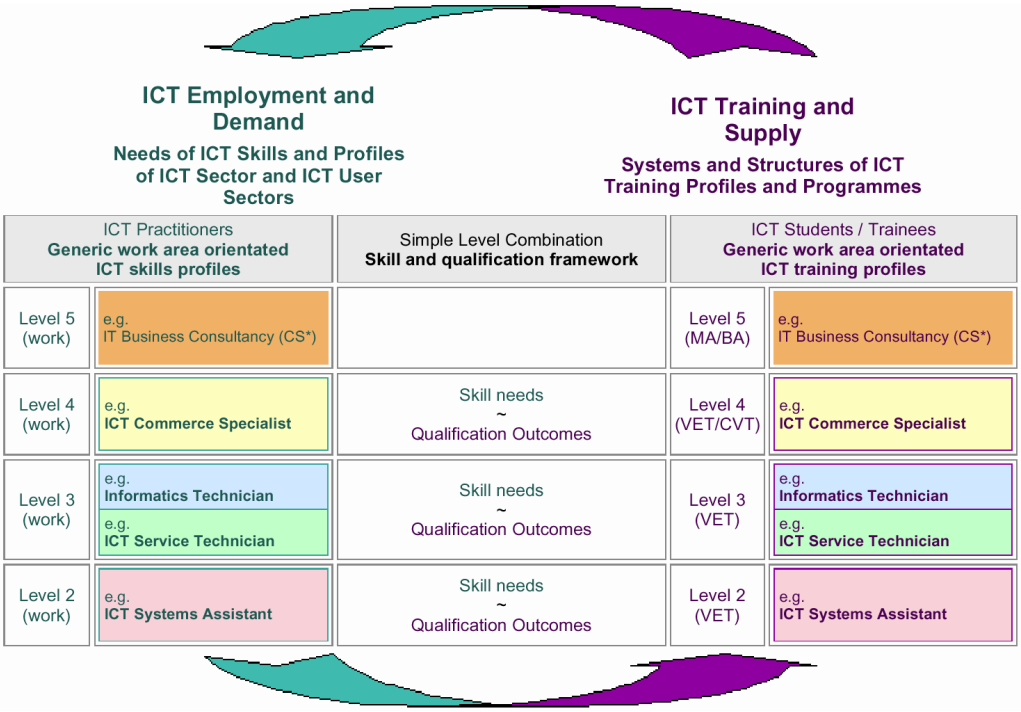


fig. 4-4: Level and profile framework with skill needs and qualification outcomes
(* Generic ICT skills profiles examples at degree level of Career Space)

Due to the change of perspective the skill needs as described and defined in each "Generic ICT skills profile" can be understood and described as the outcomes of each "Generic work area orientated ICT training profile" in terms of qualifications. Correspondingly the answer in general is:

- **the structures and contents of the skills of the "ICT skills profiles" are the fundament of the structures and contents of the qualifications as the "Outcomes" of the "ICT training profiles" (see above).**

In respect of these context and level and profile framework the gleaned structures and contents of the skill needs and all presented "Generic work area orientated ICT skills profiles" are relevant as outcomes and fundament of the ICT curriculum development and the VET programme respectively. As shown for the ICT skills profiles and the profiles at each level (to remember see examples below) the skill structure of all profiles is basically identical. The common skill structure shows three main skill fields, namely:

- **Behavioural and Personal Skills, Cross Section and Basic Work Skills, Soft and Method Skills,**
- **ICT Practitioner Skills (kernel work area orientated profile skills),**
- **Cross Work Area ICT Skills (complementary to kernel work area).**

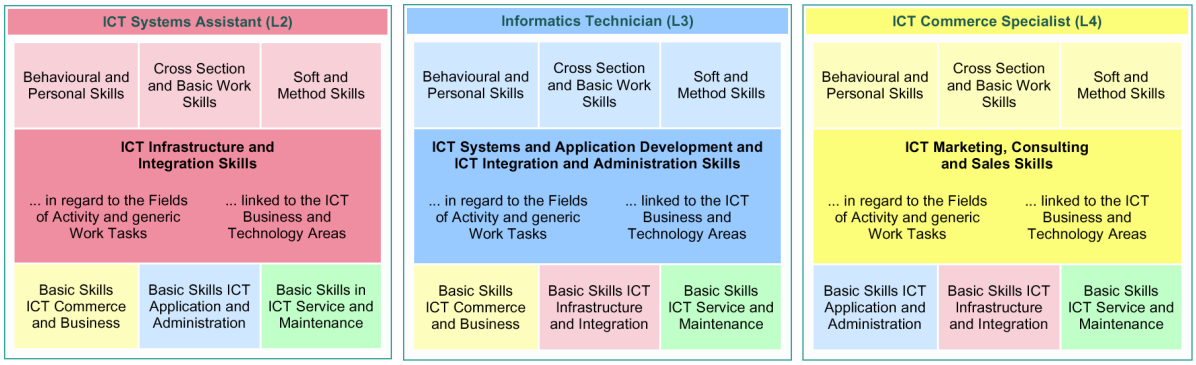


fig. 4-5: Identical skill structure of the generic work area orientated ICT skills profiles at sub-degree level

According to these identical structure and contents of the skills and therefore the qualification outcomes with their structure and contents of the ICT training profiles the basis of all ICT curriculum development can be described in a common curriculum model as a

- **qualification framework of "Work Area orientated ICT Curriculum" for all sub-degree levels.**

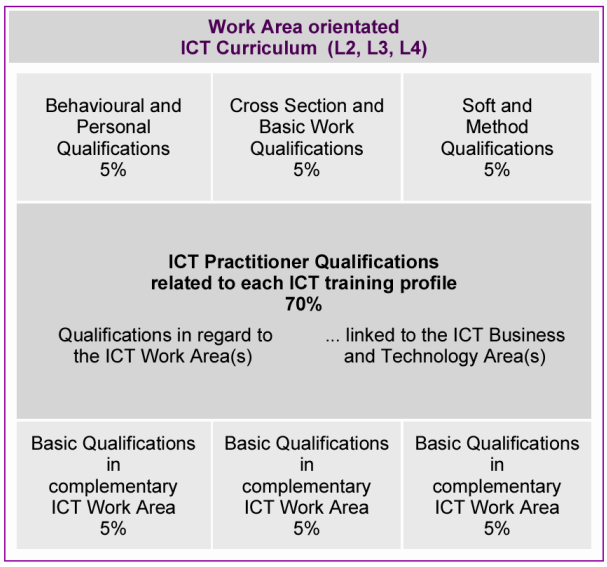


fig. 4-6: Qualification framework of the work area orientated ICT curriculum for all sub-degree levels

This curriculum model shows in strong reference to the skills and contents structure of the ICT skills profiles and the outcomes of the ICT training profiles a framework of three main qualification and content fields, that in breadth and depth of their qualifications depend on the level. Each qualification field shows further the qualification and content structure in detail, which includes by didactic reflection of the practitioner needs a recommendation of the (quantitative) curriculum extent, e.g. "ICT Practitioner Qualifications" cover 70% of the curriculum (see figure below).

The first qualification field of the ICT curriculum covers

- **Behavioural and Personal Qualifications (~5%):**

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);

- **Cross Section and Basic Work Qualifications (~5%):**

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 Qualifications (~5%):**

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 only at this level show a common structure. For instance this structure is not the direct fundament to design courses or learning processes. Especially the behavioural and personal qualifications or the cross section and basic work qualifications should and can not be taught in isolation of the other qualifications e.g. the next qualification field. For example, motivation and commitment or the self learning competence can not be taught without contents and depends 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, for instance, to business and technology contents. All soft and method qualifications like 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 orientated profile qualifications. That 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 fourteen "Generic work area orientated ICT skills profiles"). For example, for the "Informatics Specialist" at level 4 all ICT qualifications allow to work in all fields of activity and to carry out the work tasks at level 4 of the ICT work area "ICT Systems

and Application Development". Very important for the structure and contents of these ICT professional qualifications is therefore their regard to the work areas or in detail to the work processes, phases of activity and work tasks and their link to the ICT business and technology areas.

The last qualification and content field

- **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", beside the ICT professional qualifications, must also have, for instance, 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 ICT business and work processes as a whole. This not only supports team work but is also a certain precondition for qualified work in a specific work area like service and maintenance.

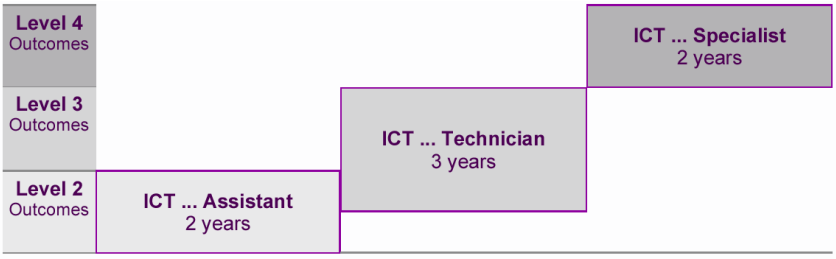
The model of "Work Area orientated ICT Curriculum" with these three main qualification fields is the common basis of the following guidelines for the development of new ICT curricula at sub-degree levels.

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

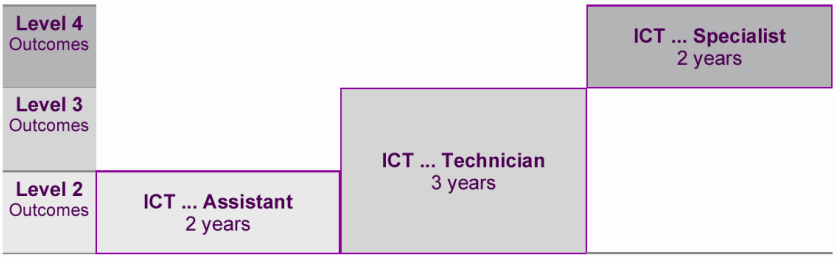
Guidelines for the development of curricula normally and first of all need to say for which learning institution or place, learning and qualifying concept and for which profile and qualification level, subject or course the curriculum is concretely intended. The recommendation and appointment of the fourteen "Generic work area orientated ICT training profiles" and their profile and level structure insofar is one of the first relevant decisions. Also very important for the development of curricula is the definition of the outcomes of the ICT training profiles. But apart from all these decisions it is basically open in which learning institution and place or based on which learning way and qualification concept the qualification outcomes can concretely be achieved. 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 like for instance only school or work based training, apprenticeship concepts etc.

In respect of the qualification outcomes and level structure of the fourteen "Generic work area orientated ICT training profiles" it is one recommendation of the curriculum guidelines to define a corresponding structure of ICT vocational training programmes by specifying the duration as indicated in the following models.

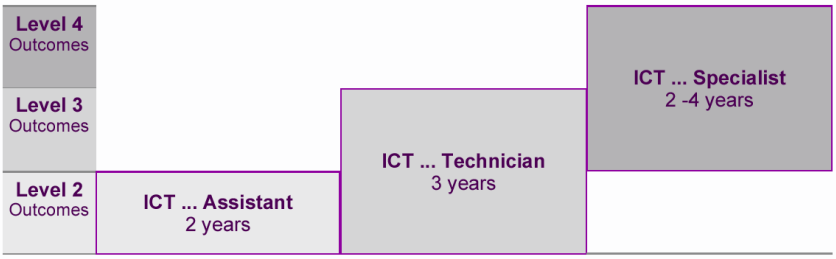
These models show a hierarchical structure and combination of 2 and 3 years ICT vocational training programmes with a more or less open learning organisation and different options of mutual recognition of certificates or examinations. Questions of entry requirements and valuing non-formal prior learning insofar are also more or less open and depend on the chosen model and the further curriculum recommendations.



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

fig. 4-7: Feasible models for the structure and duration of ICT vocational training programmes

The curricula in terms of the 2 or 3 years training programmes need a structure and definition of learning units which are here recommended and defined as "Work area orientated ICT learning modules". This name and construct have been chosen because the qualifications and contents of each learning unit orients to the description and justification of the work areas and 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 of valuing the ICT vocational training programmes in terms of credit points (CP):

Sets of "Work area orientated 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 orientated 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 and specific for the ICT Assistant curricula at level 2, the ICT Technician curricula at level 3 and the ICT Specialist curricula at level 4 recommended as follows:

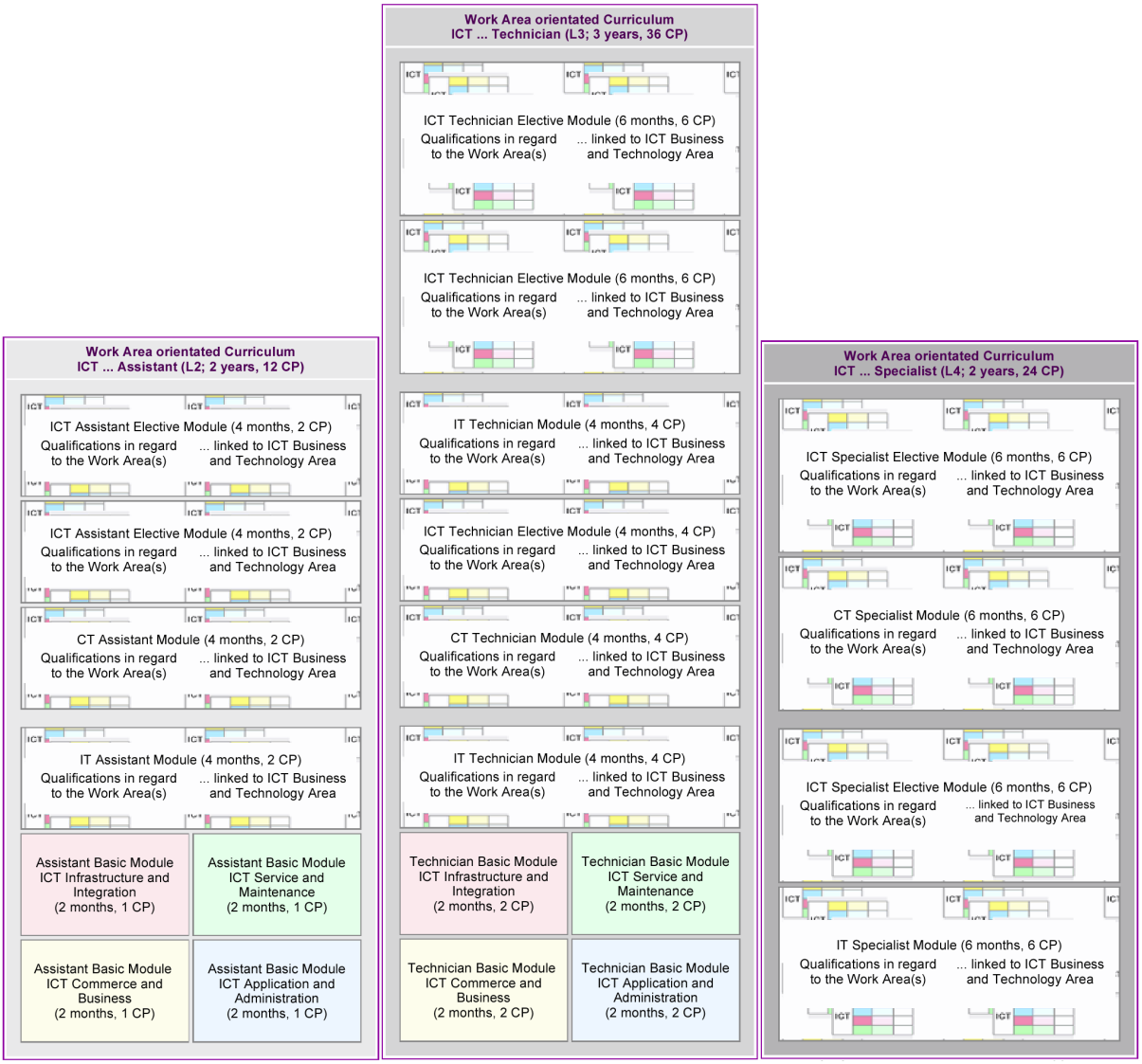
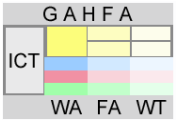
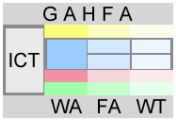
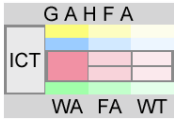
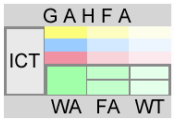


fig. 4-8: ICT Assistant, Technician and Specialist curricula with set of work area orientated learning modules

The didactic concept of the curricula for the ICT Assistants and the ICT Technicians is more or less similar insofar 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 orientated learning module of "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" to progressively get an overview with basic qualifications and knowledge on all ICT work areas. These "Basic Modules" therefore provide a work and subject orientated fundament for the acquisition of the formative ICT professional qualifications and include at the same time integrated basic qualifications like behavioural and personal competences. The duration of each "Basic Module" is assessed with 2 months and the value of each "Assistant Basic Module" is 1 credit point (CP) and of each "Technician Basic Module" 2 credit points (CP).

All the following "Assistants", "Technicians" and in the same way now all "Specialists" modules have an identical structure and the contents of each set depends in a first line 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 and further - of course - on the profile level. For example, the

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)	

In a second line each work area orientated module considers within the fields of activity and generic work tasks at the same time qualifications and contents linked to one specific business and technology area which can be extracted from the wide business area of information and communications technology (ICT). Whereas two and for the "Technicians" three modules of these sets are mandatory "ICT Modules" linked to the two overall and main business and technology areas "Information Systems, Applications and Services" (IT) and "(Tele-)Communications Systems, Applications and Services" (CT) the other modules 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 below, e.g. Sector-specific ICT Solutions, Internet and E-commerce Applications and Administration or Networks Systems and Solutions.

ICT Business Areas:
Information and Communications Technology (ICT)

Main Areas:

- Information Systems, Applications and Services (IT)
  (PCs/Desktops, workstations, notebooks, monitors, storages, print and copy systems, IT accessories, servers, cluster, middleware, mainframes, networks, systems software, development tools, web server, operating systems, open source solutions, sector applications, office applications, individual solutions, GIS, web services etc.)
- Communications Systems, Applications and Services (CT)
  (analogue and digital systems, fixed and wireless networks, CT server, mobile systems, UMTS, fax, VoIP, GPS etc.)

Specific Areas:

- Sector-specific ICT Solutions (financial and banking services, transport and logistics, health and medicine, public administration, wholesale trade, hotel and catering industry etc.)
- Internet and Intranet Systems and Applications (web design, connection / lines, service providing and monitoring, server hosting etc.)
- E-business and E-commerce Applications (e-shops, B2B, B2C, e-government etc.)
- Data Management and Database Solutions (process databases, production data, backup and recovery systems, (OO/R).D.B.M.S., internet applications etc.)
- Networks Systems and Solutions (switching, routing, operating software, printing, LAN, WLAN, SAN, WAN, ATM, ISDN, satellite etc.)
- ICT Security Solutions (antivirus, firewalls, VPN, facility management etc.)
- Business (Process) Systems and Applications (document and knowledge management, project management, CRM, ERP, SCM etc.)
- Industrial IT Systems (industrial and process automation, industrial communications, measurement, CAD etc.)
- Embedded Systems and Control (diagnostics, monitoring, communications etc.)
- Multimedia Systems and Applications (video, audio, simulations, animations, e-learning platforms, digital imaging etc.)
- Consumer and Entertainment Electronics (computer games, (H)DTV, event technology etc.)
- ICT Training Solutions (customer seminars, e-learning, blended learning etc.)
- ...

All Sectors / SMLEs

fig. 4-9: 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:

1. the business and technology areas covered by and available in a company or training institution (Keyword: Feasibility) and
2. a certain distinction and complementation to the two main business and technology areas IT and CT (Keyword: Diversity).

The mandatory and elective "ICT Modules" in each training programme complete and cover especially the "kernel" ICT professional qualifications and include - as all modules - at the same time integrated basic qualifications e.g. behavioural, cross section and method competences. And - as indicated above - the guidelines particular for the ICT Technician and Specialist curricula furthermore foresee an open number of so-entitled "ICT Add-on Modules" that are additionally supposed to cover specific qualifications within the training programmes, e.g. specific product, technology or field of activity ICT qualifications.

Regarding the duration of the ICT practitioner modules those for the ICT Assistant and most of the ICT Technician curricula have 4 months. Two elective modules of the ICT Technician curricula and all modules of the ICT Specialist curricula have a duration of 6 months training. The value in a range from 2 credit points to 6 credit points of each of these modules depends 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 the figures above and below the total value of all curricula at level 2 is 12 credit points, at level 3 36 credit points and at level 4 24 credit points.

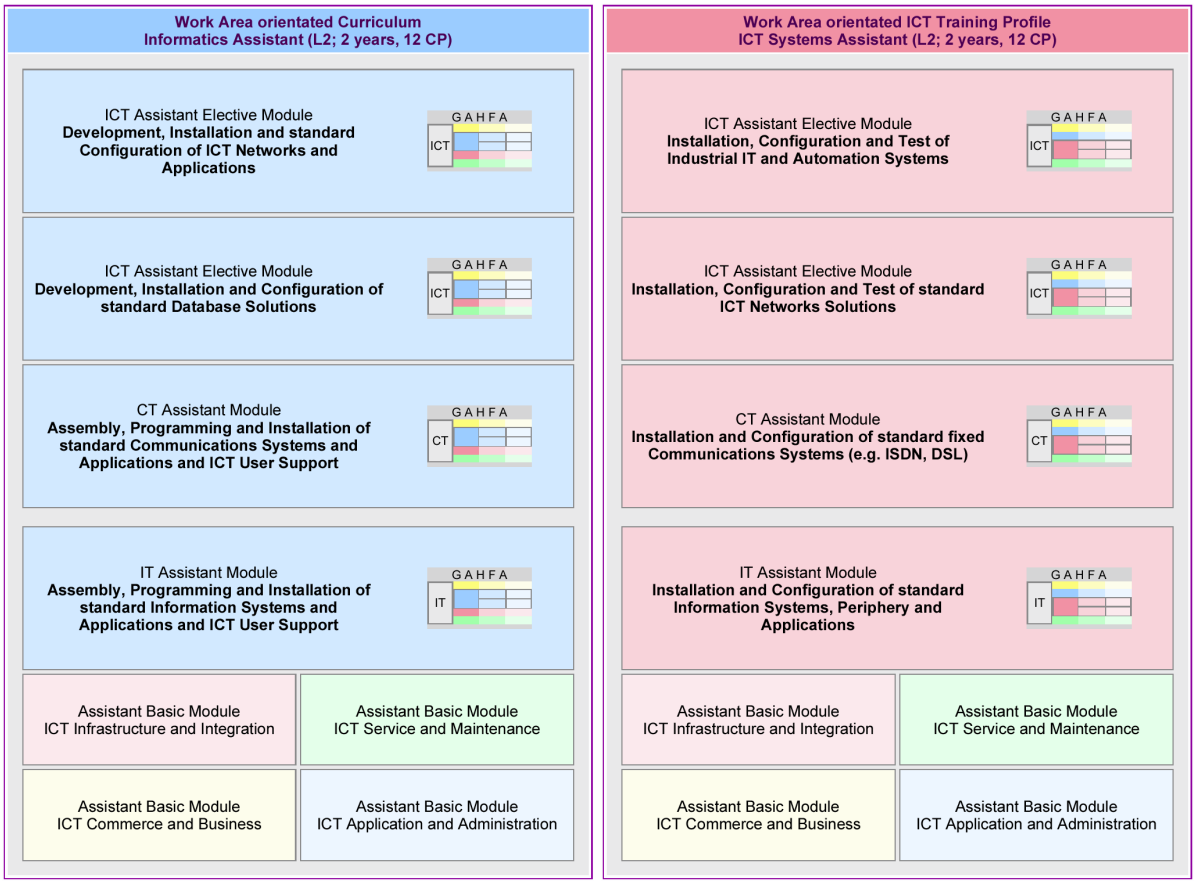


fig. 4-10: Informatics Assistant and ICT Systems Assistant curriculum at level 2

By using these curriculum guidelines the following six examples show the possibilities to concretise and develop the curricula in reference to the fourteen ICT training profiles at sub-degree levels. The choice of the six examples covers ICT training profiles at all levels and for all generic ICT work areas, beginning with two ICT curricula at level 2 shown above.

The following figures each show ICT curriculum examples at level 3 and 4:

Work Area orientated Curriculum
Informatics Technician (L3; 3 years, 36 CP)

ICT Technician Elective Module
Development, Integration and Administration of Business (Process) Systems and Applications (e.g. CRM, ERP)
G A H F A ICT

ICT Technician Elective Module
Creation, Development, Test and Integration of Database Applications
G A H F A ICT

IT Technician Module
Development, Integration and Administration of networked Information Systems and Applications
G A H F A IT

ICT Technician Elective Module
Design, Development and Administration of E-commerce Solutions
G A H F A ICT

CT Technician Module
Development, Test, Integration and Administration of Communications Systems and Applications
G A H F A CT

IT Technician Module
Development, Test, Integration and Administration of Information Systems and Applications
G A H F A IT

Technician Basic Module
ICT Infrastructure and Integration

Technician Basic Module
ICT Service and Maintenance

Technician Basic Module
ICT Commerce and Business

Technician Basic Module
ICT Application and Administration

Work Area orientated Curriculum
ICT Service Technician Technician (L3; 3 years, 36 CP)

ICT Technician Elective Module
Preparation, Diagnosis and Repairing of wireless Communications Networks and Applications (e.g. GRPS, UMTS)
G A H F A ICT

ICT Technician Elective Module
Evaluation, Upgrading and Documentation of Software
G A H F A ICT

IT Technician Module
Diagnosis, Upgrading and Administration of integrated ICT Network Solutions (e.g. LAN, ATM)
G A H F A IT

ICT Technician Elective Module
Service, Optimisation and User Instruction of Database Systems and Applications
G A H F A ICT

CT Technician Module
Service, Upgrading, Troubleshooting and Maintenance of Communications Systems and Applications (e.g. CT Server System)
G A H F A CT

IT Technician Module
Service, Upgrading, Troubleshooting and Maintenance of Information Systems, Periphery and Applications
G A H F A IT

Technician Basic Module
ICT Infrastructure and Integration

Technician Basic Module
ICT Service and Maintenance

Technician Basic Module
ICT Commerce and Business

Technician Basic Module
ICT Application and Administration

Work Area orientated Curriculum
ICT Commerce Specialist (L4; 2 years, 24 CP)

ICT Specialist Elective Module
Development, Marketing, Implementation and Evaluation of innovative, blended ICT Training Concepts and Solutions
G A H F A ICT

CT Specialist Module
Management and Organisation of the Marketing, Consulting and Sales Activities of specific Communications Systems and Applications
G A H F A CT

ICT Specialist Elective Module
Advice and Support of tailored ICT Security Solutions for complex Networks Systems
G A H F A ICT

IT Specialist Module
Management and Organisation of the Marketing, Consulting and Sales Activities of specific Information Systems and Applications
G A H F A IT

Work Area orientated Curriculum
Informatics Specialist (L4; 2 years, 24 CP)

ICT Technician Elective Module
Design, Development, Configuration and Test of individual Database Solutions (e.g. with Java, OODBMS)
G A H F A ICT

CT Specialist Module
Design, Conception, Implementation and Test of high-end integrated Communications Systems and Applications
G A H F A CT

ICT Specialist Elective Module
Design, Conception, Development and Test of integrative Multimedia Applications
G A H F A ICT

IT Specialist Module
Design, Conception, Implementation and Test of high-end Information Systems and Applications
G A H F A IT

fig. 4-11: ICT curricula at level 3 and 4

In addition to this choice of the six curriculum examples the following tables summarises the complete and assigned structure of all fourteen "Generic work area orientated ICT training profiles" in the corresponding work area(s) with their curriculum and module sets at sub-degree levels in a slightly shorter form:

ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		
		L2	L3	L4
ICT Business Area Work and Skills linked ... ▪ 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)	**ICT Business Assistant** **ICT Assistant Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Assistant Modules:** ▪ Supporting and Assistance of the IT Business and Project Management ▪ Supporting the Promotion, Sales and Consulting of Customers and End-Users of standard Communications Solutions **ICT Assistant Elective Modules:** ▪ Contribution to the Promotion, Quotation, Contracting and Support of Customers for standard Software Applications ▪ Contribution to the Purchasing, Provision and Billing of standard ICT Networks Solution ▪ Advice, Development and Provision of standard Web Pages ▪ ...	**ICT Business Technician** **ICT Technician Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Technician Modules:** ▪ Marketing, Consulting and Sales of standard Information Systems and Applications ▪ Supporting and Conducting the Development and Integration Process of Communications and Networks Systems and Applications ▪ Supporting, Coordinating and Finalising the Development and Integration Process of Information and Database Systems and Applications **ICT Technician Elective Module:** ▪ Marketing, Promotion and Quotation of individual Software and sector-specific Applications ▪ Accompanying the Development Process of Internet and E-business Applications ▪ Organisation and Optimisation of Customer Support and ICT Training Measures ▪ Consulting Customers and Users on Business (Process) Systems and Applications (e.g. CRM, ERP) ▪ ... **ICT Technician Add-on Modules:** ▪ Mobile Systems and Services ▪ Data Protection Solutions ▪ ...	**ICT Commerce Specialist (L4)** **ICT Specialist Modules:** ▪ Management and Organisation of the Marketing, Consulting and Sales Activities of specific Information Systems and Applications ▪ Management and Organisation of the Marketing, Consulting and Sales Activities of specific Communications Systems and Applications **ICT Specialist Elective Module:** ▪ Advice and Support of tailored ICT Security Solutions for complex Networks Systems ▪ Development, Marketing, Implementation and Evaluation of innovative, blended ICT Training Concepts and Solutions ▪ Conception, Consulting and Coordination of ICT / E-Legislation and Government Strategies ▪ ... **ICT Specialist Add-on Modules:** ▪ Call Centre Solutions ▪ e-Marketing and e-sales Strategies ▪ ...
	ICT Business and Project Management (B)			**ICT Business Specialist (L4)** **ICT Specialist Modules:** ▪ Process Coordination, Purchasing and Provision of Information and Database Systems and Applications ▪ Process Management, Support and Provision of complex Communications Systems and Applications **ICT Specialist Elective Module:** ▪ Management, Control and Optimisation of the Development Process of new ICT Consumer Products (e.g. Computer Game) ▪ Coordination, Support, Purchasing and Provision of ICT Security Solutions ▪ Development and Implementation of effective Quality Management Concepts ▪ ... **ICT Specialist Add-on Modules:** ▪ Human Resources Management ▪ ICT Business and Project Controlling ▪ ICT Product and Software Evaluation ▪ ...
	ICT Systems and Application Development			
	ICT Integration and Administration			
	ICT Infrastructure and Integration			
	ICT Service and Maintenance			
		L2	L3	L4
ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		

fig. 4-12: Structure of the more economic technical oriented "Generic work area orientated ICT training profiles" with their curricula and module sets at sub-degree levels

ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		
		L2	L3	L4
	ICT Marketing, Consulting and Sales			
	ICT Business and Project Management			
ICT Business Area 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 Systems and Application Development** (C)	**Informatics Assistant** **ICT Assistant Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Assistant Modules:** ▪ Assembly, Programming and Installation of standard Information Systems and Applications and ICT User Support ▪ Assembly, Programming and Installation of standard Communications Systems and Applications and ICT User Support **ICT Assistant Elective Modules:** ▪ Development, Installation and Configuration of standard Database Solutions ▪ Development, Installation and standard Configuration of ICT Networks and Applications ▪ Development of standard Web and Multimedia Applications ▪ ...	**Informatics Technician** **ICT Technician Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Technician Modules:** ▪ Development, Test, Integration and Administration of Information Systems and Applications ▪ Development, Test, Integration and Administration of Communications Systems and Applications ▪ Development, Integration and Administration of networked Information Systems and Applications **ICT Technician Elective Module:** ▪ Creation, Development, Test and Integration of Database Applications ▪ Design, Development and Administration of E-commerce Solutions ▪ Development, Integration and Administration of Business (Process) Systems and Applications (e.g. CRM, ERP) ▪ ... **ICT Technician Add-on Modules:** ▪ Multimedia Solutions ▪ Industrial IT Systems and Applications ▪ Vendor specific: Sun Certified Java Programmer, MCDBA, MCAD, MCSA, OCA, SUSE System Administration, CCEA, IBM e-business Solution Technologist ▪ ...	**Informatics Specialist (L4)** **ICT Specialist Modules:** ▪ Design, Conception, Implementation and Test of high-end Information Systems and Applications ▪ Design, Conception, Implementation and Test of high-end integrated Communications Systems and Applications **ICT Specialist Elective Module:** ▪ Design, Conception, Development and Test of integrative Multimedia Applications ▪ Design, Development, Configuration and Test of individual Database Solutions (e.g. with Java, OODBMS) ▪ Conception and Administration of customer-specific Internet and e-commerce Solutions ▪ ... **ICT Specialist Add-on Modules:** ▪ GUI Design ▪ GIS and e-logistic Solutions ▪ Configuration and Test Coordination ▪ Vendor specific: MCSD, Sun Certified Java Developer ▪ ...
	ICT Integration and Administration (D)			**ICT Administration Specialist (L4)** **Specialist Learning Modules:** ▪ Management, Integration, Configuration and Administration of Information Systems and Applications ▪ Management, Setup, Administration and Support of integrated Communications Systems and Applications **ICT Specialist Elective Module:** ▪ Deployment, Optimisation and Administration of complex E-business Applications ▪ Implementation, Configuration, Administration and Support of specific Database Management Systems ▪ Optimisation and Support of sophisticated Multimedia and Internet Solutions ▪ ... **ICT Specialist Add-on Modules:** ▪ ICT Training Management ▪ Business Systems Administration ▪ Vendor specific: CCA, CCEA, Certified Solaris Administrator, ICIS ▪ ...
	ICT Infrastructure and Integration			
	ICT Service and Maintenance			
		L2	L3	L4
ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		

fig. 4-13: More informatics / communications technical oriented "Generic work area orientated ICT training profiles" with curricula and module sets at sub-degree levels

ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		
		L2	L3	L4
ICT Business Area 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)	**ICT Systems Assistant** **ICT Assistant Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Assistant Modules:** ▪ Installation and Configuration of standard Information Systems, Periphery and Applications ▪ Installation and Configuration of standard fixed Communications Systems (e.g. ISDN, DSL) **ICT Assistant Elective Modules:** ▪ Installation, Configuration and Test of standard ICT Networks Solutions ▪ Installation, Configuration and Test of Industrial IT and Automation Systems ▪ Assembly and Installation of PC-Systems, Periphery and Connections ▪ ...	**ICT Systems Technician** **ICT Technician Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Technician Modules:** ▪ Planning, Installation, Configuration and Test of complete Information Systems, Periphery and Applications ▪ Planning, Installation, Configuration and Test of complete fixed Communications Systems and Applications (e.g. ISDN, DSL, CT Server) ▪ Planning, Installation, Configuration and Deployment of tailored ICT Networks Solutions (LAN, ATM etc.) **ICT Technician Elective Module:** ▪ Planning, Installation and Integration of ICT Security Solutions ▪ Planning, Installation and Commissioning of Digital Print and Copy Systems ▪ Assembly, Configuration and Deployment of internet-based Communications Systems (VoIP, IP Telephony) ▪ Migration or Up-grading of ICT Systems and Networks Solutions ▪ ... **ICT Technician Add-on Modules:** ▪ Database Integration ▪ Audio and Video Systems ▪ Mobile ICT Systems ▪ Vendor specific: CCP, CCSP, CCDP, CCNP, MCSE ▪ ...	**ICT Systems Specialist** **ICT Specialist Modules:** ▪ Strategic Planning, Engineering and Configuration of high-end Information Systems and individual Applications ▪ Strategic Planning, Presentation, Implementation, Test and Roll out of Communications Infrastructure and Systems (e.g. IP-based System, CTI, Wireless Infrastructure) **ICT Specialist Elective Module:** ▪ Conception, Installation, Deployment and Optimisation of an integrated business ICT Network Solution (LAN, ATM) ▪ Creation, Assembly, Test and Optimisation of integrated Industrial IT Systems including Remote Control and Visualisation ▪ Conception and Management of ICT Security Solutions, e.g. for e-business processes ▪ ... **ICT Specialist Add-on Modules:** ▪ Technical Documentation ▪ Device Design ▪ Vendor specific: MCSE, CCIE, CCIE Voice, ACS, 3Com Certified Solutions Expert ▪ ...
	ICT Service and Maintenance			
		L2	L3	L4
ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		

ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		
		L2	L3	L4
ICT Business Area 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)	**ICT Service Assistant** **ICT Assistant Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Assistant Modules:** ▪ Standard Service, Repairing and Maintenance of PC-Systems, Periphery and Applications ▪ Standard Service, Repairing and Maintenance of fixed Communications Systems and Applications (e.g. ISDN, DSL) **ICT Assistant Elective Modules:** ▪ Service, Upgrading and standard Configuration of ICT Networks Solutions ▪ Service and Maintenance of Digital Print and Copy Systems ▪ Service, Upgrading and Documentation of Office and Communications Systems ▪ ...	**ICT Service Technician** **ICT Technician Basic Modules:** ▪ ICT Commerce and Business ▪ ICT Application and Administration ▪ ICT Infrastructure and Integration ▪ ICT Service and Maintenance **ICT Technician Modules:** ▪ Service, Upgrading, Troubleshooting and Maintenance of Information Systems, Periphery and Applications ▪ Service, Upgrading, Troubleshooting and Maintenance of Communications Systems and Applications (e.g. CT Server System) ▪ Diagnosis, Upgrading and Administration of integrated business ICT Network Solutions (e.g. LAN, ATM) **ICT Technician Elective Module:** ▪ Service, Optimisation and User Instruction of Database Systems and Applications ▪ Evaluation, Upgrading and Documentation of Software ▪ Preparation, Diagnosis and Repairing of fixed / wireless Communications Network and Applications (e.g. ATM, UMTS) ▪ ... **ICT Technician Add-on Modules:** ▪ Digital Print Systems Service ▪ ICT Security Systems Service ▪ ...	**ICT Service Specialist** **ICT Specialist Modules:** ▪ Analysis, Management and Optimisation of IT Service and Maintenance Quality Assurance ▪ Consulting, Improving and Management of Communications Systems Escalation and Maintenance Plans **ICT Specialist Elective Module:** ▪ Analysis, Extension and Optimisation of complex ICT Network Solutions (LAN, ATM) ▪ Benchmarking and effective Improvement of the Helpdesk and Support for Mobile Communications Services ▪ Planning, Implementation and Evaluation of Training Measures for ICT Service Technicians and Assistants ▪ ... **ICT Specialist Add-on Modules:** ▪ Service Software Evaluation and Up-grading ▪ ICT Systems and Data Recovery ▪ Vendor specific: CNA ▪ ...
		L2	L3	L4
ICT Business Area	ICT Work Area	VET curriculum recommendation: Generic Work Area orientated ICT Training Profiles and Curricula at sub-degree levels		

fig. 4-14: Technical informatics oriented "Generic work area orientated ICT training profiles" and curricula

With these curriculum recommendations for the fourteen "Generic work area orientated ICT training profiles" at vocational sub-degree levels and their module sets the curriculum development guidelines have now been described to a certain extent. The achieved stage can be understood as a framework and fundament for the development of new European ICT training profiles and curricula at sub-degree vocational levels. The elaboration of the learning modules is one of the important further steps. But, however, certainly the results like the number and structure of the new ICT training profiles and the recommended sets of learning modules still need to be accepted before in the course of a broad European discussion. Also important in this context and especially from the acceptance point of view are the next recommendations with regard to specific aspects like entry requirements, assessment and certification, qualifying processes and designing courses.

4.4 Recommendations for specific aspects like outcomes definitions, entry requirements, assessment and certification, quality control, qualifying processes and designing courses

Outcomes definitions

The aim and output of the ICT vocational education process is a skilled worker with sub-degree ICT qualifications and certain abilities that qualify him or her to work in ICT work areas and different fields of activity and to professionally carry out the needed range of ICT work tasks. As shown by the ICT training profiles and curriculum development guidelines the qualification levels and profiles should be relevant for the different ICT work area and labour market requirements. Insofar the sub-degree ICT qualifications and the structure and definitions of the fourteen ICT training profiles are already described with their qualifications and contents structure and in the sense of outcomes definitions in strong reference to the needed skills and profiles within the ICT and user sectors (see chapter 4.2).

Correspondingly, the outcomes as sets of qualifications defined by the generic work area orientated ICT skills profiles and required to exercise ICT work at sub-degree levels are, on the one hand, the basis for developing the curricula of ICT training profiles, rather than e.g. a knowledge list of subjects, scientific disciplines and technology areas. To continuously adjust and keep the outcomes and therefore the curricula up-to-date in order to increase the employability of the skilled ICT workers on an on-going basis, the ICT skill needs within the ICT and user sectors should be evaluated also continuously e.g. through questionings and company case studies. The understanding of curriculum development therefore is an ongoing process. On the other hand the outcomes of the curricula have to be defined precisely and in detail regarding each curriculum and for instance concrete for the modules as the relevant basis for further questions like the entry requirements, assessment and certification etc. For example the qualifications and contents structure of the defined outcomes of an "Informatics Technician" at level 3 can commonly described as follows:

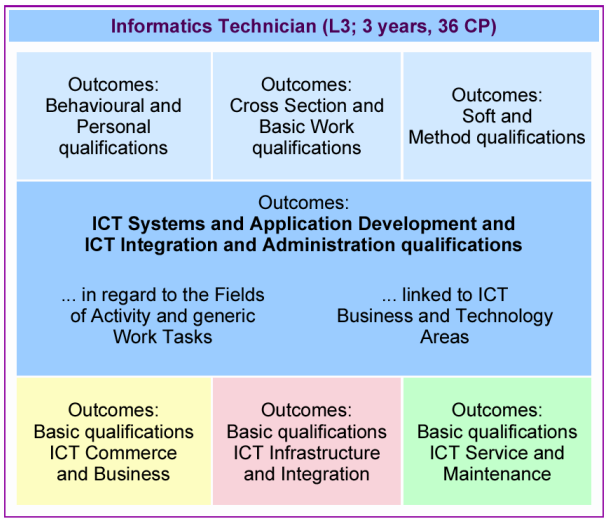


fig. 4-15: Qualifications and contents structure of defined outcomes of the "Informatics Technician" at sub-degree level 3

Concrete for one learning module of the "Informatics Technician" the curriculum with defined outcomes looks as follows:

fig. 4-16: Defined outcomes of one work area orientated ICT Technician elective module

The outcomes of the ICT training profiles at sub-degree level 2, 3 and 4 in combination with the duration of the according ICT vocational training programme are one fundament to set 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 chapter 4.3). The process of the vocational education and training normally starts at sub-degree level 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.

Assessment and certification

Other possibilities of entry and intergradation in this context can be basically open by using the recommendations of valuing and assessment as well as corresponding certification of the ICT training profiles and modules outcomes. As recommended the 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 chapter 4.3). With certificates of the profiles and modules according to the credit points and based on examinations there are various options of mutual recognition, which can be utilised between and for each profile and outcomes level respectively, as well as to set up individual entry requirements. For example the certificate proofing the ICT Assistant outcomes can be recognised with 12 CP for profiles at level 3 or the certificate of the ICT Technician outcomes can be recognised with 36 CP for the profiles at level 4. Especially and this marks a new intergradation between the sub-degree and degree level the certificate of the ICT Specialist outcomes (which include the 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 like valuing non-formal prior learning by external exam or product and vendor specific certifications in the broad ICT business areas are also possible more effectively on an outcomes basis in comparison to the proper ICT training profiles and modules outcomes. With orientation at 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 only a choice of the product and vendor specific ICT certifications diversity:

Exemplary Choice of Product and Vendor specific ICT Certifications

- **Information Systems, Applications and Services** e.g.:
  Compaq: ACT - Accreditated Compaq Technical, ASE - Accreditated 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+

In the sense of all feasibilities of mutual recognition it needs to be underlined too, that the work area orientated ICT profiles and curricula strictly focus on outcomes and that these outcomes have a clearly defined sub-degree level. The outcomes are therefore not only the basis of the recommendation and appointment of the ICT profiles and curricula and the mutual recognitions but furthermore of all processes of quality control like the qualifying and examination processes or the design of courses and last but not least the curriculum evaluation as a whole too.

Qualifying processes

The ICT curricula as proposed in the context of the guidelines described the vocational education process with a structure and sequence of modules which can be understood as the content fundament to design the qualifying and examination processes and courses. Whereas in the European countries ICT curricula at degree level are normally directly focussed on higher education processes of universities, the ICT curricula at sub-degree level in regard to learning

or training places and concepts are more or less open and stronger depend on the vocational education system. Recommendations for designing qualifying processes and courses insofar have to consider the possibilities of the different institutions and qualifying concepts like 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 structure of modules can be the fundament for different learning places and qualifying concepts there is only one recommendation to be given in general:

- **without a preliminary provision of one European qualifying concept the qualifying processes should be like the curricula and modules itself based on a work orientated didactic concept with a mix or combination of theoretical and practical training.**

The experience shows that exclusively subject or theory orientated concepts do not really meet the ICT skill needs. Also only practical training is surely not enough to understand the complex ICT business and work processes and to exercise ICT work tasks in a professional way. Training concepts like the Apprenticeships (e.g. in Germany, 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.

Course design

For the design of courses the ICT curricula and their structure of modules provide also a didactic orientation and thus the course design recommendation has the same alignment. Theory or practice courses should be organised on a work orientated didactic concept and not in subject structures like "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 work and therefore problem orientated. That means, the sequences and skill needs in regard to the fields of activity and work tasks of the ICT work processes are the orientation and basis to reflect the content structure and method and also the media for designing courses and the learning processes. To carry out the courses and moderate the learning processes in this didactical sense one implication and relevant condition is that the teachers and trainers must have certain experience, qualifications and knowledge of the ICT work processes. But, however, this is perhaps one of the biggest problems in all ICT training areas and one reason why many other traditional concepts are more common and wide spread.

Quality control and evaluation process

For the VET programmes based on each specific qualifying concept and course design decision the training institutions ought to set up a quality control and evaluation process. The gleaned results and information can be used for the further improvement of the ICT curricula and programmes and the qualifying and course concepts. In addition to the evaluation results the examination process results can be used too, because the results of exams not only evaluate the trainees' achievements but also the curriculum and qualifying concepts. In the context of the quality control and evaluation process it is also important to get feedback from industry and the trainees which finished the VET programmes by assessing the new work area orientated ICT qualifications and evaluating of how well the ICT training profiles and programmes matched the outcome objectives and the required knowledge and skills for the job. For exam-

ple and as partly shown by the results of the European questioning concerning the existing ICT training profiles and programmes within the scope of the EUQuaSIT project described in this report, first evaluation experience can be used on how to shape the quality control and evaluation process in the described direction.

5 Cooperation in Initial VET and Continuing Training at European Level

Enhancing the 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 system. 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 (cf. The Copenhagen Declaration, Nov. 2002). Corresponding action have been trying to tackle aspects such as mobility, exchanges, transparency and recognition of qualifications, definition and use of reference levels and qualification systems' structures, cooperation in areas like accreditation/certification and the validation of non-formal prior learning. Some latest developments are the Europass-Training developed by the EU or 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).

The European policy actions on vocational education and training aim at higher occupational and geographical mobility of labour forces. Even though there are several initiatives trying to improve mobility of skilled workers, there are also 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 lack of mobility is an increasingly knowledge-based and service-sector economy in which occupational mobility is essential for adapting to structural changes (cf. CEC 2002c, p. 7-9). Therefore the corporate and economical potential of ICT as typical service driven is directly threatened by low mobility of ICT practitioners.

One of the major preconditions for mobility certainly 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” thus highlights three fundamental challenges (cf. CEC 2002c, p. 4):

- Firstly, there is the challenge of inadequate occupational mobility, showing up the need to adapt education and training systems 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.
- Secondly, 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.
- 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 what concerns 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.

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

In order to improve the structural relation of ICT education and training systems and the ICT labour market it is crucial to have a clear picture and comprehensive interpretations and descriptions of the concrete skill requirements in the companies as well as the actual provision, demand and evaluation of training profiles in the relevant business and work areas. These research processes to develop 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, e.g.

- investigation of the ICT employment and demand of the ICT and user industries and the supply of ICT practitioners at all skill levels,
- investigation of ICT skill needs in European companies as well as qualification structures and existing ICT training profiles at sub-degree vocational levels in European countries and
- 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 as well as ICT curriculum development guidelines.

These results are in line with the account 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 eBusiness skills profiles in particular is needed to help ease shortages in ICT occupations and sectors" (CEC 2002c, p. 8). Primary advantage of clarifying industry's ICT skill needs from a business and work process perspective can be seen in new possibilities of establishing business and work area orientated competence structures that are fundamental for reducing the mismatch between industry's skill needs and available and future training programmes and qualification certificates respectively. This primary work area orientated 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 (cf. CEC 2002c, p. 9). For instance, especially the companies looking for ICT practitioners have been coping with a situation where formally qualified staff was not easy to find on the labour market. Correspondingly, many ICT workers qualified in other domains and professions have been asking for a recognition of their non-formal ICT skills.

Cooperation of European ICT training institutions

One concrete level of cooperation in vocational education and training is that one between ICT training institutions, e.g. in projects or programmes of the EU. In the context of the necessity of a European understanding of ICT training profiles and curricula at different levels

and the CVT area it is of interest if the ICT training providers cooperate with other ICT education and training institutions. The relevant result from the EUQuaSIT questionings indicates that app. 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. Particularly in Germany the percentage is significantly lower and thus more than 50% of the training institutions answer that no activities in this direction are actually carried out or even planned.

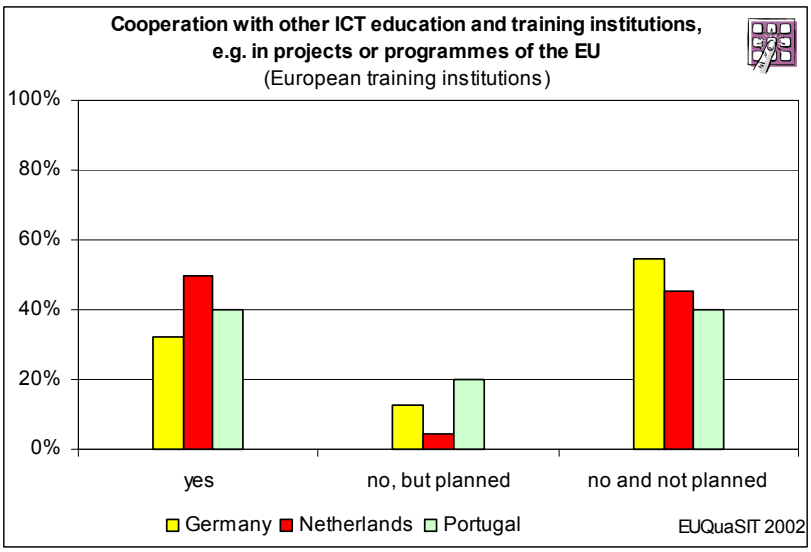


fig. 5-1: European cooperation among ICT training institutions

It has to be seen that one of the major problems in Europe still is the transparency and comparison of vocational skills and qualifications at sub-degree levels. A closer connection and dialogue between the "ICT Employment" (Demand) and "ICT Training" (Supply) side also provides a fundament to improve the concepts, provision and recognition of qualifications and competences and therefore enhances the occupational and geographical mobility in Europe.

6 Conclusions and Further Actions Recommended

The report provides quantitative and qualitative results of the European ICT employment, the demand and supply of ICT practitioners and the ICT skills needs of the ICT and user sectors. Despite a primary focus on the ICT skill and practitioner needs of the ICT industries the results equally cover the needs of the ICT user industries as well as small, medium and large enterprises (SMLEs). Detailed case study results are presented on the specific ICT skill needs at sub-degree levels using a business area model of six generic ICT work areas with according ICT fields of activity and work tasks supported by European company evaluation results of actual ICT training profiles. The analyses and conclusions lead to a structure of 14 "Generic work area orientated ICT skills profiles". Each of these generic work area orientated ICT skills profiles therefore represents detailed skill needs at a specific sub-degree level and indicates in the same time the skills mismatch as regards existing ICT training profiles. The skills profiles in its structure and contents provide combined and based on a work orientated didactic approach the fundament of an innovative framework of 14 European "Generic work area orientated ICT training profiles" at sub-degree levels. In major orientation to this framework and according to defined outcomes within three main qualification categories the report presents also 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 orientated 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 the design of courses.

The forthcoming challenge for means, programmes and actions both at European and national level now is 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 module still need to be proved in the course of a European discussion and cooperation. However some further concrete actions and tasks can be concluded and recommended considering the following aspects:

- to reasonably monitor the European ICT labour market concerning the supply and demand of ICT practitioners of the ICT and ICT user sectors based on common occupation indicators such as a mutual understanding of ICT employment, workforce and the job and skill levels,
- to continuously investigate and assess the skill and qualification needs of ICT practitioners based on quantitative, qualitative and comparative analyses like company questionings, case studies as well as the evaluation of ICT training profiles and curricula in the sense of continuous curriculum development,

- to organise and administrate broad European co-operation (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,
- to ensure greater transparency through systematic information, comparison and guidance on present European ICT training profiles and qualifications,
- to elaborate and implement the ICT learning modules and the design of courses based on the skill needs in regard to the fields of activity and work tasks of the ICT work processes,
- to monitor and evaluate the implementation of the developed modular vocational curriculum structure in various training institutions and companies,
- to ensure the European wide 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 , like the "Red Seal Program" in Canada, cf. http://www.hrdc-drhc.gc.ca/hrib/hrp-prh/redseal/english/index_e.shtml),
- to install joint methods and instruments for skills assessment and quality control,
- to discuss and draft recommendations for tailored ICT and didactic qualification concepts for teachers and trainers,
- to value and accredit for instance vendor or product specific ICT certifications, prior non-formal learning and to help improve companies' own training provision.

It is hoped that the presented results 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 not only but with special focus on vocational levels and in a representative sample of European countries. Parallel a first pilot project e.g. in Germany, the Netherlands, the UK, Greece and Portugal 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 to the subject.

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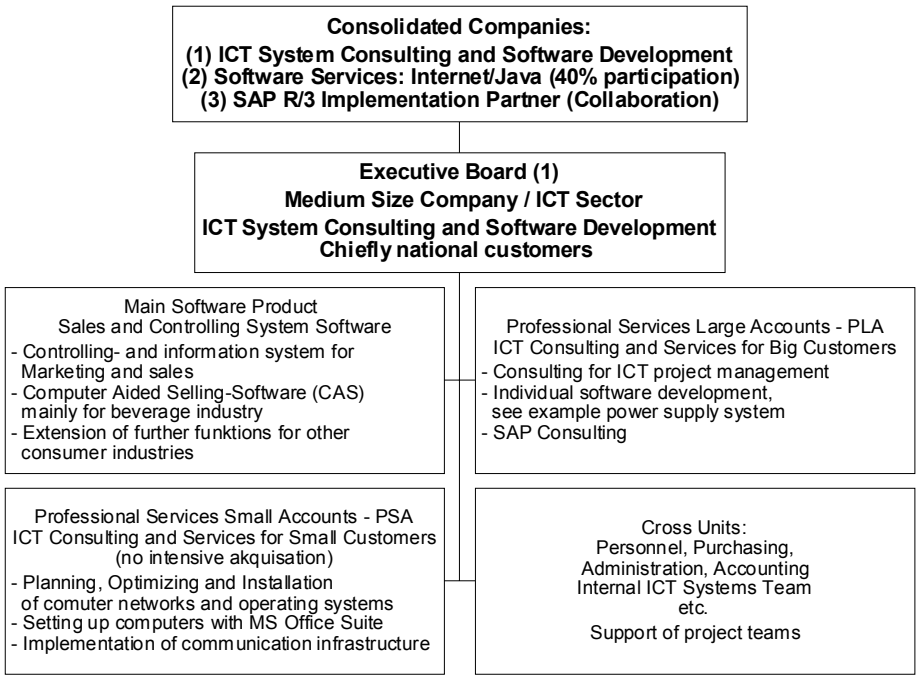
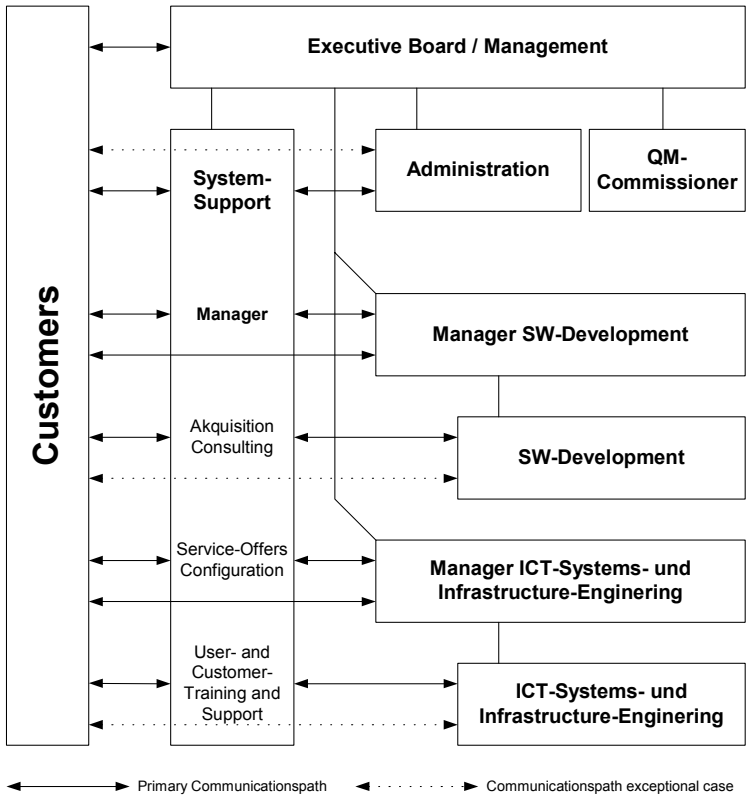
8 Annex: Case Study Examples

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 Process	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 Process	Phases of Activity	Work Tasks	ICT Practitioners			

8.2 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 Custom 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 at the customer's (C.2)	Install und configure the software applications at the customer's (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**				