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# OVERVIEW OF JOB CLASSIFICATIONS AND CERTIFICATIONS IN THE IT SECTOR

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# OVERVIEW OF JOB CLASSIFICATIONS AND CERTIFICATIONS IN THE IT SECTOR <sup>1</sup>

## EXECUTIVE SUMMARY

An assessment of the labor supply in the information technology (IT) sector of the Republic of Armenia was conducted by CAPS in 2006.<sup>2</sup> The report demonstrated a growing number of students and graduates, but also revealed the challenges related to the quality of education, renewing the IT curriculums, effective workforce development, motivation of labor force, and unemployment of people trained as IT specialists. The supply assessment revealed a further need for analysis of the accumulated international experience on classification and certification of IT-related skills and competencies.

This report provides an overview of international practices for job classification and certifications in the IT industry, particularly those which might be relevant for Armenia. The current static, broad classification of occupations in Armenia is contrasted with the more flexible and detailed systems accepted internationally.

The American and European practices in job classification and certification are presented. Certification systems offered by private companies such as Microsoft, Brainbench, and Linux are outlined.

The practice of competency based job profiles is presented and recommended. This type of job profile provides the competencies required for successful job performance and a description of the general and technical competencies needed. It provides an optimal profile for jobs at all levels from entry through senior expert. In contrast, the current qualification standards provide only the minimal specifications. Under the new approach, applicants can be evaluated for jobs based on the quality of their preparation for the job or their proficiency levels on the competencies.

IT job classifications based on skills create a common-language framework for educators, industry, and other stakeholders to develop the educational and training tools necessary to prepare students and incumbent workers for today's workplace challenges.

The summary of job classification systems adopted internationally for the IT industry is a useful first step for Armenia. Educators, industry and other stakeholders in Armenia would be best served by adopting American or European best practices. A better classification system for survey purposes would help analysts understand and forecast workforce demand, and would help educators prepare the workers to meet industry demand.

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<sup>1</sup> **DISCLAIMER: The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development of the United States Government**

<sup>2</sup> The report is entitled "Information Technologies Workforce Supply Assessment" and is available on the CAPS website: [www.caps.am](http://www.caps.am).

# 1 INTERNATIONAL PRACTICES OF JOB CLASSIFICATIONS IN THE IT INDUSTRY

## 1.1 International Standard Classification of Occupations - ISCO-88

The International Standard Classification of Occupations is an International Labor Organization (ILO) classification structure. The current version, known as **ISCO-88**, is the third iteration, following ISCO-58 and ISCO-66. There is an updated version of the structure being prepared for release by 2008. The ISCO-88 divides jobs into 10 major groups, with each group further organized into sub-major, minor and unit (not shown) groups. ISCO-88 organizes occupations in a hierarchical framework. For the purpose of the ISCO classification system, the decisive factor for determining how an occupation should be classified is the nature of the skills that are required to carry out the tasks and duties of the corresponding jobs - not the way these skills are acquired. The major groups 2, 3 indicated in Table 1 include computing professionals, computer associate professionals, as well as mathematicians, statisticians and related professionals.

The current National Occupational Classification in the Republic of Armenia is based on the Model Occupational Dictionary published by CIS Interstate Statistical agency still in 1998 and adjusted for the CIS countries based on ISCO-88 ([www.armstat.am/classificators](http://www.armstat.am/classificators)) In 9 major groups of occupations of highly qualified (Group 2) and middle qualified specialists (Group 3) and a group (Group 4) of workers employed in information processing, and office clerks can be selected. The corresponding codes for the Mathematicians, Statisticians and Related Professionals (212), Computing Professionals (213) and for the subcategories are fully corresponding to the International Standard Classification of Occupations (ISCO-88).

**Table 1. IT industry job classification according to ISCO-88**

	<b>MAJOR GROUP 2</b>
	PROFESSIONALS
21	PHYSICAL, MATHEMATICAL AND ENGINEERING SCIENCE PROFESSIONALS
211	Physicists, chemists and related professionals
2111	Physicists and astronomers
212	MATHEMATICIANS, STATISTICIANS AND RELATED PROFESSIONALS
2121	Mathematicians and related professionals
2122	Statisticians
213	COMPUTING PROFESSIONALS
2131	Computer systems designers and analysts
2132	Computer programmers
2139	Computing professionals not elsewhere classified
	<b>MAJOR GROUP 3</b>
	TECHNICIANS AND ASSOCIATE PROFESSIONALS
312	Computer associate professionals
3121	Computer assistants
3122	Computer equipment operators
3123	Industrial robot controllers

## 1.2 American Job Classification in the IT Industry

According to the Occupational Employment projections to 2014 the employment in professional and related occupations is expected to increase the fastest of all occupations and add the most jobs from 2004 to 2014<sup>1</sup>. Computer and mathematical science occupations are projected to add 967,000 jobs and grow the fastest among the eight professional subgroups. The demand for computer-related occupations increases as organizations continue to increasingly use sophisticated and technologies. *Three out of 10 new jobs will be in computer systems design and related services, and one-sixth will be in the information sector, primarily software publishers and data processing and related industries.* In both categories—computer systems design and information—growth is projected to exceed 40 percent, equivalent to a rate more than 3 times faster than the average for all occupations. In addition, in most industries, employment of computer and mathematical science workers is projected to grow a bit faster than the average for all occupations. Self-employment among computer and mathematical science workers is expected to increase 15.6 percent, with most growth occurring among network systems and data communications analysts.

**Table 2. Fastest-growing computer occupations, 2004–2014**

		Employment, thousands		Change	
		2004	2014	Number	%
15–1081	Network systems and data communications analysts	231	357	126	54.6
15–1031	Computer software engineers, applications	460	682	222	48.4
15–1032	Computer software engineers, systems software	340	486	146	43.0
15–1071	Network and computer systems administrators	278	385	107	38.4
15–1061	Database administrators	104	144	40	38.2
15–1051	Computer systems analysts	487	640	153	31.4

It can be revealed from Table 2 that among the fastest growing computer occupations in 2004-2014 are network systems and data communications analysts, computer software engineers. The employment in these occupations during 10 years is projected to increase by 494,000 or almost half a million.

According to the Standard Occupational Classification (SOC)<sup>2</sup> carried out by US Department of Labor and Bureau of Labor Statistics the job classification for the computer and mathematical occupations is a following:

<sup>1</sup> Daniel E. Hecker, Occupational employment projections to 2014, *Monthly Labor Review*, November 2005.

<sup>2</sup> Standard Occupational Classification, US Department of Labour, Bureau of Labor Statistics, 2006.

**Table 3 Job classification for the computer and mathematical occupations by Standard Occupational Classification (SOC)**

<b>15-1000 Computer Specialists</b>
15-1010 Computer and Information Scientists, Research
15-1020 Computer Programmers
15-1030 Computer Software Engineers
15-1031 Computer Software Engineers, Applications
15-1032 Computer Software Engineers, Systems Software
15-1040 Computer Support Specialists
15-1050 Computer Systems Analysts
15-1060 Database Administrators
15-1070 Network and Computer Systems Administrators
15-1080 Network Systems and Data Communications Analysts
15-1090 Miscellaneous Computer Specialists
15-1099 Computer Specialists, All Other
<b>15-2000 Mathematical Science Occupations</b>
15-2010 Actuaries
15-2020 Mathematicians
15-2030 Operations Research Analysts
15-2040 Statisticians
15-2090 Miscellaneous Mathematical Science Occupations
15-2091 Mathematical Technicians
15-2099 Mathematical Science Occupations, All Other

The definitions and competency standards for the above-classified computer and mathematical science occupations are provided in Table 2:

**Table 4. SOC definitions and competency standards for the computer and mathematical science occupations**

SOC code	Occupation code	SOC title	SOC definition
1011	100	Computer and Information Scientists, Research	Conduct research into fundamental computer and information science as theorists, designers, or inventors. Solve or develop solutions to problems in the field of computer hardware and software.
15-1021	101	Computer Programmers	Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information. May program web sites.

15-1031	102	Computer Software Engineers, Applications	Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team. Exclude "Computer Hardware Engineers" (17-2061).
15-1032	102	Computer Software Engineers, Systems Software	Research, design, develop, and test operating systems-level software, compilers, and network distribution software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications. Set operational specifications and formulate and analyze software requirements. Apply principles and techniques of computer science, engineering, and mathematical analysis.
15-1041	104	Computer Support Specialists	Provide technical assistance to computer system users. Answer questions or resolve computer problems for clients in person, via telephone or from remote location. May provide assistance concerning the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems. Exclude "Network and Computer Systems Administrators" (15-1071).
15-1051	100	Computer Systems Analysts	Analyze science, engineering, business, and all other data processing problems for application to electronic data processing systems. Analyze user requirements, procedures, and problems to automate or improve existing systems and review computer system capabilities, workflow, and scheduling limitations. May analyze or recommend commercially available software. Exclude persons working primarily as "Engineers" (17-2011 through 17-2199), "Mathematicians" (15-2021), or "Scientists" (19-1011 through 19-3099). May supervise computer programmers.
15-1061	106	Database Administrators	Coordinate changes to computer databases, test and implement the database applying knowledge of database management systems. May plan, coordinate, and implement security measures to safeguard computer databases.
15-1071	110	Network Computer Systems Administrators and	Install, configure, and support an organization's local area network (LAN), wide area network (WAN), and Internet system or a segment of a network system. Maintain network hardware and software. Monitor network to ensure network availability to all system users and perform necessary maintenance to support network availability. May supervise other network support and client server specialists and plan, coordinate, and implement network security measures. Exclude "Computer Support Specialists" (15-1041).
15-1081	111	Network Systems and Data Communications Analysts	Analyze, design, test, and evaluate network systems, such as local area networks (LAN), wide area networks (WAN), Internet, intranet, and other data communications systems. Perform network modeling, analysis, and planning. Research and recommend network and data communications hardware and software. Include telecommunications specialists who deal with the interfacing of computer and communications equipment. May supervise computer programmers.

15-1099	100	Computer Specialists, Other	All computer specialists not listed separately.
15-2011	120	Actuaries	Analyze statistical data, such as mortality, accident, sickness, disability, and retirement rates and construct probability tables to forecast risk and liability for payment of future benefits. May ascertain premium rates required and cash reserves necessary to ensure payment of future benefits.
15-2021	121	Mathematicians	Conduct research in fundamental mathematics or in application of mathematical techniques to science, management, and other fields. Solve or direct solutions to problems in various fields by mathematical methods.
15-2031	122	Operations Research Analysts	Formulate and apply mathematical modeling and other optimizing methods using a computer to develop and interpret information that assists management with decision making, policy formulation, or other managerial functions. May develop related software, service, or products. Frequently concentrates on collecting and analyzing data and developing decision support software. May develop and supply optimal time, cost, or logistics networks for program evaluation, review, or implementation.
15-2041	123	Statisticians	Engage in the development of mathematical theory or apply statistical theory and methods to collect, organize, interpret, and summarize numerical data to provide usable information. May specialize in fields, such as bio-statistics, agricultural statistics, business statistics, economic statistics, or other fields. Include mathematical statisticians.
15-2099	124	Mathematical Scientists, Other	All mathematical scientists not listed separately.
15-3011	124	Mathematical Technicians	Apply standardized mathematical formulas, principles, and methodology to technological problems in engineering and physical sciences in relation to specific industrial and research objectives, processes, equipment, and products.

However, there are some classified IT jobs included in major groups of Architecture and Engineering Occupations, Art, Design, Entertainment, Sports, and Media Occupations, as well as Office and Administrative Support Occupations, Installation, Maintenance, and Repair Occupations (Table 3).

**Table 5. IT jobs classification in the other major groups of SOC**

<b>17-0000</b>	<b>Architecture and Engineering Occupations</b>
17-2060	Computer Hardware Engineers
17-2061	Computer Hardware Engineers
17-2062	Computer Hardware Engineers, Non-R&D
17-2063	Computer Hardware Engineers, R&D
<b>27-0000</b>	<b>Arts, Design, Entertainment, Sports, and Media Occupations</b>



27-1014	Multi-Media Artists and Animators
27-1024	Graphic Designers
27-3042	Technical Writers
27-4021	Photographers
27-4031	Camera Operators, Television, Video, and Motion Picture
27-4032	Film and Video Editors
43-0000	Office and Administrative Support Occupations
43-9011	Computer Operators
43-9021	Data Entry Keyers
43-9022	Word Processors and Typists
43-9031	Desktop Publishers
49-0000	Installation, Maintenance, and Repair Occupations
49-2011	Computer, Automated Teller, and Office Machine Repairers

According to the Occupational Outlook Handbook<sup>3</sup> the classification recommended in Table 3 is corresponding to the Standard Occupational Classification while the job classification within the Career Guide to Industries<sup>4</sup> differs including not only Computer Scientists and Database Administrators, Computer Systems Design and Related Services but also Software Publishers and Wholesale Trade (see Table 6).

**Table 6. IT jobs classification according to the Occupational Outlook Handbook (OOH)**

1	Computer scientists and database administrators
2	Software Publishers
3	Wholesale Trade
4	Scientific Research and Development Services
5	Computer Systems Design and Related Services

**Computer scientists and database administrators:** Computer scientists and database administrators in USA held about 507,000 jobs in 2004, including the highest share of network systems and data communication analysts and about 66,000 self-employed. Computer scientists and database administrators are expected to be among the fastest growing occupations through 2014. Employment of these computer specialists is expected to grow much faster than the average for all occupations. Job increases will be driven by very rapid growth in computer systems design and related services, which is projected to be one of the fastest growing industries in the U.S. economy. Job growth will not be as rapid as during the previous decade, however, the information technology sector begins to mature and routine work is outsourced overseas. There is growing demand for network systems and data communication analysts helping firms maximize their efficiency. Expansion of electronic commerce (doing business on the Internet) and the continuing need for databases storing critical information are fueling demand for database administrators familiar with the latest technology. Companies look for professionals with broad range of skills, including not only technical knowledge, but also communication and other interpersonal skills. The competencies needed include:

- ability to think logically;
- good communication skills;
- ability to concentrate and pay close attention to details;
- effective communication with computer personnel.

<sup>3</sup> Occupational Outlook Handbook, US Department of Labor, 2006-2007 Edition.

<sup>4</sup> Career Guide to Industries (CGI), US Department of Labor, Bureau of Statistics, 2006-2007 Edition, www.bls.gov

For database administrator positions, many employers seek applicants having bachelor's degrees in computer science, information science, or management information systems (MIS).

**Software Publishers:** Software publishing establishments carry out the functions necessary for producing and distributing computer software, such as designing, providing documentation, assisting in installation, and providing support services to software purchasers. The software publishing industry also produces and distributes information, but usually it “publishes” or distributes its information by other methods, such as by CD-ROM's, by the sale of new computers already preloaded with software, or through distribution over the Internet, rather than in printed form. Employment in software publishing in the US is projected to increase by 68 percent during 2004-2014, ranking software publishers as the third fastest growing industry in the American economy. The huge increase in employment affords numerous opportunities to younger workers possessing the latest technical skills. As a result the overwhelming majority of the employed belongs to the 25 to 44 age range. Employees in the software publishing industry generally command higher earnings than the national average. All production or non-supervisory workers in the industry averaged \$1,342 a week in 2004, significantly higher than the average of \$529 for all industries. This reflects the concentration of professionals and specialists who often are highly compensated for their skills or expertise.

**Wholesale Trade:** There are two main types of wholesalers: merchant wholesalers and wholesale electronic markets, agents, and brokers. Firms in the *wholesale electronic markets, and agents, and brokers* subsector arrange for the sale of goods owned by others, on a fee or commission basis. This sector includes agents and brokers as well as business-to-business electronic markets that use electronic means, such as the Internet or Electronic Data Interchange (EDI), to facilitate wholesale trade.

Globalization and cost pressures promote a strong trend towards consolidation of wholesale trade firms into fewer and larger companies. It will reduce demand for office and administrative support workers. New technologies are constantly changing the shape and scope of the workforce in wholesale trade. The internet, e-commerce, and Electronic Data Interchange (EDI) have allowed wholesalers to better obtain information. This technology will allow customers of wholesale firms to purchase goods and track deliveries electronically, limiting the growth of sales and customer service workers. Customers frequently order and pay for goods electronically, therefore fewer bookkeeping, accounting, and auditing clerks will be needed. New radio frequency identification (RFID) technology will also decrease demand for administrative workers.

In 21<sup>st</sup> century a strong demand for computer specialists in the wholesale trade industry will be created. Wholesalers' presence in e-commerce and the uses of electronic data interchanges (EDI) will require more computer specialists to develop, maintain, and update these systems, install and develop radio frequency identification systems.

With these new technologies making it easier for firms to bypass the wholesaler and order directly from the manufacturer or supplier, wholesale firms are putting greater emphasis on customer service to differentiate themselves from these other suppliers.

**Scientific research and development services:** R&D comprises three types of activities: basic research funded by government, universities, or nonprofit organizations, applied research and development. Basic research involves a high level of theory and is very risky, conducted to further scientific knowledge without any direct application. Applied research is directed toward solving some general problem and is a bridge between science and business. Development, accounting for more than half of all R&D, then refines the technologies of applied research by private industry into immediately usable products. Scientific research and development services provided 548,000 jobs in 2004. Competencies include crucial creativity and adaptation to changes in technologies.

**Computer Systems Design and Related Services:** This industry includes custom computer programming, computer systems design, computer facilities management services, including computer systems or data processing facilities support services for clients; and other services such as disaster recovery services and software installation. The employment in computer systems design and related services industry in 1990-s more than doubled and currently remains one of the 25 fastest growing industries in United States with about 1.1 million jobs (2004), and an additional 132,000 self-employed and unpaid family workers. The employment in industry in 2004-2014 is expected to grow by 40 percent adding 453,000 jobs, compared with only 14 percent growth projected for the entire economy. Employment of programmers will continue to expand, but the share of programmers will decrease in relation to other computer specialists as more routine programming functions are increasingly automated.

Because of more competitive job market for computer specialists and technological advances in the field, employers are well educated hiring specialists having skills and experience in the area, as well as some expertise in other fields.

The job profiles are based on Standard Occupational Classification (SOC) and include job description, tasks, job knowledge, skills, abilities, work styles and work values, as well as description of job zone with requirements on overall experience, job training and education.

The brief job descriptions based on Occupational Outlook Handbook are provided for such occupations as computer programmers, computer software engineers, computer systems analysts, computer support specialists, data entry and information processing workers, computer chip processing operators (Annex 1).

### **1.3 American Experience with IT Skills Standards and Competencies**

IT skill standards create a common-language framework for educators, industry, and other stakeholders to develop the educational and training tools necessary to prepare students and incumbent workers for today's workplace challenges. The National Workforce Center for Emerging Technologies (NWCET), located at Bellevue Community College in Bellevue, Washington, has identified and described skill standards for eight IT career clusters. A career cluster is a grouping of representative job titles, related by close association with a common set of technical skills, knowledge, and abilities. The IT career clusters identified by NWCET have been broadly adopted by industry, education establishments and government policy-makers as a standard framework for classifying IT jobs and careers.

The eight NWCET IT career clusters include:

1. Database development and administration
2. Digital media
3. Enterprise systems analysis and integration
4. Network design and administration
5. Programming and software engineering
6. Technical support
7. Technical writing
8. Web development and administration

These career clusters represent a broad range of job titles, from entry level through senior management. They are designed to be usable to educators at every level, and to human resource professionals; training, certification, and assessment developers; students and job seekers; and organizations and individuals conducting research into information technology workforce issues.

The three-tiered pyramid (Graph 1, IT Skills Pyramid) depicts IT skill standards in three broad IT competency categories: foundation and employability skills, common technical skills, and industry-specific technical skills and organizational knowledge.

Tier 1 is the set of foundation and employability skills, knowledge, and abilities that are required of all information worker employees. These are the universal skills such as problem solving, team skills, and flexibility that are needed to apply technical knowledge and tools effectively.

Tier 2 is the set of technical skills, knowledge, and abilities common to all IT positions within an IT career cluster. For a programmer, for example, knowledge of the principles of programming applies across all industries.

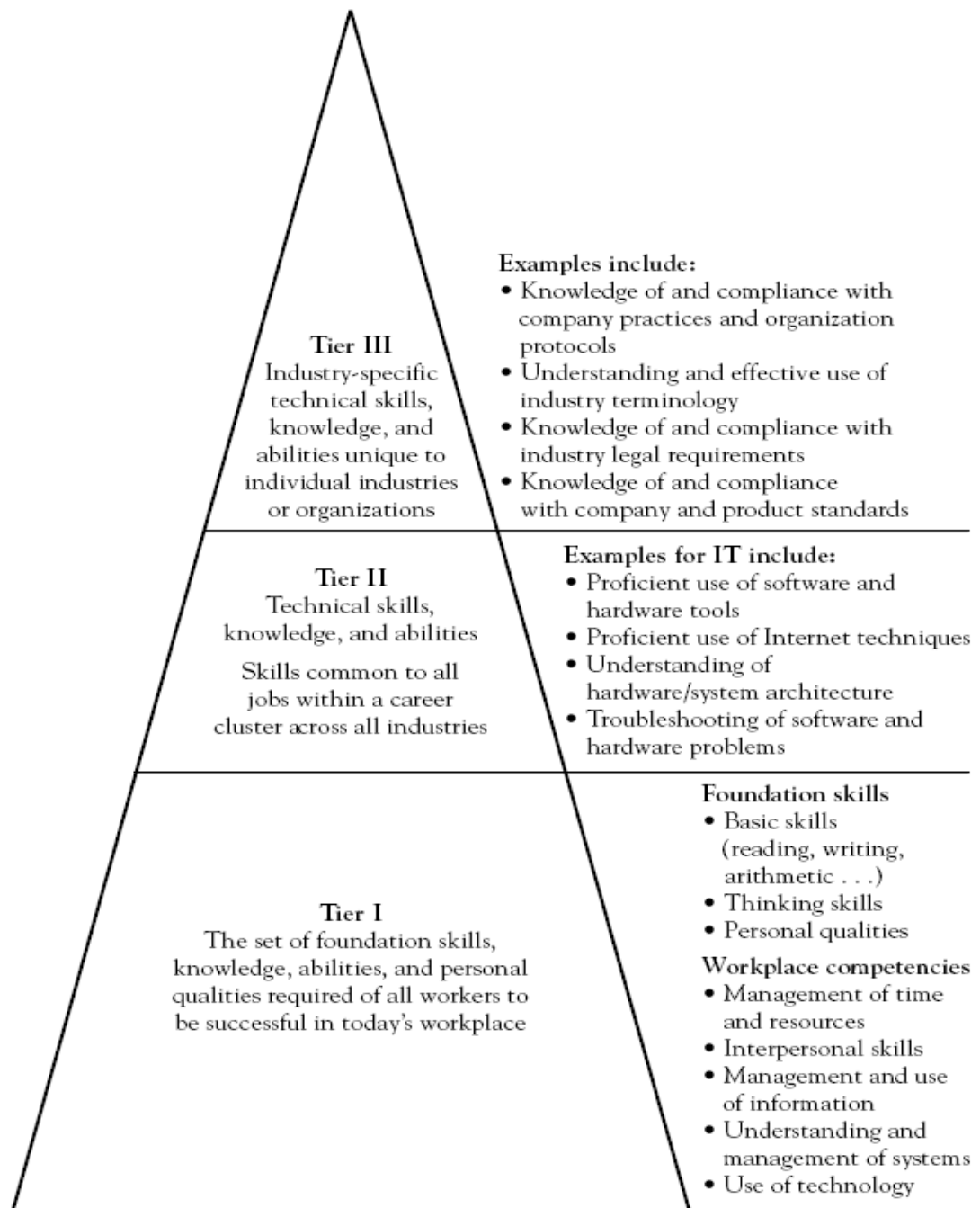
Tier 3 is the set of industry-specific technical skills, knowledge, and abilities that are unique to individual clusters and that are the most susceptible to change. For example, a programmer's required knowledge of data communications and network protocols may differ among companies and industries.

The common elements across all clusters reflecting the requirements of employers for employees are project management, task management, and problem solving and troubleshooting. Certain other process skills appear repeatedly across all eight clusters (analysis, design, development, testing, implementation, and documentation).

The nature of each of these IT skills differs with the job level and from cluster to cluster. However, employers need employees implementing the following functions:

- Apply a systematic, methodical approach to solving a problem;
- Research to see who else knows about the problem;
- Develop a rational set of possible solutions;
- Test the solutions cost-effectively and efficiently;
- Verify that the problem is truly solved;
- Document the solution for others.

**Graph 1. IT Skills Pyramid**



Future trends in IT skill standards comprise e-commerce and e-business, outsourcing, specialization, certification, and nontraditional degree pathways. The trend toward focusing on core business and core competencies which started with large firms is adopted by smaller firms and educational institutions.

The IT Core Curriculum designed by NWCET in 1999 is based on Soft Skills Assessment ([www.nwcet.org/products/softSkills.asp](http://www.nwcet.org/products/softSkills.asp)).

### **IT Core Curriculum learning components include:**

#### **Project and Process Flow Skills**

- Research
- Analysis and Synthesis
- Design and Development
- Testing and Validation
- Quality Assurance
- Project Management

#### **Communication and Coordination Skills**

- Oral Communication
- Verbal Business Communication
- Organization/Delivery of Presentations
- Written Communication
- Written Business Communication
- Proposal Writing
- Technical Documentation
- Project Documentation
- Workplace Communication
- Customer Relations
- Teamwork

#### **Business Environment Skills**

- Business Organization and Environment
- Professionalism
- Task Management
- Professional Development

#### **Analytical Skills and Problem Solving**

- Data Gathering, Analysis and Organization
- Problem Definition
- Solution Development and Testing
- Analytical and Logical Thinking
- Hypothesis Development and Design of Experimentation
- Estimation and Cost/Benefit Analysis
- .Statistical Analysis

#### **Core Computer Software and Hardware Skills**

- Windows Environment

- Hardware Installation and Configuration
- Software Installation and Configuration
- Network Technologies
- Spreadsheet Applications
- Principles of Programming

The skills based detailed job profiles for the following jobs classified as “Computer specialists” are provided in the **Annex 1**.

15-1041	Computer Support Specialists
11-3021	Computer and Information Systems Managers
15-1011	Computer and Information Scientists, Research
15-1021	Computer Programmers
15-1031	Computer Software Engineers, Applications
15-1032	Computer Software Engineers, Systems Software
15-1051	Computer Systems Analysts
15-1071	Network and Computer Systems Administrators
15-1071.01	Computer Security Specialists
17-2061	Computer Hardware Engineers
25-1021	Computer Science Teachers, Postsecondary
43-9011	Computer Operators

The job profiles are provided by the Occupational Information Network - O\*NET of the US Department of Labor and include detailed job descriptions, tasks, knowledge, skills, abilities, work styles and values, as well as the information on job zones which comprise the requirements on overall job experience, job training and education. O\*NET is playing the role of information resource for AJB (America’s Job Bank) and ACInet (America’s Career InfoNet) which are web-based information systems provided by the U.S. Department of Labor. Based on Occupational Information Network - O\*NET an experimental Japanese-language version was created in Japan.

The results of the Information Technology Workforce Capability Assessment survey<sup>5</sup> conducted in USA in 2004 showed the ten highest and lowest ranked IT skills among the list of 55 skills included in the survey which are based on responses in the intermediate, advanced and expert proficiency levels:

**Table 7. The highest and lowest ranked IT skills in USA (%)**

<b><u>Highest-ranked Skills</u></b>	<b><i>% Intermediate or Greater Proficiency</i></b>	<b><i>Rank</i></b>
Desktop Applications	77.6%	1
Windows Operating System	60.8%	2
Document Management	50.1%	3
Client-Server	46.5%	4
Testing	44.9%	5

<sup>5</sup> “Information Technology Workforce Capability Assessment survey (2004). Analysis of survey results, CIO Council, December 2004, p. 19.

Systems Maintenance and Helpdesk	41.0%	6
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<b><u>Lowest-ranked Skills</u></b>	<b><i>% Intermediate or Greater Proficiency</i></b>	<b><i>Rank</i></b>
SEI Capability Maturity Models	13.6%	46
Linux Operating System	13.6%	47
Cellular Network Technology	13.5%	48
Extensible Markup Language (XML)	13.2%	49
System Analysis and Design	37.4%	7
Project Management Software	35.1%	8
Systems Security Applications	33.2%	9
Continuity of Operations Planning	32.8%	10
Federal/OMB Enterprise Architecture	12.6%	50
Geographic Information Systems (GIS)	12.2%	51
Satellite Communications	10.7%	52
Unified Modeling Language (UML)	8.7%	53
MacOS/MacOSX Operating System	8.1%	54
Biometrics	8.1%	55

The sharp drop of proficiency ratings from the highest to lowest ranked skills by more than 40 percentage points (from 78% to 33%) indicates the specialized nature of IT skills. The assessment of 16 general competencies revealed the highest-ranked proficiency level for the interpersonal skills, problem solving, oral communication and decision making, while the lowest proficiency was registered for contracting/procurement, legal, government and jurisprudence, financial management.



**Web technology and Information Systems/Network Security** with relatively lower proficiency level was mentioned by respondents as the competencies where additional training would improve their job performance.

In 1996 the California State University (CSU) implemented a new **classification** series and compensation structure, for its information technology professionals which affected more than 1,000 employees, took five years of discussions and negotiation. The key design strategy was to focus on broader job functions and common skills sets, rather than specific job tasks. The CSU program is more of a job-based, skill/competency-influenced approach designed for information technology knowledge workers. Broad classifications inclusive of all job levels, rather than traditional discrete classifications are more suited to information technology knowledge workers because they broaden the focus from job content and scope to the knowledge, skills, and contributions of the individual doing the work. Based on functional differences more than twenty discrete classifications were grouped into six broad classifications for IT sector including:

- **Analyst/Programmer**-Performs analysis and development of systems and technology-based solutions to meet user needs, including applications, databases, and related systems.
- **Operating Systems Analyst**-Performs operating systems analysis and maintenance, including network and database systems, and their interfaces to all other systems.
- **Information Technology Consultant** - Provides a broad range of consultative support to students, faculty, and staff to enhance the use of technology systems and information access.
- **Network Analyst** - Engineers, analyzes, and supports all networks carrying voice, data, video, and/or broadcast transmissions.
- **Equipment/Systems Specialist**-Installs, modifies, and maintains equipment and systems, with a hardware and systems configuration focus.
- **Operations Specialist**-Operates, monitors, and controls multi-system information systems in data, voice, and/or video processing.

Based on the analysis of existing work only three distinct levels were clearly distinguishable within each of the six classifications:

- *Foundation* - narrow range of skills and pay appropriate for entry level positions through proficiency;
- *Career* - broad range of skills and pay from proficiency to senior career;
- *Expert* - top technical echelon; complexity and strategic orientation.

To support the administration of the three broad skill-based level definitions, skill-level guidelines were developed. These included three core skill/competency dimensions that were identified as critical to successful performance in information technology work: (1) technical know-how, which encompasses depth, breadth, and integration of knowledge, (2) critical thinking skills, which cover problem solving, future thinking skills, and organizational, self, and project management, and (3) interactive capabilities, which include listening, communication, team, and leadership skills.

**Table 8. Three core skill/competency dimensions by California State University classification (CSU)**

<b>Skill Level</b>	<b>Foundation</b>	<b>Career</b>	<b>Expert</b>
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<b>Technical Know-How</b>	Basic knowledge of specialty area with limited ability to integrate elements within the specialty	Functional, working knowledge of specialty area. Capable of integrating skills and knowledge from other specialties	Advanced and comprehensive knowledge of specialty area. Capable of substantial integration from other specialties to achieve innovative results.
<b>Critical Thinking Skills</b>	Capable of solving problems where precedents exist. Refers others appropriately	Applies theories and principles and uses reasoning and logic to analyze problems, explore alternatives, and implement the appropriate solution.	Understands problems from a broad, interactive perspective. Is able to develop and implement solutions that combine information in new ways.
<b>Interactive Skills</b>	Able to present ideas clearly in writing and orally	Competent at interpreting and communicating information, ideas, and instructions.	Demonstrated expertise using persuasion and negotiation to build cooperation to expedite projects.

In 1999 the Office of Personnel Management (OPM) revised the classification and qualification standards for critical information technology (IT) occupations in order to respond to the tight labor market requirements on innovative approaches to IT recruitment and assessment.

A competency-based job *profiles were introduced* to replace the current qualification standards for the Computer Specialist and Telecommunications series, which will provide the foundation for developing IT recruitment and assessment strategies.

Competencies involve a combination of knowledge, skills, attitudes, values and behaviors that lead to successful performance in a job and which can be acquired by doing, learning, training and coaching.

### **New Definition of IT Jobs**

#### ***Old Method***

- Knowledge, skills, abilities
- Jobs are defined as bundles of tasks
- Employees perform strictly definable tasks

#### ***New Method***

- Competencies
- Jobs are defined by competencies
- Jobs are flexible

The job profile provides the competencies required for successful job performance, a description of the general and technical competencies, and a range of suggested assessment methods, to be used individually or in combination, as appropriate, for measuring an applicant's competencies. The competency-based approach provides an optimal profile for jobs at all levels from entry through senior expert. In contrast, the current qualification standards provide only the minimal specifications. Under the new approach, applicants can be evaluated for jobs based on the quality of their preparation for the job or their proficiency levels on the competencies.

## **COMPETENCY-BASED APPROACH**

### ***Information Technology Job Profile***

#### **Competencies needed for job**

- Technical
- General

### **Recruitment**

- Entry
- Intermediate
- Journey
- Senior Expert

### **Competency Assessments**

- Crediting Plan
- Work Sample Assessment
- Assessment Center
- Structured Interview
- Test

IT new occupational competences including general and technical competencies are attached in the **Annex 2**.

The Office of Personnel Management (OPM) maintains the crosswalk between the Federal occupational series and the SOC codes ([www.opm.gov](http://www.opm.gov)). Job family standard provides series and specialty definitions for administrative positions in the Information Technology Group, GS-2200 (Table 9).

**Table 9 Federal Occupational Series and Position Titles and Their Related SOC System Codes**

Occupational Series	Standard Occupational Classification Code Based on Occupational Series		Position Title	Standard Occupational Classification Code Based on Position Title	
Information Technology Management, GS-2210	15-1099	Computer Specialists, All Other	Information Technology Specialist	15-1099	Computer Specialists, All Other
			Information Technology Specialist (Policy and Planning)	15-1099	Computer Specialists, All Other
			Information Technology Specialist (Security)	15-1099	Computer Specialists, All Other
			Information Technology Specialist (Systems Analysis)	15-1051	Computer Systems Analysts
			Information Technology Specialist (Applications Software)	15-1031	Computer Software Engineers, Applications
			Information Technology Specialist (Operating Systems)	15-1032	Computer Software Engineers, Systems Software
			Information Technology Specialist (Network Services)	15-1081	Network Systems and Data Communications Analysts
			Information Technology Specialist (Data Management)	15-1061	Database Administrators
			Information Technology Specialist (Internet)	15-1099	Computer Specialists, All Other
			Information Technology Specialist (Systems Administration)	15-1071	Network and Computer Systems Administrators
			Information Technology Specialist (Customer Support)	15-1041	Computer Support Specialists

#### 1.4 European Standard Classification of Occupations - ISCO 88 (COM)

ISCO 88 (COM) has arisen as a consequence of the harmonization of national occupational classifications across the European Union. ISCO 88 (COM) represents the culmination of a series of lengthy and detailed investigations in the twelve countries of the EU, combining the knowledge of experts in occupational classification in each country with practical considerations for coding occupational information collected by census and survey techniques and addressing the requirement for an EU-wide standard. It should not be regarded as a different classification

from ISCO-88, but rather it is the result of a coordinated effort by National Statistical Institutes to implement ISCO-88 for census and survey coding purposes.

Some of the countries within the European Union have recently developed a new or revised national occupational classification based on ISCO-88 (e.g. Denmark, Italy) or on the same basic structure (e.g. United Kingdom). Other countries, as France and Germany, established national occupational classifications which do not link directly with ISCO-88. Greece and Portugal have adopted ISCO 88 (COM) as their national classification, with minor local variations. ISCO 88 (COM) represents the most detailed level of ISCO-88 which all community countries consider feasible to relate to their national classifications.

- There are presently about 6.5 million ICT jobs in Europe, 3.9 percent of total employment and it will grow by 20 percent to 7.8 million ICT jobs over the next four years.
- The largest concentration of ICT jobs is in the software and services industry.
- Fastest growing ICT occupations are software engineers, analysts and programmers.

The Information and Communications Technology (ICT) industry in Europe is experiencing a severe shortage of skilled personnel that is threatening to slow progress towards e-Europe. The skills shortage in Europe is forecasted at 1.74 mln at the end of 2003.<sup>6</sup> The estimated loss within Western Europe is 380 bln Euro in GDP over the next 3 years. A distinction should be made between a *shortage of IT workers*, and a gap between the *current skills* of IT workers and those sought by firms. Employers seek specific combinations of IT and other skills which may not be found in many qualified job-seekers.<sup>7</sup>

When looking at growth rates of training in Europe (including “traditional” and technology-based training) a rather varied and fragmented picture emerges between Northern and Southern European countries.<sup>8</sup> In Southern European countries fragmentation looks more dramatic at regional level. Though, traditional training remains the most preferred option, existing trends in the last years showed an increased interest and adoption of e-learning solutions especially in large companies and from a geographic point of view, in Nordic countries, the UK, Germany and France.

However, a distinction needs to be made when studying the e-learning demand in enterprises between large companies and small and medium enterprises (SMEs). Whereas, large enterprises have been in fact forerunners in the adoption of e-learning throughout Europe in the last 5 years, the same cannot be said for small and medium companies, which have shown significant resistance to e-learning, demonstrating a limited interest in training generally. The strong variety of cultures and languages are among the main inhibitors to the “Europeanization” of the e-learning industry.

The share of ICT related occupations in the total economy in Europe is the highest in UK (28.7%), Luxembourg (29.5%) and Netherlands (24.5%), lowest – in Greece and Portugal (14-15%). During 1995-2004 the highest growth of the share of ICT related occupations was registered in Ireland (by almost 5 percentage points) and Luxembourg (by more than 6 percentage points) (Table 10).

**Table 10. Share of ICT-related occupations in the total economy, (broad definition) in 1995 and 2004\***

<sup>6</sup> Tony Ward “Curriculum Development”, University of York, 2002.

<sup>7</sup> Vladimir López-Bassols “ICT skills and employment”, OECD, 2002. [www.oecd.org/sti/working-papers](http://www.oecd.org/sti/working-papers).

<sup>8</sup> Claudio Dondi “Benchmarking e-learning policies in Europe”, 16 June 2006.

	1995	2004
EU15	20.63	21.93
United States	21.22	20.33
Australia	20.98	20.09
Canada	20.72	19.91
Luxembourg	22.96	29.50
United Kingdom	27.77	28.72
Netherlands	23.04	24.48
Sweden	20.38	24.41
Denmark	20.40	24.10
Finland	20.05	23.77
Ireland	17.29	22.18
Germany	20.38	21.52
Belgium	18.68	20.59
Italy	20.91	20.42
France	18.63	19.84
Spain	15.81	18.36
Austria	15.07	17.18
Portugal	12.96	15.45
Greece	10.30	14.44
Norway	-	24.09
Switzerland	-	23.37
Hungary	-	22.68
Slovenia	-	21.90
Iceland	-	21.18
Czech Rep.	-	20.38
Slovak Rep.	-	18.68
Poland	-	17.86

\* Source: EU Labor Force Survey, US Current Population Survey, Statistics Canada, Australian Bureau of Statistics, OECD (2004), Information Technology Outlook 2004, OECD, and Paris.

Broad definition - based on OECD methodology (2004, Chapter 6). The shares for non-European countries are not directly comparable with shares for European countries as the classifications were not harmonized.

The highest percentage shares of expenditure for IT equipment, hardware, software and other services in GDP in 2004 were registered in USA (4.6%), Sweden, UK and Switzerland, and the lowest – in Romania (0.3%) (Table 11).

**Table 11. Annual data on expenditure for IT hardware, equipment, software and other services as a percentage of GDP\***

	2002	2003	2004
EU (25 countries)	-	-	3.0
EU (15 countries)	3.2	3.1	3.0
Euro area	2.9	2.7	2.7
Belgium	3.1	2.9	2.9
Czech Republic	-	-	2.8

Denmark	3.6	3.5	3.5
Germany	3.1	3.0	3.1
Estonia	-	-	2.3
Greece	1.4	1.3	1.3
Spain	1.8	1.8	1.7
France	3.5	3.3	3.3
Ireland	2.3	2.0	2.1
Italy	2.1	2.0	1.9
Latvia	-	-	1.9
Lithuania	-	-	1.4
Hungary	-	-	2.4
Netherlands	4.1	3.8	3.8
Austria	3.1	3.0	3.0
Poland	:	:	2.0
Portugal	2.2	2.1	2.0
Slovenia	-	-	2.1
Slovakia	-	-	2.2
Finland	3.7	3.6	3.7
Sweden	4.9	4.5	4.4
United Kingdom	4.7	4.2	4.2
Bulgaria	-	-	1.6
Romania	-	-	0.3
Norway	3.6	3.6	3.6
Switzerland	4.5	4.2	4.2
United States	4.7	4.6	4.6
Japan	3.5	3.5	3.6

\* Source: Eurostat Database.

With the support of the European Commission, a consortium of eleven major ICT companies, (BT, Cisco Systems, IBM Europe, Intel, Microsoft Europe, Nokia, Nortel Networks, Philips Semiconductors, Siemens AG, Telefonica S.A., Thales), and EICTA, the European Information and Communications Technology Industry Association have been exploring new ways of addressing this skills shortage. A project was set up, co-coordinated by International Co-operation Europe Ltd., to put in place a clear framework for students, education institutions and governments that describe the skills and competencies required by the ICT industry in Europe.

According to the Career Space ICT Consortium there is no one single way to design the best ICT curriculum.

The basis of the necessary technical qualifications is a broad spectrum of knowledge in mathematics, science and technology. This basic knowledge is essential for a broad understanding of natural processes and their utilization in technical applications. However, the consortium recommends that ICT Curricula should consist of the following core elements:

- a scientific base of 30%;
- a technology base of 30%
- an application base and systems thinking of 25%;
- a personal and business skills element of up to 15%.

As the skills supply is falling across the EU due to reduced birth rates, and with increasing retirement rates, there will simply be fewer people available for work. Recognizing this, several EU countries have relaxed job permit rules to allow skilled ICT workers from outside the EU to arrive, and thousands have already arrived. The skills gap is not just about the quantity of skilled people needed, but their quality. Current and future roles in ICT require not just good technical and creative skills across converging technologies, but the commercial and interpersonal abilities to match services and products to customers' needs. Many of the new roles in ICT call on the softer, artistic and people skills typically associated with females – yet, barely a fifth of skilled ICT workers are women. Attracting a more balanced ICT workforce is not just a key to solving the ICT skills gap but to delivering the informed, integrated society.

The Career Space consortium urges European universities to implement both the new ICT curricula and the Bologna agreement to help solve Europe's ICT skills gap. In this context, the Bologna style two cycle degrees is recommended i.e. a first cycle degree (FCD) following three or four years of study at Bachelors degree level and a second cycle degree (SCD) following a further two year study at Masters Level. A period of work experience is to be recommended between the first and second cycle degrees.

The Career Space Consortium suggests that any ICT curriculum should consist of hierarchically organized modules:

- sets of core modules,
- sets of area-specific core modules
- sets of optional (elective) modules.

Three steps undertaken by the Career Space consortium included:

I step - develop core Generic Skills Profiles relevant to jobs in the consortium companies main activity areas, and to create a dedicated website to make this information widely available. The **Core Generic Skills Profiles** cover the main job areas for which the ICT industry is experiencing skills shortages.

II step - clustering in Groups to be covered by one curriculum; invite a number of universities across Europe to join the ICT companies in a working group aimed at drafting **Curriculum Development Guidelines**. These guidelines, which will be published shortly and also made available on our website, are intended to assist universities in designing courses to match the skills profiles and needs of the ICT industry. It has benefited from the direct involvement and support of over twenty universities and technical institutions across Europe. The resulting guidelines build on existing good curricula together with information and suggestions from the companies and associations. They provide a basis for universities and technical institutions to review and revise relevant courses.

III step - develop a methodology, which would lead to a better quantification of the resources required by the industry in Europe.

The universities are recommended to use the following **ICT 13 core Generic Skills Profiles** published by the Career Space Consortium:

- Software Architecture and Design
- Software and Applications Development
- IT Business Consultancy
- Systems Specialist
- Multimedia
- Data Communications Engineering
- Integration & Test / Implementation and Test Engineering
- Product Design
- Communications Network Design
- Technical Support
- Digital Design



- Digital Signal Processing (DSP) Applications Design
- Radio Frequency (RF) Engineering

Based on Generic Skills Profiles a clustering into three groups can be implemented.

**Table 12. Three cluster groups of core generic profiles**

<b>(1) Computer Science</b>	<b>(2) Integrated Curriculum</b>	<b>(3) Information Technology</b>
Software Architecture and Design; Software and Applications Development; IT Business Consultancy	Systems Specialist; Multimedia; Data Communications Engineering; Integration & Test / Implementation and Test Engineering; Product Design; Communications Network Design	Radio Frequency (RF) Engineering; Digital Signal Processing (DSP) Applications Design; Digital Design; Technical Support

Clustering in this way, group (1) and group (3) represent the wide area of existing ICT curricula whereas group (2) would include the innovative area of new ICT curricula which tend not to exist at present, but which are urgently needed to meet a high demand from industry for specialized highly-qualified graduates.

However, there are other solutions possible, particularly clustering 13 core generic skills profiles into four groups assigned to areas such as Computer Science (Software), IT Systems, IT Networks and Electrical Engineering (Information Technology):

**Table 13. Four cluster groups of core generic skills**

<b>(A) Computer Science (Software)</b>	<b>(B) IT Systems</b>	<b>(C) IT Networks</b>	<b>(D) Electrical Engineering (Information Technology)</b>
Software Architecture and Design; Software and Applications Development Multimedia	Systems Specialist; IT Business Consultancy; Integration & Test / Implementation and Test Engineering	Communications Network Design Data Communications Engineering Technical Support	Radio Frequency (RF) Engineering Digital Signal Processing (DSP) Applications Design Digital Design Product Design

At the latest stage a set of generic job profiles including 18 core skills has been developed in the following areas:

**Information Technology (Telecommunications)**

- Radio Frequency (RF) Engineering
- Digital Design
- Data Communications Engineering
- Digital Signal Processing Applications Design
- Communications Network Design

**Computer Science (Software & Services)**

- Software & Applications Development
- Software Architecture and Design
- Multimedia Design
- IT Business Consultancy
- Technical Support

## **IT Systems (Products & Systems)**

- Product Design
- Integration & Test / Implementation & Test Engineering
- Systems Specialist

## **Cross Sector**

- ICT Marketing Management
- ICT Project Management
- Research and Technology Development
- ICT Management
- ICT Sales Management

Generic job profiles developed for the Software and Services include job descriptions, tasks, examples of jobs, type and level of skills, and future opportunities (see in the Tables 14-16).

For each of 18 skills more than 50 technical skills and more than 20 behavioral skills are anticipated. Main prerequisites of company's strategic and effective workforce development are reflected in Graph 2.

**PanICT** is the e-skills feasibility study including:

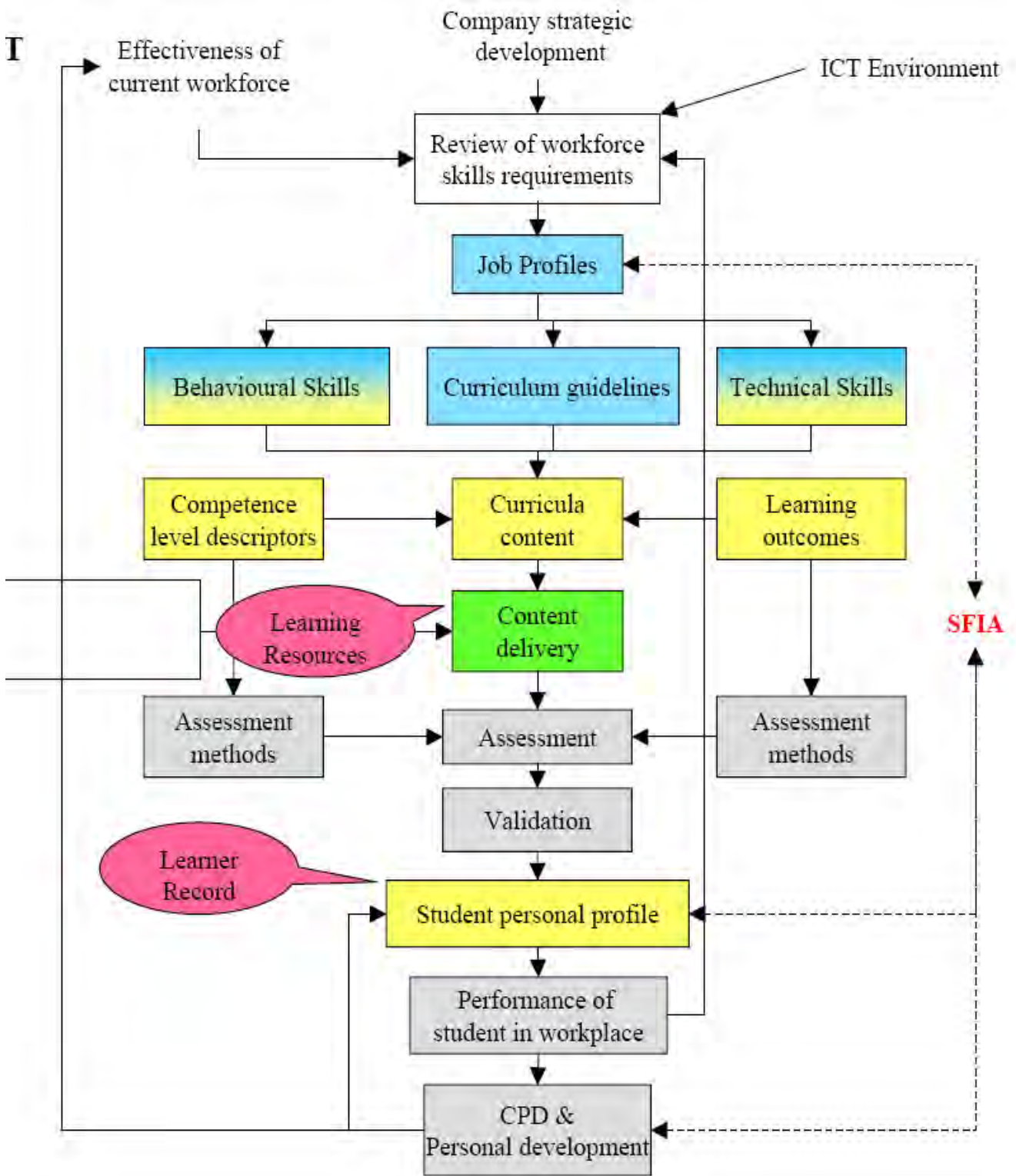
Passport to the ICT Industry / Graduate Apprenticeship which

- is an authorized record of student achievement against an agreed set of benchmarks;
- enables and promotes student mobility within the National & Institutional rules (+ Bologna agreement), is quick to implement;
- is detailed academic content for the technical skills;
- is dimensional analysis of the behavioral skills;
- is set of level descriptors for component behavioral skills.

**Genius** - Generic e-learning environments and paradigms for the new European ICT curricula. Objectives of Genius are the following:

- New Curricula content development based on the ICT curricula guidelines of Career-Space;
- Investigation of different innovative content delivery mechanisms corresponding to the new pedagogical paradigms;
- Development of pilot pan-European collaborative e-learning environment;
- Evaluation and validation of the approaches;
- Dissemination of results.

Graph 2. Career- Space, PanICT and Genius\*



“Curriculum Development”, University of York, 2002.

**Table 14 Job Descriptions for the Software and Services**

	<b>Vision</b>	<b>Role</b>	<b>Lifestyle</b>
<b>Software &amp; Applications Development</b>	<p>Many of the exciting new IT offerings rely on software to deliver the product or service. Specifying, creating, testing, installing and maintaining it is now the dominant area of development in bringing new IT systems to the market. Applications Developers have to be capable of working with colleagues to specify customer's requirements in software terms, then translate them into efficient, reliable code. Technological expertise in one of the many development environments and application domains (from computer games to electronic payments) is vital, but the ability to understand client requirements is just as important. Programming is one of the best overall groundings for a career in IT. It opens the possibilities of moving into more specialist fields, analysis, design, and project/team management. It is a good entry point for development into all these domains. Some companies offer training programs to graduates of all disciplines to enable them to work in this area.</p>	<p>In this kind of position the Software Applications Developer designs, builds, tests, implements and maintains applications to meet specific customer requirements using existing languages, D.B.M.S. (database management system), development tools etc. They also include the development of methodologies to carry out these activities. The Software Applications Developer understands a range of applications and how to transfer the customers' needs into real and robust applications.</p> <p>Applications developed include enterprise applications, e-commerce applications, and management and enterprise information applications, embedded software applications in e.g. mobile phones and Enterprise Resource Planning (E.R.P.) systems in the business and industrial environments. The customer requirements must be understood, as well as the tools to transfer this into a robust application and develop the application in the most effective way. When</p>	<p>Although in most cases the work is carried out in teams and in one location, it is also possible that teams work on multiple-sites and communicate via modern media-devices. In the initial period this job requires a lot of technical tasks with the rest of the team. With time, there is more involvement with the business and customer environment is needed to show and implement the developed solution/application. Also, a lot of interaction is needed with other Software communities (companies, institutes and universities) to stay "up-to-date" with the technology. Attending conferences and doing extra study courses might require traveling and people working in this area should also cultivate a stimulating "personal network".</p>

		<p>developing business applications, the developer must gain a thorough understanding of the business processes and constraints. Examples of applications are: Internet ticket reservations; Corporation Management Information Systems which include all aspects of the business; the technology to transfer graphics or video pictures to a mobile device, and telephone billing systems.</p>	
<p><b>Software Architecture and Design</b></p>	<p>The dramatic performance advances of hardware, calls for software systems development to keep pace, to enable it to be exploited for commercial benefit. Software Architects conceive the operating software which brings hardware to life, then specify the overall structure which will support sustainable developments on it. These are the foundations of the software technology and solutions, which make up software technological solutions. This is a deep technological role, which involves software complexity but also the ability to work as a member of a team. Entry to a career is usually via programming in a specialist, software development environment, though understanding of basic hardware functions is also important. Career development can lead to increasing technological occupations in chosen fields</p>	<p>People in these jobs work on software technologies and solutions which are the fundamental blocks on which computer applications and telecommunications networks are built. Depending on their particular role individuals may be called upon to carry out research, determine the structure (architecture), design, build, test, implement or maintain such software. This is a very technical job, which is basically concerned with programming or program design. However, it requires understanding of both hardware and the software because, at this level, the software solutions are influenced by the nature of the hardware (e.g. microchips, computers, telecommunications equipment, and individual devices</p>	<p>Most people in this type of job tend to work in software development laboratories as part of a highly capable team. The size of the team would not only depend on the product, but also on its stage of development. For instance, the development of the initial concepts of a product requires much smaller teams than the actual programming stage. More experienced people, who are often recognized experts in a product or technological area, could find themselves visiting customers to make sales calls, give presentations or solve problems; alternatively they might represent their</p>

	and, or team and project management.	<p>such as a computer controller in a car).</p> <p>This solution could be unique to one company or be intended to sell to many different customers. Examples of products worked on in this type of job are:</p> <ul style="list-style-type: none"> <li>- Operating systems (e.g. Windows)</li> <li>- Programming languages (e.g. Java)</li> <li>- Software controlling specific devices ( e.g. minidisk systems or a part of a motor car)</li> <li>-Telecommunications network controllers</li> </ul>	company at large industry events.
<b>Multimedia Design</b>	The continuing rapid development of technology to present information in novel forms is creating vibrant, dynamic, new multimedia enterprises. Most information can now be digitized; text, sound, image (still and moving), touch and presented in exciting, innovative, artistic forms. The Multimedia Designer helps clients comprehend what information can now be created, how it can be accessed, including interactively, then builds and implements software systems to deliver them. As this	<p>Having identified the available medium and proposed a solution, the designer then manages with customers, team members and external agents, the human factors and uses interfaces to visual impact.</p> <p>The designer may create prototypes, simulations on virtual environments with various multimedia technologies to represent the proposed system.</p>	Most people in this type of job tend to work in software development 'facilities as part of a highly capable team, but this kind of job also offers possibilities of tele-work via network facilities. Multimedia designers are very creative team members who give another vision to the customers' needs.

	<p>field is developing rapidly, part of the Designer's role is to explain to clients, facilities and services that they might not have imagined possible, then help them to investigate how they could exploit them for business goals. Multimedia is one of the key growth areas of the next decade and will increasingly embrace entertainment and education, as well as business, as the world gets wired up. We can only surmise how careers will develop, but it will be an exciting growth area combining media knowledge with technical skills. Entry is possible through either media design or software experience and creativity is important.</p>	<p>Alternatives they may re-design or adapt existing products to satisfy the multimedia requirements.</p> <p>The designer may produce graphics, animation, audio, tactile or video interfaces depending on instruments.</p> <p>Planning, coordinating and overseeing acceptance testing, as well as integration and installation at the customer's site, could all be the best of the designer's role, as may be training and customer's support.</p>	<p>A high level of interaction is needed with the customers and the software communities (teams, universities). They must be willing to keep up-to-date on the state-of-the-art in human computer interaction and in audio, video, internet areas (e.g. by attending conferences or working with universities).</p>
<p><b>IT Business Consultancy</b></p>	<p>The Business Consultant is a person with good overall commercial experience, who helps clients develop IT solutions to further their business goals. Knowledge of business context, imperatives and drivers is as important as the potential of IT to address them. This is a hybrid role combining business acumen with technological experience. Initial positions are usually through positions in business systems analysis, gaining practice in understanding business processes, whilst learning how technology can be exploited to satisfy business needs. Some companies offer training programs to graduates of all disciplines to enable them to work in this domain.</p>	<p>The IT Business Consultant is responsible for ensuring that business needs are met when developing and implementing IT solutions. He/she has understanding of the business strategy and the IT solutions required to support it. The person entering this type of job also requires understanding of IT industry directions and technologies and demonstrates this in ways which can be used to build the required IT solutions. He/she ensures the solutions are implemented as required by the business.</p>	<p>Most people in this type of job work in the information management or application development department of a business organization. They typically work in teams, in short-term or in longer-term projects providing application development and support services to the business. The work involves a great deal of interaction with various parts of the organisation, negotiating, solving problems, defining and configuring optimum solutions, and communicating these to</p>

		<p>The IT Business Consultant is focused on analyzing, planning and developing IT solutions that support the business needs of the firm. He/she also participates in business planning; business needs analysis and business risk assessment. The IT Business Consultant also acts as an in-house consultant working with the various functional areas of an organization, providing advice and guidance on how to support the business operations through the effective use of IT.</p>	<p>business managers. In the initial phase of the career, most people in this kind of job have a supporting role in a project, but with increasing experience they get to play the leading role in various projects.</p>
<p><b>Technical Support</b></p>	<p>Just about everyone today in work, and increasingly for leisure and pleasure, relies on accessing information via computers. With increasing complexity of computer systems, build up of inter-connected hardware and software modules, systems sometimes fail. Occasionally it is a genuine systems failure, more often it is user misunderstanding or misoperation; whatever the situation has to be resolved and access restored. Technical Support Staff specializes in identifying, analyzing and fixing faults which prevent users connecting with their systems. And as new facilities develop, Technical Support Staff train users in the enhancements and how</p>	<p>Depending on their particular role, people in these jobs may be answering customer questions and concerns over the phone, or in person, either resolving the issues with the customer or referring the problem to other technical personnel. They may be responsible for the monitoring and tuning of the computer and telecommunication systems, for installing upgrades, and ensuring the day to day availability of any type of user applications, or computer and telecommunication systems or networks. They may be responsible for the operation of the computers,</p>	<p>Depending on their particular role, people in these jobs may be answering customer questions and concerns over the phone, or in person, either resolving the issues with the customer or referring the problem to other technical personnel. They may be responsible for the monitoring and tuning of the computer and telecommunication systems, for installing upgrades, and ensuring the day to day availability of any type of user applications, or computer and</p>



	<p>to maximize their potential and usability. Customer handling and good interpersonal skills are as important as technical know how and the desire to investigate and resolve problems. Careers starting in Technical Support can form a sound basis for either enhanced business or technical development. This is a useful entry point for those who wish to enter IT, but have no previous experience.</p>	<p>immediate problem solving and maintaining the service to the agreed levels. In some capacities they may be expected to contribute to user training and make recommendations about system upgrades.</p>	<p>telecommunication systems or networks. They may be responsible for the operation of the computers, immediate problem solving and maintaining the service to the agreed levels. In some capacities they may be expected to contribute to user training and make recommendations about system upgrades.</p>
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**Table 15 Examples of Jobs, Tasks and Types of Skills for the Software and Services**

	<b>Examples of Jobs</b>	<b>Tasks</b>	<b>Types of Skills</b>
<b>Software and Applications Development</b>	<ul style="list-style-type: none"> <li>• Application Programmer</li> <li>• Software (SW) Engineer</li> <li>• System Developer</li> <li>• Technical System designer</li> <li>• Software Architect</li> <li>• Maintenance &amp; Support Specialist</li> </ul>	<ul style="list-style-type: none"> <li>• Specifying user and functional requirements</li> <li>• Drawing up the plan of action for the structural design, the code development and other phases of the Software development cycle</li> <li>• Applying modern design methods and associated development tools</li> <li>• Developing the code and test algorithms and/or real-time control aspects in a modular way of working that follows the planned structure.</li> <li>• Analyzing system routines/modules, performance, memory size, etc. of (embedded) technical systems (when applicable).</li> <li>• Supporting project management</li> <li>• Building the System and the Sub-systems according to the design and the developed structure and modular set-up .</li> <li>• Building prototypes of (parts of ) the system.</li> </ul>	<p><b>Technical Skills</b></p> <ul style="list-style-type: none"> <li>• Computer Programming</li> <li>• Software Engineering</li> <li>• Embedded Systems</li> <li>• Business Requirements Analysis</li> <li>• Systems Design and Architecture</li> <li>• Project Management</li> <li>• Testing</li> <li>• Quality Assurance</li> <li>• Technical Documentation</li> <li>• Systems Development Tools</li> <li>• Systems Development Methods</li> </ul> <p><b>Behavioral Skills</b></p> <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Technical Orientation and Interest</li> <li>• Communication</li> <li>• Teamwork</li> <li>• Flexibility and Self Learning</li> <li>• Attention to Detail</li> </ul>

		<ul style="list-style-type: none"> <li>• Co-operating with the Systems Architect and/or System Designer.</li> <li>• Designing the module test(s), assisting in the design of the integration and installation test. Executing the system integration, integration testing and installation.</li> <li>• Developing and/or applying a version control procedure, installation procedure and make a full documentation set. Adding relevant documents like release bulletins.</li> <li>• Executing the technical introduction, the installation, final testing, system</li> <li>• Evaluating and arranging the Maintenance &amp; Support.</li> </ul>	<ul style="list-style-type: none"> <li>• Commitment to Excellence</li> <li>• Planning and Organisation</li> <li>• Problem Solving</li> </ul>
<p><b>Software Architecture and Design</b></p>	<ul style="list-style-type: none"> <li>• Software Programmer</li> <li>• Systems Developer</li> <li>• Systems Architect</li> <li>• Systems Architecture &amp; Design Scientist</li> <li>• Systems Integrator (creates specific products by putting components together)</li> </ul>	<ul style="list-style-type: none"> <li>• Establishing market requirements or enterprise needs.</li> <li>• Building architecture.</li> <li>• Designing solutions.</li> <li>• Designing &amp; testing prototypes.</li> <li>• Defining detailed specifications.</li> <li>• Creating &amp; testing solutions.</li> <li>• Creating maintenance and</li> </ul>	<p><b>Technical Skills</b></p> <ul style="list-style-type: none"> <li>• Software Engineering</li> <li>• Computing Systems Design</li> <li>• Mathematics</li> <li>• Computer Programming</li> <li>• Systems Design and Architecture</li> <li>• Systems Development Methods</li> </ul>

	<ul style="list-style-type: none"> <li>• Computer Scientist</li> </ul>	<ul style="list-style-type: none"> <li>• implementation plans.</li> <li>• Enhancing products.</li> </ul>	<ul style="list-style-type: none"> <li>• Technical Documentation</li> <li>• Applications Design Concepts</li> <li>• Database Concepts</li> <li>• Networking Concepts and Architectures</li> </ul> <p><b>Behavioral Skills</b></p> <ul style="list-style-type: none"> <li>• Technical Orientation and Interest</li> <li>• Analytical</li> <li>• Creative</li> <li>• Teamwork</li> <li>• Professional Attitude</li> <li>• Attention to Detail</li> </ul>
<b>Multimedia Design</b>	<ul style="list-style-type: none"> <li>• Multimedia Programmer</li> <li>• Multimedia Network Designer</li> <li>• Web Designer</li> <li>• Human Interface Designer</li> <li>• Multimedia Architect</li> <li>• Internet/Intranet, audio, video Engineer</li> </ul>	<ul style="list-style-type: none"> <li>• Analyzing enterprise or customer's needs.</li> <li>• Identifying, interpreting and evaluating requirements and specific constraints.</li> <li>• Identifying available media</li> <li>• Designing user interfaces.</li> <li>• Managing - with customers, team members and external agencies- interactive developments and integrating human factors and user interface for visual design.</li> <li>• Creating prototypes,</li> </ul>	<p><b>Technical Skills</b></p> <ul style="list-style-type: none"> <li>• Artistic Knowledge</li> <li>• Embedded Systems</li> <li>• Software Engineering</li> <li>• Systems Design and Architecture</li> <li>• Systems Development Methods</li> <li>• Applications Design Concepts</li> <li>• Networking Concepts and Architectures</li> </ul>

		<p>simulations or virtual environments with various multimedia technologies.</p> <ul style="list-style-type: none"> <li>• Redesigning and adapting existing products to fit into multimedia systems.</li> <li>• Creating or/and integrating media elements.</li> <li>• Producing graphics, animation, audio, tactile, video contents.</li> <li>• Identifying time and other constraints</li> <li>• Integrating, planning and co-coordinating acceptance testing, installation at the customer site with training and support.</li> </ul>	<ul style="list-style-type: none"> <li>• End User Interface</li> </ul> <p><b>Behavioral Skills</b></p> <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Creative</li> <li>• Relationships</li> <li>• Communication</li> <li>• Flexibility and Self Learning</li> <li>• Technical Orientation and Interest</li> </ul>
<p><b>IT Business Consultancy</b></p>	<ul style="list-style-type: none"> <li>• Enterprise Wide Information Specialist</li> <li>• Business Analyst</li> <li>• Business Architect</li> <li>• Application Specialist</li> <li>• I.T. Strategy Consultant</li> <li>• Strategic Information Management Consultant</li> <li>• Information Management</li> </ul>	<ul style="list-style-type: none"> <li>• Defining business requirements for the I.T. solution.</li> <li>• Defining I.T. strategy for the business, participating in business needs planning &amp; strategy process.</li> <li>• Identifying and defining opportunities to simplify improve or redesign business processes using I.T. solutions.</li> <li>• Analyzing, planning, configuring and developing I.T. solutions.</li> </ul>	<p><b>Technical Skills</b></p> <ul style="list-style-type: none"> <li>• Business Strategy Planning</li> <li>• Business Requirements Analysis</li> <li>• Process Improvement and Change Management</li> <li>• Software Engineering</li> <li>• Rollout Issue</li> </ul> <p><b>Behavioral Skills</b></p>

		<ul style="list-style-type: none"> <li>• Overseeing and co-coordinating various aspects of the solution including information flow, data security, business recovery, system implementation, and change management.</li> <li>• Defining and ensuring implementation of standards and processing across the organization in support of the solutions.</li> </ul>	<ul style="list-style-type: none"> <li>• Flexibility and Self Learning</li> <li>• Analytical</li> <li>• Creative</li> <li>• Communication</li> <li>• Negotiation</li> <li>• Persuasiveness</li> <li>• Teamwork</li> <li>• Problem Solving</li> </ul> <p>Strategy and Planning</p>
<b>Technical Support</b>	<ul style="list-style-type: none"> <li>• Computer Operator</li> <li>• Operations Analyst</li> <li>• Help Desk Operator</li> <li>• Problem Manager</li> <li>• Trouble-shooter</li> <li>• Configuration Management Specialist</li> <li>• Network Management Specialist</li> </ul>	<ul style="list-style-type: none"> <li>• Installing, configuring and testing new operating software, software applications and software upgrades.</li> <li>• Monitoring and maintaining computer systems and networks.</li> <li>• Document installation and configuration procedures, and maintenance schedule.</li> <li>• Troubleshooting system and network problems.</li> <li>• Interacting with users to assess technical problems and needs.</li> <li>• Interacting with vendors to assess technology products and resolve technical issues.</li> <li>• Managing system resolution</li> </ul>	<p><b>Technical Skills</b></p> <ul style="list-style-type: none"> <li>• Troubleshoot Technical Problems</li> <li>• Systems Design and Architecture</li> <li>• Networking Concepts and Architectures</li> <li>• Software Engineering</li> <li>• Hardware Knowledge</li> <li>• Technical Documentation</li> <li>• Computer Programming</li> </ul> <p><b>Behavioral Skills</b></p> <ul style="list-style-type: none"> <li>• Communication</li> <li>• Relationships</li> <li>• Problem Solving</li> </ul>

		<p>with users.</p> <ul style="list-style-type: none"> <li>• Researching technical solution alternatives and implement solutions.</li> <li>• Operating the computer system and networks.</li> <li>• Running network applications to support system and users.</li> <li>• Answering, or forwarding to appropriate personnel, user questions and feedback.</li> <li>• Documenting user issues and make recommendations for user training.</li> <li>• Making recommendations for system improvement.</li> <li>• Taking part in technical reviews, staff meetings and perform appropriate communication functions.</li> </ul>	<ul style="list-style-type: none"> <li>• Flexibility and Self Learning</li> <li>• Technical Orientation and Interest</li> <li>• Attention to Detail</li> <li>• Analytical</li> <li>• Initiative</li> </ul>
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**Table 16. Description of Future Opportunities**

	<b>Future Opportunities</b>
<b>Software &amp; Applications Development</b>	<p>With experience the role could involve more intensive customer requirements analysis and user interface aspects (become e.g. a full Multimedia Designer/Developer), or extend towards the more scientific side to fulfill computer science roles in e.g. research environments. A broadening of experience could lead to project manager/leader with a wider overview. This would be supported by extensive (project) management training. Also in the technical area positions like Systems Developer/Designer and Software-Architect would be career path development opportunities. These would also be based on the broader experience from various projects. A wide range of experience in the business is also a way to move into commercial functions in the I.T. area or become a Manager and/or an Entrepreneur.</p>
<b>Software Architecture and Design</b>	<p>Probably starting as a programmer either developing or enhancing a specific component on product, the professional can develop into building the design and possibly the architecture of products or even families of products. At this stage the person would be a recognized authority on a particular product within the company and possibly even within the industry.</p> <p>With some experience in this type of work there are also possibilities of developing a career along other lines such as:</p> <ul style="list-style-type: none"> <li>- Understanding how to satisfy customer needs in the market place and developing requirements for new capabilities and products. Experienced people in this field could end up setting overall directions for the development of product families or even a whole industry sector.</li> <li>- Project Management. This involves managing and controlling a team of developers. For successful individuals the size of projects being managed would increase and could end up</li> </ul>



	directing the activities of a whole development laboratory.
<b>Multimedia Design</b>	<p>To develop a career a graduate would need a few years of experience and also need a great deal of ability to:</p> <ul style="list-style-type: none"> <li>- innovate, to create in a perpetually changing technical environment;</li> <li>- to take a broad view of technologies and to use them in a project, and/or</li> <li>- willingness to keep up to date technically.</li> </ul> <p>This is a booming area where creativity will always be needed.</p> <p>The technical aspect of the career path progress might be:</p> <ul style="list-style-type: none"> <li>- Multimedia Programmer who is able to develop and implement elements in specific languages (e.g. HTML, Lingo, Java..) and use specific tools (FrontPage, Visual Tools, Illustrator...),</li> <li>- Multimedia Designer, Multimedia Analyst who is able to gather data to identify various customers requirements, Multimedia Architect who is able to use Software and Hardware technologies (including networks, mainframe and PC client server, internet.) and Multimedia Project Manager. Another step could be to provide technical support for other functions in the enterprise like communication and marketing to open up new market areas. A move into management could be another career development e.g. to become a Design Manager. A move into marketing or communication or training jobs would be yet another possibility.</li> </ul>

<p><b>IT Business Consultancy</b></p>	<p>The entry position in this career may typically be that of a Business Analyst. More experience with the business and process work leads to positions which focus on developing the business (Business Development Consultant). Some years' experience in various business related I.T projects is required for Project Manager's position. A broadening experience leads to work with I.T on the strategic level (IT Strategy Consultant).</p>
<p><b>Technical Support</b></p>	<p>Many Technical Support personnel start in technical call centers, answering user questions or referring them to more specialized technical departments. As they gain experience, they may move to specialized help desk areas where they deal with more complex technical questions. As they continue to gain experience, they become more closely involved with the system, installing, configuring and troubleshooting hardware and software: starting with user applications and progressively moving towards system operations. As they gain expertise, they are involved with more of the planning and optimizing of the system. With further education, they may choose to move towards careers such as network design and implementation specialists.</p> <p>As the Technical Support person develops expertise and a professional network of business contacts, some will choose to become consultants. Many consultants tend to specialize in one or two vendor systems and will often obtain certifications from these vendors to increase their demand in the computer Technical Support market.</p> <p>Some people with Technical Support background will choose to migrate in the area of user training.</p>

## 1.5 British Standard Occupational Classification - SOC2000

The Standard Occupational Classification (SOC2000) used in United Kingdom is based on ISCO-88 and uses the same coding for the “Information and Communication Technology Professionals” group of occupations.

### **213 Information And Communication Technology Professionals**

2131 IT strategy and planning professionals

2132 Software professionals

### **313 IT Service Delivery Occupations**

3131 IT operations technicians

3132 IT user support technicians

In 2006, there were around 960,000 people employed in IT occupations in the UK and 56,000 people employed in Telecoms occupations which accounted for 3.8% of UK employment. A continued increase in IT occupations is forecasted, at a rate of 1.5-2.2% per year. This growth is driven by IT services such as consulting and outsourcing (the transfer of IT functions to an external service provider). The growth in employment is due to:

- the creation of new jobs mainly within the IT industry;
- changes in job types within the IT workforce, such as geo-sourcing (the transfer of IT work and functions to across the world), increase in IT services and more “client-facing” roles;
- changing dynamics of IT professions within the IT industry and IT professionals working outside the IT industry.

The composition of IT occupations has changed over the last seven years and further changes are forecasted encompassing business, interpersonal and project skills and developing expertise in systems integration networking; and security. The most common IT professional job role in UK, ‘Software professional’ will increase by 2014, together with IT strategy and planning. In contrast, the share of ICT managers, IT operations technicians, IT user support occupations, Database assistants and Computer engineers is set to decline by 2014. Regionally, Greater London and the South East account for 38% of employment in IT and Telecoms occupations, which are expected to increase further by 2014.

- The UK needs to build a new IT skills development infrastructure through collaboration between government, educators, employers and employees.
- New delivery methods that integrate work-based, vocational and academic learning need to be development.
- There needs to be consideration of the difficulties of releasing employees from work (especially in small companies).
- Private training can not deliver the necessary IT skills development needed in the UK.
- Skills development and training courses must take account of those individuals who are at risk of exclusion.
- Employers and employees must share responsibility for skills development.

The UK government's WorkTrain is an information system containing recruitment, occupational, and job-training information.

Some IT job profiles covering tasks, skills and interests are attached to the Annex 2 and include the following positions:

- computer service and repair technician;
- database developer/administrator;
- information scientist;
- IT security coordinator;
- IT support technician;
- network engineer;
- software developer;
- systems analyst.

### 1.6 Comparison of American, European and British Job Profiles

The comparison of the American and British IT job profiles (Tables 17, 18) particularly for the position of “**Systems Analyst**” shows some differences. The American job profile includes much more detailed tasks as ten tasks are anticipated in American job profile against only six tasks in British profile.

**Table 17 Tasks according to US and UK Job Profiles for Systems Analyst**

US	UK
1. Provide staff and users with assistance solving computer related problems, such as malfunctions and program problems.	1. Drawing up specific proposals for a modified or replacement system
2. Test, maintain, and monitor computer programs and systems, including coordinating the installation of computer programs and systems.	2. Carrying out commercial feasibility assessments of proposals
3. Use object-oriented programming languages, as well as client/server applications development processes and multimedia and Internet technology.	3. Working closely with programmers and developers who build the system
4. Confer with clients regarding the nature of the information processing or computation needs a computer program is to address.	4. Overseeing the installation of a new system

5. Coordinate and link the computer systems within an organization to increase compatibility and so information can be shared.	5. Planning and working to a completion deadline
6. Consult with management to ensure agreement on system principles.	6. Providing training and training manuals to users of a new or upgraded system.
7. Expand or modify system to serve new purposes or improve work flow.	-
8. Interview or survey workers, observe job performance and/or perform the job in order to determine what information is processed and how it is processed.	-
9. Determine computer software or hardware needed to set up or alter system.	-
10. Train staff and users to work with computer systems and programs.	-

**Table 18. Skills according to US and UK Job Profiles for Systems Analyst**

<b>US</b>	<b>UK</b>
<b>Knowledge and Skills</b>	<b>Skills and Interests</b>
1. Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.	1. Extensive knowledge of hardware, software and programming
2. Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.	2. Be able to gather and interpret data
3. Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.	3. Excellent communication skills, for discussing ideas with colleagues from technical and non-technical roles, and clients
4. Knowledge of design techniques,	4. Excellent analytical skills and

tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.	creative approach to problem solving
5. Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.	5. Good negotiating skills
6. Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.	6. Be able to plan and manage a project
7. Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.	7. Have an appreciation of wider business demands
8. <b>Active Learning</b> — Understanding the implications of new information for both current and future problem-solving and decision-making.	9. Be able to work within a budget
10. <b>Reading Comprehension</b> — Understanding written sentences and paragraphs in work related documents.	11. Be willing to update skills in line with developments within the sector
12. <b>Complex Problem Solving</b> — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	13. Be able to work as part of a team.
14. <b>Critical Thinking</b> — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.	-
15. <b>Active Listening</b> — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.	-
16. <b>Troubleshooting</b> — Determining causes of operating errors and deciding what to do about it.	-
17. <b>Service Orientation</b> — Actively looking for ways to help people.	-
18. <b>Time Management</b> — Managing one's own time and the time of others.	-
19. <b>Monitoring</b> — Monitoring/Assessing one's performance, other individuals, or organizations to make	-

improvements or take corrective action.	
<b>20. Quality Control Analysis</b> — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.	-

Required knowledge and skills in the American job profile for *Systems Analyst* also considerably exceed skills and interests in the British profile (20 skills and knowledge are mentioned against only 13 skills in the British job profile). Some skills are missed in American profile as communication and negotiating skills while detailed other skills – in the British job profile.

The comparison of the IT career clusters and IT core curriculum carried out by National Workforce Center of Emerging Technologies in USA and IT core skills developed by EU Career Space consortium shows that there are some common IT skills or clusters.

### **IT Common Skills and Clusters in US and EU**

- Digital Design and Digital Media
- Technical Support
- Network Design and Administration; Network Technologies
- Project Management
- Research
- Programming
- Software Engineering, (Software Architecture and Design, Software and Applications Development)
- Systems Analysis and Integration
- IT Business Consultancy (Business Organization and Environment)

## **2 CURRENT PRACTICES OF CERTIFICATION IN THE IT INDUSTRY**

### **2.1 IT Certification in United States**

Technical or professional certification is a best way to earn official recognition of new skills or the way by which employers ensure the competency or quality of computer professionals. According to SmallTech magazine if you don't have the latest skills in information technologies then you are the equivalent of the immigrants coming to the New-York harbor for the first time.

Certification can be obtained voluntarily, although many vendors now offer employees help in becoming certified or even require professionals who work with their products to be certified.

Voluntary certification is available through many different types of organizations. Hundreds of different certifications are available, ranging from a certified Internet Webmaster to a certified networking professional. Although professional certification is not mandatory, it may provide a jobseeker a competitive advantage. Also, government, academic institutions, and other employers increasingly seek workers with certifications in

information security, reflecting the importance of keeping complex computer networks and vital electronic infrastructure safe from intruders.

Certification is a byproduct of competency. Certification, in itself, is not a goal, but Professionalism is.

The forces driving growth in IT professional certification are the development of technology, business pressures, Government policy. As the results of international studies show, the main reasons for seeking certification include professional growth (45.3%), credential (37.3 %), self-evaluation (5.1%), while the financial reward is gained only 0.4%.

Nevertheless, the certified professionals averaged a 16.3% salary increase in 2005 in USA.

**Benefits of certification are:**

- A practical means of assessing skills and experience;
- Support to career advancement and compensation, improving job opportunities in a tight labor market;
- An opportunity to test your knowledge in a specific area of the profession by sitting for a specialty exam to just earn a proficiency certificate.

In general, the international certifications are provided in four major industry quadrants: Systems Development, Media, Operations and Engineering.

**Table 19. Vendor & Generalized Certifications by Major Industry Quadrants**

	<b>Certification</b>	<b>IT Skills</b>
<b>Systems Development</b>	<ul style="list-style-type: none"> <li>• CCP, I.S.P., CDMP, CBIP</li> <li>• Oracle Certification</li> <li>• MCSD, MCDBA</li> </ul>	<ul style="list-style-type: none"> <li>• I.T. Management</li> <li>• Programmer-Analyst</li> <li>• Business &amp; Systems Analysis</li> <li>• Data and Process Modeling</li> </ul> <p>Data Warehousing</p>
<b>Media</b>	<ul style="list-style-type: none"> <li>• CCP, I.S.P., CDMP, CBIP</li> <li>• Web Master Certification</li> <li>• Internet +</li> <li>• Adobe, Macro-Media</li> </ul>	<ul style="list-style-type: none"> <li>• Advertising &amp; Image Design</li> <li>• Multimedia Developer</li> <li>• Web Master-Web Designer</li> <li>• Radio, Film &amp; TV Arts</li> <li>• Printing and Publishing</li> <li>• Graphics &amp; Animation</li> </ul>



**Table 19 (continued)**

<b>Operations</b>	<ul style="list-style-type: none"> <li>• CCP, I.S.P., CDMP, CBIP</li> <li>• Linux UNIX, MCSE, CNE</li> <li>• A+, Network+</li> <li>• International Computer Drivers License (ICDL)</li> </ul>	<ul style="list-style-type: none"> <li>• Linux/Unix Administrator</li> <li>• Computer &amp; Network Administrator</li> <li>• Systems Support Analyst</li> <li>• Service Technician</li> <li>• Call Center Support</li> </ul>
<b>Engineering</b>	<ul style="list-style-type: none"> <li>• CCP, I.S.P., CDMP, CBIP</li> <li>• Unix, AS/400 Certification</li> <li>• Cisco, Intel Networking Communications Certification</li> </ul>	<ul style="list-style-type: none"> <li>• Telecomm &amp; Network Design</li> <li>• Computer Engineering</li> <li>• Network Engineering</li> <li>• Processor Design</li> <li>• Process Control and Design</li> <li>• Software Engineering</li> </ul>

The sources of training supporting acquisition of the certifications are the following:

1. Cisco: [www.cisco.com/go/certification](http://www.cisco.com/go/certification).
2. Microsoft: [www.microsoft.com/traincert](http://www.microsoft.com/traincert).
3. Novell: [www.novell.com/training/certinfo](http://www.novell.com/training/certinfo).
4. CompTIA: [www.comptia.org/certification](http://www.comptia.org/certification).
5. Oracle: [www.oracle.com/education/certification](http://www.oracle.com/education/certification).
6. Macromedia: [www.macromedia.com/support/training/certified\\_professional\\_program/](http://www.macromedia.com/support/training/certified_professional_program/).
7. Sun Microsystems: [suned.sun.com/US/certification](http://suned.sun.com/US/certification).
8. Apple Computer: [www.apple.com/training](http://www.apple.com/training).
9. (ISC)2 CISSP: <http://www.isc2.org/>.
10. Certified Wireless Network Professional (CWNP): <http://www.cwne.com/>.
11. Institute for Certification of Computing Professionals (ICCP)
12. Hands On Technology Transfer Inc. (HOTT): [www.traininghott.com](http://www.traininghott.com)
13. Linux Professional Institute (LPI)
14. ETA (Electronics Technicians Association) and Motorola Computer Group (MCG)

### **Classification of certifications**

US certification programs include:

- performance-based programs;
- new and technically advanced programs;

- entry-level programs;
- specialty programs;
- vendor-neutral programs;
- recertification programs.

**Performance-based (hands-on) certification programs.** Certification demands demonstration of skills and knowledge as a part of an exam, involve on-the-spot analysis and problem-solving skill.

1. Cisco Certified Internet work Expert (CCIE) and Cisco Career Certifications (Associate, Professional and Specialist);
2. Red Hat Certified Engineer (RHCE);
3. Novell Certified Directory Engineer (CDE);
4. Oracle9i DBA Certified Professional and Database Administrator Certified Master (OCM);
5. Field Certified Systems Engineer (FCSE), Field Certified Systems Administrator (FCSA) and Field Certified PC Technician (FCPT);
6. Certified Professional Information Technology Consultant (CPITC):

**New and technically advanced certification programs:** Some certifications require deep skills and knowledge, at least 8-10 years of relevant work experience. These new certification programs comprise innovative topics.

1. ASIS International (the American Society for Industrial Security)
2. NACSE (National Association of Communication Systems Engineers) and NARTE (National Association of Radio & Telecommunications Engineers): HP Master Accredited Systems Engineer (Master ASE)
3. (ISC)2 Certified Information Systems Security Professional (CISSP)
4. Sun Certified Enterprise Architect for the Java 2 Platform, Enterprise Edition:.
5. EC-Council Certified Ethical Hacker (CEH): Apple Certified Technician for Pro Products
6. Dell Certified Enterprise Engineer (DCEE)
7. Sun Business Component Developer:
8. CompTIA Security+

**Entry-level certification programs.** All these certifications are starting for IT professionals and particularly include: Cisco Certified Network Associate (CCNA), Sun Certified Programmer for the Java 2 Platform (SCJP), Red Hat Certified Technician (RHCT), CompTIA A+, and Microsoft Certified Professional (MCP).

### **Specialty certification programs**

Specialty certifications are designed for intermediate- to senior-level IT professionals to focus on relatively narrow subject areas.

1. Cisco Specialist Certifications: Areas - broadcast media, telephony, firewalls, virtual private networks (VPNs), wireless technologies.
2. Project Management Professional (PMP): An increasingly important adjunct certification for IT professionals from all parts of the industry, from services to

- development jobs. CISSP Concentrations: Areas - security engineering, architecture and management.
3. IBM Tivoli Software Program: Tivoli Management Environment (TME)
  4. HP Accredited Systems Engineer (ASE) and Master ASE: Topics: from systems management to high availability and clustering to DBMS platforms.
  5. IBM DB2 Universal Database Certifications: A top IBM platform
  6. Microsoft MCSA/MCSE Specializations: Specializations in security and messaging for Windows 2000 and Windows Server 2003.

### **Vendor-neutral certification programs**

The following industry or professional organizations with strong roots in academia and in industry maintain vendor-neutrality: Brainbench, NACSE, NARTE, Project Management Institute (PMI), Field Certified Professional Association (FCPA), Information Systems Audit and Control Association (ISACA), BICSI, Service & Support Professionals Association (SSPA), Linux Professional Institute (LPI), The Computing Technology Industry Association (CompTIA).

**Institute for Certification of Computing Professionals (ICCP)** located in Des Plaines (Chicago) is the world's leading and authoritative certification body for ICT professionals. ICCP was established in 1973 as an independent certification organization by the major professional associations in North America to provide centralized exam development and testing for the Information and Communications Technology industry.

The ICCP examinations are available at over 250 test centers throughout North America.

**Core IT skills** mandatory for CCP designation include:

- Microcomputing and Networks
- Communications
- Business Information Systems
- Database Administration
- Data Management
- Data Resource Management
- Data Warehousing
- Integrated Project Management
- T. Management
- Object Oriented Analysis and Design
- Procedural Programming Systems Development
- Office Information Systems
- Software Engineering
- Systems Security
- Operating Systems Programming

ICCP offers four (experience based, professional level) professional credentials, the Certified Business Intelligence Professional (CBIP), Certified Computing Professional – CCP, Certified Data Management Professional - CDMP and two (entry level); the Associate Computing Professional-ACP; and Information Systems Analyst (ISA) for graduates of 4 year university programs. Additionally “Expert – Mastery proficiency” level credentials in specialized computing areas and in programming languages are offered.

## The Microsoft Certifications

Microsoft in collaboration with Microsoft Certified Technical Education Centers (Microsoft Certified Partners for Learning Solutions programs) and Microsoft Certified Trainers (MCTs) provide training and offer a wide range of certifications covering the spectrum of professions within the IT industry.

Six steps to Microsoft certification include:

- I Decide the type of certification
- II Gain hands-on experience with Microsoft products (6 months or more)
- III Expand experience with training
- IV Know what to expect on exams
- V Take a trial run with a practice test
- VI Take required exams

**Table 20 Microsoft Certifications**

<b>MCTC</b>	Microsoft Certified Technology Specialist (MCTS) certifications enable professionals to target specific technologies and to distinguish themselves by demonstrating in-depth knowledge and expertise in the various Microsoft specialized technologies.
<b>MCITP</b>	The Microsoft Certified IT Professional (MCITP) certifications demonstrate comprehensive skills in planning, deploying, supporting, maintaining, and optimizing IT infrastructures.
<b>MCPD</b>	The Microsoft Certified Professional Developer (MCPD) credentials distinguish you as an expert Windows Application Developer, Web Application Developer, or Enterprise Applications Developer. These credentials demonstrate that you can build rich applications that target a variety of platforms using Microsoft .NET Framework 2.0.
<b>Microsoft Certified Architect Program</b>	Microsoft Certified Architect Program targets practicing solutions architects and infrastructure architects who successfully apply frameworks and methodologies to create architecture through the entire IT life cycle.
<b>MCDST</b>	Microsoft Certified Desktop Support Technicians (MCDSTs) have the technical and customer service skills to troubleshoot hardware and software operation issues in Microsoft Windows environments.

<b>MCLC</b>	The Microsoft Certified Learning Consultant (MCLC) credential recognizes MCTs whose job roles have grown to include frequent consultative engagements with customers. These MCTs are experts in designing and delivering customized learning solutions.
<b>MCSA</b>	Microsoft Certified Systems Administrators (MCSAs) administer network and systems environments based on the Microsoft Windows operating systems. Specializations include MCSA: Messaging and MCSA: Security.
<b>MCSE</b>	Microsoft Certified Systems Engineers (MCSEs) design and implement an infrastructure solution that is based on the Windows operating system and Microsoft Windows Server System software. Specializations include MCSE: Messaging and MCSE: Security.
<b>MCDBA</b>	Microsoft Certified Database Administrators (MCDBAs) design, implement, and administer Microsoft SQL Server databases.
<b>MCT</b>	Microsoft Certified Trainers (MCTs) are qualified instructors who are certified by Microsoft to deliver Microsoft training courses to IT professionals and developers.
<b>MCAD</b>	Microsoft Certified Application Developers (MCADs) use Microsoft technologies to develop and maintain department-level applications, components, Web or desktop clients, or back-end data services.
<b>MCSD</b>	Microsoft Certified Solution Developers (MCSDs) design and develop leading-edge business solutions with Microsoft development tools, technologies, platforms, and the Microsoft Windows architecture.
<b>Microsoft Office Specialist</b>	Microsoft Office Specialists (Office Specialists) are globally recognized for demonstrating advanced skills with Microsoft desktop software.

There are 13 Microsoft Competencies available today (Table 21).

**Table 21 Microsoft Competencies**

Competencies	Specializations	
<b>Advanced Infrastructure Solutions.</b>	<ul style="list-style-type: none"> <li>• Active Directory and Identify Management</li> <li>• Exchange Migration and Deployment</li> </ul>	<ul style="list-style-type: none"> <li>• Hosting Solutions</li> <li>• Storage Solutions</li> <li>• Systems Management</li> </ul>
<b>Business Process and Integration</b>		
<b>Custom Development Solutions</b>	<ul style="list-style-type: none"> <li>• Application Infrastructure Development</li> </ul>	<ul style="list-style-type: none"> <li>• Smart Client Development</li> <li>• Web Development</li> </ul>
<b>Data Management Solutions</b>	<ul style="list-style-type: none"> <li>• Business Intelligence</li> </ul>	<ul style="list-style-type: none"> <li>• Database Management</li> </ul>
<b>Information Worker Solutions</b>	<ul style="list-style-type: none"> <li>• Enterprise Project Management</li> <li>• Messaging and Collaboration</li> <li>• Office Smart Client Development</li> </ul>	<ul style="list-style-type: none"> <li>• Office System Desktop Deployment</li> <li>• Portals and Enterprise Content Management</li> </ul>
<b>ISV/Software Solutions</b>		
<b>Learning Solutions</b>		
<b>Licensing Solutions</b>	<ul style="list-style-type: none"> <li>• License Delivery</li> </ul>	<ul style="list-style-type: none"> <li>• Software Asset Management</li> </ul>
<b>Microsoft Business Solutions</b>	<ul style="list-style-type: none"> <li>• Microsoft Business Solutions—Axapta</li> <li>• Microsoft CRM</li> <li>• Microsoft Business Solutions—C5</li> </ul>	<ul style="list-style-type: none"> <li>• Microsoft Business Solutions—Great Plains</li> <li>• Microsoft Business Solutions—Navision</li> <li>• Microsoft Business Solutions—Solomon</li> </ul>
<b>Mobility Solutions</b>		
<b>Networking Infrastructure Solutions</b>		
<b>OEM Hardware Solutions</b>	<ul style="list-style-type: none"> <li>• System Building</li> </ul>	<ul style="list-style-type: none"> <li>• Device Manufacturing</li> </ul>
<b>Security Solutions</b>	<ul style="list-style-type: none"> <li>• Infrastructure Security</li> </ul>	<ul style="list-style-type: none"> <li>• Security Management</li> </ul>

## Brainbench Certifications

Brainbench is the global leader in measuring the individual skills and abilities with more than 5.5 million registered users and more than 600 different assessments. The number of certified individuals made up 303,651 from 179 countries.

Brainbench is best known for its information technology assessments amongst employers using Brainbench for pre-employment testing purposes. Thus the IT rankings include certifications in 6 major skill areas:

- Database Development and Administration;
- Programming and Development;
- Systems and Network Administration;
- Technical Support;
- Telecommunications;
- Web Development and Administration

Certification implies passing score of  $\geq 2.75$  out of 5 on a Brainbench assessment and nearly half of individuals passed Brainbench certification assessments.

The most popular skills for IT job function are listed below.

**Table 22 Most Popular Skills for IT job Function by Brainbench**

<b>1</b>	<b>Database Development and Administration</b>	<ul style="list-style-type: none"> <li>• RDBMS Concepts</li> <li>• Oracle PL/SQL</li> <li>• SQL (ANSI) Fundamentals</li> <li>• SQL (ANSI)</li> <li>• MS SQL Server 2000 Programming</li> </ul>
<b>2</b>	<b>Programming and Development</b>	<ul style="list-style-type: none"> <li>• 1.C++</li> <li>• Java 2 Fundamentals</li> <li>• C++ Fundamentals</li> <li>• 4.C</li> <li>• 5.C#</li> </ul>
<b>3</b>	<b>Systems and Network Administration</b>	<ul style="list-style-type: none"> <li>• Networking Concepts</li> <li>• Linux Administration (General)</li> <li>• Unix Administration (General)</li> </ul>

		<ul style="list-style-type: none"> <li>• Internet Security</li> <li>• MS Windows Server 2003 Administration</li> </ul>
4	<b>Technical Support</b>	<ul style="list-style-type: none"> <li>• MS Windows XP Desktop Administration</li> <li>• Computer Technical Support</li> <li>• Technical Help Desk</li> <li>• Computer Electronics</li> <li>• Network Technical Support</li> </ul>
5	<b>Telecommunications</b>	<ul style="list-style-type: none"> <li>• Cisco Network Support</li> <li>• Telecommunications Industry Knowledge</li> <li>• LAN/WAN Communications</li> <li>• IP Routing &amp; Switching</li> <li>• 5.WAN Technologies</li> </ul>
6	<b>Web Development and Administration</b>	<ul style="list-style-type: none"> <li>• ASP.NET</li> <li>• HTML 4.0</li> <li>• PHP 4</li> <li>• Java Server Pages (JSP 1.2)</li> <li>• Web Design Concepts</li> </ul>

The U.S., India, and Russian Federation are the countries with the most Brainbench certifications, accumulating the largest portion of competent and available IT resources.<sup>9</sup> The United States are leading in 24 of the 30 IT categories, dominating in MS Excel 2002, Technical Help Desk, MS Windows XP Desktop Administration, Computer Tech Support, and Web Design Concepts. However, during the last two years certifications in India increased over 300% and India is leading in 6 skill areas, including all three Java programming competencies. India is also emerging not just as a recipient of instructions but as a leading center of technological innovation.

IT competence is a significant economic factor and an engine for economic development and prosperity for all countries but especially for newly independent countries including Armenia. Development of new knowledge and skills-based economies stimulates development of a skilled and competitive labor force. According to data from the Global Skills Report 2005 on country ranking based on number of certifications received, Armenia with 939 certifications is ranked as 20-th country in the world leaving behind such countries as France, Italy, Sweden, Norway and Mexico. Armenia also takes 4-th position among the CIS countries giving in only to Russia, Ukraine and Belarus (see Table 23). However, considering certifications as a percentage of population, evidently Armenia takes more advanced positions along with Baltic countries, Bulgaria, Romania, USA and Belarus (see Table 23)

**Table 23 Share of population having certifications (%)\***

<sup>9</sup> Brainbench's Global Skills Report 2005, Brainbench Inc., 2005, p. 4.



		Number of population (mln)	Number of certifications	Certifications as % of population
1	Latvia	2.3	4742	0.207
2	Bulgaria	7.45	5276	0.071
3	Estonia	1.3	883	0.068
4	Romania	22.3	12720	0.057
5	Lithuania	3.4	1805	0.053
6	USA	299.0	125722	0.042
7	Belarus	10.3	3724	0.036
8	<b>Armenia</b>	<b>3.2</b>	<b>939</b>	<b>0.029</b>
9	Canada	32.3	8872	0.027
10	Ukraine	46.5	10551	0.023
11	UK	59.7	8093	0.014
12	Australia	20.2	2635	0.013
13	Russia	143.4	16037	0.011
14	Philippines	83.1	4795	0.006
15	India	1122	60771	0.005
16	Poland	38.5	1330	0.003
17	Germany	82.7	2139	0.003
18	South Africa	47.4	1082	0.002
19	Pakistan	157.9	3235	0.002
20	Indonesia	222.8	3562	0.002
21	Mexico	107.0	937	0.001
22	Brazil	186.4	1168	0.001

\* Source: Brainbench's Global Skills Report 2005, author's calculations.

At the same time the results of the company needs assessment by the Economy and Values Research Center in RA showed that the most important workforce problems that the employers face are the problems of finding staff with adequate vocational training.

### Linux Certifications

Linux is a major operating system and currently there are more web servers running on Linux than on any other operating system. According to a recent study, more than 75% of the fortune 500 companies have already deployed Linux or consider doing so in near future.

Along with this growing Linux deployment the demand for certified specialists increased. Currently there are three major organizations providing Linux Certification:

- Linux Professional Institute (LPI)
- CompTIA (Linux+)
- Red Hat

LPI is a non-profit organization, dedicated to creating the best and standardized Linux Certification. LPI has developed and currently offers two levels of certification: for experienced system and network administrators at the intermediate and advanced levels, LPI Level 1 and LPI Level 2.

LPI Level 1 certified professionals will be able to:

- Work at the UNIX command line, and perform routine maintenance tasks;
- Perform backups and restores and perform shutdowns & reboots;
- They should be able to install and configure a workstation and connect it to the LAN, or connect a stand-alone PC via modem to the Internet

LPI Level 2 certified professionals will be able to:

- Administer a small to medium-sized site;
- Plan, implement, maintain and troubleshoot a small network;
- Advise management regarding issues such as automation and purchases

Linux+ certification program offered by CompTIA is aimed at entry level Linux professionals. CompTIA's focus is towards help desk personnel.

Red Hat is the only major distribution vendor which is currently providing a certification for its own distribution.

### **Motorola Computer Group (MCG) Certifications**

Motorola Computer Group (MCG), headquartered in Tempe (Arizona), is the world's leading supplier of embedded computing platforms to OEMs for use in telecommunications applications, network storage, imaging, medical equipment, and semiconductor production and test equipment ( <http://www.motorola.com/computer>). In 1999 sales amounted to 33.1 billion USD.

In cooperation with Motorola, the Electronics Technicians Association (ETA) provides both basic and advanced certifications for Motorola Technicians and Service Stations. ETA certified technicians meet international electronics industry standards and are hired first by thousands of employers.

The following certifications are available: Computer Service Technician (CST), Certified Network Computer Technician (CNCT), Certified Network Systems Technician (CNST), Certified Web Specialist (CWS), and E-Commerce Developer (ECD).

### **SUN Microsystems Certifications**

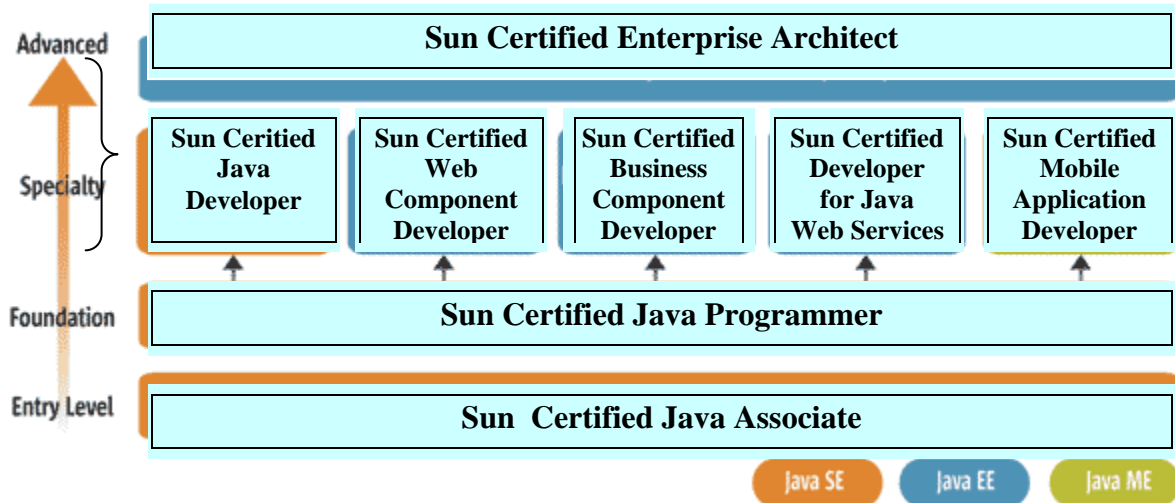
Sun's certification program in Java technology is an industry recognized, worldwide program that focuses on critical job roles in software application development and enterprise architecture. Sun offers the following Java technology professional certifications for entry level, specialty and advanced:

- Sun Certified Java Associate (SCJA) - **Entry level**
- Sun Certified Java Programmer (SCJP) – **Foundation**
- Sun Certified Java Developer (SCJD)-
- Sun Certified Web Component Developer (SCWCD)

- Sun Certified Business Component Developer (SCBCD)
- Sun Certified Developer For Java Web Services (SCDJWS)
- Sun Certified Mobile Application Developer (SCMAD)
- Sun Certified Enterprise Architect (SCEA) – **Advanced**

**Specialty**

**Graph 3 Types of Sun Java Technology Certification**



**IBM Certifications**

IBM offers a variety of certifications. The certifications currently available from IBM, are organized by "levels of difficulty" (Entry, Intermediate, and Advanced).

- IBM Certified Specialist or IBM eServer Certified Specialist **Entry level**
- IBM Certified Specialist or IBM eServer Certified Specialist – **Intermediate, Advanced levels**

Required knowledge and skills for certification as an IBM Certified Associate Developer include basic knowledge of Java development and Web development.

The IBM Certified XML Developer has a strong understanding and knowledge of XML fundamentals, concepts and related technologies, information modeling, XML processing, rendering and XML query.

**Cisco Systems Certifications**

The Cisco Systems provides General and Focused certifications. Three levels of general certification with increasing level of expertise are: Associate (Foundation), Professional (Advanced), and Expert (Highest level of achievement) (Table 24). Different certification

paths across these levels include Routing and Switching, Design, Network Security, Service Provider and Storage Networking.

**Table 24 Cisco general certifications\***

General Certifications			
Certification Paths	Associate	Professional	Expert (CCIE)
Routing & Switching	CCNA	CCNP	CCIE Routing & Switching
Design	CCNA & CCDA	CCDP	None
Network Security	CCNA	CCSP	CCIE Security
Service Provider	CCNA	CCIP	CCIE Service Provider
Storage Networking	CCNA	none	CCIE Storage Networking
Voice	CCNA	CCVP	CCIE Voice

\*Source: [Introduction-Career Certifications & Paths - Cisco Systems.](#)

In addition, a variety of Specialist focused certifications requiring knowledge in specific technologies are provided by Cisco Systems.

According to the results of the IT workforce capability assessment survey (CIO Council, December 2004) nearly one-third of certified IT specialists in the US were certified in Network Support, Project Management, Operating Systems, Computing, Information Systems and Information Systems Security. The following types of certification and certification areas were identified:

1. **Business Applications** - PeopleSoft, SAP, Oracle, Lotus, Citrix
2. **CIO** - Chief Information Officer Certificate, GSA CIO University Program
3. **Computing** - Computer Service, Repair, Data Processing, Document Imaging, CompTIA A+, Certified Computing Professional (Institute for Certification of Computing Professionals)
4. **Database** - Microsoft MCDBA, Oracle Certified Database Administrator, IBM DB2 Database Administrator
5. **Engineering** - Licensed Engineer
6. **Evidence Collection** - Certified Electronic Evidence Collection Specialist
7. **Healthcare** - Certified Professional in Healthcare Information and Management Systems
8. **Information Systems** - CISA (Certified Information Systems Auditor), Certified System Professional, Certified Administrator, Certified Systems Engineer, Certified Solutions Architect, Microsoft MCSA, Dell DCSE, Certified Java Developer, Certified Information System Auditor Certificate
9. **Information Systems Security** - Information Systems Security Professional (CISSP), Information Systems Security Associate (ISSA), Systems Security Certified Practitioner (SSCP), Systems Security Professional NSTISSI No. 4011 Certificate (NDU / IRMC), Checkpoint
10. **Mechanical** - Certified Mechanical Inspector

11. **Network Security** - Security Certified Network Architect, Security Certified Network Professional, Certified Network Support/Administration, Certified Firewall Analyst, Certified Intrusion Analyst, Certified Incident Handler, Certified Windows Security Administrator, Certified UNIX Security Administrator
12. **Network Support** - Certified Professional, Certified Call Center Manager, Certified Help Desk Director, Certified Help Desk Manager, Certified Help Desk Professional, Certified Network Administrator, Novell (various), Netware, Cisco (various), Microsoft MCSE
13. **Operating Systems** - Microsoft MCSE, IBM AIX, Sun Solaris, HP-UX, Linux, Red Hat Certified Engineer, SCO Certification
14. **Project Management** - Project Management Institute (PMI), Defense Acquisition University (DAU), other equivalent Project Management Certification, Advanced Management Program (NDU / IRMC), eGovernment Leadership Certificate Program (eGOV) (NDU / IRMC)
15. **Quality** - Certified Quality Auditor, Certified Quality Auditor - Hazard Analysis Critical Control Point, Certified Quality Engineer, Certified Quality Improvement Associate, Certified Quality Technician, Certified Reliability Engineer, Certified Software Quality Engineer, Strategic & Tactical Advocates for Results
16. **Software Development** - Certified Software Development Professional, Microsoft MCSD, Certified Java Developer
17. **Training** - Certified Technology Trainer, Microsoft Certified Trainer
18. **Web** - HyCurve Web Design Specialist, Prosoft CIW (Certified Internet Webmaster), Master Certified Webmaster, USDA Graduate School Webmaster Certification.

## 2.2 IT Certification in Europe

According to European Computer Driving License Foundation (ECDL) a major strategic goal for 2010 is to become the most competitive and dynamic knowledge-based economy in the world, creating a digitally literate Europe, and an establishment of European diploma for basic information technology skills, with decentralized certification procedures (see Graph 4). The ECDL is recommended as a Europe wide basic accreditation scheme and a measure of digital literacy.

**Graph 4. A way forward in certification in Europe**



The European Certification of Informatics Professionals (EUCIP) is a professional certification and competency development scheme, aimed at IT-professionals and practitioners. It has a vocational structure for IT and non-IT industry and is financed by CEPIS (Council of Europe Professional Informatics Societies), CEPIS member societies and the European Commission.

#### **EUCIP Goals**

- Use an industry-driven vocational structure and standards for the IT profession
- Establish a sustainable European services network for IT competence development
- Be a vehicle for life-long learning and competency enhancement for the IT profession

A market validation project was successfully completed in Norway, Ireland, Germany, Italy, Finland, and Greece.

EUCIP certificates are provided:

- after the completion of the core level (3 modules) - EUCIP foundation certificate
- per vocational category, ISM (Industry Structure Model) EUCIP certified professional.

IT Competency developing building blocks include courses, schools, self-study, e-learning schemes, accreditation of professional development schemes, e.g. ISEB, SFIA, EXIN, AIG.

### **Irish Case**

Within the National Qualifications Authority (NQA) the following Irish Certification bodies under 1999 Qualifications Act can be considered:

- HETAC (Higher Education Training and Awards Council)
- Dublin Institute of Technology
- Universities
- FETAC (Further Education Training and Awards Council)
- Department of Education

SKILLSCERT is a program that enables individuals and organizations to profile, validate and certify their job roles and skills to a recognized standard, as ICT professionals.

SKILLSCERT was developed in response to a number of issues which cause concern in the ICT industry:

- Job roles lack definition according to an industry standard
- The essential nature of job roles remains constant amid technological change
- Job roles are frequently defined solely by the technology being used
- Non-technical roles and skills of ICT practitioners have not been routinely identified or described
- Many ICT professionals develop important skills in an informal way
- The professional experience of the ICT practitioner has not been recognized or accredited
- Planning career paths is a challenging task for ICT practitioners
- ICT practitioners have not experienced the sense of belonging to a profession

SKILLSCERT utilizes a custom built online application to enable ICT practitioners to profile their particular skill sets related to their jobs and the level of responsibility. The certification of an individual's skills is followed by the independent verification of the profile by ICS (Irish Computer Society) SKILLS.

SKILLSCERT comprises three key elements including a common language to define job roles, a standardized methodology, with process and product benefits, a custom, online software application to streamline and simplify the procedure.

SKILLSCERT utilizes the SFIA – the Skills Framework for the Information Age., which was developed by e-Skills UK, in partnership with industry leaders including the British Computer Society, BT Cellnet, Cisco Systems, Department of Trade and Industry, IBM, ICL (Fujitsu), Nortel, Oracle, Orange, QA Training and Vodafone.

Industry e-Skills Certifications in Ireland in 2003 comprised of the following types:

MOUS / MOS, CompTIA, Prosoft / C.I.W, ECDL, Microsoft Certified Professional, Linux Professional, City & Guilds, IC3, JAVA Programmer.

## **2.3 The International Certifications Most Relevant for the Goals of the Armenian IT Industry Cluster Development**

### **Systems Development**

- CCP, I.S.P., CDMP, CBIP
- Oracle Certification
- MCSA, MCDBA

### **Media**

- CCP, I.S.P., CDMP, CBIP
- Web Master Certification
- Internet +
- Adobe, Macro-Media

### **Operations**

- CCP, I.S.P., CDMP, CBIP
- LinuxUnix,
- International Computer Drivers License (ICDL)

### **Engineering**

- CCP, I.S.P., CDMP, CBIP

Cisco, Intel Networking Communications Certification

### **Performance-based (hands-on) certification programs**

Cisco Certified Internetwork Expert (CCIE)

### **New and technically advanced certification programs**

Sun Certified Enterprise Architect for the Java 2 Platform, Enterprise Edition

### **Specialty certification programs**

Project Management Professional (PMP)

ICCP (Institute for Certification of Computing Professionals) certifications

Currently Arminco Global Telecommunications is implementing in RA a Microsoft Certified Partner program. The following certification programs are available:

**Microsoft Certified Systems Administrator (MCSA on Windows Server 2003, MCSA on Windows 2000);**

**Microsoft Certified Systems Engineer (MCSE 2003, MCSE 2000)**



Microsoft Certified Systems Administrator (MCSA on Windows Server 2003, MCSA on Windows 2000) program of certification is developed for the specialists engaged in realization, management and elimination of faults in existing systems on the base of Windows 2000, including Windows Server 2003.

**MCSA program certification on Windows 2000 is aimed for the following specialists:**

- network administrators;
- engineers of network maintenance;
- system administrators;
- specialists of information technologies;
- administrators of information systems;
- technicians of network maintenance;
- specialists of technical support.

Microsoft Certified Systems Engineer (MCSE 2003) certificate is universally recognized and certifies the knowledge and high skills of a specialist, necessary for successful planning, realization and administering Microsoft Windows platform and Microsoft server products. MCSE is aimed for system engineers, engineers of technical support, system analysts, network analysts, technical consultants.

According to the view of the Armenian IT companies they need better wide-specialization experts with no special emphasis on one or another producer. An expert certified by Cisco works only with Cisco equipment but the companies need system administrators, analysts and network architects with fundamental knowledge and ability to find optimal solution to a given task. The network tasks of small and medium-sized companies do not require expensive sophisticated equipment by Sun or Cisco.

## Annex 1 - Job descriptions based on Occupational Outlook Handbook (USA)

**Computer programmers:** Computer programmers write, test, and maintain the detailed instructions or programs that computers must follow to perform their functions. Programmers also conceive, design, and test logical structures for solving problems by computer. Computer programmers often are grouped into two broad types—applications programmers and systems programmers. Applications programmers write programs to handle a specific job, or may revise existing packaged software or customize generic applications. Systems programmers, in contrast, write programs to maintain and control computer systems software. Employment is expected to grow much more slowly than that for other computer specialists.

Due to the growing number of qualified applicants and the specialization the level of education and experience required by employers increased. Bachelor's degree is commonly required, but some programmers may qualify for certain jobs with 2-year degrees or certificates. The associate degree is widely used for prospective computer programmers.

In 2004 more than two-thirds of computer programmers had a bachelor's or higher degree. Competencies include:

- Knowledge of management information systems and business;
- Knowledge of newer, object-oriented programming languages and tools such as C++ and Java;
- Extensive knowledge of a variety of operating systems;
- Familiarity with fourth-generation and fifth-generation languages that involve graphic user interface and systems programming;
- Ability to work with database systems, such as DB2, Oracle, or Sybase;
- Familiarity with digital security issues and skills in using appropriate security technology;
- General business skills and experience related to the operations of the firm;
- Thinking logically and paying close attention to detail;
- Patience, persistence, and the ability to work on exacting analytical work, especially under pressure;
- Ingenuity and creativity;
- Continuous updating the knowledge and skills;
- Ability to communicate with non-technical personnel.

Computer programmers in USA held about 455,000 jobs in 2004. The largest concentration of computer programmers is in computer systems design and related services. Employment of programmers during 2004-2014 is expected to grow more slowly than the average for all occupations. The reasons are the followings:

1. Computer software now can eliminate the need for many programmers to do routine work;
2. More of the programming functions can be transferred from programmers to other information workers;
3. The outsourcing of the jobs to other countries limits the growth of employment because computer programmers can perform job from any place in the world and digitally transmit programs to any location via e-mail.

**Computer Software Engineers.** *Computer applications software engineers* analyze users' needs and design, construct, and maintain general computer applications software using different programming languages. The most often used programming languages are C, C++, and Java, with FORTRAN and COBOL used less commonly. *Computer systems software engineers* coordinate the construction and maintenance of computer systems and plan their future growth. Computer software engineers held about 800,000 jobs in 2004 and are projected to be one of the fastest growing occupations during 2004-2014. Employment of computer software engineers is expected to increase much faster than the average for all occupations.

Competencies required include:

- strong programming, systems analysis, interpersonal, and business skills;
- strong problem-solving and analytical skills;
- ability to communicate effectively with team members, other staff, and their customers;
- ability to concentrate and pay close attention to detail;
- continuing education and professional development as a program certification alone is not sufficient for the majority of software engineering jobs.

Academic programs in software engineering may be offered as a degree option or in conjunction with computer science degrees. A bachelor's degree in computer science or computer information systems is typical for systems software engineering jobs. Computer training programs leading to certification are offered for systems engineering jobs that place less emphasis on workers having a computer-related degree. Nevertheless, certification alone is not sufficient for the majority of software engineering jobs.

**Computer Systems Analysts:** Computer systems analysts solve computer problems and apply computer technology to meet the individual needs of organizations helping to realize the maximum benefit from its investment in equipment, personnel, and business processes. Systems analysts may plan and develop new computer systems or devise ways to apply existing systems' resources to additional operations. Most systems analysts work with specific types of systems including business, accounting, financial systems, or scientific and engineering systems. Some systems analysts are also known as **systems developers or systems architects**.

Computer systems analysts held about 487,000 jobs in 2004. Competencies include:

- broad background and range of skills, including not only technical knowledge, but also communication and other interpersonal skills;
- relevant work experience;
- capability of implementing "hot" new technologies such as the wireless Internet;
- business management or closely related skills;
- ability to think logically;
- continuing education and professional development seminars to keep skills up to date.

**Computer Support Specialists:** Computer support specialists provide technical assistance and advice to customers and other users. This occupational group includes **technical support specialists** and **help-desk technicians**. Technical support specialists install, modify, clean, and repair computer hardware and software, also may write training manuals and train computer users. Help-desk technicians assist computer users. A bachelor's degree in computer science or information systems is a prerequisite for this job,

however, only a computer-related associate's degree can be required in some other cases. A certification and practical experience demonstrating the needed skills will be essential for applicants without a degree. Computer support specialists and systems administrators held about 797,000 jobs in 2004. Employment of computer support specialists during 2004-2014 is expected to increase faster than the average for all occupations. The growth of electronic commerce promotes demand for computer support specialists. However this growth can be tempered as firms cut costs by shifting routine work to countries with highly skilled and cheap labor force.

Competencies include:

- strong background in fundamental computer skills;
- good interpersonal and communication skills;
- practical experience.

**Data Entry and Information Processing Workers:** Data entry and information processing workers include data entry keyers, word processors and typists. They help ensuring the smooth and efficient handling of information by keying in text, entering data into a computer, operating a variety of office machines, and performing other clerical duties.

Competencies include:

- spelling, punctuation, and grammar skills;
- familiarity with standard office equipment and procedures;
- training or experience in word processing or data entry tasks;
- willing to upgrade the skills continuously.

Employers generally hire high school graduates who meet their requirements for keyboarding speed. Overall employment of data entry and information processing workers is projected to decline during 2004-2014.

**Computer Chip Processing Operators: Semiconductor processors.**

Semiconductor processors are the production workers manufacturing semiconductors in disks (wafers) of varying sizes (generally eight to twelve inches wide) and making wafers by means of photolithography. **Operators**, making up the majority of the workers, start and monitor the sophisticated equipment that performs the various tasks during the many steps of the semiconductor production sequence while **technicians** account for a smaller percentage of the workers, but they troubleshoot production problems and make equipment adjustments and repairs. They also take the lead in assuring quality control and in maintaining equipment.

Competencies include:

- a solid background in mathematics and the physical sciences;
- ability to think analytically and critically to anticipate problems and avoid costly mistakes;
- experience;
- communication skills and ability to convey their thoughts and ideas both orally and in writing.

For semiconductor processor jobs the associate degree programs are preferred. However, completion of a 1-year certificate program in semiconductor technology supplemented by experience, or a degree in high-tech manufacturing may also be sufficient. Degree or certificate program graduates getting hands-on training while attending school should have the best prospects.

Employment of semiconductor processors is expected to decline over the next 10 years because of increasing automation of fabrication plants in United States and the building of many new plants abroad. Despite the expected decline in employment of semiconductor processors, the demand for semiconductor chips remains very high based on many applications for semiconductors in computers, appliances, machinery, biotechnology, vehicles, cell phones and other telecommunications devices, and other equipment.

## ***Annex 2 - IT Occupational Competencies***

### GENERAL COMPETENCIES

**Administration and Management** – Knowledge of planning, coordination, and execution of business functions, resource allocation, and production.

1. **Arithmetic** – Performs computations such as addition, subtraction, multiplication, and division correctly using whole numbers, fractions, decimals, and percentages.
2. **Attention to Detail** – Is thorough when performing work and conscientious about attending to detail.
3. **Conflict Management** – Manages and resolves conflicts, grievances, confrontations, or disagreements in a constructive manner to minimize negative personal impact.
4. **Creative Thinking** – Uses imagination to develop new insights into situations and applies innovative solutions to problems; designs new methods where established methods and procedures are inapplicable or are unavailable.
5. **Customer Service** – Works with clients and customers (individuals who use or receive the services or products that your work unit produces, including the general public, individuals who work in the agency, other agencies, or organizations outside the Government) to assess their needs, provide information or assistance, resolve their problems, or satisfy their expectations; knows about available products and services; is committed to providing quality products and services.
6. **Decision Making** – Makes sound, well-informed, and objective decisions; perceives the impact and implications of decisions; commits to action, even in uncertain situations, to accomplish organizational goals; causes change.
7. **Education and Training** – Knowledge of teaching, training, research, making presentations, lecturing, testing, and other instructional methods.
8. **Engineering and Technology** – Knowledge of engineering concepts, principles, and practices, and of equipment, tools, mechanical devices, and their uses to produce motion, light, power, technology, and other applications.
9. **External Awareness** – Identifies and understands economic, political, and social trends that affect the organization.
  
12. **Financial Management** – Prepares, justifies, and/or administers the budget for program areas; plans, administers, and monitors expenditures to ensure cost-effective support of programs and policies; assesses financial condition of an organization.
13. **Flexibility** – Is open to change and new information; adapts behavior or work methods in response to new information, changing conditions, or unexpected obstacles; effectively deals with ambiguity.
14. **Influencing/Negotiating** – Persuades others to accept recommendations, cooperate, or change their behavior; works with others towards an agreement; negotiates to find mutually acceptable solutions.
15. **Integrity/Honesty** – Contributes to maintaining the integrity of the organization; displays high standards of ethical conduct and understands the impact of violating these standards on an organization, self, and others; is trustworthy.
16. **Interpersonal Skills** – Shows understanding, friendliness, courtesy, tact, empathy, concern, and politeness to others; develops and maintains effective relationships with others; may include effectively dealing with individuals who are difficult, hostile, or distressed; relates well to people from varied backgrounds and different situations; is sensitive to cultural diversity, race, gender, disabilities, and other individual differences.

17. **Leadership** – Influences, motivates, and challenges others; adapts leadership styles to a variety of situations.
18. **Learning** – Uses efficient learning techniques to acquire and apply new knowledge and skills; uses training, feedback, or other opportunities for self-learning and development
19. **Legal, Government and Jurisprudence** – Knowledge of laws, legal codes, court procedures, precedents, legal practices and documents, government regulations, executive orders, agency rules, government organization and functions, and the democratic political process.
20. **Managing Human Resources** – Plans, distributes, coordinates, and monitors work assignments of others; evaluates work performance and provides feedback to others on their performance; ensures that staff are appropriately selected, utilized, and developed, and that they are treated in a fair and equitable manner.
21. **Mathematical Reasoning** – Solves practical problems by choosing appropriately from a variety of mathematical and statistical techniques.
22. **Memory** – Recalls information that has been presented previously.
23. **Mental Visualization** – Sees things in the mind by mentally organizing and processing symbols, pictures, graphs, objects, or other information (for example, sees a building from a blueprint, or sees the flow of work activities from reading a work plan).
24. **Oral Communication** – Expresses information (for example, ideas or facts) to individuals or groups effectively, taking into account the audience and nature of the information (for example, technical, sensitive, controversial); makes clear and convincing oral presentations; listens to others, attends to nonverbal cues, and responds appropriately.
25. **Organizational Awareness** – Knows the organizations mission and functions, and how social, political, and technological systems work and operates effectively within them; this includes the programs, policies, procedures, rules, and regulations of the organization.
26. **Planning and Evaluating** – Organizes work, sets priorities, and determines resource requirements; determines short- or long-term goals and strategies to achieve them; coordinates with other organizations or parts of the organization to accomplish goals; monitors progress and evaluates outcomes.
27. **Problem Solving** – Identifies problems; determines accuracy and relevance of information; uses sound judgment to generate and evaluate alternatives, and to make recommendations.
28. **Public Safety and Security** – Knowledge of the military, weaponry, and intelligence operations; public safety and security operations; occupational health and safety; investigation and inspection techniques; or rules, regulations, precautions, and prevention techniques for the protection of people, data, and property.
29. **Reading** – Understands and interprets written material, including technical material, rules, regulations, instructions, reports, charts, graphs, or tables; applies what is learned from written material to specific situations.
30. **Reasoning** – Identifies rules, principles, or relationships that explain facts, data, or other information; analyzes information and makes correct inferences or draws accurate conclusions.
31. **Self-Esteem** – Believes in own self-worth; maintains a positive view of self and displays a professional image.
32. **Self-Management** – Sets well-defined and realistic personal goals; displays a high level of initiative, effort, and commitment towards completing assignments in a timely manner; works with minimal supervision; is motivated to achieve; demonstrates responsible behavior.

33. **Strategic Thinking** – Formulates effective strategies consistent with the business and competitive strategy of the organization in a global economy. Examines policy issues and strategic planning with a long-term perspective. Determines objectives and sets priorities; anticipates potential threats or opportunities.
34. **Stress Tolerance** – Deals calmly and effectively with high stress situations (for example, tight deadlines, hostile individuals, emergency situations, dangerous situations).
35. **Teaching Others** – Helps others learn through formal or informal methods; identifies training needs; provides constructive feedback; coaches others on how to perform tasks; acts as a mentor.
36. **Teamwork** – Encourages and facilitates cooperation, pride, trust, and group identity; fosters commitment and team spirit; works with others to achieve goals.
37. **Technical Competence** – Uses knowledge that is acquired through formal training or extensive on-the-job experience to perform one's job; works with, understands, and evaluates technical information related to the job; advises others on technical issues.
38. **Technology Application** – Uses machines, tools, or equipment effectively; uses computers and computer applications to analyze and communicate information in the appropriate format.
39. **Vision** – Understands where the organization is headed and how to make a contribution; takes a long-term view and recognizes opportunities to help the organization accomplish its objectives or move toward the vision.
40. **Writing** – Recognizes or uses correct English grammar, punctuation, and spelling; communicates information (for example, facts, ideas, or messages) in a succinct and organized manner; produces written information, which may include technical material that is appropriate for the intended audience.
41. **Contracting/Procurement** - Knowledge of various types of contracts, techniques for contracting or procurement, and contract negotiation and administration. conduct and understands the impact of violating these standards on an organization, self, and others; chooses an ethical course of action; is trustworthy.

## TECHNICAL COMPETENCIES

**Accessibility** - Knowledge of tools, equipment, and technologies (for example, voice recognition, screen readers) used to help individuals with disabilities use computer equipment and software.

1. **Artificial Intelligence** - Knowledge of principles, methods, and tools to design systems that perform human intelligence functions (for example, expert systems, knowledge-based systems).
2. **Business Process Reengineering** - Knowledge of methods, metrics, tools, and techniques of Business Process Reengineering.
3. **Capacity Management** - Knowledge of the principles and methods for monitoring, estimating, and reporting actual performance or the performance capability of information systems or components.
4. **Capital Planning and Investment Assessment** - Knowledge of the principles and methods of capital investment analysis and business case analysis including best practices assessment and return on investment analysis.
5. **Computers and Electronics** – Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming.
6. **Computer Languages** - Knowledge of computer languages and their applications.



7. **Computer Forensics** - Knowledge of tools and techniques used in data recovery and preservation of electronic evidence (for example, chain of evidence rules).
8. **Configuration Management** - Knowledge of the principles and methods for planning and managing the implementation, updating, and integration of information system components, including software, controlling future releases, and documenting information and physical characteristics of an information system or product.
9. **Cost-Benefit Analysis** - Knowledge of the principles and methods of cost-benefit analysis, including the time value of money, present value concepts, cost accounting, business economics, and quantifying the tangible and intangible benefits.
10. **Data Management** - Knowledge of the principles, procedures, and tools of data management, such as modeling techniques, data backup and recovery, data dictionaries, data mining, data warehousing concepts, data disposal management, and data standardization processes.
11. **Database Administration** - Knowledge of the principles, methods, and tools for automating, developing, implementing, and administering database management systems, such as logical and physical design, space allocation, and performance monitoring.
12. **Database Management Systems** - Knowledge of database management systems and their applications.
15. **Distributed Systems** - Knowledge of the principles, theoretical concepts, and tools underlying distributed systems.
16. **Electronic Commerce (e-Commerce)** - Knowledge of principles and methods of electronic transactions (for example, requests, orders).
17. **Embedded Computers** - Knowledge of specifications and uses of embedded computers including appropriate programming languages.
18. **Encryption** - Knowledge of procedures, tools, and applications used to keep data or information secure (for example, public key infrastructure, point-to-point encryption, smart cards).
19. **Hardware** - Knowledge of specifications, uses, and types of hardware components.
20. **Hardware Engineering** - Knowledge of the principles, methods, and tools for designing, developing, and testing computer or computer-related equipment.
21. **Human Factors** - Knowledge of human factors principles, methods, tools, and applications, for example Graphic User Interface Design.
22. **Information Assurance** - Knowledge of methods and procedures to protect information systems and data by ensuring their availability, authentication, confidentiality, and integrity.
23. **Information Resources Strategy and Planning** - Knowledge of the principles, methods and techniques of information technology (IT) assessment, planning, management, monitoring and evaluation, such as IT baseline assessment, interagency functional analysis, contingency planning and disaster recovery.
24. **Information Systems Security Certification** - Knowledge of principles, methods, and tools for evaluating information systems security features against a set of specified security requirements, includes developing certification and accreditation plans and procedures, documenting deficiencies, reporting corrective actions, and recommending changes to improve the security of information systems.
25. **Information Systems/Network Security** - Knowledge of methods for developing, evaluating, coordinating, and disseminating security tools and procedures; ensuring, protecting, and restoring the security of information systems and network services and capabilities; identifying and eliminating information system

- vulnerabilities to inadvertent disclosure, modification, destruction, or denial of service.
26. **Information Technology Architecture**- Knowledge of architectural methodologies for information systems or applications design and development.
  27. **Information Technology Performance Assessment** - Knowledge of the principles, methods and tools for conducting performance assessments of information technology systems (for example, customer surveys, system performance measures, and the Government Performance and Results Act).
  28. **Infrastructure Design** - Knowledge of the architecture and typology of software, hardware, and networks, including LANS, WANS, and telecommunication systems, their components and associated protocols and standards, and how they operate and integrate with one another and with associated controlling software.
  29. **Knowledge Management** - Knowledge of the business value of information and the processes for making data available and useful to decision-makers.
  30. **Logical Systems Design** - Knowledge of principles and methods for designing user interfaces, data inputs, system processes/outputs, business logic components, and productivity tools (e.g. CASE).
  31. **Modeling and Simulation** - Knowledge of modeling and simulation tools and techniques to characterize systems of interest, support decisions involving requirements, evaluate design alternatives, support training, or support operational preparation.
  32. **Multimedia Technologies** - Knowledge of the principles, methods, tools, and techniques of multimedia technologies and their applications.
  33. **Network Management** - Knowledge of the operation, management, and maintenance of network and telecommunication systems and linked systems and peripherals, including operational performance monitoring, estimating, and reporting; configuration management; fault detection and isolation; security management; and corrective action.
  34. **Object Technology** - Knowledge of the principles, methods, tools, and techniques of object technology, including object-oriented languages, analysis, and design methodologies.
  35. **Operating Systems** - Knowledge of computer network, desktop, and mainframe operating systems and their applications.
  36. **Operations Support** - Knowledge of procedures to troubleshoot, recover, adjust, modify, and improve systems to ensure production or delivery of products and services, including tools and mechanisms for distributing new or enhanced software.
  37. **Organizational Development** - Knowledge of the principles of organizational development and change management theories and their application in an information technology environment.
  38. **Process Control**- Knowledge of process control applications and procedures including the design, development, and maintenance of associated software, hardware, and systems.
  39. **38. Product Evaluation** - Knowledge of methods for researching and analyzing external products to determine their potential for meeting organizational standards and business needs.
  40. **Project Management**- Knowledge of methods, principles or tools for managing IT projects, including acquisition/procurement management.
  41. **Quality Assurance** - Knowledge of principles, methods and tools of quality assurance.
  42. **Requirements Analysis** - Knowledge of principles and methods to identify, analyze, specify, design, and manage the client's functional and infrastructure

- requirements; includes translating functional requirements into technical requirements used for logical design or presenting alternative technologies or approaches.
43. **Risk Management** - Knowledge of methods and tools used for risk assessment and mitigation of risk to information systems and data.
  44. **Software Development** - Knowledge of the principles, methods, and tools for designing, developing, and testing software in a given environment (e.g. computer applications, operating systems-level software, compilers, and network distribution software). Knowledge of the uses of commercial off-the-shelf (COTS) software applications.
  45. **Software Engineering** - Knowledge of software development methodology, paradigms, and tools; software requirements analysis; the software lifecycle; software reusability; and software reliability metrics.
  46. **Software Testing and Evaluation** - Knowledge of principles, methods, and tools for analyzing and developing test and evaluation procedures.
  47. **Standards** - Knowledge of information systems standards that either are compliant with or derived from other industrial, Government, and international standards and guidelines.
  48. **Systems Integration** - Knowledge of principles, methods, and procedures for optimizing, integrating, and installing information system components.
  49. **Systems Life Cycle** - Knowledge of Systems Life Cycle Management concepts used to plan, develop, implement, operate, and maintain information systems.
  50. **Systems Testing and Evaluation** - Knowledge of principles, methods, and tools for analyzing development and technical characteristics of IT systems; identifying critical operational issues; defining, documenting, implementing, executing, and reporting results of systems tests and evaluations.
  51. **Technical Documentation** - Knowledge of procedures for developing technical and operational support documentation.
  52. **Technology Awareness** – Monitors and evaluates developments and new applications of information technology (hardware, software, telecommunications); applies emerging technologies to business processes; applies and monitors implementation of information systems to meet organizational requirements.
  53. **Telecommunications** – Knowledge of transmissions, broadcasting, switching, control, and operation of telecommunications systems.
  54. **Web Technology** - Knowledge of the principles and methods of web technologies, tools and delivery systems.

### ***Annex 3 - Skills Based IT Job Profiles<sup>1</sup> (USA)***

#### **15-1041.00 - Computer Support Specialists**

Computer Support Specialists provide technical assistance to computer system users. They answer questions or resolve computer problems for clients in person, via telephone or from remote location. Computer Support Specialists may provide assistance concerning the use of computer hardware and software, including printing, installation, word processing, electronic mail, and operating systems.

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<sup>1</sup> US Department of Labor's Occupational Information Network, O\*Net, Standard Occupational Classification (SOC), <http://online.onetcenter.org>.

**Sample of reported job titles:** Information Technology Specialist (IT Specialist), Electronic Data Processing Auditor (EDP Auditor), Help Desk Analyst, Computer Technician, Desktop Support Technician, Office Systems Coordinator

## Tasks

- Answer users' inquiries regarding computer software and hardware operation to resolve problems.
- Enter commands and observe system functioning to verify correct operations and detect errors.
- Install and perform minor repairs to hardware, software, and peripheral equipment, following design or installation specifications.
- Oversee the daily performance of computer systems.
- Set up equipment for employee use, performing or ensuring proper installation of cable, operating systems, and appropriate software.
- Maintain record of daily data communication transactions, problems and remedial action taken, and installation activities.
- Read technical manuals, confer with users, and conduct computer diagnostics to investigate and resolve problems and to provide technical assistance and support.
- Confer with staff, users, and management to establish requirements for new systems or modifications.
- Develop training materials and procedures, and/or train users in the proper use of hardware and software.
- Refer major hardware or software problems or defective products to vendors or technicians for service.

## Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**Production and Processing** — Knowledge of raw materials, production processes, quality control, costs, and other techniques for maximizing the effective manufacture and distribution of goods.

**Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

**Psychology** — Knowledge of human behavior and performance; individual differences in ability, personality, and interests; learning and motivation; psychological research methods; and the assessment and treatment of behavioral and affective disorders.

## Skills

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Writing** — Communicating effectively in writing as appropriate for the needs of the audience.

**Speaking** — Talking to others to convey information effectively.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Learning Strategies** — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.

**Instructing** — Teaching others how to do something.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

## Abilities

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong.

It does not involve solving the problem, only recognizing there is a problem.
<b>Information Ordering</b> — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
<b>Near Vision</b> — The ability to see details at close range (within a few feet of the observer).
<b>Speech Clarity</b> — The ability to speak clearly so others can understand you.
<b>Speech Recognition</b> — The ability to identify and understand the speech of another person.

### Work Styles

<b>Attention to Detail</b> — Job requires being careful about detail and thorough in completing work tasks.
<b>Adaptability/Flexibility</b> — Job requires being open to change (positive or negative) and to considerable variety in the workplace.
<b>Analytical Thinking</b> — Job requires analyzing information and using logic to address work-related issues and problems.
<b>Dependability</b> — Job requires being reliable, responsible, and dependable, and fulfilling obligations.
<b>Cooperation</b> — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.
<b>Independence</b> — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.
<b>Integrity</b> — Job requires being honest and ethical.
<b>Persistence</b> — Job requires persistence in the face of obstacles.
<b>Concern for Others</b> — Job requires being sensitive to others' needs and feelings and being understanding and helpful on the job.
<b>Initiative</b> — Job requires a willingness to take on responsibilities and challenges.

### Job Zone

Title	Job Zone Three: Medium Preparation Needed
<b>Overall Experience</b>	Previous work-related skill, knowledge, or experience is required for these occupations. For example, an electrician must have completed three or four years of apprenticeship or several years of vocational training, and often must have passed a licensing exam, in order to perform the job.
<b>Job Training</b>	Employees in these occupations usually need one or two years of training involving both on-the-job experience and informal training with experienced workers.
<b>Job Zone Examples</b>	These occupations usually involve using communication and organizational skills to coordinate, supervise, manage, or train others to accomplish goals. Examples include funeral directors, electricians,

	forest and conservation technicians, legal secretaries, interviewers, and insurance sales agents.
<b>SVP Range</b>	(6.0 to < 7.0)
<b>Education</b>	Most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

#### **Work Values**

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

## 15-1011.00 - Computer and Information Scientists, Research

Conduct research into fundamental computer and information science as theorists, designers, or inventors. Solve or develop solutions to problems in the field of computer hardware and software.

### Tasks

- Analyze problems to develop solutions involving computer hardware and software.
- Apply theoretical expertise and innovation to create or apply new technology, such as adapting principles for applying computers to new uses.
- Conduct logical analyses of business, scientific, engineering, and other technical problems, formulating mathematical models of problems for solution by computers.
- Consult with users, management, vendors, and technicians to determine computing needs and system requirements.
- Design computers and the software that runs them.
- Evaluate project plans and proposals to assess feasibility issues.
- Approve, prepare, monitor, and adjust operational budgets.
- Assign or schedule tasks in order to meet work priorities and goals.
- Develop and interpret organizational goals, policies, and procedures.
- Develop performance standards, and evaluate work in light of established standards.

## 15-1021.00 - Computer Programmers

Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information. May program web sites.

**Sample of reported job titles:** Programmer Analyst, Programmer, Computer Programmer, Software Developer, Internet Programmer, Web Programmer

### Tasks

- Correct errors by making appropriate changes and then rechecking the program to ensure that the desired results are produced.
- Conduct trial runs of programs and software applications to be sure they will produce the desired information and that the instructions are correct.
- Compile and write documentation of program development and subsequent revisions, inserting comments in the coded instructions so others can understand the program.
- Write, update, and maintain computer programs or software packages to handle specific jobs, such as tracking inventory, storing or retrieving data, or controlling other equipment.



- Consult with managerial, engineering, and technical personnel to clarify program intent, identify problems, and suggest changes.
- Perform or direct revision, repair, or expansion of existing programs to increase operating efficiency or adapt to new requirements.
- Write, analyze, review, and rewrite programs, using workflow chart and diagram, and applying knowledge of computer capabilities, subject matter, and symbolic logic.
- Write or contribute to instructions or manuals to guide end users.
- Investigate whether networks, workstations, the central processing unit of the system, and/or peripheral equipment are responding to a program's instructions.
- Prepare detailed workflow charts and diagrams that describe input, output, and logical operation, and convert them into a series of instructions coded in a computer language.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

### Skills

**Programming** — Writing computer programs for various purposes.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Learning Strategies** — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.

**Operations Analysis** — Analyzing needs and product requirements to create a design.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Technology Design** — Generating or adapting equipment and technology to serve user needs.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

## Abilities

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Written Expression** — The ability to communicate information and ideas in writing so others will understand.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Speech Clarity** — The ability to speak clearly so others can understand you.

## Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

## Work Styles

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling

obligations.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Achievement/Effort** — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

**Independence** — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.

**Integrity** — Job requires being honest and ethical.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Persistence** — Job requires persistence in the face of obstacles.

**Cooperation** — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

### **Work Values**

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability, Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

## 15-1031.00 - Computer Software Engineers, Applications

Develop, create, and modify general computer applications software or specialized utility programs. Analyze user needs and develop software solutions. Design software or customize software for client use with the aim of optimizing operational efficiency. May analyze and design databases within an application area, working individually or coordinating database development as part of a team.

**Sample of reported job titles:** Software Engineer, Application Integration Engineer, Programmer Analyst, Computer Consultant, Software Architect, Software Developer, Software Development Engineer, Business Systems Analyst, Programmer, Software Analyst

### Tasks

- Confer with systems analysts, engineers, programmers and others to design system and to obtain information on project limitations and capabilities, performance requirements and interfaces.
- Modify existing software to correct errors, allow it to adapt to new hardware, or to improve its performance.
- Analyze user needs and software requirements to determine feasibility of design within time and cost constraints.
- Consult with customers about software system design and maintenance.
- Coordinate software system installation and monitor equipment functioning to ensure specifications are met.
- Design, develop and modify software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Develop and direct software system testing and validation procedures, programming, and documentation.
- Analyze information to determine, recommend, and plan computer specifications and layouts, and peripheral equipment modifications.
- Supervise the work of programmers, technologists and technicians and other engineering and scientific personnel.
- Obtain and evaluate information on factors such as reporting formats required, costs, and security needs to determine hardware configuration.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control,

and operation of telecommunications systems.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

### Skills

**Programming** — Writing computer programs for various purposes.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Judgment and Decision Making** — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

**Technology Design** — Generating or adapting equipment and technology to serve user needs.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Operations Analysis** — Analyzing needs and product requirements to create a design.

**Systems Analysis** — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

### Abilities

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Speech Clarity** — The ability to speak clearly so others can understand you.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Speech Recognition** — The ability to identify and understand the speech of another person.

### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

### Work Styles

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

**Cooperation** — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

**Achievement/Effort** — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

**Innovation** — Job requires creativity and alternative thinking to develop new ideas for and answers to work-related problems.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Persistence** — Job requires persistence in the face of obstacles.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Integrity** — Job requires being honest and ethical.

### Work Values

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment.

Corresponding needs are Ability Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employs to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

## 15-1032.00 - Computer Software Engineers, Systems Software

Research, design, develop, and test operating systems-level software, compilers, and network distribution software for medical, industrial, military, communications, aerospace, business, scientific, and general computing applications. Set operational specifications and formulate and analyze software requirements. Apply principles and techniques of computer science, engineering, and mathematical analysis.

**Sample of reported job titles:** Software Engineer, Software Developer, Systems Engineer, Network Engineer, Publishing Systems Analyst, Application Developer, Averaged HEND (High-Energy Neutron Data) Data Product Lead (AHD Product Lead), Customer Information Control System Programmer (CICS Programmer), Program Analyst, Systems Programmer

### Tasks

- Modify existing software to correct errors, to adapt it to new hardware or to upgrade interfaces and improve performance.
- Design and develop software systems, using scientific analysis and mathematical models to predict and measure outcome and consequences of design.
- Consult with engineering staff to evaluate interface between hardware and software, develop specifications and performance requirements and resolve customer problems.
- Analyze information to determine, recommend and plan installation of a new system or modification of an existing system.
- Develop and direct software system testing and validation procedures.
- Direct software programming and development of documentation.
- Consult with customers and/or other departments on project status, proposals and technical issues such as software system design and maintenance.
- Advise customer about, or perform maintenance of software system.
- Coordinate installation of software system.
- Monitor functioning of equipment to ensure system operates in conformance with specifications.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Customer and Personal Service** — Knowledge of principles and processes for providing



customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**Communications and Media** — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.

**Clerical** — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

### Skills

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Technology Design** — Generating or adapting equipment and technology to serve user needs.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Programming** — Writing computer programs for various purposes.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Systems Analysis** — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

**Mathematics** — Using mathematics to solve problems.

**Operations Analysis** — Analyzing needs and product requirements to create a design.

### Abilities

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Mathematical Reasoning** — The ability to choose the right mathematical methods or formulas to solve a problem.

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Originality** — The ability to come up with unusual or clever ideas about a given topic or situation, or to develop creative ways to solve a problem.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

### Work Styles

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Cooperation** — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Achievement/Effort** — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Innovation** — Job requires creativity and alternative thinking to develop new ideas for and

answers to work-related problems.

**Integrity** — Job requires being honest and ethical.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

**Leadership** — Job requires a willingness to lead, take charge, and offer opinions and direction.

#### **Work Values**

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

### **15-1051.00 - Computer Systems Analysts**

Analyze science, engineering, business, and all other data processing problems for application to electronic data processing systems. Analyze user requirements, procedures, and problems to automate or improve existing systems and review computer system capabilities, workflow, and scheduling limitations. May analyze or recommend commercially available software. May supervise computer programmers.

**Sample of reported job titles:** Systems Analyst, Programmer Analyst, Computer Systems Consultant, Business Systems Analyst, Systems Engineer, Computer Specialist, Computer Systems Analyst, Data Processing Systems Analyst, Information Technology Consultant (IT Consultant), Information Technology Specialist

#### **Tasks**

- Provide staff and users with assistance solving computer related problems, such as malfunctions and program problems.
- Test, maintain, and monitor computer programs and systems, including coordinating the installation of computer programs and systems.
- Use object-oriented programming languages, as well as client/server applications development processes and multimedia and Internet technology.
- Confer with clients regarding the nature of the information processing or computation needs a computer program is to address.
- Coordinate and link the computer systems within an organization to increase compatibility and so information can be shared.
- Consult with management to ensure agreement on system principles.
- Expand or modify system to serve new purposes or improve work flow.
- Interview or survey workers, observe job performance and/or perform the job in order to determine what information is processed and how it is processed.
- Determine computer software or hardware needed to set up or alter system.
- Train staff and users to work with computer systems and programs.

## Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

## Skills

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Service Orientation** — Actively looking for ways to help people.

**Time Management** — Managing one's own time and the time of others.

**Monitoring** — Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

**Quality Control Analysis** — Conducting tests and inspections of products, services, or processes to evaluate quality or performance.

## Abilities

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Speech Recognition** — The ability to identify and understand the speech of another person.

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Speech Clarity** — The ability to speak clearly so others can understand you.

#### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

#### Work Styles

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Persistence** — Job requires persistence in the face of obstacles.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling

obligations.
<b>Initiative</b> — Job requires a willingness to take on responsibilities and challenges.
<b>Integrity</b> — Job requires being honest and ethical.
<b>Cooperation</b> — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.
<b>Achievement/Effort</b> — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.
<b>Stress Tolerance</b> — Job requires accepting criticism and dealing calmly and effectively with high stress situations.

#### **Work Values**

<b>Independence</b> — Occupations that satisfy this work value allow employs to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.
<b>Achievement</b> — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

### **15-1071.00 - Network and Computer Systems Administrators**

Install, configure, and support an organization's local area network (LAN), wide area network (WAN), and Internet system or a segment of a network system. Maintain network hardware and software. Monitor network to ensure network availability to all system users and perform necessary maintenance to support network availability. May supervise other network support and client server specialists and plan, coordinate, and implement network security measures.

**Sample of reported job titles:** Systems Administrator, Network Administrator, Network Engineer, Information Technology Specialist (IT Specialist), Information Technology Manager (IT Manager), LAN Administrator (Local Area Network Administrator), Systems Engineer, Information Technology Director (IT Director), Network Manager, Network Specialist

#### **Tasks**

- Diagnose hardware and software problems, and replace defective components.
- Perform data backups and disaster recovery operations.
- Maintain and administer computer networks and related computing environments, including computer hardware, systems software, applications software, and all configurations.
- Plan, coordinate, and implement network security measures in order to protect data, software, and hardware.
- Operate master consoles in order to monitor the performance of computer systems and networks, and to coordinate computer network access and use.
- Perform routine network startup and shutdown procedures, and maintain control records.

- Design, configure, and test computer hardware, networking software and operating system software.
- Recommend changes to improve systems and network configurations, and determine hardware or software requirements related to such changes.
- Confer with network users about how to solve existing system problems.
- Monitor network performance in order to determine whether adjustments need to be made, and to determine where changes will need to be made in the future.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

### Skills

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

<b>Service Orientation</b> — Actively looking for ways to help people.
<b>Coordination</b> — Adjusting actions in relation to others' actions.
<b>Equipment Selection</b> — Determining the kind of tools and equipment needed to do a job.
<b>Installation</b> — Installing equipment, machines, wiring, or programs to meet specifications.

### Abilities

<b>Near Vision</b> — The ability to see details at close range (within a few feet of the observer).
<b>Problem Sensitivity</b> — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.
<b>Inductive Reasoning</b> — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
<b>Oral Comprehension</b> — The ability to listen to and understand information and ideas presented through spoken words and sentences.
<b>Deductive Reasoning</b> — The ability to apply general rules to specific problems to produce answers that make sense.
<b>Information Ordering</b> — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
<b>Oral Expression</b> — The ability to communicate information and ideas in speaking so others will understand.
<b>Written Comprehension</b> — The ability to read and understand information and ideas presented in writing.
<b>Finger Dexterity</b> — The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
<b>Flexibility of Closure</b> — The ability to identify or detect a known pattern (a figure, object, word, or sound) that is hidden in other distracting material.

### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.



## Work Styles

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Cooperation** — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Stress Tolerance** — Job requires accepting criticism and dealing calmly and effectively with high stress situations.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Achievement/Effort** — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

**Independence** — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.

**Integrity** — Job requires being honest and ethical.

## 15-1071.01 - Computer Security Specialists

Plan, coordinate, and implement security measures for information systems to regulate access to computer data files and prevent unauthorized modification, destruction, or disclosure of information.

**Sample of reported job titles:** Information Technology Specialist, Computer Specialist, Data Security Administrator, Information Systems Security Analyst, Computer Security Specialist, PC Analyst (Personal Computer Analyst), Computer Systems Technician, Information Systems Security Officer, Security Director

### Tasks

- Train users and promote security awareness to ensure system security and to improve server and network efficiency.
- Develop plans to safeguard computer files against accidental or unauthorized modification, destruction, or disclosure and to meet emergency data processing needs.
- Confer with users to discuss issues such as computer data access needs, security violations, and programming changes.
- Monitor current reports of computer viruses to determine when to update virus protection systems.
- Modify computer security files to incorporate new software, correct errors, or change individual access status.

- Coordinate implementation of computer system plan with establishment personnel and outside vendors.
- Monitor use of data files and regulate access to safeguard information in computer files.
- Perform risk assessments and execute tests of data processing system to ensure functioning of data processing activities and security measures.
- Encrypt data transmissions and erect firewalls to conceal confidential information as it is being transmitted and to keep out tainted digital transfers.
- Document computer security and emergency measures policies, procedures, and tests.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Law and Government** — Knowledge of laws, legal codes, court procedures, precedents, government regulations, executive orders, agency rules, and the democratic political process.

**Communications and Media** — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.

**Economics and Accounting** — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

### Skills

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Systems Evaluation** — Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Time Management** — Managing one's own time and the time of others.

**Systems Analysis** — Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Judgment and Decision Making** — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

**Writing** — Communicating effectively in writing as appropriate for the needs of the audience.

### Abilities

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Finger Dexterity** — The ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern is according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Category Flexibility** — The ability to generate or use different sets of rules for combining or grouping things in different ways.

### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall</b>	A minimum of two to four years of work-related skill, knowledge, or

<b>Experience</b>	experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

### Work Styles

<b>Integrity</b> — Job requires being honest and ethical.
<b>Initiative</b> — Job requires a willingness to take on responsibilities and challenges.
<b>Dependability</b> — Job requires being reliable, responsible, and dependable, and fulfilling obligations.
<b>Persistence</b> — Job requires persistence in the face of obstacles.
<b>Stress Tolerance</b> — Job requires accepting criticism and dealing calmly and effectively with high stress situations.
<b>Attention to Detail</b> — Job requires being careful about detail and thorough in completing work tasks.
<b>Self Control</b> — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.
<b>Achievement/Effort</b> — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.
<b>Cooperation</b> — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.
<b>Adaptability/Flexibility</b> — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

### Work Values

<b>Independence</b> — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.
<b>Achievement</b> — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

## 11-3021.00 - Computer and Information Systems Managers

Plan, direct, or coordinate activities in such fields as electronic data processing, information systems, systems analysis, and computer programming.

**Sample of reported job titles:** Information Systems Director (IS Director), MIS Director (Management Information Systems Director), Information Technology Director (IT Director), Information Technology Manager (IT Manager), Data Processing Manager, Director of Application Development, Technical Services Manager, Director of Data Operations, Information Technology Systems Director (ITS Director), MIS Manager (Management Information Systems Manager)

## Tasks

- Manage backup, security and user help systems.
- Consult with users, management, vendors, and technicians to assess computing needs and system requirements.
- Direct daily operations of department, analyzing workflow, establishing priorities, developing standards and setting deadlines.
- Assign and review the work of systems analysts, programmers, and other computer-related workers.
- Stay abreast of advances in technology.
- Develop computer information resources, providing for data security and control, strategic computing, and disaster recovery.
- Review and approve all systems charts and programs prior to their implementation.
- Evaluate the organization's technology use and needs and recommend improvements, such as hardware and software upgrades.
- Control operational budget and expenditures.
- Meet with department heads, managers, supervisors, vendors, and others, to solicit cooperation and resolve problems.

## Knowledge

<p><b>Computers and Electronics</b> — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.</p>
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<p><b>Administration and Management</b> — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.</p>
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<p><b>Mathematics</b> — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.</p>
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<p><b>Design</b> — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.</p>
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<p><b>English Language</b> — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.</p>
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<p><b>Clerical</b> — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.</p>
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<p><b>Engineering and Technology</b> — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.</p>
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**Economics and Accounting** — Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**Personnel and Human Resources** — Knowledge of principles and procedures for personnel recruitment, selection, training, compensation and benefits, labor relations and negotiation, and personnel information systems.

### **Skills**

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Judgment and Decision Making** — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Negotiation** — Bringing others together and trying to reconcile differences.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Management of Financial Resources** — Determining how money will be spent to get the work done, and accounting for these expenditures.

**Systems Evaluation** — Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

**Time Management** — Managing one's own time and the time of others.

### **Abilities**

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Speech Clarity** — The ability to speak clearly so others can understand you.

<b>Inductive Reasoning</b> — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).
<b>Information Ordering</b> — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).
<b>Speech Recognition</b> — The ability to identify and understand the speech of another person.

### Job Zone

<b>Title</b>	Job Zone Five: Extensive Preparation Needed
<b>Overall Experience</b>	Extensive skill, knowledge, and experience are needed for these occupations. Many require more than five years of experience. For example, surgeons must complete four years of college and an additional five to seven years of specialized medical training to be able to do their job.
<b>Job Training</b>	Employees may need some on-the-job training, but most of these occupations assume that the person will already have the required skills, knowledge, work-related experience, and/or training.
<b>Job Zone Examples</b>	These occupations often involve coordinating, training, supervising, or managing the activities of others to accomplish goals. Very advanced communication and organizational skills are required. Examples include librarians, lawyers, aerospace engineers, physicists, school psychologists, and surgeons.
<b>SVP Range</b>	(8.0 and above)
<b>Education</b>	A bachelor's degree is the minimum formal education required for these occupations. However, many also require graduate school. For example, they may require a master's degree, and some require a Ph.D., M.D., or J.D. (law degree).

### Work Styles

<b>Dependability</b> — Job requires being reliable, responsible, and dependable, and fulfilling obligations.
<b>Self Control</b> — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.
<b>Integrity</b> — Job requires being honest and ethical.
<b>Adaptability/Flexibility</b> — Job requires being open to change (positive or negative) and to considerable variety in the workplace.
<b>Independence</b> — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.
<b>Persistence</b> — Job requires persistence in the face of obstacles.
<b>Analytical Thinking</b> — Job requires analyzing information and using logic to address work-related issues and problems.
<b>Cooperation</b> — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

**Leadership** — Job requires a willingness to lead, take charge, and offer opinions and direction.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

#### **Work Values**

**Independence** — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

### **17-2061.00 - Computer Hardware Engineers**

Research, design, develop, and test computer or computer-related equipment for commercial, industrial, military, or scientific use. May supervise the manufacturing and installation of computer or computer-related equipment and components.

**Sample of reported job titles:** Hardware Engineer, Engineer, Systems Engineer, Design Engineer, Field Service Engineer, Network Engineer, Project Engineer, Systems Integration Engineer

#### **Tasks**

- Update knowledge and skills to keep up with rapid advancements in computer technology.
- Provide technical support to designers, marketing and sales departments, suppliers, engineers and other team members throughout the product development and implementation process.
- Test and verify hardware and support peripherals to ensure that they meet specifications and requirements, analyzing and recording test data.
- Monitor functioning of equipment and make necessary modifications to ensure system operates in conformance with specifications.
- Analyze information to determine, recommend, and plan layout, including type of computers and peripheral equipment modifications.
- Build, test and modify product prototypes, using working models or theoretical models constructed using computer simulation.
- Analyze user needs and recommend appropriate hardware.
- Direct technicians, engineering designers or other technical support personnel as needed.
- Confer with engineering staff and consult specifications to evaluate interface between hardware and software and operational and performance requirements of overall system.
- Select hardware and material, assuring compliance with specifications and product requirements.



## Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**Communications and Media** — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.

**Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.

## Skills

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Judgment and Decision Making** — Considering the relative costs and benefits of potential actions to choose the most appropriate one.

**Time Management** — Managing one's own time and the time of others.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Systems Evaluation** — Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.

**Equipment Selection** — Determining the kind of tools and equipment needed to do a job.

### Abilities

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Speech Clarity** — The ability to speak clearly so others can understand you.

**Written Expression** — The ability to communicate information and ideas in writing so others will understand.

**Speech Recognition** — The ability to identify and understand the speech of another person.

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations)

### Job Zone

<b>Title</b>	Job Zone Four: Considerable Preparation Needed
<b>Overall Experience</b>	A minimum of two to four years of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
<b>Job Training</b>	Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
<b>Job Zone Examples</b>	Many of these occupations involve coordinating, supervising, managing, or training others. Examples include accountants, human resource managers, computer programmers, teachers, chemists, and police detectives.
<b>SVP Range</b>	(7.0 to < 8.0)
<b>Education</b>	Most of these occupations require a four - year bachelor's degree, but some do not.

## Work Styles

**Persistence** — Job requires persistence in the face of obstacles.

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Cooperation** — Job requires being pleasant with others on the job and displaying a good-natured, cooperative attitude.

**Integrity** — Job requires being honest and ethical.

**Concern for Others** — Job requires being sensitive to others' needs and feelings and being understanding and helpful on the job.

**Independence** — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.

**Innovation** — Job requires creativity and alternative thinking to develop new ideas for and answers to work-related problems.

**Stress Tolerance** — Job requires accepting criticism and dealing calmly and effectively with high stress situations.

## Work Values

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employees to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

## 25-1021.00 - Computer Science Teachers, Postsecondary

Teach courses in computer science. May specialize in a field of computer science, such as the design and function of computers or operations and research analysis.

Sample of reported job titles: Professor, Instructor, Computer Science Professor, Computer Information Systems Instructor (CIS Instructor), Information Technology Instructor (IT Instructor), Computer Science Instructor, Faculty Member, Computer Instructor, Computer Technology Instructor, Lecturer

## Tasks

- Evaluate and grade students' class work, laboratory work, assignments, and papers.
- Maintain student attendance records, grades, and other required records.
- Prepare and deliver lectures to undergraduate and/or graduate students on topics such as programming, data structures, and software design.
- Prepare course materials such as syllabi, homework assignments, and handouts.

- Compile, administer, and grade examinations, or assign this work to others.
- Keep abreast of developments in their field by reading current literature, talking with colleagues, and participating in professional conferences.
- Initiate, facilitate, and moderate classroom discussions.
- Plan, evaluate, and revise curricula, course content, and course materials and methods of instruction.
- Supervise students' laboratory work.
- Maintain regularly scheduled office hours in order to advise and assist students.

### Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Education and Training** — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

**Mathematics** — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.

**Telecommunications** — Knowledge of transmission, broadcasting, switching, control, and operation of telecommunications systems.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Engineering and Technology** — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

**Communications and Media** — Knowledge of media production, communication, and dissemination techniques and methods. This includes alternative ways to inform and entertain via written, oral, and visual media.

### Skills

**Instructing** — Teaching others how to do something.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Learning Strategies** — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Speaking** — Talking to others to convey information effectively.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Complex Problem Solving** — Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.

**Writing** — Communicating effectively in writing as appropriate for the needs of the audience.

**Time Management** — Managing one's own time and the time of others.

### Abilities

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Speech Clarity** — The ability to speak clearly so others can understand you.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Written Expression** — The ability to communicate information and ideas in writing so others will understand.

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

### Job Zone

Title	Job Zone Five: Extensive Preparation Needed
<b>Overall Experience</b>	Extensive skill, knowledge, and experience are needed for these occupations. Many require more than five years of experience. For example, surgeons must complete four years of college and an additional five to seven years of specialized medical training to be able to do their job.
<b>Job Training</b>	Employees may need some on-the-job training, but most of these occupations assume that the person will already have the required skills, knowledge, work-related experience, and/or training.
<b>Job Zone Examples</b>	These occupations often involve coordinating, training, supervising, or managing the activities of others to accomplish goals. Very advanced communication and organizational skills are required. Examples include librarians, lawyers, aerospace engineers, physicists, school

	psychologists, and surgeons.
<b>SVP Range</b>	(8.0 and above)
<b>Education</b>	A bachelor's degree is the minimum formal education required for these occupations. However, many also require graduate school. For example, they may require a master's degree, and some require a Ph.D., M.D., or J.D. (law degree).

#### **Work Styles**

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

**Integrity** — Job requires being honest and ethical.

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Self Control** — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Independence** — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.

**Persistence** — Job requires persistence in the face of obstacles.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Concern for Others** — Job requires being sensitive to others' needs and feelings and being understanding and helpful on the job.

#### **Work Values**

**Achievement** — Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment. Corresponding needs are Ability Utilization and Achievement.

**Independence** — Occupations that satisfy this work value allow employs to work on their own and make decisions. Corresponding needs are Creativity, Responsibility and Autonomy.

### **43-9011.00 - Computer Operators**

Monitor and control electronic computer and peripheral electronic data processing equipment to process business, scientific, engineering, and other data according to operating instructions. May enter commands at a computer terminal and set controls on computer and peripheral devices. Monitor and respond to operating and error messages.

#### **Sample of reported job titles:**

Computer Operator, Operations and Maintenance Technician, Computer Specialist, Information Technology Specialist, Software Technician

## Tasks

- Enter commands, using computer terminal, and activate controls on computer and peripheral equipment to integrate and operate equipment.
- Monitor the system for equipment failure or errors in performance.
- Notify supervisor or computer maintenance technicians of equipment malfunctions.
- Respond to program error messages by finding and correcting problems or terminating the program.
- Read job set-up instructions to determine equipment to be used, order of use, material such as disks and paper to be loaded, and control settings.
- Operate spreadsheet programs and other types of software to load and manipulate data and to produce reports.
- Retrieve, separate and sort program output as needed, and send data to specified users.
- Load peripheral equipment with selected materials for operating runs, or oversee loading of peripheral equipment by peripheral equipment operators.
- Answer telephone calls to assist computer users encountering problems.
- Oversee the operation of computer hardware systems, including coordinating and scheduling the use of computer terminals and networks to ensure efficient use.

## Knowledge

**Computers and Electronics** — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.

**Customer and Personal Service** — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

**Sales and Marketing** — Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.

**Clerical** — Knowledge of administrative and clerical procedures and systems such as word processing, managing files and records, stenography and transcription, designing forms, and other office procedures and terminology.

**Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

**English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.

## Skills

**Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

**Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.

**Critical Thinking** — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.

**Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.

**Time Management** — Managing one's own time and the time of others.

**Instructing** — Teaching others how to do something.

**Troubleshooting** — Determining causes of operating errors and deciding what to do about it.

**Speaking** — Talking to others to convey information effectively.

**Service Orientation** — Actively looking for ways to help people.

**Coordination** — Adjusting actions in relation to others' actions.

### Abilities

**Information Ordering** — The ability to arrange things or actions in a certain order or pattern according to a specific rule or set of rules (e.g., patterns of numbers, letters, words, pictures, mathematical operations).

**Oral Comprehension** — The ability to listen to and understand information and ideas presented through spoken words and sentences.

**Problem Sensitivity** — The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing there is a problem.

**Written Comprehension** — The ability to read and understand information and ideas presented in writing.

**Deductive Reasoning** — The ability to apply general rules to specific problems to produce answers that make sense.

**Oral Expression** — The ability to communicate information and ideas in speaking so others will understand.

**Inductive Reasoning** — The ability to combine pieces of information to form general rules or conclusions (includes finding a relationship among seemingly unrelated events).

**Near Vision** — The ability to see details at close range (within a few feet of the observer).

**Written Expression** — The ability to communicate information and ideas in writing so others will understand.

**Speech Recognition** — The ability to identify and understand the speech of another person.

### Job Zone

<b>Title</b>	Job Zone Three: Medium Preparation Needed
<b>Overall Experience</b>	Previous work-related skill, knowledge, or experience is required for these occupations. For example, an electrician must have completed three or four years of apprenticeship or several years of vocational training, and often must have passed a licensing exam, in order to perform the job.
<b>Job Training</b>	Employees in these occupations usually need one or two years of



	training involving both on-the-job experience and informal training with experienced workers.
<b>Job Zone Examples</b>	These occupations usually involve using communication and organizational skills to coordinate, supervise, manage, or train others to accomplish goals. Examples include funeral directors, electricians, forest and conservation technicians, legal secretaries, interviewers, and insurance sales agents.
<b>SVP Range</b>	(6.0 to < 7.0)
<b>Education</b>	Most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree. Some may require a bachelor's degree.

### Work Styles

**Attention to Detail** — Job requires being careful about detail and thorough in completing work tasks.

**Dependability** — Job requires being reliable, responsible, and dependable, and fulfilling obligations.

**Initiative** — Job requires a willingness to take on responsibilities and challenges.

**Innovation** — Job requires creativity and alternative thinking to develop new ideas for and answers to work-related problems.

**Achievement/Effort** — Job requires establishing and maintaining personally challenging achievement goals and exerting effort toward mastering tasks.

**Adaptability/Flexibility** — Job requires being open to change (positive or negative) and to considerable variety in the workplace.

**Independence** — Job requires developing one's own ways of doing things, guiding oneself with little or no supervision, and depending on oneself to get things done.

**Analytical Thinking** — Job requires analyzing information and using logic to address work-related issues and problems.

**Leadership** — Job requires a willingness to lead, take charge, and offer opinions and direction.

**Self Control** — Job requires maintaining composure, keeping emotions in check, controlling anger, and avoiding aggressive behavior, even in very difficult situations.

### Work Values

**Support** — Occupations that satisfy this work value offer supportive management that stands behind employees. Corresponding needs are Company Policies, Supervision: Human Relations and Supervision: Technical.

**Working Conditions** — Occupations that satisfy this work value offer job security and good working conditions. Corresponding needs are Activity, Compensation, Independence, Security, Variety and Working Conditions.

## ***Annex 4 - Skills Based IT Job Profiles<sup>1</sup> (UK)***

### **Computer Service and Repair Technician**

Computer service and repair technicians install, repair and maintain computer systems. They work in a variety of job settings, which can include:

- being a member of an IT support team within a large organization, servicing the computer network
- carrying out commercial contract work for a specialist IT service company
- working as a field technician for a computer manufacturer, visiting home users to fix PC problems
- running their own small business, combining computer retail sales with repair and upgrade services.

#### **Tasks:**

- installation and support of new systems
- upgrading existing hardware and software
- devising and operating maintenance procedures for clients
- routine testing, fault diagnosis and correction
- maintenance of servers and IT security systems
- maintenance of email systems for internal and external networks
- maintenance of peripherals such as printers, scanners and video conferencing equipment
- preparing estimates for new installations
- routine administration such as scheduling support staff rota.

Technicians may also have responsibility for training staff to use equipment correctly and safely.

#### **Skills and Interests**

As a computer service technician, you should:

- have a thorough knowledge of networking and operating systems, hardware and common software
- have good communication and customer service skills
- have excellent analytical skills
- be patient and have a methodical approach to work
- be able to work to deadlines
- be able to keep up to date with developments in IT
- be aware of safety issues associated with electrical equipment.

#### **Entry**

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1 learndirect - Info Technology & Info Management

- NCFE Certificate for IT Practitioners (General) Level 2
- BTEC First Certificate (Level 2) and National Certificate IT Practitioners (ICT Systems Support) Level 3
- City & Guilds (E-Equals) IT Practitioners Certificate at Level 1 and Diploma (7262) at Level 2
- OCR (iPRO) Certificate for IT Practitioners (ICT Systems Support) Level 2.

### **Training**

- ICT hardware and software support
- problem solving
- advanced networking (LAN and WAN)
- network systems management
- customer support systems
- repair centre procedures
- telecommunications planning.

Other relevant qualifications include:

Alternative industry-recognized training includes:

CompTIA A+ Certification covering: installation, configuring and upgrading, diagnosis and troubleshooting, preventive maintenance, motherboards, processors and memory, printers, basic networking, operating system fundamentals and networks. For more information see CompTia website in Further Information.

### **Information Scientist**

Information scientists find, organize and distribute information, manage and maintain information resources and develop systems.

### **Tasks:**

- cataloguing, classifying and storing information
- researching, selecting and acquiring new resources
- making sure that information resources are up-to-date and comprehensive
- dealing with research enquiries from colleagues, managers or the organization's clients
- managing IT and creating information architecture, for instance developing intranets or designing user-friendly search engines
- developing new information systems
- managing a team of information staff
- budget management
- writing reports, briefings and website content
- training colleagues how to use the systems.

### **Skills and Interests**

- be highly organized with good time-management skills
- have excellent written and spoken communication skills
- work accurately and pay attention to detail
- be able to think both logically and creatively to solve problems
- have good research skills

- have excellent computer skills, especially in using databases and the internet
- be able to manage a budget, and, where necessary, a team
- be aware of information issues like accessibility and copyright

### **Entry**

- a degree in information management or librarianship that has been accredited by the Chartered Institute of Library and Information Professionals (CILIP);
- a degree in any subject, plus a postgraduate qualification accredited by CILIP.

### **Training**

Most information scientists work towards chartered membership of Chartered Institute of Library and information Professionals (CILIP) and having a CILIP-accredited qualification.

### **Software Developer**

Software developers are responsible for writing specifications, designing, developing, installing, testing and maintaining software applications. Work on generic products, which can be used by a range of organizations or develop tailored packages to match a client's specific requirements.

### **Tasks:**

- working with the client, the developer analyses existing procedures, documents client needs and draws up detailed test specifications
- they build a working version (or modify an existing version) using programming code
- version checks are carried out by testing data
- installation and integration tests are done
- developers evaluate test results and fix technical problems (bugs)
- the full installation is implemented and final validation checks carried out before going live
- maintenance and support routines in place.

### **Skills and Interests**

- expert knowledge of current hardware, software and programming languages
- excellent analytical skills
- excellent communication skills
- be able to work with people at all levels including non-technical staff
- be able to pay attention to detail
- project management skills
- be able to work under pressure and to deadlines
- be able to work as part of team
- be customer focused and have an appreciation of wider business demands
- respect the confidentiality of a client's processes and information

### **Entry**

A degree or BTEC HNC/HND, at least five GCSEs (A-C)/S grades (1-3) and two or three A levels/three or four H grades (including math or computing), or equivalent qualifications such as vocational A levels.

An understanding of some of the main programming languages is essential including:

- Java
- C++
- Smalltalk
- Powerbuilder
- Visual Basic
- Oracle
- UML (Unified Modelling Language)
- Delphi
- Prolog
- .NET frameworks (such as C# (C-sharp), ASP and VB)

## **Training**

In case of degree-level qualification, work-based graduate apprenticeships may be available. Additional software manufacturers' certification courses promote skills development. The Graduate Professional Development Award (GDPA), developed by e-skills in conjunction with higher education institutions and IT employers, is studied as part of an undergraduate, postgraduate or work-based training program. The Award covers key skills required by the industry including communication and problem solving, team working and technical competencies.

Certification qualifications are available through software development companies:

- Microsoft Certified Solution Developer (MCSD) and Certified Applications Developer (MCAD)
- Sun Microsystems Java Certified Programmer (SCJP) and Developer (SCJD)
- Oracle PL/SQL Developer (databases)
- Certified Internet Webmaster (CIW) Master Enterprise Specialist, Web Developer and Applications Developer.

## **Systems Analyst**

Systems analysts are IT specialists who are brought in by companies to evaluate their IT systems, business functions and procedures; to identify areas for improvement; design and integrate computer-based solutions to meet the particular business needs.

### **Tasks:**

- drawing up specific proposals for a modified or replacement system
- carrying out commercial feasibility assessments of proposals
- working closely with programmers and developers who build the system
- overseeing the installation of a new system
- planning and working to a completion deadline
- providing training and training manuals to users of a new or upgraded system

Computer Assisted Software Engineering (CASE) tools and object-orientated programming languages, such as Visual Basic, C++ , Java and Smalltalk, are increasingly

used, which allow the analysis and programming functions to be combined and carried out within the same role.

### **Skills and Interests**

- extensive knowledge of hardware, software and programming
- be able to gather and interpret data
- excellent communication skills, for discussing ideas with colleagues from technical and non-technical roles, and clients
- excellent analytical skills and creative approach to problem solving
- good negotiating skills
- be able to plan and manage a project
- have an appreciation of wider business demands
- be able to work within a budget
- be willing to update skills in line with developments within the sector
- be able to work as part of a team

### **Entry**

A degree or BTEC HNC/HND. Minimum entry for a degree course is five GCSEs (A-C)/S grades (1-3) with two A levels/three H grades, or equivalent. Minimum entry to BTEC HNC/HND is four GCSEs (A-C)/S grades (1-3) with one A level/two H grades, or equivalent.

Knowledge of some of the following may be helpful when applying for positions: Customer Relationship Management (CRM) applications, Relational Database Management Systems (RDBMS), Oracle, SQL, Unified Modeling Language (UML) and SAP software applications.

### **Training**

The British Computer Society (BCS) offers a series of professional awards – Certificate, Diploma and Professional Graduate Diploma equivalent to the first, second and third year of a university honors degree, respectively. The Institute for the Management of Information Systems (IMIS) offers a series of programs ranging from introductory level through to the equivalent of ordinary degree level A. Graduate Professional Development Award (GDPA) has been developed by e-skills in conjunction with higher education institutions and employers in the IT sector. The Award covers key skills required by the industry including communication and problem solving, team working and technical competencies. Proprietary certification qualifications are also available through software development companies.

### **IT Support Technician**

IT support technicians help to diagnose and correct software and hardware problems for IT users, may work as part of a team within their own organisation or work for external commercial customers.

### **Tasks:**

- working with the client to determine the exact nature of the fault

- analyzing the reasons for breakdown of systems or peripherals (printers, scanners, modems)
- visiting clients, or sending out a field technician, to deal with problems that cannot be resolved over the phone or website
- installing and configuring new equipment and upgrading existing systems
- testing, repairing and maintaining equipment
- documenting problems and solutions
- giving basic training to new users or customers in using their PCs or specialist software applications

### **Skills and Interests**

- have a thorough knowledge of networking and operating systems, hardware and common office software
- have excellent analytical skills
- be able to explain clearly problems and solutions, in non-technical terms
- be able to work calmly and professionally under pressure
- be patient and have a methodical approach to work
- be able to work alone or as part of a team
- be able to prioritise tasks
- be able to work to deadlines
- be able to keep up to date with developments in IT
- be aware of safety issues associated with electrical equipment

### **Entry**

- NCFE Certificate for IT Practitioners (General) Level 2
- BTEC First Certificate (Level 2) and National Certificate IT Practitioners (ICT Systems Support) Level 3
- City & Guilds (E-Quals) IT Practitioners Certificate at Level 1 and Diploma (7262) at Level 2
- OCR (iPRO) Certificate for IT Practitioners (ICT Systems Support) Level 2.

### **Training**

- ICT hardware and software support
- problem solving
- advanced networking (LAN and WAN)
- network systems management
- customer support systems
- repair centre procedures
- telecommunications planning.

Other relevant qualifications include:

- BTEC National Diploma IT Practitioners (ICT Systems Support) Level 3
- City & Guilds (E-Quals) IT Practitioners Advanced Diploma (7262) Level 3 and City & Guilds Higher Professional Diploma for IT Practitioners (ICT Systems Support) Level 4
- OCR (iPRO) Certificate for IT Practitioners (ICT Systems Support) Level 3 and OCR (iPRO) Higher Level award IT Professionals (ICT Systems Support) Level 4.

## **Network Engineer**

Network engineers, are responsible for installing and maintaining computer communication networks within an organisation or between organizations.

### **Tasks:**

- installation and support for new software and hardware
- setting up user-accounts, permissions and passwords
- maintaining adequate security, especially where networks link to the internet
- monitoring network usage
- fault diagnosis and rectification
- implementing preventative maintenance schedules
- technical support for end-users
- providing training on new systems
- working with other IT professionals in day-to-day administration and monitoring of networks
- planning and implementing future developments.

### **Skills and Interests**

- excellent IT skills
- excellent analytical skills
- be able to prioritise tasks
- be able to explain technical issues clearly
- be able to work within a team
- good interpersonal skills
- an excellent working knowledge of networking technologies and be able to keep up to date with latest developments.

### **Entry**

Four or five GCSEs (A-C)/S grades (1-3) including math, English and information technology. Alternative qualifications: City & Guilds (E-Quals ICT Systems Support 7262) IT Practitioners Diploma Level 2 and Advanced Diploma Level 3

- BTEC National Certificate/Diploma for IT Practitioners (ICT Systems Support)
- OCR (iPRO) Certificate for IT Practitioners (ICT Systems Support) at levels 2 and 3
- CompTIA i-Net+ Certification.

### **Training**

- CompTIA Network+ Certification
- Certified Novell Engineer (CNE)
- City & Guilds Higher Professional Diploma in Information Management Using ICT or IT Practitioners Level 4
- OCR (iPRO) Higher Level award for IT Professionals (ICT Systems Support) Level 4.
- CCNA (Cisco Certified Network Associate) – although not essential, it is recommended that you have a level 3 IT qualification (such as those listed in Entry) or equivalent experience



- CCNP (Cisco Certified Network Professional) – CCNA or equivalent level of knowledge and experience
- CCIE (Cisco Certified Internetwork Expert) – this is an extremely high standard and it is recommended that you have several years' IT experience.

### **Database Developer/Administrator**

A database developer/administrator is responsible for the planning, design, testing, installation and maintenance of information management systems used by companies and institutions across the commercial, public and education sectors.

#### **Tasks:**

Administrators draw up procedures and documentation for:

- updating information
- making additions, deletions and error-reporting
- data backup, archiving and disaster-recovery plans
- implementing security measures to verify data and control access to information

#### **Skills and Interests**

- excellent analytical and organisational skills
- be able to work accurately and pay attention to detail
- a comprehensive understanding of database architecture, software and DBMS
- be able to work under pressure and to deadlines
- be able to think quickly and be decisive
- a good understanding of wider business demands
- excellent communication, presentation and negotiation skills
- respect confidentiality
- understanding the implications of information legislation, such as the Data Protection Act
- be prepared to keep up-to-date with developments in technology
- work well as part of a team.

#### **Entry**

- Foundation degrees, BTEC HNC/HNDs and degrees;
- At least five GCSEs (A-C)/S grades (1-3) and two or three A levels/three or four H grades (including math and a science subject), or equivalent qualifications such as vocational A levels.

#### **Training**

**Proprietary certification qualifications** are available through software development companies:

- Microsoft Certified Database Administrator (MCDBA)
- Sybase Adaptive Enterprise Server (Developer and Administrator pathways)
- Oracle PL/SQL Developer, and 9i and 10g Administrator (Associate, Professional and Master levels)
- IBM DB2 and Informix certification programs.

## **IT Security Coordinator**

IT security coordinators, known as information security analysts, advise, plan, design and coordinate security measures to protect clients' information and data from unauthorized access, deliberate attack, theft and corruption, also implement controls to allow secure transmission of files and data across computer networks, such as the internet.

### **Tasks:**

- carrying out risk assessments of installations and applications and developing plans to minimize potential threats
- designing new security systems or upgrading existing ones
- testing and evaluating security products
- contingency planning for disaster recovery in the event of security breaches
- carrying out simulated breaches to test procedures (penetration testing)
- investigating actual breaches and implementing remedial action
- carrying out audits and reviews of security systems to test for weak points (vulnerability scanning)
- ensuring procedures adhere to national and international standards covering network security
- preparing reports and technical documentation
- supervising and training staff
- contributing to overall development of company security

### **Skills and Interests**

- an excellent knowledge of IT security systems, tools and procedures
- excellent communication skills
- strong analytical skills
- be trustworthy
- project management skills
- be able to work under pressure and to deadlines
- be able to interpret and evaluate data accurately
- keep up to date with current and emerging security threats, technologies, issues and trends
- be aware of commercial pressures
- be proactive and able to take responsibility
- keep up to date with information security standards and legislation

### **Entry**

The experience should cover Windows 2000/NT/2003, UNIX and Linux platforms, and common security technologies and procedures. These include firewall configuration, anti-virus software, intrusion detection systems (IDS), encryption techniques, such as Public Key Infrastructure (PKI) and Secure Socket Layer (SSL), authentication (passwords, digital certificates and more recently, biometrics), penetration testing and vulnerability scanning.

The common corporate and regulatory guidelines include international information security standard BS7799 and its successor: ISO/IEC 27001, the Data Protection and Freedom of Information Acts, and the IT Infrastructure Library (ITIL) framework, detailing best practice.

## **Training**

Systems Security Certified Practitioner (SSCP) requires a minimum of one year's experience in one or more of the seven areas covered by the certification: access control; administration; audit and monitoring; cryptography; data communications; risk, response and recovery.

Microsoft Certified Systems Engineer (MCSE) and Systems Administrator (MCSA) certification both contain security options. For the MCSA, 12 months' experience of administering and maintaining network security is recommended; for the MCSE - 2 years' work in design and planning of security systems.

Certified Information Systems Security Professional (CISSP), Certified Information Security Manager (CISM) trainings are for professionals working at intermediate and senior level, with three to four years' demonstrable experience and senior staff with five years' experience of managing security systems.

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## List of Abbreviations

RA – Republic of Armenia

ACInet - America's Career InfoNet

CGI - Career Guide to Industries

CIS – Commonwealth of Independent States

DOL - Department of Labor

ECDL - European Computer Driving License Foundation

EDI - Electronic Data Interchange

EICTA - European Information and Communications Technology Industry Association

EUCIP - European Certification of Informatics Professionals

GENIUS - Generic E-Learning Environments and Paradigms for the New European ICT Curricula

HOTT - Hands On Technology Transfer Inc.

ICCP - Institute for Certification of Computing Professionals

ICS - Irish Computer Society

ISCO -88 - International Standard Classification of Occupations

ISCO 88 (COM) - EU Standard Classification of Occupations

ILO - [International Labor Organization](http://www.ilo.org)

IT – Informational Technologies

ICT - Information and communication technologies

LPI - Linux Professional Institute

NOC - National Occupational Classification

NWCET - National Workforce Center for Emerging Technologies

OPM - Office of Personnel Management

OOH – Occupational Outlook Handbook

O\*NET - Occupational Information Network

SOC – Standard Occupational Classification ([www.bls.gov/soc/](http://www.bls.gov/soc/))