

# COMPUTER CENTER ADMINISTRATION AND STAFF

## 1. Computer and information systems managers

### What they do

Computer and information systems managers, often called information technology (IT) managers, or IT project managers, plan, coordinate, and direct computer-related activities in an organization. They help determine the information technology goals of an organization and are responsible for implementing computer systems to meet those goals.

### Duties

---

Computer and information systems managers typically do the following:

- Analyze their organization's computer needs and recommend possible upgrades to top executives
- Plan and direct installing and upgrading computer hardware and software
- Ensure the security of an organization's network and electronic documents
- Assess the costs and benefits of a new project and justify spending on the project to top executives
- Learn about new technology and look for ways to upgrade their organization's computer systems
- Determine short- and long-term personnel needs for their department
- Plan and direct the work of other IT professionals, including computer systems analysts, software developers, information security analysts, and computer support specialists
- Negotiate with vendors to get the highest level of service for their organization's technology

Few managers carry out all of these duties. There are various types of computer and information systems managers, and the specific duties of each are determined by the size and structure of the firm. Smaller firms may not employ every type of manager.

The following are types of computer and information systems managers:

**Chief information officers (CIOs)** are responsible for the overall technology strategy of their organizations. They help determine the technology or information goals of an organization and then oversee planning to implement technology to meet those goals. CIOs may focus on a specific area, such as electronic data processing or information systems, but they differ from chief technology officers (CTOs; see next) in that the CIO is more focused on long-term, or "big picture," issues. At small organizations a CIO has more direct control over the IT department, while at larger organizations other managers under the CIO may handle the day-to-day activities of the IT department.

CIOs who do not have technical expertise and who focus solely on the business aspects of creating an overall company vision are included in a separate profile on top executives.

**Chief technology officers (CTOs)** evaluate new technology and determine how it can help their organization. When both CIOs and CTOs are present, the CTO usually has more technical expertise.

The CTO is responsible for designing and recommending the appropriate technology solutions to support the policies and directives issued by the CIO. CTOs also work with different departments to implement the organization's technology plans.

The CTO usually reports directly to the CIO and also may be responsible for overseeing the development of new technologies or other research-and-development activities. When a company does not have a CIO, the CTO determines the overall technology strategy for the firm and presents it to top executives.

**IT directors**, including management information systems (MIS) directors, are in charge of their organizations' information technology (IT) departments, and they directly supervise other employees. IT directors help to determine the business requirements for IT systems, and they implement the policies that have been chosen by top executives. IT directors often have a direct role in hiring members of the IT department. It is their job to ensure the availability of data and network services by coordinating IT activities. IT directors also oversee the financial aspects of their department, such as budgeting.

**IT security managers** oversee their organizations' network and data security. They work with top executives to plan security policies and promote a culture of information security throughout the organization. They develop programs to keep employees aware of security threats. These managers must keep up to date on IT security measures. They also supervise investigations if there is a security violation.

## **Work Environment**

Computer and information systems managers held about 332,700 jobs in 2012.

The industries that employed the most computer and information systems managers in 2012 were as follows:

Computer systems design and related services	19%
Finance and insurance	12
Information	11
Management of companies and enterprises	9

The industries that employed the most computer and information systems managers in 2012 were as follows:

As network speeds increase, telecommuting is becoming more common. Although few managers can work remotely, many have to supervise employees who work from home.

### **Work Schedules**

Most computer and information systems managers work full time. Many of them must work overtime to solve problems. In 2012, about one third worked more than 40 hours per week.

### **How to Become a Computer and Information Systems Manager**

Computer and information systems managers usually spend 5-10 years in an IT occupation before being promoted to a manager.

Typically, a bachelor's degree in computer or information science, plus related work experience, is required. Many computer and information systems managers also have a graduate degree.

### **Education**

Computer and information systems managers normally must have a bachelor's degree in a computer- or information science–related field. Such a degree usually takes 4 years to complete and includes courses in computer programming, software development, and mathematics. Management information systems (MIS) programs usually include business classes as well as computer-related ones.

Many organizations require their computer and information systems managers to have a graduate degree as well. A master of business administration (MBA) is common and takes 2 years beyond the undergraduate level to complete. Many people pursuing an MBA take classes while working, an option that can increase the time required to complete that degree.

### **Work Experience in a Related Occupation**

Most jobs for computer and information systems managers require several years of experience in a related information technology (IT) job. Lower level management positions may require only a few years of experience. Directors are more likely to need 5 to 10 years of related work experience. A chief technology officer (CTO), who oversees the technology plan for a large organization, may need more than 15 years of experience in the IT field before being considered for a job.

The number of years of experience required varies with the organization. Generally, smaller companies do not require as much experience as larger, more established ones.

Computer systems are used throughout the economy, and IT employees may gain experience in a variety of industries. However, an applicant's work experience should be related to the industry the applicant plans to manage. For example, an IT security manager should have previously worked in information security. A hospital IT director should have experience in the healthcare field.

### **Advancement**

---

Most computer and information systems managers start out as lower level managers and advance to higher positions within the IT department. IT directors or project managers can advance to become CTOs. A CTO or other manager who is especially business minded can advance to become a chief information officer (CIO), the person in charge of all IT-related decisions in an organization. CIOs can advance to become top executives in an organization.

### **Important Qualities**

---

**Analytical skills.** IT managers must be able to analyze a problem, consider ways to solve the problem, and select the best way.

**Communication skills.** IT managers must be able to explain their work to top executives and give clear instructions to their subordinates.

**Decision-making skills.** Some IT managers must make important decisions about how to allocate their organizations' resources in order to reach their goals.

**Leadership skills.** IT managers must be able to lead and motivate IT teams or departments so that workers are efficient and effective.

**Organizational skills.** Some IT managers must coordinate the work of several different IT departments to make the organization run efficiently.

## **2. Computer Programmers**

- Significant Points
- Almost 8 out of 10 computer programmers held an associate's degree or higher in 2006; nearly half held a bachelor's degree, and 2 out of 10 held a graduate degree.
- Employment of computer programmers is expected to decline by four percent through 2016.
- Job prospects will be best for applicants with a bachelor's degree and experience with a variety of programming languages and tools.

### **Nature of the Work**

Computer programmers write, test, and maintain the detailed instructions, called programs, that computers follow to perform their functions. Programmers also conceive, design, and test logical structures for solving problems by computer. With the help of other computer specialists, they figure out which instructions to use to make computers do specific tasks. Many technical innovations in programming—advanced computing technologies and sophisticated new languages and programming

tools, for example—have redefined the role of a programmer and elevated much of the programming work done today.

Job titles and descriptions may vary, depending on the organization, but computer programmers are individuals whose main job function is programming. Programmers usually write programs according to the specifications given by computer software engineers and systems analysts. (Sections on computer software engineers and on computer systems analysts appear elsewhere in the Handbook.) After engineers and analysts design software—describing how it will work—the programmer converts that design into a logical series of instructions that the computer can follow. The programmer codes these instructions in a conventional programming language such as COBOL; an artificial intelligence language such as Prolog; or one of the more advanced object-oriented languages, such as Java, C++, or ACTOR.

Different programming languages are used depending on the purpose of the program. Programmers generally know more than one programming language, and because many languages are similar, they often can learn new languages relatively easily. In practice, programmers often are referred to by the language they know, such as Java programmers, or by the type of function they perform or environment in which they work—for example, database programmers, mainframe programmers, or Web programmers.

Programmers also update, repair, modify, and expand existing programs. Some, especially those working on large projects that involve many programmers, use computer-assisted software engineering (CASE) tools to automate much of the coding process. These tools enable a programmer to concentrate on writing the unique parts of a program. Programmers working on smaller projects often use “programmer environments,” applications that increase productivity by combining compiling, code walk through, code generation, test data generation, and debugging functions. Programmers also use libraries of basic code that can be modified or customized for a specific application. This approach yields more reliable and consistent programs and increases programmers’ productivity by eliminating some routine steps.

Programs vary widely depending on the type of information they will access or generate. For example, the instructions involved in updating financial records are very different from those required to simulate flight for pilot training. Simple programs can be written in a few hours, but some programs draw data from many existing systems or use complex mathematical formulas. These programs may take more than a year to create. In most cases, several programmers work together as a team under a senior programmer’s supervision.

Programmers test a program by running it to ensure that the instructions are correct and that the program produces the desired outcome. If errors do occur, the programmer must make the appropriate change and recheck the program until it produces the correct results. This process is called testing and debugging. Programmers may continue to fix problems for as long as a program is used.

Programmers working on a mainframe, a large centralized computer, may prepare instructions for a computer operator who will run the program. (A section on computer operators appears elsewhere in the Handbook.) Programmers also may contribute to the instruction manual for a program.

Programmers in software development companies may work directly with experts from various fields to create specialized software—either programs designed for specific clients or packaged software for general use—ranging from games and educational software to programs for desktop publishing and financial planning. Programming of packaged software constitutes one of the most rapidly growing segments of the computer services industry.

Increasingly, advanced software platforms are bridging the gap between computer programmers and computer users. New platforms, such as spreadsheet, accounting, and enterprise resource planning applications, have created demand for computer specialists who have first-hand knowledge of a user-base. These workers use such platforms to develop programs that meet the specific needs of this base. Computer programmers often are responsible for creating the software platform, and then fine-tuning the final program after it has been made.

Computer programmers often are grouped into two broad types—applications programmers and systems programmers. Applications programmers write programs to handle a specific job, such as a program to track inventory within an organization. They also may revise existing packaged software or customize generic applications purchased from vendors. Systems programmers, in contrast, write programs to maintain and control computer systems software for operating systems, networked systems, and database systems. These workers make changes in the instructions that determine how the network, workstations, and central processing unit of a system handle the various jobs they have been given, and how they communicate with peripheral equipment such as terminals, printers, and disk drives. Because of their knowledge of the entire computer system, systems programmers often help applications programmers determine the source of problems that may occur with their programs.

In some organizations, workers known as programmer-analysts are responsible for both the systems analysis and programming. (A more detailed description of the work of programmer-analysts is presented in the section on computer systems analysts elsewhere in the Handbook.)

**Work environment.** Programmers spend the majority of their time in front of a computer terminal, and work in clean, comfortable offices. Telecommuting is becoming more common, however, as technological advances allow more work to be done from remote locations.

Most computer programmers work about 40 hours per week. Long hours or weekend work may be required, however, to meet deadlines or fix unexpected technical

problems. About four percent work part-time, compared with about 15 percent for all occupations.

Like other workers who spend long periods in front of a computer terminal typing at a keyboard, programmers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

### **Training, Other Qualifications, and Advancement**

A bachelor's degree commonly is required for computer programming jobs, although a two-year degree or certificate may be adequate for some positions. Employers favor applicants who already have relevant programming skills and experience. Skilled workers who keep up to date with the latest technology usually have good opportunities for advancement.

Education and training. Most programmers have a bachelor's degree, but a two-year degree or certificate may be adequate for some jobs. Some computer programmers hold a college degree in computer science, mathematics, or information systems, whereas others have taken special courses in computer programming to supplement their degree in a field such as accounting, finance, or another area of business. In 2006, more than 68 percent of computer programmers had a bachelor's degree or higher, but as the level of education and training required by employers continues to rise, this proportion is expected to increase.

Employers who use computers for scientific or engineering applications usually prefer college graduates who have a degree in computer or information science, mathematics, engineering, or the physical sciences. Employers who use computers for business applications prefer to hire people who have had college courses in management information systems and business, and who possess strong programming skills. A graduate degree in a related field is required for some jobs.

Most systems programmers hold a four-year degree in computer science. Extensive knowledge of a variety of operating systems is essential for such workers. This includes being able to configure an operating system to work with different types of hardware and being able to adapt the operating system to best meet the needs of a particular organization. Systems programmers also must be able to work with database systems, such as DB2, Oracle, or Sybase.

In addition to educational attainment, employers highly value relevant programming skills, as well as experience. Although knowledge of traditional programming languages still is important, employers are placing an emphasis on newer, object-oriented languages and tools such as C++ and Java. Additionally, employers seek people familiar with fourth- and fifth-generation languages that involve graphic user interface and systems programming. College graduates who are interested in changing careers or developing an area of expertise may return to a two-year community college or technical school for specialized training. In the absence of a degree, substantial specialized experience or expertise may be needed.

Entry-level or junior programmers may work alone on simple assignments after some initial instruction, or they may be assigned to work on a team with more experienced programmers. Either way, beginning programmers generally must work under close supervision.

Because technology changes so rapidly, programmers must continuously update their knowledge and skills by taking courses sponsored by their employer or by software vendors, or offered through local community colleges and universities.

Certification and other qualifications. When hiring programmers, employers look for people with the necessary programming skills who can think logically and pay close attention to detail. Programming calls for patience, persistence, and the ability to perform exacting analytical work, especially under pressure. Ingenuity and creativity are particularly important when programmers design solutions and test their work for potential failures. The ability to work with abstract concepts and to do technical analysis is especially important for systems programmers because they work with the software that controls the computer's operation.

Because programmers are expected to work in teams and interact directly with users, employers want programmers who are able to communicate with non-technical personnel. Business skills are also important, especially for those wishing to advance to managerial positions.

Certification is a way to demonstrate a level of competence and may provide a jobseeker with a competitive advantage. In addition to language-specific certificates, product vendors or software firms also offer certification and may require professionals who work with their products to be certified. Voluntary certification also is available through various other organizations.

Advancement. For skilled workers who keep up to date with the latest technology, prospects for advancement are good. In large organizations, programmers may be promoted to lead programmer and be given supervisory responsibilities. Some applications programmers may move into systems programming after they gain experience and take courses in systems software. With general business experience, programmers may become programmer-analysts or systems analysts, or may be promoted to managerial positions. Programmers with specialized knowledge and experience with a language or operating system may work in research and development and may even become computer software engineers. As employers increasingly contract with outside firms to do programming jobs, more opportunities should arise for experienced programmers with expertise in a specific area to work as consultants.

## **Employment**

Computer programmers held about 435,000 jobs in 2006. Programmers are employed in almost every industry, but the largest concentration is in computer systems design and related services. Large numbers of programmers also work for software



publishers, financial institutions, insurance carriers, educational institutions, government agencies, and management of companies and enterprises. Many computer programmers work independently as consultants on a temporary or contract basis, some of whom are self-employed. About 17,000 computer programmers were self-employed in 2006.

## **Job Outlook**

Employment of computer programmers is expected to decline slowly. Job prospects should be best for those with a bachelor's degree and experience with a variety of programming languages and tools.

**Employment change.** Employment of computer programmers is expected to decline slowly, decreasing by 4 percent from 2006 to 2016. The consolidation and centralization of systems and applications, developments in packaged software, advances in programming languages and tools, and the growing ability of users to design, write, and implement more of their own programs mean that more programming functions can be performed by other types of information workers, such as computer software engineers.

Another factor contributing to employment decline will be the offshore outsourcing of programming jobs. Because they can transmit their programs digitally, computer programmers can perform their job function from anywhere in the world, allowing companies to employ workers in countries that have lower prevailing wages. Computer programmers are at a much higher risk of having their jobs outsourced abroad than are workers involved in more complex and sophisticated information technology functions, such as software engineering. Much of the work of computer programmers requires little localized or specialized knowledge and can be made routine once knowledge of a particular programming language is mastered—and computer programming languages have become known internationally.

Nevertheless, employers will continue to need some local programmers, especially those who have strong technical skills and who understand an employer's business and its programming requirements. This means that programmers will have to keep abreast of changing programming languages and techniques. Given the importance of networking and the expansion of client/server, Web-based, and wireless environments, organizations will look for programmers who can support data communications and help implement business and intranet strategies. Demand for programmers with strong object-oriented programming capabilities and technical specialization in areas such as client/server programming, wireless applications, multimedia technology, and graphic user interface likely will stem from the expansion of intranets, extranets, and Internet applications. Programmers also will be needed to create and maintain expert systems and embed these technologies in more products. Finally, a growing emphasis on cybersecurity will lead to increased demand for programmers who are familiar with digital security issues, and are skilled in using appropriate security technology.

Job prospects. Although employment is projected to decline, numerous job openings will result from the need to replace programmers who leave the labor force or transfer to other occupations. Prospects for these openings should be best for applicants with a bachelor's degree and experience with a variety of programming languages and tools. The languages that are in demand today include C++, Java, and other object-oriented languages, as well as newer, domain-specific languages that apply to computer networking, database management, and Internet application development. As technology evolves, however, and newer, more sophisticated tools emerge, programmers will need to update their skills in order to remain competitive. Obtaining vendor-specific or language-specific certification also can provide a competitive edge.

Jobs for both systems and applications programmers should be most plentiful in computer consulting businesses. These establishments are part of the computer systems design and related services industry, which is projected to be among the fastest growing industries in the economy over the 2006 to 2016 period.

### **3. Computer Software Engineers**

#### **Significant Points**

- Computer software engineers are one of the occupations projected to grow the fastest and add the most new jobs over the 2006-16 decade.
- Excellent job prospects are expected for applicants with at least bachelor's degree in computer engineering or computer science and with practical work experience.
- Computer software engineers must continually strive to acquire new skills in conjunction with the rapid changes that occur in computer technology.

#### **Nature of the Work**

Computer software engineers apply the principles of computer science and mathematical analysis to the design, development, testing, and evaluation of the software and systems that make computers work. The tasks performed by these workers evolve quickly, reflecting new areas of specialization or changes in technology, as well as the preferences and practices of employers. (A separate section on computer hardware engineers appears in the engineers section of the Handbook.)

Software engineers can be involved in the design and development of many types of software, including computer games, word processing and business applications, operating systems and network distribution, and compilers, which convert programs to machine language for execution on a computer.

Computer software engineers begin by analyzing users' needs, and then design, test, and develop software to meet those needs. During this process they create the detailed sets of instructions, called algorithms, that tell the computer what to do. They also may be responsible for converting these instructions into a computer language, a

process called programming or coding, but this usually is the responsibility of computer programmers. (A separate section on computer programmers appears elsewhere in the Handbook.) Computer software engineers must be experts in operating systems and middleware to ensure that the underlying systems will work properly.

Computer applications software engineers analyze users' needs and design, construct, and maintain general computer applications software or specialized utility programs. These workers use different programming languages, depending on the purpose of the program. The programming languages most often used are C, C++, and Java, with Fortran and COBOL used less commonly. Some software engineers develop both packaged systems and systems software or create customized applications.

Computer systems software engineers coordinate the construction, maintenance, and expansion of an organization's computer systems. Working with the organization, they coordinate each department's computer needs—ordering, inventory, billing, and payroll recordkeeping, for example—and make suggestions about its technical direction. They also might set up the organization's intranets—networks that link computers within the organization and ease communication among various departments.

Systems software engineers also work for companies that configure, implement, and install the computer systems of other organizations. These workers may be members of the marketing or sales staff, serving as the primary technical resource for sales workers. They also may help with sales and provide customers with technical support. Since the selling of complex computer systems often requires substantial customization to meet the needs of the purchaser, software engineers help to identify and explain needed changes. In addition, systems software engineers are responsible for ensuring security across the systems they are configuring.

Computer software engineers often work as part of a team that designs new hardware, software, and systems. A core team may comprise engineering, marketing, manufacturing, and design people, who work together to release a product.

**Work environment.** Computer software engineers normally work in clean, comfortable offices or in laboratories in which computer equipment is located. Software engineers who work for software vendors and consulting firms frequently travel overnight to meet with customers. Telecommuting is also becoming more common, allowing workers to do their jobs from remote locations.

Most software engineers work at least 40 hours a week, but about 17 percent work more than 50 hours a week. Software engineers also may have to work evenings or weekends to meet deadlines or solve unexpected technical problems.

Like other workers who spend long hours typing at a computer, software engineers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

## **Training, Other Qualifications, and Advancement**

Most employers prefer applicants who have at least a bachelor's degree and experience with a variety of computer systems and technologies. In order to remain competitive, computer software engineers must continually strive to acquire the latest technical skills. Advancement opportunities are good for those with relevant experience.

**Education and training.** Most employers prefer applicants who have at least a bachelor's degree and broad knowledge of, and experience with, a variety of computer systems and technologies. The usual college major for applications software engineers is computer science or software engineering. Systems software engineers often study computer science or computer information systems. Graduate degrees are preferred for some of the more complex jobs. In 2006, about 80 percent of workers had a bachelor's degree or higher.

Academic programs in software engineering may offer the program as a degree option or in conjunction with computer science degrees. Because of increasing emphasis on computer security, software engineers with advanced degrees in areas such as mathematics and systems design will be sought after by software developers, government agencies, and consulting firms.

Students seeking software engineering jobs enhance their employment opportunities by participating in internships or co-ops. These experiences provide students with broad knowledge and experience, making them more attractive to employers. Inexperienced college graduates may be hired by large computer and consulting firms that train new employees in intensive, company-based programs.

**Certification and other qualifications.** Systems software vendors offer certification and training programs, but most training authorities say that program certification alone is not sufficient for the majority of software engineering jobs.

People interested in jobs as computer software engineers must have strong problem-solving and analytical skills. They also must be able to communicate effectively with team members, other staff, and the customers they meet. Because they often deal with a number of tasks simultaneously, they must be able to concentrate and pay close attention to detail.

As technology advances, employers will need workers with the latest skills. Computer software engineers must continually strive to acquire new skills if they wish to remain in this dynamic field. To help keep up with changing technology, workers may take continuing education and professional development seminars offered by employers, software vendors, colleges and universities, private training institutions, and professional computing societies. Computer software engineers also need skills related to the industry in which they work. Engineers working for a bank, for example, should have some expertise in finance so that they understand banks' computer needs.

Advancement. As with most occupations, advancement opportunities for computer software engineers increase with experience. Entry-level computer software engineers are likely to test designs. As they become more experienced, engineers may begin helping to design and develop software. Eventually, they may advance to become a project manager, manager of information systems, or chief information officer, especially if they have business skills and training. Some computer software engineers with several years of experience or expertise find lucrative opportunities working as systems designers or independent consultants.

## **Employment**

Computer software engineers held about 857,000 jobs in 2006. Approximately 507,000 were computer applications software engineers, and about 350,000 were computer systems software engineers. Although they are employed in most industries, the largest concentration of computer software engineers—more than 29 percent—is in computer systems design and related services. Many computer software engineers also work for establishments in other industries, such as software publishers, government agencies, manufacturers of computers and related electronic equipment, financial institutions, insurance providers, and management of companies and enterprises.

An increasing number of computer software engineers work as independent consultants on a temporary or contract basis, many of whom are self-employed. About 17,000 computer software engineers were self-employed in 2006.

## **Job Outlook**

Job prospects should be excellent, as computer software engineers are expected to be among the fastest-growing occupations through the year 2016.

Employment change. Employment of computer software engineers is projected to increase by 38 percent over the 2006 to 2016 period, which is much faster than the average for all occupations. This occupation will generate about 324,000 new jobs, over the projections decade, one of the largest employment increases of any occupation.

Employment growth will result as businesses and other organizations adopt and integrate new technologies and seek to maximize the efficiency of their computer systems. Competition among businesses will continue to create incentive for sophisticated technological innovations, and organizations will need more computer software engineers to implement these changes.

Demand for computer software engineers will also increase as computer networking continues to grow. For example, expanding Internet technologies have spurred demand for computer software engineers who can develop Internet, intranet, and World Wide Web applications. Likewise, electronic data-processing systems in business, telecommunications, government, and other settings continue to become

more sophisticated and complex. Implementing, safeguarding, and updating computer systems and resolving problems will fuel the demand for growing numbers of systems software engineers.

New growth areas will also continue to arise from rapidly evolving technologies. The increasing uses of the Internet, the proliferation of Web sites, and mobile technology such as wireless Internet have created a demand for a wide variety of new products. As individuals and businesses rely more on hand-held computers and wireless networks, it will be necessary to integrate current computer systems with this new, more mobile technology.

In addition, information security concerns have given rise to new software needs. Concerns over “cyber security” should result in businesses and government continuing to invest heavily in software that protects their networks and vital electronic infrastructure from attack. The expansion of this technology in the next 10 years will lead to an increased need for computer engineers to design and develop the software and systems to run these new applications and integrate them into older systems.

As with other information technology jobs, outsourcing of software development to other countries may temper somewhat employment growth of computer software engineers. Firms may look to cut costs by shifting operations to foreign countries with lower prevailing wages and highly educated workers. Jobs in software engineering are less prone to being offshored than are jobs in other computer specialties, however, because software engineering requires innovation and intense research and development.

Job prospects. As a result of rapid employment growth over the 2006 to 2016 decade, job prospects for computer software engineers should be excellent. Those with practical experience and at least a bachelor’s degree in computer engineering or computer science should have the best opportunities. Employers will continue to seek computer professionals with strong programming, systems analysis, interpersonal, and business skills. In addition to jobs created through employment growth, many job openings will result from the need to replace workers who move into managerial positions, transfer to other occupations, or leave the labor force. Consulting opportunities for computer software engineers also should continue to grow as businesses seek help to manage, upgrade, and customize their increasingly complicated computer systems.

#### **4. Computer Support Specialists and Systems Administrators**

##### **Significant Points**

Growth in computer support specialist jobs will be about as fast as the average, while growth in network and computer system administrator jobs will be much faster than average.

There are many paths of entry to these occupations.

Job prospects should be best for college graduates with relevant skills and experience; certifications and practical experience are essential for people without degrees.

## **Nature of the Work**

In the last decade, computers have become an integral part of everyday life at home, work, school, and nearly everywhere else. Of course, almost every computer user encounters a problem occasionally, whether it is the annoyance of a forgotten password or the disaster of a crashing hard drive. The explosive use of computers has created demand for specialists who provide advice to users, as well as for the day-to-day administration, maintenance, and support of computer systems and networks.

**Computer support specialists** provide technical assistance, support, and advice to customers and other users. This occupational group includes technical support specialists and help-desk technicians. These troubleshooters interpret problems and provide technical support for hardware, software, and systems. They answer telephone calls, analyze problems by using automated diagnostic programs, and resolve recurring difficulties. Support specialists work either within a company that uses computer systems or directly for a computer hardware or software vendor. Increasingly, these specialists work for help-desk or support services firms, for which they provide computer support to clients on a contract basis.

**Technical support specialists** respond to inquiries from their organizations' computer users and may run automatic diagnostics programs to resolve problems. They also install, modify, clean, and repair computer hardware and software. In addition, they may write training manuals and train computer users in how to use new computer hardware and software. These workers also oversee the daily performance of their company's computer systems and evaluate how useful software programs are.

**Help-desk technicians** respond to telephone calls and e-mail messages from customers looking for help with computer problems. In responding to these inquiries, help-desk technicians must listen carefully to the customer, ask questions to diagnose the nature of the problem, and then patiently walk the customer through the problem-solving steps.

**Help-desk technicians** deal directly with customer issues and companies value them as a source of feedback on their products. They are consulted for information about what gives customers the most trouble, as well as other customer concerns. Most computer support specialists start out at the help desk.

**Network and computer systems administrators** design, install, and support an organization's computer systems. They are responsible for local-area networks (LAN), wide-area networks (WAN), network segments, and Internet and intranet systems. They work in a variety of environments, including professional offices, small businesses, government organizations, and large corporations. They maintain network hardware and software, analyze problems, and monitor networks to ensure their availability to system users. These workers gather data to identify customer needs and

then use the information to identify, interpret, and evaluate system and network requirements. Administrators also may plan, coordinate, and implement network security measures.

**Systems administrators** are responsible for maintaining network efficiency. They ensure that the design of an organization's computer system allows all of the components, including computers, the network, and software, to work properly together. Furthermore, they monitor and adjust the performance of existing networks and continually survey the current computer site to determine future network needs. Administrators also troubleshoot problems reported by users and by automated network monitoring systems and make recommendations for future system upgrades.

In some organizations, **computer security specialists** may plan, coordinate, and implement the organization's information security. These workers educate users about computer security, install security software, monitor networks for security breaches, respond to cyber attacks, and, in some cases, gather data and evidence to be used in prosecuting cyber crime. The responsibilities of computer security specialists have increased in recent years as cyber attacks have become more common. This and other growing specialty occupations reflect an increasing emphasis on client-server applications, the expansion of Internet and intranet applications, and the demand for more end-user support.

Work environment. **Computer support specialists and systems administrators** normally work in well-lighted, comfortable offices or computer laboratories. They usually work about 40 hours a week, but if their employer requires computer support over extended hours, they may be "on call" for rotating evening or weekend work. Overtime may be necessary when unexpected technical problems arise. Like other workers who type on a keyboard for long periods, computer support specialists and systems administrators are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

**Computer support specialists and systems administrators** constantly interact with customers and fellow employees as they answer questions and give advice. Those who work as consultants are away from their offices much of the time, sometimes spending months working in a client's office.

As computer networks expand, more computer support specialists and systems administrators may be able to provide technical support from remote locations. This capability would reduce or eliminate travel to the customer's workplace. Systems administrators also can administer and configure networks and servers remotely, although this practice is not as common as it is among computer support specialists.

### **Training, Other Qualifications, and Advancement**

A college degree is required for some computer support specialist positions, but certification and relevant experience may be sufficient for others. A bachelor's degree



is required for many network and computer systems administrator positions. For both occupations, strong analytical and communication skills are essential.

**Education and training.** Due to the wide range of skills required, there are many paths of entry to a job as a computer support specialist or systems administrator. Training requirements for computer support specialist positions vary, but many employers prefer to hire applicants with some formal college education. A bachelor's degree in computer science or information systems is a prerequisite for some jobs; other jobs, however, may require only a computer-related associate degree. And for some jobs, relevant computer experience and certifications may substitute for formal education. For systems administrator jobs, many employers seek applicants with bachelor's degrees, although not necessarily in a computer-related field.

A number of companies are becoming more flexible about requiring a college degree for support positions. In the absence of a degree, however, certification and practical experience are essential. Certification training programs, offered by a variety of vendors and product makers, may help some people to qualify for entry-level positions.

**Other qualifications.** People interested in becoming a computer support specialist or systems administrator must have strong problem-solving, analytical, and communication skills because troubleshooting and helping others are vital parts of the job. The constant interaction with other computer personnel, customers, and employees requires computer support specialists and systems administrators to communicate effectively on paper, via e-mail, over the phone, or in person. Strong writing skills are useful in preparing manuals for employees and customers.

**Advancement.** Beginning computer support specialists usually work for organizations that deal directly with customers or in-house users. Support specialists may advance into positions in which they use what they have learned from customers to improve the design and efficiency of future products. Job promotions usually depend more on performance than on formal education. Eventually, some computer support specialists become software engineers, designing products rather than assisting users. Computer support specialists in hardware and software companies often enjoy great upward mobility; advancement sometimes comes within months of becoming employed.

Entry-level network and computer systems administrators are involved in routine maintenance and monitoring of computer systems, typically working behind the scenes in an organization. After gaining experience and expertise, they often are able to advance to more senior-level positions. For example, senior network and computer systems administrators may make presentations to executives and managers on the security of the company computer network. They also may translate the needs of an organization into a set of technical requirements based on the available technology. As with support specialists, administrators may become software engineers involved in system and network design.

As technology continues to improve, computer support specialists and systems administrators must strive to acquire new skills. Many continuing education programs are provided by employers, hardware and software vendors, colleges and universities, and private training institutions. Professional development seminars offered by computing services firms also can enhance skills and advancement opportunities.

## **Employment**

Computer support specialists and systems administrators held about 862,000 jobs in 2006. Of these, approximately 552,000 were computer support specialists and about 309,000 were network and computer systems administrators. Although they worked in a wide range of industries, about 23 percent of all computer support specialists and systems administrators were employed in professional, scientific, and technical services industries, principally computer systems design and related services. Substantial numbers of these workers were also employed in administrative and support services companies, financial institutions, insurance companies, government agencies, educational institutions, software publishers, telecommunications organizations, health care organizations, and management of companies and enterprises.

Employers of computer support specialists and systems administrators range from startup companies to established industry leaders. As computer networks become an integral part of business, industries not typically associated with computers—such as construction—increasingly need computer support workers.

## **Job Outlook**

Employment of computer support specialists and systems administrators is expected to increase much faster than the average. Job prospects should be best for those with a college degree and relevant experience.

Employment change. Employment of computer support specialists and systems administrators is expected to increase by 18 percent from 2006 to 2016, which is much faster than the average for all occupations. In addition, this occupation is expected to add 155,000 jobs over the projection decade

Employment of computer support specialists is expected to increase by 13 percent from 2006 to 2016, which is about as fast as the average for all occupations. Demand for these workers will result as organizations and individuals continue to adopt increasingly sophisticated technology. Job growth will continue to be driven by the ongoing expansion of the computer system design and related services industry, which is projected to remain one of the fastest-growing industries in the U.S. economy. Growth will not be as explosive as during the previous decade, however, because the information technology industry is maturing and because some of these jobs are expected to be outsourced offshore where prevailing wages are lower. Physical location is not as important for computer support specialists as it is for other

occupations because these workers can provide assistance remotely and support services are provided around the clock across time zones.

Job growth among computer support specialists reflects the rapid evolution of technology. As computers and software become more complex, support specialists will be needed to provide technical assistance to customers and other users. The adoption of new mobile technologies, such as the wireless Internet, will continue to create a need for these workers to familiarize and educate computer users. Consulting jobs for computer support specialists also should continue to increase as businesses seek help managing, upgrading, and customizing ever more complex computer systems.

Employment of network and computer systems administrators is expected to increase by 27 percent from 2006 to 2016, which is much faster than the average for all occupations. Computer networks have become an integral part of business, and demand for these workers will increase as firms continue to invest in new technologies. The wide use of electronic commerce and the increasing adoption of mobile technologies mean that more establishments will use the Internet to conduct business online. This growth translates into a need for systems administrators who can help organizations use technology to communicate with employees, clients, and consumers.

Demand for computer security specialists will grow as businesses and government continue to invest heavily in “cyber security,” protecting vital computer networks and electronic infrastructures from attack. The information security field is expected to generate many new system administrator jobs over the next decade as firms across all industries place a high priority on safeguarding their data and systems.

Employment of network and computer systems administrators, however, may be tempered somewhat by offshore outsourcing, as firms transfer work to countries with lower-prevailing wages and highly skilled work forces. Systems administrators may increasingly be able to manage computer systems from remote locations as technology advances.

### **Job prospects.**

Job prospects should be best for college graduates who possess the latest technological skills, particularly graduates who have supplemented their formal education with relevant work experience. Employers will continue to seek computer specialists who possess strong fundamental computer skills combined with good interpersonal and communication skills. Due to the demand for computer support specialists and systems administrators over the next decade, those who have strong computer skills but do not have a college degree should continue to qualify for some entry-level positions.

## 5. Computer Systems Analysts

### Significant Points

- Employers generally prefer applicants who have at least a bachelor's degree in computer science, information science, or management information systems (MIS).
- Employment is expected to increase much faster than the average and more new jobs are expected to arise than in all but a few other occupations.
- Very good job prospects are expected as organizations continue to adopt increasingly sophisticated technologies.

### Nature of the Work

All organizations rely on computer and information technology to conduct business and operate efficiently. Computer systems analysts help organizations to use technology effectively and to incorporate rapidly changing technologies into their existing systems. The work of computer systems analysts evolves rapidly, reflecting new areas of specialization and changes in technology.

Computer systems analysts solve computer problems and use computer technology to meet the needs of an organization. They may design and develop new computer systems by choosing and configuring hardware and software. They may also devise ways to apply existing systems' resources to additional tasks. Most systems analysts work with specific types of computer systems—for example, business, accounting, or financial systems or scientific and engineering systems—that vary with the kind of organization. Analysts who specialize in helping an organization select the proper system software and infrastructure are often called system architects. Analysts who specialize in developing and fine-tuning systems often are known as systems designers.

To begin an assignment, systems analysts consult managers and users to define the goals of the system. Analysts then design a system to meet those goals. They specify the inputs that the system will access, decide how the inputs will be processed, and format the output to meet users' needs. Analysts use techniques such as structured analysis, data modeling, information engineering, mathematical model building, sampling, and cost accounting to make sure their plans are efficient and complete. They also may prepare cost-benefit and return-on-investment analyses to help management decide whether implementing the proposed technology would be financially feasible.

When a system is approved, systems analysts determine what computer hardware and software will be needed to set it up. They coordinate tests and observe the initial use of the system to ensure that it performs as planned. They prepare specifications, flow charts, and process diagrams for computer programmers to follow; then they work with programmers to “debug,” or eliminate errors, from the system. Systems analysts

who do more in-depth testing may be called software quality assurance analysts. In addition to running tests, these workers diagnose problems, recommend solutions, and determine whether program requirements have been met.

In some organizations, programmer-analysts design and update the software that runs a computer. They also create custom applications tailored to their organization's tasks. Because they are responsible for both programming and systems analysis, these workers must be proficient in both areas. (A separate section on computer programmers appears elsewhere in the Handbook.) As this dual proficiency becomes more common, analysts are increasingly working with databases, object-oriented programming languages, client-server applications, and multimedia and Internet technology.

One challenge created by expanding computer use is the need for different computer systems to communicate with each other. Systems analysts work to make the computer systems within an organization, or across organizations, compatible so that information can be shared. Many systems analysts are involved with these "networking" tasks, connecting all the computers internally, in an individual office, department, or establishment, or externally, as when setting up e-commerce networks to facilitate business among companies.

Work environment. Computer systems analysts work in offices or laboratories in comfortable surroundings. They usually work about 40 hours a week—about the same as many other professional or office workers. Evening or weekend work may be necessary, however, to meet deadlines or solve specific problems. Many analysts telecommute, using computers to work from remote locations.

Like other workers who spend long periods typing on a computer, computer systems analysts are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome or cumulative trauma disorder.

### **Training, Other Qualifications, and Advancement**

Training requirements for computer systems analysts vary depending on the job, but many employers prefer applicants who have a bachelor's degree. Relevant work experience also is very important. Advancement opportunities are good for those with the necessary skills and experience.

Education and training. When hiring computer systems analysts, employers usually prefer applicants who have at least a bachelor's degree. For more technically complex jobs, people with graduate degrees are preferred.

The level and type of education that employers require reflects changes in technology. Employers often scramble to find workers capable of implementing the newest technologies. Workers with formal education or experience in information security, for example, are currently in demand because of the growing use of computer networks, which must be protected from threats.

For jobs in a technical or scientific environment, employers often seek applicants who have at least a bachelor's degree in a technical field, such as computer science, information science, applied mathematics, engineering, or the physical sciences. For jobs in a business environment, employers often seek applicants with at least a bachelor's degree in a business-related field such as management information systems (MIS). Increasingly, employers are seeking individuals who have a master's degree in business administration (MBA) with a concentration in information systems.

Despite the preference for technical degrees, however, people who have degrees in other majors may find employment as systems analysts if they also have technical skills. Courses in computer science or related subjects combined with practical experience can qualify people for some jobs in the occupation.

Employers generally look for people with expertise relevant to the job. For example, systems analysts who wish to work for a bank should have some expertise in finance, and systems analysts who wish to work for a hospital should have some knowledge of health management.

Technological advances come so rapidly in the computer field that continuous study is necessary to remain competitive. Employers, hardware and software vendors, colleges and universities, and private training institutions offer continuing education to help workers attain the latest skills. Additional training may come from professional development seminars offered by professional computing societies.

### **Other qualifications.**

Employers usually look for people who have broad knowledge and experience related to computer systems and technologies, strong problem-solving and analytical skills, and the ability to think logically. In addition, because they often deal with a number of tasks simultaneously, the ability to concentrate and pay close attention to detail is important. Although these workers sometimes work independently, they frequently work in teams on large projects. Therefore, they must have good interpersonal skills and be able to communicate effectively with computer personnel, users, and other staff who may have no technical background.

### **Advancement.**

With experience, systems analysts may be promoted to senior or lead systems analyst. Those who possess leadership ability and good business skills also can become computer and information systems managers or can advance into other management positions such as manager of information systems or chief information officer. Those with work experience and considerable expertise in a particular subject or application may find lucrative opportunities as independent consultants, or may choose to start their own computer consulting firms.

## **Employment**

Computer systems analysts held about 504,000 jobs in 2006. Although they are increasingly employed in every sector of the economy, the greatest concentration of these workers is in the computer systems design and related services industry. Computer systems analysts are also employed by governments; insurance companies; financial institutions; hospitals; management, scientific, and technical consulting services firms; data processing services firms; professional and commercial equipment wholesalers; universities; and management of companies and enterprises.

A growing number of systems analysts are employed on a temporary or contract basis; many of these individuals are self-employed, working independently as contractors or consultants. About 29,000 computer systems analysts were self-employed in 2006.

## **Job Outlook**

Employment is expected to grow much faster than the average for all occupations. As a result of this rapid growth, job prospects should be very good.

**Employment change.** Employment of computer systems analysts is expected to grow by 29 percent from 2006 to 2016, which is much faster than the average for all occupations. In addition, the 146,000 new jobs that are expected to arise over the projections decade will be substantial. Demand for these workers will increase as organizations continue to adopt and integrate increasingly sophisticated technologies. Job growth will not be as rapid as during the preceding decade, however, as the information technology sector matures and as routine work is increasingly outsourced offshore to foreign countries with lower prevailing wages.

The growth of electronic commerce and the integration of Internet technologies into business have resulted in a growing need for specialists who can develop and support Internet and intranet applications. Moreover, falling prices of computer hardware and software should continue to induce more businesses to expand their computerized operations and incorporate new technologies.

The demand for computer networking within organizations will also drive demand for computer systems analysts. The introduction of the wireless Internet, known as WiFi, and of personal mobile computers has created a need for new systems that can integrate these technologies into existing networks. Explosive growth in these areas is expected to fuel demand for analysts who are knowledgeable about systems integration and network, data, and communications security.

As more sophisticated and complex technology is implemented across all organizations, demand for systems analysts will remain strong. These workers will be called upon to solve problems and to integrate new technologies with existing ones. Also, the increasing importance being placed on “cybersecurity”—the protection of electronic information—will result in a need for workers skilled in information security.

As with other information technology jobs, employment growth may be tempered somewhat as some computer systems analyst jobs are outsourced offshore. Firms may look to cut costs by shifting operations to foreign countries with lower prevailing wages and highly educated workers who have strong technical skills.

Job prospects. Job prospects should be very good. Job openings will occur as a result of strong job growth and from the need to replace workers who move into managerial positions or other occupations, or who leave the labor force. As technology becomes more sophisticated and complex, employers demand a higher level of skill and expertise from their employees. Individuals with an advanced degree in computer science or computer engineering or with an MBA with a concentration in information systems should have the best prospects. College graduates with a bachelor's degree in computer science, computer engineering, information science, or management information systems also should enjoy very good prospects, particularly if they have supplemented their formal education with practical experience. Because employers continue to seek computer specialists who can combine strong technical skills with good interpersonal and business skills, graduates with non-computer-science degrees who have had courses in computer programming, systems analysis, and other information technology subjects also should continue to find jobs in computer fields.