1 Background on Computer Systems

SUMMARY

Computer systems consist of hardware, software, and data, which need to be supported by staff, facilities, and management programs. Although most local governments use personal computers, counties are more likely than cities or school districts to use mainframe computers or minicomputers. About 27 percent of cities with populations under 500 do not have personal computers. Counties, school districts, and large cities typically have more complex computer systems than medium and small cities.

Because the complexity of local government computer systems varies, this chapter begins by defining the major components of computer systems for readers who may not be familiar with them. Experienced computer users, however, may wish to bypass this basic information. This chapter also describes some differences and similarities we found in the computer systems used by Minnesota's counties, cities, and school districts. In the chapter we ask:

- **What does a computer system include? What infrastructure is necessary to support computer systems, however complex they may be?**

To answer the questions we reviewed national literature and Web sites from organizations that focus on computer system management. We also surveyed Minnesota local governments in the fall of 2001 for basic information on their computer systems. Information about our survey methodology is in Appendix A. Aggregate results of the survey are available on-line at www.auditor.leg.state.mn.us/ped/2002/pe0209.htm.

COMPUTER SYSTEM OVERVIEW

Although early government computer systems were typically large computers isolated from most staff, information technology (IT) now comprises much more than large, stand-alone computers. Today, many local government staff use personal computers to perform a range of functions. Software applications designed to work together can link citizens to services and provide information across departments. Recent studies suggest that gains in worker productivity

during the last decade are in part due to IT, more so as organizations change how they do business to take advantage of available technologies.[1]

For the purpose of this study, we defined computer systems broadly:

- **Computer systems consist of a core of hardware, software, and data and the infrastructure necessary to support that core.**

Computer support requires staff, facilities, and a maintenance program.

As shown in Table 1.1, the **core system** includes:

- All **computer equipment or hardware**, such as desktop computers and network and telecommunications equipment;
- **Software**, including application programs (to process payroll, for instance) and operating systems software (to control a computer's central processing); and
- **Data** and information that are used and stored within the computer system.

Table 1.1: Computer System Components

Core
- Computer hardware and equipment
- Software
- Data

Support
- Staff
- Facilities
- Program for managing the computer system

SOURCE: Office of the Legislative Auditor.

The **support infrastructure** includes:

- **Staff** that manage and use the equipment;
- **Facilities** to house both equipment and staff; and
- A **comprehensive program** for managing computer systems, including procedures for planning, maintaining, and monitoring the system and providing security.

1 McKinsey Global Institute, B. Solow *et al.*, *US Productivity Growth 1995-2000: Understanding the Contribution of Information Technology Relative to Other Factors* (Washington, D.C.: October 2001); www.mckinsey.com/knowledge/mgi/reports/pdfs/productivity/IT_implications_10_12_last.pdf; accessed January 15, 2002.

Core System

Computer Hardware

Perhaps the most visible part of the computer system is its equipment or hardware, including mainframe computers, minicomputers, personal computers, computer workstations, and computer networks. Mainframe computers are large relative to other types of computers and have the massive memory and processing power needed for very large, complex business applications. Minicomputers are mid-range machines, physically smaller than mainframes and with less power, but substantially more powerful than other computers. Individual personal computers, often referred to as "PCs," are the most easily recognized computer. Table 1.2 lists the typical hardware components of PCs. Computer workstations are similar to PCs but typically have additional computing power or storage for specialized applications.

Table 1.2: Typical Hardware Components of Personal Computers

- Central processing unit (CPU)
- Primary storage, usually a hard disk drive
- Secondary storage, such as a floppy disk drive, zip drive, or rewritable CD
- Input devices, such as the keyboard or mouse
- Output devices, such as the printer or video display
- Communications devices, such as a modem or network connection

SOURCE: Kenneth C. Laudon and Jane P. Laudon, *Management Information Systems: Organization and Technology in the Networked Enterprise 6th ed.* (NJ: Prentice Hall, 2000), 163.

According to our survey:

- **With the exception of about 27 percent of small cities, nearly all local governments in Minnesota use at least one personal computer or computer workstation.**

In a few cities, staff use their own computers for city work.

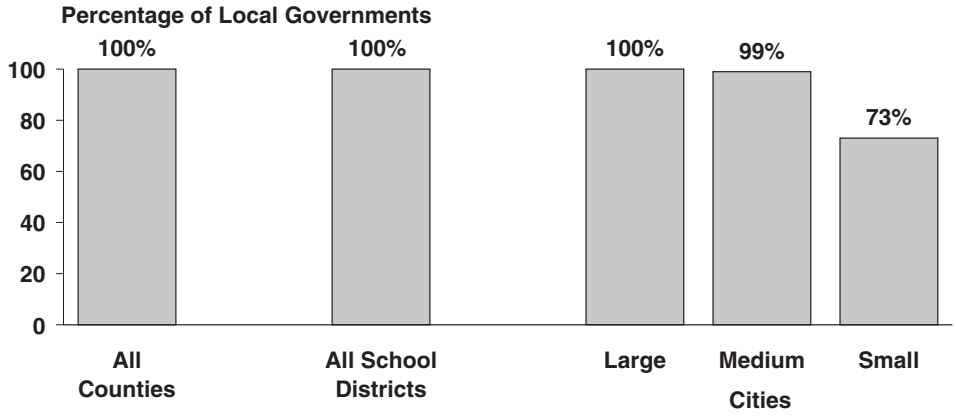
As shown in Figure 1.1, virtually all counties, school districts, and medium to large cities have personal computers or workstations, according to our 2001 survey. However, 27 percent of cities with fewer than 500 residents reported that they did not have any personal computers. Twelve small cities reported that while the city owned no computers, for some city business, staff used computers they owned themselves.

The use of PCs sharply contrasts with the use of minicomputers and mainframe computers. Figure 1.2 shows that:

- **Counties were far more likely than school districts or cities to report using minicomputers and mainframe computers.**

For the most part, only small cities reported having no computers for use in city operations.

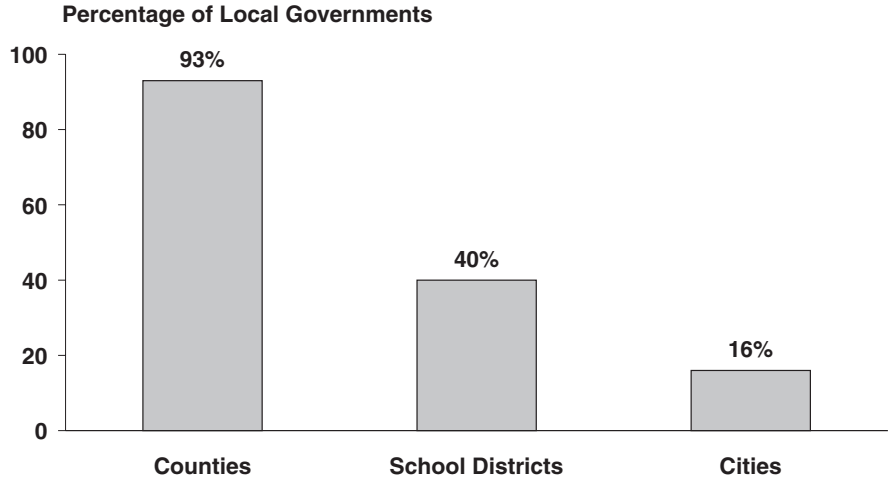
Figure 1.1: Local Governments Using Personal Computers or Workstations, 2001



NOTES: The question read: "Which of the following best describes the computers currently used in your [jurisdiction]?" A "large" city has a population of 5,000 or greater, a "medium" city has a population between 500 and 4,999, and a "small" city has a population under 500.

SOURCE: Office of the Legislative Auditor, Survey of Counties, Cities, and School Districts, October 2001.

Figure 1.2: Local Governments Using Minicomputers or Mainframes, 2001



NOTE: The question read: "Which of the following best describes the computers currently used in your [jurisdiction]?"

SOURCE: Office of the Legislative Auditor, Survey of Counties, Cities, and School Districts, October 2001.

County use of mainframes or minicomputers was higher than that reported for school districts of any size and much higher than that for cities, even among large cities.

Computer Networks

A network is a collection of compatible hardware and software arranged to communicate information (text, graphics, voice, or video) from one computer to others or to peripheral equipment such as printers. Among other purposes, computer networks are used to increase communications and share data files or equipment such as scanners.

Networks vary in complexity. Simple networks may link several PCs and a printer. More sophisticated "client/server" computing is widely used to (1) distribute the task of inputting data to various "client" software and computers and (2) centralize data storage and processing in one or more "server" computers, managed by the server software.[2]

A network can serve a few computers in a room, dozens of computers in a building, or several different governmental units crossing several counties.[3] Table 1.3 lists typical components of a network. Local-area networks or LANs are limited in range to a few thousand feet (although fiber optic cables are expanding the range). Wide-area networks or WANs connect multiple sites or computer networks at high speed across a broad geographic area using switched and dedicated lines (wire, cable, or fiber), microwave, or satellite communications. As the complexity of a computer network increases, so do its support costs, as is discussed at the end of this chapter.

Table 1.3: Typical Network Components

- Cabling or wireless equipment to link computers with other devices
- File servers to store and process data (and possibly manage the network)
- Network interface cards (special adapters that connect computers to the network cable)
- Routers to direct packets of data through the network
- Gateways (usually communications processors to connect to public computer networks)
- Network operating system software that routes and manages communication on the network and coordinates network resources
- Security hardware and software, such as firewalls

SOURCE: Kenneth C. Laudon and Jane P. Laudon, *Management Information Systems: Organization and Technology in the Networked Enterprise 6th ed.* (NJ: Prentice Hall, 2000), 270-71, 511.

2 Servers may be powerful personal computers with large hard-disk capacity, minicomputers, mainframe computers, or specialized computers designed specifically as servers. They share resources, such as files and printers, with other computers on a network.

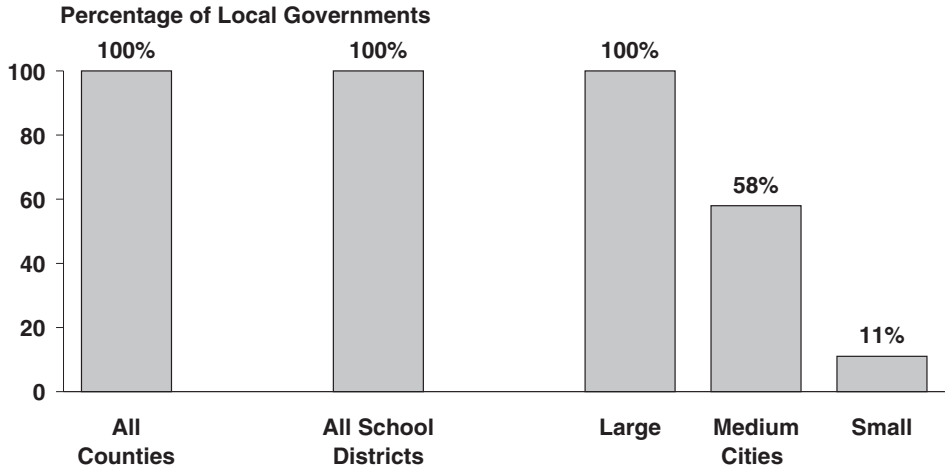
3 In addition, by using Internet networking standards, local governments may create private internal networks called "intranets" that are useful for sharing information among staff in a single government unit. See: Kenneth C. Laudon and Jane P. Laudon, *Management Information Systems: Organization and Technology in the Networked Enterprise 6th ed.* (NJ: Prentice Hall, 2000), 298.

As shown in Figure 1.3,

- **All counties, school districts, and large cities reported that their personal computers were partially or fully networked, compared with 58 percent of medium-sized cities and 11 percent of small cities.**

Small cities tend to have less complex computer systems than do other local governments.

Figure 1.3: Local Governments With Networked Personal Computers or Workstations, 2001



NOTES: The question read: "Which of the following best describes the computers currently used in your [jurisdiction]?" A "large" city has a population of 5,000 or greater, a "medium" city has a population between 500 and 4,999, and a "small" city has a population under 500.

SOURCE: Office of the Legislative Auditor, Survey of Counties, Cities, and School Districts, October 2001.

Telecommunications Equipment

Telecommunications systems contain computers and additional technology equipment needed for electronic transmission of data, voice, or video between and among computer networks. Within telecommunications systems, communication channels, such as those provided via cable, telephone wire, fiber optics, or satellite, provide the means to transmit data. Using telecommunications infrastructure, computer users connect to the Internet and communicate with other computer networks around the globe.[4]

Software

Software is a set of detailed instructions that controls the operation of a computer. "Operating system" software manages the computer resources, such as the central processing unit (or CPU).[5] Users are often unaware of the system software because it works in the background. In contrast, "application" software provides tools to complete specific tasks, such as word processing. Unlike system

4 The Internet is a worldwide system of computer networks interconnected for communications.

5 Laudon, *Management Information Systems*, 194-195.

software, most users are familiar with the application software that allows them, for instance, to compose a letter or create a map. Some specialized software, known as systems development software, allows programmers to develop their own application programs.

Most local governments with computers use application software to provide common functions, such as processing financial data. Beyond that, some applications are unique to specific functions of cities, counties, or school districts. Unless a local jurisdiction develops its own application, it usually pays yearly license fees to use software, with fees commonly based on the number of users.

Data

Governments collect and produce a large amount of information, and they face many decisions about their electronic data: what information to collect; what information to keep; how to preserve what is kept; whether the data are private or confidential (implying that access to them must be restricted); whether data should be shared and with whom; how the data will be retrieved; what level of protection is needed; and where to locate data. Answers to these questions vary and will affect computer management decisions. For example, storage of health records may require more secure computer management procedures than e-mail records because they involve a higher level of confidentiality.

Support Infrastructure

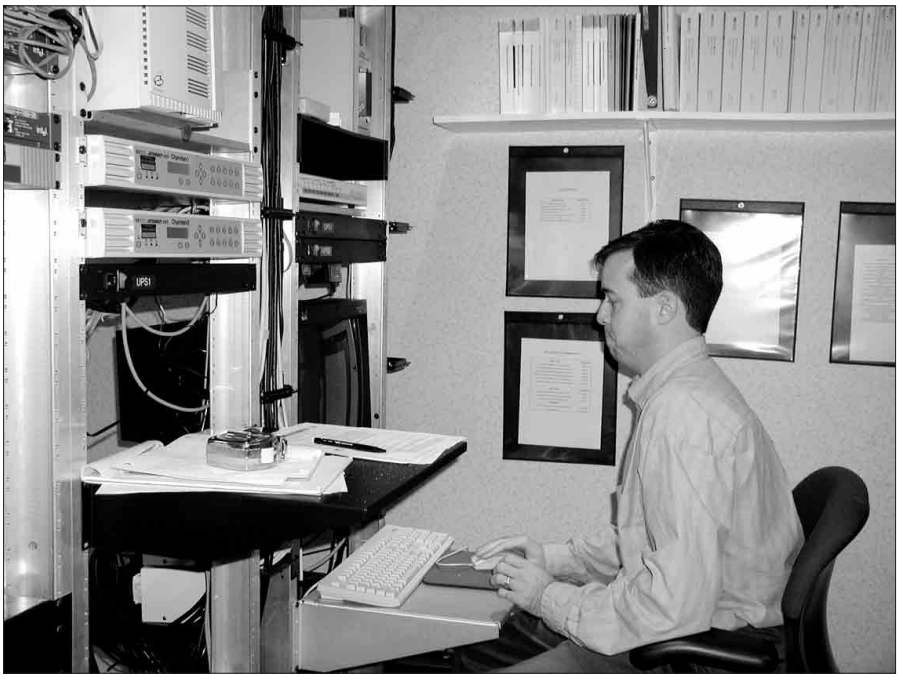
Computer System Staff

Computer system staff operate hardware and software, train and support users, and plan for system management. Many functions, such as high-level network design and operation, require advanced training. In some cases, specially trained staff may focus on specific functions such as computer security or network administration. In other cases, such as in small local governments, one person may perform many computer-related tasks. In yet other cases, staff with special expertise from outside a local government may manage the jurisdiction's computer system or part of it.

Facilities

Secure facilities can help protect computer systems.

The facilities that house computer equipment are an important part of the system. Most computer hardware is valuable, easily damaged, and sensitive to temperature and humidity levels, making the facilities that house computers an important part of protecting technology investments. Similarly, appropriate facilities can help prevent data and software from being inadvertently changed or destroyed. When remodeling or constructing buildings, the computer network needs are an important part of the planning. If technology considerations are not planned up front, the facilities may not support the computer network's cabling or other infrastructure needs, or the facilities may need to be changed later at additional cost.



Highly trained staff are needed to support computer systems.

Computer-System Management Program

The ongoing maintenance of a computer system should be detailed in a management program.

Operating and maintaining a computer system may be complicated. A computer system-management program brings together policies and procedures for the implementation, operation, maintenance, and ongoing control of the computer system.[6]

A management program typically addresses the components discussed in this chapter—hardware, software, data, and facilities, as well as support for system users. It also includes security measures to protect the computer system. The management program might include software that automates certain procedures, such as requiring password changes. How the program looks will depend upon the local government's size, technical capabilities, budget, staff resources, and the degree to which the government relies on technology.[7] Computer management programs are more fully described in Chapter 3.

COMPUTER SYSTEM COMPLEXITY

Although all computer systems have core components of hardware, software, and data, and all need infrastructure to support that core, the systems vary in complexity. The complexity of a computer system is a function of the system's hardware configuration, software programs, and the local government's data

6 Gartner Research, "Guidelines for the Content of IT Policies," *Research Note* TU-13-9550, July 26 2001, 1-2.

7 Right Track Associates, Inc., "IT Management Strategies in Small Business," *ITToolkit;* www.ittoolkit.com; accessed January 17, 2002.

requirements. For instance, hardware configurations range from a single stand-alone computer to multiple computer networks connecting hundreds of desktop computers and several computer servers housed at multiple locations.

Computer systems around the state vary in complexity.

Computer systems that connect users across many buildings scattered over a broad geographic area require more sophisticated hardware and have more demanding support needs than less complex systems. Table 1.4 illustrates three systems in Minnesota of differing complexity. For some local governments, a computer "system" may actually consist of multiple discrete computer systems that serve different government programs and that may not "talk" to one another or share data.

As mentioned earlier, counties, school districts, and large cities have computer systems that are fully or partially networked, but computer networks are far less common in small cities. Another indication of computer system differences is the use of file servers (computers that share files, printers, and other resources with other computers on a network). More complex computer systems have

Table 1.4: Examples of Three Computer Systems

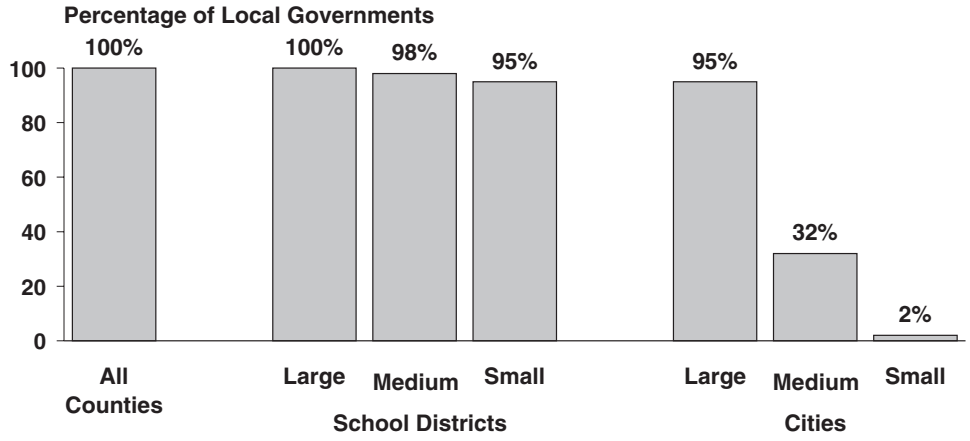
City of Mantorville	Swift County	Anoka County
Mantorville has one computer and two printers; one printer is used for faxing and scanning. A single staff person uses a software package purchased from a vendor in Texas (from whom the city also purchased the computer), which covers most of the city's computing needs. All remaining computing is done using word processing and spreadsheet programs or the software that came with the computer. Staff and elected officials use the single computer but also receive e-mail at home regarding city business.	In Swift County, each office is responsible for its own hardware and software purchases and maintenance. There is no centralized inventory or standards for purchasing computer equipment. An internal network connects several file servers and a number of personal computers. In addition, the county contracts with a vendor who provides the software applications and user support for six county programs (property tax calculations, fixed assets, vital statistics, payroll, finances, and library systems). For these applications, county staff connect to computers housed at the vendor's work site. The vendor maintains and protects the databases.	Anoka County employs 54 IT staff to provide operations, maintenance, development, and user support for over 1,800 PCs, a large number of servers, a minicomputer, and a mainframe computer. A wide area network connects more than a dozen county work sites to a central network. County staff developed and continue to support several large applications including the property tax program. While the county has also purchased several software applications, in most cases county IT staff provide user support. IT services are centralized in one countywide IT department and are organized into four sections: infrastructure, applications services, PC systems tech services, and help desk, which also includes imaging and records management.

SOURCE: Office of the Legislative Auditor.

networks with file servers that centralize data storage and processing. As shown in Figure 1.4,

- **Minnesota counties, school districts, and large cities are more likely to use file servers than medium or small cities.**

Figure 1.4: Local Governments With File Servers, 2001



NOTES: The question read: "Which of the following best describes the computers currently used in your [jurisdiction]?" A "large" school district has 3,000 or more students, a "medium" district has between 800 and 2,999 students, and a "small" districts has fewer than 800 students. A "large" city has a population of 5,000 or greater, a "medium" city has a population between 500 and 4,999, and a "small" city has a population under 500.

SOURCE: Office of the Legislative Auditor, Survey of Counties, Cities, and School Districts, October 2001.

According to our survey, all counties, nearly all school districts, and most cities with populations over 5,000 reported using file servers. In contrast, less than one-third of medium-sized cities and almost no small cities reported using them. Further, as described earlier, many small cities have no computers at all, with about 27 percent of small cities reporting that they have no computers.