

## **A.2. Infrastructure for Health Services Information Systems and Technology (IS&T)**

The future of Information Technology (IT) as a whole could not be brighter, particularly as it concerns health services and its users, patients, and other constituents. Virtually every category of IT is experiencing progress that promises to bring powerful processing and problem solving to the industry. New technologies are emerging and rapidly maturing, in some cases even faster than users can absorb and integrate them. Developments in technology are divided into the categories of hardware, software, and systems architecture.

### **A.2.1. Hardware and Software**

The ongoing improvements in hardware technology — the oldest element of computing — show no signs of letting up. Computer hardware consists of these main components:

- *Processors* - The logic and arithmetic units of computers will continue to see strong advances. In fact, the physics of silicon and circuitry promise to yield an additional 100-fold increase in processor speed and power before reaching the natural barrier of the individual atom as a unit of data storage. Recent breakthroughs in the semiconductor industry involve the use of higher performance copper chips in integrated circuits. This could increase processor speed and power by an order of magnitude over the aluminum wiring traditionally used in chip manufacturing. In health services IS&T this means faster processing for less cost for all applications, but particularly for such data-intensive functions such as patient chart access and update, image retrieval and manipulation, and chronological retrieval of clinical laboratory data. It also means improved workstations for both healthcare providers and administrators, available at lower cost for dispersal over the enterprise.
- *Storage* - Research and development in files has been no less dramatic, producing unprecedented advances in capacity, performance, and price. Already on the market are hard disk drives that can store a billion characters on a square inch, with additional three-fold increases in the laboratories. Also, new 3½ inch devices are now available which allow storage of over 13 gigabytes of data on 10,000 RPM drives with average seek times of 6.3 milliseconds. In addition, optical storage has been rapidly developing in all key aspects. Traditional tape storage systems have also continued to see improvements. All of these devices have enjoyed better engineering, with fewer moving parts, higher reliability, and less energy consumption. For health services IS&T this means faster, better, more reliable storage media for the very large files required by the large, integrated health services organizations seeking to provide the continuum of care. It also means improved capacity for the enormous amounts of data generated, for example, by radiographic images, and for the massive data mining requirements generated by outcomes research and clinical studies.
- *Displays* - The trend in video display technology is toward larger, thinner screens, higher resolution, better use of color, and improved price/performance. There are now available a

number of models thin enough to fit onto a wall, and which display thousands of color combinations. On the other end of the spectrum, very small hand-held devices are available inexpensively. While limited in their ability to deliver large amounts of data, they provide easy, quick, portable access to many kinds of information. All these improvements are required for health services IS&T, since high-quality, low-cost displays are needed to present the data-rich information commonly found in the clinical setting. These include charts and graphs such as ICU flow sheets and ECG waveforms, and radiographic images requiring very high resolution. Display screens must be thin and compact enough for mounting in limited-space environments such as inpatient rooms. They must be inexpensive enough to station at all relevant points of care, not only inpatient rooms, but also outpatient clinic treatment rooms and care givers' offices and homes.

- *Multimedia* - This is a catchall category for the efforts to integrate data, text, voice, and full-motion video. It is also perhaps the most visible and popular point of interest in the industry at present. While still emerging and relatively expensive, multimedia has promise for providing integrated information. This is good news for health services IS&T, since the industry has excellent application potential for this technology. A typical use of multimedia might be to present a full-motion video of a patient's beating heart, alongside an ECG wave form moving in conjunction with the video, together with data from laboratory results, problem lists, and demographics, all accompanied by a voice playback of the cardiologist's assessment and diagnosis.
- *Personal Identification Devices* - Technology of all types continues to improve. Magnetic-stripe badge readers have been in use for some time, and will continue to play a large part of many systems. They currently enable employee identification and controlled access. The development of denser data storage in badges heralds the advent of the so-called "chip card or smart card", in which a patient will be able to carry a credit card that contains coded clinical data (allergies, problems, medications, physicians, etc.), demographics, and coverage data. Other technologies include fingerprint recognition devices, which are already replacing magnetic-stripe readers for employee identification and controlled access, and newly emerging retina scanners, which promise even more speed, accuracy, and ease of use.
- *Bandwidth Technology* - Communications technology will grow the size and speed of data transmission, especially over fiberoptic cable, microwave links, and satellites. This is especially important to healthcare since much clinical data, such as radiographic images, consists of very large packages. A typical mammogram, for instance, requires 64 megabytes for storage. Compression technologies may reduce the file size and improve transmission rates.
- *Connectivity Equipment* - An entire business segment has sprung up around the requirement to link together different portions of a network. Hubs, routers, and their kin are now integral parts of a powerful communications system that supports the health services enterprise of today and tomorrow.
- *Other Input/Output Devices* - Traditional hardware systems for data entry and output will also see improvement, albeit not as dramatically as those in the other categories. Printers and fax

machines will continue to become more compact, quieter, and less expensive while printing faster, in a broader range of colors. This has direct application in sending rich patient data to healthcare providers and administrative offices located remotely. Relatively new devices like scanners will experience the same improvements, enabling the capture and transmission of clinical and administrative data across and between enterprises.

Just as important as hardware to the utilization of information technology is the progress in software. In this respect health services IS&T is very much like other industries, which depend on a variety of programs to perform the industry-specific tasks that give computers their value. While there are many types of software for many functions, we have chosen to list the ones pertinent to the health services industry, as follows:

- *Software Languages* - Although the progress in software language development has not equaled that of hardware, advances have nonetheless been steady and sure. Recent times have seen new languages and techniques designed to exploit new hardware and networking technology. Other types of software enable programmers to “paint” screens with data from other applications and databases. Health services IS&T benefits from progress in software language development by acquiring applications sooner, that run faster, over a variety of computing environments. These applications are just in time to support the explosion in application development brought about by the changes in healthcare described in Chapter 5.
- *Systems Software* - While the development of mainframe operating systems has proceeded quietly but steadily over the years, there have been quantum leaps in systems software for workstations, client/server systems, and devices. In particular, personal computer multi-tasking, multi-programming operating systems have enjoyed tremendous growth, as have graphical user interfaces (GUI). The significance of software to health services IS&T is paramount, since these capabilities are necessary to permit healthcare providers an easy and powerful use of workstations for patient-centric work.
- *Software Enablers* - Recent years have seen significant growth in software that logically operates between the systems software and the application layer. They include database management systems, security systems, interface engines, messaging systems, and a variety of software generally known as “middleware”, to name the most prominent. Health services IS&T requires the latest in this technology to enable complex processing to take place without the IS&T staff having to concern itself with development and maintenance of complex, system-wide functions.
- *Communications Software* - This category includes network programming like Ethernet, Token Ring, ATM (Asynchronous Transfer Mode), and other software designed to manage the flow of data along communication lines. In addition, we have elected to include in this category most of the software developed for the Internet, such as hypertext markup language (HTML), web browsers, and other programs for connectivity. These are vital to health services IS&T as the industry joins others in the leap to electronic commerce.
- *Application Software* - Nowhere, however, is there more focus and excitement than in application software development. This is understandable, since this is the primary emphasis

of the user; and the user — the health services administrator or healthcare provider — is now involved in IS&T as never before. The new emphasis on the Computer-based Patient Record has seen application development expand to include not only the traditional billing and accounting functions but also clinical applications for clinical users. The new emphasis on Healthcare Networks has seen new applications for linking the traditional payer and provider functions into a single network. Whole new types of applications have arisen, such as speech recognition, with programs written to handle domain-specific vocabularies such as radiology and pathology.

Table 1 summarizes the hardware and software developments, some key examples, and their chief applicability to the health services industry:

**Table 1. Software and Hardware Developments**

<b>Computer Hardware</b>	<b>Applicability to Health</b>
Processors	Data-rich clinical functions
Storage	Longitudinal medical records
Displays	Ubiquitous placement, intuitive presentation of many clinical data types
Multimedia	Single-point presentation of multiple patient data types; distance learning
Personal Identification Devices	Employee identification, patient “smart card”
Bandwidth	Longitudinal medical record transmission
Connectivity Equipment	Transmission of high-volume patient data
Other Input/Output Devices	Transmission of patient data to clinical points of care
<b>Computer Software</b>	<b>Applicability to Health</b>
Software Languages	Faster development of software for a rapidly changing industry
Systems Software	Easier presentation of data to healthcare providers
Software Enablers	Health services IS&T developers focus on applications
Application Software	New applications improve the value of health services IS&T to the healthcare process
Communications Software	Construction of Healthcare Networks