**Technology Guide 1: Hardware**

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| Chapter Outline |

TG 1.1 Introduction to Hardware

TG 1.2 Strategic Hardware Issues

TG 1.3 Computer Hierarchy

TG 1.4 Input and Output Technologies

TG 1.5 The Central Processing Unit

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| Learning Objectives |

1. Identify the major hardware components of a computer system.
2. Discuss strategic issues that link hardware design to business strategy.
3. Describe the various types of computers in the computer hierarchy.
4. Differentiate the various types of input and output technologies and their uses.
5. Describe the design and functioning of the central processing unit.

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| Teaching Tips and Strategies |

Computer hardware has become so ubiquitous that some students do not realize that even their smartphones, iPods, and tablet computers contain processors. Even though students have grown up with computers, many students cannot distinguish among the myriad processors and memory options that are available. Students usually think the faster the processor, the better the computer. However, as this guide explains, this is not always the case.

This Technology Guide is designed to help students better understand the computer hardware decisions they make for themselves and, in some cases, will make for their future employers. Many of the design principles presented in this guide apply to most computers. The guide also covers the dynamics of innovation and the costs that can affect personal as well as corporate hardware decisions.

It is sometimes helpful to briefly review the history of computers to make certain that students realize that computers have not always been available to general consumers. I have also found it helpful to go over the basics of the binary and hexadecimal number systems and why they are important to computers. Trivia such as where numbers like 64 and 256 come from and why 1 megabyte is really not 1 million bytes seems to interest the students.

Most students are into game machines such as Xbox, PlayStation 3, and Wii. Ask the class if they remember their first game system. Then, ask what their thoughts are about the playability and graphics of the machine. Proceed to a discussion about the older technology that was involved with those machines compared to today’s technology. This discussion will pique students’ interest in how quickly technology changes. It will also make students aware that if game machines do not keep up with technology, they might become obsolete like Atari, Coleco Vision, Intellevision, and Sega Dreamcast. (If you have any older students, ask them if they can remember Pong or Motorola’s games from the early 1970s.)

This is a great chapter to demonstrate how computers have changed every aspect of our lives and how businesses communicate on a daily basis.

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| IT’s About Business |

There are no case studies in this Technology Guide.

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| before you go on… |

1. Decisions about hardware focus on what three factors?

Answer: The three factors are: capability (power and appropriateness for the task), speed, and cost.

Level: Easy

Section/Learning Objective: Section TG1.1 /Learning Objective 1

Bloom’s Category: Knowledge

AACSB Category: Reflective Thinking

2. What are the overall trends in hardware?

Answer: The overall trends in hardware have been smaller, faster, cheaper, and more powerful over time. In fact, these trends are so rapid that they make it difficult to know when to purchase (or upgrade) hardware. This difficulty lies in the fact that companies that delay hardware purchases will, more than likely, be able to buy more powerful hardware for the same amount of money in the future.

Level: Easy

Section/Learning Objective: Section TG1.2 /Learning Objective 2

Bloom’s Category: Comprehension

AACSB Category: Reflective Thinking

3. Define hardware and list the major hardware components.

Answer: Hardware refers to the physical equipment used for the input, processing, output, and storage activities of a computer system. It consists of:

* Central processing unit: (CPU): manipulates the data and controls the tasks performed by the other components.
* Primary storage: internal to the CPU; temporarily stores data and program instructions during processing.
* Secondary storage: external to the CPU; stores data and programs for future use
* Input technologies: accept data and instructions and convert them to a form that the computer can understand.
* Output technologies: present data and information in a form people can understand.
* Communication technologies: provide for the flow of data from external computer networks (e.g., the Internet and intranets) to the CPU, and from the CPU to computer networks.

Level: Easy

Section/Learning Objective: Section TG1.1 /Learning Objective 1

Bloom’s Category: Knowledge

AACSB Category: Reflective Thinking

4. Describe the different types of computers.

Answer: The computer hierarchy beginning the most powerful and ending with the least powerful:

* Supercomputers are the computers with the most processing power. The primary application of supercomputers has been in scientific and military work, but their use is growing rapidly in business as their price decreases. Supercomputers are especially valuable for large simulation models of real-world phenomena, where complex mathematical representations and calculations are required, or for image creation and processing. Example supercomputer applications include weather modeling for better weather prediction, nondestructive weapons testing, aircraft design, and motion picture production. Supercomputers generally operate at 4 to 10 times faster than the next most powerful class, the mainframe.
* Mainframe computers - Large corporations use mainframe computers for centralized data processing and maintaining large databases. Applications that run on a mainframe can be large and complex, allowing for data and information to be shared by thousands of users throughout the organization. Examples of mainframe applications include airline reservation systems, corporate payroll, and student grade calculation and reporting.
* Midrange, ie.so called minicomputers and servers, are relatively small, inexpensive, and compact computers that perform the same function as mainframe computers, but to a more limited extent. Minicomputers are usually designed to accomplish specific tasks such as process control, scientific research, office automation, and engineering applications. IBM is the market leader with its AS/400 series of computers. Servers are smaller midrange computers that are used to support networks.
* Workstations were originally developed for engineers requiring high levels of processing performance. They are typically based on RISC (reduced instruction set computing) architecture and provide both very high-speed calculations and high-resolution graphic displays. These machines have found widespread acceptance with the scientific community and, more recently, within the business community.
* The distinction between workstations and personal computers is rapidly blurring. The latest personal computers have the computing power of recent workstations. Low-end workstations are now indistinguishable from high-end personal computers.
	+ Microcomputers (also called micros, personal computers, or PCs) are the smallest and least expensive category of general-purpose computers. They can be subdivided into three classifications based on their size: desktops, laptops and notebooks, network computers, and palmtops.
	+ Desktop PCs are the typical, familiar microcomputer system that has become a standard tool for business and, increasingly, the home. It is usually modular in design, with separate but connected monitor, keyboard, and CPU.
	+ Laptop and notebook computers are small, easily transportable, lightweight microcomputers that fit easily into a briefcase. Notebooks and laptops are designed to be as convenient and easy to transport as possible.
* A netbook is a very small, lightweight, portable computer that is energy efficient and relatively inexpensive. Netbooks are generally optimized for Internet-based services such as Web browsing and emailing.
* A tablet computer, or simply tablet, is a complete computer contained entirely in a flat touch screen that users operate via a stylus, a digital pen, or their fingertip instead of a keyboard or mouse

Level: Medium

Section/Learning Objective: Section TG1.3 /Learning Objective 3

Bloom’s Category: Comprehension

AACSB Category: Reflective Thinking

5. Distinguish between human data-input devices and source-data automation.

Answer: Human data-input devices allow people to communicate with the computer. Some of these devices are very common, such as the keyboard and the mouse. Others, such as the touch screen, stylus, trackball, joystick, and microphone, are used for somewhat more specialized purposes.

The objective of source-data automation is to input data with minimal human intervention. These technologies speed up data collection, reduce errors, and can gather data at the source of a transaction or other event. Common devices in source-data automation are automated teller machines (ATMs), point-of-sale (POS) terminals, bar code scanners, and optical mark readers. Voice recognition systems (VRS) are an emerging source-data automation tool used in conjunction with microphones to input speech into computers. Finally, sensors collect data from the environment and input them into a computer system. Examples include heating, ventilating and air-conditioning (HVAC) control sensors in building automation systems, and the myriad types of sensors built into a modern aircraft.

Level: Medium

Section/Learning Objective: Section TG1.4 /Learning Objective 4

Bloom’s Category: Analysis

AACSB Category: Analytic

1. Briefly describe how a microprocessor functions.

Answer: A microprocessor fundamentally accepts inputs, stores them until needed, at which point they are retrieved and processed and the output is stored and delivered somewhere.

Level: Easy

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Knowledge

AACSB Category: Reflective Thinking

1. Distinguish between primary storage and secondary storage.

Answer: Primary storage.

* RAM holds a program and small accounts of data for processing and is volatile.
* Registers have the least capacity, storing instructions and data for a short time before processing.
* Cache memory is a type of high-speed memory that enables the computer to temporarily store blocks of data that are used often so the processor can access them more rapidly.
* ROM is a type of chip where certain critical instructions are safeguarded and is not volatile.

Secondary storage.

* Magnetic media (such as hard disks, floppy disks or tape)
* Optical media - read by a laser, slower than magnetic drives, but are less fragile

Primary storage is faster, but more costly and has a smaller capacity than secondary storage.

Level: Medium

Section/Learning Objective: Section TG1.1 /Learning Objective 6

Bloom’s Category: Analysis

AACSB Category: Analytic

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| Discussion Questions |

1. What factors affect the speed of a microprocessor?

Answer: The speed is commonly measured by the number of instructions the chip processes per second – machine instructions cycles per second, or MIPS. This number depends on the following four factors:

* The preset speed of the clock that times all chip activities, measured in megahertz (MHz). The faster the clock speed the faster the chip (a 500 MHz chip is half as slow as a 1.0 GHz chip).
* The word length, which is the number of bits (0s and 1s) that can be processed at any time. Today’s chips are designed to handle 32-bit or 64-bit word length. The larger the word length, the faster the chip.
* The bus width. The wider the bus (the physical avenues down which the data and information travel as electrical impulses), the more data can be moved and the faster the processing. Buses are measured in microns (millionths of a meter).
* The physical design of the chip. Generally, a greater number of transistors and shorter line width (distance between transistors) give faster processing speeds.

Level: Medium

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Synthesis

AACSB Category: Analytic

2. If you were the chief information officer (CIO) of a firm, what factors would you consider when selecting secondary storage media for your company’s records (files)?

Answer: Factors a CIO might consider when selecting secondary storage media for company records:

* Cost per byte of storage
* Amount of storage capacity required
* Archival storage requirements
* Back up considerations
* Retrieval speed
* Portability and cross platform support

Level: Medium

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Synthesis

AACSB Category: Analytic

3. Given that Moore’s Law has proven itself over the past two decades, speculate on what chip capabilities will be in 10 years in the future. What might your desktop PC be able to do?

Answer: The brightest prospects for desktop computers in 10 years are in multimedia systems design. While sound, video, and animation are still most important for educational and game software, multimedia PCs has already begun to suffice business applications as well. The cost of videoconferencing has plummeted while its quality has improved. Film clips and animations are enhancing tutorials and training materials. Shared documents with voice digitized photographs, or 3-D graphics are beginning to make the rounds on the company network. The next generation Internet initiative will deliver a highly graphical Web, for good or ill, will be more commonplace as bad coffee in today’s office.

Level: Hard

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Synthesis

AACSB Category: Analytic

4. If you were the chief information officer (CIO) of a firm, how would you explain the workings, benefits, and limitations of thin clients as opposed to using fat clients?

Answer: CIOs can focus on the total cost of ownership (TCO) aspect of thin client versus fat client. Thin client based systems are not only less expensive to buy than standard personal computers, but they accrue additional cost benefits over the life of the computer. Savings can be achieved with thin clients through minimizing technical support, less training for users and less frequent replacement. It is good to have a choice for client computing and it is unlikely that thin clients will make today’s fat client obsolete. There are scenarios were both client systems work best.

Level: Medium

Section/Learning Objective: Section TG1.2 /Learning Objective 2

Bloom’s Category: Synthesis

AACSB Category: Analytic

5. Where might you find embedded computers at home, at school, and/or at work?

Answer:

* Embedded computers for improved healthcare. Applications based on remote diagnosis of vital health signs.
* Embedded computers and sensors for monitoring all aspects relating to home security, comfort and control.
* Embedded computers to deliver emergency signals from homes to monitoring stations.

Level: Easy

Section/Learning Objective: Section TG1.2 /Learning Objective 2

Bloom’s Category: Comprehension

AACSB Category: Reflective Thinking

6. What does this statement mean: “Hardware is useless without software.”

Answer: Basically, a computer (hardware) does not have any capabilities without the operating system and application software to utilize the capabilities of the hardware.

Level: Easy

Section/Learning Objective: Section TG1.2 /Learning Objective 2

Bloom’s Category: Comprehension

AACSB Category: Reflective Thinking

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| Problem Solving Activities |

1. Access the websites of the major chip manufacturers—for example, Intel (*www.intel.com*), Motorola (*www.motorola.com*), and Advanced Micro Devices (*www.amd.com*)—and obtain the latest information on new and planned chips. Compare performance and costs across these vendors. Ensure to take a close look at the various multicore chips.

Answer: Students should research and report their findings.

Level: Medium

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Analysis

AACSB Category: Analytic

2. Access “The Journey Inside” on Intel’s website at *http://www.intel.com/content/www/us/en/education/k12/the-journey-inside.html*. Prepare a presentation of each step in the machine instruction cycle.

Answer: Students should research and report their findings.

Level: Medium

Section/Learning Objective: Section TG1.5 /Learning Objective 5

Bloom’s Category: Analysis

AACSB Category: Analytic

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| Chapter Glossary |

**arithmetic logic unit (ALU)** Portion of the CPU that performs the mathematical calculations and makes logical comparisons.

**augmented reality** A live, direct or indirect, view of a physical, real-world environment whose elements are enhanced by computer-generated sensory input such as sound, video, graphics, or GPS data.

**bit** Short for *binary digit* (0s and 1s), the only data that a CPU can process.

**byte** An 8-bit string of data, needed to represent any one alphanumeric character or simple mathematical operation.

**cache memory** A type of high-speed memory that enables the computer to temporarily store blocks of data that are used more often and that a processor can access more rapidly than main memory (RAM).

**central processing unit (CPU)** Hardware that performs the actual computation or “number crunching” inside any computer.

**control unit** Portion of the CPU that controls the flow of information.

**fat clients** Computers that offer full functionality without having to connect to a network.

**flash memory devices** Nonvolatile electronic storage devices that are compact, are portable, require little power, and contain no moving parts.

**gesture recognition** An input method that interprets human gestures, in an attempt for computers to begin to understand human body language.

**magnetic disks (or hard drives or fixed disk drives)** A form of secondary storage on a magnetized disk divided into tracks and sectors that provide addresses for various pieces of data.

**magnetic tape** A secondary storage medium on a large open reel or in a smaller cartridge or cassette.

**microprocessor** The CPU, made up of millions of transistors embedded in a circuit on a silicon wafer or chip.

**Moore’s law** Prediction by Gordon Moore, an Intel cofounder, that microprocessor complexity would double approximately every two years.

**multimedia technology** Computer-based integration of text, sound, still images, animation, and digitized full-motion video.

**optical storage devices** A form of secondary storage in which a laser reads the surface of a reflective plastic platter.

**primary storage (also called main memory)** High-speed storage located directly on the motherboard that stores data to be processed by the CPU, instructions telling the CPU how to process the data, and operating system programs.

**random access memory (RAM)** The part of primary storage that holds a software program and small amounts of data when they are brought from secondary storage.

**read-only memory (ROM)** Type of primary storage where certain critical instructions are safeguarded; the storage is nonvolatile and retains the instructions when the power to the computer is turned off.

**registers** High-speed storage areas in the CPU that store very small amounts of data and instructions for short periods.

**secondary storage** Technology that can store very large amounts of data for extended periods.

**sequential access** Data access in which the computer system must run through data in sequence to locate a particular piece.

**server** Computers that support networks, enabling users to share files, software, and other network devices.

**solid-state drives (SSDs)** Data storage devices that serve the same purpose as a hard drive and store data in memory chips.

**thin client** A computer that does not offer the full functionality of a fat client.

**thumb drive** Storage device that fits into the USB port of a personal computer and is used for portable storage.