3.5.2 CPU Facts

When selecting a Central Processing Unit (CPU), you will need to match the motherboard and the CPU. Either select a CPU supported by the motherboard, or select a motherboard that will support the processor you have chosen. The following table lists several considerations for choosing a processor:

Feature	Description
CPU Manufacturer	Intel and AMD are the two major producers of processors used in modern PCs. - Both Intel and AMD processors work in PC systems and support Windows software. - Intel has a larger market share, while AMD processors generally cost less. - Processor performance and special features vary between models and manufacturers.

32-Bit or 64-Bit	A 32-bit processor can process 32-bits of information at a time; a 64-bit processor can process 64-bits of information.
	- The biggest advantage of 64-bit processors over 32-bit processors is in the amount of memory they can use. 32-bit processors have a limit of 4GB. 64-bit processors have a theoretical limit of 16 EB, although operating system and current hardware limitations impose a much lower practical limit.
	- The operating system and applications must be written for 64-bits to take full advantage of 64-bit processing.
	- The processor instruction set identifies all instructions (operations) that a processor can perform.
	    - 32-bit processors use the IA-32 instruction set (also referred to as x86).
	    - Itanium processors from Intel use the IA-64 instruction set.
	    - AMD64 and Intel 64 processors use the x86-64 instruction set (also referred to as x64).
	- 32-bit applications can run on 64-bit processors using the following methods:
	    - Itanium processors use a software layer to translate between IA-32 and IA-64.
	    - x64 processors execute both 32-bit and 64-bit instructions in the hardware.
	    - You can run a 32-bit operating system on a computer with a 64-bit processor.
	- Applications typically perform better on 64-bit systems.
	    - 64-bit applications typically perform better than 32-bit applications.
	    - In some cases, 32-bit applications might perform better on 64-bit systems.

Multi-Core	A multiple core processor has multiple processors within a single processor package. - Dual-core, triple-core, and quad-core processors are typical in desktop systems. - Multi-core systems enable the operating system to run multiple applications simultaneously. Without multiple processors, applications appear to run at the same time, but must wait their turn for processing time from the single processor. - Some applications can be written to execute on multiple processors at the same time. - Some motherboards use two (or more) processor sockets to provide a multiple processor solution. Multi-core processors use a single motherboard socket to support multiple processors.
Speed	Processors operate using an internal clock that is the same as, or is a multiple of, the motherboard bus speed. The speed is represented in megahertz (MHz) and is also referred to as the frequency. - You can purchase processors of the same type but with different speed ratings. - When selecting a processor, make sure the motherboard supports the processor speed by reading the motherboard documentation first. - Most motherboards automatically detect the processor speed. If not, you might need to use jumpers or edit the CMOS to configure the processor speed.
Cache	*Cache* is memory that the processor can access directly without using the system RAM. There are four types of processor cache: - Level 1 (L1) cache is integrated on the processor die itself and stores instructions for the processor. On multi-core systems, each processor typically has its own L1 cache. Some processors might have two L1 caches, one for instructions and one for data. - Level 2 (L2) cache is additional cache used for both instructions and data. Depending on the processor, L2 cache might be shared between two or more cores, or exclusive to a single core. - Level 3 (L3) cache is additional cache beyond the level 2 cache. For multi-core systems, L3 cache is shared between all cores. - Level 4 (L4) cache is shared dynamically between the on-die graphics processor unit (GPU) and CPU. Be aware of the following regarding processor cache: - The size of the cache increases as you move from L1 to L4, with L1 cache being the smallest. - As a general rule, a processor with more cache performs better than a processor with less cache (all other things being equal). - Originally, only L1 cache was on the processor die, with L2 cache being on the motherboard between the CPU and the RAM. As processor technology has advanced, L2 cache moved to the processor die, with L3 cache being on the motherboard. Today, all three cache levels are located on the processor.

	▪ The L4 cache acts an overflow cache for the L3. Information evicted from L3 is dumped into L4.
Process Size	The *process size* refers to the manufacturing process used to etch transistors onto the silicon wafer that will become the CPU. A smaller process size means smaller transistors, which translates into a smaller CPU die with more transistors and less power consumption. Process size is expressed in microns (such as .25 microns) or nanometers (90 nm which equals .09 microns).
Hyper-Treading	*Hyper-threading* is a feature of some Intel processors that allows a single processor to run threads (instructions) in parallel, as opposed to processing threads linearly. Hyper-threading enables a processor to execute two threads at the same time. For example, on a quad-core Intel system that supports hyper-threading, the processor can execute 8 threads at a time (2 on each core). Hyper-threading is not the same as multithreading. *Multithreading* is a feature of an application that allows it to send multiple threads at the same time. Applications are typically written to support multithreading to take advantage of multiple cores (executing threads on two or more processors at the same time) or hyper-threading features.
Throttling	*Throttling* is the process of modifying the operating characteristics of a processor based on current conditions. ▪ Throttling is often used in mobile processors to change the operating frequency to minimize power consumption and heat output. ▪ Throttling can also be used in low memory conditions to slow down the processing of I/O memory requests, processing one sequence at a time in the order the request was received. ▪ Related to throttling, processors or the operating system can shut down unused cores in multi-core systems to conserve energy.
Overclocking	*Overclocking* is pushing a CPU beyond its designed specifications. Overclocking can give you a marginal increase in performance, but will decrease your CPU's life. Some Intel processors include a Turbo Boost feature. Turbo Boost, the opposite of throttling, allows the processor to dynamically run above its rated speed to improve performance. *Unlocked* processors are processors whose speed can be changed above their rated speed through overclocking. ▪ With overclocking, you increase the speed and often the voltage to increase the performance of the processor. ▪ Overclocking typically voids the CPU warranty and could lead to shorter component lifetimes. ▪ Some multi-core processors (such as a triple-core CPU) have additional cores that have been disabled. With the appropriate motherboard support, you might be able to unlock and use the additional core(s). However, stability of the extra cores is not guaranteed.
Mobile Processors	Mobile CPUs are used in mobile computers and cell phones where portability and mobility are a concern. Special versions of processors are built to minimize power consumption and the amount of heat generated.

Virtualization	Virtualization is the ability to install and run multiple operating systems simultaneously on a single physical machine. Virtualization typically includes the following components: a physical machine, hypervisor, virtual machine, and virtual hard disk (VHD). The virtual machines appear as self-contained and separate physical systems.
	
	▪ Virtualization is performed by adding a thin layer of software, called a hypervisor, between the physical system and the operating system. A hypervisor allows virtual machines to interact with the hardware without going through the host operating system.
	▪ Early virtualization was performed using software only. Newer virtualization uses special instructions supported by the processor to improve performance.
	▪ There are several different types of hypervisor software.
	    ▪ VMware Workstation and ESX (made by VMware)
	    ▪ Hyper-V (made by Microsoft)
	    ▪ XEN (open source)
	▪ If you are planning on implementing a virtual solution, check to see whether hardware support in the CPU is required. Hardware support is provided by processors with the following features:
	    ▪ Intel's Virtualization Technology (VT)
	    ▪ AMD's AMD Virtualization (AMD-V)

Integrated Memory Controller	To improve performance, some processors include the memory controller with an integrated graphics processing unit (GPU) on the processor die, resulting in faster memory access by the processor.
Cooling	Processors require some form of heat dissipation system to function properly. Without a heat dissipation system, a processor will overheat and burn out in less than a minute. CPUs use a heat sink, fan, thermal paste, liquid, or fanless cooling system to transfer heat from the CPU to the cooling unit.