



Exam	220-801 – 220-802
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Chapter 1

Hardware

Hardware is one of nine domains on the 2012 CompTIA A+ exams. Hardware accounts for 40% of the 220-801 exam. Therefore, it is the most significant domain on either the 220-801 or 220-802 exams.

CPUs

The central processing unit (CPU) is the main processing unit of the personal computer (PC). It has an integral relationship with the motherboard and the system memory. These three devices control the data-processing aspect of the PC. Drives handle data storage, and input/output (I/O) interfaces allow human interaction, communication with peripherals, and network communication. The interaction between these components is controlled by the system BIOS or UEFI firmware.

32-Bit Versus 64-Bit CPUs

32-bit processors are designed to work with 32 bits of data at a time. This creates a limitation in the amount of installed memory they can access (4GB) and creates performance limitations when working with large data sets and many programs running in memory at the same time. 32-bit processors are often referred to as x86 processors.

64-bit processors work with 64 bits of data at a time, and can use much larger amounts of RAM than 32-bit processors and provide faster performance. Although the first 64-bit processor to run some version of Microsoft Windows, the Intel Itanium, was not compatible with x86 software, 64-bit processors made for desktop computers are compatible with 32-bit or 64-bit operating systems and programs. 64-bit processors that can also run 32-bit software are often referred to as x64 or x86-64 processors.

Almost all CPUs released in 2009 or later support 64-bit operation, but support for 64-bit operation among older designs varies. To determine whether a particular processor is a 32-bit or 64-bit processor, look up its specifications, or, if it is installed in a computer running Windows, use a utility such as CPU-Z (Figure 1-1).

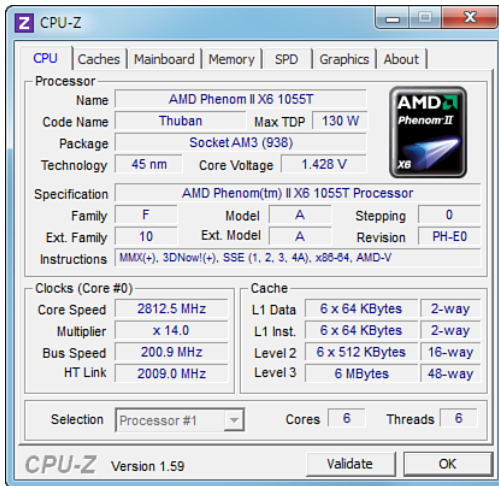


Figure 1-1 The processor in this computer is an AMD Phenom II X6 and it supports 64-bit (x86-64) instructions.

Clock Rate

The actual speed of the CPU is governed by a BIOS setting called the clock rate. CPUs run at a range of speeds, not just one specific speed. The speed can be varied by power management settings or by the BIOS in the event the processor overheats.

Although the latest processors from Intel and AMD have built-in overclocking options (overclocking is the process of running the processor and memory at faster performance than normal), most processors can be overclocked by manually adjusting the clock rate, voltage, and memory settings, if the motherboard and BIOS include these options.

You can see the core speed of the CPU, its clock multiplier, and the bus speed displayed in some BIOS dialogs, or by using a program such as CPU-Z (refer to Figure 1-1).

Cores and Cache

The portion of the CPU that performs calculations and operations is known as the processor core. Until recently, CPUs contained only one core. To improve performance, some server and workstation motherboards can support multiple CPUs (multiprocessor).

In recent years, most CPUs now include two or more cores. The term *multicore processor* applies to any processor with two or more cores:

- **Two cores**—Dual-core
- **Three cores**—Triple-core
- **Four cores**—Quad-core
- **Six cores**—Six-core

The more cores in a processor, the larger the number of programs and tasks it can run at the same time.

Table 1-1 lists some common multicore processors from Intel and AMD.

Table 1-1 Common Multicore CPUs

Manufacturer	CPU Model	Number of Cores
Intel	Core i7	4, 6 (desktop); 2, 4 (mobile)
	Core i5	2, 4 (desktop); 2 (mobile)
	Core i3	2 (desktop, mobile)
	Core2 Quad	4
	Core2 Duo	2
	Pentium D	2
AMD	FX 8xxx, 6xxx, 4xxx	8xxx (8), 6xxx (6), 4xxx (4)
	Phenom II X6, X4, X3	X6 (6), X4 (4), X3 (3)
	Athlon II X4, X3, X2	X4 (4), X3 (3), X2 (2)
	Athlon 64 X2	2
	A8, A6, A4	A8 (4), A6 (4), A2 (2)

Large amounts of shared cache memory also help multicore processors provide better performance. Cache is a temporary storage for the core so that it can “remember” the most recent processes. It is like looking up a topic in this *Quick Reference* guide as opposed to a giant 900-page A+ exam-preparation book.

There are three levels of cache:

- Level one cache (L1 cache) is located in the CPU core.
- Originally, level two cache (L2 cache) was located on the motherboard in either removable or soldered memory chips or modules. However, almost all processors for a number of years now include L2 cache as part of the CPU die.
- Level three cache (L3 cache), when present, is cache memory also located on the CPU die.

Level one, level two, and level three refer to the order in which the processor checks for information it needs to retrieve from memory. If the processor finds the information needed in level one, it uses it. If not, it checks level two, and so on. The processor checks main memory only if none of the cache memory contains the needed information.

Hyperthreading

Hyperthreading (also known as HT Technology) is a feature found in many single-core and some multicore processors made by Intel. It enables a processor core to run two execution threads at the same time. If you use multithreaded applications (applications that have more than one process happening at the same time), enabling HT Technology in the system BIOS can improve performance. To determine if a particular Intel processor supports HT Technology, look it up at the Intel ARK website (<http://ark.intel.com>).

Virtualization Support

Virtualization is the process of running one or more operating systems inside separate windows on the same computer. For example, you could run Windows XP inside a window on a computer while it runs Windows 7. Almost all current AMD and many current Intel processors support hardware-assisted virtualization, which improves the performance of virtualized operating systems.

Intel uses the term *VT-x* to identify processors that support virtualization, while AMD uses the term *AMD-V*. To enable hardware-assisted virtualization support, you must have a processor that supports this feature and enable this feature in the system BIOS.

Integrated Graphics (GPU)

Although computers have featured graphics (video) components on the motherboard for many years, only recently have CPUs actually incorporated graphics components in the CPU die itself.

Intel's Core i3, Core i5, and some Core i7 desktop processors (and all mobile processor in these families) include integrated graphics, although not all motherboards used with these processors support the feature.

AMD uses the term Accelerated Processing Unit (APU) to refer to its processors with integrated graphics. These processors are collectively referred to AMD Fusion.

CPU Interfaces and Socket Types

Intel and Advanced Micro Devices (AMD) have many models and qualities of CPUs. Each model is designed to fit into a specific socket on the motherboard. Many pins connect the CPU to the motherboard. Bending (or breaking) even one pin renders the CPU inoperable. A Zero Insertion Force (ZIF) physical interface lets you set the CPU into the array, and then you actuate a lever to make actual contact. It is imperative to orient the CPU correctly. Usually, there is an obvious guide or indication, like a missing corner pin on the CPU that aligns to a missing hole in the ZIF. Pin Grid Array (PGA) and Staggered Pin Grid Array (SPGA) describe the pin arrangement of the CPU interface with the motherboard. Land Grid Array (LGA) and Ball Grid Array (BGA) refer to processors that use contact-based rather than pin-based connections to the motherboard. Figure 1-2 illustrates a PGA socket, the AMD Socket AM3. Figure 1-3 illustrates an LGA socket, the Intel Socket 1155.

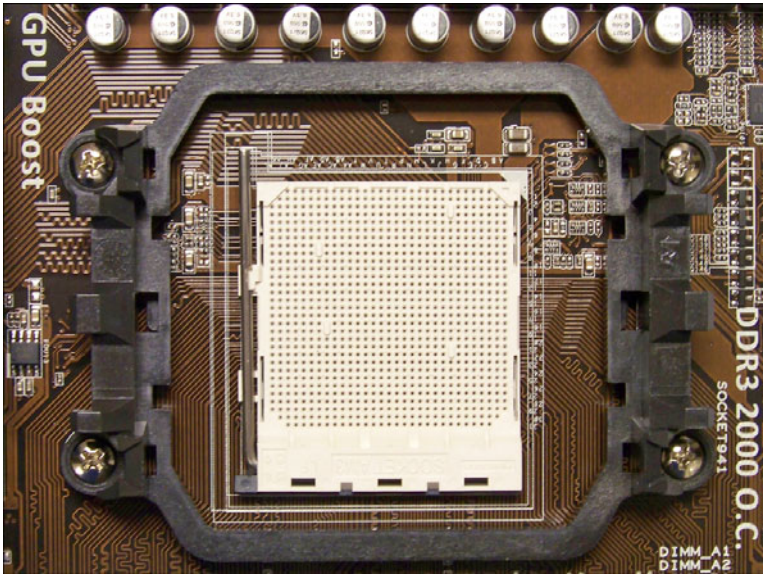


Figure 1-2 Socket AM3 is designed for AMD processors such as the Phenom II X6.

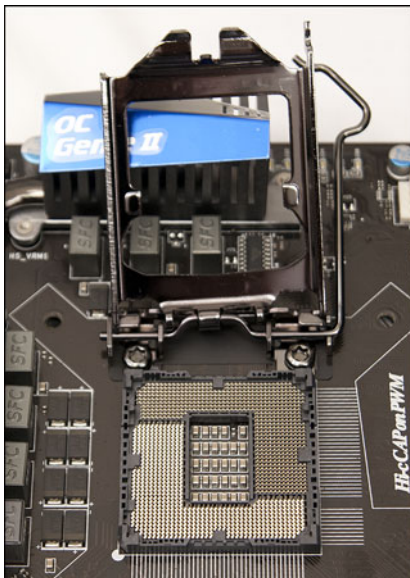


Figure 1-3 Socket LGA 1155 is designed for Intel processors, such as the “Sandy Bridge” second-generation Core i7, Core i5, and Core i3.

Tables 1-2 and 1-3 list processors and their associated sockets. Note that some processors are available in models for different sockets.

Table 1-2 AMD Sockets and CPUs

Socket	Supported CPUs
Socket 462 and Socket A	Athlon, XP, XP-M, and MP Duron Sempron
Socket 754	Athlon 64 Sempron Turion 64
Socket 940	Opteron Athlon 64 FX
Socket 939	Athlon 64, FX, and X2 Opteron Sempron
Socket S1	Turion 64, X2 Athlon 64 X2 Mobile Sempron
Socket AM2	Athlon X2 Athlon 64, FX, LE, and X2 Phenom, X3, and X4 Sempron and LE Opteron and SE
Socket AM2+	Athlon X2 BE Athlon 64, FX, LE, and X2 Phenom, X3, and X4 Phenom II X2, X3, and X4 Sempron and Sempron LE Opteron and Opteron SE

Socket	Supported CPUs
Socket AM3 (Socket 941)	Athlon II X2, X3, and X4 Phenom and Phenom FX Phenom II X3, X4, and X6 Sempron
Socket AM3+	FX 8xxx, 6xxx, 4xxx
Socket F	Opteron
Socket 563	Athlon XP-M
Socket FM1 (BGA-413)	AMD Fusion processors
Socket G34	Opteron MCM 6000-series
Socket C32	Opteron 4000 series

Table 1-3 Intel Sockets and CPUs

Socket	Supported CPUs
Socket 370	Pentium III Celeron
Socket 478 and Socket N	Pentium 4, 4 EE, and M Celeron
Socket 495	Celeron
PAC418	Itanium
Socket 603	Xeon
PAC611	Itanium 2
Socket 604	Xeon
Socket 479	Pentium M Celeron M Core Solo and Core Duo
LGA 775 and Socket T	Pentium 4, D, and XE Celeron and Celeron D Core 2 Duo and Core 2 Extreme

Table 1-3 Continued

Socket	Supported CPUs
Socket M	Core Solo and Core Duo
	Core 2 Duo
	Dual-Core Xeon
LGA 771 and Socket 771	Xeon
Socket P	Core 2 Duo, Quad
	Pentium Dual-Core
	Celeron M
Socket 441	Atom
LGA-1156	Core i5
	Core i3
	Pentium Dual-Core
LGA-1155	Core i7
	Core i5
	Core i3
Socket B and LGA 1366	Core i7
	Xeon
	Celeron

CPU Cooling Methods

There are several methods of removing heat from a CPU. The most common solution is an active heat sink: a fan that blows air across a multifinned aluminum or copper assembly fastened firmly to the CPU. The fan is powered by the motherboard, and the hardware monitor feature in the system BIOS measures fan speed and processor temperature. Many GPUs also have their own cooling fan and heat sink assembly. Figure 1-4 illustrates typical active heat sink assemblies for an AMD Phenom II CPU and an Intel Core i5 CPU.

A thermal compound is used between the heat sink and the CPU. Note that the thermal compound is poisonous and toxic to humans. Use care when applying or removing thermal compound. Note that heat sinks included with a processor typically include pre-applied thermal compound.

Over time, dust collects on the heat sink’s fins and the fan, which decreases its efficiency. Use compressed air or a PC vacuum to remove dust.

In some high-end gaming PCs, liquid cooling systems transfer heat from the CPU to a radiator using water and antifreeze. These work in much the same way as an automobile’s cooling system, providing excellent heat exchange and enabling much higher clock speeds than with air cooling.



Figure 1-4 Manufacturer-supplied heat sinks for AMD (left) and Intel (right) CPUs.

System Memory

There are two major types of RAM (random access memory): dynamic and static. Dynamic RAM (DRAM) loses information in a very short period of time in the absence of power. Static RAM (SRAM) retains its data for longer periods without power and is faster than DRAM, but is bulkier and much more expensive. In general, DRAM is used as system memory, and SRAM is used for cache and storage devices.

Although the first PCs used individually socketed memory chips, memory modules (multiple memory chips on a small circuit board) were soon found to be more reliable and less bulky. Fast-page mode DRAM and Extended Data-Out (EDO) memory used a type of memory module called a single inline memory module (SIMM). The 30-pin SIMMs have 8-bit-wide memory access, and the 72-pin SIMMs have 32-bit-wide memory access.

Synchronous dynamic RAM (SDRAM) has replaced older forms of DRAM. *Synchronous* means that the data transfer is timed to the system clock. 168-pin SDRAM modules were the first type of SDRAM used in PCs. The next type of SDRAM was double data rate (DDR) memory in a 184-pin DIMM, and currently systems use DDR2 and DDR3 (both of which use 240-pin modules, but are not interchangeable). The memory modules used for SDRAM-class memory are known as dual inline memory module (DIMM). These modules provide 64-bit-wide memory access.

Like most things on a PC, RAM is measured in speed. The motherboard must support the speed of the RAM; otherwise, the increased performance promised by the fast RAM will not be realized, or worse, the PC might not even power-on self-test (POST).

Dual-Channel and Triple-Channel Memory

x86 (32-bit) and x86-64 (64-bit) processors have a 64-bit data bus, the same size data bus as on DIMMs. Therefore, memory can be added one module at a time.

However, to improve performance, many recent systems support dual-channel or triple-channel memory. In these systems, you can add two or three matched memory modules (modules with the same speed and timing characteristics, and for most motherboards, they should also be the same size in GB), and the system will access them as a single very wide module for increased speed. To determine if a particular system or motherboard supports these memory access methods, check the documentation. If you don't use matched modules or if the modules are not installed in the correct sockets, the memory will be accessed as separate 64-bit modules, providing lower memory performance than with dual-channel or triple-channel access.

Other Types of RAM

The RAMBUS Inline Memory Module (RIMM) uses a proprietary 184- or 232-pin slot. This RAM, often called RDRAM, is found in some game console systems and a limited number of PCs. On such systems, empty RIMM slots must be filled with Continuity RIMM (CRIMM) modules.

Laptops use a small form factor called Small Outline DIMM (SODIMM). Many netbooks, Ultra Mobile PCs (UMPC), and portable devices, such as cell phones and PDAs, use a MicroDIMM form factor. Figure 1-5 compares the relative size and form factors found in RAM.

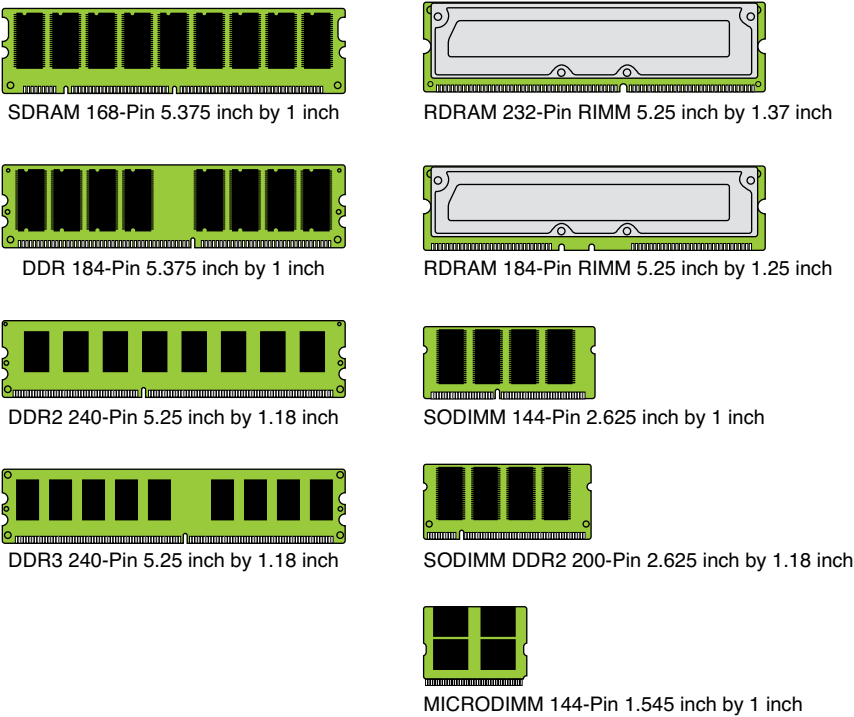


Figure 1-5 Memory module comparison.