Memory

## KT0601 Types of memory: RAM and ROM including DRAM, SRAM, CMOS RAM, and VRAM

### Types of RAM

As you've probably noticed, RAM is a sort of universal name for memory. Beyond that, each new name refers more to the mode of operation than an actual type of memory. The "D" in DRAM refers to the dynamic access. The "S" in SRAM and SDRAM refers to synchronizing the chip to the motherboard. EDO RAM refers to the extended data output whereby the column address isn't turned off after a read.

### Dynamic RAM (DRAM)

First, dynamic means moving or always changing. In dynamic RAM, electricity always has to be moving through the chip to keep refreshing the memory. DRAM is the basic type of memory chip, and everything that came later was mainly a way to get address information faster. Dynamic also means that data can be moved into or out of memory, over and over again, for as long as power is available.

Data in a DRAM chip is stored in very compact form, with each bit using only its own capacitor and accompanying transistor. Once again, if the capacitor has a charge, the computer reads that as a 1. If it does not have a charge, it's a 0. Capacitors have a tendency to leak their charge fairly quickly. For that reason, they often have to be refreshed. The controller refreshes the DRAM sequentially during any given operation.

### Synchronous RAM (SRAM)

SRAM introduced a clock that was actually built onto the memory module. This allows the module to be synchronized to the motherboard clock, introducing the term synchronous, or synchronized memory. Another feature of SRAM chips was that they weren't as dense as DRAM. The chips used a matrix of 6-transistors and no capacitors. Transistors don't require power to prevent leakage, so SRAM didn't have to be refreshed on a regular basis. By staying charged, the data changed only when a register changed, making the chips a lot faster than DRAM.

Because of the extra space in the matrix, SRAM uses more chips than DRAM for the same amount of storage space. Manufacturing costs are higher, so although DRAM was slower, the higher density and lower cost still made them popular in many machines. However, combining the best of both technologies quickly led to the development of SDRAM chips.

**CAUTION**

L-2 memory caches are usually on SRAM, which is extremely fast (as fast as 7–9 ns and 2–5 ns for ultra fast SRAM). Level 2 cache is usually installed in sizes of 256KB or 512KB.

SRAM is also used for CMOS configuration setups and requires a small amount of electricity, provided by a backup battery on the system board, to keep its data. It comes on credit-card-sized memory cards, is available in 128KB, 256KB, 512KB, 1MB, 2MB, and 4MB sizes, and has a battery life of 10 or more years.

**Synchronous DRAM (SDRAM)**

When the concept of synchronizing a memory chip to the motherboard proved successful, the idea was retrofitted to DRAM chips. Synchronous DRAM synchronizes the interrupt requests to the motherboard and works just like SRAM, only with the higher density (and lower cost) of the DRAM chip. Most SDRAM controllers are built into the North bridge of the motherboard chip set.

SDRAM uses the synchronization feature to eliminate the waiting problems between the CPU and the memory controller. When the CPU is ready to access data from memory, it goes to a specified clock point. The CPU knows when operations are going to be completed and when data is going to be available. No wait states means better performance (approximately 20 percent better than EDO memory, in most cases).

As we've seen, DRAM, fast page mode, and extended data output mode all measured memory speeds in nanoseconds (billionths of a second). A 70 ns part would be a "7," a 60 ns part a "6," and so on. The lower the number, the faster the memory. With the introduction of SDRAM, this measurement became less accurate. At such short intervals, per-second time began to lose any real value. Instead, the transfer speed of the front side bus began to make more sense as a measure of speed. For this reason, SDRAM modules began to be rated as 66MHz, 100MHz, 133MHz, 800MHz, and so on.

**Rambus DRAM (RDRAM)**

RDRAM comes out of technology developed originally by Rambus, Inc., for the Nintendo 64 gaming system. It's not that new, but it seems new because Intel started to use it with its Pentium 4 processors and 800-series chipset. Rambus memory is integrated onto

Rambus Inline Memory Modules (RIMMs). The modules use Rambus DRAM (RDRAM) chips. We discuss the Rambus modules later in this chapter.

RDRAM chips are synchronized to the processor's memory bus (not the motherboard clock). Therefore, the processor won't request something at mid tick (the reverse of an interrupt). In DRAM, the CPU is synchronized to the motherboard (which is fairly slow), but the memory chip is not. In SRAM and SDRAM, both the CPU and the memory are synched to the motherboard. In RDRAM, the synchronization is no longer tied to a slow motherboard, but is synchronized to the memory bus. The memory bus clock is derived from the processor, but it still uses a multiplier of the motherboard clock.

**Video RAM (VRAM)**

VRAM and WRAM have been supplanted by DDR memory chips, but you may find a question about VRAM (pronounced "vee-ram") on the exam. Video RAM was designed to provide two access paths to the same memory address. It's as if VRAM were a café that has two doors, one in the front and one in the back. Information came in one "entrance" at the same time that other information flowed out the other "exit." When the video controller read the memory for information, it accessed an address with one of the paths. When the CPU wrote data to that memory, it accessed the address via the other path. Because of these two access paths, we say that VRAM was dual-ported.

Manipulating graphics is processing-intensive, and so this ability to push data in and out of the chip at the same time helps a moving image appear continuous. VRAM chips were about 20 percent larger than DRAM chips, due to extra circuitry requirements. Modern computers usually have modest graphics processing integrated right onto the motherboard, with the AGP as a convenient way to add an extra video card.

**VRAM, WRAM, and AGP**

The AGP acronym stands for Accelerated Graphics Port. Most computers include this accelerated port, which is an integrated part of the I/O system. An AGP is not the same thing as VRAM or a video accelerator card, nor is it the same thing as today's integrated graphics. Although some video cards still use the expansion bus, most connect with the port.

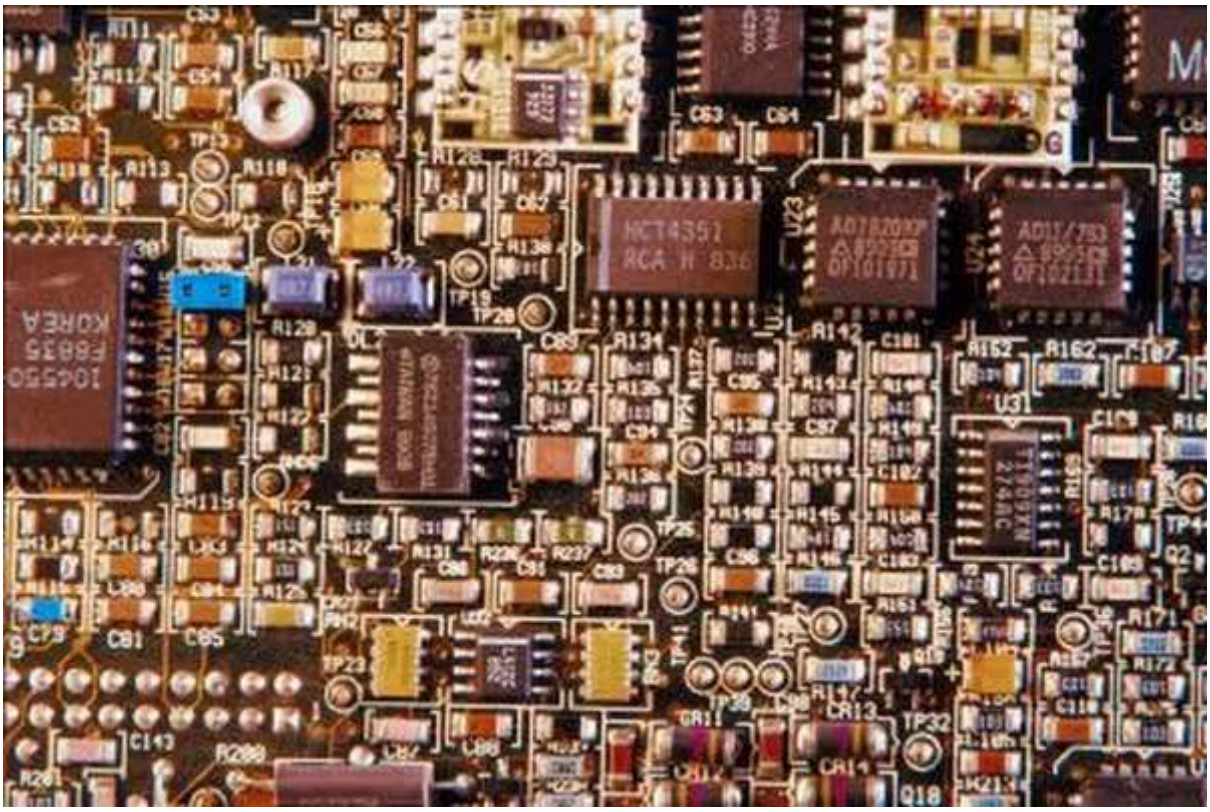
To say that a computer has "AGP memory," or "comes with AGP," can be confusing at best. At worst, it can demonstrate a faulty knowledge of the distinction between video memory and I/O subsystems. AGP is discussed in Chapter 7.

WRAM is short for Windows RAM, and has no connection with Microsoft, even though the acronym includes the word "Windows." WRAM, like VRAM, was dual-ported, but used large block addressing to achieve higher bandwidth. Additional features provided better

performance than video RAM at lower manufacturing costs. With the advent of AGP and DDR RAM, both video and Windows RAM have faded from the marketplace. That's not to say that add-on graphics accelerator cards have vanished.

**KT0602 Purpose of memory**

**What Are the Functions of Computer Memory?**



The basic function of computer memory is essentially to store data. Depending on the type of data it stores and the role it plays in computer operation, however, memory performs several different functions. Although all of these functions involve data storage, RAM, ROM, flash memory and hard drives each perform a different and necessary function to keep a computer and its peripherals working.

**RAM**

Random access memory (RAM) provides temporary application data storage. Instead of having to go back and find information on the hard drive every time a computer needs a piece of data, the computer temporarily stores frequently used files on RAM, making them easier to find. When the computer shuts down, all the data in RAM is erased or transferred to the hard drive, making room for new data when the computer begins operating again.

**Hard Drive**

A hard drive is core of a computer's data storage. It provides memory space for system and user files -- everything from your operating system to documents and images. In mechanical terms, a hard drive is a rotating disk treated with a magnetic coating, similar to the magnetic ribbons that store data on cassettes. A moving arm reads and copies data to and from the rotating disk, allowing you to open files from the hard disk or save new data.

**Flash Memory**

Flash memory, the common term for electronically erasable programmable read-only memory (EEPROM), is used in computer video game cards and to store some vital system information. Unlike other memory types that copy or erase data byte-by-byte, EEPROM can edit data in groups of bytes, making it a popular choice for devices like memory sticks and cameras where the data stored is constantly changing. Unlike hard drives, EEPROM does not require a fragile moving arm, prompting some computer manufacturers to move toward replacing hard disks with flash architecture, although the technology remains more expensive than hard disks.

**ROM**

Read-only memory (ROM) is used to store data that controls the most basic computer functionality, such as starting up, detecting peripherals and operating the computer fan. As the name suggests, the data cannot be edited by the system or users and, unlike RAM, the data stays recorded even when the computer is off. Like hard drives and flash memory, ROM is an example of non-volatile memory -- meaning that it remains in place when the power is off -- while RAM is considered volatile memory.

***Internal Assessment Criteria and Weight***

• IAC0601 Purpose of memory and how it relates to computer components is described

***(Weight 5%)***

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