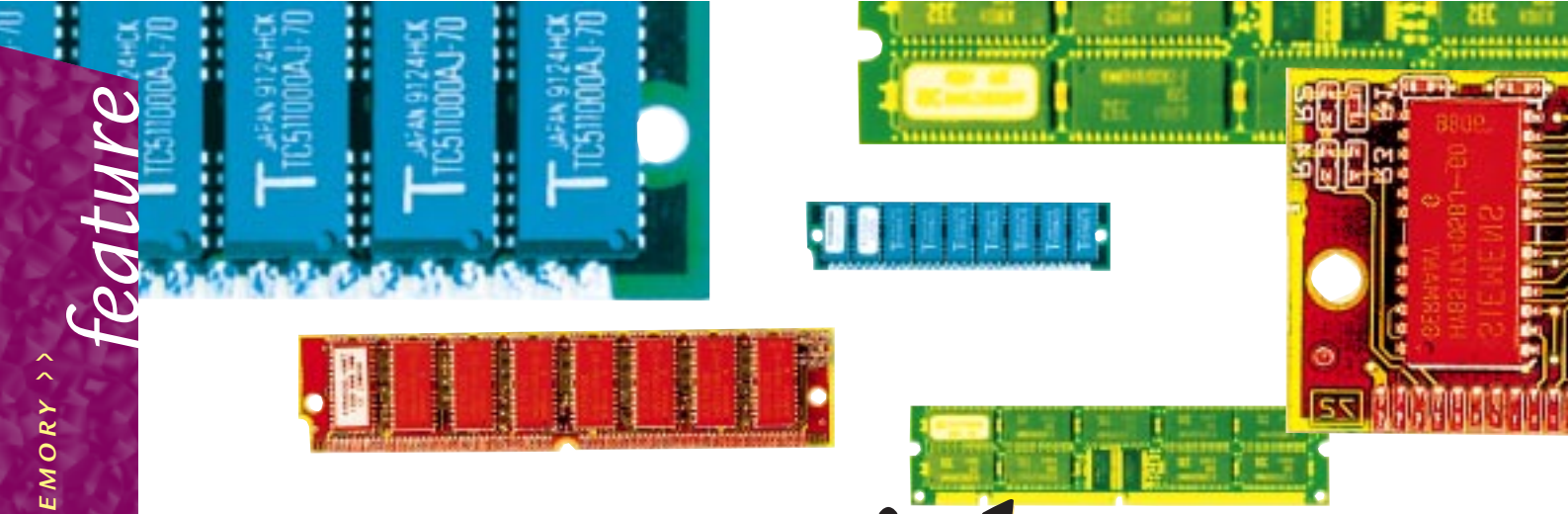


RAM raid

GETTING THE AMOUNT AND **TYPE OF MEMORY** RIGHT IS VITAL IN INCREASING THE USABILITY OF YOUR PC, WRITES ROGER GANN.

Memory is cheaper than ever, which is just as well, because you can never have enough of the stuff. It has to be the right sort, too, because current memory technology is so slow that it is actually holding back processor performance.

Random access memory, or RAM, constitutes your computer's 'workspace'. When you launch a program, the files and data are read from the disk and copied to RAM chips. These are made up of a capacitor and a transistor; the capacitor stores the charge and the transistor turns it on or off.

Because the data is held as a series of small electrical charges, it can be rapidly accessed by the CPU, allowing the chip to do its job without having to pause for the data it requires to be delivered. The data can also be accessed randomly: the CPU can locate, address, change or erase any bit, in any order, among several million.

Today's RAM chips typically have an access time of 60ns – it takes 60 billionths of a second to perform this round-trip function. This access time is faster than that of the 100-120ns chips of a few years ago, but it's still slower than the ideal access time of zero.

To speed up access times, the CPU can use cache memory. At 20ns or better, cache memory is faster than main memory, but systems contain less of it (it's expensive) and thus only the data the CPU is likely to need next is placed inside it. Generally, more cache equals better performance, but no amount of cache can keep pace with processors as they head for gigahertz clock speeds.

Having the right amount of RAM in your PC has a crucial effect on its performance and usability. It allows you to run bigger programs, or more simultaneously, or load larger data files. It also makes your PC run faster, because all versions of Windows make use of virtual, or disk-based, memory. When Windows runs low

CPU	Arrival Year	CPU Speed MHz	Intel Chipsets	Memory Bus Speed	Memory Module Speed
486	1989	50 100 150	EX ZX TX	33 50	33/66 Fast page mode EDO
Pentium K5	1993	166 200	EX	66	66 EDO
Pentium MMX K5	1996	166 200 233	VX	66	66 EDO SDRAM
Pentium Pro K5	1997	200	FX TX LX	66	66 EDO SDRAM
Pentium II K6	1998	233 266 300	LX	66	EDO SDRAM PC-66
Pentium III K6-III	1999	450 500 550	BX	100	100 SDRAM PC-100

on real memory, it temporarily writes data to disk to free up RAM, reading it back into memory when it next needs it. If this can be done quickly, it looks like you have more memory than in reality.

Using virtual memory is considerably slower than using real silicon, and this 'disk churn' slows down Windows 9x. If you add more memory, Windows becomes less reliant on virtual memory and runs faster. In fact, adding more memory is a more effective performance booster than installing a faster processor.

So, you've decided to increase your installed RAM. But what is the right amount? There are so-called 'sweet spots' in installed memory, above which the installation of additional RAM improves neither performance nor functionality. Many Windows 9x PCs ship with 32Mb. Consider increasing this to 64 or 128Mb but no more; above 128Mb, Windows 9x doesn't run faster or more smoothly.

Bus technologies

In 1994, a DRAM data access scheme called fast page mode (FPM) enabled a CPU to access new data in half the normal time, as long as it was on the same page as the previous request. This was superseded by extended data out (EDO) memory, which shortens the read cycle between memory and CPU. EDO memory allowed a CPU to access memory ten to 15 percent faster than comparable FPM chips.

The current DRAM technology, Synchronous DRAM (SDRAM), uses a clock to synchronise signal input and output on a memory chip. The clock is co-ordinated with the CPU clock so the timing of the memory chips and the timing of the CPU are in sync. This allows the CPU to perform other operations without waiting for the memory to locate the address and read or write the data.

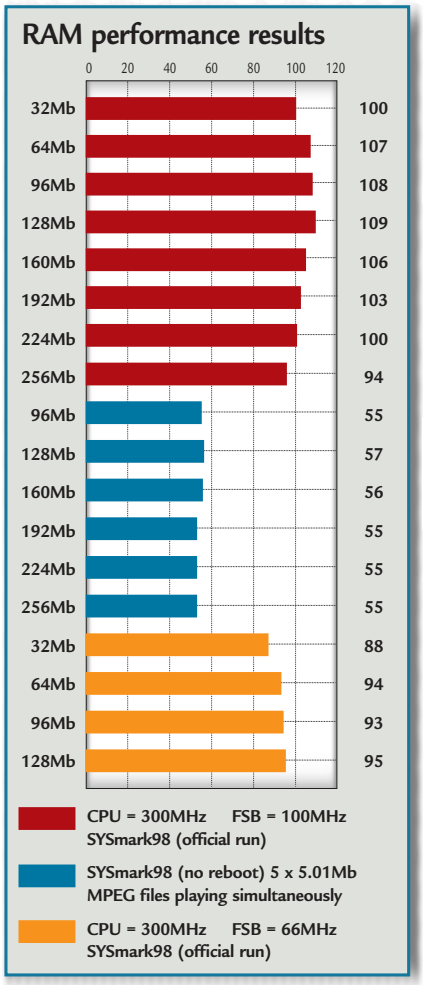
Originally, the SDRAM memory bus ran at 66MHz. With the advent of 350MHz processors, this was increased to 100MHz — the so-called PC-100 memory specification. But SDRAM bus speeds cannot be increased much beyond this. The performance lag has become so bad that processor speed increases have become almost pointless unless memory can keep pace with it.

Later this year Intel will launch the 0.18-micron version of the Pentium III processor which will run at speeds starting in the 600MHz range. Current SDRAM memory technology just doesn't cut the mustard for this class of CPU, and Rambus, a new kind of RAM technology, is needed.

The Rambus architecture is based on the Direct Rambus Channel, a high-speed bus operating at a clock rate of 400MHz with a data rate of 800MHz, far surpassing SDRAM's highest transfer rate of 100MHz. A two-bytes-wide data path allows for a peak data transfer rate of 1.6Gb/sec, twice SDRAM's 800Mb/sec.

Intel has had problems with both the Rambus technology and the motherboard chipset for it, the i820, *aka* Camino. This crucial piece of silicon enables systems to move to a faster, 133MHz frontside bus and provides the interface for Direct Rambus DRAM. Difficulties with Direct RDRAM manufacturing yields and issues related to clock-IC timing and printed-circuit-board impedance have resulted in significant delays. Not only are Rambus inline memory modules (RIMMs) hard to make, but testing them is also proving difficult.

Intel eventually confessed that the 800MHz Camino chipset would be delayed until September and that a Camino chipset which supports slower, 600MHz Rambus memory will be launched in June. Because of the delays, Intel has provided a means of re-using SDRAM DIMMs: the i820 chipset will now support either today's SDRAM DIMMs or Direct RDRAM RIMMs, dubbed the 'Synchronous' RIMM.



Parallel processing

Many PC manufacturers are reportedly hedging their bets, doing parallel development for both D-RDRAM and PC-133 for desktop PCs. A third hedge is double-data-rate SDRAM, which uses the trailing and leading edges of the CPU clocks to synchronise data, thus potentially increasing the speeds of operation to up to three times more than conventional SDRAM.

Current microprocessors have a bandwidth of up to 800Mb/sec, which is precisely that of PC-100 SDRAM. Processors planned for later this year, however, will have bandwidths of 1,066 to 1,600Mb/sec. RDRAM is expected to support transfer rates of 1200 to 1600Mb/sec. PC-133 can support 1066Mb/sec and DDR-SDRAM can support 1600 to 2133Mb/sec.

Intel will play no part in these technologies; its roadmap runs strictly from PC-100 to Rambus. It will, however, extend its current PC-100 memory to SDRAM 100-166, an increase in clock speed up to 166MHz. Rambus memory will be more expensive than today's cheap SDRAM — some say at least 40 percent dearer. This raises the question of whether RDRAM can offer sufficient performance gains to justify the higher price. □