The question of how fast a computer performs does not depend solely on how many megahertz the microprocessor runs at or how much RAM it has. Performance is highly application specific and is dominated by how many cycles per second the microprocessor is kept busy with useful instructions and data.

# CHAPTER 8
# High-Performance Memory Technologies

Memory is an interesting and potentially challenging portion of a digital system design. One of the benefits of decades of commercial solid-state memory development is the great variety of memory products available for use. Chances are that there is an off-the-shelf memory product that fits your specific application. A downside to the modern, ever-changing memory market is rapid obsolescence of certain products. DRAM is tied closely to the personal computer market. The best DRAM values are those devices that coincide with the sweet spot in PC memory configurations. As the high-volume PC market moves on to higher-density memory ICs, that convenient DRAM that you used in your designs several years ago may be discontinued so that the manufacturer can retool the factory for parts that are in greater demand.

Rapid product development means that memory capabilities improve dramatically each year. Whether it's higher density or lower power that an application demands, steady advances in technology put more tools at an engineer's disposal. SRAM and flash EPROM devices have more stable production lives than DRAM. In part, this is because they are less dependent on the PC market, which requires ever increasing memory resources for ever more complex software applications.

Memory is a basic digital building block that is used for much more than storing programs and data for a microprocessor. Temporary holding buffers are used to store data as it is transferred from one interface to another. There are many situations in networking and communication systems where a block of data arrives and must be briefly stored in a buffer until the logic can figure out exactly what to do with it. Lookup tables are another common use for memory. A table may store precomputed terms of a complex calculation so that a result can be rapidly determined when necessary. This chapter discusses the predominant synchronous memory technologies, SDRAM and SSRAM, and closes with a presentation of CAM, a technology that is part RAM and part logic.

No book can serve as an up-to-date reference on memory technology for long, as a result of the industry's rapid pace. This chapter discusses technologies and concepts that are timeless, but specifics of densities, speeds, and interface protocols change rapidly. Once you have read and understood the basics of high-performance memory technologies, you are encouraged to browse through the latest manufacturers' data sheets to familiarize yourself with the current state of the art. Corporations such as Cypress, Hynix, Infineon, Micron, NEC, Samsung, and Toshiba provide detailed data sheets on their web sites that are extremely useful for self-education and selecting the right memory device to suit your needs.

## 8.1 SYNCHRONOUS DRAM

As system clock frequencies increased well beyond 50 MHz, conventional DRAM devices with asynchronous interfaces became more of a limiting factor in overall system performance. Asynchro-