FUNDAMENTALS OF COMPUTER DESIGN

Today' s desktop computers (less than $500 cost) ar e having more performance, larger memory and storage than a computer bought in 1085 for 1 million dollar. Highest performance microprocessors of today outperform Supercomputers of less than 10 years ago. The rapid improvement has come both from advances in the technology used to build computers and innovations made in the computer design or in other words, the improvement made in the computers can be attributed to innovations of technology and architecture design.

During the first 25 years of electronic computers, both forces made a major contribution, delivering performance improvement of about 25% per year. Microprocessors were evolved during late 1970s and their ability along with improvements made in the Integrated Circuit (IC) technology y contributed to 35% performance growth per year.

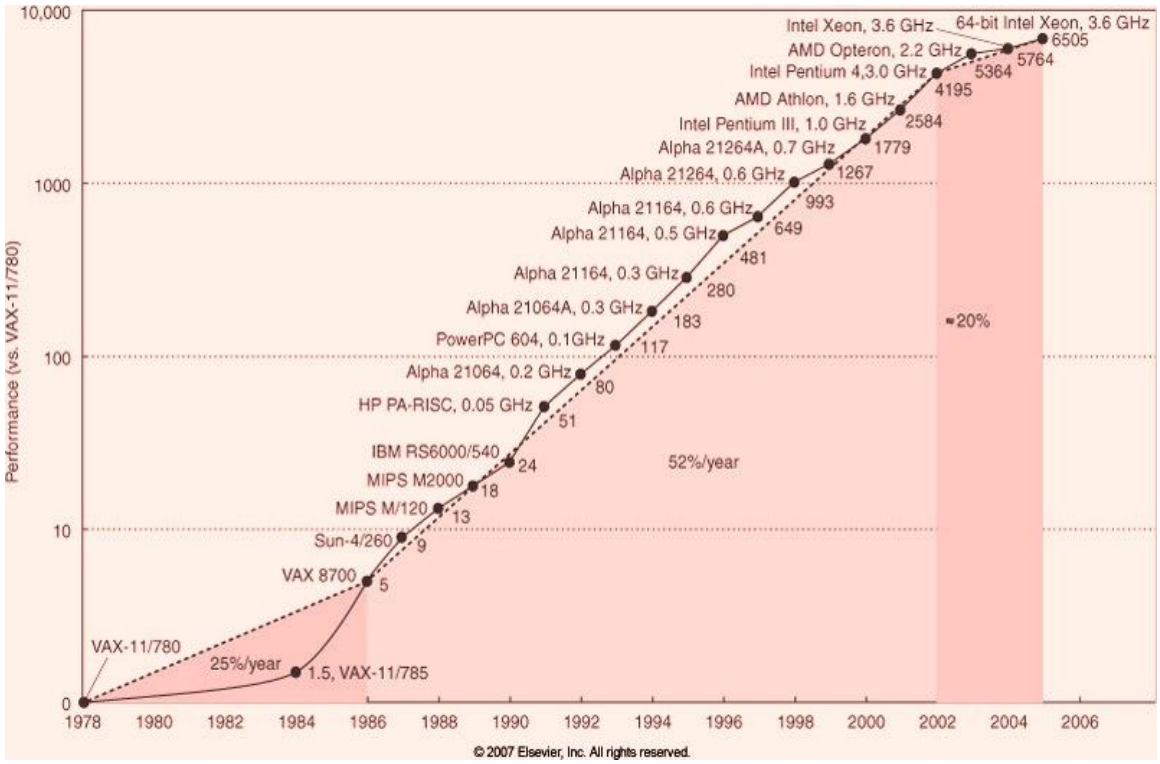
The virtual elimination of assembly language programming reduced the n eed for object-code compatibility. The creation of standardized vendor-independent operating system lowered the cost and risk of bringing out a new architecture.

In the yearly 1980s, the Reduced Instruction Set Computer (RISC) based machines focused the attention of designers on two critical performance techniques, the exploitation Instruction Level Parallelism (ILP) and the use of caches. The figu re 1.1 shows the growth in processor performance since the mid 1980s. The graph plots performance relative to the VAX-11/780 as measured b y the SPECint benchmarks. From the figure it is clear that architectural and organizational enhancements led to 16 years of sustained growth in performance at an annual rate of over 50%. Since 2002, processor performance improvement has dropped to about 20% per year due to the following hurdles:

•Maximum power dissipation of air-cooled chips
•Little ILP left to exploit efficiently
•Limitations laid by memory latency

The hurdles signals historic switch from relying solely on ILP to Thread Level Parallelism (TLP) and Data Level Parallelism (DLP).

Figure 1.1 The evolution of various classes of computers:



Classes of Computers

1960: Large Main frames (Millions of $)
(Applications: Business Data processing, large Scientific computin g)
1970: Minicomputers (Scientific laboratories, Time sharing concepts)
1980: Desktop Computers (µPs) in the form of Personal computers and workstations.
(Larger Memory, more computing power, Replaced Time sharing g systems)
1990: Emergence of Internet and WWW, PDAs, emergence of high performance digital consumer electronics
2000: Cell phones
These changes in computer use have led to three different computing classes each characterized by different applications, requirements and computing technologies.owth in processor performance since 1980s

Desktop computing

The first and still the largest market in dollar terms is desktop computing. Desktop computing system cost range from $ 500 (low end) to $ 5000 (high-end configuration). Throughout this range in price, the desktop market tends to drive to optimize price- performance. The perf ormance concerned is compute performance and graphics performance. The combination of performance and price are the driving factors to the customers and the computer designer. Hence, the newest, high performance and cost effective processor often appears first in desktop computers.

Servers:

Servers provide large-scale and reliable computing and file services and are mainly used in the large-scale en terprise computing and web based services. The three important

characteristics of servers are:

•**Dependability**: Severs must operate 24x7 hours a week. Failure of server system is far more catastrophic than a failure of desktop. Enterprise will lose revenue if the server is unavailable.

•**Scalability:** as the business grows, the server may have to provide more functionality/ services. Thus ability to scale up the computin g capacity, memory, storage and I/O bandwidth is crucial.

•**Throughput**: transactions completed per minute or web pages served per second are crucial for servers.

Embedded Computers

Simple embedded microprocessors are seen in washing machines, printers, network switches, handheld devices such as cell phones, smart cards video game devices etc. embedded computers have the widest spread of processing power and cost. The primary goal is often meeting the performance need at a minimum price rather than achieving higher performance at a higher price. The other two characteristic requirements are to minimize the memory and power.

In many embedded applications, the memory can be substantial portion of the systems cost and it is very important to optimize the memory size in such cases. The application is expected to fit totally in the memory on the p rocessor chip or off chip memory. The importance of memory size translates to an emphasis on code size which is dictated by the application. Larger memory consumes more power. All these aspects are considered while choosing or designing processor for the embedded applications.