Past, Present, and Future of Processors

1-27-2003

Opening Discussion

- Have you seen anything in the news?
- Questions from minute essays
  - How do they grow silicon crystals? http://my.netian.com/~archi2/semi/crystalgrowing.htm
  - How did people figure this out?
  - What are testing procedures?
  - How do currents move through a chip?
  - How does Dr. Lewis know so much?

Conductivity Physics

- Electrons are fermions. As a result, only one can be in a given state. At low temperatures they all pile up into the lowest energy states. The highest energy on the pile is called the Fermi energy. Electrons have to get into a non-full shell to conduct.

Transistor Physics

- An n-type semiconductor has electrons as the majority current carrier. Electricity doesn't flow across a p-n junction.
- When a voltage is applied to the gate, the electric field repels holes and makes the top layer act like an n-type.

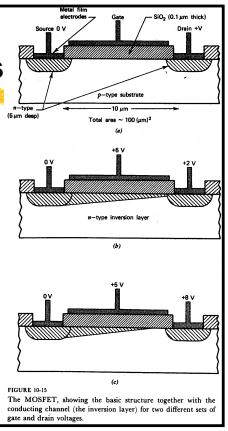
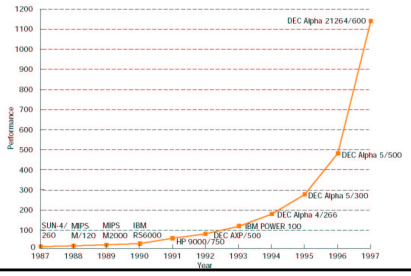


FIGURE 10-15
The MOSFET, showing the basic structure together with the conducting channel (the inversion layer) for two different sets of gate and drain voltages.

Just for Fun

- In case you thought I was making up everything about the DEC Alpha being fast...



History of Computing

- So hopefully you did the reading on the history of computing. I personally always enjoy seeing the pictures of old computers.
- Given what we have talked about, can you think of a reason why a computer that big almost has to be slow by modern standards (unless you do a lot of work for special programming)?

This Worth Noting

- All the earliest computers used vacuum tubes. The 1900 operations per second on the ENIAC is pathetically slow by today's standards, but still a huge improvement over doing things by hand.
- The IBM/360 and PDP-8 they show are using transistors, as did almost everything coming out in the 60s.
- Figure 1.26 is quite astounding to me. Unlike the more modern chips, you can actually see the circuitry in it.

Computing Today

- Our industry changes so quickly it is in a constant state of flux. However, there are some things that can be said.
  - The desktop market is dominated by the x86 architecture. PowerPC distant second.
  - Servers are very split and getting more so.
  - Greatest growth in low-power area.
- You should try to keep up a bit on the areas of hardware that interest you. New architectures are on the rise.

Future of Computing

- Are computers too fast? Can they store too much? Computer progress has been motivated by consumers demand for improvement. Today, the fraction of people who need more then 1GHz and 100GB isn't all that large. Where does this put us?
- Ubiquitous computing might push computing in other directions.

Ubiquitous Computing

- Several factors seem to be coming together to try to change the way computers appear in our life, to make them truly ubiquitous. The Oxygen lab at MIT has been working on this a while.
- With lower power consumption and wireless communication, computers can be put virtually anywhere. Add in the developing ability to make circuits in plastics and other materials and you get a situation where computers can be everywhere and we don't "sit down" at one to use one.

Parallel Computing

- Of course, some people always want more speed. UC can actually help in that as well. Grid computing is a currently popular idea of trying to reclaim the wasted clock cycles of the many desktop machines that are under utilized.
- More connected processors in a ubiquitous computing world could greatly increase total computing power.

Molecular/Biological Computing

- In the longer term we might find the need to move away from Silicon as the basis for our high powered processors. One direction that this might go in is to molecular or biological computing where logic components are made from organic molecules. Some single molecule transistors have already been made, but making chips is harder. Self-assembly may be required.

Quantum Computing

- Another possible direction of future computing is quantum computing. At the level of single atoms, things don't behave the way we are used to and quantum processes start to matter. Computation models that use entangled states can do some operations asymptotically faster than a standard model computer. A lot of work is going into this, but it is still way off.

Minute Essay

- Do you have any remaining questions from chapter #1? The future of computing is obviously very important to you because it could reshape your lives in 5-10 years. What do you see that future being like?
- Quiz #1 will be at the beginning of next class. Material from the beginning of chapter 2 is likely to be somewhere on it.