Computer Organization &
Assembly Language Programming

CSE 2312

Lecture 3  Computer Components

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Administration Reviewing

• Course CSE2312
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Reviewing (1)

• How to make computer convenient for people and hardware built-in simultaneously
  – Designing the L1 language including a new set of instructions that is more convenient for people to use than those in built-in machine instructions (L0 language)

• Solution: Translation
  – Executing a program written in L1 is first replace each instruction in it by an equivalent sequence of instructions in L0
  – The computer execute the new L0 program instead of the old L1 program

• Solution: Interpretation
  – Write a program in L0 to take programs in L1 as input data
  – Examine each instruction in turn and execute the equivalent sequence of L0 instruction directly
Reviewing (2)

- **Similarity**
  - In both of them, the computer carried out instructions in L1 by executing equivalent sequences of instructions in L0

- **Dissimilarity**
  - In translation, the entire L1 program is converted to a L0 program. Then the new L0 program is loaded into the memory and executed. During Execution, the new L0 program is running and in control of computer.
  - In interpretation, after each L1 instruction is examined and decoded, it is carried out immediately. The interpreter is in control of computer. In this case, L1 program is just data.
A six-level computer. The support method for each level is indicated below it.
Reviewing (4)

- **Model of a computer that used stores programs**
  - Both Data and Program stored in memory
  - Allows the computer to be “Re-programmed”
Different Computers

- Greeting Card (electronic music) $1
- Electronic control in cars $5~$10
- Game Computer $50~$100
- Personal Computer $500~$1,000
- Computer Servers $5,000
- Mainframe Computer $5,000,000
# Different Computers

<table>
<thead>
<tr>
<th>Type</th>
<th>Price ($)</th>
<th>Example application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disposable computer</td>
<td>0.5</td>
<td>Greeting cards</td>
</tr>
<tr>
<td>Microcontroller</td>
<td>5</td>
<td>Watches, cars, appliances</td>
</tr>
<tr>
<td>Game computer</td>
<td>50</td>
<td>Home video games</td>
</tr>
<tr>
<td>Personal computer</td>
<td>500</td>
<td>Desktop or notebook computer</td>
</tr>
<tr>
<td>Server</td>
<td>5K</td>
<td>Network server</td>
</tr>
<tr>
<td>Collection of Workstations</td>
<td>50–500K</td>
<td>Departmental minisupercomputer</td>
</tr>
<tr>
<td>Mainframe</td>
<td>5M</td>
<td>Batch data processing in a bank</td>
</tr>
</tbody>
</table>
Personal Computer

- Printed circuit board
  - The heart of every personal computer. (Figure: Intel D875PBZ board)

1. Pentium 4 socket
2. 875P Support chip
3. Memory sockets
4. AGP connector
5. Disk interface
6. Gigabit Ethernet
7. Five PCI slots
8. USB 2.0 ports
9. Cooling technology
10. BIOS
Some Computer Families

• **Pentium 4 by Intel**
  – Popular personal computer

• **UltraSPARC III by Sun Microsystems**
  – Open architecture with many suppliers of parts and systems
  – Aimed at high-end applications, such as large multiprocessor web servers with dozens of CPUs and physical memories of up to 8 TB ($10^{12}$ bytes)
  – Small versions also can be used in notebooks as well

• **The 8051 chip by Intel, used for embedded systems**
  – Use read-only memories for the program plus a small amount of read-write memory, called RAM (Random Access Memory) for data storage
  – Cheaper price
  – Lot of information about the 8051
  – www.8051.com
## Intel Computer Family (1)

<table>
<thead>
<tr>
<th>Chip</th>
<th>Date</th>
<th>MHz</th>
<th>Transistors</th>
<th>Memory</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4004</td>
<td>4/1971</td>
<td>0.108</td>
<td>2300</td>
<td>640</td>
<td>First microprocessor on a chip</td>
</tr>
<tr>
<td>8008</td>
<td>4/1972</td>
<td>0.108</td>
<td>3500</td>
<td>16 KB</td>
<td>First 8-bit microprocessor</td>
</tr>
<tr>
<td>8080</td>
<td>4/1974</td>
<td>2</td>
<td>6000</td>
<td>64 KB</td>
<td>First general-purpose CPU on a chip</td>
</tr>
<tr>
<td>8086</td>
<td>6/1978</td>
<td>5–10</td>
<td>29,000</td>
<td>1 MB</td>
<td>First 16-bit CPU on a chip</td>
</tr>
<tr>
<td>8088</td>
<td>6/1979</td>
<td>5–8</td>
<td>29,000</td>
<td>1 MB</td>
<td>Used in IBM PC</td>
</tr>
<tr>
<td>80286</td>
<td>2/1982</td>
<td>8–12</td>
<td>134,000</td>
<td>16 MB</td>
<td>Memory protection present</td>
</tr>
<tr>
<td>80386</td>
<td>10/1985</td>
<td>16–33</td>
<td>275,000</td>
<td>4 GB</td>
<td>First 32-bit CPU</td>
</tr>
<tr>
<td>80486</td>
<td>4/1989</td>
<td>25–100</td>
<td>1.2M</td>
<td>4 GB</td>
<td>Built-in 8-KB cache memory</td>
</tr>
<tr>
<td>Pentium</td>
<td>3/1993</td>
<td>60–233</td>
<td>3.1M</td>
<td>4 GB</td>
<td>Two pipelines; later models had MMX</td>
</tr>
<tr>
<td>Pentium Pro</td>
<td>3/1995</td>
<td>150–200</td>
<td>5.5M</td>
<td>4 GB</td>
<td>Two levels of cache built in</td>
</tr>
<tr>
<td>Pentium II</td>
<td>5/1997</td>
<td>233–450</td>
<td>7.5M</td>
<td>4 GB</td>
<td>Pentium Pro plus MMX instructions</td>
</tr>
<tr>
<td>Pentium III</td>
<td>2/1999</td>
<td>650–1400</td>
<td>9.5M</td>
<td>4 GB</td>
<td>SSE Instructions for 3D graphics</td>
</tr>
<tr>
<td>Pentium 4</td>
<td>11/2000</td>
<td>1300–3800</td>
<td>42M</td>
<td>4 GB</td>
<td>Hyperthreading; more SSE instructions</td>
</tr>
</tbody>
</table>

The Intel CPU family. Clock speeds are measured in MHz (megahertz) where 1 MHz is 1 million cycles/sec.
Intel Computer Family (2)

The Pentium 4 chip
Intel Computer Family (3)
# MCS-51 Family

<table>
<thead>
<tr>
<th>Chip</th>
<th>Program memory</th>
<th>Mem. type</th>
<th>RAM</th>
<th>Timers</th>
<th>Interrupts</th>
</tr>
</thead>
<tbody>
<tr>
<td>8031</td>
<td>0 KB</td>
<td></td>
<td>128</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>8051</td>
<td>4 KB</td>
<td>ROM</td>
<td>128</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>8751</td>
<td>8 KB</td>
<td>EPROM</td>
<td>128</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>8032</td>
<td>0 KB</td>
<td></td>
<td>256</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>8052</td>
<td>8 KB</td>
<td>ROM</td>
<td>256</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>8752</td>
<td>8 KB</td>
<td>EPROM</td>
<td>256</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
# Class of CPU

<table>
<thead>
<tr>
<th></th>
<th>Server</th>
<th>Desktop</th>
<th>Embedded</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost of System</strong></td>
<td>5K to 1 M</td>
<td>700$ to 5K</td>
<td>100 to 700$</td>
</tr>
<tr>
<td><strong>Cost of CPU</strong></td>
<td>50$ to 1K</td>
<td>70 $ to 200$</td>
<td>$ 1 to $100</td>
</tr>
<tr>
<td><strong>Performance Metrics</strong></td>
<td>Throughput Availability</td>
<td>Response time, Price Graphics</td>
<td>Power, Battery life Graphics</td>
</tr>
</tbody>
</table>
Future

• **Advanced Architectures**
  – Multi-core (more than 1 CPU on a chip)

• **Performance Accelerators**
  – Graphic chips (Xbox, Wii, nintendo)
  – Probability Processing

• **Embedded Computing**
  – Processors in vending machines, washer dryers, cars

• **Cloud Computing**
  – Computing as a utility

• **Low Energy Design**
  – Green is IN
Exercise

• Ex 1: TRUE OR FALSE, Why?
  – An interpreter converts programs in one language to another, while a translator carries out a program instruction by instruction.
  – Answer: F
  – Reason: An translator converts programs in one language to another, while a interpreter carries out a program instruction by instruction.

• Ex 2: TRUE OR FALSE, Why?
  – L1 language is less convenient for people to use than those in built-in machine instructions.
  – Answer: F
  – Reason: L1 language is more convenient for people
Exercise

• **Ex 3: TRUE OR FALSE, Why?**
  – Computer Architecture is to study how to design parts of a computer system that are visible to the programmers.
  – **Answer: T**

• **Ex 4: TRUE OR FALSE, Why?**
  – Hardware and software are functionally equivalent. Any function done by one can, in principle, be done by the other.
  – **Answer: T**
Exercise

• **Ex 5: Which of following is true for Translation and Interpretation?**
  
  – (a) In both of them, the computer carried out instructions in L1 by executing equivalent sequences of instructions in L0
  
  – (b) In translation, the entire L1 program is converted to a L0 program.
  
  – (c) In interpretation, after each L1 instruction is examined and decoded, it is carried out immediately.
  
  – (d) Interpretation is more efficient than Translation
  
  – **Answer: [a, b, c]**
Exercise

• Ex 6: Which of following can be stored in the memory?
  – (a) Data only
  – (b) Program only
  – (c) Both data and program
  – (d) None of them

  – Answer: [c]
Exercise

• **Ex 7: Which of following is true based on Moore Law:**
  – (a) 2X processor speed increment every 8 months.
  – (b) 2X processor speed increment every 18 months.
  – (c) 4X processor speed increment every 8 months.
  – (d) 4X processor speed increment every 18 months.

  – Answer: [b]
Exercise

• Ex 8: Which of following is true in Multilevel Machine?
  – (a) Instruction Set Architecture Level lay between Digital Logic Level and Microarchitecture Level.
  – (b) Assembly Language Level lay between Instruction Set Architecture Level and Operating System Level
  – (c) Operating System Level lay between Assembly Language Level and Instruction Set Architecture Level
  – (d) Microarchitecture Level lay between Digital Logic Level and Instruction Set Architecture Level

  – Hint: Please draw down the diagram of multilevel machine first

  – Answer: [c, d]
Six-level Computer

Level 5  Problem-oriented language level
         Translation (compiler)
Level 4  Assembly language level
         Translation (assembler)
Level 3  Operating system machine level
         Partial interpretation (operating system)
Level 2  Instruction set architecture level
         Interpretation (microprogram) or direct execution
Level 1  Microarchitecture level
         Hardware
Level 0  Digital logic level

A six-level computer. The support method for each level is indicated below it.
Exercise

- Ex 9: Please draw a diagram for the Von Neumann Machine

  - Answer:

    ![Von Neumann Machine Diagram]

  - CPU is central to the computer
    - Data
    - Control

  - Memory Unit
  - Input Unit
  - Output Unit
  - Arithmetic and Logic (ALU)
  - Control Unit
Exercise

• Ex 10: What is the key gap in computer design? How to bridge this gap?

– Answer:
– Human prefers natural language while it’s easy to use machine (binary) language for computers.
– Designing a high level language (L1) including a new set of instructions that is more convenient for people to use than those in built-in machine instructions (L0 language).