Chapter 1: Basic Concepts

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• Chapter corrections (Web)  Assembly language sources (Web)

• Printing a slide show

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Assembly Language Applications

• Some representative types of applications:
  • Business application for single platform
  • Hardware device driver
  • Business application for multiple platforms
  • Embedded systems & computer games

(see next panel)
## Comparing ASM to High-Level Languages

<table>
<thead>
<tr>
<th>Type of Application</th>
<th>High-Level Languages</th>
<th>Assembly Language</th>
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<tbody>
<tr>
<td>Business application software, written for single platform, medium to large size.</td>
<td>Formal structures make it easy to organize and maintain large sections of code.</td>
<td>Minimal formal structure, so one must be imposed by programmers who have varying</td>
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<td>levels of experience. This leads to difficulties maintaining existing code.</td>
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<tr>
<td>Hardware device driver.</td>
<td>Language may not provide for direct hardware access. Even if it does, awkward coding</td>
<td>Hardware access is straightforward and simple. Easy to maintain when programs are</td>
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<td>techniques must often be used, resulting in maintenance difficulties.</td>
<td>short and well documented.</td>
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<tr>
<td>Business application written for multiple platforms (different operating systems).</td>
<td>Usually very portable. The source code can be recompiled on each target operating</td>
<td>Must be recoded separately for each platform, often using an assembler with a</td>
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<td>system with minimal changes.</td>
<td>different syntax. Difficult to maintain.</td>
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<tr>
<td>Embedded systems and computer games requiring direct hardware access.</td>
<td>Produces too much executable code, and may not run efficiently.</td>
<td>Ideal, because the executable code is small and runs quickly.</td>
</tr>
</tbody>
</table>

[Web site]  
[Examples]
Virtual Machine Concept

- Virtual Machines
- Specific Machine Levels
Virtual Machines

- Tanenbaum: Virtual machine concept
- Programming Language analogy:
  - Each computer has a native machine language (language L0) that runs directly on its hardware
  - A more human-friendly language is usually constructed above machine language, called Language L1
- Programs written in L1 can run two different ways:
  - Interpretation – L0 program interprets and executes L1 instructions one by one
  - Translation – L1 program is completely translated into an L0 program, which then runs on the computer hardware
Translating Languages

**English:** Display the sum of A times B plus C.

**C++:** cout << (A * B + C);

**Assembly Language:**

- `mov eax, A`
- `mul B`
- `add eax, C`
- `call WriteInt`

**Intel Machine Language:**

```
A1 00000000
F7 25 00000004
03 05 00000008
E8 00500000
```
The 6th Edition does not consider Level 1, but we will keep this level. Also, we consider Level 6, which may include Logical Symbolic Programming: Prolog, Lisp, Mathematica, MatLab.
Digital Logic

- Level 0
- CPU, constructed from digital logic gates
- System bus
- Memory
- Implemented using bipolar transistors

next: Data Representation
Microarchitecture

- Level 1
- Interprets conventional machine instructions (Level 2)
- Executed by digital hardware (Level 0)
Instruction Set Architecture

- Level 2
- Also known as conventional machine language
- Executed by Level 1 (microarchitecture) program
Operating System

- Level 3
- Provides services to Level 4 programs
- Translated and run at the instruction set architecture level (Level 2)
Assembly Language

• Level 4
• Instruction mnemonics that have a one-to-one correspondence to machine language
• Calls functions written at the operating system level (Level 3)
• Programs are translated into machine language (Level 2)
High-Level Language

- Level 5
- Application-oriented languages
  - C++, Java, Pascal, Visual Basic . . .
- Programs compile into assembly language (Level 4)

HPP, P8, P12, Sections Review