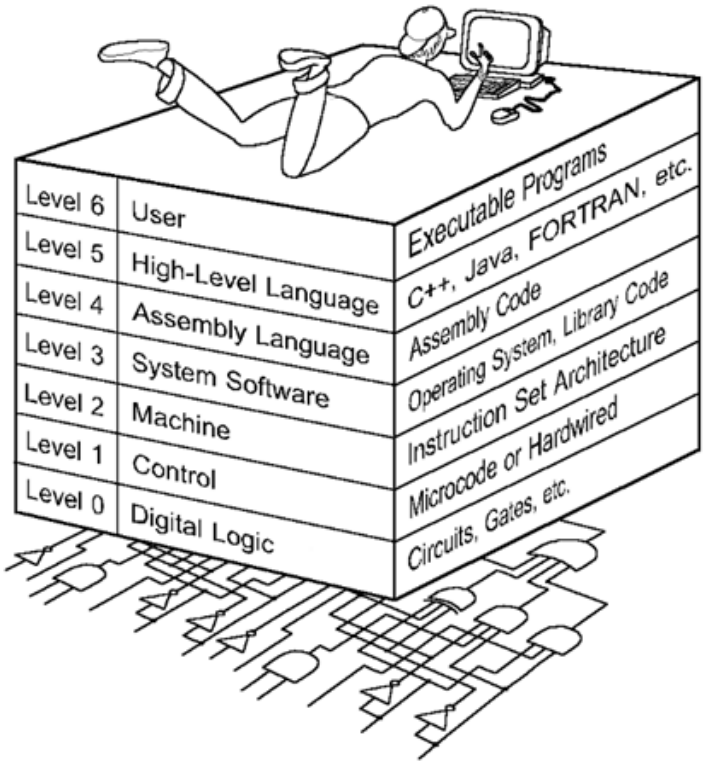

Figure 1.3 The Abstract Levels of Modern Computing Systems

Term	Discussion
virtual machine	A virtual machine is a specification of a computer including its memory, registers, instructions, input, and output.

Level	Discussion
6	The **User Level** is composed of applications and is the level with which everyone is most familiar. At this level, we run programs such as word processors, graphics packages, or games. The lower levels are nearly invisible from the User Level.
5	The **High-Level Language Level** consists of languages such as C, C++, Fortran, Lisp, Pascal, and Prolog. These languages must be translated (using either a compiler or an interpreter) to a language the machine can understand.
4	The **Assembly Language Level** encompasses some type of assembly language. Assembly language instructions have a one-to-one relationship with machine language instructions. Assembly language merely contains mnemonics for machine codes.
3	The **System Software Level** deals with operating system instructions. This level is responsible for abstracting basic hardware capabilities for one or more users. System software is responsible for managing program execution, memory, communication facilities, input, output, and permanent storage (hard disk).
2	The **Instruction Set Architecture (ISA) Level** is the **Machine Leve**l and consists of the machine language recognized by the particular architecture of the computer system. Programs written in a computer's true machine language on a hardwired computer can be executed directly by electronic circuits without any interpreters, translators, or compilers.
1	The **Control Level** is where a **control unit** makes sure that instructions are decoded and executed properly and that data are moved where and when they should be. The control unit interprets the machine instructions passed to it, one at a time, from the level above, causing the required actions to take place. Control units can be designed in one of two ways: They can be **hardwired** or they can be **microprogrammed**.
0	The Digital Logic Level is where we find the physical components of the computer system: the gates and conductors. These are the fundamental building blocks that are used to implement mathematical logic.