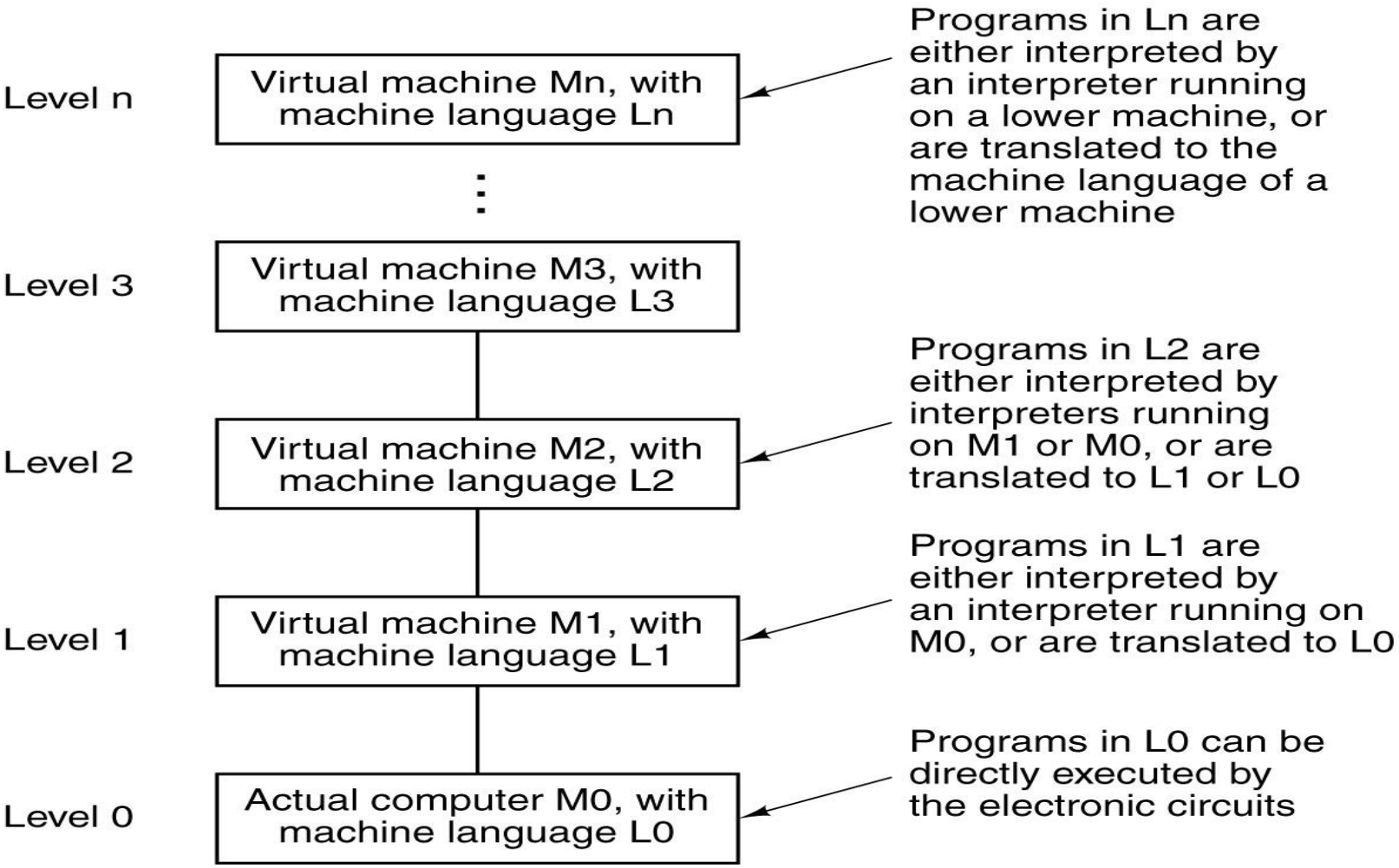
CAO: Lecture 10
Multilevel Viewpoint

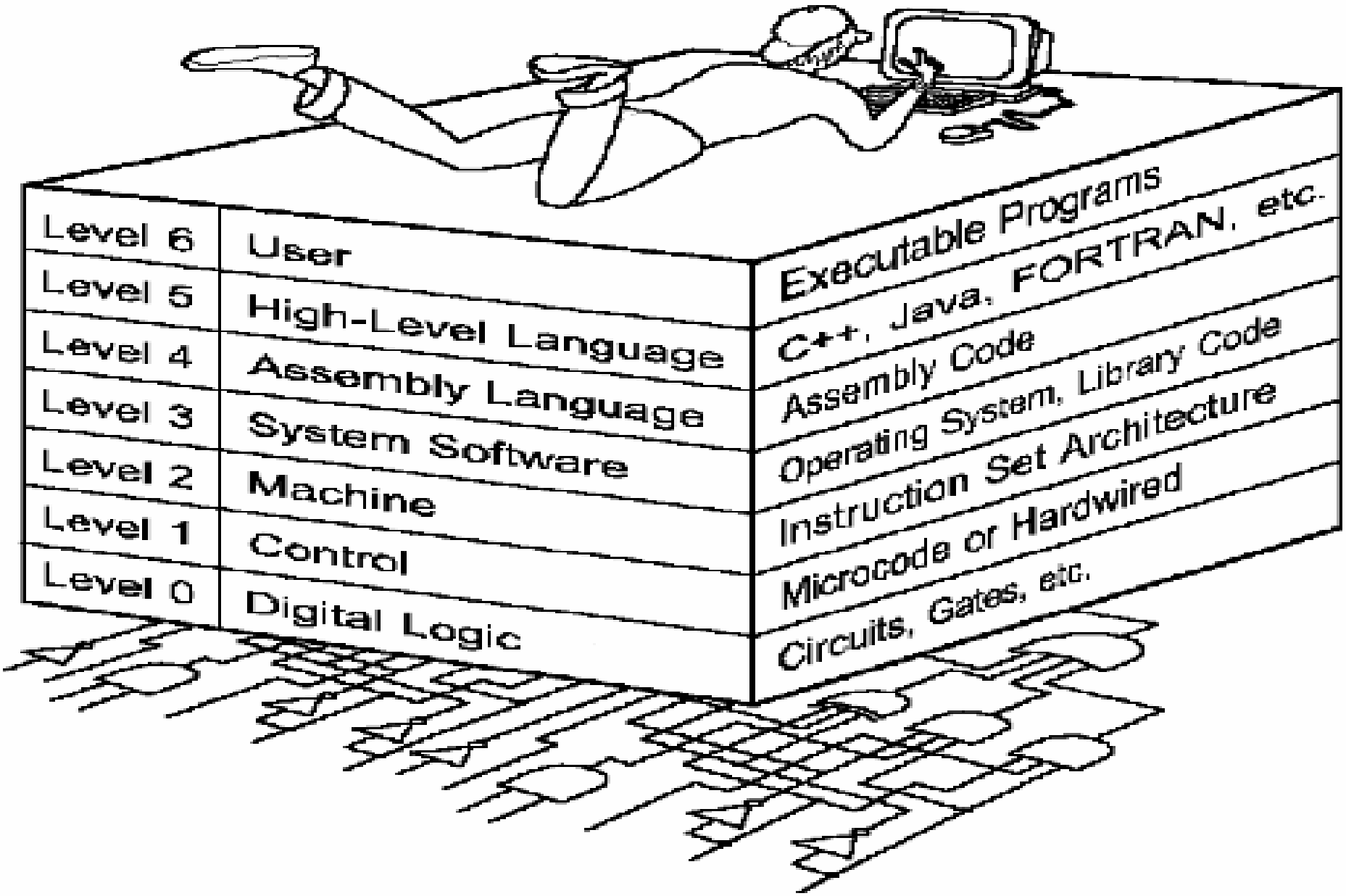
Topics Covered

- Multilevel View Point of A Machine
- The Computer Level Hierarchy
- Hardwired Control
- Micro programmed Control
- Instruction Set Architecture (ISA)
- Actual Multilevel Computer

Multilevel View Point of A Machine



The Computer Level Hierarchy



Level 0: Digital Logic Level

- This level is where we find digital circuits (the chips).
- Digital circuits consist of gates and wires.
- These components implement the mathematical logic of all other levels.
- This level is where we view physical devices as just switches (On/Off)
- Instead of viewing their physical behavior (i.e. in terms of voltages and currents) we use two value logic i.e. 0 (off) and 1(on)

Level 1: Control Level / Microarchitecture Level

- A *control unit* decodes and executes instructions and moves data through the system.
- Control units can be *microprogrammed* or *hardwired*.

- Computer Architecture is the combination of microarchitecture and instruction set design.

Hardwired Control

- Hardwired control units consist of hardware that directly executes machine instructions.
- The control logic is implemented with gates, flip flops, decoders, and other digital circuits.
- It has the advantage that it can be optimized to produce a fast mode of operation
- Making any change is difficult

Micro programmed Control

- Microprogramed control unit is built around a storage unit called control memory where all control signals are stored in program like format.
- Control memory stores a set of microprograms which are designed to implement instruction set.
- Each instruction causes a set of microprogram to be fetched.
- And its control information is extracted in a manner that resembles the fetching and execution of program from main memory.
- Design changes can be easy by just altering the contents of the control memory.

A micro program is a program written in a low-level language that is implemented by the hardware.

Level 2: Machine Level

- Also known as the Instruction Set Architecture (ISA) Level.
- Consists of instructions that are particular to the architecture of the machine.

Instruction Set Architecture (ISA)

- The *Instruction Set Architecture* (ISA) is the part of the processor that is visible to the programmer or compiler writer.
- The ISA serves as the boundary between software and hardware.
- An **instruction set**, or **instruction set architecture** (ISA), is the part of the computer architecture related to programming, including the native data types, instructions, registers, addressing modes, memory architecture, interrupt and exception handling, and external I/O.
- An ISA includes a specification of the set of opcodes, the native commands implemented by a particular CPU design.

Example

- An operation (ADD) is a part of Instruction set stored in a memory. It is a binary code that tells computer to perform ADD operation.
- Control units decodes instructions from the memory. Then issues a sequence of control signals to initiate micro operations in internal computer registers

- ***For every operation code, the control issues a sequence of micro operations needed for the hardware implementation of the specified operation***

Level 3: System Software Level

- Controls executing processes on the system.
- Protects system resources.
- Assembly language instructions often pass through Level 3 without modification.
- Operating System software supervises other programs
  - Controls execution of multiple programs
  - Protects system resources. E.g. Memory and I/O devices
- Other utilities
  - Compilers, Interpreters, Linkers, Library etc.

Level 4: Assembly Language Level

- Acts upon assembly language produced from Level 5, as well as instructions programmed directly at this level.
- Lowest human readable form before dealing with 1s and 0s (machine language)
- Assembler converts assembly to machine language

Level 5: High-Level Language Level

- The level with which we interact when we write programs in languages such as C, Pascal, Lisp, and Java
- The level allows users to write their own application with languages such as C, Java and many more
- High-level languages are easier to read, write, and maintain
- User at this level sees very little of the lower level

Level 6: The User Level

- Program execution and user interface level.
- The level with which we are most familiar.
- Composed of application programs such as Word Processor,Paint etc.
- The implementation of the application is hidden completely from the user

Actual Multilevel Computer