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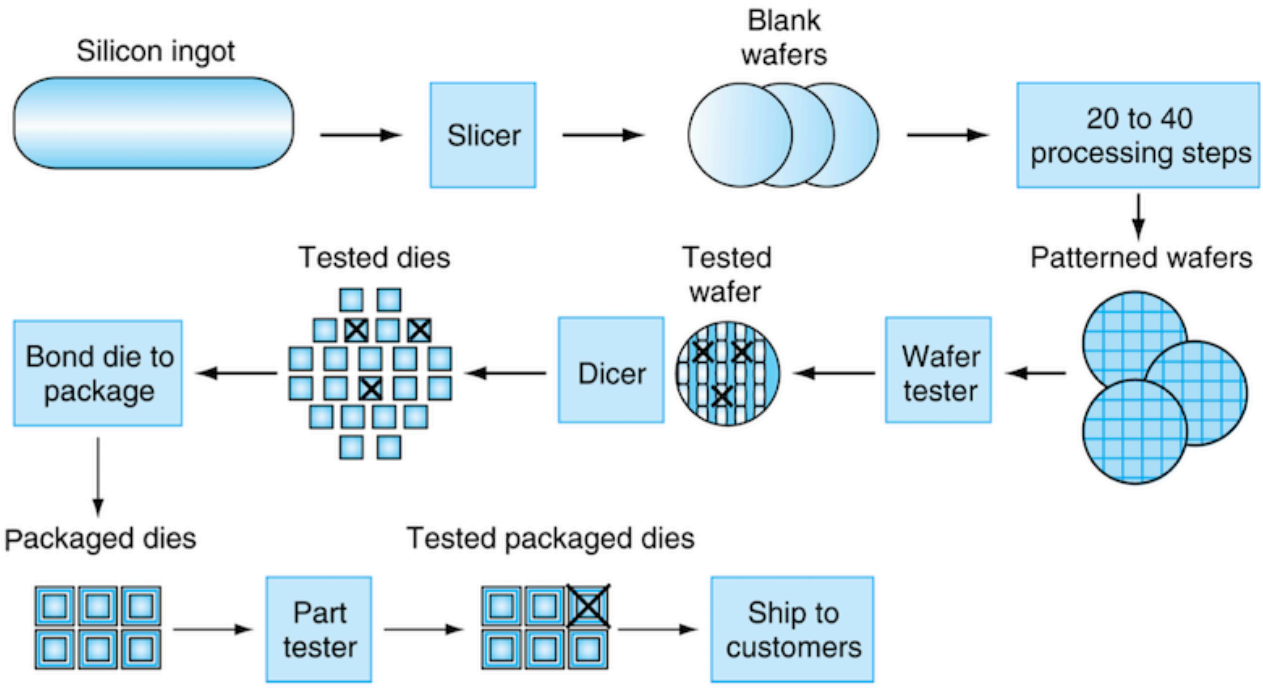
- Classes of computers: personal computers, server, supercomputers, embedded computers, personal mobile device (PMD), cloud computing.
- Eight great ideas in computer architecture: Moore's Law, abstraction, common case fast, parallelism, pipelining, prediction, hierarchy of memories, dependability via redundancy.
- Levels of program code: high-level language, assembly language, and machine language.
    - **Instructions**: collections of bits that the computer understands and obeys, can be thought of as numbers.
    - **Compilers** translates a program written in a high-level language into instructions that the hardware can execute.
    - **Assembler** translates a symbolic version of an instruction into the binary version.
- Classic components of a computer: I/O devices, memory, and processor (datapath and control).
    - Liquid crystal displays (LCDs) use an **active matrix** that has a tiny transistor switch at each pixel to precisely control current and make sharper images.
    - The computer hardware support for graphics consists mainly of a **raster refresh buffer**, or **frame buffer**, to store the bit map.
    - The **datapath** performs the arithmetic operations.
    - **Control** tells the datapath, memory, and I/O devices what to do according to the wishes of the instructions of the program.
    - The **memory** is built from **dynamic random access memory (DRAM)** chips.
    - **Cache memory**, a small fast memory that acts as a buffer for the DRAM memory, is built from **static random access memory (SRAM)**, which is faster but less dense, and hence more expensive, than DRAM.
    - **Instruction set architecture** is the interface between the hardware and the lowest-level software.
    - The combination of the basic instruction set and the operating system interface is called **application binary interface (ABI)**.
- A **transistor** is simply an on/off switch controlled by electricity. The **integrated circuit (IC)** combined dozens to hundreds of transistors into a single chip.
- The chip manufacturing process:



- The cost of an integrated circuit:
  - **Cost per die** = cost per wafer / (dies per wafer × yield)
  - **Dies per wafer** = wafer area / die area
  - **Yield** ≈ 1 / (1 + defects per area × die area / 2)^2
- Two aspects of performance:
  - **Response time** or **execution time**: the time between the start and completion of a task.
  - **Throughput** or **bandwidth**: the total amount of work done in a given time.
  - Decreasing response time almost always improves throughput.
  - In many real computer systems, changing either execution time or throughput often affects the other.
  - **Performance** = 1 / execution time