Integrated Circuits (ICs)

- Integrated Circuit (IC) = “chip”
  - Microprocessor
  - Application-Specific Instruction Set Processor (ASIP)
  - Application-Specific IC (ASIC)
- IC package contains:
  - silicon chip = “die”
  - pins

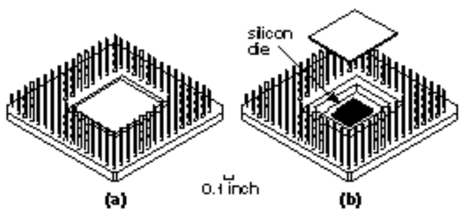

Figure from *Application-Specific Integrated Circuits*, Smith, Addison-Wesley, 1997

  - Package may have heat sink attached

Integrated Circuits (ICs) (cont.)

- A modern digital system is built out of a collection of integrated circuits (ICs), each of which is made up of gates
- ICs are typically classified based on the number of gates they contain
  - SSI (small scale integration) < 10
    - 4 nand gates
    - 4 or gates
    - 4 and gates
  - MSI (medium…) 10-100
    - simple adders, counters
    - multiplexers
    - flip-flops
  - LSI (large…) 100-10,000
    - Interface devices
    - Calculators
    - Digital clocks
    - Simple microprocessors

Integrated Circuits (ICs) (cont.)

- Classification, cont.
  - VLSI (very large…) >10,000
    - Modern microprocessors
      - 8086 = 29,000
      - i386DX = 275,000
      - i486DX = 1,200,000
      - Pentium = 3,100,000
      - Pentium MMX = 4,500,000
      - Pentium Pro = 5,500,000
      - Pentium II = 7,500,000
      - PA8000 = 3,900,000
      - (Data from "CPU & System Performance Info" at CPU Info Center — http://infopad.eecs.berkeley.edu/cic)
    - Application-specific integrated circuits (ASICs):
      - Dedicated controllers (portable telephone, CD player, auto dashboard)
      - Digital signal processors (image processing, multimedia)
    - Field-programmable logic devices (FPLDs)

Some Applications of ICs

- Home
  - Appliances, intercom, telephones, security system, garage door opener, answering machines, fax machines, home computers, TVs, cable TV tuner, VCR, camcorder, video games, cellular phones, sewing machines, cameras, exercise equipment, microwave oven
- Office
  - Telephones, computers, security system, fax machines, copier, printers, pagers
- Automobile
  - Trip computer, air bags, ABS, instrumentation, security system, transmission control, entertainment system, climate control, keyless entry, cellular phone, GPS

List from *Hardware/Software Codesign*, Giovanni De Micheli, 1996.

Logic Synthesis Design Flow

- Computer-aided design (CAD) tools for logic synthesis:
  - Schematic capture — draw and interconnect structural elements
  - Synthesis — produce gates, minimizing area, propagation delay, or power
  - Simulation and verification — make sure the design does what you think it does
- Logic synthesis in a larger context:
  - System synthesis — converts a task specification into processors, memories, ASICs, etc.
  - Behavioral (high-level)synthesis — converts an algorithmic description of behavior into registers, adders, ALUs, busses, multiplexors, etc.
  - Logic synthesis — converts a structural description into gates and flip-flops

Logic Synthesis Design Flow (cont.)

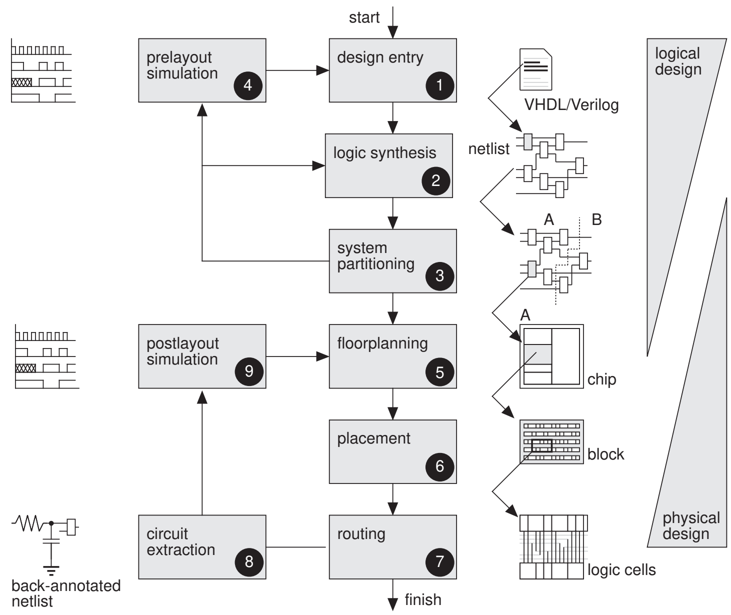

Figure from *Application-Specific Integrated Circuits*, Smith, Addison-Wesley, 1997

Overview of This Course: 4 Main Components

- Introduction to VLSI design
  - Brief introduction to ASICs, Review of logic design
  - Using CAD tools for schematic capture and simulation
- IC technology
  - Brief introduction to CMOS, Comparison of various FPLDs
  - Students work on Project 1 — paper design using Viewlogic's Workview Office
- FPGA-based design
- CAD algorithms
  - Some basic CAD algorithms
  - Students work on Project 2 — FPLD-based design using Altera's Max-PLUS II