Integrated Circuits (ICs)

- 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
    - 4-bit adder
    - 8-input 1-bit multiplexer
  - LSI (large…) 100-10,000
    - Simple microprocessors
    - interface devices
    - PLAs

PLAs

- A 2-level *and-or* structure is replicated many times in a programmable array called a *PLA* (*programmable logic array*)

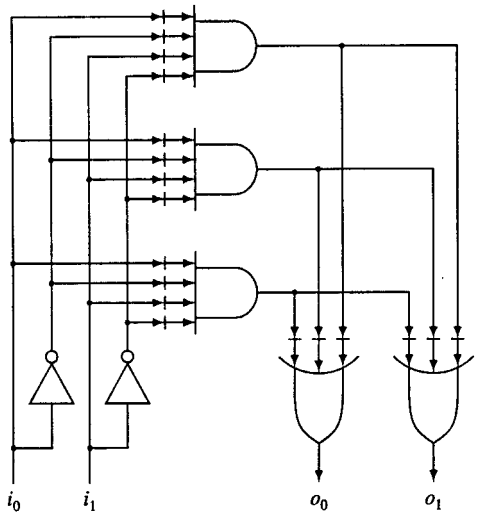

Diagram from *Computer Systems*, Maccabe, Irwin 1993

- This PLA has 2 inputs, 2 outputs, and can represent up to 3 product terms

PLAs (cont.)

- This is an *abstract* diagram of a PLA with 6 inputs, 4 outputs, which can represent up to 12 product terms

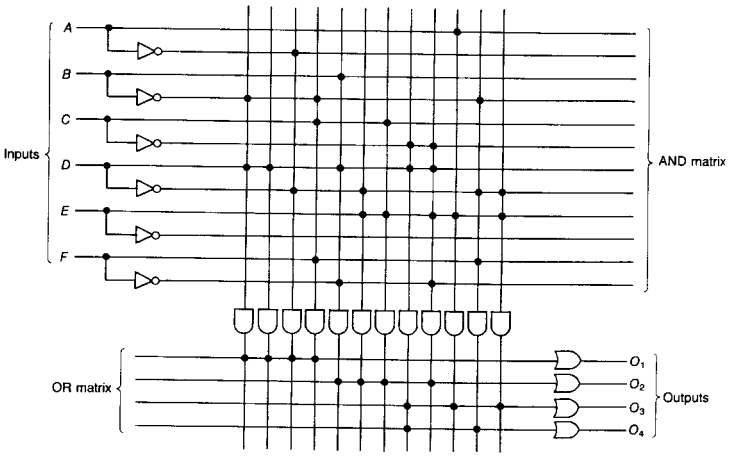

Diagram from *Digital Design*, Johnson & Karim, PWS-Kent 1987

- Try the Java KMap->PLA animation at http://tech-www.informatik.uni-hamburg.de/applets/kvd

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)

Field-Programmable Logic Device

- The next step beyond a PLA is the field-programmable logic device (FPLD), also called:
  - Field-programmable gate array (FPGA)
  - Field-programmable logic array (FPLA)
  - Complex programmable logic device (CPLD)
- Essentially, a FPLD is an nxn array of PLA, with interconnection between them
  - Connections to 4 nearest neighbors
    - "Longer" connections across chip
  - May include D (or more complex) flip-flops, to easily build sequential circuits
  - May include RAM
  - Can be "field-programmed" repeatedly
  - Available in different sizes up to 100,000 gates or so per device

The VLSI Design Process

- Design tasks:
  - 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
- 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

Homework #2 — Due 9/28/98 (Part 3/3)

5. Can the Boolean expression (A' + B)(C + D') be implemented using a PLA? Explain your answer.

(This is the last question on Homework #2)