Computer Science CSCI 355 Fall 2020

Digital Logic and Computer Organization

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Course Overview

- Objectives:
  - design, analyze and simulate digital circuits
  - understand the fundamentals of digital design
  - introduce microcomputer design fundamentals
  - overview concepts in design verification
- Prerequisite: MATH 123 and Min. "C" in each of CSCI 161 and CSCI 261
- No face-to-face instruction
- Course Outline and Information Web Pages:
  - http://csci.viu.ca/~pwalsh/teaching/355/Info-Sheet.html
  - http://csci.viu.ca/~pwalsh/teaching/355/355.html

Hardware/Software Resources

- Student IT Requirements:
  - high-speed Internet connection
  - computer with audio and video capabilities

- Laboratory (Physics Room 115):
  - lab contains 17 cub machines running Linux
  - there is no physical access to Room 115
  - access the cubs using ssh and/or PuTTY
  - Verilog simulation replaces bread-boarding

- Key Internet Applications:
  - VIUOnline (Zoom)
  - VIUTube (Video Portal)
  - VIULearn (Assessment)

Course Delivery

- Lectures:
  - lecture videos posted to VIUTube
- Labs:
  - pre-lab videos posted to VIUTube
  - scheduled lab time is reserved for Q and A and student evaluation using Zoom
  - no labs the first week of term

Course Delivery cont.

- Office Hours:
  - reserved for answering email questions
- Quizzes:
  - administered through VIULearn
  - dates TBD
- Lab Exercises:
  - see course page for task specification
  - Zoom for on-line evaluation
  - git for off-line evaluation

Student Attendance for CSCI 355

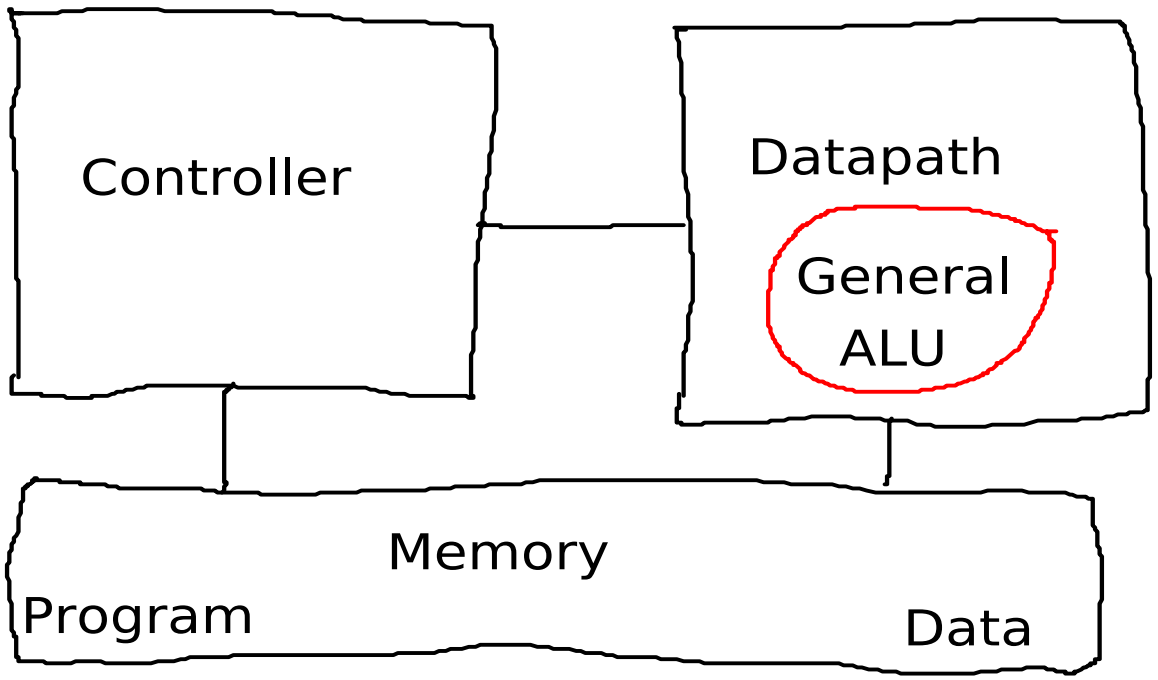
- On-Campus
  - you are NOT required to be on-campus
- Off-Campus
  - you are expected to attend your scheduled labs by Zoom
  - you must submit your lab task solutions by Zoom or git prior to assigned deadlines
  - you must complete quizzes through VIULearn prior to assigned deadlines
  - my goal is to answer all email questions during my office hours
  - you may view all other course work-products at your leisure

Key Computer System Technologies

- Processor
  - architecture of the computing engine
- Integrated Circuit (IC)
  - implementation (organization) of the computing engine
- Design
  - techniques (algorithms and analysis)
  - computer aided design (CAD) tools

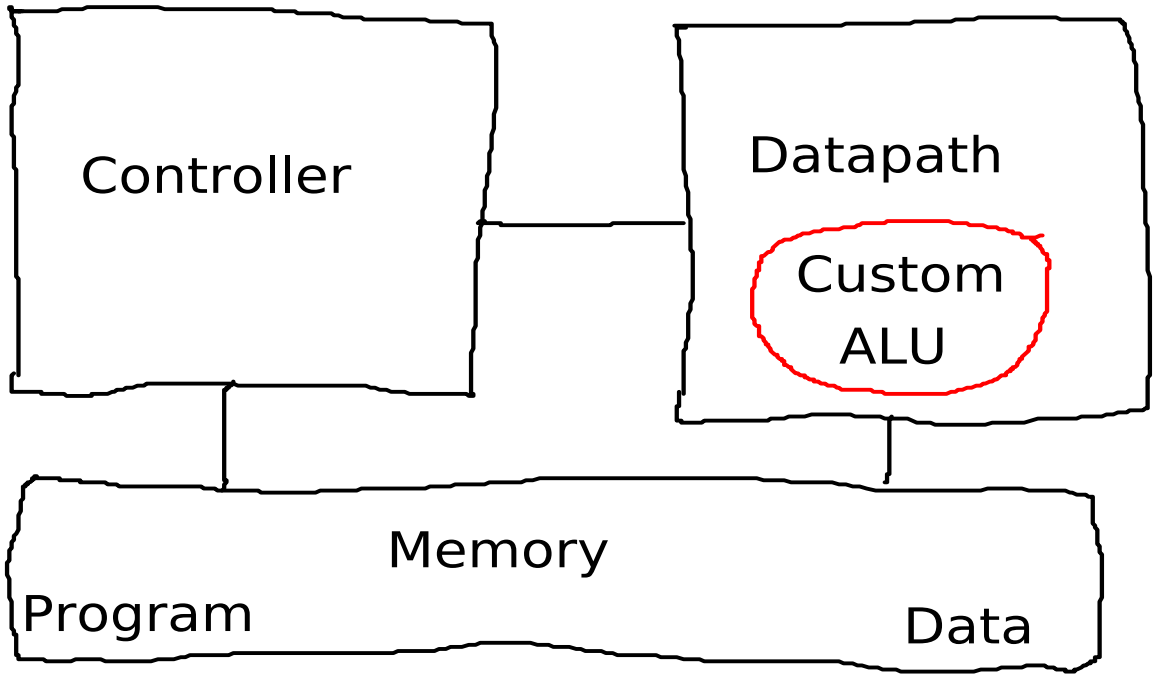
Processor Technology

- General Purpose Processor



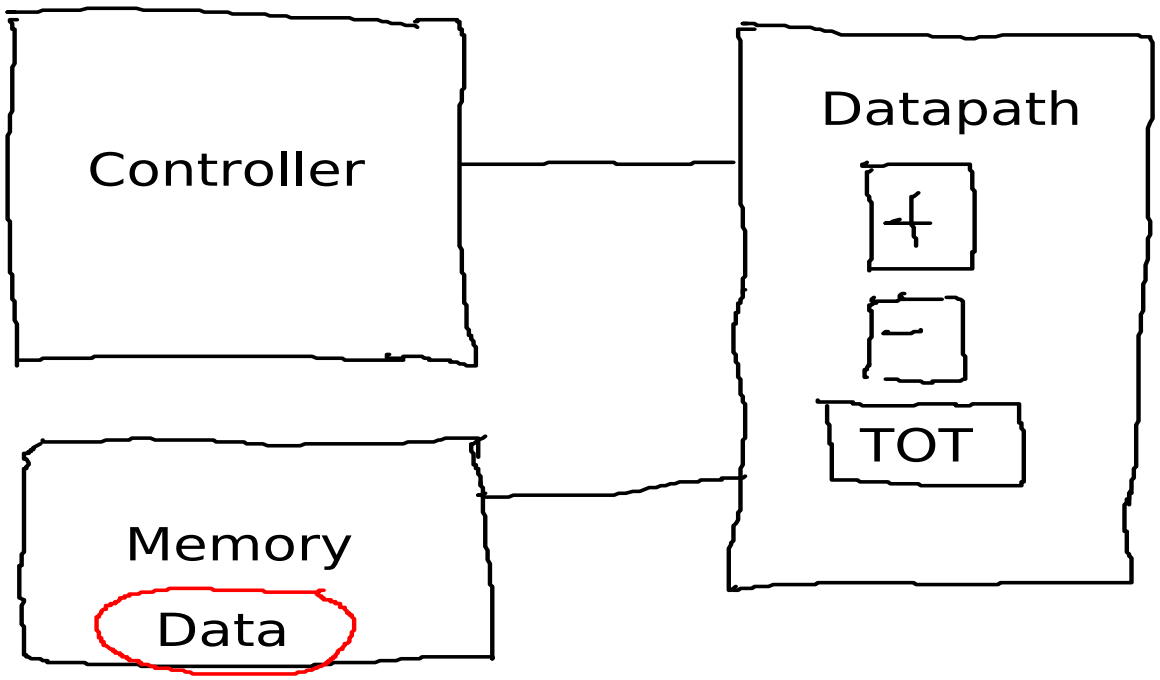
Processor Technology cont.

- Application Specific Processor



Processor Technology cont.

- Single Purpose Processor

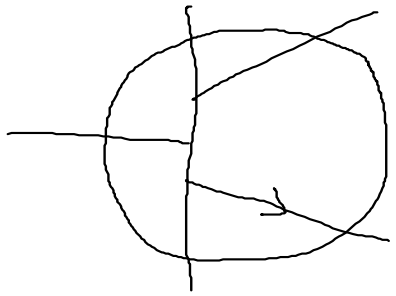


IC Technology - Standard Chips

- Small Scale Integration (SSI)
  - less than 10 gates
  - e.g. inverter
- Medium Scale Integration (MSI)
  - 10 to 100 gates
  - e.g. adder
- Large Scale Integration (LSI)
  - 100 to 5000 gates
  - e.g. small cpu
- Very Large Scale Integration (VLSI)
  - >= 5,000 gates
  - e.g. microprocessor

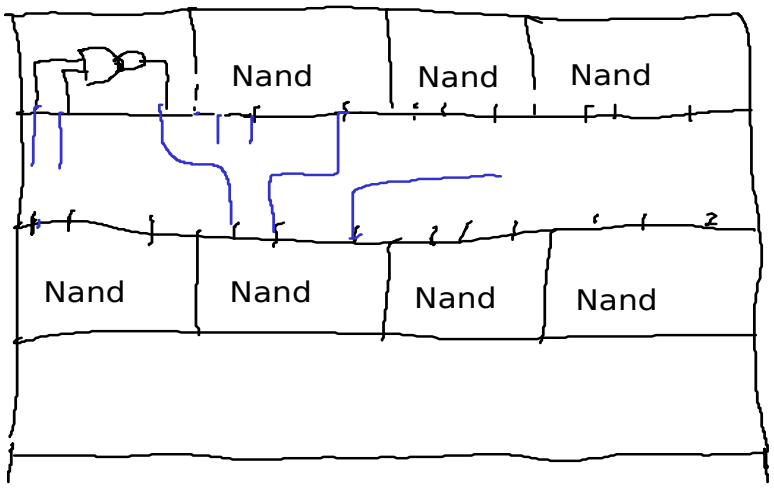
IC Technology - VLSI Flavours

- Full-Custom
  - designed from scratch
  - high performance and high densities
  - long design time
  - >= 4 weeks from design ready to first part
  - suitable for high volume IC production
  - e.g. Pentium (x86)



IC Technology - VLSI Flavours cont.

- Semi-Custom
  - designed from pre-existing components
  - slower and cheaper than full-custom
  - 1 to 2 weeks from design ready to first part
  - suitable for small volume IC production
  - e.g. Gate Array



IC Technology - VLSI Flavours cont.

- Field Programmable
  - designed from libraries
  - slower and cheaper than semi-custom
  - design and test flexibility
  - < 1 day from design ready to first part
  - suitable for very small IC production
  - e.g. Field Programmable GA (FPGA)

Design Technology

- Capture
  - schematic
  - hardware description language (HDL)
    e.g. VHDL and Verilog
- Minimization and Synthesis
  - combinational circuits
    e.g. datapath components
  - sequential circuits
    e.g. control unit as a finite state machine (FSM)
- Testing
  - behaviour
  - timing
  - manufacture

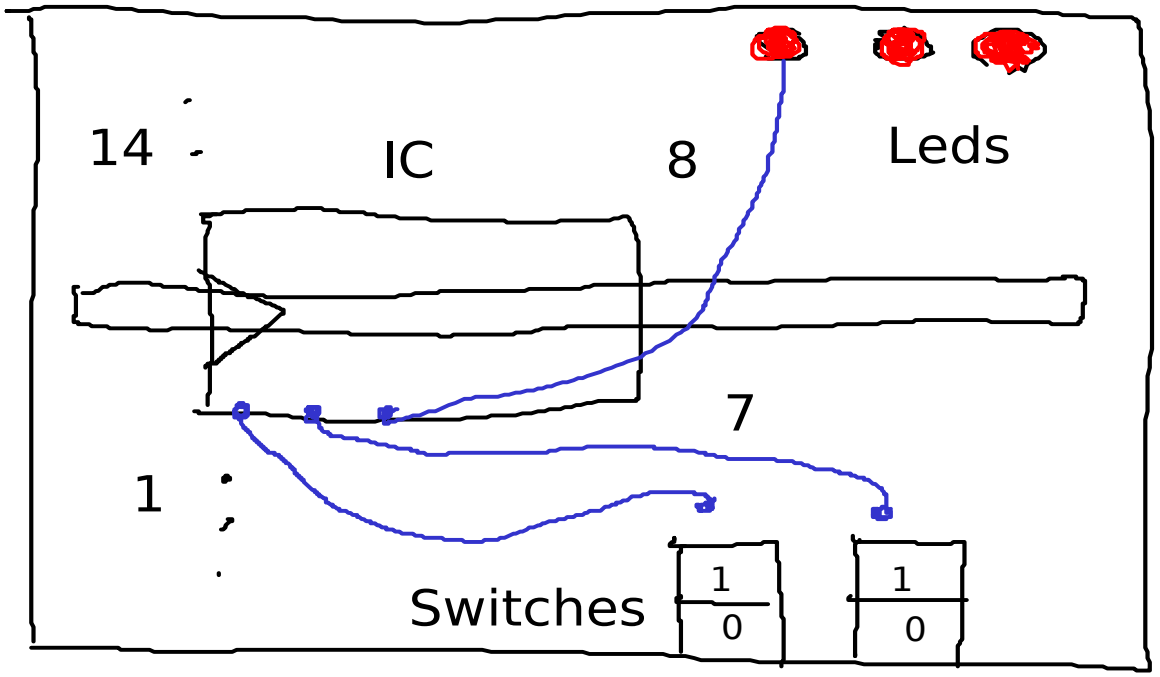
Rules Of Thumb

- Advances in design technology lags advances in processor and IC technologies

- Product success in influenced by time-to-market
  - first to market will succeed
  - second to market will survive
  - third to market will fail

Implementation Options

- Breadboarding

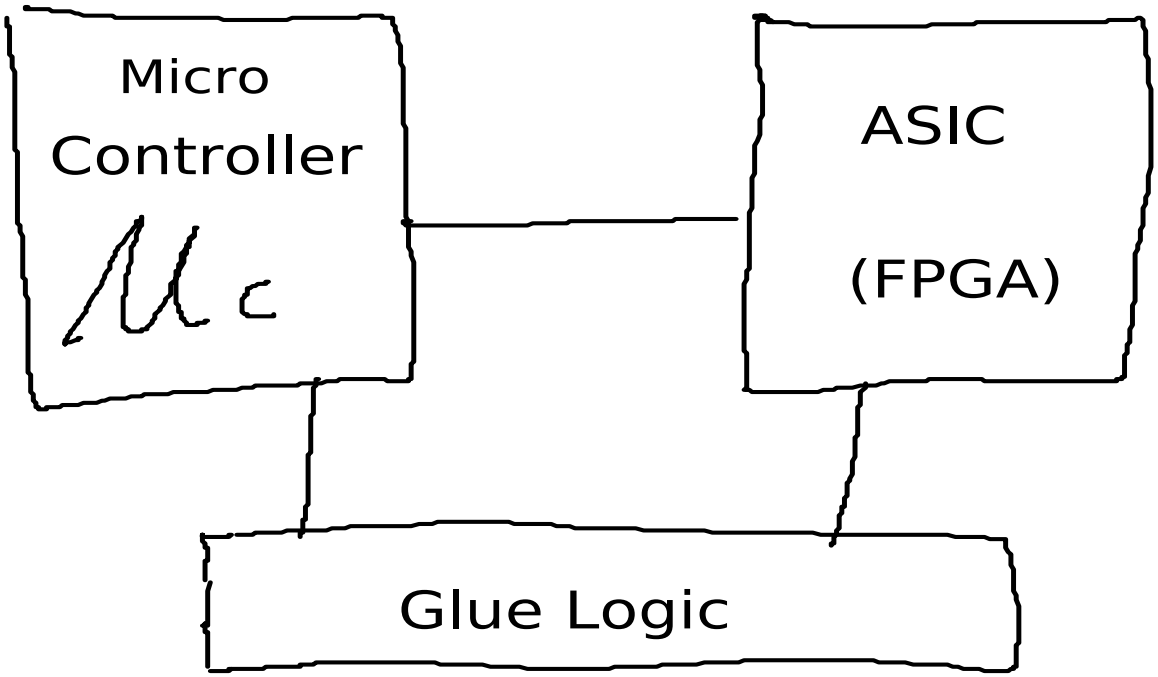


Implementation Options cont.

- Microcontroller
  - no fundamental difference between what hardware and software can implement
  - any processor technology can be mapped to any IC technology
  - any choice between hardware and software for a particular function is a tradeoff among design metrics such as
    - performance
    - power
    - size
    - non recurring engineering costs (NRE)
    - time to market

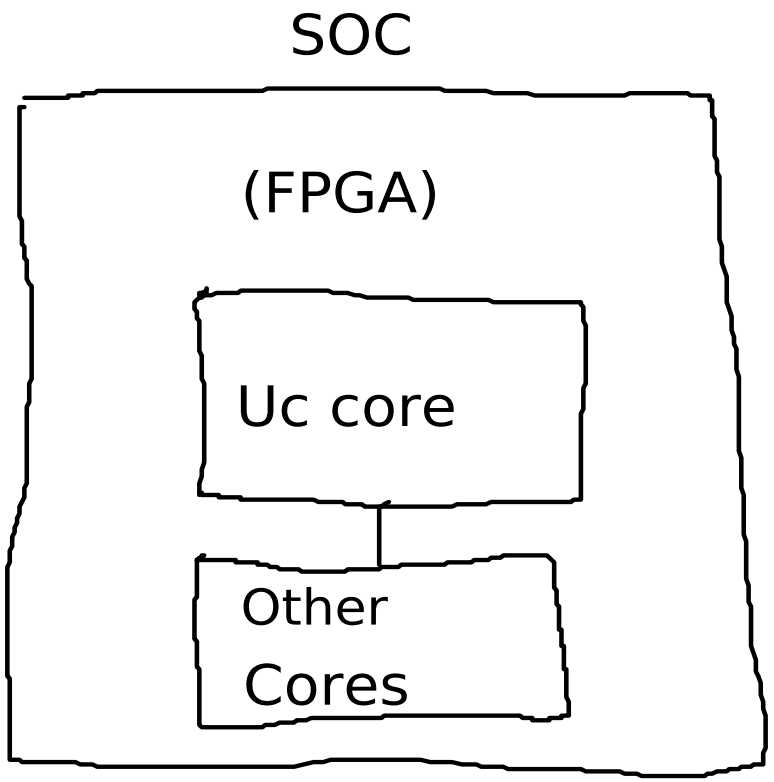
Implementation Options cont.

- Codesign
  - application specific IC (ASIC)



Implementation Options cont.

- System On A Chip (SOC)



355 Circuit Design Flow