ITM1010
Computer and Communication Technologies

Lecture #8
Part I: Introduction to Computer Technologies
Sequential Circuits and Introduction to Computer Organization
REGISTERS

- A group of latches or flip-flops used to store, transfer, or shift data

- Serial Shift Register
  - Data is clocked into the register bit by bit
RING COUNTER

- The counter is a shift register that has its output connected back to its own input.
JONHSON COUNTER

- Each bit is toggled in turn
- Mod-6
  - 000
  - 100
  - 110
  - 111
  - 011
  - 001
  - 000

- With its unique bit pattern, any sequence can be detected with a 2-input gate
MULTIPLY/DIVIDE REGISTER

- A left shift operation multiplies a binary number by a factor of 2
- A right shift operation divides a binary number by a factor of 2
Pseudo-random sequence generator

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<tr>
<th>$Q_A$</th>
<th>$Q_B$</th>
<th>$Q_C$</th>
<th>$Q_D$</th>
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INVALID CONDITION
A brief overview of computer programming
Programs

- Programs are instructions to make a computer perform a task.
- The part of the computer that actually executes the “program” is the microprocessor or central processing unit, CPU.
- CPU is a digital component that decodes and execute instructions.
Types of Instructions

- **Data Transfer Instructions**: Move data from one place to another including
  - REGISTERS, MEMORIES, I/O DEVICES

- **Data Operation Instructions**: Perform operations using one or two data and store the result. Operations include
  - ARITHMETIC, LOGIC, SHIFT

- **Program Control Instructions**: Change the sequence of operations (consecutive instruction flow) conditionally or non-conditionally

- **Others**
  - INTERRUPT
  - HALT
Instruction codes

- A binary pattern in a specific format. Example of a microprocessor which has a simple instruction set:

<table>
<thead>
<tr>
<th>opcode</th>
<th>operand #1</th>
<th>operand #2</th>
<th>operand #3</th>
<th>Instruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 bits</td>
<td>2 bits</td>
<td>2 bits</td>
<td></td>
<td>ADD A, B, C (A = B + C) 1010 00 01 10</td>
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</tbody>
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<th>operand #2</th>
<th>Instruction</th>
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<tbody>
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<td>4 bits</td>
<td>2 bits</td>
<td></td>
<td>MOVE A, B (A = B) 1000 00 01</td>
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<td></td>
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<td></td>
<td>ADD A, C (A = A + C) 1010 00 10</td>
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<td>4 bits</td>
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<tr>
<td></td>
<td>LOAD B  (Acc = B) 0000 01</td>
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<td></td>
<td>ADD C   (Acc = Acc + C) 1010 10</td>
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<td>STORE A (A = Acc) 0001 00</td>
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Levels of programming languages

- High-level – platform independent
  - C++
  - JAVA
  - FORTRAN

- Assembly Language – microprocessor dependent
  - Instruction mnemonics representing individual instruction codes

- Machine Language – microprocessor dependent
  - Actual instruction codes
Compiling

High-level language program (C++, Fortran, etc.)

- Compiler for Pentium Windows PC
  - Other Pentium object files
  - Pentium object code
  - Pentium linker
    - Pentium executable file
    - Windows Pentium PC

- Compiler for G4 Power Mac Computer
  - Other G4 object files
  - G4 object code
  - G4 linker
    - G4 executable file
    - G4 Power Mac

- Compiler for SPARC UNIX workstation
  - Other SPARC object files
  - SPARC object code
  - SPARC linker
    - SPARC executable file
    - SPARC UNIX workstation
Assembling

- Assembly language program for processor X
- Assembler for processor X
- Processor X object code
- Other processor X object files
- Process X linker
- Processor X executable file
- Computer with processor X
Java Compilation process

1. Java applet source code
2. Java compiler
3. Byte code
4. Java VM for Windows Pentium PC
   - Windows Pentium PC
5. Java VM for G4 Power Mac
   - G4 Power Mac
6. Java VM for SPARC UNIX workstation
   - SPARC Unix workstation
Computer Organization

What is inside a computer?
Motherboard

Sometimes called the system board or main board, the motherboard is the main circuit board of a PC. The motherboard typically contains the processor (or CPU), BIOS (basic input/output system), memory, mass storage interfaces, serial and parallel ports, expansion slots, and all the controllers required to communicate with standard peripheral devices, such as the display screen, mouse, keyboard and disk drive.
ASUS P4B533 Motherboard

1. +12V connector
2. ATX (AT eXtended) 12V connector
3. DIP switches for CPU external frequency
4. CPU socket
5. North bridge controller (MCH)
6. DDR (Double Data Rate) DRAM sockets
7. Floppy disk connector
8. ATX power supply
9. South bridge controller (ICH4)
10. IDE connectors
11. DIP switches for CPU frequency multiple
12. Flash EEPROM (4MB)
13. ASUS ASIC for voltage & IRQ control
14. Standby power LED (Light Emitting Diode)
15. Audio controller
16. PCI slots
17. Super I/O controller for floppy, PP, SP etc
18. AGP warning LED
19. AGP slot

DIP: Dual In-line Package
Electrically Erasable Programable Read Only Memory
Interrupt ReQuest

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20. PS/2 (Personal System 2) mouse port
21. Parallel port (0.15 – 2MBPS)
22. Audio line in jack
23. Audio line out jack
24. Microphone jack

25. USB 2.0 ports 1 and 2
26. Serial port (0.23MBPS)
27. USB 2.0 port 3 and 4
28. PS/2 keyboard port

**USB 1.1**: 1.5 - 12MBPS

**FireWire** is a cross-platform implementation of the high-speed serial data bus - defined by IEEE Standard 1394: 400MBPS – 1600MBPS.

**USB 2.0**: 1.5 - 480MBPS
Intel 850 Chipset Family for P4 CPUs

- Memory Controller Hub
- I/O Controller Hub 2
- Basic Input Output System
- Universal Serial Bus
- Local Area Network
- Accelerated Graphics Port
- Advanced Technology
- AT Attachment
- Integrated Drive Electronics
- Peripheral Component Interconnect
- Random Access Memory
- Dynamic RAM
- Rambus DRAM
- Read Only Memory
- Central Processing Unit
- Graphics Processing Unit
Generic Computer Organization

CPU

Address Bus

Data Bus

Control Bus

Memory Subsystem

I/O Subsystem

I/O Device

... I/O Device
System Buses

- **Address Bus**
  - Specify a memory location for access by CPU

- **Data Bus**
  - Data channel between CPU and other components

- **Control Bus**
  - A collection of individual control signals
  - e.g. a signal to indicate whether a data is to be read into or written out of CPU

A system may have a hierarchy of buses. For example, it may use its address, data, and control buses to access memory, and an I/O controller. The I/O controller, in turn, may access all I/O devices using a second bus, often called an I/O bus or a local bus.
  - e.g. PCI bus