Systems Design and Programming

Instructor:
Chintan Patel

Text:

Supplementary text:

Lab Text:
Bob Neveln, 'Linux Assembly Language Programming', Prentice Hall PTR.

Web:
http://www.cs.umbc.edu/~cpatel2
Course Description

This course covers:

- Intel 80x86 assembly language.
- Architecture of the Intel microprocessors.
- Hardware configuration and control of:
  - Common microprocessor support chips, e.g. Interrupt controller.
  - Popular I/O devices, e.g. UART, sound card.

Prerequisites:

- Experience with the C programming language.
- Some familiarity with Operating Systems, such as Windows.
- Experience with the Linux operating system.

Projects:

- Assembly Language Programming
- Hardware Project
80x86 Evolution

4004:
- 4-bit microprocessor.
- 4KB main memory.
- 45 instructions.
- PMOS technology.
- 50 KIPS

8008: (1971)
- 8-bit version of 4004.
- 16KB main memory.
- 48 instructions.
- NMOS technology.

8080: (1973)
- 8-bit microprocessor.
- 64KB main memory.
- 2 microseconds clock cycle time; 500,000 instructions/sec.
- 10X faster than 8008.
80x86 Evolution

**8085: (1977)**
- 8-bit microprocessor - upgraded version of the 8080.
- 64KB main memory.
- **1.3 microseconds** clock cycle time; 769,230 instructions/sec.
- 246 instructions.
- Intel sold 100 million copies of this 8-bit microprocessor.

**8086: (1978) 8088 (1979)**
- **16-bit** microprocessor.
- 1MB main memory.
- 2.5 MIPS (400 ns).
- 4- or 6-byte instruction cache.
- Other improvements included more registers and additional instructions.

**80286: (1983)**
- 16-bit microprocessor very similar in instruction set to the 8086.
- **16MB** main memory.
- 4.0 MIPS (250 ns/8MHz).
80x86 Evolution

80386: (1986)
- **32-bit** microprocessor.
- **4GB** main memory.
- 12-33MHz.
- Memory management unit added.
- Variations: DX, EX, SL, SLC (cache) and SX.
  - 80386SX: 16MB through a 16-bit data bus and 24 bit address bus.

80486: (1989)
- 32-bit microprocessor, 32-bit data bus and 32-bit address bus.
- 4GB main memory.
- 20-50MHz. Later at 66 and 100MHz
- Incorporated an 80386-like microprocessor, 80387-like floating point coprocessor and an 8K byte cache on one package.
- About half of the instructions executed in 1 clock instead of 2 on the 386.
- Variations: SX, DX2, DX4.
  - DX2: Double clocked version:
    - 66MHz clock cycle time with memory transfers at 33MHz.
80x86 Evolution

Pentium: (1993)

- 32-bit microprocessor, 64-bit data bus and 32-bit address bus.
- 4GB main memory.
- 60, 66, 90MHz.
  - 1-and-1/2 100MHz version.
  - Double clocked 120 and 133MHz versions.
  - Fastest version is the 233MHz (3-and-1/2 clocked version).
- 16KB L1 cache (split instruction/data: 8KB each).
- Memory transfers at 66MHz (instead of 33MHz).
- Dual integer processors.

80486DX

- Co-Processor
- CPU
- 8K L1 cache

Pentium

- Co-Processor
- Int CPU1
- Int CPU2
- 8K L1 cache
- 66 MHz
- Memory
**80x86 Evolution**

**Pentium Pro: (1995)**
- 32-bit microprocessor, 64-bit data bus and 36-bit address bus.
- **64GB** main memory.
- Starts at 150MHz.
- 16KB L1 cache (split instruction/data: 8KB each).
- **256KB L2 cache.**
- Memory transfers at 66MHz.
- **3 integer processors.**

![Diagram of Pentium Pro]

- Int CPU₁
- Int CPU₂
- Int CPU₃

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80x86 Evolution

**Pentium II: (1997)**
- 32-bit microprocessor, 64-bit data bus and 36-bit address bus.
- 64GB main memory.
- Starts at 266MHz.
- **32KB** split instruction/data L1 caches (16KB each).
- **Module integrated 512KB L2 cache (133MHz).**
- Memory transfers at 66MHz to **100MHz** (1998).
80x86 Evolution

Pentium III: (1999)

- 32-bit microprocessor, 64-bit data bus and 36-bit address bus.
- 64GB main memory.
- 800MHz and above.
- 32KB split instruction/data L1 caches (16KB each).
- **On-chip 256KB L2 cache (at-speed).**
- Memory transfers 100MHz to **133MHz**.
- **Dual Independent Bus** (simultaneous L2 and system memory access).

![Diagram of Pentium III architecture](https://via.placeholder.com/150)
80x86 Evolution

**Pentium IV: (2002)**
- 1.4 to 1.9GHz and the latest at 3.20 GHz and 3.46GHz (Hyper-Threaded)!
- 1MB/512KB/256KB L2 cache.
- 800 MHz (about 6.4GB/s)/533 MHz (4.3 GB/s)/ 400MHz (3.2 GB/s) system bus.
- 1066 MHz front side bus just available.
- Specialized for streaming video, game and DVD applications (144 new SIMD 128-bit instructions).
- 0.13um, more than 55 million transistors.
- Newer ones are in 90nm transistors, >125 million possible

**Pentium D, Core 2 Duo, Core Duo, Core 2 Extreme Edition: (2005-2006)**
- Dual processing cores
- Upto 4MB L2 cache and 1066 MHz FSB
- 65 nm transistors

Refer to the following URL for more details:
http://www.intel.com/design/