Systems Design and Programming

Instructor:

    Chintan Patel

Text:

    Barry B. Brey, 'The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor, Pentium II, Pentium III and Pentium 4, Architecture, Programming and Interfacing' Sixth Edition, Prentice Hall (2003).

Supplementary text:

    Muhammad Ali Mazidi and Janice Gillispie Mazidi, 'The 80x86 IBM PC and Compatible Computers (Volumes I&II), Assembly Language, Design, and Interfacing', Third Edition, Prentice Hall (2000).

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.
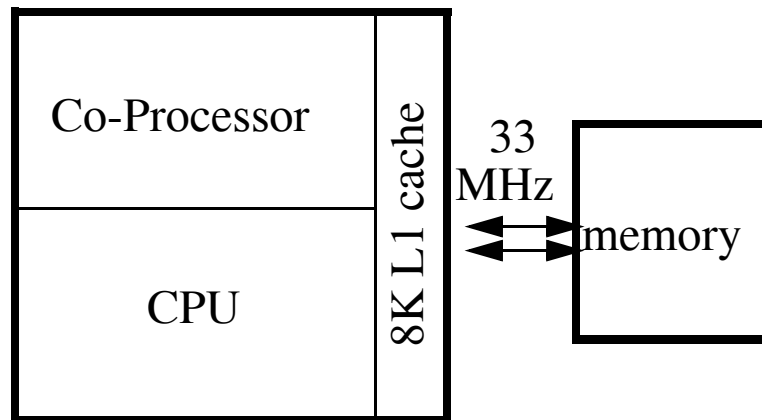- Variations: SX, DX2, DX4.

    DX2: Double clocked version:

    66MHz clock cycle time with memory transfers at 33MHz.
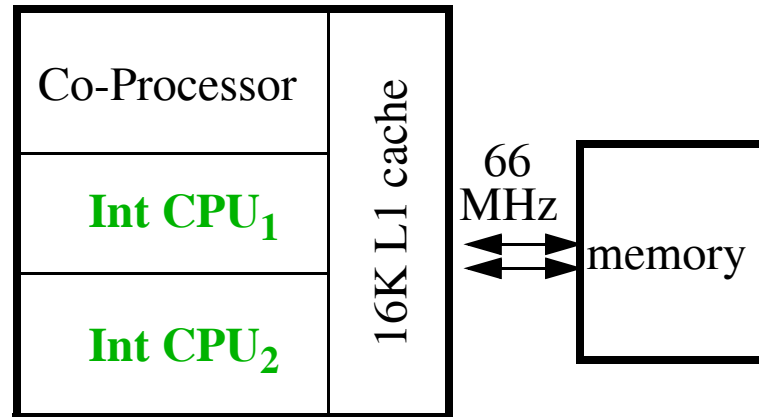
80x86 Evolution

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 | 33 MHz | memory

Pentium

Co-Processor | Int CPU$_1$ | Int CPU$_2$ | 16K L1 cache | 66 MHz | memory
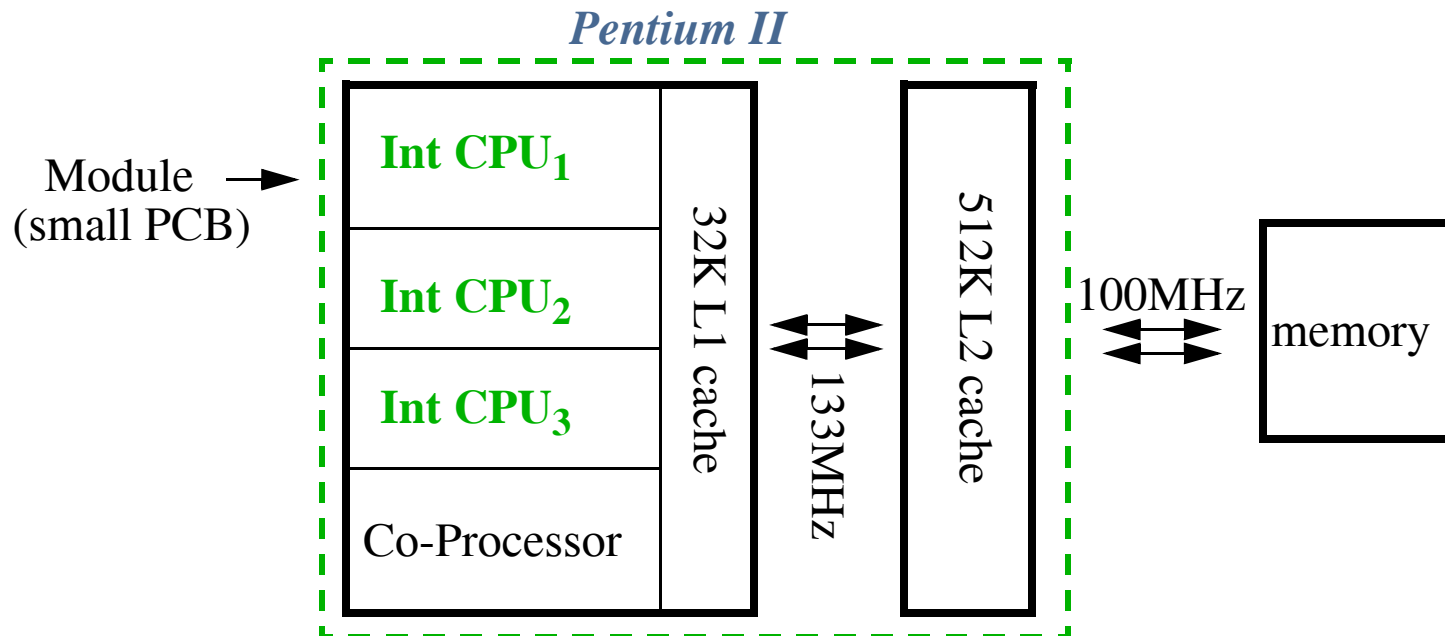
80x86 Evolution

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.**

Pentium Pro

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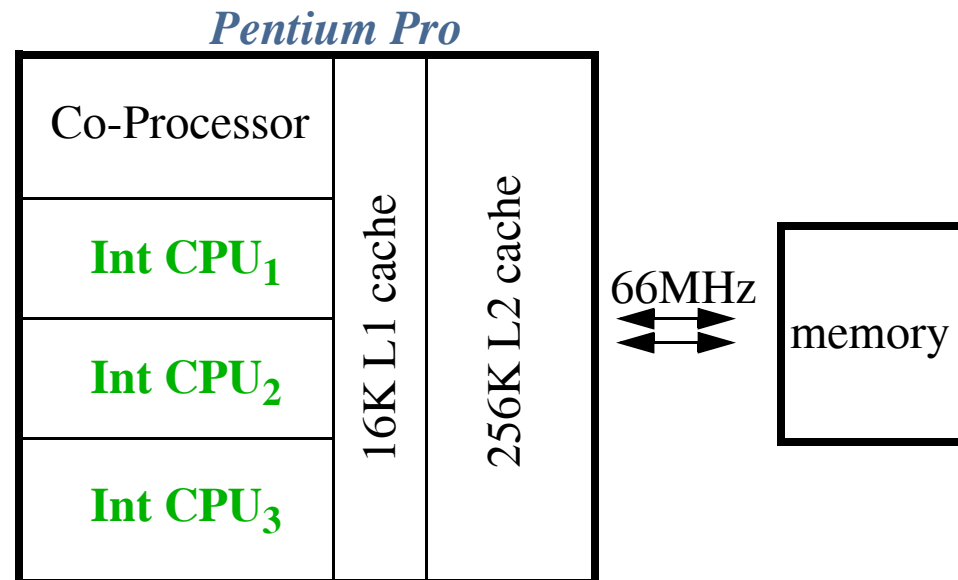
80x86 Evolution

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).

Pentium II

Module
(small PCB) →

Int CPU$_1$

Int CPU$_2$

Int CPU$_3$

Co-Processor

32K L1 cache

133MHz

512K L2 cache

100MHz

memory

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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).**

Pentium III

Co-Processor	16K L1 cache	256K L2 cache		
Int CPU$_1$			133MHz	memory
Int CPU$_2$				
Int CPU$_3$				
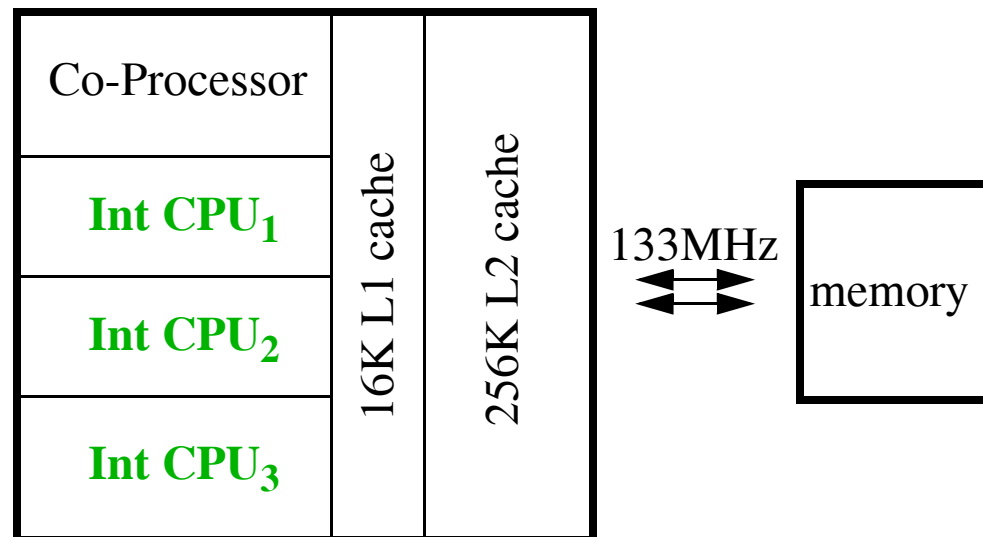
80x86 Evolution

Pentium IV: (2002)

- 1.4 to 1.9GHz and the latest at 3.20 GHz and 3.46GHz (Hyper-Threading)!
- 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, 60nm transistors.
- Newer ones are in 90nm transistors, more than 125 million possible.

  Refer to the following URL for more details:
  http://www.intel.com/design/pentium4/documentation.htm