

University of Dhaka

Department of Computer Science and Engineering

CSE-3103: Microprocessor & Microcontroller

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Assignment: 2

Name: Comparison of Microprocessors (8086, 80286, 80386, 80486, Pentium,
Pentium Pro, Dual Core, Core 2 Duo, Core 2 Quad, i3, i5 & i7)

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Features of 8086

The most prominent features of an 8086 microprocessor are as follows –

- It has an instruction queue, which is capable of storing six instruction bytes from the memory resulting in faster processing.
- It was the first 16-bit processor having 16-bit ALU, 16-bit registers, internal data bus, and 16-bit external data bus resulting in faster processing.
- It is available in 3 versions based on the frequency of operation –
 - 8086 → 5MHz
 - 8086-2 → 8MHz
 - (c)8086-1 → 10 MHz
- It uses two stages of pipelining, i.e. Fetch Stage and Execute Stage, which improves performance.
- Fetch stage can prefetch up to 6 bytes of instructions and stores them in the queue.
- Execute stage executes these instructions.
- It has 256 vectored interrupts.
- It consists of 29,000 transistors.

Comparison between 8085 & 8086 Microprocessor

- **Size** – 8085 is 8-bit microprocessor, whereas 8086 is 16-bit microprocessor.
- **Address Bus** – 8085 has 16-bit address bus while 8086 has 20-bit address bus.
- **Memory** – 8085 can access up to 64Kb, whereas 8086 can access up to 1 Mb of memory.
- **Instruction** – 8085 doesn't have an instruction queue, whereas 8086 has an instruction queue.
- **Pipelining** – 8085 doesn't support a pipelined architecture while 8086 supports a pipelined architecture.
- **I/O** – 8085 can address $2^8 = 256$ I/O's, whereas 8086 can access $2^{16} = 65,536$ I/O's.
- **Cost** – The cost of 8085 is low whereas that of 8086 is high.

Features of 80286

The 80286 microprocessor is an advanced version of the 8086 microprocessor that is designed for multi user and multitasking environments

- The 80286 addresses 16 M Byte of physical memory and 1G Bytes of virtual memory by using its memory-management system
- The 80286 is basically an 8086 that is optimized to execute instructions in fewer clocking periods than the 8086
- Like the 80186, the 80286 doesn't incorporate internal peripherals; instead it contains a memory management unit (MMU)
- The 80286 operates in both the real and protected modes
- In the real mode, the 80286 addresses a 1MByte memory address space and is virtually identical to 8086
- In the protected mode, the 80286 addresses a 16MByte memory space
- The clock is provided by the 82284 clock generator, and the system control signals are provided by the 82288 system bus controller
- The 80286 contains the same instructions except for a handful of additional instructions that control the memory-management unit.

Features of 80386

The 80386 microprocessor is an enhanced version of the 80286 microprocessor and includes a memory-management unit is enhanced to provide memory paging

- The 80386 also includes 32-bit extended registers and a 32-bit address and data bus
- The 80386 has a physical memory size of 4GBytes that can be addressed as a virtual memory with up to 64TBytes
- The 80386 is operated in the pipelined mode, it sends the address of the next instruction or memory data to the memory system prior to completing the execution of the current instruction
- This allows the memory system to begin fetching the next instruction or data before the current is completed
- This increases access time, thus reducing the speed of the memory
- The I/O structure of the 80386 is almost identical to the 80286, except that I/O can be inhibited when the 80386 is operated in the protected mode through the I/O bit protection map
- The register set of the 80386 contains extended versions of the registers introduced on the 80286 microprocessor. These extended registers include EAX, EBX, ECX, EDX, EBP, ESP, EDI, ESI, EIP and EFLAGS
- The instruction set of the 80386 is enhanced to include instructions that address the 32-bit extended register set

- Interrupts, in the 80386 microprocessor, have been expanded to include additional predefined interrupts in the interrupt vector table
- The 80386 memory manager is similar to the 80286, except the physical addresses generated by the MMU are 32 bits wide instead of 24-bits
- The 80386 is also capable of paging
- The 80386 is operated in the real mode (i.e. 8086 mode) when it is reset
- The real mode allows the microprocessor to address data in the first 1MByte of memory
- In the protected mode, 80386 addresses any location in its 4G bytes of physical address space

Features of 80486

The 80486 microprocessor is an improved version of the 80386 microprocessor that contains an 8K-byte cache and an 80387 arithmetic co-processor; it executes many instructions in one clocking period

- The 80486 microprocessor executes a few new instructions that control the internal cache memory
- A new feature found in the 80486 in the BIST (builtin self-test) that tests the microprocessor, coprocessor, and cache at reset time
- If the 80486 passes the test, EAX contains a zero
- Additional test registers are added to the 80486 to allow the cache memory to be tested
- These new test registers are TR3 (cache data), TR4 (cache status), and TR5 (cache control)

Features of Pentium

- The Pentium microprocessor is almost identical to the earlier 80386 and 80486 microprocessors
- The main difference is that the Pentium has been modified internally to contain a dual cache (instruction and data) and a dual integer unit
- The Pentium also operates at a higher clock speed of 66 MHz
- The data bus on the Pentium is 64 – bits wide and contains eight byte-wide memory banks selected with bank enable signals
- Memory access time, without wait states, is only about 18 ns in the 66 MHz Pentium
- The superscalar structure of the Pentium contains three independent processing units: a floating point processor and two integer processing units

- A new mode of operation called the System Memory Management (SMM) mode has been added to the Pentium. It is intended for high-level system functions such as power management and security
- The Built-in Self-test (BIST) allows the Pentium to be tested when power is first applied to the system
- Allows 4MByte memory pages instead of the 4KByte pages

Features of Pentium Pro

The Pentium Pro is an enhanced version of the Pentium microprocessor that contains not only the level 1 caches found inside the Pentium, but the level 2 cache of 256 K or 512K found on most main boards

- The Pentium Pro operates using the same 66 MHz bus speed as the Pentium and the 80486
- It uses an internal clock generator to multiply the bus speed by various factors to obtain higher internal execution speeds
- The only significant software difference between the Pentium Pro and earlier microprocessors is the addition of FCMOV and CMOV instructions
- The only hardware difference between the Pentium Pro and earlier microprocessors is the addition of 2M paging and four extra address lines that allow access to a memory address space of 64G Bytes

Features of Dual Core

Generally, dual core processor integrates *two processors* in a single chip. Physically, it seems one CPU but in the inside it has two CPU cores. Each processor core has its own cache and an interface that connects to the system bus (FSB). This type of processor executes two complete instructions at the same time. It is like having two computers processors combined in single CPU chip. This enables the processors to share the work load between the two cores and enhance processing capacity.

- Integrates two processors in a single package
- Support *hyper threading technology* (not in all dual core Intel CPU's)
- Capable of 64-bit instructions
- Multitasking and multithreading capability (Read more below)
- Ideal for multitasking.

- Consumes less energy
- Its design is well tested and reliable

Features of Core 2 Duo

The Core 2 brand refers to Intel's x86/x86-64 microprocessors with the Core microarchitecture targeted at the consumer and business markets (except servers) above Pentium. The Core 2 solo branch covered single-core CPUs for notebook computers, Core 2 Duo – dual-core CPUs for both desktop and notebook computers, Core 2 Quad – quad-core CPUs for both desktop and notebook computers, and Core 2 Extreme – dual-core and quad-core CPUs for both desktop and notebook computers.

- 64bit support, Dual core processor with shared level 2 cache, Execute Disable Bit, Partially Intel Virtualization Technology (VT), Socket M (starting from Santa Rosa socket P), 291 million transistors
- With an Intel® Core™2 Duo processor you will get performance-rich technologies, including up to 6MB of shared L2 cache, up to 1333 MHz Front Side Bus, plus these additional Intel® technologies built in: Level-1 and Level-2 caches are the cache memories in a computer Much faster than RAM L1 is built on the microprocessor chip itself. L2 is a separate chip L2 cache is much larger than L1 cache
- provides greater multitasking performance by combining two independent processor cores in one physical package
- The Core 2 Duo processors are produced in 65 nm (and later in 45nm), contain 14 stages pipelines and 2-4 MB level 2 cache (depending on the model)

Features of Core 2 Quad

- Larger L2 memory cache (up to 6 MB for dual-core CPUs and up to 12 MB for quad-core CPUs).
- Split load caches.
- Faster buses (up to 1,600 MHz).
- New SSE4 instruction set (which brings 47 new SSE instructions to the CPU).
- Deep Power Down Technology (only on mobile CPUs).
- Enhanced Intel Dynamic Acceleration Technology (only on mobile CPUs).
- Fast Radix-16 Divider (FPU enhancement).

- Super Shuffle engine (FPU enhancement).
- Enhanced Virtualization Technology (between 25% and 75% performance improvement on virtual machine transition time).

Features of Core i3

Developed and manufactured by Intel, the Core i3 is a dual-core computer processor, available for use in both desktop and laptop computers. It is one of three types of processors in the "i" series (also called the Intel Core family of processors).

- The Core i3 processor is available in multiple speeds, ranging from 1.30 GHz up to 3.50 GHz, and features either 3 MB or 4 MB of cache.
- It utilizes either the LGA 1150 or LGA 1155 socket on a motherboard. Core i3 processors are most often found as dual core, having two cores. However, a select few high-end Core i3 processors are quad core, featuring four cores.
- The most common type of RAM used with a Core i3 processor is DDR3 1333 or DDR3 1600.

Features of Core i5

Developed and manufactured by Intel, the Core i5 is a computer processor, available as dual-core or quad-core. It can be used in both desktop and laptop computers, and is one of three types of processors in the "i" series (also called the Intel Core family of processors).

- The Core i5 processor is available in multiple speeds, ranging from 1.90 GHz up to 3.80 GHz, and it features 3 MB, 4 MB or 6 MB of cache.
- It utilizes either the LGA 1150 or LGA 1155 socket on a motherboard. Core i5 processors are most often found as quad core, having four cores. However, a select few high-end Core i5 processors feature six cores.
- The most common type of RAM used with a Core i5 processor is DDR3 1333 or DDR3 1600, however, higher performance RAM can be used as well (if the motherboard supports it).

Power usage varies for the Core i5 processors:

- Slower speeds (1.90 GHz to 2.30 GHz) use 11.5 W of power
- Medium speeds (2.60 GHz to 3.10 GHz) use 15 W, 25 W, 28 W or 37 W of power

- Faster speeds (3.20 GHz to 3.80 GHz) use 35 W, 37 W, 45 W, 47 W, 65 W or 84 W of power

Features of Core i7

Core i7 is first processor using Nehalem Micro- architecture and a processor with faster, intelligent, multi-core technology. Examples are- i7-5550u, i7-5557u, i7-5500u etc.

- New Platform Architecture
- Higher-Performance Multiprocessor Systems with QPI
- CPU Performance Boost via Intel Turbo Boost Technology
- Improved Cache Latency with Smart L3 Cache
- Optimized Multithreaded Performance through Hyper-Threading
- Higher Data-Throughput via PCI Express 2.0 and DDR3 Memory Interface
- Improved Virtualization Performance
- Remote Management of Networked Systems with Intel Active Management Technology (AMT)
- Multitasking, for running multiple programs at the same time
- Multithreading applications
- Extreme 3D gaming
- Creating professional movies and editing graphical tasks
- More than enough for basic tasks such as word processing, internet browsing and e-mail