Chapter 01: Introduction

Lesson 05:

Evolution of Computers Part 5– Fourth generation computers

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Objective

- Understand how electronic computers evolved during the Fourth generation of computers
- IBM PC and Pentium
- Greatly reduced power dissipation, space and computation time compared to 3rd generation

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Fourth generation Electronic Systems

- 1975 onwards
- Very Large scale Transistor Integrated circuits (VLSIs) evolved for electronic circuits of microprocessors, RAMs and ROMs
- Very Very Large scale Transistor Integrated circuits (VVLSIs) evolved for electronic circuits of microprocessors, RAMs and ROMs
- Fourth generation computer systems

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VLSI s and VVLSIs

- IC with 100000–1000000 electronic logic gates a very large scale integrated (VLSI) circuit
- IC with 1000000–10000000 electronic logic gates a very large scale integrated (VVLSI) circuit

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The 4th generation Computer

- A microprocessor consisting of CPU, cache, and bus interfacing unit
- A computer consisting of the microprocessor, main memory, interrupt handler, timers, video monitor, mouse, keyboard, pen drives, hard disks, CD drives, floppy diskettes, and Ethernet card

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4th Generation of Computers

Examples—

- IBM PC 1980 onwards
- Pentium 1992 onwards

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4th Generation Computer

- Single VLSI CPU chip as microprocessor
- Cache memory
- Large number of registers of 16- or 32-bit each with a microprocessor
- Large-sized main memory chips (2, 8, 16, or 128 MB chips) as main memory

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4th Generation Computer

- A large number of executable opcodes (distinct instruction)
- Addition and subtraction, multiplication and division on fixed point and floating point numbers and on multiple data types with multiple word sizes (8-bit byte, 16-bit short, 32-bit word or 64-bit double word)

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4th Generation Computer

- The concepts of pipelining, super-scaling and multi-core execution units for execution of instructions
- Pipeline-based execution
- Processing time of the execution unit operating at faster clock rate in case of multiple instructions at the pipeline, each at a distinct logic circuit stages

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4th Generation Computer

- Programming in assembly and as well as in many high-level languages: for example, COBOL, PASCAL, C, C++, Java, J2EE, .net, ...
- Operating systems and software-reusable objects and modules
- 32-bit and 64-bit fixed as well as variable length 8-bit to 64-bit instruction formats

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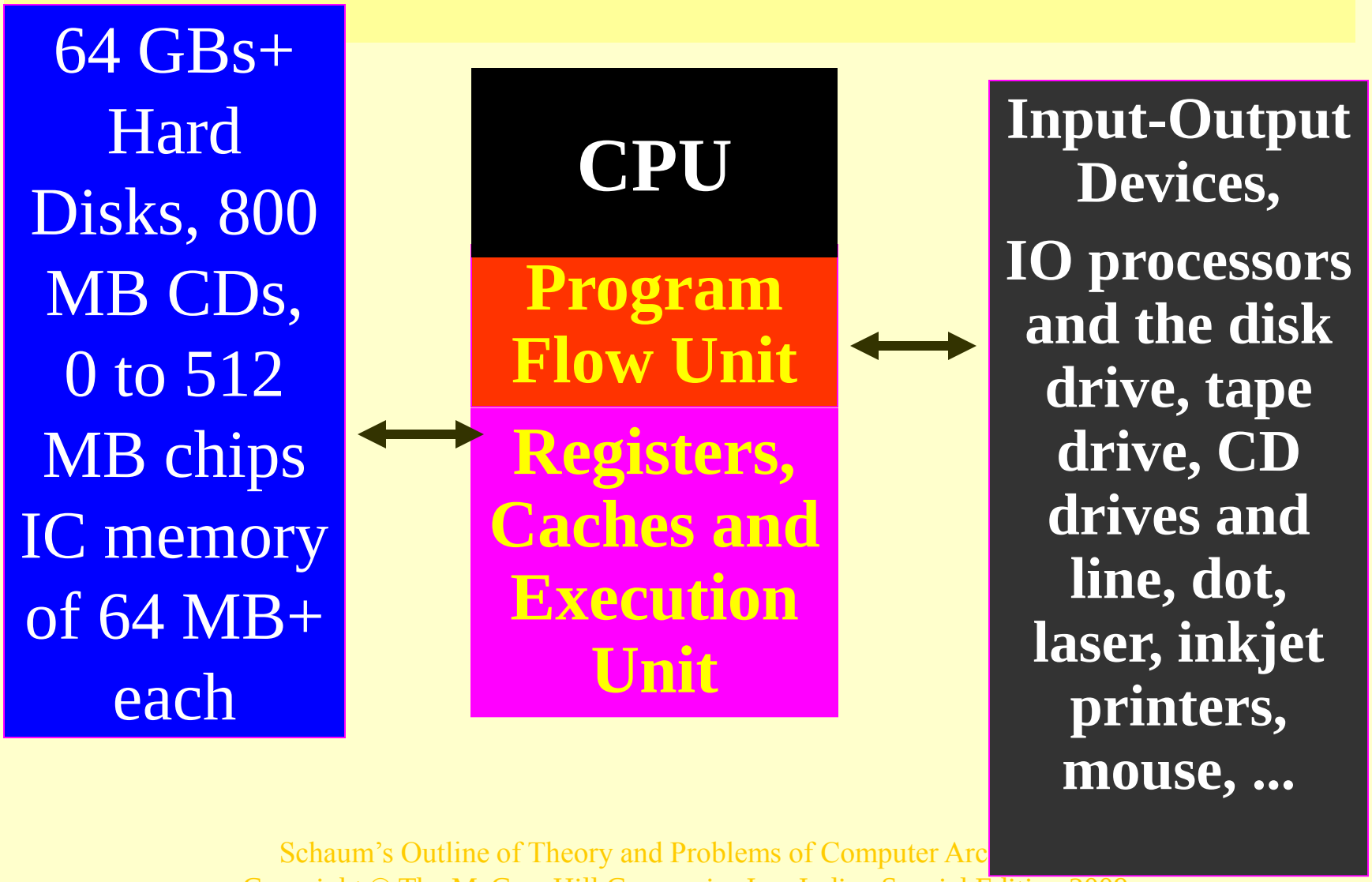
4th Generation Computer — Architecture



Schaum's Outline of Theory and Problems of Computer Arc
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CPU Execution Unit

- Registers, Index Registers, Segment Registers, Flag Registers,
- Control memory (Missing in RISCs and Stack Organised Computers)
- Pipelines
- Parallel Pipelines

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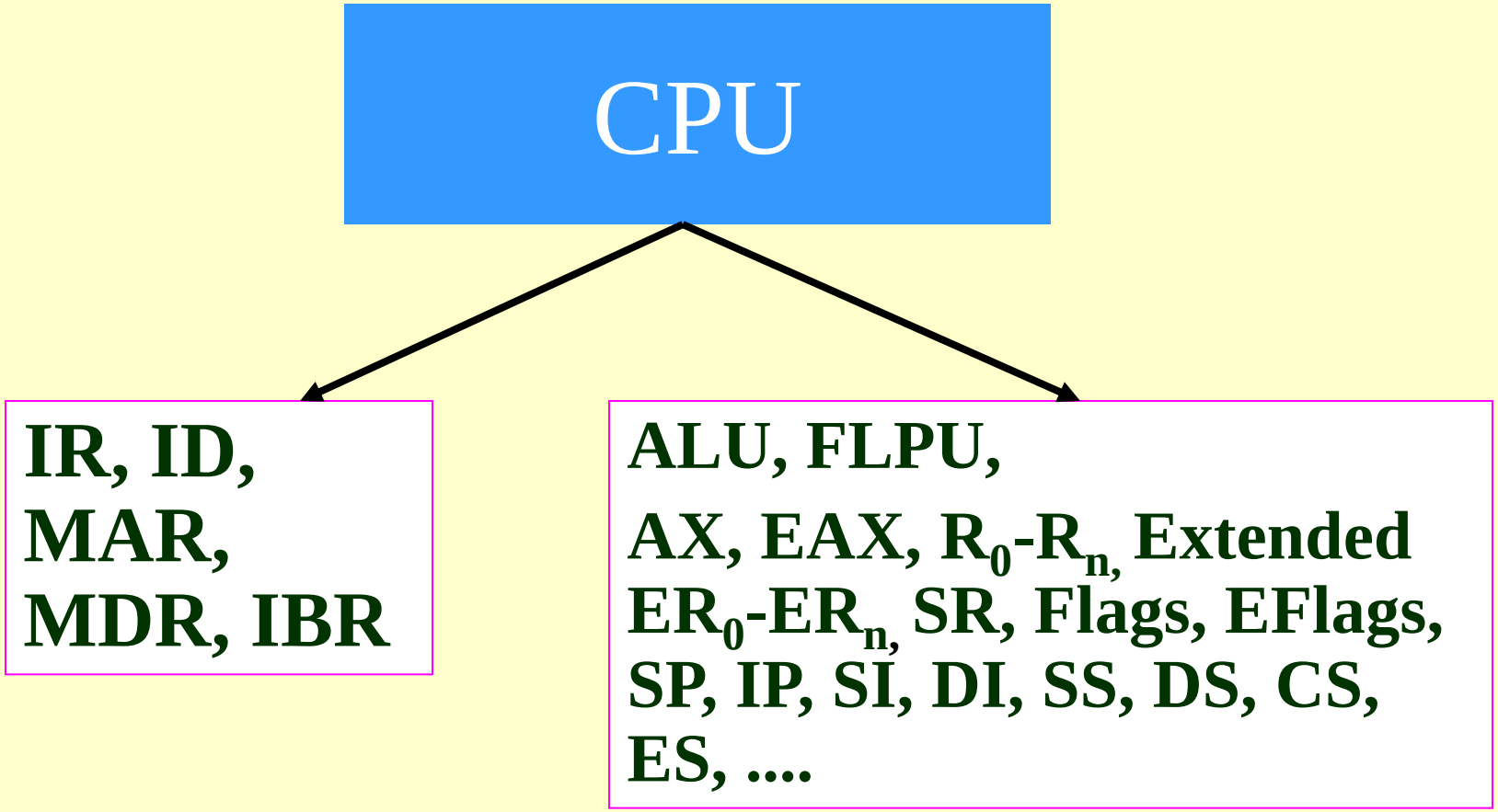
CPU Registers



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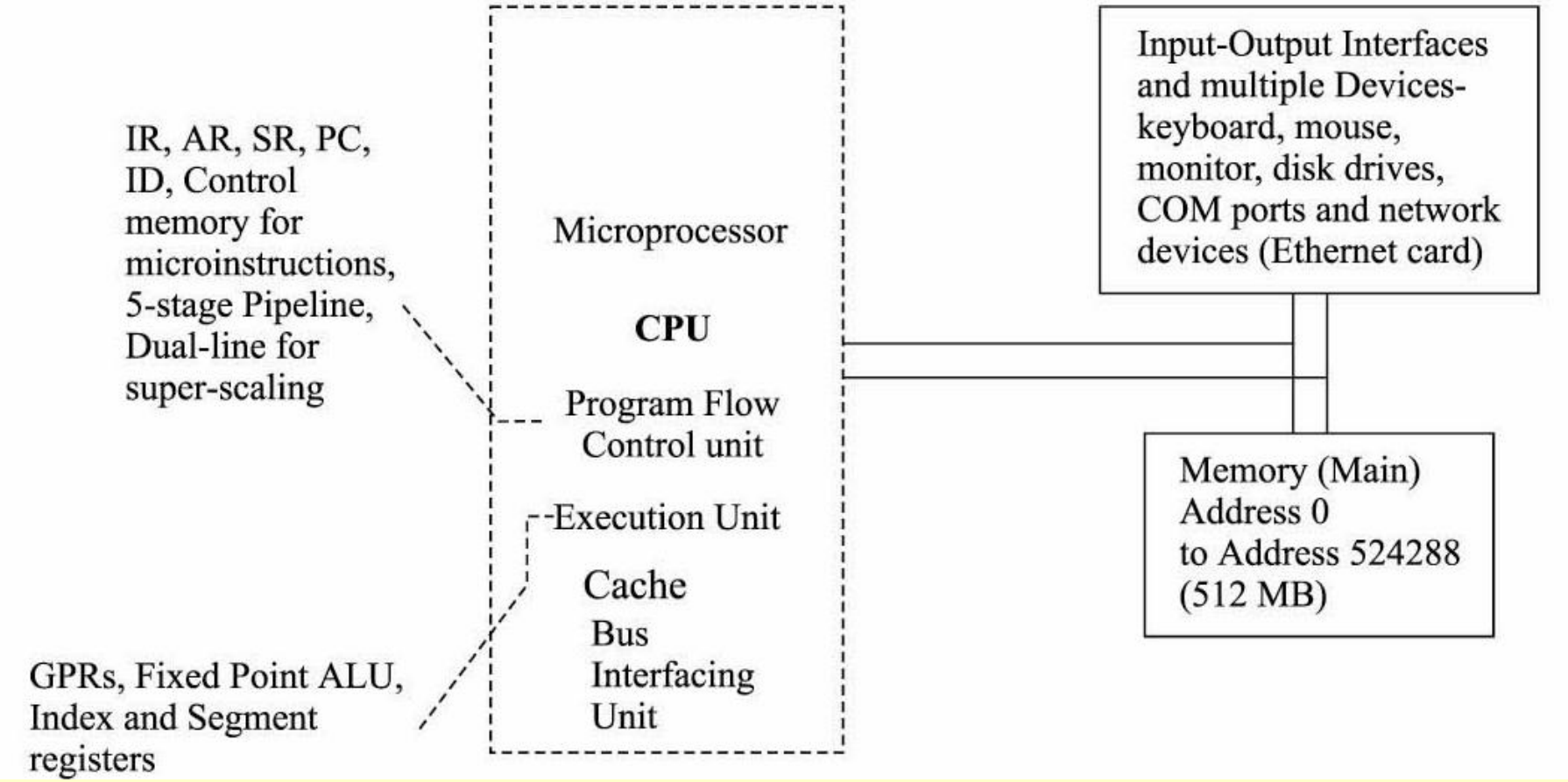
IBM PC



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VLSI IC reduction in circuit space requirements

- Assume— a VLSI IC needs 0.04×0.03 cm^2 silicon area for 1000 transistors
- There will be a reduction in circuit space requirements by a factor of $(0.4/0.04) \times (0.3/0.03) \times 1000 = 100000$ times = 0.1 million over a single transistor used in second generation computers

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Greatly Reduced Power Dissipation

- Assume─ an IC operated at 5V and 4 μA
- Now assume a 0.13 μm VVLSI gates operate at 2V and 10 nA
- Reduction in power dissipation by factor of 20 μW/20 nW = 1000 times/gate

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Greatly Enhanced Main Memory Needs

- Large programs need 512 M words, each of 32-bits
- Number of transistors required for 4 M words where each word is of 32 bits is $4 \times 4 \times 1024 \times 1024 \times 32 = 16M \times 32 = 512$ M
- An LSI IC stores 1024 bits; therefore, the number of LSI ICs needed for 16 MB main memory will equal $512M/ (1K \times 4) = 128$ K

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Greatly Reduced Memory ICs Size

- A VVLSI chip introduced in 1992 stored 16 Mbit in a single chip
- Therefore, for 16MB/(16 Mbit) = 8, only 8 chips were needed in 1992
- A memory stick in digital camera 8 GB in 2008

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Greatly Reduced Space

- Let an LSI IC have 1000 transistors in 0.4 cm × 0.4 cm silicon area
- Assume a 1 cm^2 silicon chip has 625 M/cm^2 number of transistors (1992)
- Assume further that a VVLSI IC has 0.04 cm × 0.04 cm area for 1M transistors. [1μm = 1 m/1000000]

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Greatly Reduced Space

- VVLSI IC will reduce silicon space requirement by a factor of (1000000/1000) × 10 × 10 = 100000 times over the third generation IC

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Greatly Reduced Space

- 0.13 μm Very-Very Large Scale Integrated Chips
- Silicon area 0.13 μm × 0.13 μm = 0.13 × 0.13 × 10^{-4} × 10^{-4} cm^2 = 1.69 × 10^{-10} cm^2
- Density = [1/(1.69 × 10^{-10})] cm^{-2} = ~ 6000 M/cm^2

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Greatly Reduced Computational Time

- Assume─ a transistor circuit within an LSI IC switches current from state 0 to 1 in 0.1 μs and a transistor circuit within in VLSI IC in 0.001 μs
- An enhancement in processing speed by a factor of 0.1 μs /0.001 μs, 100 times over the speed of a third generation computer

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Greatly Reduced Computational Time

- Assume a VVLSI IC transistor switches 0 to 1 in 0.1 ns = 0.0001 μs
- An enhancement in processing speed by a factor of 0.1 μs /0.0001 μs, equal to 1000 times over the speed of a third generation computer

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Computational Performance Enhancement five-stage pipeline

- Improves computer performance ~ 5 times, as five instructions can be processed in the pipeline with execution unit operating at 5 times faster clock cycle at each instance when executing the instructions

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Computational Performance Enhancement four parallel pipelines

- Improves computer performance ~ 4 times, as four instructions can be processed in each pipeline with execution units in each

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Computational Performance Enhancement Multi-cores

- This improves computer performance ~ 4 times, as four instructions can be processed in each core with separate execution units in each

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Summary

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We learnt

- Fourth Generation computers
- VLSI and VVLSI based computers
- IBM PC and Pentiums
- Uses VLSI main RAM memories and caches
- Reduced power dissipation 1000 plus times over 3rd generation
- Reduced space 1000 times
- Reduced computational time 100 plus times
- Pipelines, parallel pipelines and multi-cores

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End of Lesson 05:

Evolution of Computers Part 5– Fourth generation computers

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