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Week 2

Chapter 2: x86 Processor Architecture

Class 5,6

What's Next

- General Concepts
- IA-32 Processor Architecture
- **IA-32 Memory Management**
- 64-Bit Processors
- Components of an IA-32 Microcomputer
- Input-Output System

IA-32 Memory Management

- Real-address mode
- Calculating linear addresses
- Protected mode
- Multi-segment model
- Paging
- Virtual Machine Manager (VMM)

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Protected Mode (1 of 2)

- 4 GB addressable RAM
 - (00000000 to FFFFFFFFh)
- Each program assigned a memory partition which is protected from other programs
- Designed for multitasking
- Supported by Linux & MS-Windows

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64-Bit Processors

- 64-Bit Operation Modes
 - Compatibility mode – can run existing 16-bit and 32-bit applications (Windows supports only 32-bit apps in this mode)
 - 64-bit mode – Windows 64 uses this
- Basic Execution Environment
 - addresses can be 64 bits (48 bits, in practice)
 - 16 64-bit general purpose registers
 - 64-bit instruction pointer named RIP

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64-Bit General Purpose Registers

- 32-bit general purpose registers:
 - EAX, EBX, ECX, EDX, EDI, ESI, EBP, ESP, R8D, R9D, R10D, R11D, R12D, R13D, R14D, R15D
- 64-bit general purpose registers:
 - RAX, RBX, RCX, RDX, RDI, RSI, RBP, RSP, R8, R9, R10, R11, R12, R13, R14, R15

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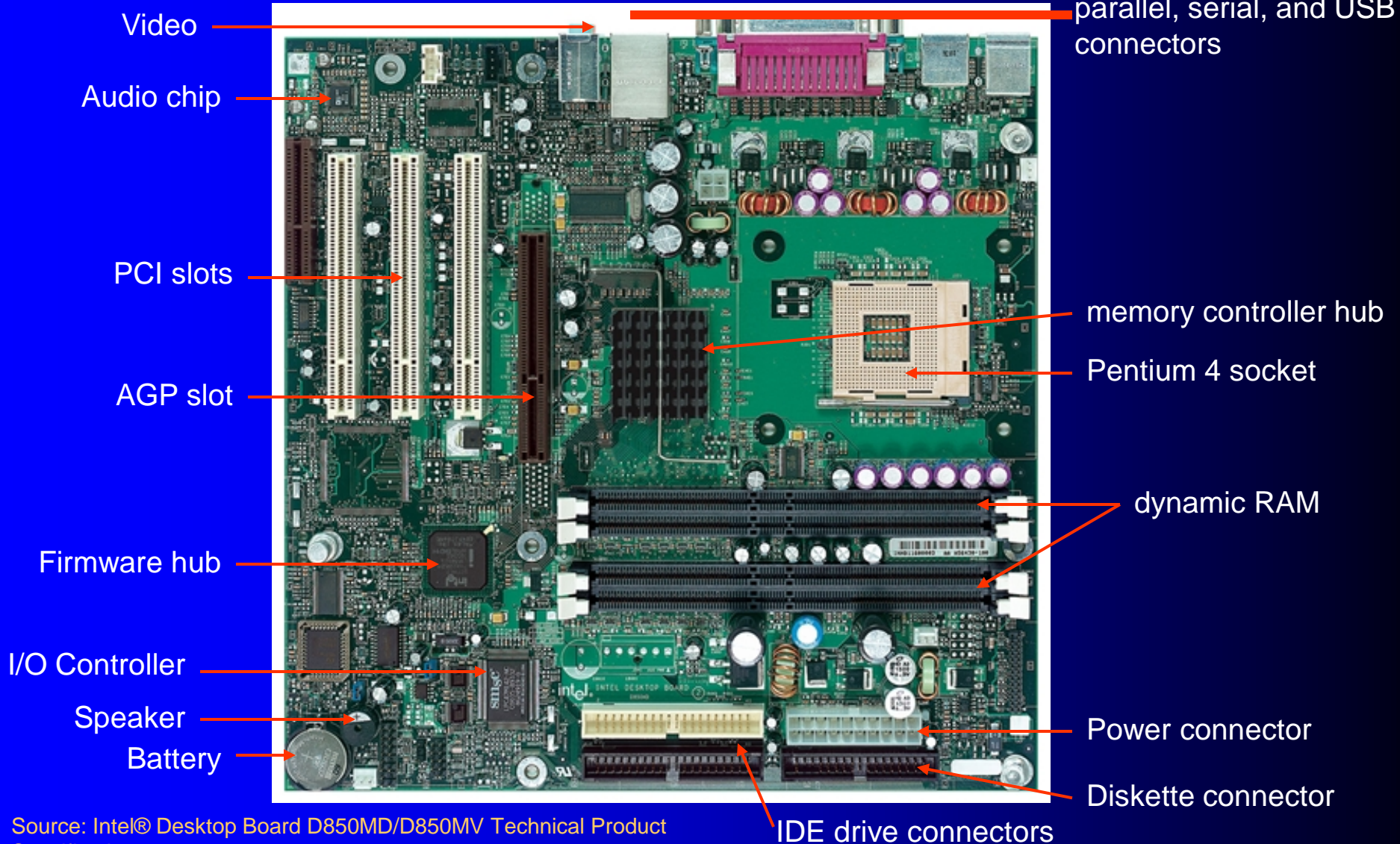
Components of an IA-32 Microcomputer

- Motherboard
- Video output
- Memory
- Input-output ports

Motherboard

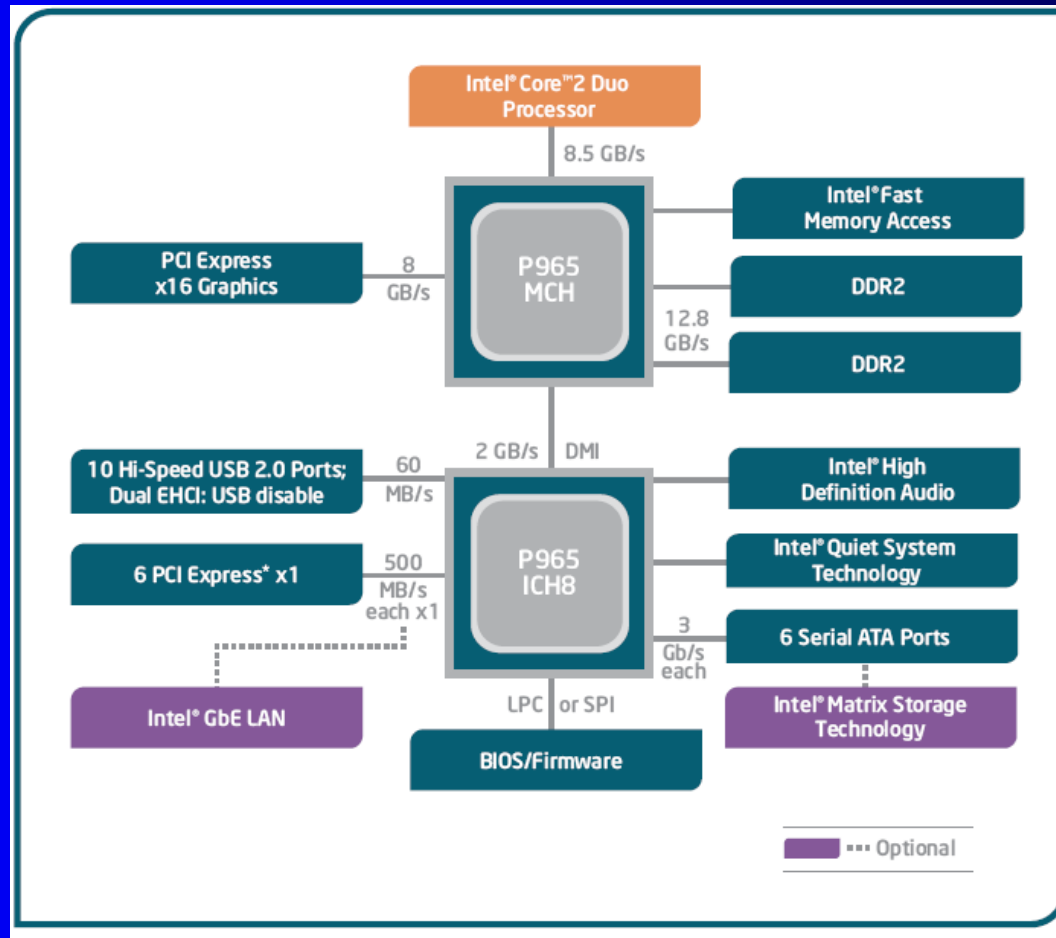
- CPU socket
- External cache memory slots
- Main memory slots
- BIOS chips
- Sound synthesizer chip (optional)
- Video controller chip (optional)
- IDE, parallel, serial, USB, video, keyboard, joystick, network, and mouse connectors
- PCI bus connectors (expansion cards)

Intel D850MD Motherboard



Source: Intel® Desktop Board D850MD/D850MV Technical Product Specification

Intel 965 Express Chipset

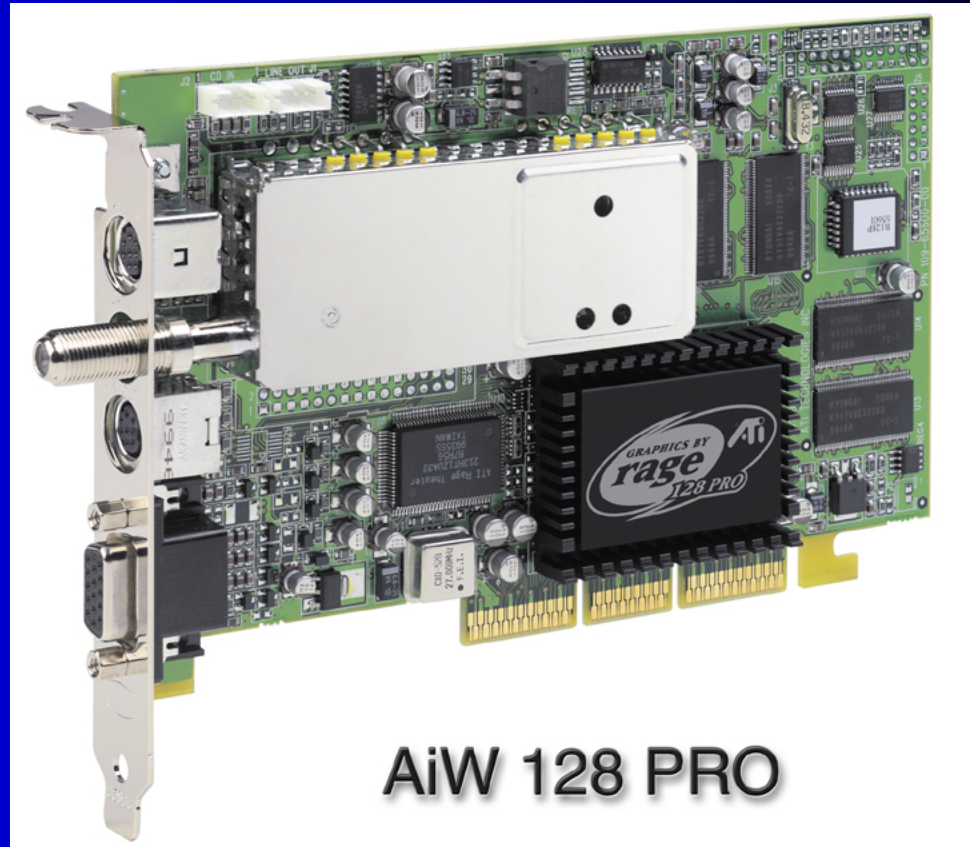


Video Output

- Video controller
 - on motherboard, or on expansion card
 - AGP (accelerated graphics port technology)*
- Video memory (VRAM)
- Video CRT Display
 - uses raster scanning
 - horizontal retrace
 - vertical retrace
- Direct digital LCD monitors
 - no raster scanning required

Sample Video Controller (ATI Corp.)

- 128-bit 3D graphics performance powered by RAGE™ 128 PRO
- 3D graphics performance
- Intelligent TV-Tuner with Digital VCR
- TV-ON-DEMAND™
- Interactive Program Guide
- Still image and MPEG-2 motion video capture
- Video editing
- Hardware DVD video playback
- Video output to TV or VCR



AiW 128 PRO

Memory

- ROM
 - read-only memory
- EPROM
 - erasable programmable read-only memory
- Dynamic RAM (DRAM)
 - inexpensive; must be refreshed constantly
- Static RAM (SRAM)
 - expensive; used for cache memory; no refresh required
- Video RAM (VRAM)
 - dual ported; optimized for constant video refresh
- CMOS RAM
 - complimentary metal-oxide semiconductor
 - system setup information
- See: [Intel platform memory](#) (Intel technology brief: link address may change)

Input-Output Ports

- USB (universal serial bus)
 - intelligent high-speed connection to devices
 - up to 12 megabits/second
 - USB hub connects multiple devices
 - *enumeration*: computer queries devices
 - supports *hot* connections
- Parallel
 - short cable, high speed
 - common for printers
 - bidirectional, parallel data transfer
 - Intel 8255 controller chip

Input-Output Ports (cont)

- Serial
 - RS-232 serial port
 - one bit at a time
 - uses long cables and modems
 - 16550 UART (universal asynchronous receiver transmitter)
 - programmable in assembly language

Device Interfaces

- ATA host adapters
 - intelligent drive electronics (hard drive, CDROM)
- SATA (Serial ATA)
 - inexpensive, fast, bidirectional
- FireWire
 - high speed (800 MB/sec), many devices at once
- Bluetooth
 - small amounts of data, short distances, low power usage
- Wi-Fi (wireless Ethernet)
 - IEEE 802.11 standard, faster than Bluetooth

What's Next

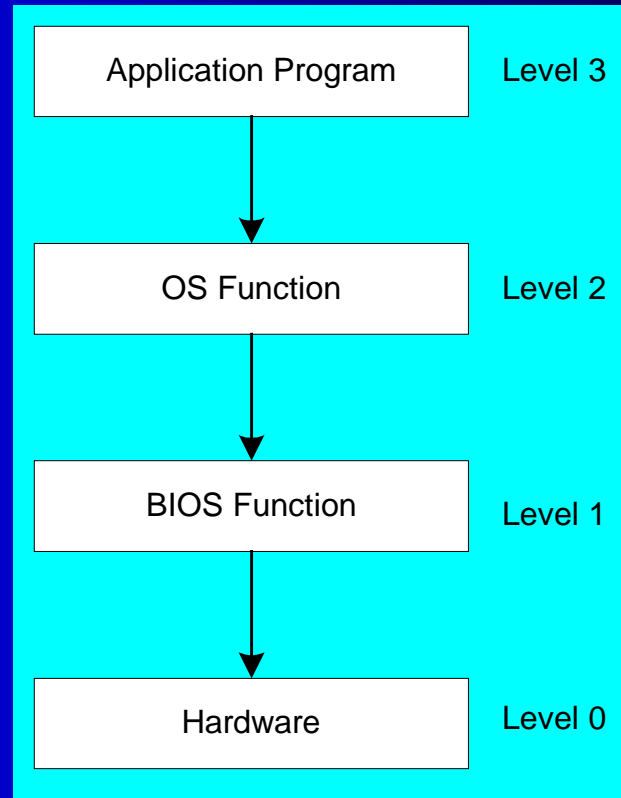
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Levels of Input-Output

- Level 3: High-level language function
 - examples: C++, Java
 - portable, convenient, not always the fastest
- Level 2: Operating system
 - Application Programming Interface (API)
 - extended capabilities, lots of details to master
- Level 1: BIOS
 - drivers that communicate directly with devices
 - OS security may prevent application-level code from working at this level

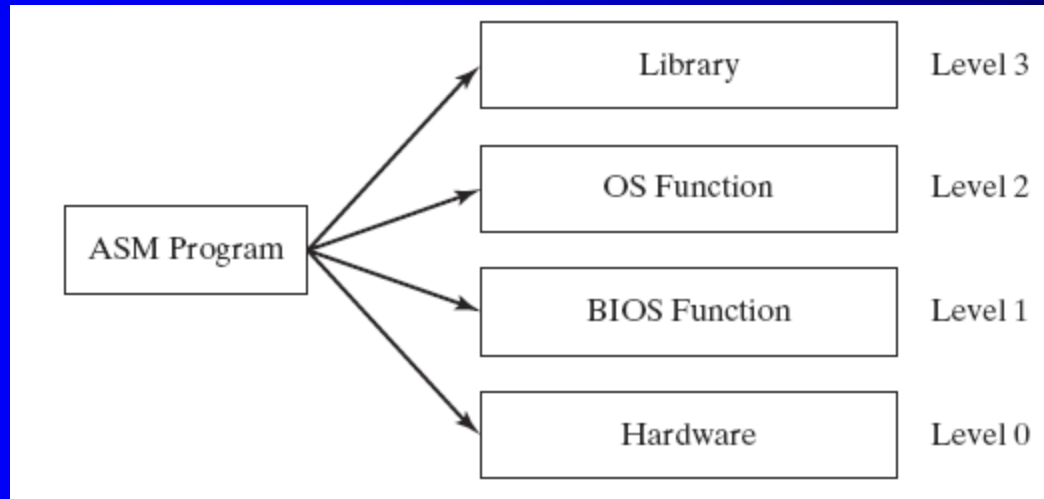
Displaying a String of Characters

When a HLL program displays a string of characters, the following steps take place:



Programming levels

Assembly language programs can perform input-output at each of the following levels:



Summary

- Central Processing Unit (CPU)
- Arithmetic Logic Unit (ALU)
- Instruction execution cycle
- Multitasking
- Floating Point Unit (FPU)
- Complex Instruction Set
- Real mode and Protected mode
- Motherboard components
- Memory types
- Input/Output and access levels