Basic Architecture

Basic components

- Memory
  - DRAM
  - SRAM
  - Cache
  - ROM
  - Flash
  - EEPROM

- Microprocessor
  - 8086
  - through
  - Pentium IV

- I/O System
  - VESA
  - PCI
  - EISA
  - ISA
  - Bus
  - Serial
  - Plotter
  - Keyboard
  - Floppy
  - Tape
  - Hard Drive
  - Mouse
  - Scanner
  - DVD
  - CDROM
  - Monitor
  - Printer
Basic Architecture

Bus Architecture:

The Pentium bus architecture is not this simple. We will elaborate on this later.
Basic Bus Architecture

Bus Architecture:- Three buses:

- **Address:**
  - If I/O, a value between 0000H and FFFFH is issued.
  - If memory, it depends on the architecture:
    - 20-bits (8086/8088)
    - 24-bits (80286/80386SX)
    - 25-bits (80386SL/SLC/EX)
    - 32-bits (80386DX/80486/Pentium)
    - 36-bits (Pentium Pro/II/III)

- **Data:**
  - 8-bits (8088)
  - 16-bits (8086/80286/80386SX/SL/SLC/EX)
  - 32-bits (80386DX/80486/Pentium)
  - 64-bits (Pentium/Pro/II/III)

- **Control:**
  - Most systems have at least 4 control bus connections (active low).
  - **MRDC** (Memory Read Control), **MWRC**, **IORC** (I/O Read Control), **IOWC**.
**Basic Bus Architecture**

Bus Standards:

- **ISA (Industry Standard Architecture):** 8 MHz
  - 8-bit (8086/8088)
  - 16-bit (80286-Pentium)

- **EISA:** 8 MHz
  - 32-bit (older 386 and 486 machines).

- **PCI (Peripheral Component Interconnect):** 33 MHz
  - 32-bit or 64-bit (Pentiums)
  - New: PCI Express and PCI-X 533 MTS

- **VESA (Video Electronic Standards Association):** Runs at processor speed.
  - 32-bit or 64-bit (Pentiums)
  - Only disk and video. Competes with the PCI but is not popular.
Basic Bus Architecture

Bus Standards:

- **USB (Universal Serial Bus)**: 1.5 Mbps, 12 Mbps and now 480 Mbps.
  - Newest systems.
  - Serial connection to microprocessor.
  - For keyboards, the mouse, modems and sound cards.
  - *To reduce system cost through fewer wires.*

- **AGP (Advanced Graphics Port)**: 66MHz
  - Newest systems.
  - Fast parallel connection: Across 64-bits for 533MB/sec.
  - For video cards.
  - *To accommodate the new DVD (Digital Versatile Disk) players.*
  - *Latest AGP 3.0 with peak bandwidth of 2.1GB/s.*
Basic Memory Architecture

Bank layout

1 MB

Odd bytes

Even bytes

8088

8086 (1MB only), 80286, 80386SX
80386SL/SLC(32MB)
Basic Memory Architecture

Bank layout

Bank 3

Bank 2

Bank 1

Bank 0

80386DX, 80486
**Basic Memory Architecture**

Bank layout

Bank 0
- 8 bits
- 512 MB
- D7-D0
- FFFFFFF0
- FFFFFFF8

Bank 1
- 8 bits
- 512 MB
- D15-D8
- FFFFFFF1
- FFFFFFF9

Bank 2
- 8 bits
- 512 MB
- D23-D16
- FFFFFFF2
- FFFFFFFA

Bank 3
- 8 bits
- 512 MB
- D31-D24
- FFFFFFF3
- FFFFFFFB

Bank 4
- 8 bits
- 512 MB
- D39-D32
- FFFFFFF4
- FFFFFFFC

Bank 5
- 8 bits
- 512 MB
- D47-D40
- FFFFFFF5
- FFFFFFFD

Bank 6
- 8 bits
- 512 MB
- D55-D48
- FFFFFFF6
- FFFFFFFE

Bank 7
- 8 bits
- 512 MB
- D63-D56
- FFFFFFF7
- FFFFFFFF

Pentium/Pro/II/III
Basic I/O Architecture

- Active Processes
- ISR NIC
- ISR sound
- Other OS code
- Interrupt Vectors

DRAM (Main Memory)

I/O Space

NIC

Ports

Microprocessor

Mem Bus

Data/Address Bus

INTR

IRPs

Ports

Sound card

UMBC
Interrupt Vectors (DOS PC)

<table>
<thead>
<tr>
<th>BIOS Program Area</th>
<th>FFFFFFFH</th>
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<tbody>
<tr>
<td>Read-Only Memory</td>
<td></td>
</tr>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOS Data area</td>
<td></td>
</tr>
<tr>
<td>Available Int. vectors</td>
<td>00500H</td>
</tr>
<tr>
<td>(DOS int #s 20H-3FH)</td>
<td>64 long words</td>
</tr>
<tr>
<td>Interrupt Vectors</td>
<td>00400H</td>
</tr>
<tr>
<td>DRAM (Main Memory)</td>
<td>224 long words</td>
</tr>
<tr>
<td></td>
<td>00080H</td>
</tr>
<tr>
<td></td>
<td>32 long words</td>
</tr>
<tr>
<td></td>
<td>00000H</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>Interrupt #</th>
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<tbody>
<tr>
<td>7C-7F</td>
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<td>78-7F</td>
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<td>74-77</td>
<td>Video Initialization</td>
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<tr>
<td>70-73</td>
<td><strong>Timer Tick</strong> (18.2/sec)</td>
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<tr>
<td>6C-6F</td>
<td>Keyboard Break</td>
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<tr>
<td>68-6F</td>
<td>Time of Day</td>
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<tr>
<td>64-67</td>
<td>Bootstrap</td>
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<tr>
<td>60-63</td>
<td>Resident BASIC</td>
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<tr>
<td>5C-5F</td>
<td>Printer</td>
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<tr>
<td>58-5B</td>
<td>Keyboard</td>
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<td>54-57</td>
<td>Cassette</td>
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<td>50-53</td>
<td>Communications</td>
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<td>4C-4F</td>
<td>Diskette/Disk</td>
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<td>48-4B</td>
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<td>44-47</td>
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<td>3C-3F</td>
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<td>38-3B</td>
<td>Diskette</td>
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<td>34-37</td>
<td>Disk</td>
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<tr>
<td>30-33</td>
<td>Communications</td>
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<tr>
<td>2C-2F</td>
<td>Communications</td>
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<tr>
<td>28-2B</td>
<td>Reserved</td>
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<td>24-27</td>
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<td>20-23</td>
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<td>1D-1F</td>
<td>Reserved</td>
</tr>
<tr>
<td>18-1B</td>
<td>Reserved</td>
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<td>14-17</td>
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<td>10-13</td>
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<tr>
<td>C-F</td>
<td><strong>Breakpoint</strong> (CPU)</td>
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<tr>
<td>8-B</td>
<td>Non-maskable (8087)</td>
</tr>
<tr>
<td>4-7</td>
<td>Single Step (CPU)</td>
</tr>
<tr>
<td>0-3</td>
<td>Divide by zero (CPU)</td>
</tr>
</tbody>
</table>

Address Interrupts

- Hardware Interrupts
  - 8259A
- Asynchronous Software Interrupts
  - Synchronous
- Microprocessor Interrupts

- Pits to CPU
I/O Space

It is important to notice that these I/O addresses are NOT memory-mapped addresses on the 80x86 machines.

<table>
<thead>
<tr>
<th>64K 8-bit I/O devices</th>
</tr>
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<td>I/O Device Space</td>
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<tr>
<td>COM1</td>
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<tr>
<td>Floppy Disk Controller</td>
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<tr>
<td>CGA Adapter</td>
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<td>LPT1</td>
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<tr>
<td>Hard Disk Controller</td>
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<tr>
<td>COM2</td>
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<tr>
<td>8255 (PIA)</td>
</tr>
<tr>
<td>Timer (8253)</td>
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<tr>
<td>Interrupt Controller</td>
</tr>
<tr>
<td>DMA Controller</td>
</tr>
</tbody>
</table>

Special instructions (IN/OUT) are used to communicate to the I/O devices.