PCI
Peripheral Component Interface

LISTA/UFSC

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The Standard

- More than a bus
  - PCI specifies the interaction between several hardware components (mechanical, electrical, timing, protocols)

- Replacement for ISA

- Used on IA-32, IA-64, Alpha, PowerPC, Sparc64, and others
Features

- 32 or 64 bits (also 64 data and 32 address)
- Synchronous operation
  - 33 MHz ~ 132 MB/s
  - 66 MHz ~ 528 MB/s
  - Down to 0 MHz
- Single or multiple bus masters
- Bus parity error reporting
- Cache support
Architectural Overview
Transactions

- Initiator (or Master)
  - Owns the bus and initiates the data transfer
  - Must also be a Target
- Target (or Slave)
  - Target of the data transfer (read or write)
- Agent
  - Any initiator or target on the bus
- Burst transaction
  - More than one data phase
Transactions
Bus Signals

Required Pins

Address & Data
- AD[31:00]
- C/B#[3:0]
- PAR
- FRAME#
- TRDY#
- IRDY#
- STOP#
- DEVSEL#
- IDSEL

Interface Control
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

Arbitration (masters only)
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

Error Reporting
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

System
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

Optional Pins

PCI COMPLIANT DEVICE
- AD[63:32]
- C/B#[7:4]
- PAR64
- REQ64#
- ACK64#
- M66EN
- LOCK#
- Interrupt A-D#
- Clkrun#
- SBO#
- SDONE
- TDI
- TDO
- TCK
- TMS
- TRST#

64-Bit Extension
- AD[63:32]
- C/B#[7:4]
- PAR64
- REQ64#
- ACK64#
- M66EN
- LOCK#
- Interrupt A-D#
- Clkrun#
- SBO#
- SDONE
- TDI
- TDO
- TCK
- TMS
- TRST#

Interface Control
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

Cache Support
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2

JTAG (IEEE 1149.1)
- REQ#
- GNT#
- PERR#
- SERR#
- CLK
- RST
- Present 1-2
Bus Signals

- **CLK**
  - Can be lowered to 0 MHz
- **IDSEL**
  - Individual device select for configuration (one per agent)
  - Allows address configuration
- **Arbitration (REQ/GNT)**
  - Individual connections to/from arbiter
Address Spaces

- Configuration space (256 bytes)
  - Basic information about devices
  - Supports Plug-N-Play
  - Accessed by OS to perform settings

- I/O space
  - IBM PC (IA-32)
  - 4 B to 2 GB per device

- Memory space
  - Everything else
  - 16 B to 2 GB per device (> 4 K suggested)
## PCI Commands

<table>
<thead>
<tr>
<th>C/BE</th>
<th>Command</th>
<th>Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>Interrupt acknowledge</td>
<td>I/O</td>
</tr>
<tr>
<td>0001</td>
<td>Special cycle</td>
<td>Memory</td>
</tr>
<tr>
<td>0010</td>
<td>I/O read</td>
<td>Config</td>
</tr>
<tr>
<td>0011</td>
<td>I/O write</td>
<td></td>
</tr>
<tr>
<td>0110</td>
<td>Memory read</td>
<td></td>
</tr>
<tr>
<td>0111</td>
<td>Memory write</td>
<td></td>
</tr>
<tr>
<td>1100</td>
<td>Memory read multiple</td>
<td></td>
</tr>
<tr>
<td>1101</td>
<td>Dual address cycle</td>
<td></td>
</tr>
<tr>
<td>1110</td>
<td>Memory read line</td>
<td></td>
</tr>
<tr>
<td>1111</td>
<td>Memory write and invalidate</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IDSEL</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1010</td>
<td>Configuration read</td>
<td></td>
</tr>
<tr>
<td>1011</td>
<td>Configuration write</td>
<td></td>
</tr>
</tbody>
</table>
# Configuration Space Header

<table>
<thead>
<tr>
<th>Address</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Vendor ID</td>
</tr>
<tr>
<td>0x10</td>
<td>Device ID</td>
</tr>
<tr>
<td>0x20</td>
<td>Command Reg</td>
</tr>
<tr>
<td>0x30</td>
<td>Status Reg.</td>
</tr>
<tr>
<td>0x40</td>
<td>Revision ID</td>
</tr>
<tr>
<td>0x50</td>
<td>Class Code</td>
</tr>
<tr>
<td>0x60</td>
<td>Cache Line</td>
</tr>
<tr>
<td>0x70</td>
<td>Latency</td>
</tr>
<tr>
<td>0x80</td>
<td>Timer</td>
</tr>
<tr>
<td>0x90</td>
<td>Header Type</td>
</tr>
<tr>
<td>0xA0</td>
<td>BIST</td>
</tr>
</tbody>
</table>

- **Required Register**
- **Optional Register**

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PCI Variations

- **AGP**
  - Point-to-point protocol
  - Graphics on PCs

- **CardBus**
  - PCI in a PCMCIA form factor
  - Portable systems

- **CompactPCI**
  - PCI in a EUROCARD form factor
  - Passive backplane
  - Used in telecom and industrial applications