# 3.11.2 Expansion Bus Types

Expansion cards are used to expand a computer's functionality or increase its performance. Expansion cards are installed into the expansion slot on a motherboard. Expansion cards and slots use different expansion bus standards that define communication specifications as well as physical characteristics.

The following table describes the characteristics of the most common expansion bus types:

| Bus Type | Characteristics |
|---|---|
| Peripheral Component Interconnect (PCI) | PCI was developed to replace the obsolete ISA and VESA bus standards. PCI:<br>▪ Is processor independent, meaning the CPU and PCI bus can process concurrently<br>▪ Supports plug-and-play, meaning installed devices are detected and configured automatically<br>▪ Is used most commonly by devices such as sound cards, modems, network cards, and storage device controllers<br>▪ Can run at 33 MHz and transfer data at 133 MBps or run at 66 MHz and transfer data at 266 MBps |
| PCI Express (PCIe) | PCIe was developed to replace PCI, PCI-X, and AGP. Instead of a shared bus, each PCIe slot links to a switch that prioritizes and routes data through a point-to-point dedicated connection and provides a serial, full-duplex method of transmission. PCIe uses several different connection types.<br>▪ PCIe types are defined by the number of transmission lanes that are used to transfer data. For example, PCIe x1 provides one lane for transmission (x1), while PCIe x16 provides sixteen lanes for transmission. PCIe defines x2, x4, x8, x16, and x32 connection types.<br>▪ PCIe data rates depend on the protocol version and number of transmission lanes:<br>  ▪ 1.0: 250 MBps (x1); 4 GBps (x16)<br>  ▪ 2.0: 500 MBps (x1); 8 GBps (x16)<br>  ▪ 3.0: 1 GBps (x1); 16 GBps (x16)<br>  ▪ 4.0: 2 GBps (x1); 32 GBps (x16)<br>▪ In addition to greatly increased speed, PCIe offers higher quality service.<br>▪ PCIe can run alongside legacy PCI technology (e.g., both PCIe and PCI buses can be in the same system).<br>▪ PCIe x1 slots are typically used for network cards, USB cards, and sound cards. PCIe x16 slots are primarily used for dedicated video cards.<br><br>PCIe cards are cross-size compatible, as long as the slot size is the same or larger than the card size. For example, a PCIe x1 card can be installed in a PCIe x16 slot, but a PCIe x16 card cannot be installed in a PCIe x1 slot. |
| Legacy buses | Buses that have been replaced by newer types are considered legacy buses. Legacy buses are rarely used and include the following:<br>▪ AGP (accelerated graphics port) was a dedicated bus type used by dedicated video cards.<br>▪ AMR (audio/modem riser) was a riser card that attached to the motherboard and allowed additional cards (called daughter cards) to be installed. |

| | |
|---|---|
| | ▪ CNR (communications network riser) was a riser card slot that allowed for installing network, sound, or modem functions. |