System Expansion

Feature Expansion

Data Buses

Storage Systems

Form Factor Considerations

Personal Computer Usage Patterns

- There has been a significant shift in usage patterns for personal computing devices with regard to feature expansion.
  - Desktops (1970's to 2000's)
    - Buy base unit,
      - Additional hardware added to inside of box (PC model)
      - Satellite devices added via external cables (Mac model)
  - Laptops (early 1990's +)
    - Increasingly configuration determined at purchase tim
      - Less internal hardware, more satellites
      - More local network attached devices
  - Tablets / Smartphones (2010's +)
    - Hardware configuration exclusively determine at initial purchase
      - More Wide are networking for attached devices
        - » Bluetooth / WIFI – local
        - » Broadband – non-local

Feature expansion

- In this lecture, we focus on Desktop Hardware

- Expansion cards: connect to the expansion slots
  - graphics cards
  - TV tuner cards
  - peripheral interface cards (connects external peripherals)

- Storage interfaces
  - hard disk drives
  - CD drives
  - DVD drives etc

Chipset: legacy

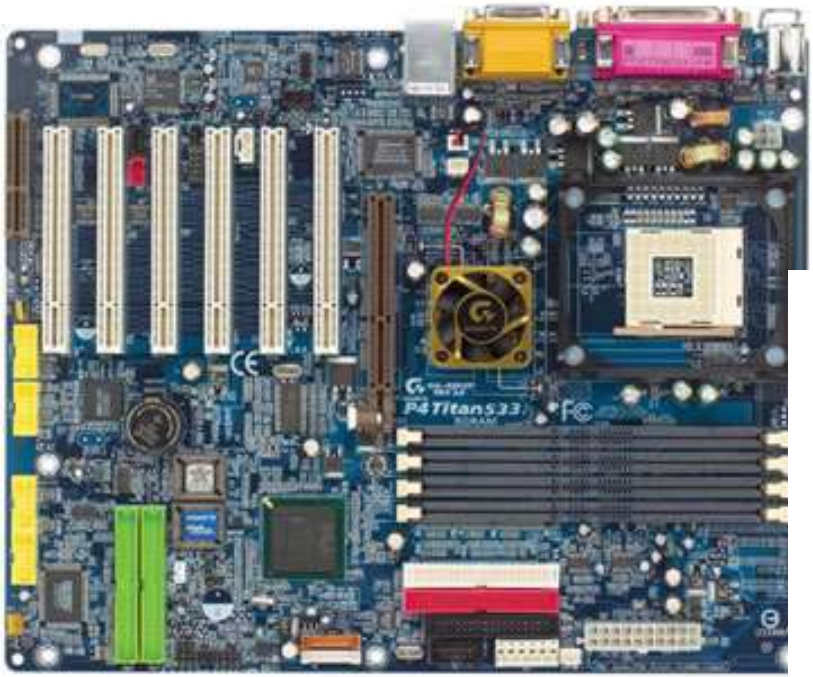
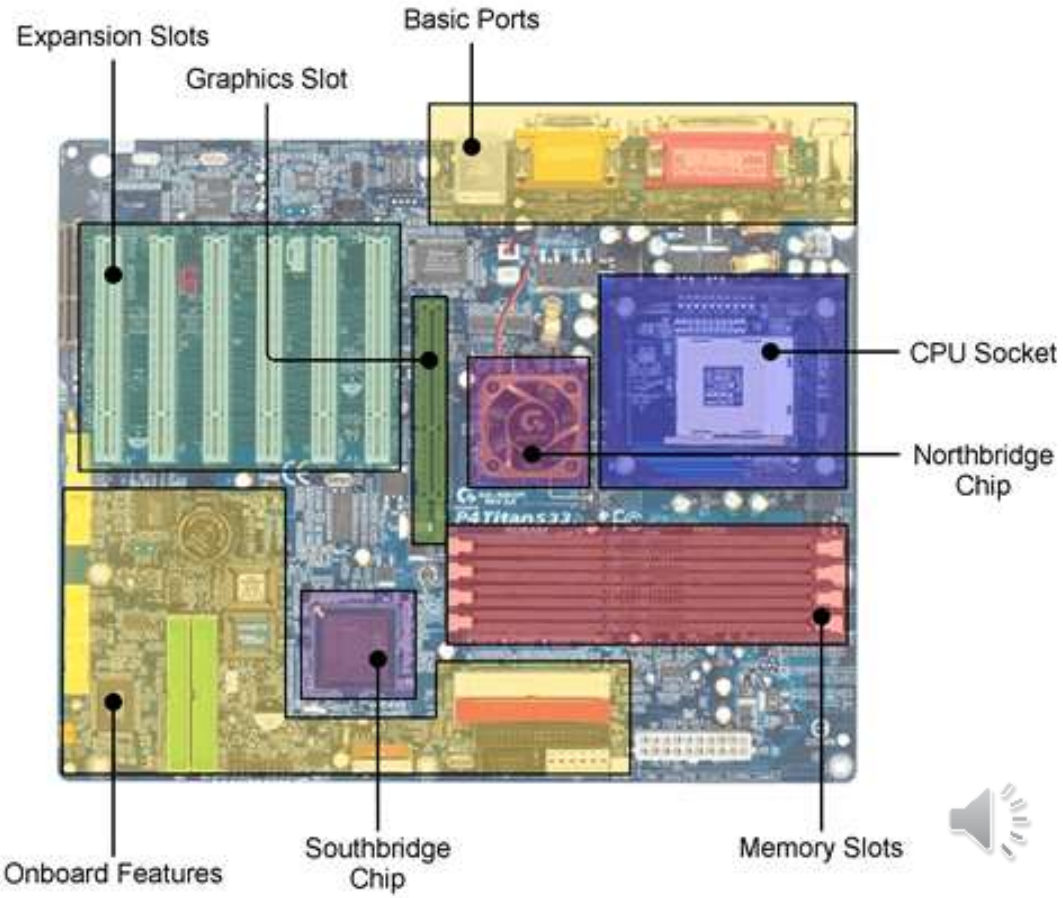
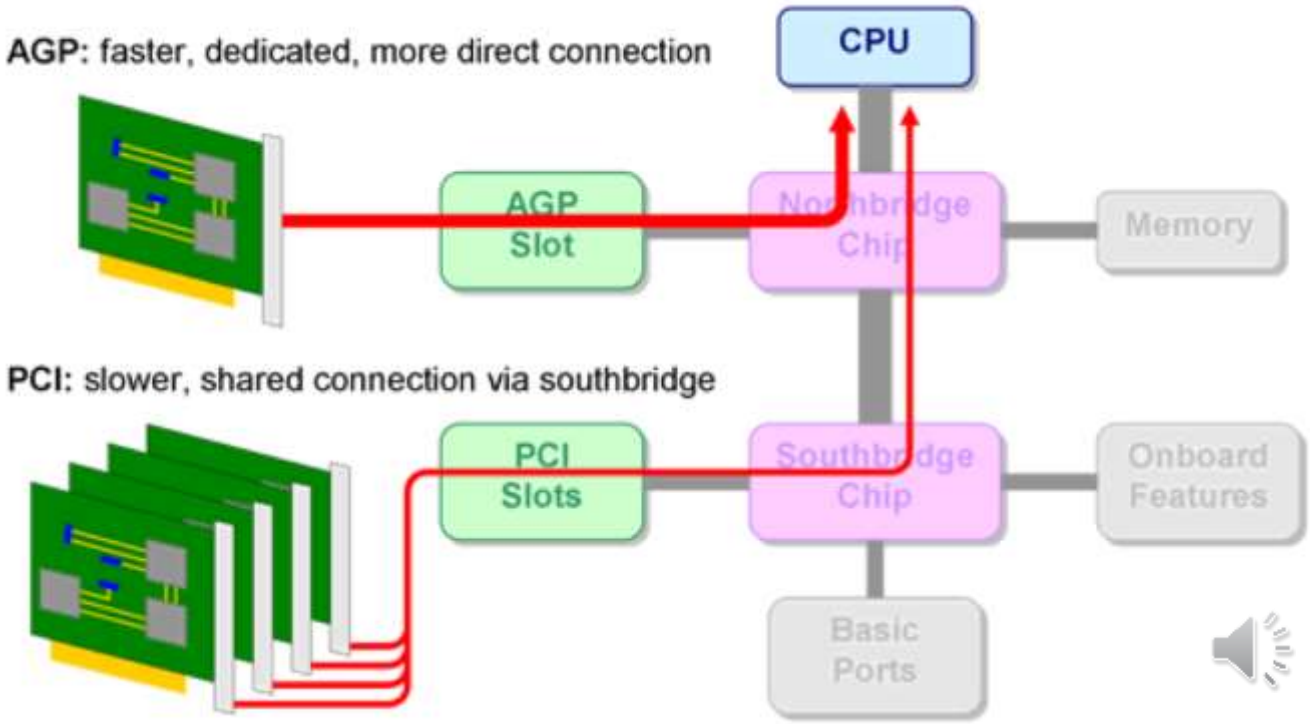


Photo: Gigabyte Co



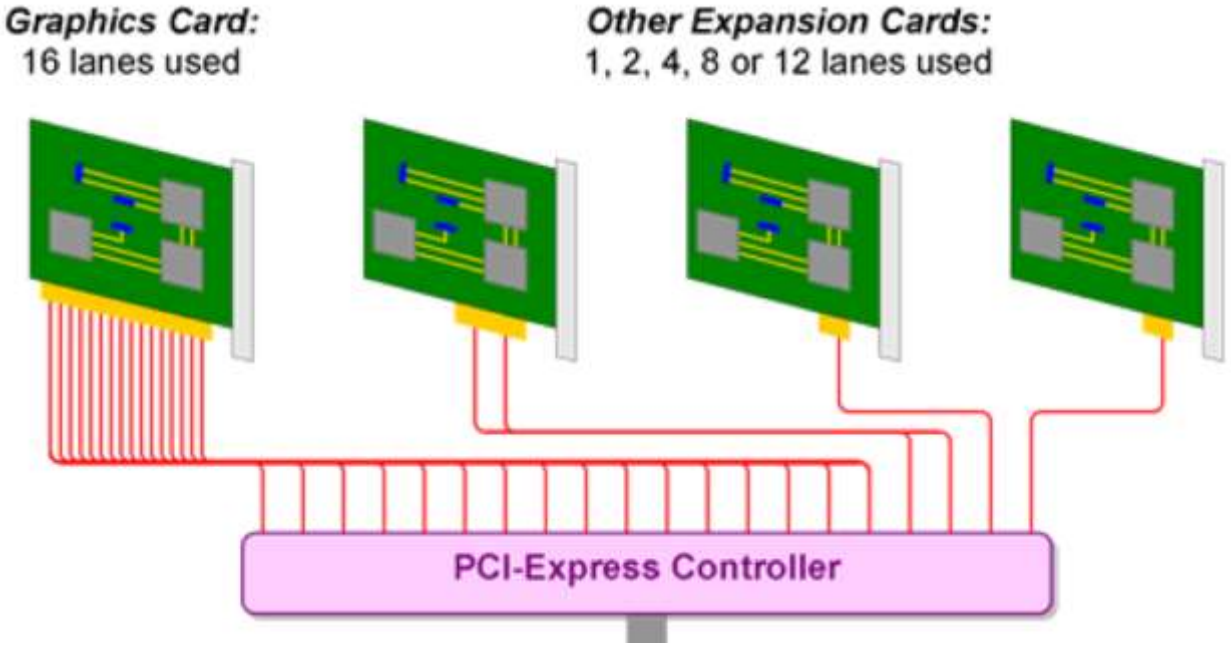
Data Buses

- Peripheral Component Interconnect (PCI)
  - bus topology: being a bus created a bottleneck
  - rapidly became too slow for graphics
- Accelerated Graphics Port (AGP)
  - separated graphics card from PCI bus
  - quick access to CPU & memory



Data Buses

- PCI Express
  - point to point connection, so no bottlenecks
  - bandwidth units organized into lanes



PCI Express version	Bandwidth/lane
1.x	250 MB/s
2.x	500 MB/s
3.0	1 GB/s
4.0	2 GB/s

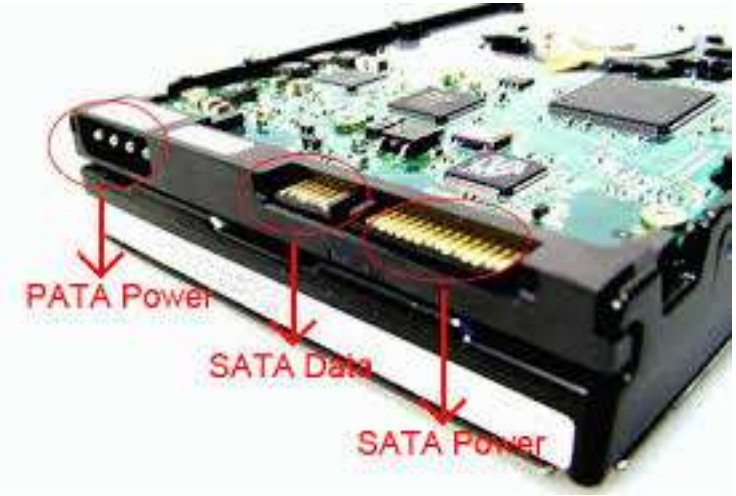
Storage systems interfaces

- The main mass storage interface standards are ATA and SCSI

- ATA (Advanced Technology Attachment)
  - older version also called IDE (Integrated Drive Electronics)
  - used to transfer data via the CPUs registers, now uses DMA (Direct Memory Access)
  - used to be parallel connection, resulting in 40 wire-wide cables (due to crosstalk, another a grounding wire was eventually placed next to each data wire)
  - parallel ATA was bus topology, which could cause bottlenecks
  - serial ATA (SATA) was developed in 2003 and permits hot-plugging

ATA / IDE connectors

SATA connectors



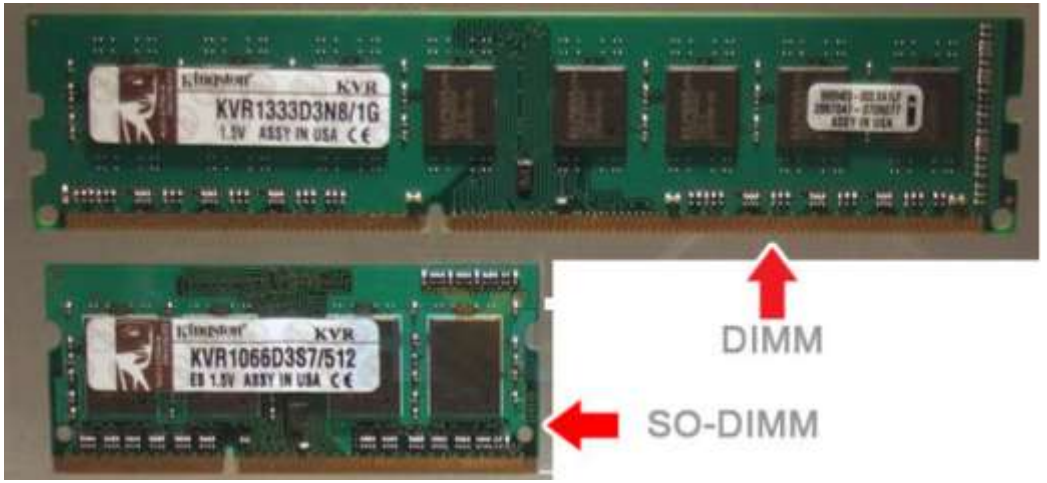
Storage system interfaces

- SCSI (Small Computer Systems Interface)
  - legacy version was parallel
  - newer versions serial: serial attached SCSI (SAS)

Form factor considerations

- There are miniaturized expansion interfaces for laptops and other small computers

SO-DIMM (Small outline DIMM)



Mini PCIe

can be PCI Express, USB, SATA transfer modes

Form factor considerations

- External portable computer expansion cards
  - slide into external slot
  - hot swappable

Expansion interfaces:

- Card Bus (equivalent to PCI)
- Express Card (equiv. PCI Express/USB)