# Module 6

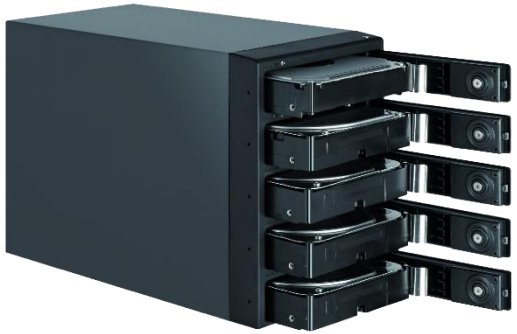
RAID and Expansion Devices

# Objectives

1. PC Hardware
   A. 1.5 Compare and contrast RAID types
   B. 1.8 Compare expansion devices

# RAID

# RAID



1. **R**edundant **A**rray of **I**ndependent (or **I**nexpensive) **D**isks
2. Uses multiple hard drives
3. Increases performance
4. Provides protection against data loss

# Why RAID?

1. Can combine several physical disks into one larger "virtual" device
2. Frequently on servers
3. Not a substitute for good backups
4. Good for common hardware problems (single disk failure)
5. Not a complete data safety solution

# RAID Controllers

1. Uses specialized disk controllers
2. Use advanced technology attachment (ATA) or small computer system interface (SCSI) technologies
3. Limited number of ATA disks can be attached
4. SCSI may multiple channels
5. Controllers must be installed before installing the operating system

# Software vs Hardware

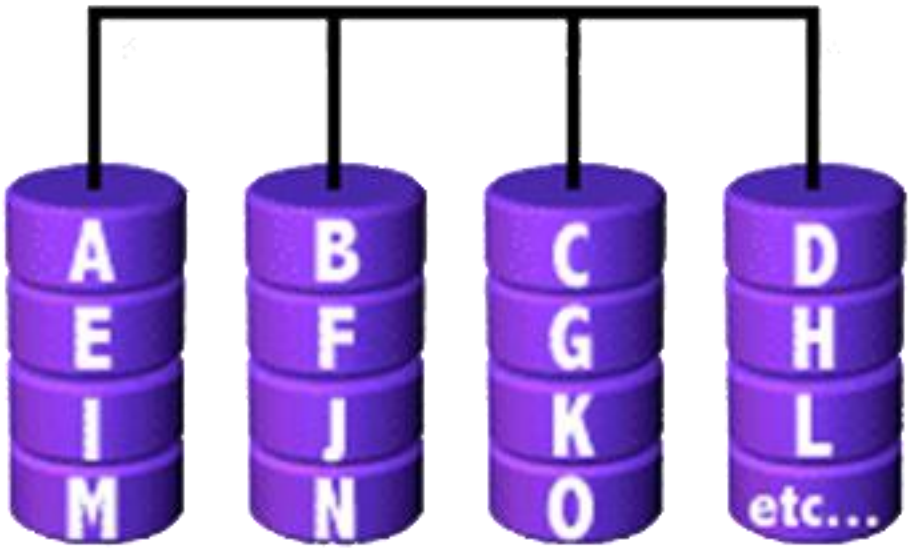
1. Can be implemented in software
2. Software RAID systems usually support RAID 0, 1, and 5
3. Can be based on disk partitions rather than entire disk drives

# RAID Levels

| Level | Features |
|---|---|
| **Level 0** | **Striped Disk Array without Fault Tolerance** |
| **Level 1** | **Mirroring and Duplexing** |
| Level 2 | Error-Correcting Coding |
| Level 3 | Parallel transfer with parity |
| Level 4 | Independent Data disks with shared Parity disk |
| **Level 5** | **Independent Data disks with distributed parity blocks** |
| Level 6 | Independent Data disks with two independent distributed parity schemes |
| Level 7 | Optimized Asynchrony for High I/O Rates |
| **Level 10** | **A Stripe of Mirrors** |
| Level 53 | High I/O Rates and Data Transfer Performance |
| **Level 0+1** | **A Mirror of Stripes** |

# RAID 0: Striped Disk Array without Fault Tolerance

Requires a minimum of 2 hard drives to implement



# RAID 0: Striped Disk Array without Fault Tolerance

1. Characteristics/Advantages
   A. Implements a striped disk array
   B. Extends the size of a volume
   C. Does not provide reliability or mirroring
   D. I/O performance is greatly
   E. Best performance is achieved when data is striped across multiple controllers with only one drive per controller
   F. No parity calculation overhead
   G. Very simple design
   H. Easy to implement
2. Disadvantages
   A. Not a "True" RAID
   B. No fault-tolerant
   C. Single point of failure
   D. Should never be used in mission critical environments

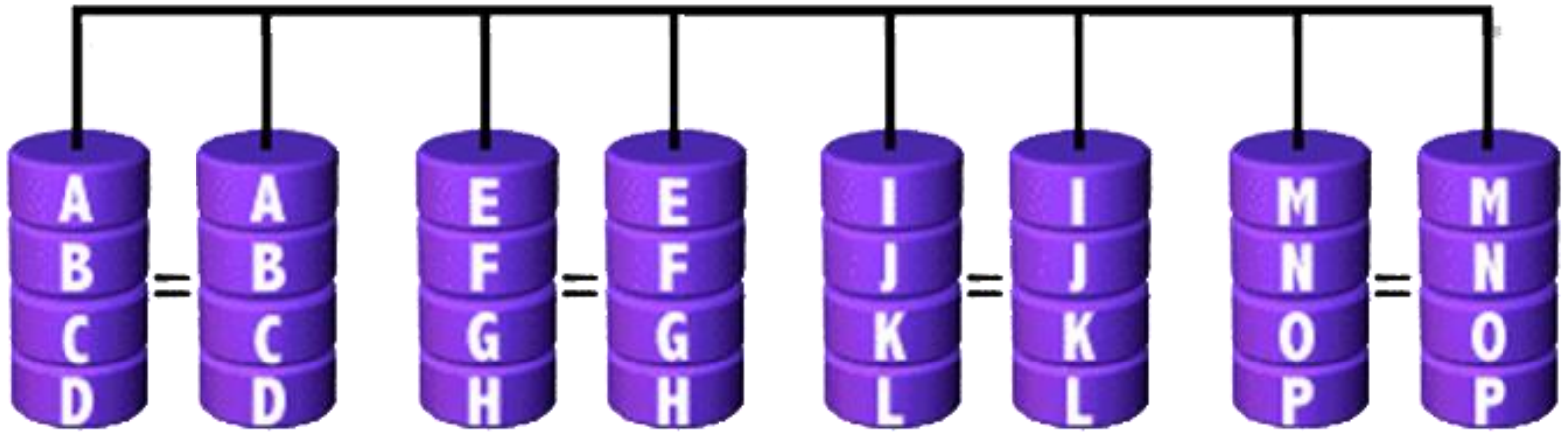
# RAID 0: Striped Disk Array without Fault Tolerance

Recommended Applications

1. Video Production and Editing
2. Image Editing
3. Pre-Press Applications
4. Any application requiring high bandwidth

# RAID 1: Mirroring and Duplexing

1. For Highest performance, the controller must be able to perform two concurrent separate Reads per mirrored pair or two duplicate Writes per mirrored pair
2. Requires a minimum of 2 hard drives to implement



# RAID 1: Mirroring and Duplexing

1. Characteristics/Advantages
   A. One write or two reads possible per mirrored pair
   B. Twice the read/write transaction rate of single disks
   C. 100% redundancy of data Transfer rate per block is equal to that of a single disk
   D. Simplest RAID storage subsystem design
2. Disadvantages
   A. Highest disk overhead
   B. Done by system software
   C. Hardware implementation is strongly recommended

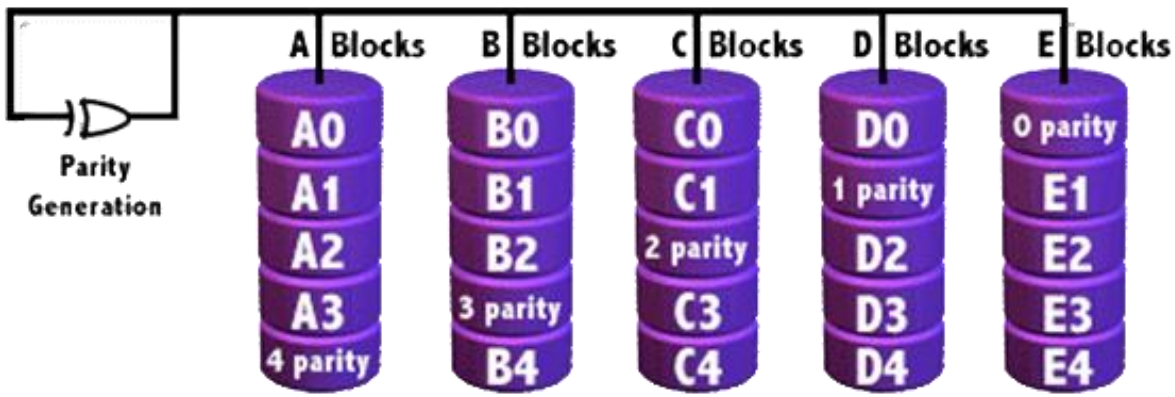
# RAID 1: Mirroring and Duplexing

Recommended Applications

1. Accounting
2. Payroll
3. Financial
4. Any application requiring very high availability

# RAID 5: Independent Data disks with distributed parity blocks

1. Each entire data block is written on a data disk
2. Parity for blocks
3. Requires a minimum of 3 hard drives to implement



# RAID 5: Independent Data disks with distributed parity blocks

1. Characteristics/Advantages
   A. Highest Read data transaction rate
   B. Medium Write data transaction rate
   C. Low ratio of ECC (Parity) disks to data disks
   D. High efficiency
   E. Good aggregate transfer rate
2. Disadvantages
   A. Disk failure has a medium impact on throughput
   B. Most complex controller design
   C. Difficult to rebuild in the event of a disk failure
   D. Individual block data transfer rate same as single disk

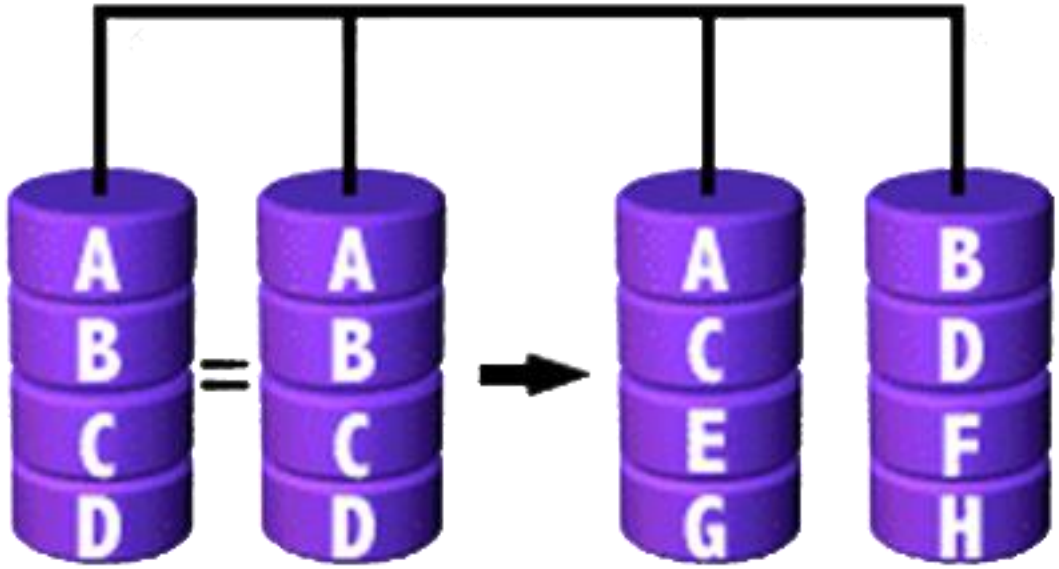
# RAID 5: Independent Data disks with distributed parity blocks

Recommended Applications

1. File and Application servers
2. Database servers
3. WWW, E-mail, and News servers
4. Intranet servers
5. Most versatile RAID level

# RAID 10: Very High Reliability combined with High Performance

Requires a minimum of 4 hard drives to implement



# RAID 10: Very High Reliability combined with High Performance

1. Characteristics/Advantages
   A. Implemented as a striped array
   B. Same fault tolerance as RAID level 1
   C. Same overhead for fault-tolerance as mirroring alone
   D. High I/O rates are achieved
   E. Can sustain multiple simultaneous drive failures
2. Disadvantages
   A. Very expensive
   B. High overhead
   C. All drives must move in parallel to proper track lowering sustained performance
   D. Very limited scalability
   E. High inherent cost

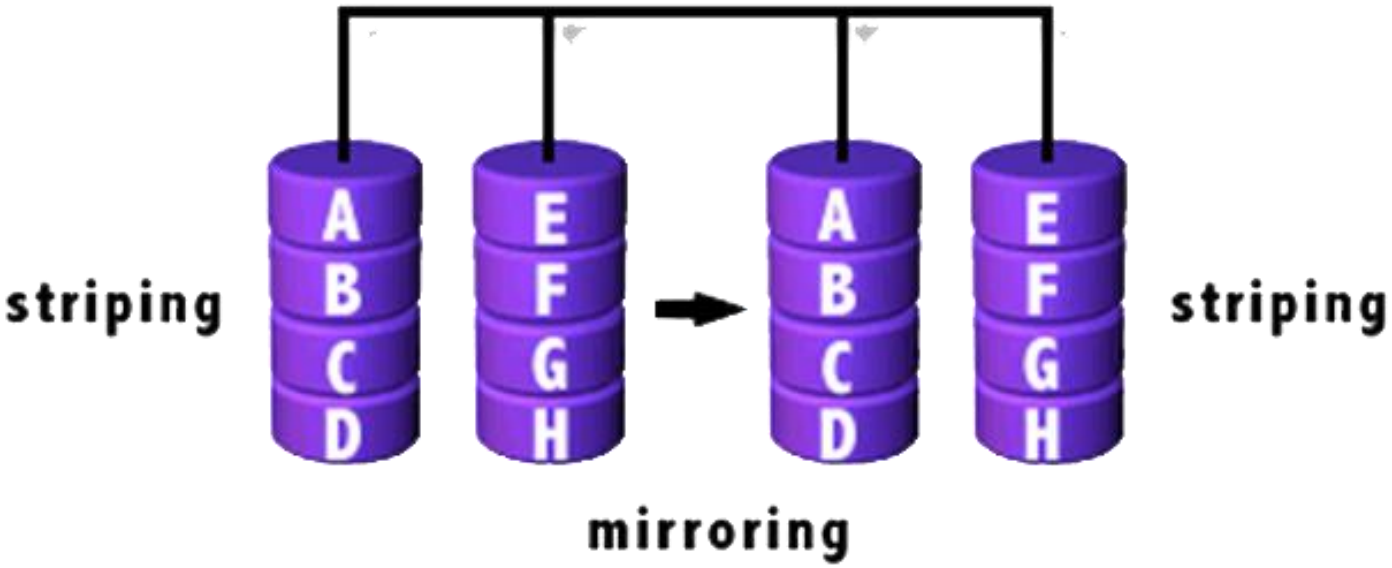
# RAID 10: Very High Reliability combined with High Performance

Recommended Applications

1. Database server

# RAID 0+1: High Data Transfer Performance

Requires a minimum of 4 hard drives to implement



# RAID 0+1: High Data Transfer Performance

1. Characteristics/Advantages
   A. Implemented as a mirrored array whose segments are RAID 0 arrays
   B. Same fault tolerance as RAID level 5
   C. Same overhead for fault-tolerance as mirroring alone
   D. High I/O rates
   E. Excellent solution for sites that need high performance but are not concerned with achieving maximum reliability
2. Disadvantages
   A. Don’t confused with RAID 10
   B. Very expensive
   C. High overhead
   D. All drives must move in parallel
   E. Very limited scalability

# RAID 0+1: High Data Transfer Performance

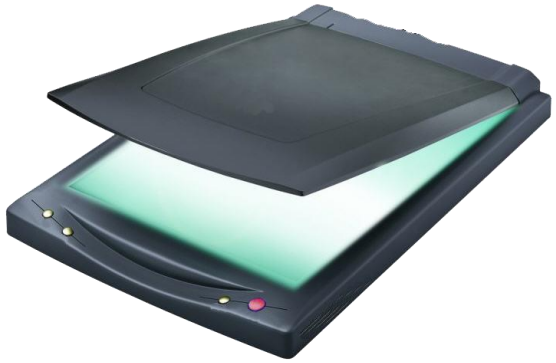
Recommended Applications

1. Imaging applications
2. General fileserver

# EXPANSION DEVICES

# Scanners

1. A device that optically scans images and printed text and converts it to a digital image
2. Common examples:
   A. Flatbed scanner
   B. Hand-held scanners
   C. Mechanically driven scanners
   D. 3D scanners
3. Require drivers
4. May have Optical Character Recognition (OCR) software



# Biometric Devices

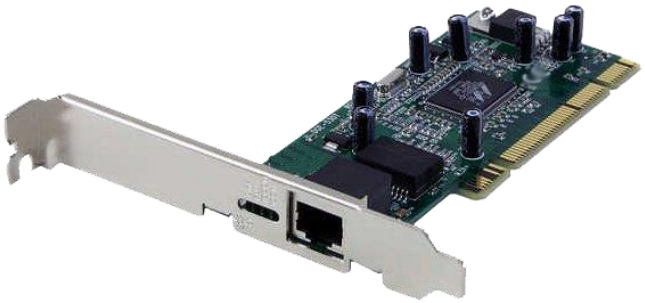
1. The identification of humans by distinctive and measurable characteristics used to label and describe individuals
2. Used as a form of identification and access control
3. Requires manufacturer supplied drivers

# Audio/Video Devices

1. Expands the functionality of computers
2. Many are built-in
3. Allow for 5.1 or 7.1 surround sound
4. Require no additional drivers for basic use
5. Additional drivers add functionality

# Network Devices

1. Wired and wireless devices
2. Allow connections to outside resources and shared information
3. Require drivers



# Summary

In the module we discussed:

1. Different types of RAID, their characteristics, advantages, and disadvantages
2. Types of expansion devices and their uses