

# Outline

- Chapter 14: Disk Scheduling
- RAID paper



# Disk scheduling

- Schedule disk accesses to gain performance
  - FCFS - first come first service
  - SSTF - shorted seek time first
    - starvation
  - SCAN
    - Elevator algorithm
  - CSCAN
    - Restarts from the beginning after each cycle
  - LOOK
    - Look till end of direction
  - CLOOK
- Disk scheduling harder with smart disks that can rearrange bad sectors



# RAID

- Reliability vs redundancy
- Performance via parallelism
  
- Raid 0: striping w/o redundancy
  - No redundancy
  - Good I/O performance
- Raid 1: Mirrored disks
  - Highly redundant
  - Twice read rate, same write performance
- Raid 2: Hamming code ECC
  - Separate disks for data and error correction code
  - Commercially not viable



## Raid levels

- Raid 3: bit-interleaved parity organization
  - Data with separate parity disks
- Raid 4: block-interleaved parity
  - Separate parity disk
- Raid 5: Block-interleaved distributed parity
  - Parity data is distributed across all disks
  - Complex implementation on the controller
- Raid 6: Independent Data disks with two independent distributed parity schemes
- Raid 10 (striped array whose segments are RAID 1 arrays), 50, 0+1, 53, ...



# Disk attachment

- Host-attached storage
  - SCSI, Fibre-Channel
- Network attached storage (NAS)
  - Device implements a complete file system
- Storage-Area Networks
  - High speed interconnect
  - Can dynamically reassign disks to other servers
- iSCSI
  - SCSI using IP protocols
  - Security, congestion etc. are issues
- Direct Access File System (DAFS)
  - Emerging standard leveraging Remote Direct Memory Access infrastructure
  - <http://www.dafscollaborative.org/>



## So far....

- Process management
  - Processes, threads, CPU scheduling, Synchronization and deadlocks
- Storage management
  - Memory management, Virtual memory, File systems
- I/O Systems
  - I/O systems and storage structure
- Still left: Protection and security

