Announcements

- Reading Chapter 13
- Project #5 handout available
- Midterm #2 will be returned Thursday

NTFS

- File system may
  - Be a partition (fraction) of a disk
  - May spam multiple disks
- Clusters
  - Group sectors into a larger group (typically 4KB)
  - Logical cluster numbers (0…N) describe where a cluster is
- File consists of a set of attributes
  - Attributes
    - arbitrary sized
    - Linear ordering from 0…n
  - Examples
    - Filename
    - File data
    - Security
    - Mac Resource fork

NTFS Files

- Each file is stored in an entry in the Master File Table (MFT)
  - Each entry 1-4KB
  - Small attributes stored directly in MFT
  - Larger attributes are stored in one or more extents (contiguous clusters on the disk)
- Special Files
  - MFT – file 0
  - Copy of first 16 entries in MFT
  - Log file – log of changes to file system
  - Attribution definition table
  - Root directory
  - Bitmap free list
  - Boot file (must be at a standard disk address)
  - Bad cluster file

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NTFS (cont)

- Each Directory is stored in a B+ Tree
  - Permits fast lookup of information
  - Index root is a cluster with the top of the B+ tree
  - Larger directories contain additional clusters
- Security
  - Each file has an access token (owner info) and an ACL list
  - Permissions not normally checked on directories

NTFS

- Logs
  - Stores redo and undo info for changes to FS state
    - Only represents data structures of the file system not data
  - Writes a commit record when the update is done
- Multi-partition files
  - Volume set
    - Concat up to 32 partitions into one larger file system
  - Stripe set (basically RAID0)
    - Round robin among partitions on a per LCN basis
  - Stripe set with parity (RAID5)
  - Disk mirroring (RAID1)

NTFS Plugin Features

- Change Journal
  - Way for user space processes to learn what files have changed
    - Useful content index services
    - Used by replication services
- Volume Shadow Copy
  - Provides copy on write of files after the shadow copy
  - Permits
    - Backups in a consistent state
    - User file undo operations

Extent Based Storage

- Try to keep blocks together
- Allocate blocks prior to use
  - Reserves space for file (user can specify size)
  - Ensures clusters are together

UNIX Shell and Current Directory

- Current Directory
  - Maintained on a per process basis by kernel
  - System Calls: get/set the current directory
  - Open system Call
    - File name checked and if it lacks a leading /, pre-pend cwd onto path
- Shell (file path)
  - Entirely implemented in user space
  - PATH Environment variable
    - Lists directories to search
  - Hash table of commands and their location (file, or internal)