ToyFs -- a simple inode based file system

ToyFS Disk:

- All numbers in Little Endian format
- Blocks are 4k file system blocks
- ToyFs -- Block 0
  - 4 bytes: TyF4
  - 4 bytes: Size of disk in sectors
  - 4 bytes: Number of inodes (multiple of 64)
  - 4 bytes: Number of blocks of data block bit map (DBBM)
  - 4 bytes: Number of words of inode bitmap (iCnt)
  - 4*iCnt bytes: Inode bitmap, 0 => free inode, 1 => used
- Block 1 - DBBM
  - 4 bytes: Number of words of data bitmap (dCnt)
  - 4*dCnt bytes: Data bitmap, 0 => free inode, 1 => used
- Sector DBBM+1 - DBBM+1+M: inodes (64 inodes per sector, M = NumberOfInodes/64)
- Sector DBBM+1M+1 - end: data blocks
- Inodes and data blocks are indexed starting at 1
- Inode 1 is the root directory

On Disk Inode structure

- 2 bytes: number of links
- 2 bytes: mode (file type, r, w, x bits)
- 4 bytes: size of file in bytes
- 4 bytes: number of data blocks allocated
- 40 bytes: 10 direct links
- 4 bytes: single indirect
- 4 bytes: double indirect (for future use)
- 4 bytes: spare (unused)

Total size: 64 bytes => 64 inodes per block

Directory entry

- Maximum of 10 sectors for limited directory size
- Each sector contains an integral number of entries
  - No entry goes across a sector boundry
- Multiple entries per sector, entry format:
  - 4 bytes, inode number
  - 4 bytes, name length (max 255, no '\0' terminating)
  - n+1 bytes, name
  - entries are padded with 0 to 3 charaters to make word aligned entries
- entry inode number meanings:
  - -1: end of all directory entries
  - 0: end of directory entries in this sector, more next sector
  - >0: actual inode number, more entries follow
- Required names: . and ..

Toy Filesystem and related classes

toy_filesystem class -- Methods provided

- toy_filesystem() -- the constructor
- mountFS() -- called when we want to open the disk for use
- saveRootandbMaps() -- save the core filesystem information
- openLastDir (string, workDir, lastElementLoc)
- nameToInodeNum (string, workDir)
- AllocInode() -- returns inodeNum, -1 => no more left
- FreeInode (inodeNum)
- AllocDataBlock () -- returns blockNum, -1 => no more left
- FreeDataBlock(blockNum)
- GetDiskInfo(diskInfo) -- implemented for you
- Open(name, dir, flags, mode) -- Mostly done

- Open: Open the file for operations
- nameToInodeNum, GetFCB: lookup file and just get the FCB, not a full open.
  - FCB still needs to be released.
  - Should be used in Stat and ChangeMode methods. (see next page)

toy_filesystem class -- Methods you need to implement

- Read(openF, userBuf, size)
  - Write(openF, userBuf, size)
  - Stat (name, statBuf)
  - ChangeMode (name, newmode) (CSCI 509)

InodeData class (Class used by ToyFS)

- Methods of interest (not listing all getters)
  - InodeData(), Print()
  - WriteInode() -- writes the inode back to disk
  - LoadIndSec() -- gets a frame / reads in indirect sector
  - WriteIndSec() -- changes have been made to indiret block, save it

- Methods to Implement
  - AllocateNewBlock(logicalBlock)
    - May have to allocate a new indirect block
    - updates direct block or indirect block, save modified data

Other Objects in the Kernel

FileControlBlock -- One per file

- FileControlBlock(), Print()
- Load() -- reads inode from disk
- Hold() -- adds another user of the FDB
- Flush() -- Writes out the sector in the FCB buffer
- Release() -- Should have been flushed before this call
- ReadBytes (target, offset, bytes) - read from disk to kernel memory
- WriteBytes (target, offset, butes) - write from kernel memory to disk
- various other getters

OpenFile -- Many methods implemented

- OpenFile, Print, LoadExecutable
- NewReference -- Increments numberOfUsers
- Lookup -- Lookup a name in an open directory
- GetNextEntry -- Get the next entry in an open directory

- Need to implement
  - Read, Write -- dispatches to correct subsystem
  - Seek -- does different things depending on file type, implements Seek
  - ReadDir -- implements Sys_ReadDir
  - Dup -- implementes Sys_Dup
  - Close -- partially impelemented. Needs to be upgraded.

Locking in the File System

- fsLock -- filesystem operations
- inodeLock -- serializes ALL inode operations as there is one lock for all inodes
- each fcb has a lock
- each OpenFile has a lock

Improvements still could be made to Toy FS.