W4118: xv6 file and disk systems

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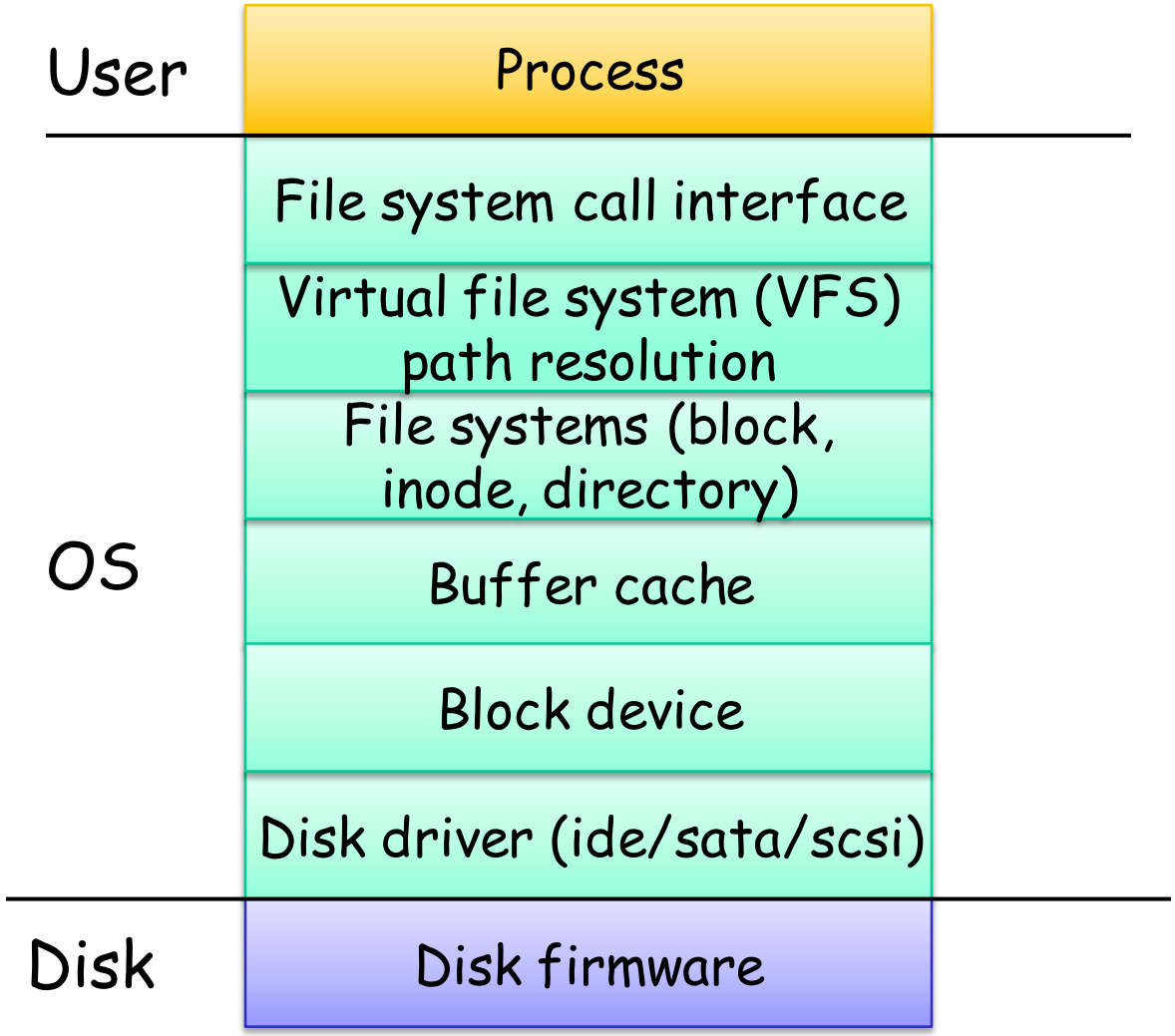
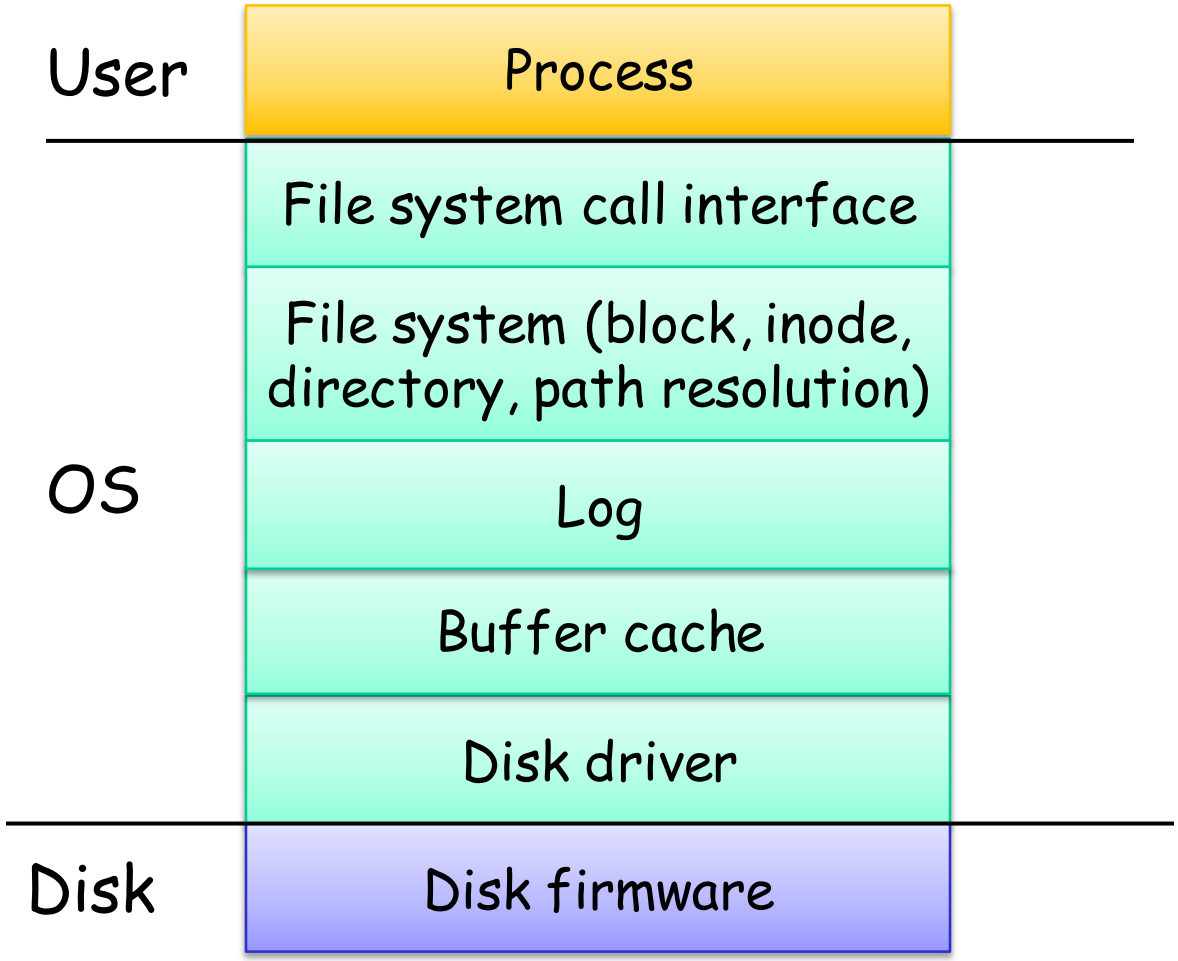
References: Modern Operating Systems (3rd edition), Operating Systems Concepts (8th edition), previous W4118, and OS at MIT, Stanford, and UWisc

Layered approach to storage systems



xv6 storage layers



xv6 disk driver

- ide.c

- iderw(struct buf *b): read or write disk sector
- idestart(struct buf *b): start request for b
- ideintr(): ide interrupt handler
- ideinit(): ide initializer

xv6 buffer cache

- bio.c
- *struct buf*
  - flags: B_BUSY, B_VALID, B_DIRTY
- *struct bcache*
  - head: LRU list of cached blocks
- bread(): read disk sector and return buffer
- bwrite(): write buffer to disk sector
- bget(): look up buffer cache for sector and set busy flag
- brelse(): clear busy flag and move buffer to head
- binit(): initialize buffer cache

xv6 log

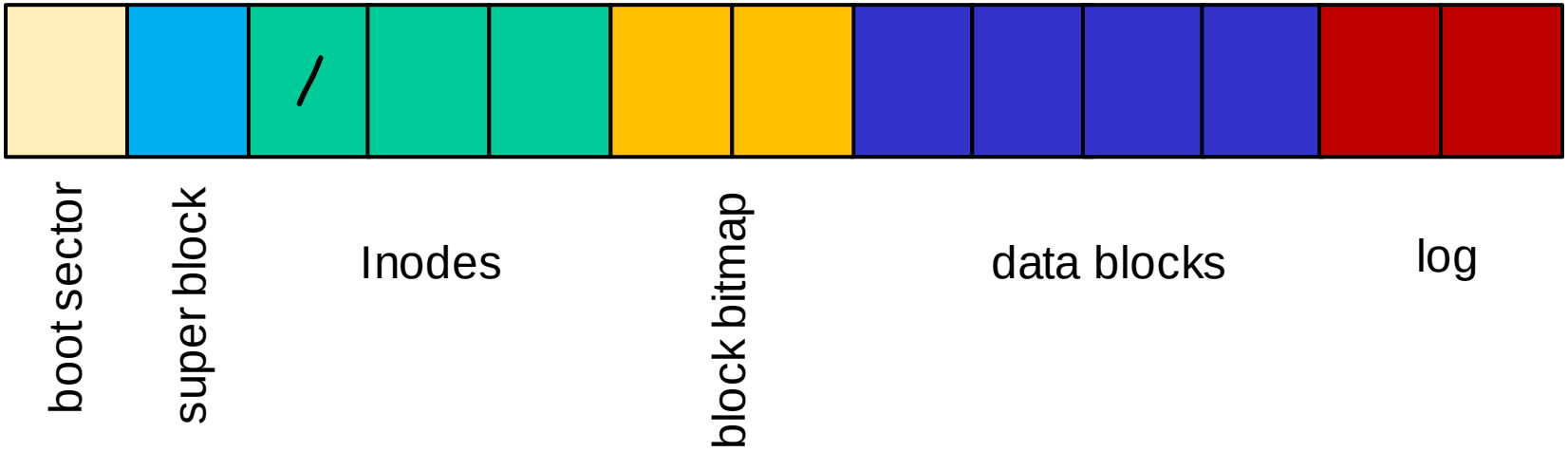
- log.c

- *struct log*
- *struct logheader*
  - Contents of the header block
- begin_trans(): begin a file system transaction
- commit_trans: commit a file system transaction
- log_write(): append modified block to the log
- recover_from_log(): replay log to patch FS
- initlog(): initialize the in-mem log structure and recover from log

xv6 buffer cache locking

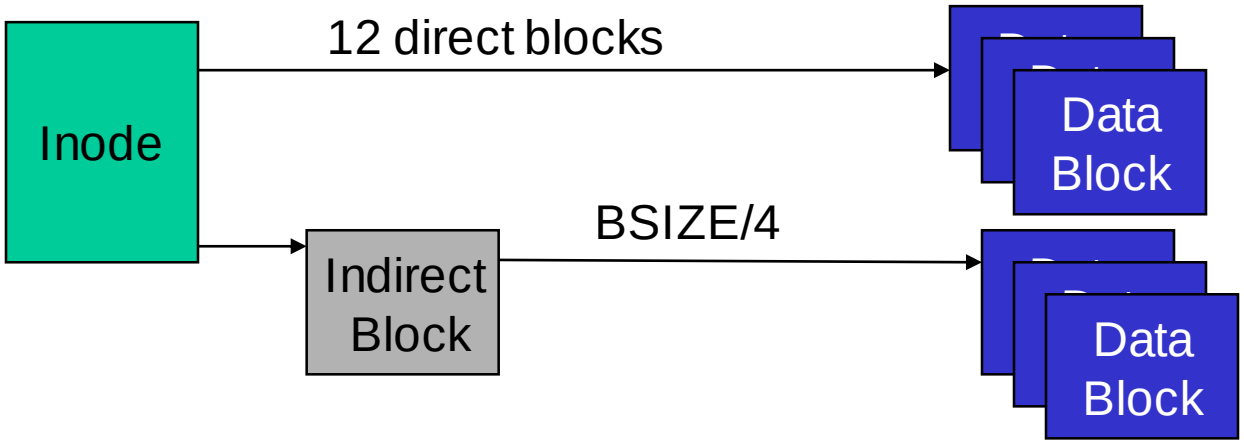
- bcache.lock: lock for entire buffer cache
- b->flags & B_BUSY: busy bit for each buffer
  - Why flag? Hold no spinlock for disk access
- Ensures that only one process can be touching a *struct buf* at any time

xv6 file system layout



- fs.h, fs.c, mkfs.c
- *struct superblock*

xv6 file and directory layout



- NDIRECT = 12
- NINDIRECT = BSIZE/4 = 128
- *struct dinode* in fs.h, *struct inode* in file.h
- *struct dirent* in fs.h

xv6 block operations

- readsb(): read on-disk super block into in-mem super block

- bzero(): zero a block
- balloc(): allocate a block, set bitmap
- bfree(): free a block, clear bitmap

xv6 inode operations

- bmap(): map data block number to disk block number
- itrunc()
- ialloc(): allocate a new inode
- iupdate()

xv6 inode synchronization operations

- iget(): find in-memory inode from inode cache and bump reference count
- idup(): bump reference count
- iput(): decrement reference count and truncate inode if necessary
- ilock(): lock inode for read and write by setting I_BUSY flag
- iunlock(): unlock inode by clearing I_BUSY flag; must call iunlock() before iput()

xv6 file system calls

- file.c, sysfile.c

- Examples file system calls
  - sys_open()
  - sys_mkdir()

- Path resolution
  - namei()
  - nameiparent()