Section 8

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Today

- Project 3 Recap
- Project 4
- File Systems

Project 3 Recap

- How was performance?
  - Async vs. Sync?
  - Sync. # of threads?
  - Async. # of calls?
  - Buffer size?

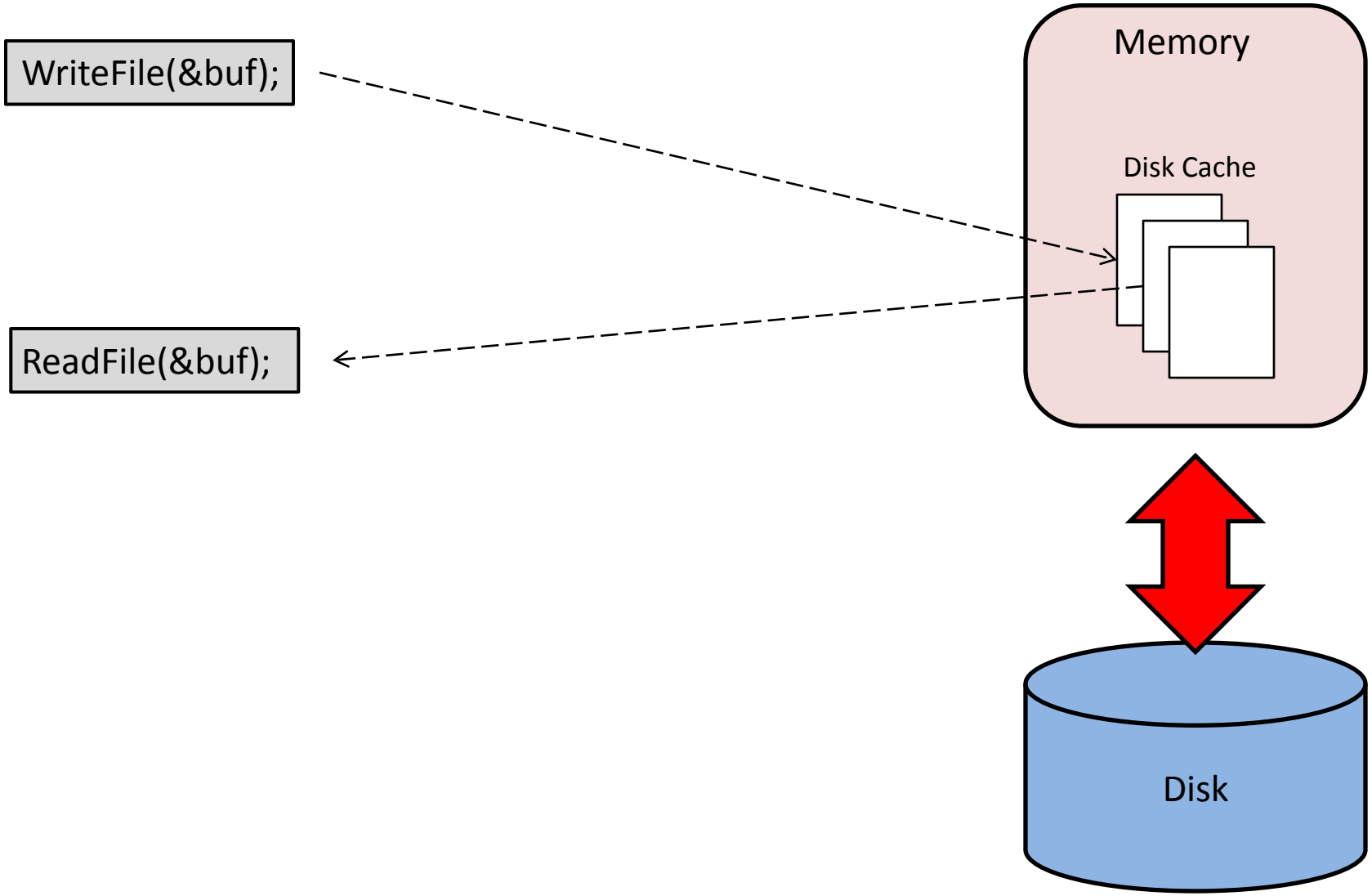
Project 3 (Under the Hood)

- Calls to disk are all sequential access!
  - Seems like concurrency won't help much…

Project 3 (Under the Hood)

- Calls to disk are all sequential access!
  - Seems like concurrency won't help much…
- Disk Caching!
  - Optimizations to keep pages in memory

Disk Caching



Disc Caching

- Disk scheduler can minimize amount of I/O between memory and disk.
- Delay write to disk as long as possible
- Reads **must** be immediate
  - If a write occurs on a file, a read on the same file must fetch from disk.

Project 4

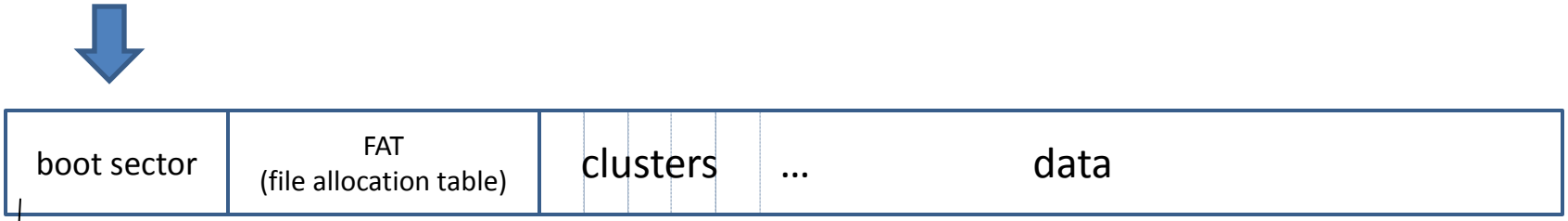
- Due March 5th
- Please set up environment soon, if you have not already!

Project 4

- Goals: Modify the FAT file system to
  - Make all directories sortable
  - Compact directories

Note: I have not done the project yet. All slides to follow are based on knowledge from someone who has.

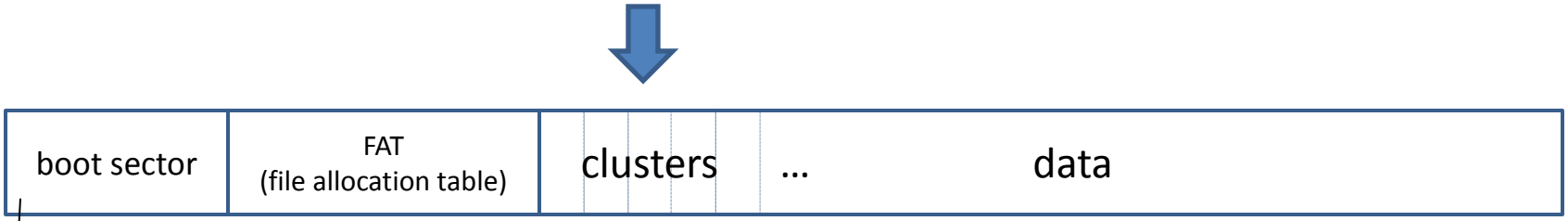
The FAT File System



Goal of FAT: store files and directories!

Size of FAT
Size of data area
Size of each cluster
Location of root dirent

The FAT File System



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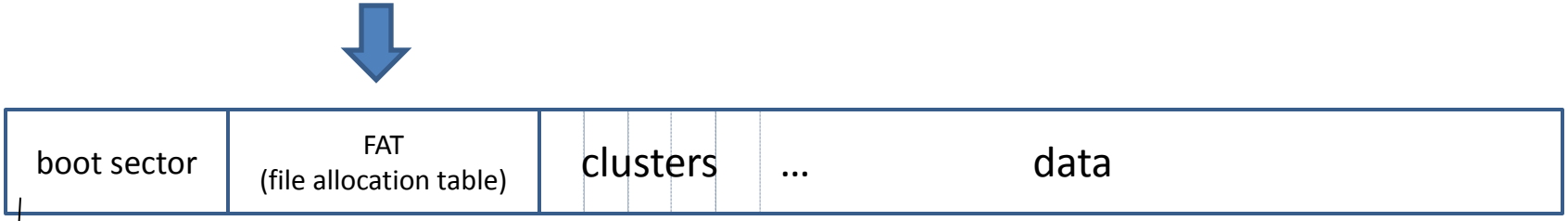
Each cluster either:

- Stores data for a file or…
- Stores lists of files in a directory (dirent)

The FAT File System



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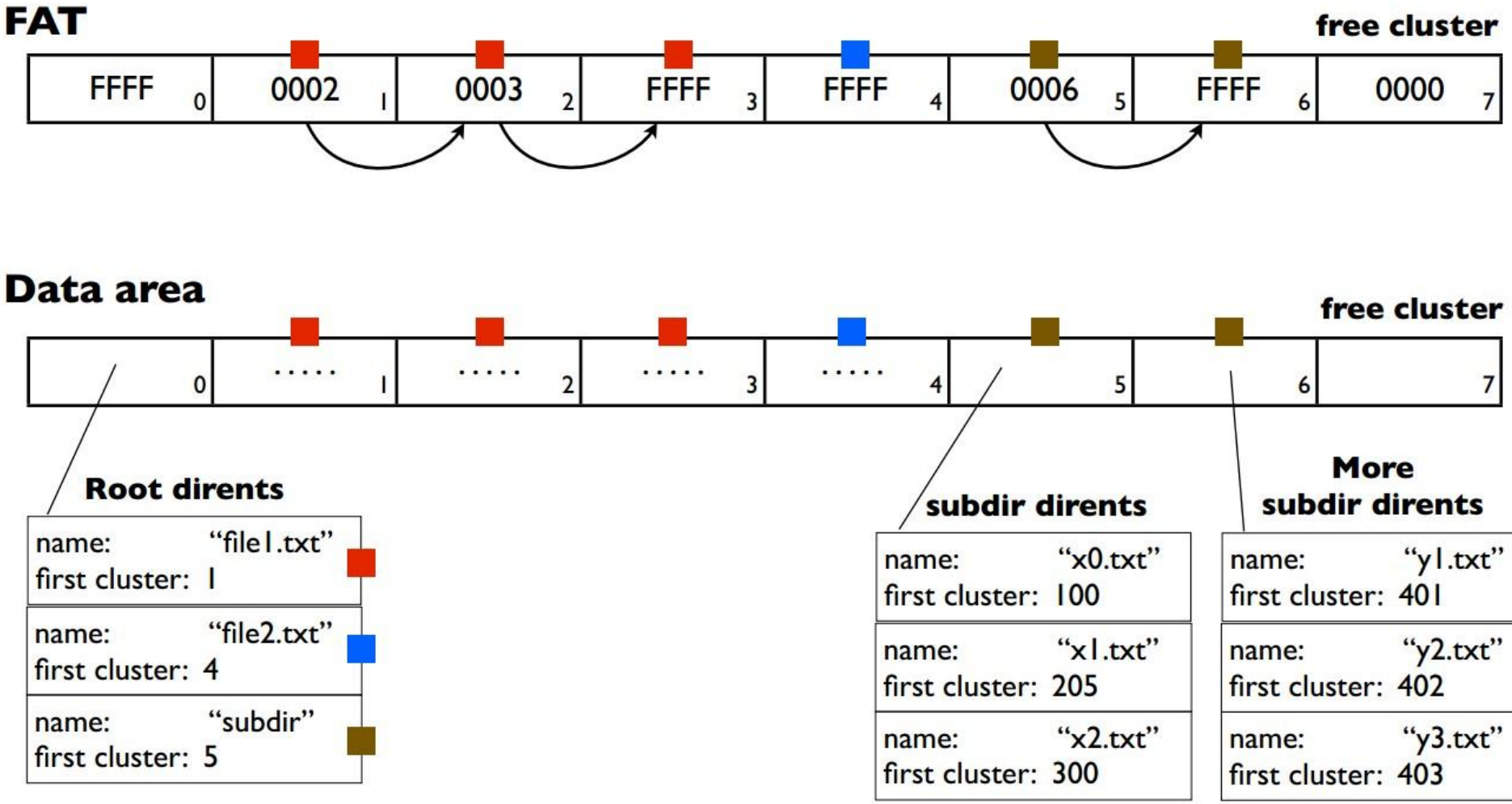
File Allocation Table

- Linked list of clusters
- As many entries as there are clusters

The FAT File System

- So, how do we get files?

The FAT File System



Project 4

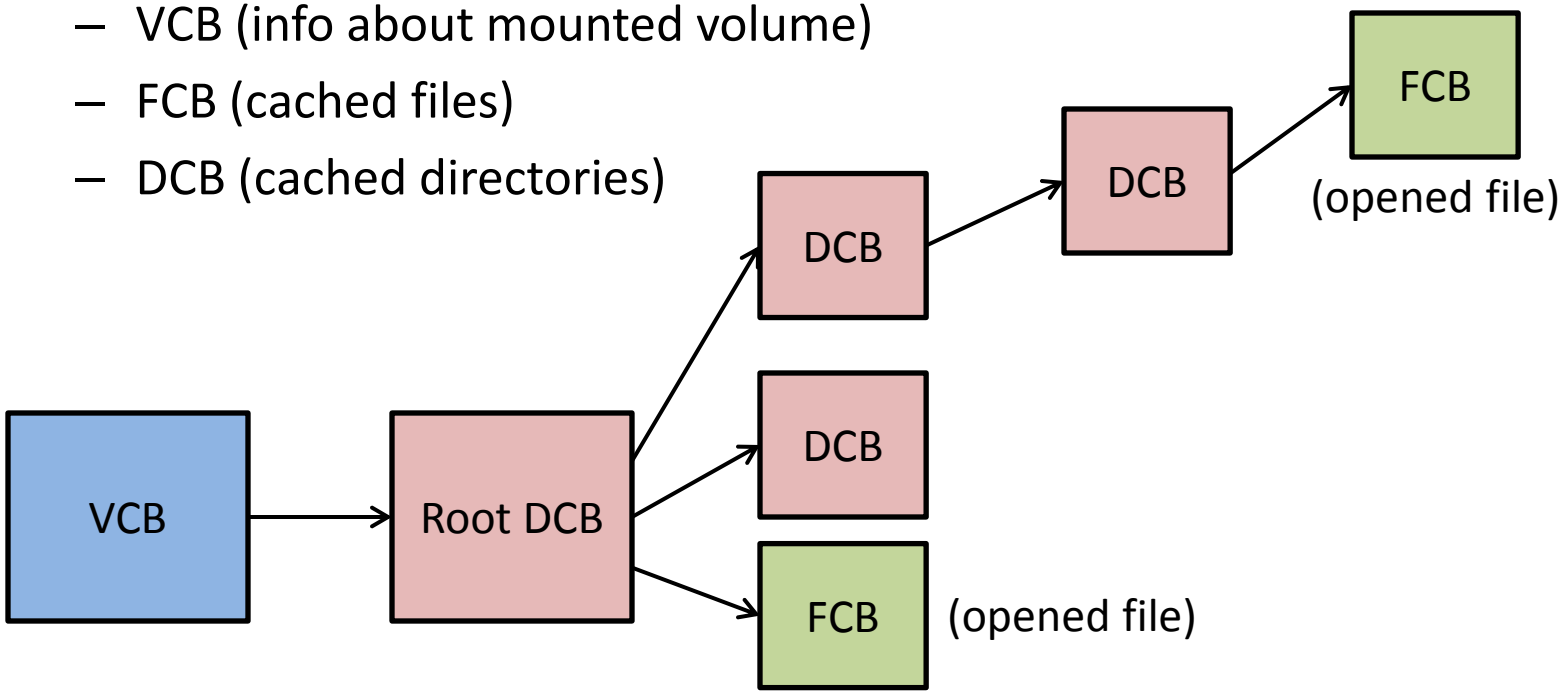
- Goal: keep dirents sorted in each directory
  - Note: This means implementing your own sorting algorithm!

PACKED_DIRENT (from fat.h)

```
FileName:                   “file1.txt”
LastWriteTime:              …
FirstClusterOfFile:         1
FileSize:                   4052
```

Project 4

- Kernel data structures: on-disk (fat.h)
  - PACKED_BOOT_SECTOR (boot info… don't modify)
  - BIOS_PARAMETER_BLOCK (boot info… don't modify)
  - PACKED_DIRENT (DIRENT struct)
- Kernel data structures: in-memory (fatstruc.h)
  - VCB (info about mounted volume)
  - FCB (cached files)
  - DCB (cached directories)



Project 4

- Resort dirents when:
  - Creating a new file (name, extension, cluster number)
  - Closing a file (timestamp, size)
  - Re-sorting the entire dirent
- Starting points:
  - Examples similar to what you need to do, in dirsup.c
  - Getting the volume label: VCB -> Vpb -> VolumeLabel (see FatMountVolume and FatLocateVolumeLabel)

File Systems

- FAT is extremely limited. For n = bits in FAT ptr:
  - DriveSize = 2^n * clusterSize
- FAT16 (16 bit FAT pointers)

Drive Size	Cluster Size
32 MB – 64 MB	1 KB
64 MB – 128 MB	2 KB
128 MB – 256 MB	4 KB
256 MB – 512 MB	8 KB
512 MB – 1 GB	16 KB
1 GB – 2 GB	32 KB

File Systems

- FAT is extremely limited. For n = bits in FAT ptr:
  - DriveSize = 2^n * clusterSize
- FAT**32** (**32** bit FAT pointers)

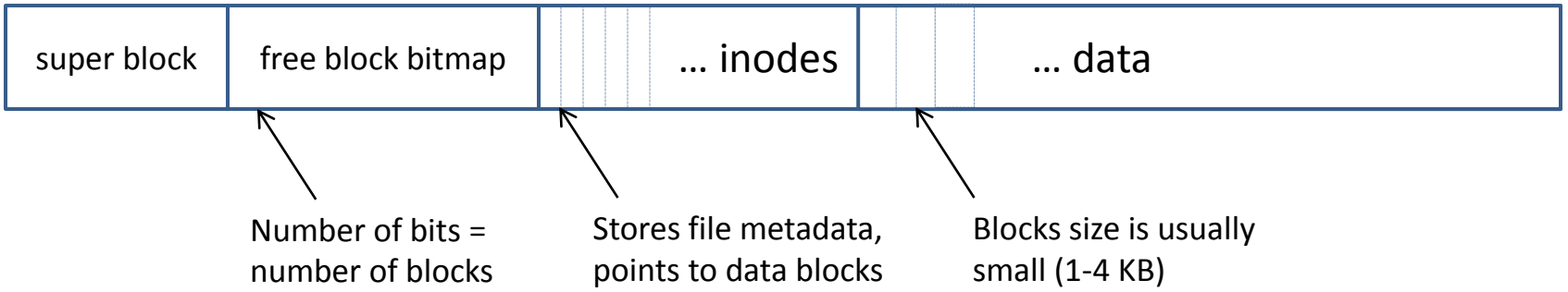
Drive Size	Cluster Size
32 MB – 64 MB	0.5 KB
64 MB – 128 MB	1 KB
128 MB – 256 MB	2 KB
256 MB – 8 GB	4 KB
8 GB - 16 GB	8 KB
16 GB – 32 GB	16 KB

File Systems

- Disk utilization in FAT can be wasteful
- Storing n-bit allocation tables can be space consuming:
  - FAT32 needs to store 2^{32} 32-bit entries (16 MB)
  - FAT64 needs to store 2^{64} 64-bit entries (too large!)
- What if we just stored 1 bit per entry?

Inodes

- Use a block bitmap
  - If bit=1, block is free to use
- Store file data pointers in inodes



File Systems