



COMPUTER SYSTEMS FUNDAMENTALS (4COSC004W)

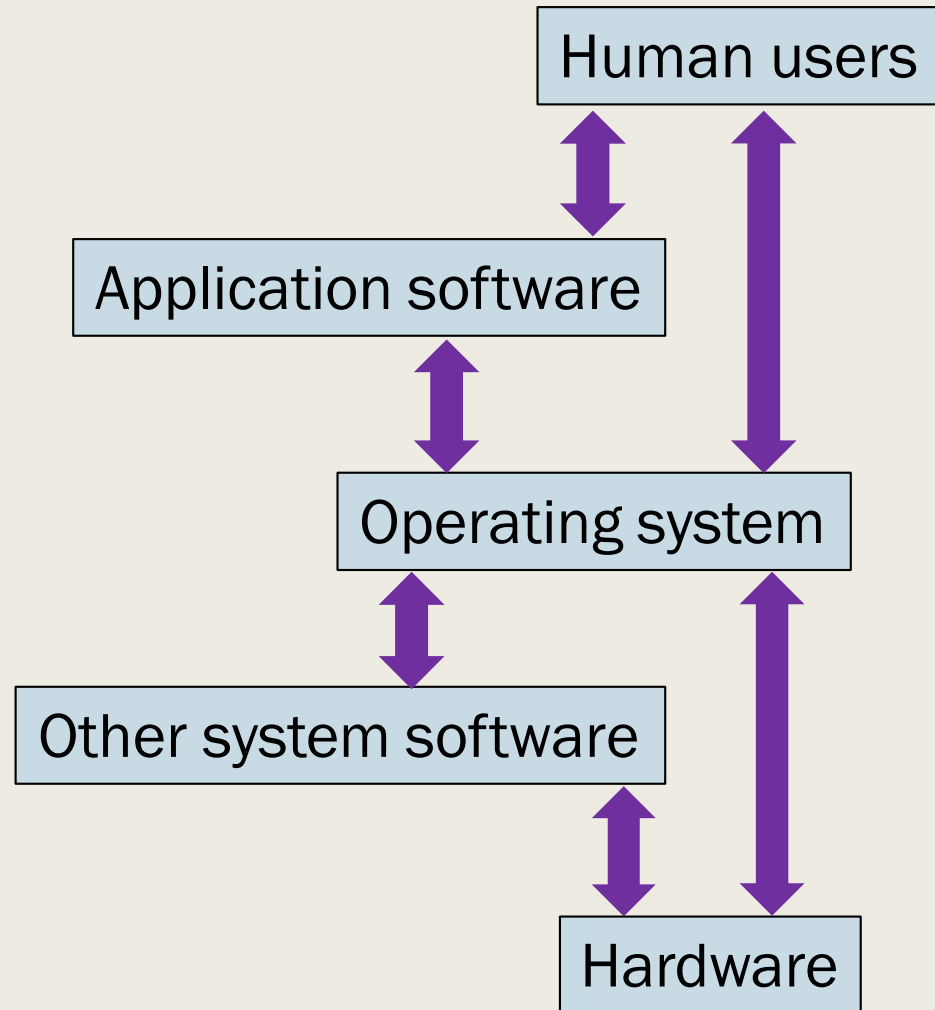
Lecture: Week 5



Operating systems overview:

- Operation of Hardware is controlled by software.
 - *Operating system*
 - Every computer must have
 - Human role: King, Emperor, Director
- Different types for different purposes
- Functions
 1. *File Management*
 2. *Memory Management*
 3. *Process Management*
 4. *Input/output functionality*
 5. *General purpose functions – system information*
- File systems

Operating System interactions



In this video we will cover:

- Sector addressing
- Disk partitioning
 - *Partition consistency*
 - *Formatting*
 - *PC-based partitions*
- Master Boot Record (MBR) Partitions
 - *Partition table*
 - *Disk Sector Zero*
 - Endianness

FILE SYSTEMS part a

Disk anatomy, MBR partitions & Disk Sector Zero

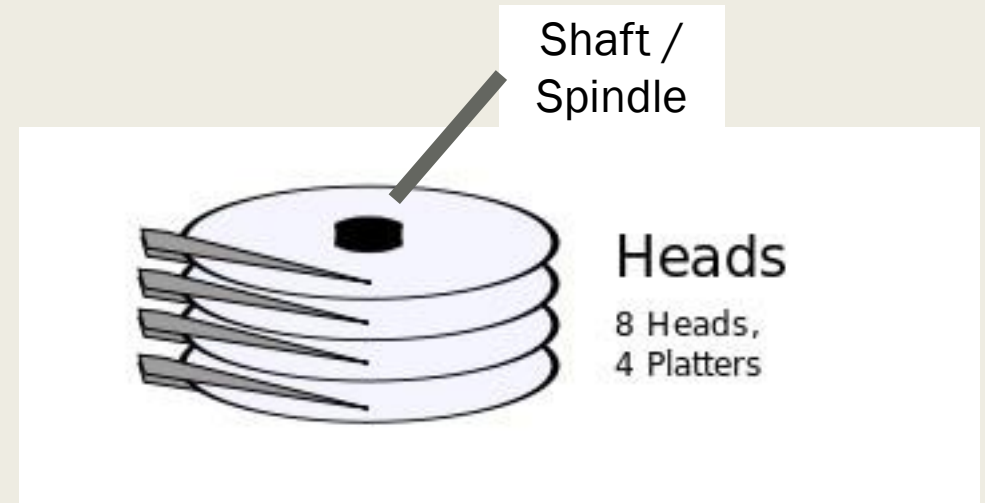
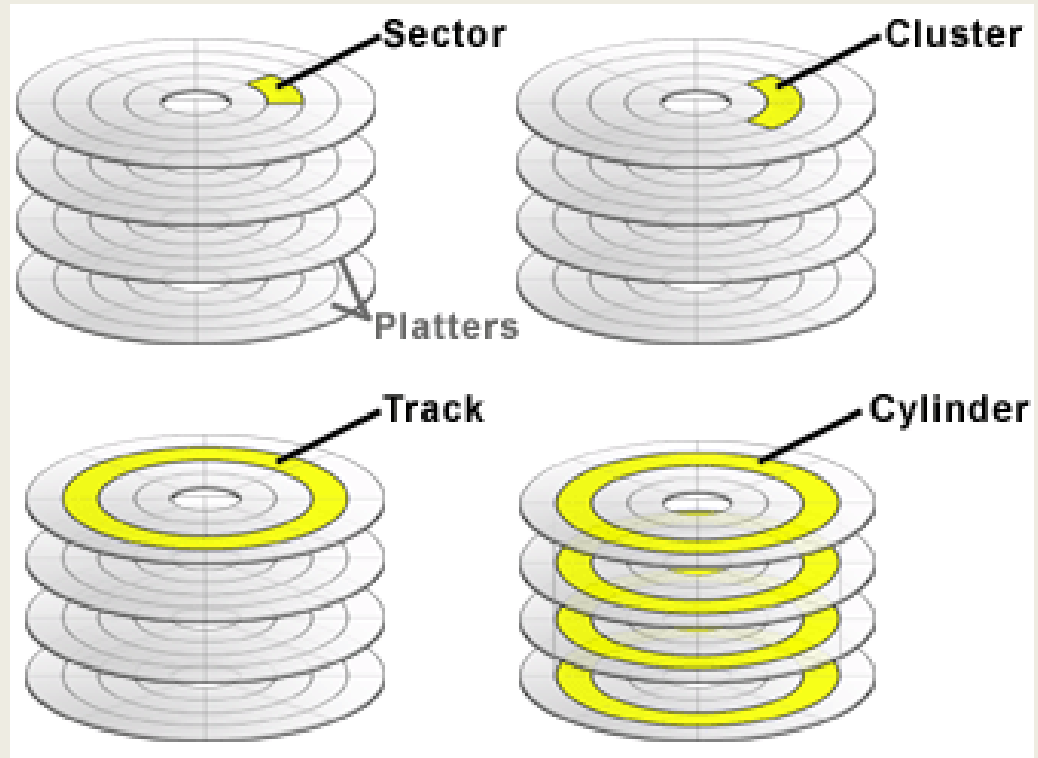
By the end of this video you will gain an understanding of:

- Sector addressing
- Disk partitioning
 - *Partition consistency*
 - *Formatting*
 - *PC-based partitions*
- Master Boot Record (MBR) Partitions
 - *Partition table*
 - *Disk Sector Zero*
 - Endianness

In File Systems part b (after ICT 1)

- FAT File Systems
 - *FAT structure*
 - *FAT Boot Sector*
- Windows volumes
- Unix volumes
- Directories
- Absolute path names
- Relative path names
- File types
- File operations
- Unix file systems
 - *File permissions*
 - *Access control*
 - *Indexing*
- Disk scheduling

Anatomy of a disk



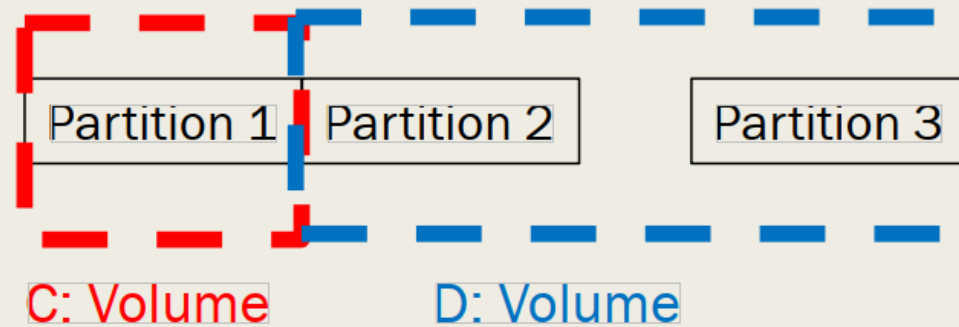
HARD DISK AUTOPSY

Addressing, PC Based Partitions & Disk Sector Zero

Sector addressing

- Sector
 - *Smallest addressable storage unit*
 - *Usually 512 Bytes*
- CHS (Cylinder Head Sector) Addressing
 - *Upto ½ GB*
- LBA (Logical Block Addressing)
 - *Directly linked to physical address*
 - *0, ...*

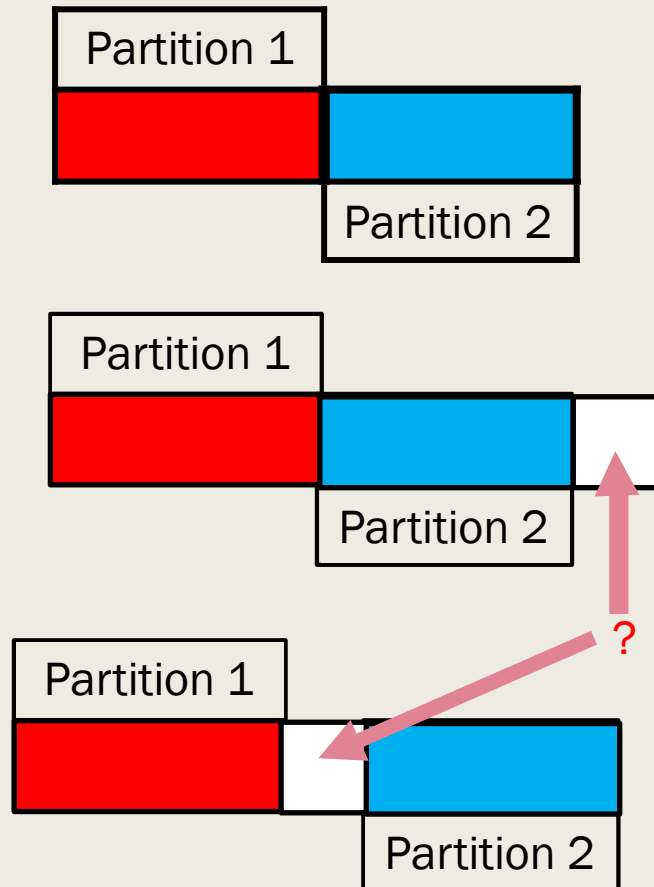
Disk partitioning



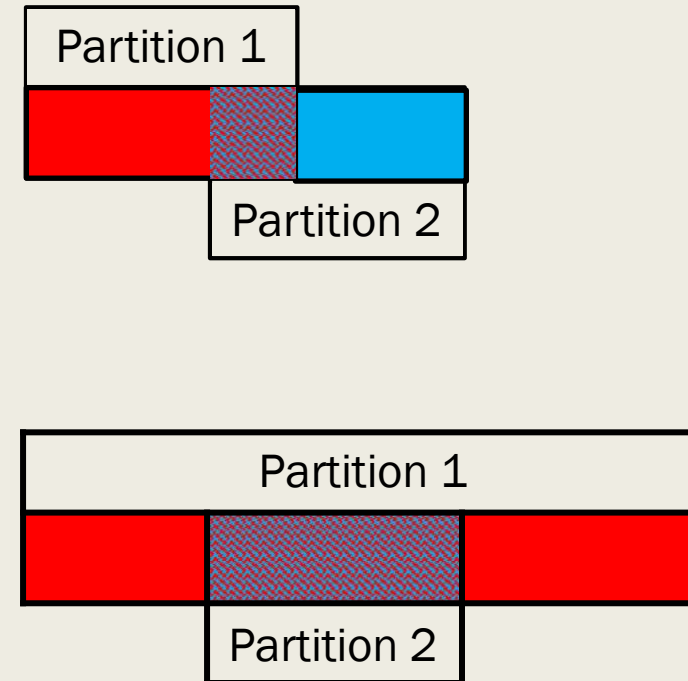
- Volume
 - *Collection of addressable sectors that an OS or application can use for data storage.*
- Partition
 - *Collection of consecutive sectors in a volume*

Partition consistency

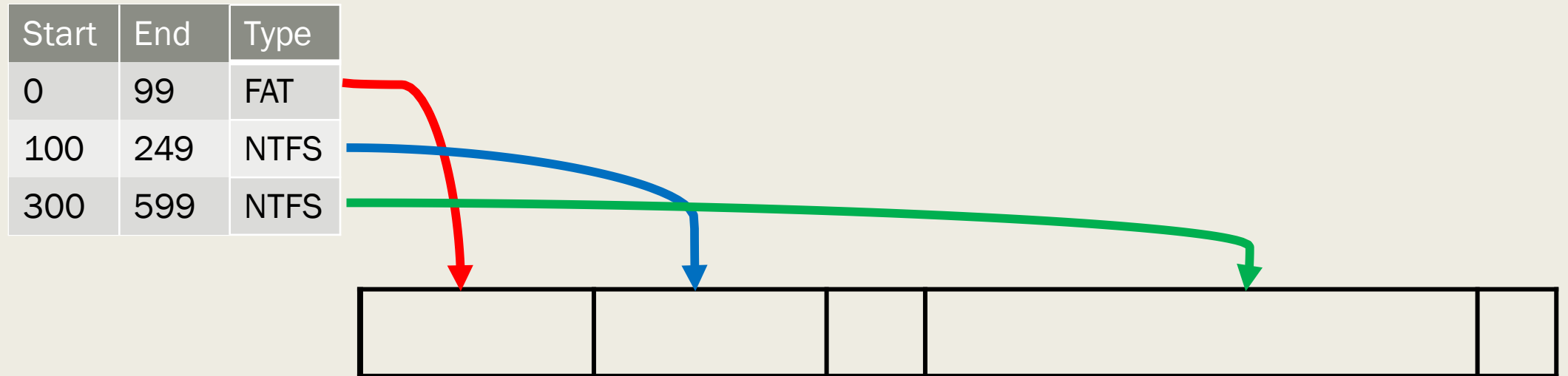
Healthy :



Problematic:



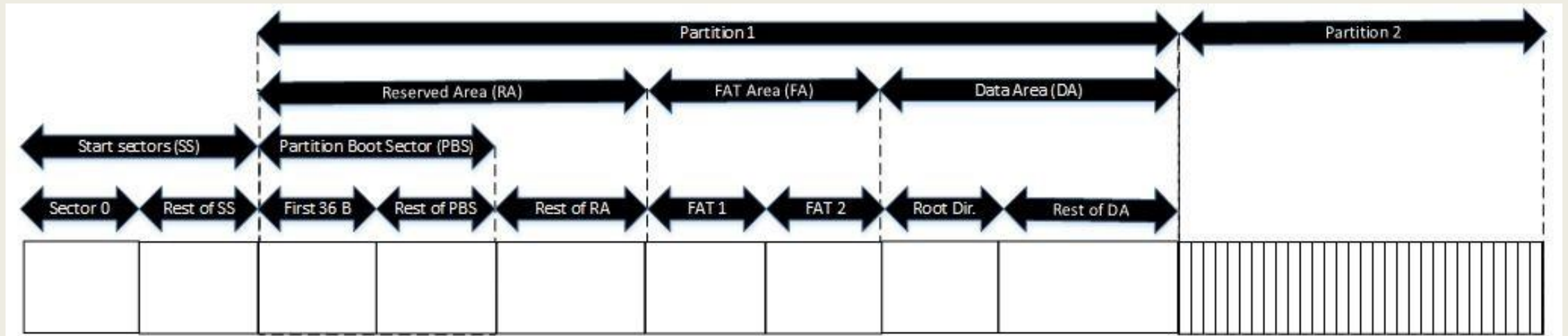
Disk formatting



PC-based partitions

- DOS-styled partition & MBR (Master Boot Record) disks
 - *Partitions limited to 2TB*
- GUID (Global Unique Identifier) Partition Table (GPT)
 - *Multiple ZetaBytes* 10^{21}

Schematic view of a Disk



MBR Partitions

Disk Sector Zero

Byte range		Description	Essential
Denary	Hex		
0 – 445	0-1BD	Boot code	No
446 – 461	1BE-1CD	Partition table entry # 1	Yes
462 – 477	1CE-1DD	Partition table entry # 2	Yes
478 – 493	1DE-1ED	Partition table entry # 3	Yes
494 – 509	1EE-1FD	Partition table entry # 4	Yes
510 – 511	1FE-1FD	Signature Value 0xAA55	No

MBR Partitions – Sector Zero

```

HxD - [E:\4COSC004w\dds\DiskSectorZero\disk-sector-zero-2.dd]
File Edit Search View Analysis Extras Window ?
26 16 ANSI dec
disk-sector-zero-2.dd
Offset(d) 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15
00000000 33 C0 8E D0 BC 00 7C FB 50 07 50 1F FC BE 1B 7C
00000016 BF 1B 06 50 57 B9 E5 01 F3 A4 CB BD BE 07 B1 04
00000032 38 6E 00 7C 09 75 13 83 C5 10 E2 F4 CD 18 8B F5
00000048 83 C6 10 49 74 19 38 2C 74 F6 A0 B5 07 B4 07 8B
00000064 F0 AC 3C 00 74 FC BB 07 00 B4 0E CD 10 EB F2 88
00000080 4E 10 E8 46 00 73 2A FE 46 10 80 7E 04 0B 74 0B
00000096 80 7E 04 0C 74 05 A0 B6 07 75 D2 80 46 02 06 83
00000112 46 08 06 83 56 A0 00 E8 21 00 73 05 A0 B6 07 EB
00000128 BC 81 3E FE 7D 55 AA 74 0B 80 7E 10 00 74 C8 A0
00000144 B7 07 EB A9 8B FC 1E 57 8B F5 CB BF 05 00 8A 56
00000160 00 B4 08 CD 13 72 23 8A C1 24 3F 98 8A DE 8A FC
00000176 43 F7 E3 8B D1 86 D6 B1 06 D2 EE 42 F7 E2 39 56
00000192 0A 77 23 72 05 39 46 08 73 1C B8 01 02 BB 00 7C
00000208 8B 4E 02 8B 56 00 CD 13 73 51 4F 74 4E 32 E4 8A
00000224 56 00 CD 13 EB E4 8A 56 00 60 BB AA 55 B4 41 CD
00000240 13 72 36 81 FB 55 AA 75 30 F6 C1 01 74 2B 61 60
00000256 6A 00 6A 00 FF 76 0A FF 76 08 6A 00 68 00 7C 6A
00000272 01 6A 10 B4 42 8B F4 CD 13 61 61 73 0E 4F 74 0B
00000288 32 E4 8A 56 00 CD 13 EB D6 61 F9 C3 16 C5 89 A2
00000304 85 18 CB 6B 26 1A C0 E0 41 B3 38 3E 71 E8 14 9F
00000320 AF 94 1B 30 FC 09 52 C5 F0 65 C2 B8 DB 9B F8 4B
00000336 4B 95 B0 EF 1F DA 66 16 6C 9E D5 95 E9 42 94 9D
00000352 B1 87 4F E0 76 09 61 65 8B CB BC 1E 50 E0 6C 49
00000368 F1 81 21 27 80 0E 84 97 D8 DD 59 9E D6 CE 9C F3
00000384 CB FA 1E 03 44 0B 5F 18 83 FB 99 94 40 61 00 00
00000400 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00000416 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00000432 00 00 00 00 00 2C 44 63 F1 AA B5 54 00 00 80 01
00000448 01 00 06 40 E0 BC 20 00 00 00 E0 DF 1D 00 00 00
00000464 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00000480 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00000496 00 00 00 00 00 00 00 00 00 00 00 00 00 55 AA

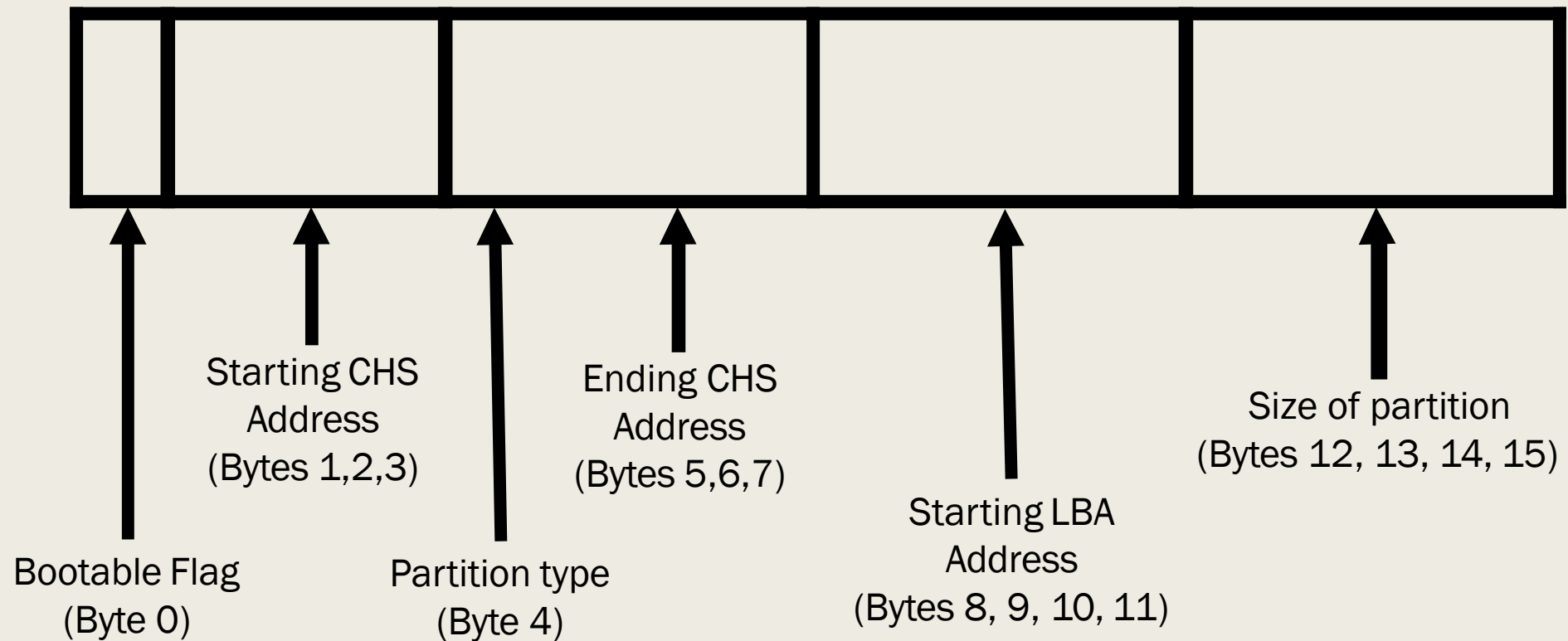
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MBR Partitions

00000416	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00000432	00	00	00	00	00	2C	44	63	F1	AA	B5	54	00	00	80	01
00000448	01	00	07	40	E0	BC	20	00	00	00	E0	DF	1D	00	00	00
00000464	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00000480	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00000496	00	00	00	00	00	00	00	00	00	00	00	00	00	00	55	AA

Byte range	Description	Essential
0 - 445	Boot code	No
446 - 461	Partition table entry # 1	Yes
462 - 477	Partition table entry # 2	Yes
478 - 493	Partition table entry # 3	Yes
494 - 509	Partition table entry # 4	Yes
510 - 511	Signature Value 0x55AA	No

Partition Table Data Diagrammatic



Partition Table data

01 00 07 40 E0 BC 20 00 00 00 E0 DF 1D 00

80 01

Byte range	Description	Value
0 - 0	Bootable Flag	80
1 - 3	Starting CHS Address	01 01 00
4 - 4	Partition Type	07
5 - 7	Ending CHS Address	40 E0 BC
8 - 11	Starting LBA Address	20 00 00 00
12 - 15	Size in Sectors	E0 DF 1D 00

Endianness

- Byte ordering for the representation of data
 - *IA32 based system*
- Big Endian
 - *Most significant Byte first*
 - *10 25 03 is written as 10 25 03*
- Little Endian
 - *Least significant Byte first*
 - *10 25 03 is written as 03 25 10*
- So knowing the endianness used by a particular computer, we can read the information stored in it.

Partition Table data

Byte range	Description	Value	
		Little Endian	Big Endian
0 - 0	Bootable Flag	80	
1 - 3	Starting CHS Address	01 01 00	00 01 01
4 - 4	Partition Type	07	
5 - 7	Ending CHS Address	40 E0 BC	BC E0 40
8 - 11	Starting LBA Address	20 00 00 00	00 00 00 20
12 - 15	Size in Sectors	E0 DF 1D 00	00 1D DF E0

Type values for DOS Partitions

Type	Description
0x00	Empty
0x01	FAT 12, CHS
0x04	FAT 16, 16-32 MB , CHS
0x06	FAT 16, 32 MB – 2 GB , CHS
0x07	NTFS
0x0b	FAT 32, CHS
0x0c	FAT 32, LBA
0x82	Solaris x86
0x83	Linux
0xa5	FreeBSD
0xa6	OpenBSD
0xa8	Max OSX

Partition Table data

Byte range	Description	Value			
		Little Endian	Big Endian		
0 - 0	Bootable Flag	80		Bootable	
1 - 3	Starting CHS Address	01 01 00	00 01 01		
4 - 4	Partition Type	07		NTFS	
5 - 7	Ending CHS Address	40 E0 BC	BC E0 40		
8 - 11	Starting LBA Address	20 00 00 00	00 00 00 20	Sector: 32	16 KB
12 - 15	Size in Sectors	E0 DF 1D 00	00 1D DF E0	Sectors: 1957856	978928 KB

$$(1 \times 1048576) + (13 \times 65536) + (13 \times 4096) + (15 \times 256) + (14 \times 16)$$

$$1048576 + 851968 + 53248 + 3840 + 224 = 1957856$$

Using the Information sheet:

1

D

D

F

E

O

Multiplication tables:

1048576 table	
1	1048576
2	2097152
3	3145728
4	4194304
5	5242880
6	6291456
7	7340032
8	8388608
9	9437184
10	10485760
11	11534336
12	12582912
13	13631488
14	14680064
15	15728640

65536 table	
1	65536
2	131072
3	196608
4	262144
5	327680
6	393216
7	458752
8	524288
9	589824
10	655360
11	720896
12	786432
13	851968
14	917504
15	983040

4096 table	
1	4096
2	8192
3	12288
4	16384
5	20480
6	24576
7	28672
8	32768
9	36864
10	40960
11	45056
12	49152
13	53248
14	57344
15	61440

256 table	
1	256
2	512
3	768
4	1024
5	1280
6	1536
7	1792
8	2048
9	2304
10	2560
11	2816
12	3072
13	3328
14	3584
15	3840

16 table	
1	16
2	32
3	48
4	64
5	80
6	96
7	112
8	128
9	144
10	160
11	176
12	192
13	208
14	224
15	240

Converting from Sectors to KB and MB

- There are 512 Bytes in a Sector
- To convert from Sectors to KB:
 - *Divide no. Sectors by 2*
- To convert from KB to MB:
 - *Divide no. KB by 1024*

After the ICT 1, File Systems part b

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