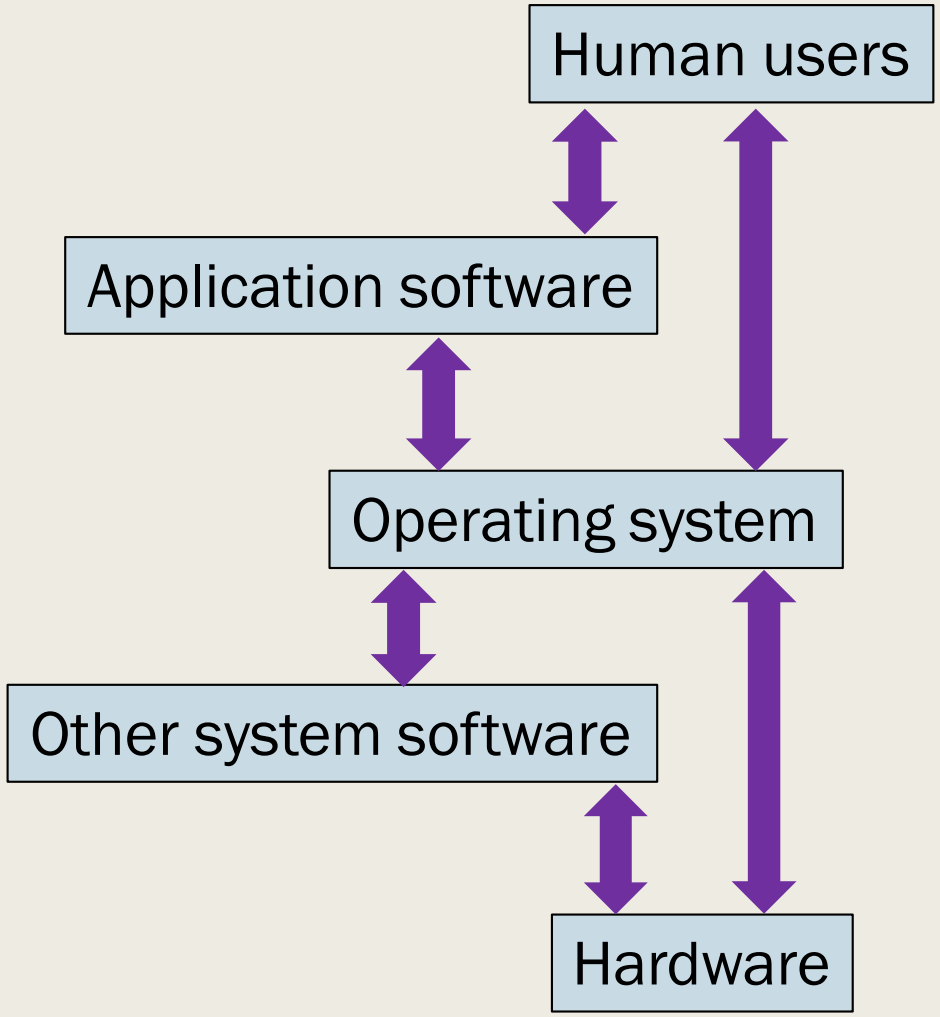
COMPUTER SYSTEMS FUNDAMENTALS
(4COSC004W)

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

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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

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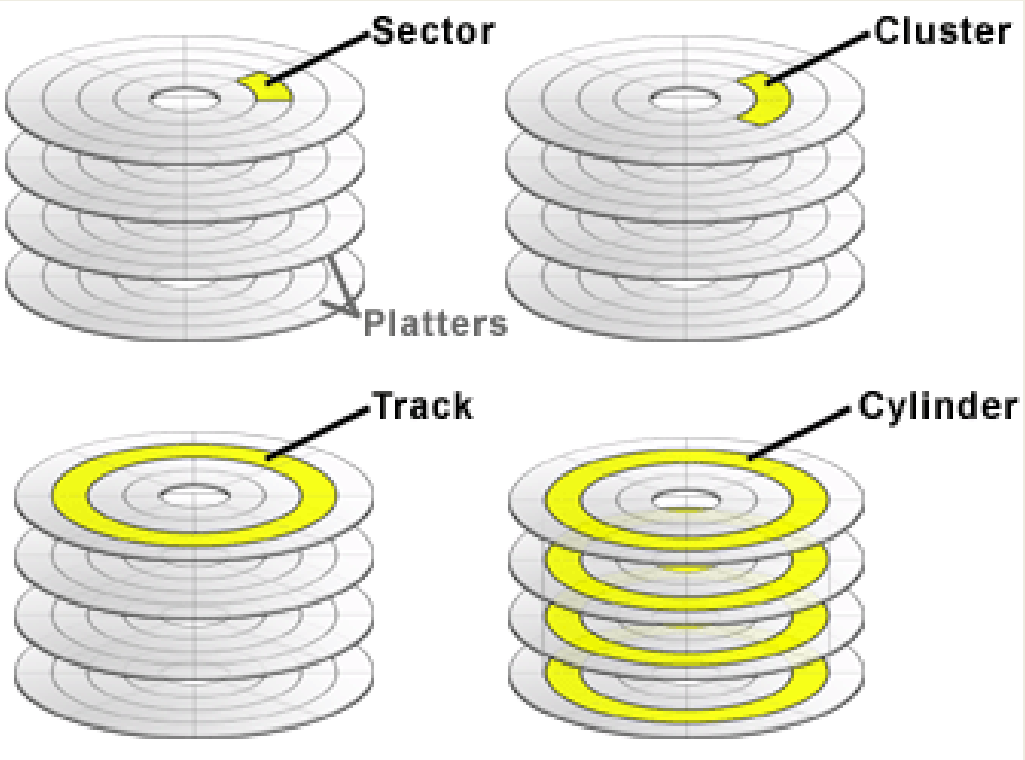
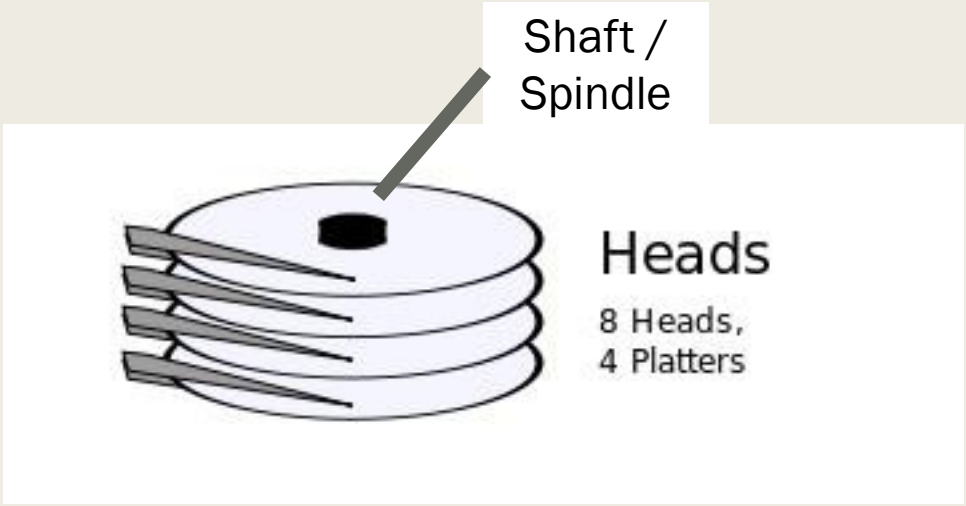
Anatomy of a disk





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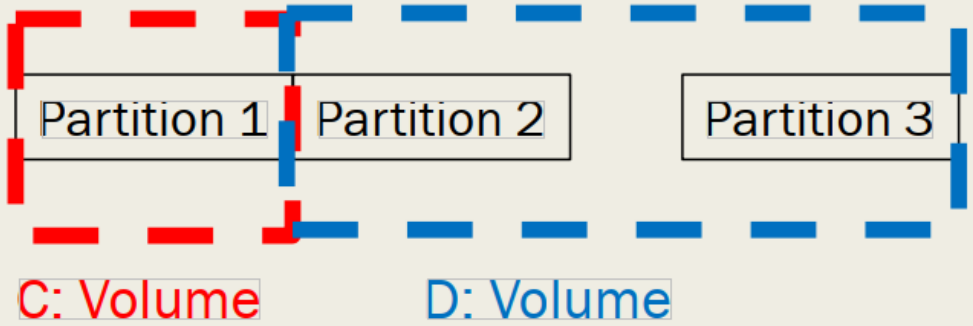
HARD DISK AUTOPSY

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, …*

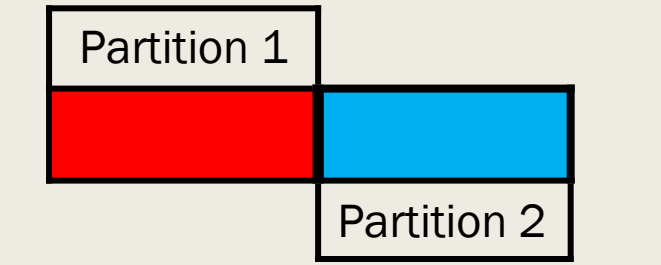
Disk partitioning

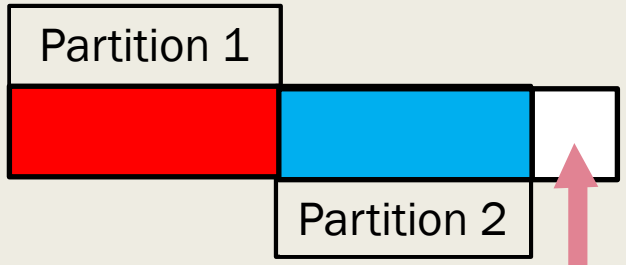


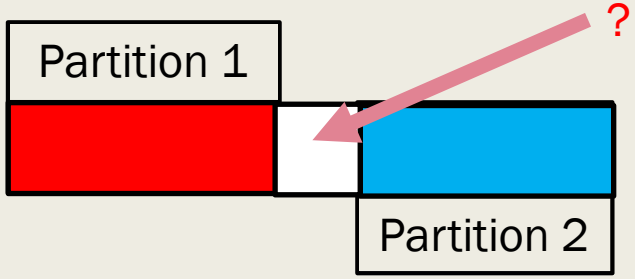
- Volume
  - *Collection of addressable sectors that an OS or application can use for data storage.*
- Partition
  - *Collection of consecutive sectors in a volume*

Partition consistency

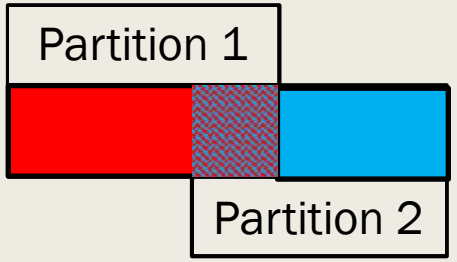
Healthy :

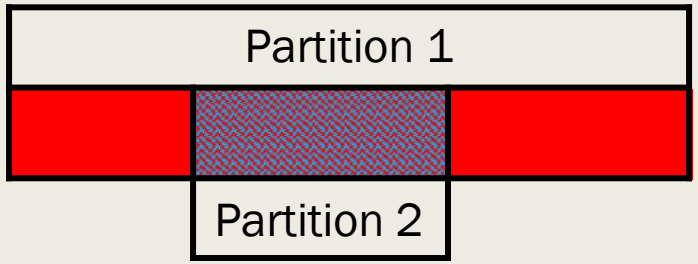






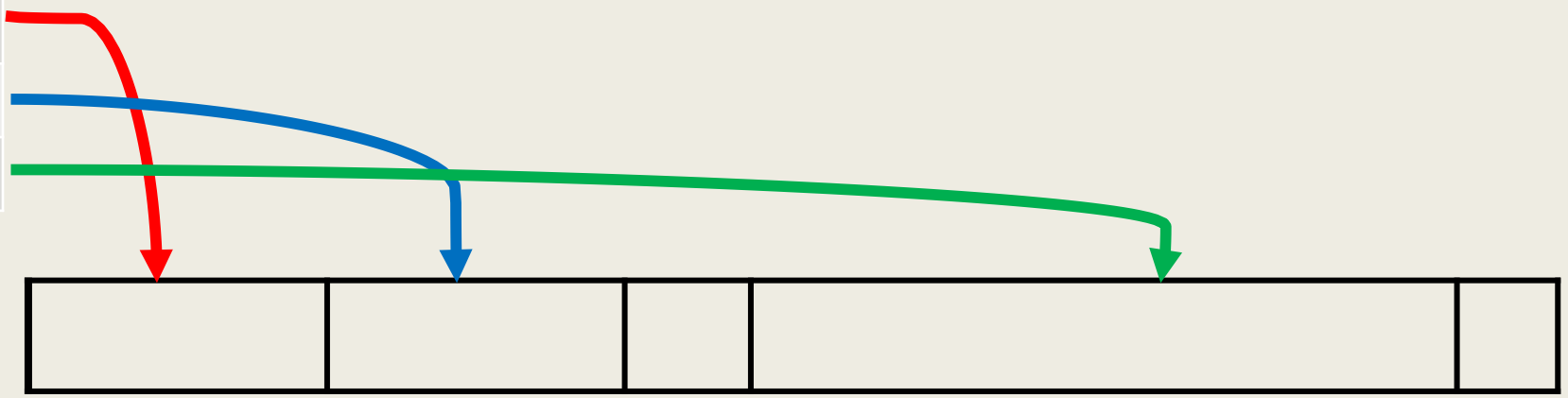
Problematic:





Disk formatting

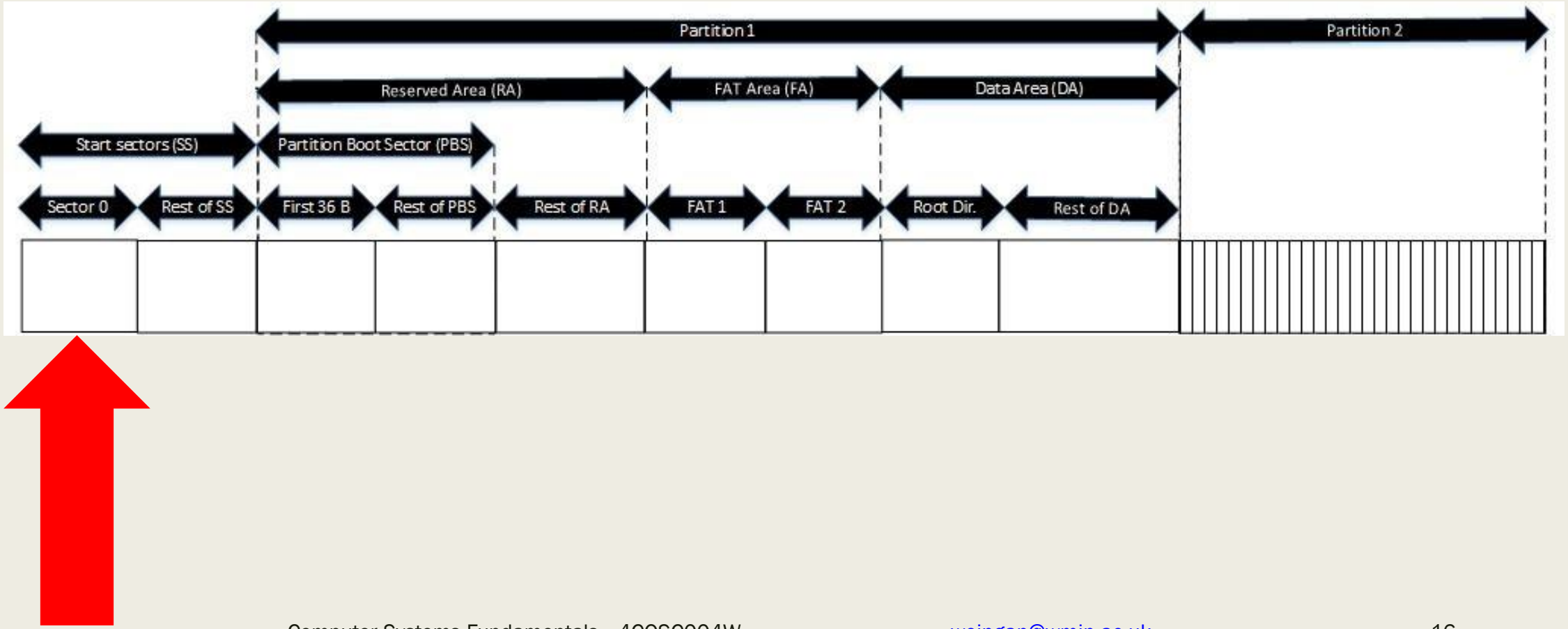
Start	End	Type
0	99	FAT
100	249	NTFS
300	599	NTFS



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}

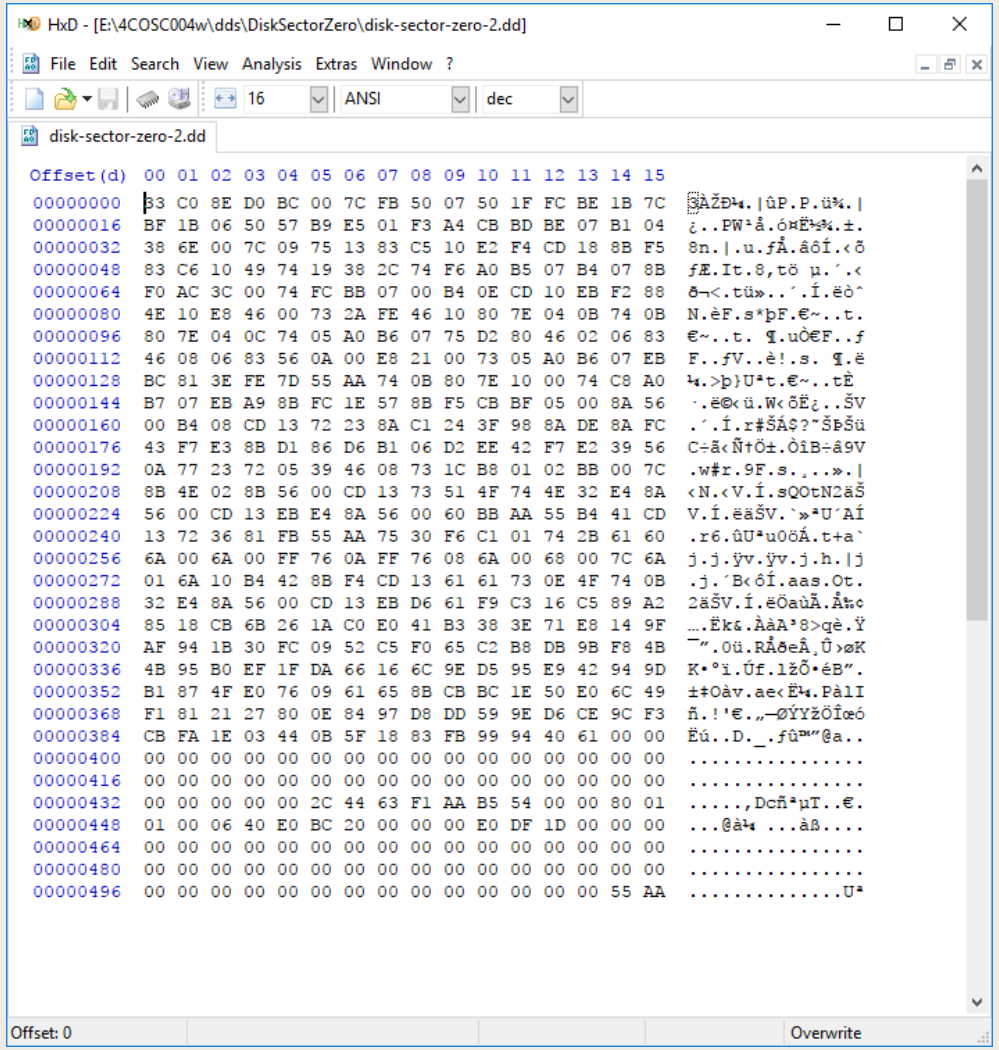
Schematic view of a Disk



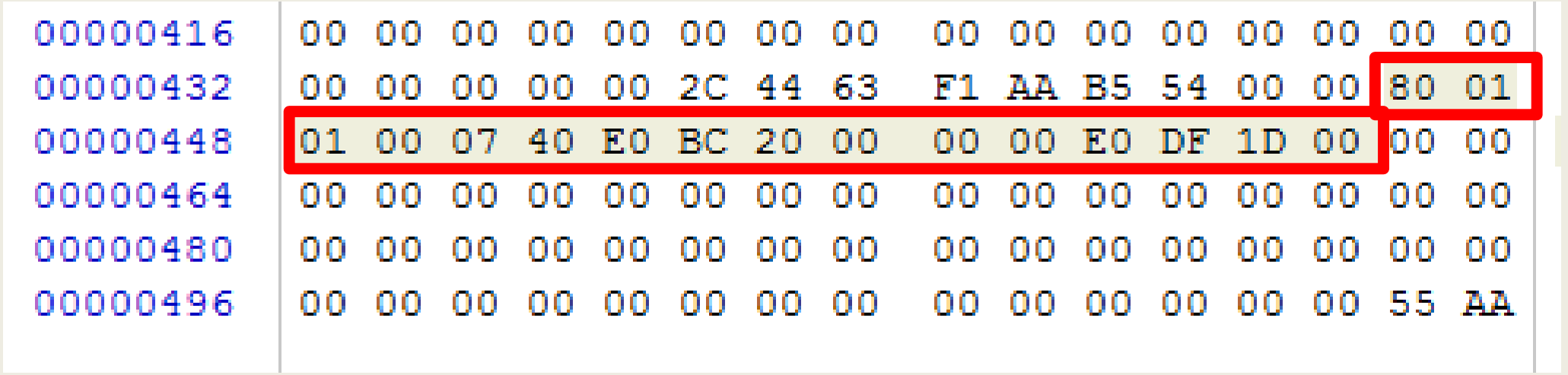
MBR Partitions
Disk Sector Zero

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



MBR Partitions



Byte range	Description	Essential
0 – 445	Boot code	No
446 – 461	Partition table entry # 1	Yes
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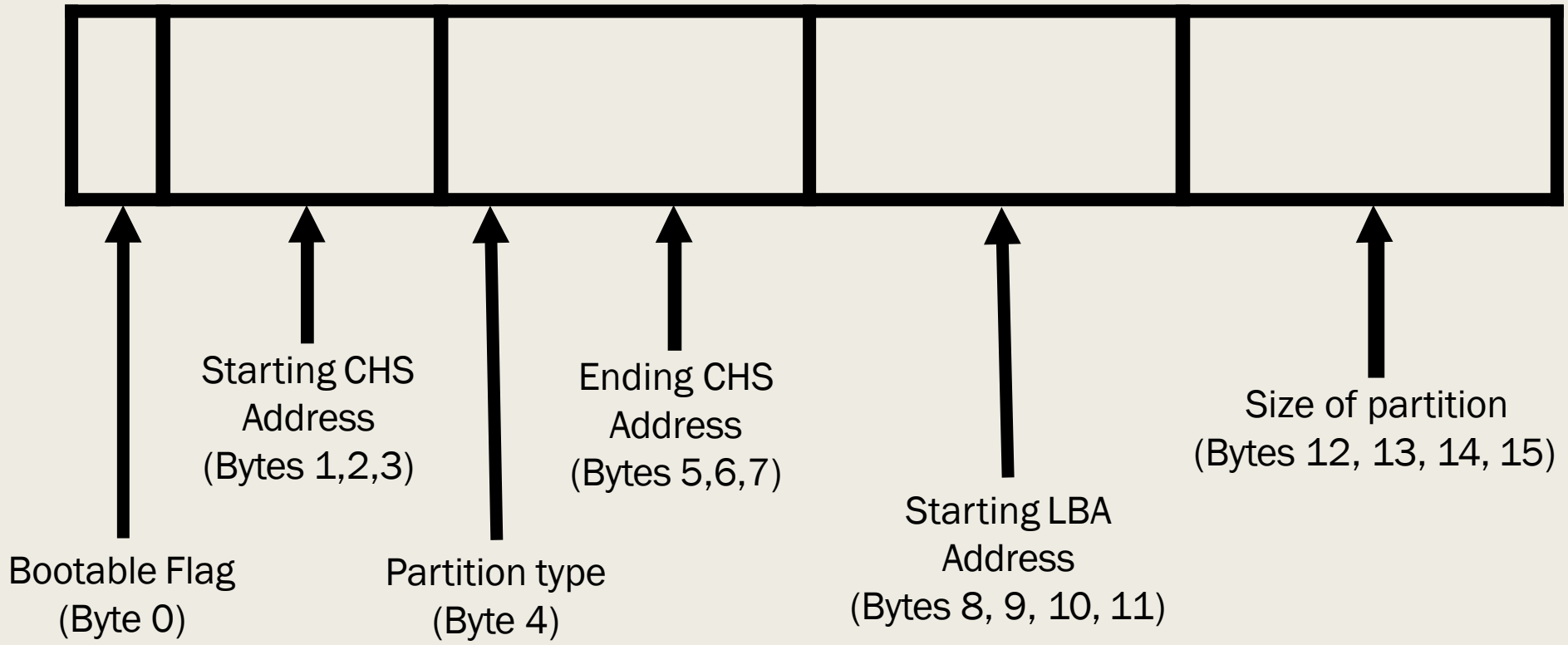
494 – 509	Partition table entry # 4	Yes
510 - 511	Signature Value 0x55AA	No

Partition Table Data Diagrammatic



Partition Table data

80 01

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

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 0

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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