COMPUTER SYSTEMS FUNDAMENTALS

(4COSC004W)

In File Systems part b:

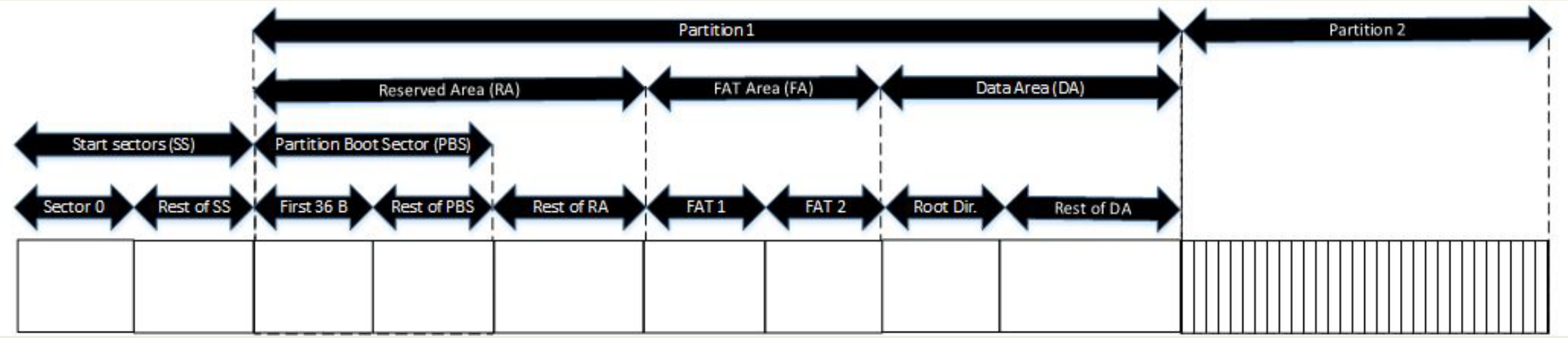
- FAT File Systems
  - *FAT structure*
  - *FAT Boot Sector*
- Windows volumes
- Unix volumes
- Directories
- Absolute path names
- Relative path names

FILE SYSTEMS part b

In this unit we will cover:

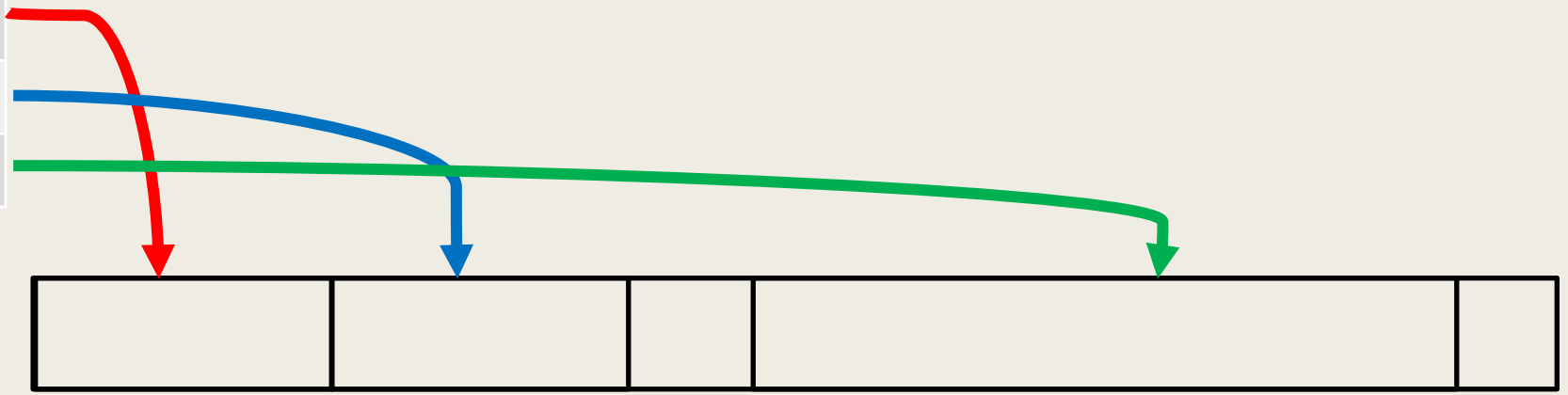
- Partition Sector Zero
  - *FAT16*
  - *Reading & understanding*
- Volumes & Partitions
- Windows & Unix partitions
- Directory structures & terminology
  - *Root Directory*
  - *Parent Directory & Subdirectory*
  - *Absolute Path Names & Relative Path Names*

Schematic view of a Disk



Disk formatting

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



Endianness

- **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.

File System at Sector 80325

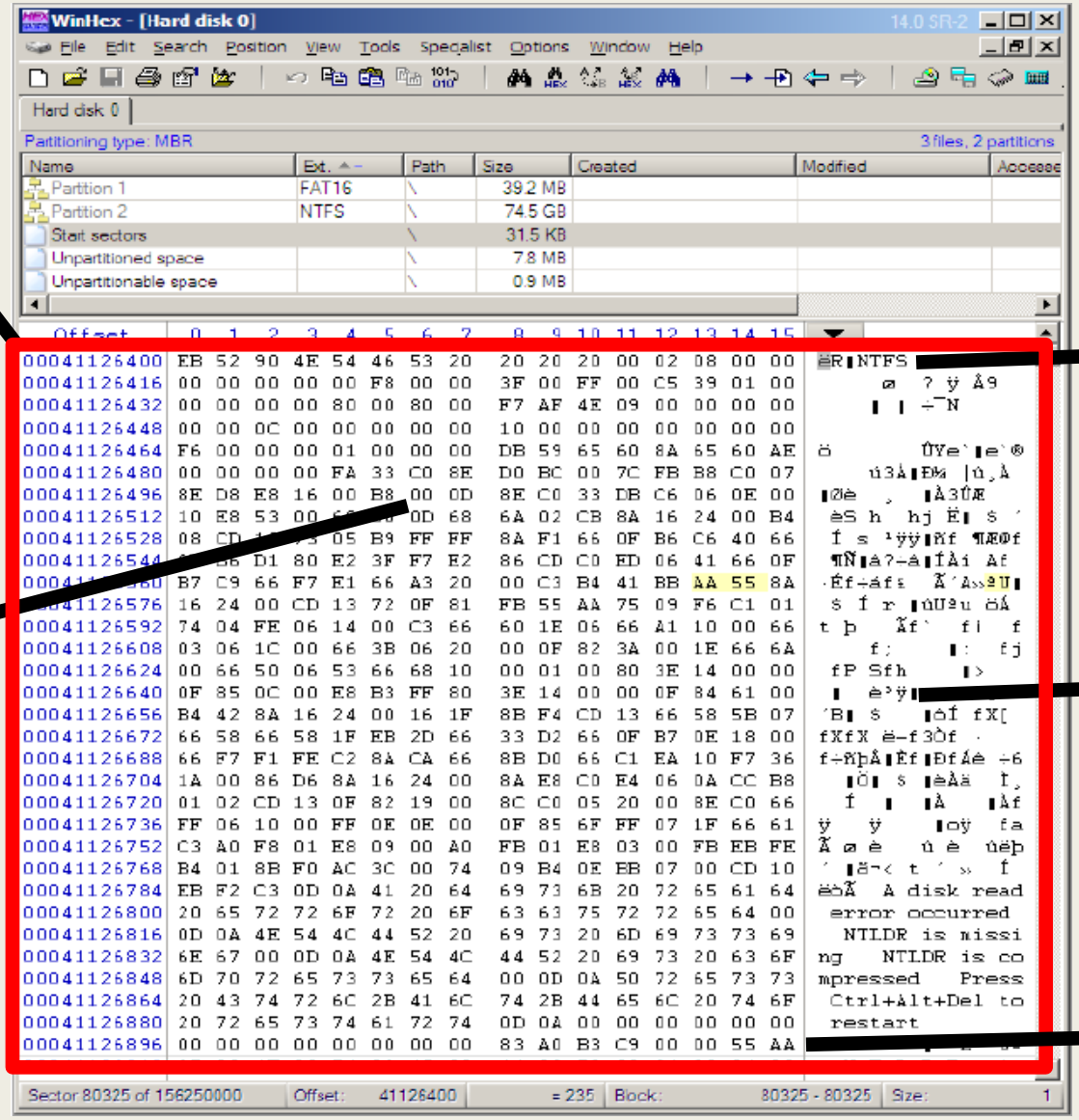
Start of sector 80325 (or byte 41126400)

Contents in Hexadecimal

NTFS File System

Contents in ASCII

Signature value



FAT File Systems

- Arrived with DOS
  - *Used to be widely used in many operating systems and devices*
  - *FAT12/16*
  - *FAT32*
- NTFS (New Technology File System) is more common today

FAT Structure

- FAT12/16, Reserved Area is only 2 sectors.
  - *FAT32 can have several sectors in RA*
- FAT Area contains the File Allocation Tables
  - *Generally 2 FATs*
- Root Directory falls in Data Area
  - *FAT12/16, always at the beginning*
  - *FAT32, can be anywhere*

FAT Boot Sector

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
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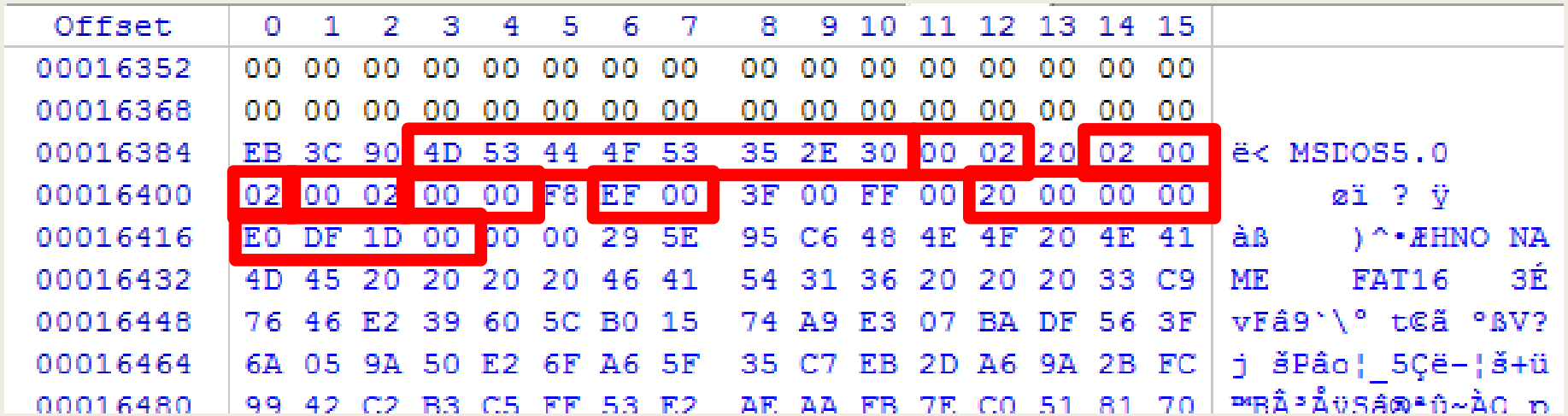

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00016352	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	øï ? ÿ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß)^•ÆHNO NA
00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
00016448	76	46	E2	39	60	5C	B0	15	74	A9	E3	07	BA	DF	56	3F	vFâ9`\° t©ã °ßV?
00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo¦_5Çë-¦š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³ÅÿSâ®ªû~ÀQ p

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00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
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FAT Boot Sector
Bytes per sector

Bytes 11-12: Bytes per sector
Little-Endian: 00 02
Big-Endian: 02 00
Value: 0x0200
$2 \times 256 = \mathbf{512}$ **Bytes per Sector**

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FAT Boot Sector
Sectors per cluster

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Byte 13: Sectors per cluster
Little-Endian: 20
Big-Endian: 20
Value: 0x20
$2 \times 16 = \mathbf{32}$ **Sector per cluster**

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00016352	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
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FAT Boot Sector
Size of RA

Byte 14-15: Size of RA in Sectors
Little-Endian: 02 00
Big-Endian: 00 02
Value: 0x0002
Reserved Area is 2 Sectors large

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FAT Boot Sector
Number of FATs

Byte 16: Number of FATs
Little-Endian: 02
Big-Endian: 02
Value: 0x02
2 FATs

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FAT Boot Sector
Max files in Root Dir

Byte 17-18: Max. files in Root Dir.
Little-Endian: 00 02
Big-Endian: 02 00
Value: 0x0200

$$2 \times 256 = 512\ files$$

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FAT Boot Sector
Sectors in partition

Bytes 19-20: 16-bit value
Little-Endian: 00 00

Bytes 32-35: 32-bit value
Little-Endian: E0 DF 1D 00
Big-Endian: 00 1D DF E0
Value: 0x001DDFE0

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00016352	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	øï ? ÿ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß)^•ÆHNO NA
00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
00016448	76	46	E2	39	60	5C	B0	15	74	A9	E3	07	BA	DF	56	3F	vFâ9`\° t©ã °ßV?
00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo¦_5Çë-¦š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³ÅÿSâ®ªû~ÀQ p

FAT Boot Sector
Media type

Bytes 21: Media type
Value: 0xF8

Ie. Fixed disk

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	**Description:**
0 – 2	Assembly instruction to jump to boot code needed to boot the operating system
3 – 10	OEM Name in ASCII
11 – 12	Bytes per sector. Allowed values are 512, 1024, 2048 and 4096
13 – 13	Sector per cluster (data unit). Allowed values are powers of 2
14 – 15	Size in sectors of the reserved area
16 – 16	Number of FATs. Typically 2 for redundancy
17 – 18	Maximum number of files in the root directory for FAT12 and FAT16. This is 0 for FAT32 and typically 512 for FAT16.
19 – 20	16–bit value of number of sectors in the file system. If the number of sectors is larger than can be represented in this 2–byte value, a 4– byte value exists later in the data structure and this value should be 0 in that case
21 – 21	Media type. For fixed disks, value is 0xF8, for removable value is 0xF0
22 – 23	16–bit size in sectors of each FAT for FAT12 and FAT16. For FAT32, this field is 0
24 – 25	Sectors per track of storage device
26 – 27	Number of heads in storage device
28 – 31	Number of sectors before the start of partition
32 - 35	32–bit value of number of sectors in file system. Either this value or the 16–bit value above must be 0

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00016352	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	øï ? ÿ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß)^•ÆHNO NA
00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
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00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo¦_5Çë-¦š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³Åÿ Sâ®ªû~ÀQ p

FAT Boot Sector
Size of each FAT

Bytes 22-23: Size of each FAT in sectors
Little-Endian: EF 00
Big-Endian: 00 EF
Value: 0x00EF

$$224 + 15 = 239\ sectors$$

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	**Description:**
0 – 2	Assembly instruction to jump to boot code needed to boot the operating system
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00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	øï ? ÿ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß)^•ÆHNO NA
00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
00016448	76	46	E2	39	60	5C	B0	15	74	A9	E3	07	BA	DF	56	3F	vFâ9`\° t©ã °ßV?
00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo¦_5Çë-¦š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³ÅÿSâ®ªû~ÀQ p

FAT Boot Sector
Sectors per track

Byte 24-25: Number of sectors per track
Little-Endian: 3F 00
Big-Endian: 00 3F
Value: 0x003F

$$48 + 15 = 63\ sectors$$

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	**Description:**
0 – 2	Assembly instruction to jump to boot code needed to boot the operating system
3 – 10	OEM Name in ASCII
11 – 12	Bytes per sector. Allowed values are 512, 1024, 2048 and 4096
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00016352	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	øï ? ÿ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß)^•ÆHNO NA
00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
00016448	76	46	E2	39	60	5C	B0	15	74	A9	E3	07	BA	DF	56	3F	vFâ9`\° t©ã °ßV?
00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo¦_5Çë-¦š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³Åÿ Sâ®ªû~ÀQ p

FAT Boot Sector
Number of heads

Byte 26-27: Number of heads
Little-Endian: FF 00
Big-Endian: 00 FF
Value: 0x00FF

$$240 + 15 = 255\ heads$$

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	**Description:**
0 – 2	Assembly instruction to jump to boot code needed to boot the operating system
3 – 10	OEM Name in ASCII
11 – 12	Bytes per sector. Allowed values are 512, 1024, 2048 and 4096
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00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
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00016432	4D	45	20	20	20	20	46	41	54	31	36	20	20	20	33	C9	ME FAT16 3É
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00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³Åÿ Sâ®ªû~ÀQ p

FAT Boot Sector
Sectors before partition

Byte 28-31: Sectors before partition
Little-Endian: 20 00 00 00
Big-Endian: 00 00 00 20
Value: 0x00000020
32 Sectors
$32 \times 512 = 16384\ B$

FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	**Description:**
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00016368	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
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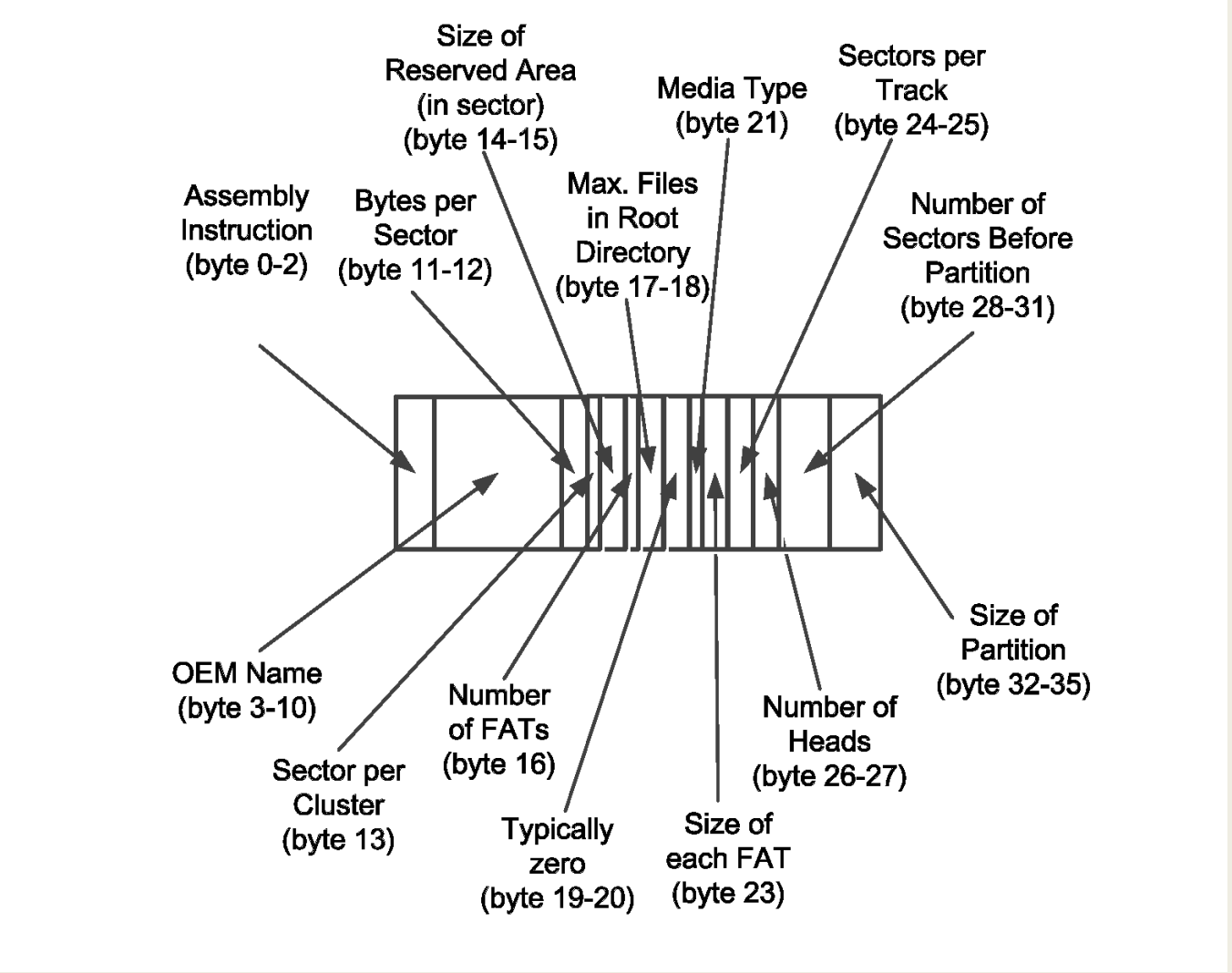
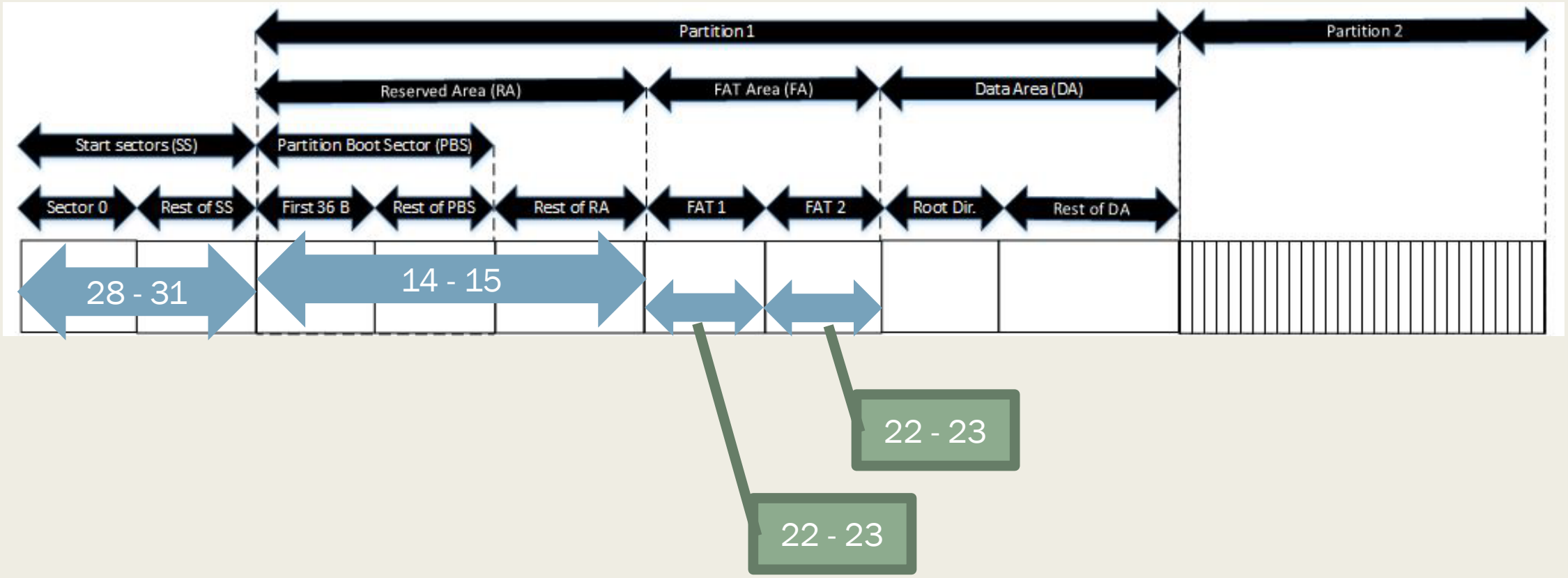
00016480	99	42	C2	B3	C5	FF	53	E2	AE	AA	FB	7E	C0	51	81	70	™BÂ³Åÿ Sâ®ªû~ÀQ p

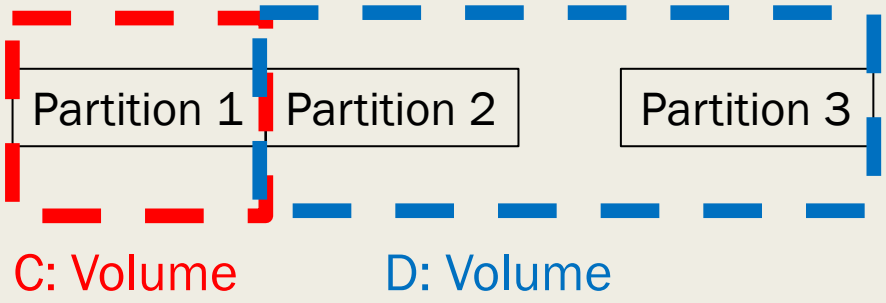
FAT Boot Sector - Diagrammatic



Schematic view of a Disk

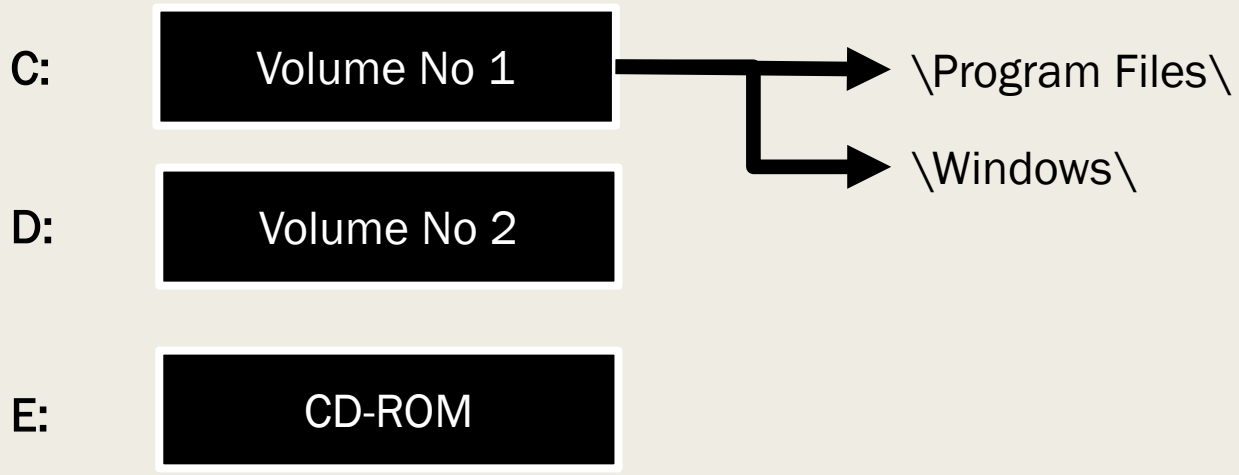


Disk partitioning

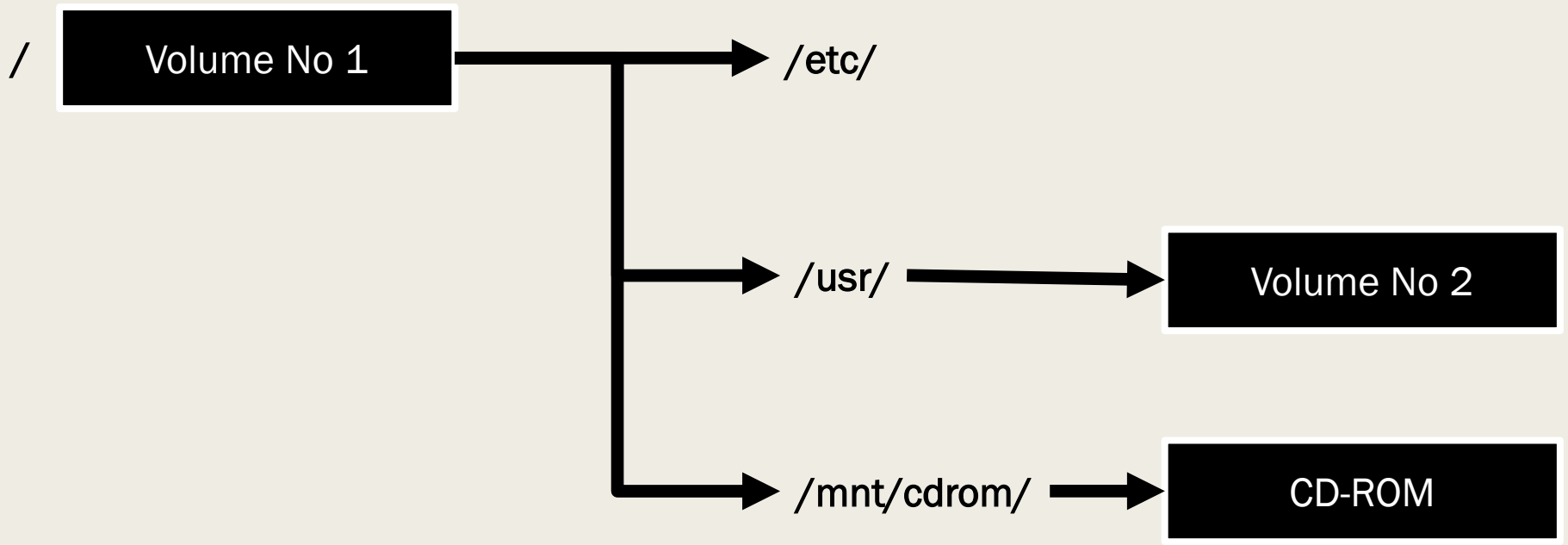


- Volume
  - *Collection of addressable sectors that an OS or application can use for data storage.*
- Partition
  - *Collection of **consecutive** sectors in a volume*

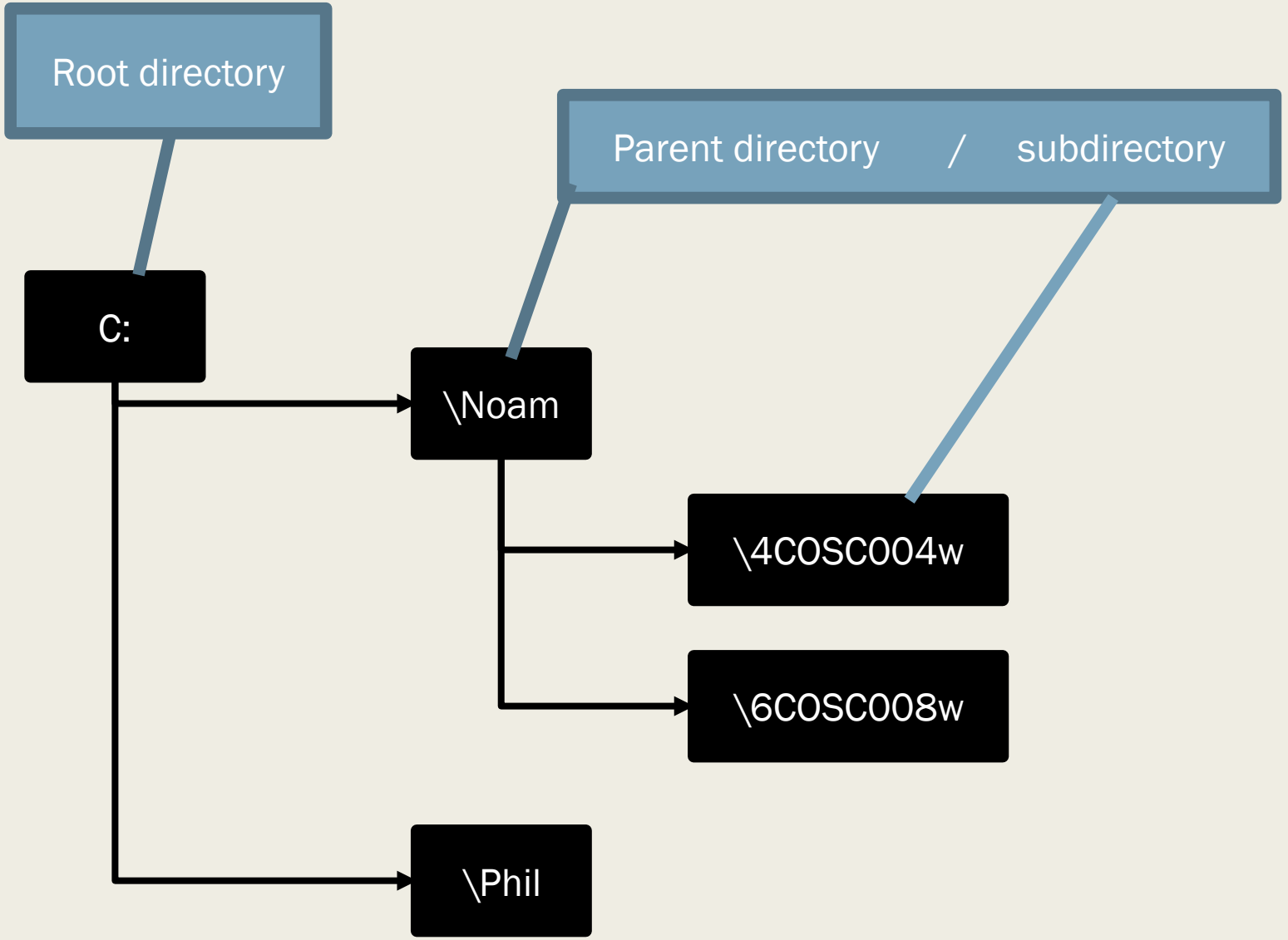
Windows OS



Unix OS



Directory Trees - Logical view



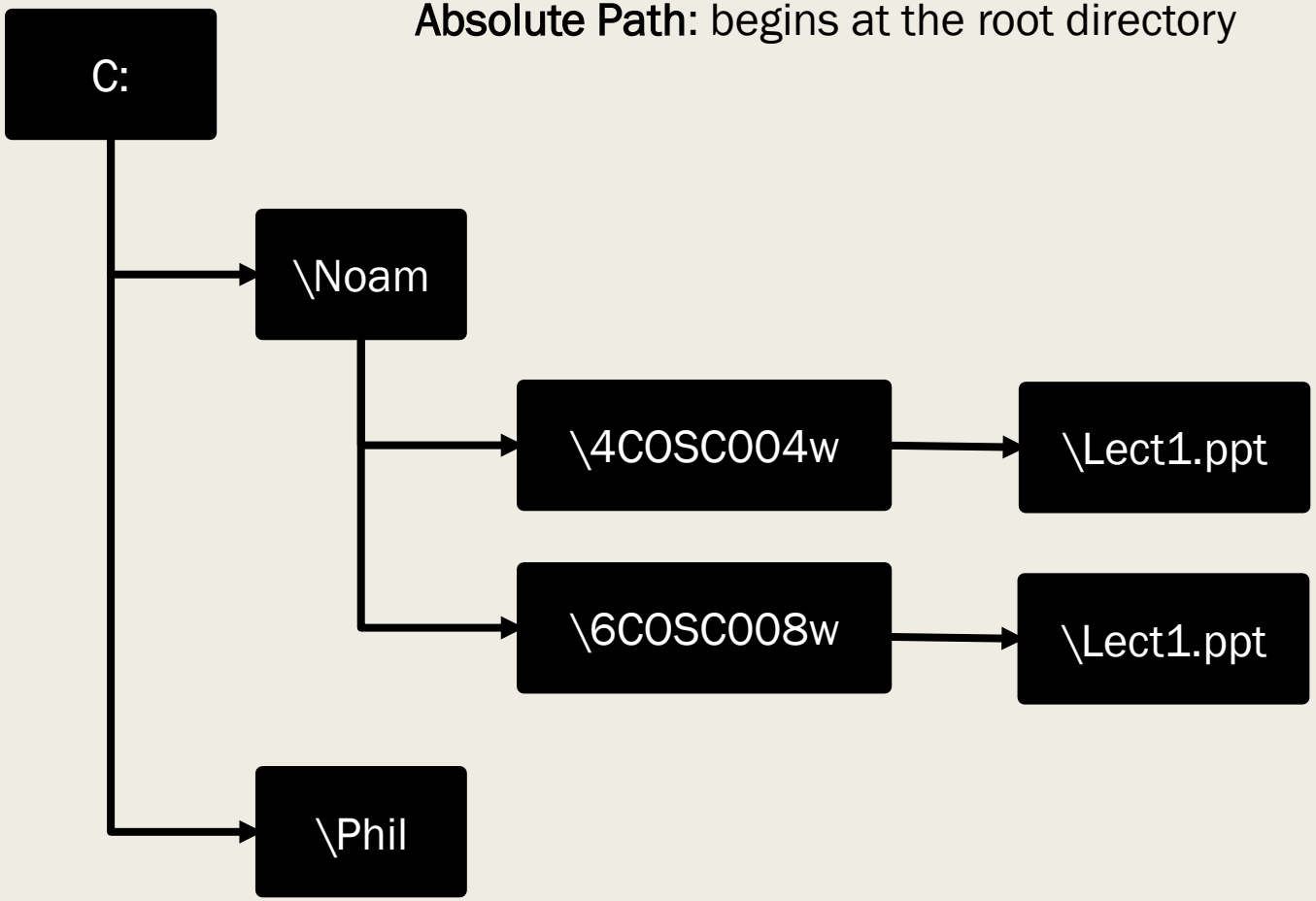
Directory tree – Working directory

- At any point in time, you are working in a specific location.
  - *Directory*
- **Working Directory**

Directory Trees - Absolute path names

Path : text designation to the location of a file or subdirectory in a file system.
Consists of the series of directories to find the file

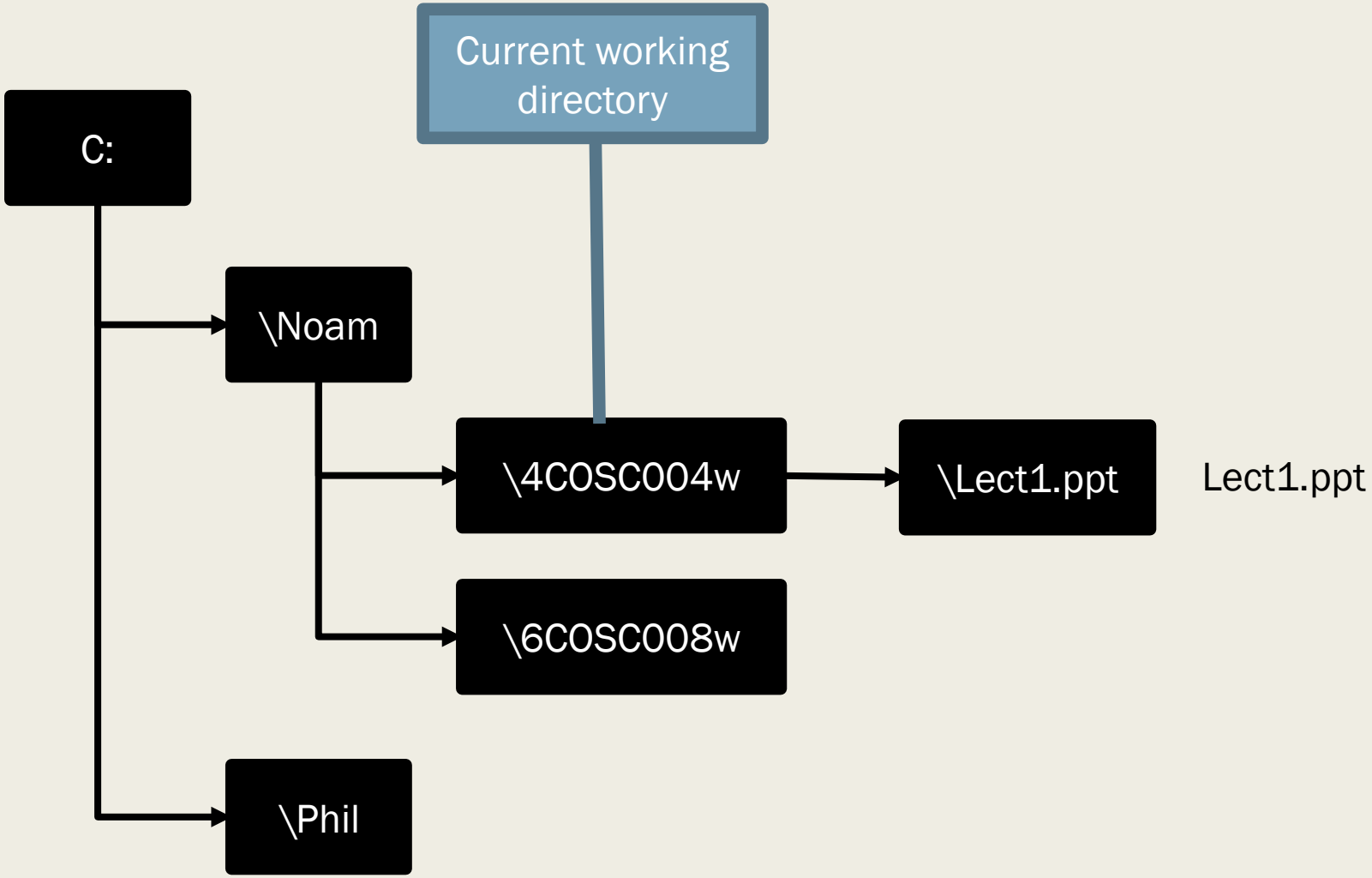
Absolute Path: begins at the root directory



C:\Noam\4COSC004W\Lect1.ppt

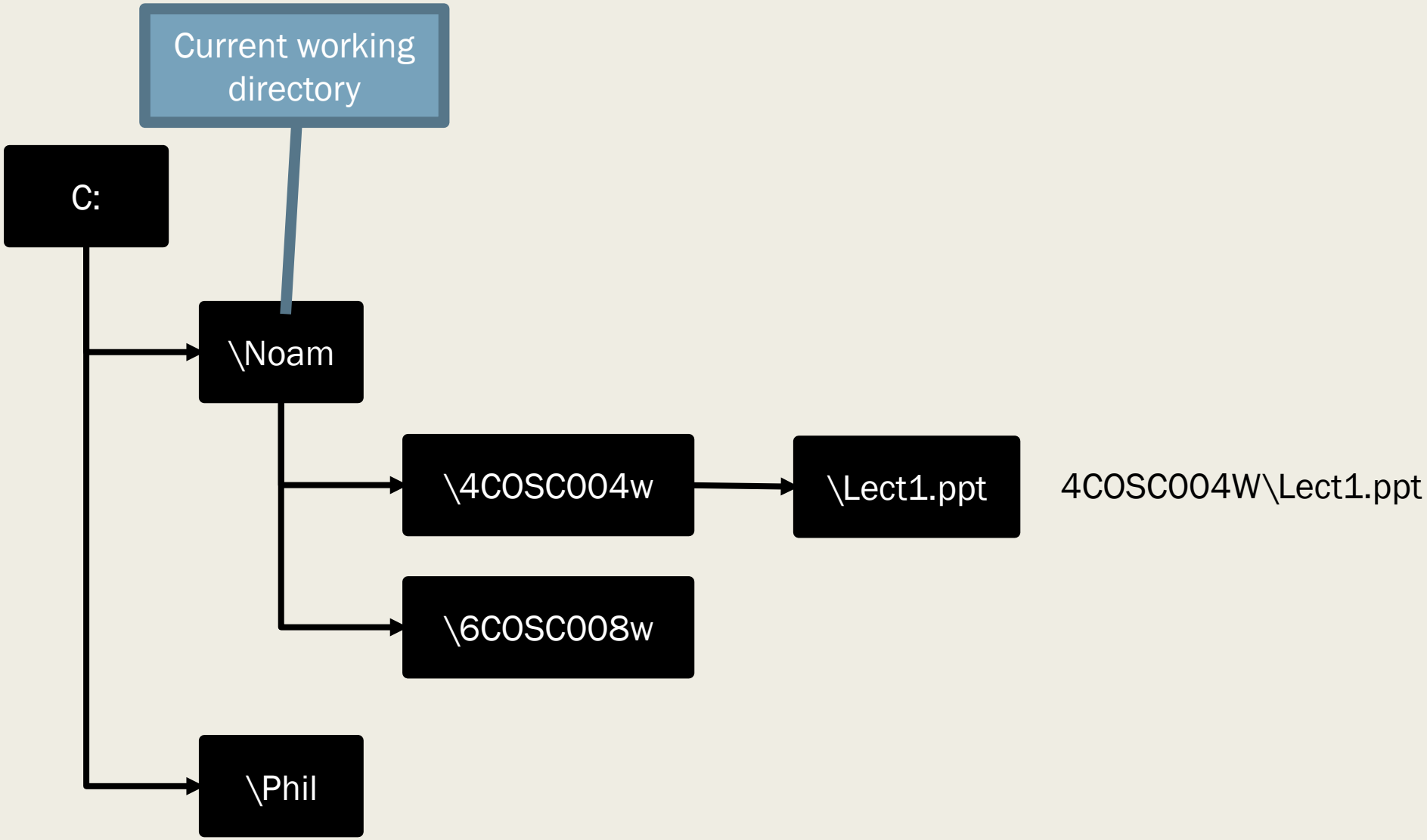
C:\Noam\4COSC008W\Lect1.ppt

Directory Trees - Relative path names



Lect1.ppt

Directory Trees - Relative path names



File Systems – Definitions of Terms

- **File**: A named collection of related data and is a collection of bits stored as bytes on a medium. Bytes are grouped as Blocks or Sectors. Data are transferred to/from main memory in chucks of Blocks as defined by the File Management Software.
- **File System**: The Logical View that an OS provides so that users can manage information as a collection of files.
- **Directory**: A named group of files

Thank you