



COMPUTER SYSTEMS FUNDAMENTALS (4COSC004W)



In File Systems part b:

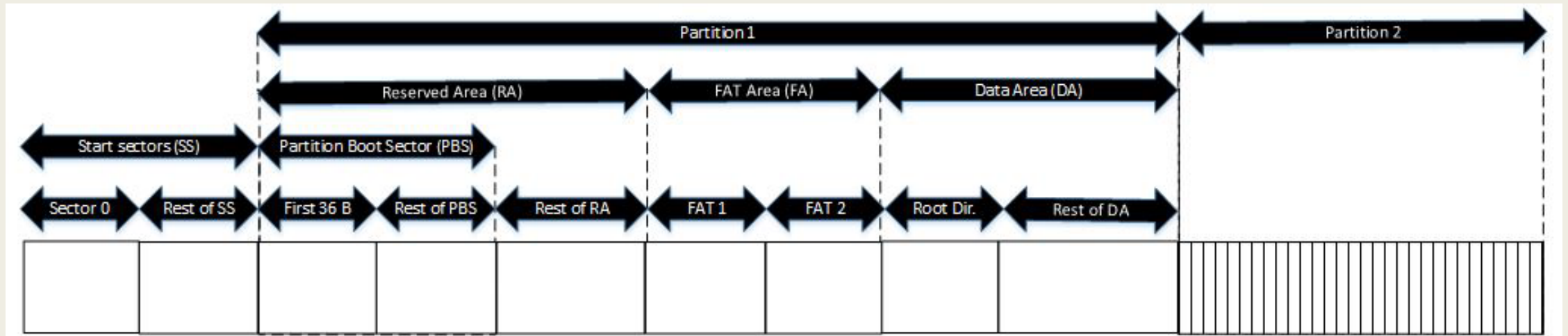
- FAT File Systems
 - *FAT structure*
 - *FAT Boot Sector*
- Windows volumes
- Unix volumes
- Directories
- Absolute path names
- Relative path names

FILE SYSTEMS part b

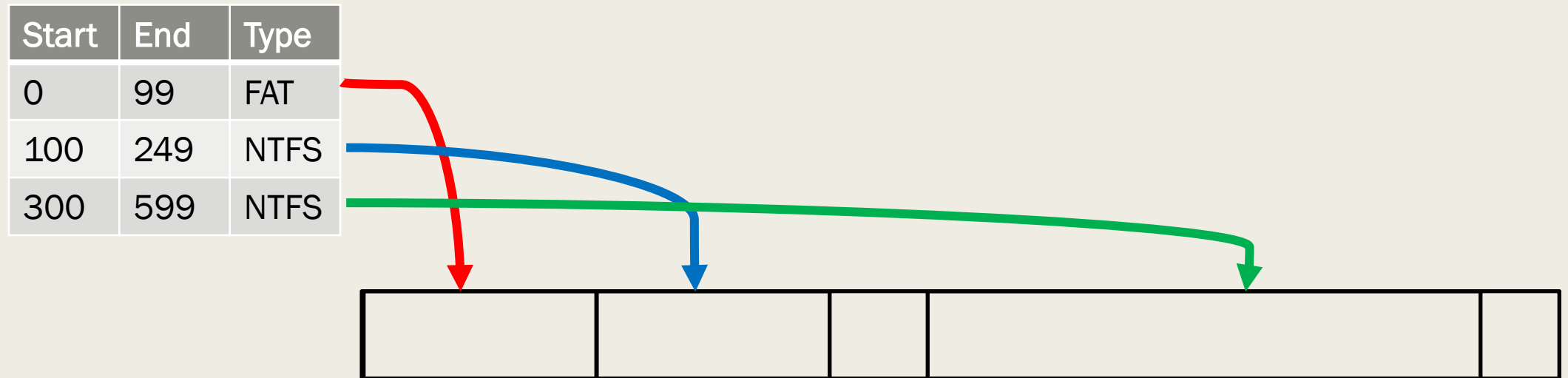
In this unit we will cover:

- 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



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

WinHex - [Hard disk 0] 14.0 SR-2

Partitioning type: MBR 3 files, 2 partitions

Name	Ext.	Path	Size	Created	Modified	Accesses
Partition 1	FAT16	\	392 MB			
Partition 2	NTFS	\	745 GB			
Start sectors		\	31.5 KB			
Unpartitioned space		\	78 MB			
Unpartitionable space		\	0.9 MB			

Offset: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

00041126400 EB 52 90 4E 54 46 53 20 20 20 20 00 02 08 00 00
00041126416 00 00 00 00 00 00 F8 00 00 3F 00 FF 00 C5 39 01 00
00041126432 00 00 00 00 00 80 00 80 00 F7 AF 4E 09 00 00 00 00
00041126448 00 00 0C 00 00 00 00 00 10 00 00 00 00 00 00 00
00041126464 F6 00 00 00 01 00 00 00 DB 59 65 60 8A 65 60 AE
00041126480 00 00 00 00 FA 33 C0 8E D0 BC 00 7C FB B8 C0 07
00041126496 8E D8 E8 16 00 B8 00 0D 8E C0 33 DB C6 06 0E 00
00041126512 10 E8 53 00 00 00 00 68 6A 02 CB 8A 16 24 00 B4
00041126528 08 CD 10 05 B9 FF FF 8A F1 66 0F B6 C6 40 66
00041126544 00 00 D1 80 E2 3F F7 E2 86 CD C0 ED 06 41 66 0F
00041126560 B7 C9 66 F7 E1 66 A3 20 00 C3 B4 41 BB AA 55 8A
00041126576 16 24 00 CD 13 72 0F 81 FB 55 AA 75 09 F6 C1 01
00041126592 74 04 FE 06 14 00 C3 66 60 1E 06 66 A1 10 00 66
00041126608 03 06 1C 00 66 3B 06 20 00 0F 82 3A 00 1E 66 6A
00041126624 00 66 50 06 53 66 68 10 00 01 00 80 3E 14 00 00
00041126640 0F 85 0C 00 E8 B3 FF 80 3E 14 00 00 0F 84 61 00
00041126656 B4 42 8A 16 24 00 1F 8B F4 CD 13 66 58 5B 07
00041126672 66 58 66 58 1F EB 2D 66 33 D2 66 0F B7 0E 18 00
00041126688 66 F7 F1 FE C2 8A CA 66 8B D0 66 C1 EA 10 F7 36
00041126704 1A 00 86 D6 8A 16 24 00 8A E8 C0 E4 06 0A CC B8
00041126720 01 02 CD 13 0F 82 19 00 8C C0 05 20 00 8E C0 66
00041126736 FF 06 10 00 FF 0E 0E 00 0F 85 6F FF 07 1F 66 61
00041126752 C3 A0 F8 01 E8 09 00 A0 FB 01 E8 03 00 FB EB FE
00041126768 B4 01 8B F0 AC 3C 00 74 09 B4 0E EB 07 00 CD 10
00041126784 EB F2 C3 0D 0A 41 20 64 69 73 6B 20 72 65 61 64
00041126800 20 65 72 72 6F 72 20 6F 63 63 75 72 72 65 64 00
00041126816 0D 0A 4E 54 4C 44 52 20 69 73 20 6D 69 73 73 69
00041126832 6E 67 00 0D 0A 4E 54 4C 44 52 20 69 73 20 63 6F
00041126848 6D 70 72 65 73 73 65 64 00 0D 0A 50 72 65 73 73
00041126864 20 43 74 72 6C 2B 41 6C 74 2B 44 65 6C 20 74 6F
00041126880 20 72 65 73 74 61 72 74 0D 0A 00 00 00 00 00 00
00041126896 00 00 00 00 00 00 00 00 83 A0 B3 C9 00 00 55 AA

Sector 80325 of 156250000 Offset: 41126400 = 235 Block: 80325 - 80325 Size: 1

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

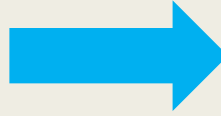
FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
Byte Range:	Description:
0 – 2	Assembly instruction to jump to boot code needed to boot the operating system
3 – 10	OEM Name in ASCII
11 – 12	Bytes per sector. Allowed values are 512, 1024, 2048 and 4096
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14 – 15	Size in sectors of the reserved area
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Offset	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
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	zi ? ŷ
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`\" ° tCã °BV?
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	F2	AF	AA	FB	7F	C0	51	81	70	MRÂ°ÅŮSÂ@°û~ÀQ n

FAT Boot Sector

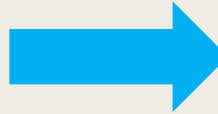


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00016384	EB	3C	90	4D	53	44	4F	53	35	2E	30	00	02	20	02	00	ë< MSDOS5.0
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00016480	99	42	C2	B3	C5	FF	53	E2	AF	AA	FB	7E	C0	51	81	70	MRÂ°ÂŮSÂ@°Ů~ÀŮ n

FAT Boot Sector

Bytes per sector



Bytes 11-12: Bytes per sector

Little-Endian: 00 02

Big-Endian: 02 00

Value: 0x0200

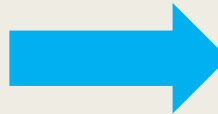
$2 \times 256 = 512$ Bytes per Sector

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FAT Boot Sector

Sectors per cluster



Byte 13: Sectors per cluster

Little-Endian: 20

Big-Endian: 20

Value: 0x20

$2 \times 16 = 32$ Sector per cluster

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FAT Boot Sector

Size of RA

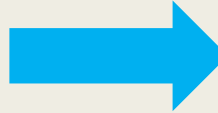
Byte 14-15: Size of RA in Sectors

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

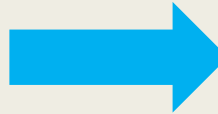
Byte 16: Number of FATs

Little-Endian: 02

Big-Endian: 02

Value: 0x02

2 FATs



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FAT Boot Sector

Max files in Root Dir

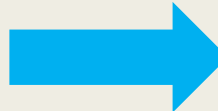
Byte 17-18: Max. files in Root Dir.

Little-Endian: 00 02

Big-Endian: 02 00

Value: 0x0200

$2 \times 256 = 512$ files



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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	ě< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	ěi ? ŷ
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`\"° tCă °BV?
00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo!_5Çě-!š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AF	AA	FB	7F	C0	51	81	70	MRÂ°ÂŮSÂ@°Ů~ÀŮ n

FAT Boot Sector Sectors in partition

Bytes 19-20: 16-bit value

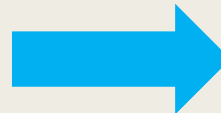
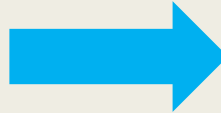
Little-Endian: 00 00

Bytes 32-35: 32-bit value

Little-Endian: E0 DF 1D 00

Big-Endian: 00 1D DF E0

Value: 0x001DDFE0



FAT Partition – Details of the First 36 Bytes in the FAT Partition Boot Sector	
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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	ě< MSDOS5.0
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00016480	99	42	C2	B3	C5	FF	53	E2	AF	AA	FB	7F	C0	51	81	70	MRÂ°ÂŮSÂ@°Ů~ÀŮ n

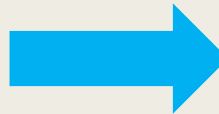
FAT Boot Sector

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	
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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	ě< MSDOS5.0
00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00	00	ěi ? ŷ
00016416	E0	DF	1D	00	00	00	29	5E	95	C6	48	4E	4F	20	4E	41	àß) ^•ÆHNO NA
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00016464	6A	05	9A	50	E2	6F	A6	5F	35	C7	EB	2D	A6	9A	2B	FC	j šPâo!_5Çě-!š+ü
00016480	99	42	C2	B3	C5	FF	53	E2	AF	AA	FB	7E	C0	51	81	70	MRÂ°ÂŮSÂ@°Ů~ÀŮ n

FAT Boot Sector

Size of each FAT

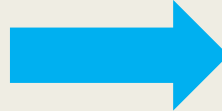
Bytes 22-23: Size of each FAT in sectors

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	
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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	AF	AA	FB	7E	C0	51	81	70	MRÂ°ÂŮSÂ@°Ů~ÀŮ n

FAT Boot Sector

Sectors per track

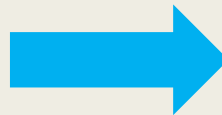
Byte 24-25: Number of sectors per track

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	
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FAT Boot Sector

Number of heads

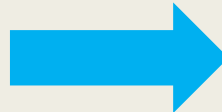
Byte 26-27: Number of heads

Little-Endian: **FF** **00**

Big-Endian: **00** **FF**

Value: **0x00FF**

$240 + 15 = 255 \text{ heads}$



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

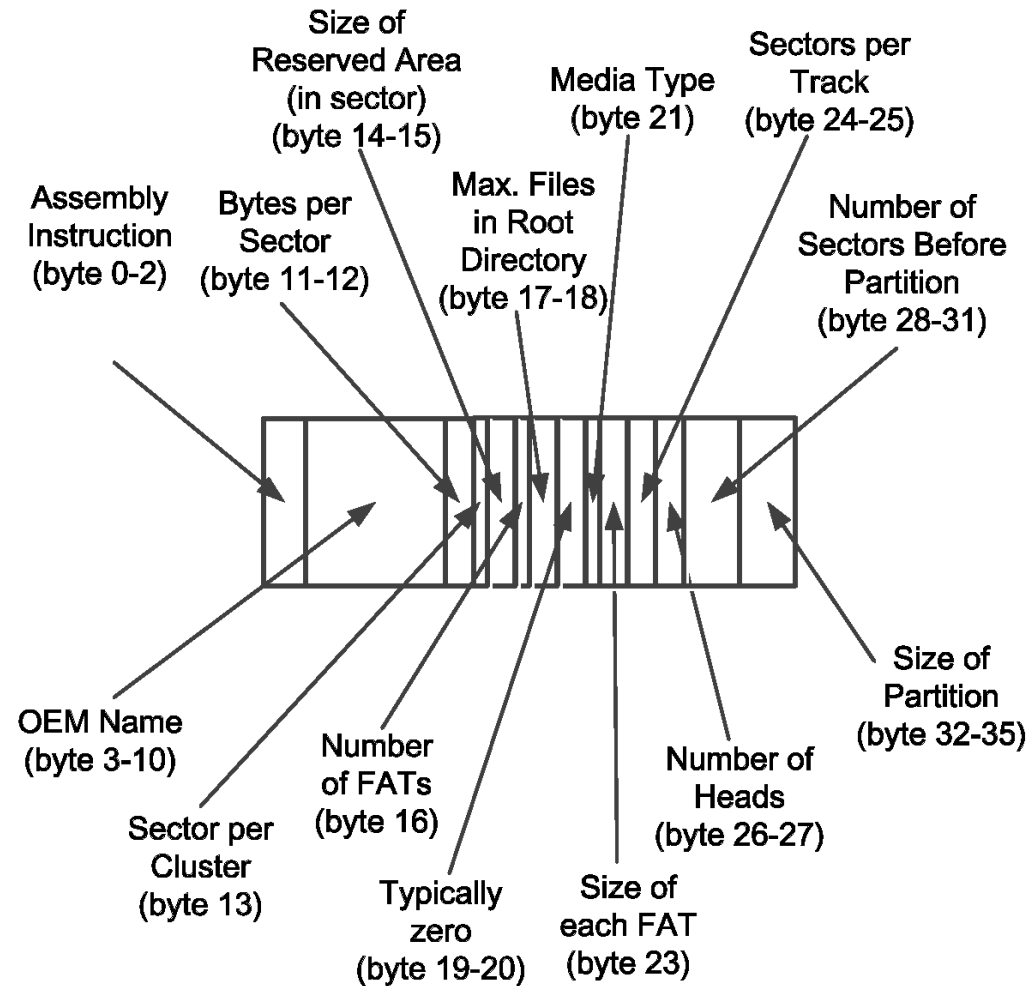
32 Sectors

$32 \times 512 = 16384 \text{ B}$

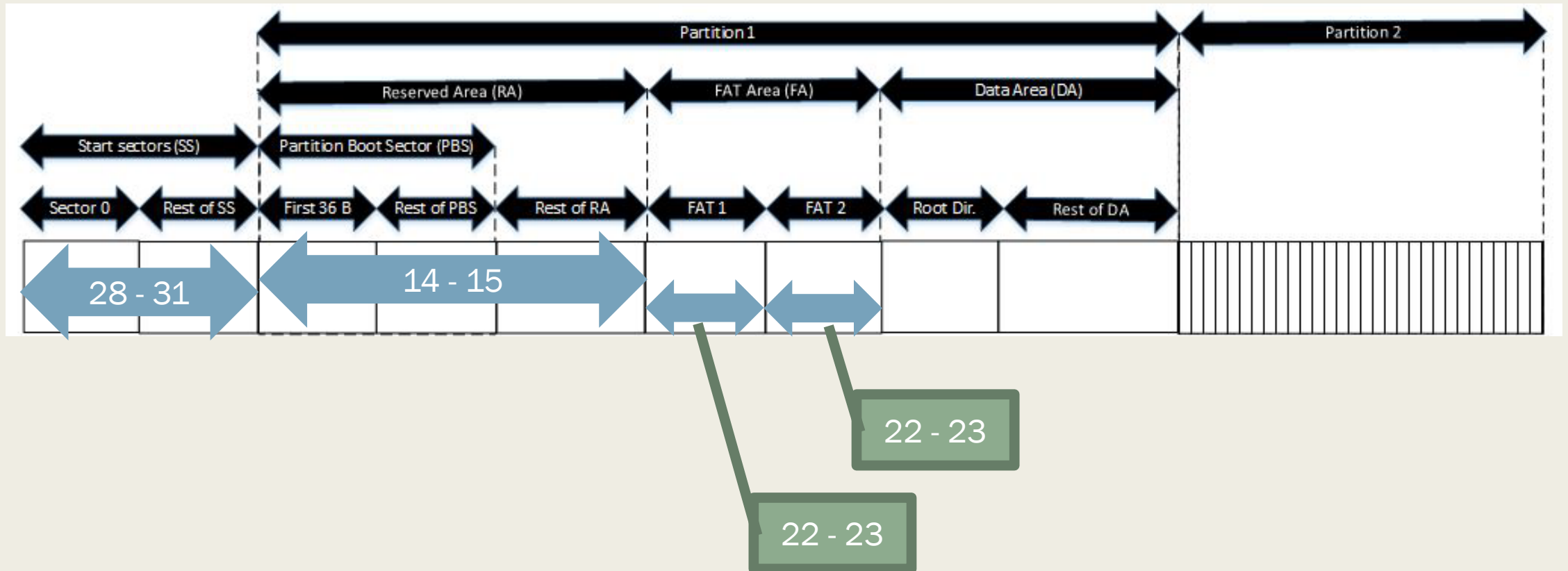
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00016400	02	00	02	00	00	F8	EF	00	3F	00	FF	00	20	00	00 00
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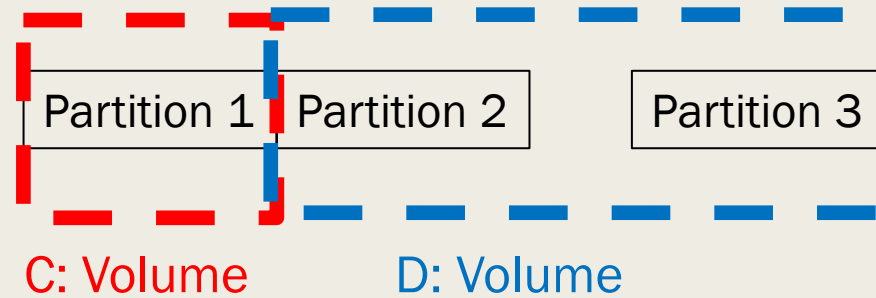
FAT Boot Sector - Diagrammatic



Schematic view of a Disk

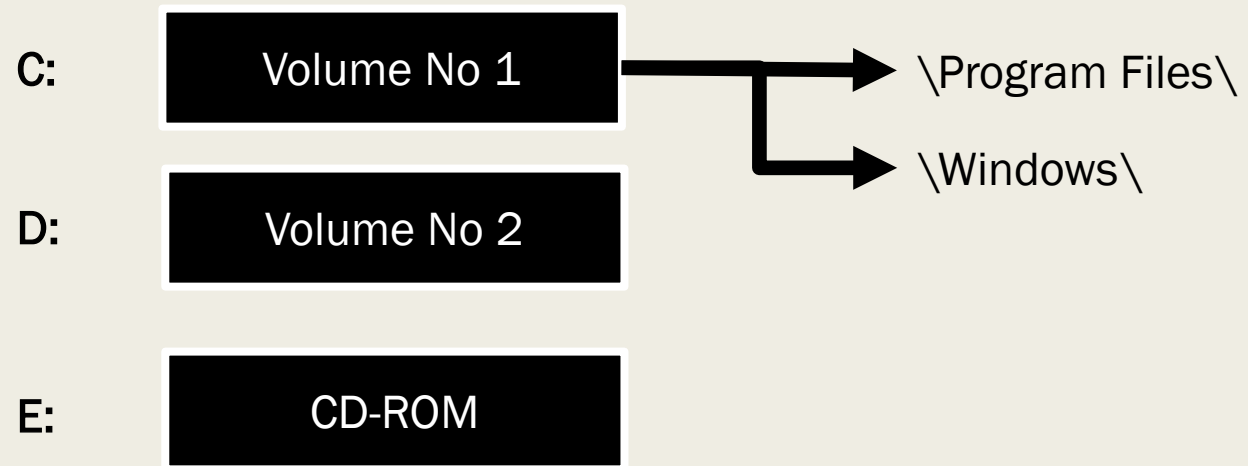


Disk partitioning

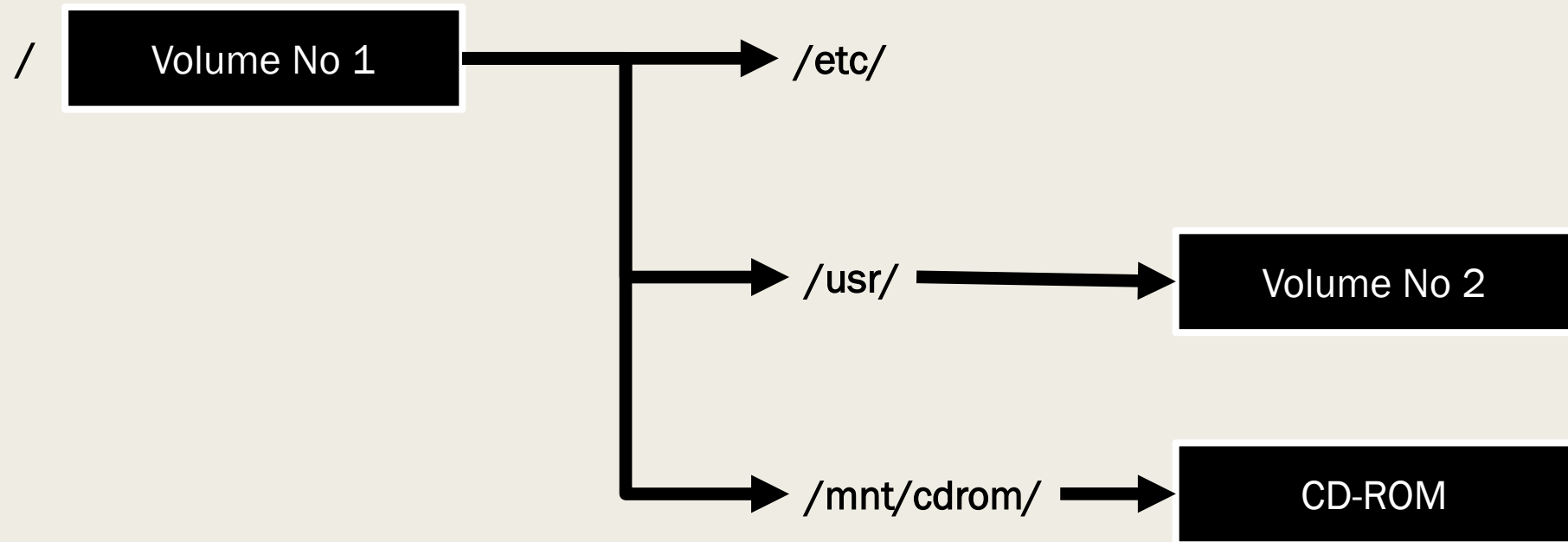


- Volume
 - *Collection of addressable sectors that an OS or application can use for data storage.*
- Partition
 - *Collection of **consecutive** sectors in a volume*

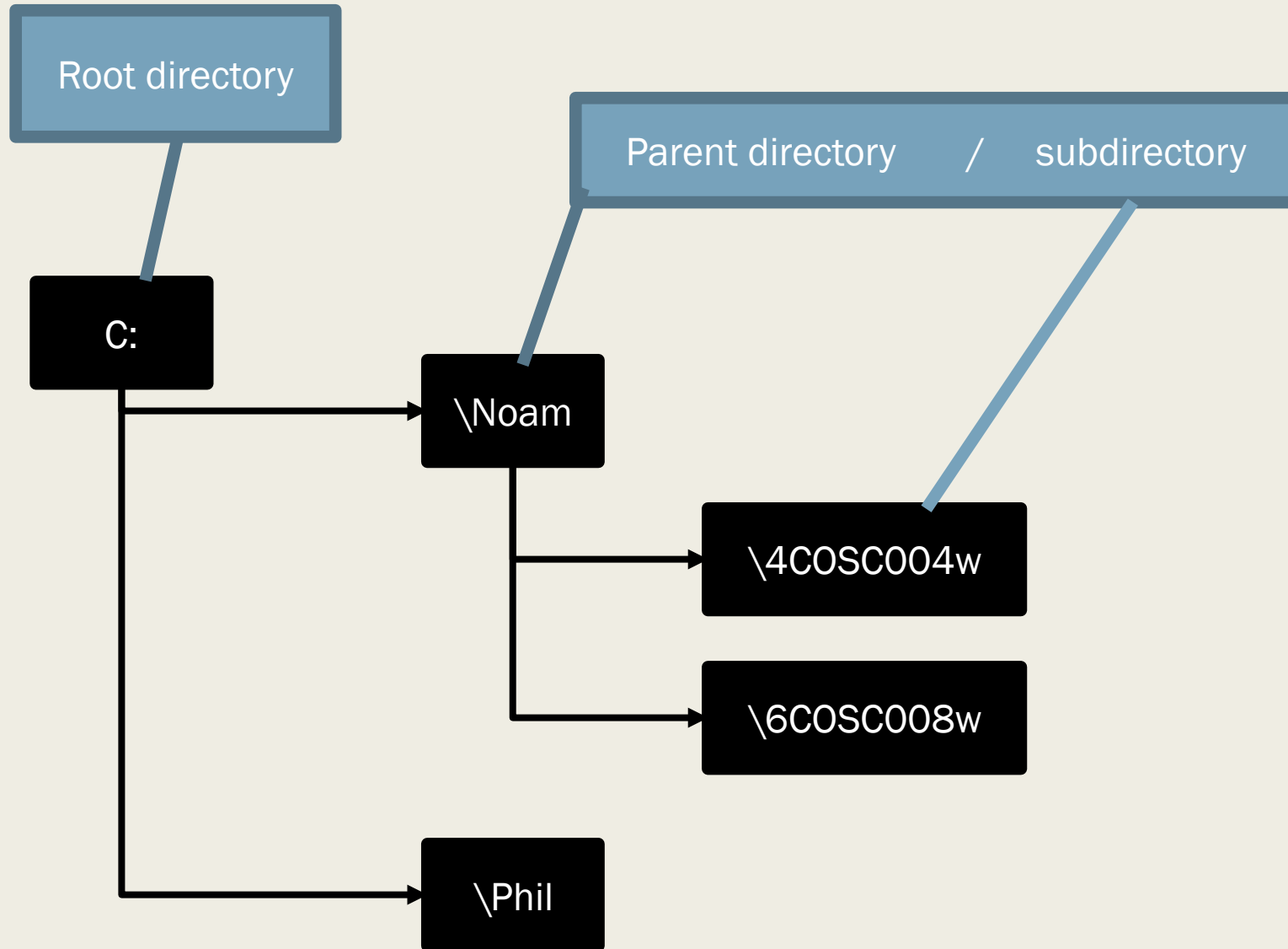
Windows OS



Unix OS



Directory Trees - Logical view



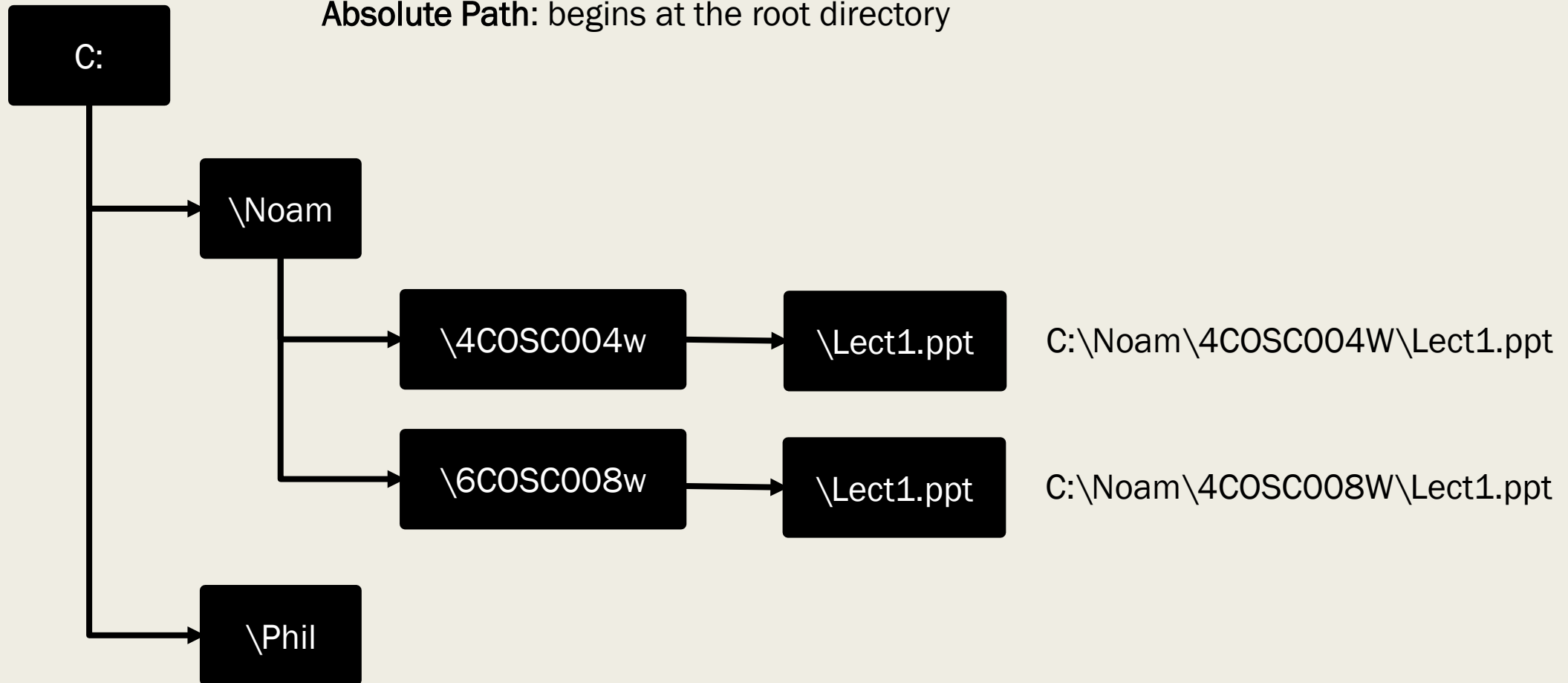
Directory tree – Working directory

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

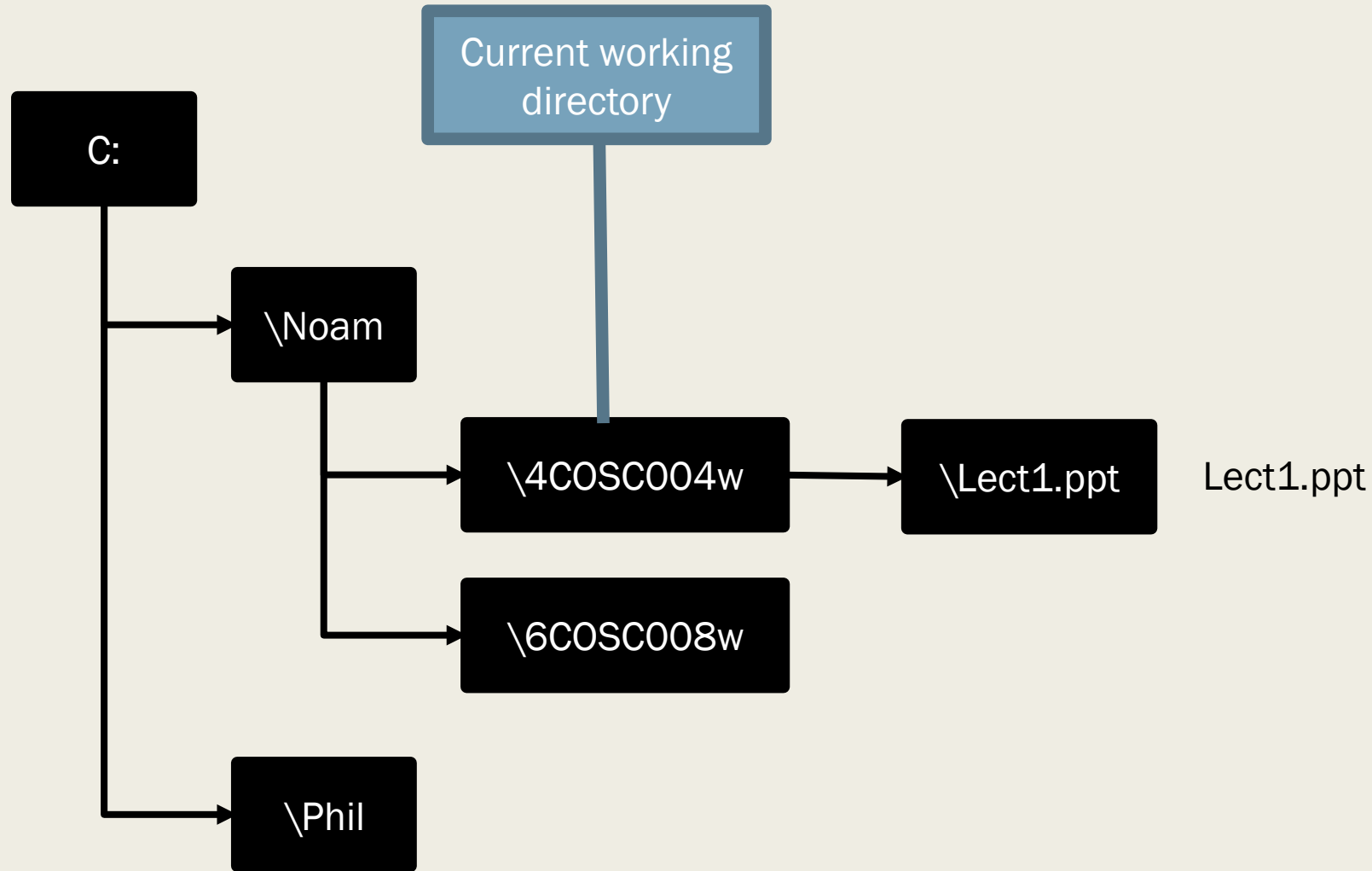
Directory Trees - Absolute path names

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

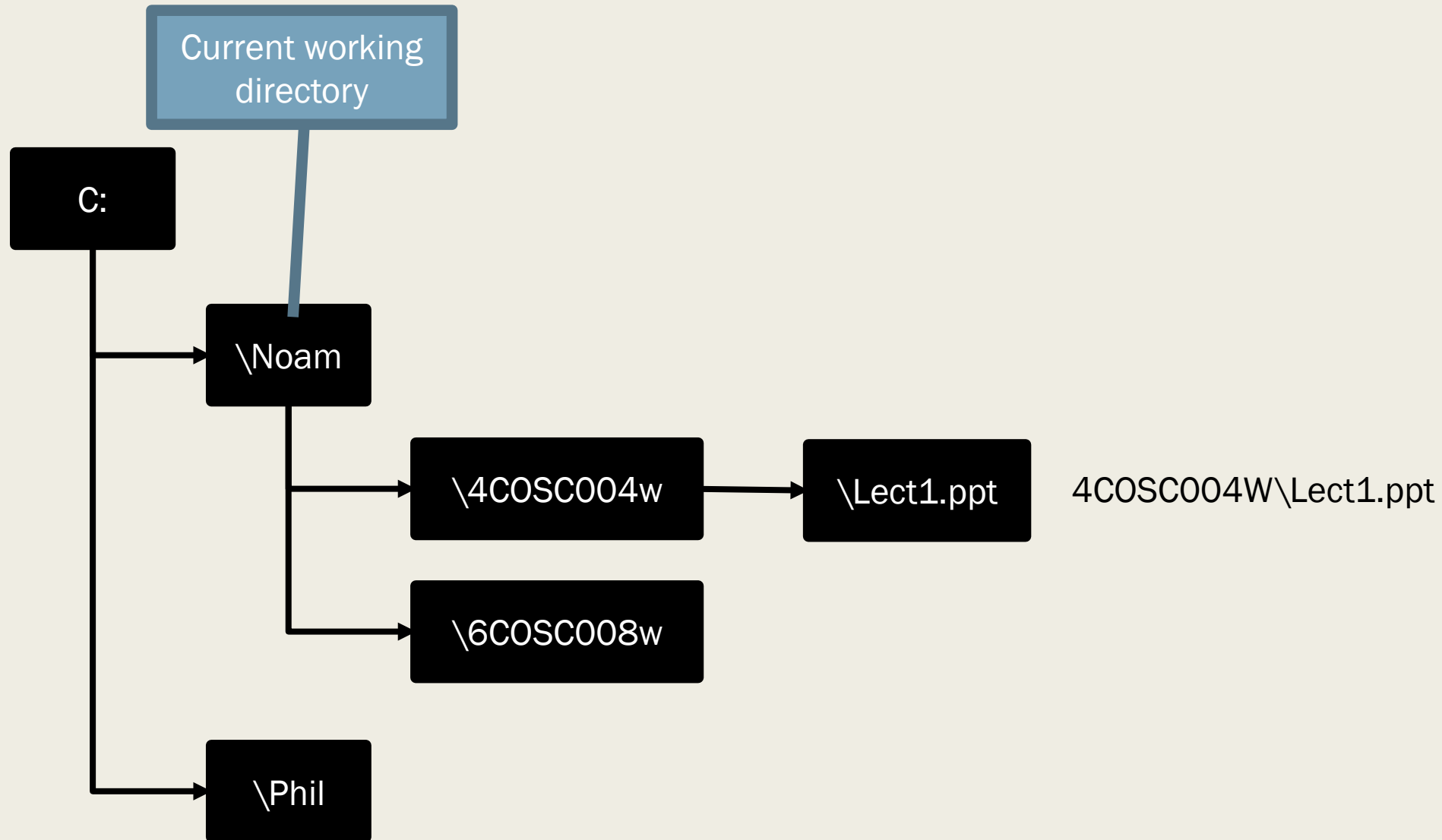
Absolute Path: begins at the root directory



Directory Trees - Relative path names



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 chunks 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

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These slides have been reviewed and amended by Adem Coskun, Izzet Kale and George Charalambous.
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