East West University Bangladesh
Computing Science and Engineering Department

CSE-325: Operating System

Disk and File System Basics

Objectives:

The goal of this lab is to know the windows File Allocation Table (FAT). In this lab, you will learn:

- Hexadecimal Number System.
- FAT file system and boot sector details.
  - (Part a) tracing information from the given boot sector data (512 bytes)
  - (Part b) FAT, root directory and data area

Activity Background

Hexadecimal Number System:

Dec	Hx	Oct	Char	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL (null)	32	20	040		Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH (start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX (start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX (end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT (end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ (enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK (acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL (bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS (backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB (horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF (NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT (vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF (NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR (carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO (shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI (shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE (data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1 (device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2 (device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3 (device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4 (device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK (negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN (synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB (end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN (cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM (end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB (substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC (escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS (file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174			|
29	1D	035	GS (group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS (record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US (unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

Source: www.LookupTables.com

File Allocation Table (FAT)

File Allocation Table (FAT) is a file system that was created by Microsoft in 1977. FAT is still in use today as the preferred file system for floppy drive media and portable, high capacity storage devices like flash drives.

On-disk Structure of a FAT file system:

All disks using the FAT file system are divided into several areas. The following table summarizes the areas in the order that they appear on the disk, starting at block 0:

Area description	Area size
Boot block	1 block (512 bytes)
File Allocation Table (may be multiple copies)	Depends on file system size
Disk root directory	Variable (selected when disk is formatted)
File data area	The rest of the disk

The Boot Block:

The boot block occupies just the first block of the disk. It holds a special program (the bootstrap program) which is used for loading the operating system into memory.
However, in the FAT file system it also contains several important data areas which help to describe the rest of the file system. Thus, to understand how a particular disk is laid out, it is necessary first to understand at least part of the contents of the boot block. The relevant areas are shown in the following table, together with their byte offsets from the start of the boot block.

First an explicit example (of the boot sector of a DRDOS boot floppy).

```
0000000 eb 3f 90 49 42 4d 20 20 33 2e 33 00 02 01 01 00
0000020 02 e0 00 40 0b f0 09 00 12 00 02 00 00 00 00 00
0000040 00 00 00 00 00 00 00 00 00 00 70 00 ff ff 49 42
0000060 4d 42 49 4f 20 20 43 4f 4d 00 50 00 00 08 00 18
...
```

The 2-byte numbers are stored little endian (low order byte first).

Offset from start	Length	Description
0x00	3 bytes	Part of the bootstrap program.
0x03	8 bytes	Optional manufacturer description.
0x0b	2 bytes	Number of bytes per block (almost always 512).
0x0d	1 byte	Number of blocks per allocation unit.
0x0e	2 bytes	Number of reserved blocks. This is the number of blocks on the disk that are not actually part of the file system; in most cases this is exactly 1, being the allowance for the boot block.
0x10	1 byte	Number of File Allocation Tables.
0x11	2 bytes	Number of root directory entries (including unused ones).
0x13	2 bytes	Total number of blocks in the entire disk. If the disk size is larger than 65535 blocks (and thus will not fit in these two bytes), this value is set to zero, and the true size is stored at offset 0x20.
0x15	1 byte	Media Descriptor. This is rarely used, but still exists. .
0x16	2 bytes	The number of blocks occupied by one copy of the File Allocation Table.
0x18	2 bytes	The number of blocks per track. This information is present primarily for the use of the bootstrap program, and need not concern us further here.
0x1a	2 bytes	The number of heads (disk surfaces). This information is present primarily for the use of the bootstrap program, and need not concern us further here.
0x1c	4 bytes	The number of *hidden blocks*. The use of this is largely historical, and it is nearly always set to 0; thus it can be ignored.
0x20	4 bytes	Total number of blocks in the entire disk (see also offset 0x13).
0x24	2 bytes	Physical drive number. This information is present primarily for the use of the bootstrap program, and need not concern us further here.
0x26	1 byte	Extended Boot Record Signature This information is present primarily for the use of the bootstrap program, and need not concern us further here.
0x27	4 bytes	Volume Serial Number. Unique number used for identification of a particular disk.
0x2b	11 bytes	Volume Label. This is a string of characters for human-readable identification of the disk (padded with spaces if shorter); it is selected when the disk is formatted.
0x36	8 bytes	File system identifier (padded at the end with spaces if shorter).
0x3e	0x1c0 bytes	The remainder of the bootstrap program.
0x1fe	2 bytes	Boot block 'signature' (0x55 followed by 0xaa).

The signature is found at offset 510-511. This will be the end of the sector only in case the sector size is 512.

Media descriptor byte

The ancient media descriptor type codes are:

```
For 8" floppies:
fc, fd, fe - Various interesting formats

For 5.25" floppies:
Value  DOS version  Capacity  sides  tracks  sectors/track
ff     1.1           320 KB    2      40      8
fe     1.0           160 KB    1      40      8
fd     2.0           360 KB    2      40      9
fc     2.0           180 KB    1      40      9
fb                   640 KB    2      80      8
fa                   320 KB    1      80      8
f9     3.0          1200 KB    2      80     15

For 3.5" floppies:
Value  DOS version  Capacity  sides  tracks  sectors/track
fb                   640 KB    2      80      8
fa                   320 KB    1      80      8
f9     3.2           720 KB    2      80      9
f0     3.3          1440 KB    2      80     18
f0                  2880 KB    2      80     36

For RAMdisks:
fa

For hard disks:
Value  DOS version
f8     2.0
```

ACTIVITY

From the below FAT table Boot Sector (block 0) trace the following information:

1. Number of bytes per block
2. Number of File Allocation Tables.
3. Number of root directory entries (including unused ones).
4. Total number of blocks in the entire disk.
5. Media Descriptor. This is rarely used, but still exists. .
6. The number of blocks occupied by one copy of the File Allocation Table.
7. The number of blocks per track.
8. Physical drive number.
9. Volume Serial Number.
10. Volume Label.
11. File system identifier
12. Boot block 'signature'

```
        0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
000000 eb 3c 90 4d 53 44 4f 53 35 2e 30 00 02 01 01 00
000010 02 e0 00 40 0b f0 09 00 12 00 02 00 00 00 00 00
000020 00 00 00 00 00 00 29 ca 18 39 19 4d 53 44 4f 53
000030 20 20 20 20 20 20 46 41 54 31 32 20 20 20 fa 33
000040 c0 8e d0 bc 00 7c 16 07 bb 78 00 36 c5 37 1e 56
000050 16 53 bf 3e 7c b9 0b 00 fc f3 a4 06 1f c6 45 fe
000060 0f 8b 0e 18 7c 88 4d f9 89 47 02 c7 07 3e 7c fb
000070 cd 13 72 79 33 c0 39 06 13 7c 74 08 8b 0e 13 7c
000080 89 0e 20 7c a0 10 7c f7 26 16 7c 03 06 1c 7c 13
000090 16 1e 7c 03 06 0e 7c 83 d2 00 a3 50 7c 89 16 52
0000a0 7c a3 49 7c 89 16 4b 7c b8 20 00 f7 26 11 7c 8b
0000b0 1e 0b 7c 03 c3 48 f7 f3 01 06 49 7c 83 16 4b 7c
0000c0 00 bb 00 05 8b 16 52 7c a1 50 7c e8 92 00 72 1d
0000d0 b0 01 e8 ac 00 72 16 8b fb b9 0b 00 be e6 7d f3
0000e0 a6 75 0a 8d 7f 20 b9 0b 00 f3 a6 74 18 be 9e 7d
0000f0 e8 5f 00 33 c0 cd 16 5e 1f 8f 04 8f 44 02 cd 19
000100 58 58 58 eb e8 8b 47 1a 48 48 8a 1e 0d 7c 32 ff
000110 f7 e3 03 06 49 7c 13 16 4b 7c bb 00 07 b9 03 00
000120 50 52 51 e8 3a 00 72 d8 b0 01 e8 54 00 59 5a 58
000130 72 bb 05 01 00 83 d2 00 03 1e 0b 7c e2 e2 8a 2e
000140 15 7c 8a 16 24 7c 8b 1e 49 7c a1 4b 7c ea 00 00
000150 70 00 ac 0a c0 74 29 b4 0e bb 07 00 cd 10 eb f2
000160 3b 16 18 7c 73 19 f7 36 18 7c fe c2 88 16 4f 7c
000170 33 d2 f7 36 1a 7c 88 16 25 7c a3 4d 7c f8 c3 f9
000180 c3 b4 02 8b 16 4d 7c b1 06 d2 e6 0a 36 4f 7c 8b
000190 ca 86 e9 8a 16 24 7c 8a 36 25 7c cd 13 c3 0d 0a
0001a0 47 65 65 6e 20 73 79 73 74 65 65 6d 73 63 68 69
0001b0 6a 66 20 6f 66 20 73 63 68 69 6a 66 66 6f 75 74
0001c0 0d 0a 56 65 72 76 61 6e 67 20 64 69 73 6b 65 74
0001d0 74 65 20 65 6e 20 64 72 75 6b 20 6f 70 20 74 6f
0001e0 65 74 73 0d 0a 00 49 4f 20 20 20 20 20 20 53 59
0001f0 53 4d 53 44 4f 53 20 20 20 53 59 53 00 00 55 aa
```

(Continue…)

Next Week: Part b will be covered.