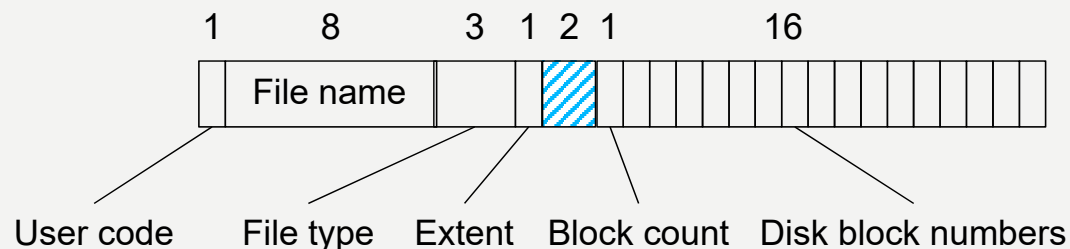# DIRECTORY IMPLEMENTATIONS

Module Number 4. Section 2b
COP4600 – Operating Systems
Richard Newman

FILE SYSTEMS TOPICS

- Introduction
- Directories
- File Allocation
- Block Management
- File System Reliability
- File System Optimization

DIRECTORIES IN CPM

```
  1     8      3 1 2 1        16
┌──┬────────┬──┬─┬▨┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┬─┐
│  │File name│  │ │▨│ │ │ │ │ │ │ │ │ │ │ │ │ │ │ │ │
└──┴────────┴──┴─┴▨┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┴─┘
```

    User code   File type   Extent Block count Disk block numbers

CPM has only one directory, but only the files belonging to the currently logged in user are checked (User code field).
Block count indicates how many of the 16 disk block numbers are valid.
Extent is used for files with more than 16 blocks – it states which set of up to 16 blocks are named in this directory entry.

What is largest file possible in CPM?

Figure 5-11 in 2/e: CPM directory entry contains disk block numbers for each file.
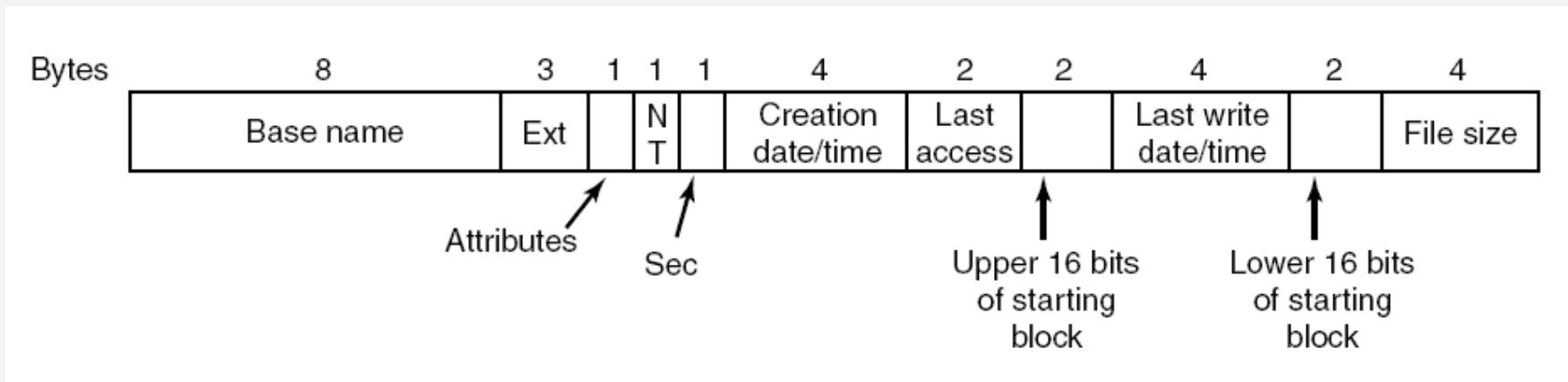
DIRECTORIES IN WINDOWS 98 (1)

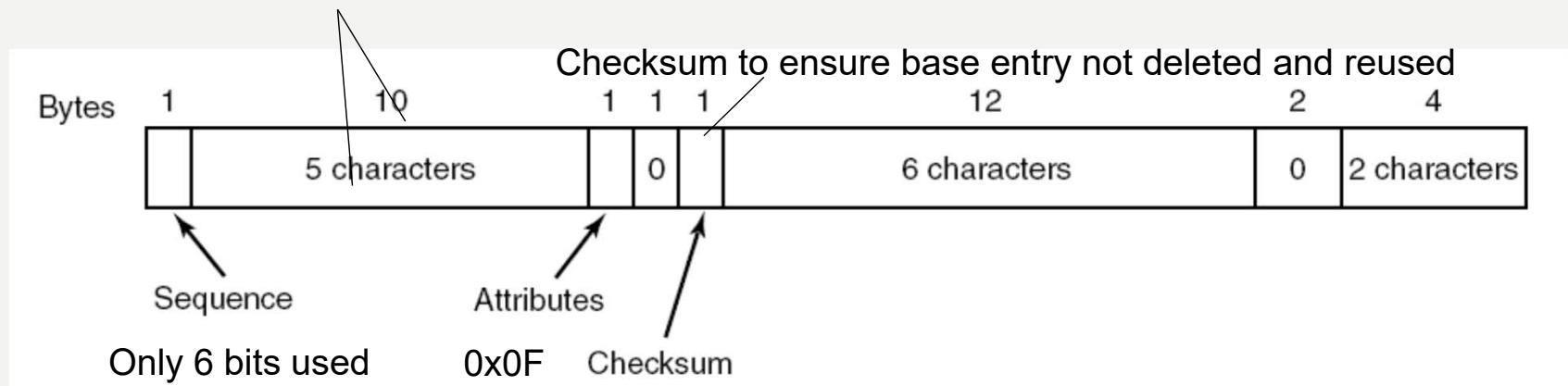Figure 5-13. A Windows 98 base directory entry.

Like Windows 95, has space for 8 character name only.

Note FAT-32 block pointers.

DIRECTORIES IN WINDOWS 98 (2)

All files have long file name entry(ies) before base entry in directory

Double bytes per character for unicode

Checksum to ensure base entry not deleted and reused

Bytes: 1 | 10 | 1 | 1 | 1 | 12 | 2 | 4

| 5 characters | | 0 | | 6 characters | 0 | 2 characters |

Sequence

Attributes

0x0F   Checksum

Only 6 bits used

64 (0x40) added
to last seq # as flag

Not possible in MS-DOS, so entry ignored by MS-DOS

What is longest name now?

Figure 5-14. An entry for (part of) a long file name in Windows 98.

Bit in Sequence marks end of long file name.

Attributes has value 0x0f invalid for older MS-DOS, Win95 FSs.

DIRECTORIES IN WINDOWS 98 (3)

Two files: "Short name.ext" and "This is a very long file name.ext"

0x40 is flag for last entry

42	ame	0F	00	xx		0000			Long name 2-3
01	y lon	0F	00	xx	g file	0000	n		Long name 2-2
00	This	0F	00	xx	is a v	0000	er		Long name 2-1
THIS l~1	ext	xx	nt	xx	date	date	00A5	date	7FE3	000105C	Base entry 2
40	Short	0F	00	xx	name	0000			Long name 1
SHORT ~1	ext	xx	nt	xx	date	date	0036	date	5A14	0000FF3	Base entry 1

Checksum covers all filename – guards against deletion in MS-DOS,
then reuse of base entry by another file

Long entry

Bytes	1	10	1	1	1	12	2	4
		5 characters	A	0	C	6 characters	0	2 characters

Base entry

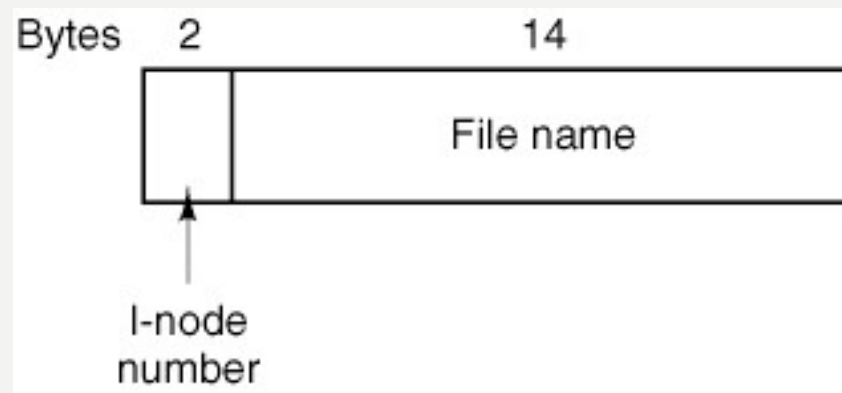| Bytes	8	3	1	1	1	4	2	2	4	2	4
	Base name	Ext	A	N T	S	Creation date/time	Last access		Last write date/time		File size

DIRECTORIES IN UNIX (1)

Figure 5-15. A Version 7 UNIX directory entry.

How many files can this system have?
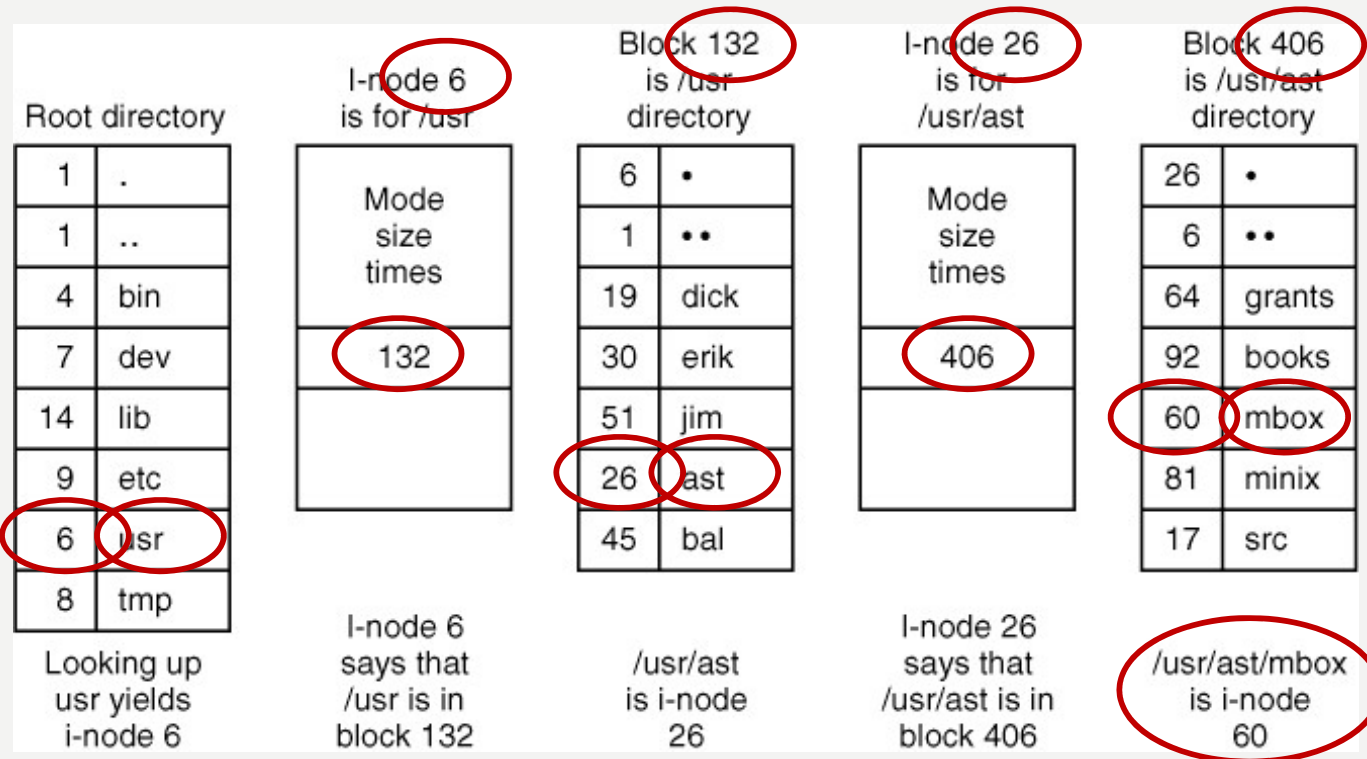
DIRECTORIES IN UNIX (2)

Figure 5-16. The steps in looking up /usr/ast/mbox.
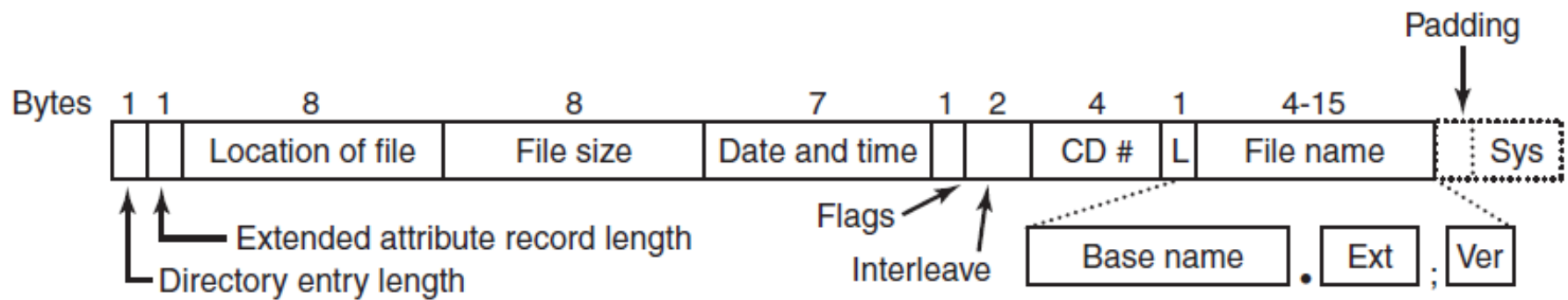
THE ISO 9660 FILE SYSTEM

Figure 4-35. The ISO 9660 directory entry.

ROCK RIDGE EXTENSIONS

1. PX - POSIX attributes.
2. PN - Major and minor device numbers.
3. SL - Symbolic link.
5. NM - Alternative name.
6. CL - Child location.
7. PL - Parent location.
8. RE - Relocation.
9. TF - Time stamps.

JOLIET EXTENSIONS

1. Long file names.

2. Unicode character set.

3. Directory nesting deeper than eight levels.

4. Directory names with extensions