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Red Hat Enterprise Linux Release 9.2 Manual Pages on 'inode.7' command

$ man inode.7

INODE(7) Linux Programmer's Manual INODE(7)

NAME

inode - file inode information

DESCRIPTION

Each file has an inode containing metadata about the file. An applica?
tion can retrieve this metadata using stat(2) (or related calls), which
returns a stat structure, or statx(2), which returns a statx structure.
The following is a list of the information typically found in, or asso?
ciated with, the file inode, with the names of the corresponding struc?
ture fields returned by stat(2) and statx(2):

Device where inode resides

stat.st_dev; statx.stx_dev_minor and statx.stx_dev_major

Each inode (as well as the associated file) resides in a
filesystem that is hosted on a device. That device is identi?
fied by the combination of its major ID (which identifies the
general class of device) and minor ID (which identifies a spe?
cific instance in the general class).

Inode number

stat.st_ino; statx.stx_ino

Each file in a filesystem has a unique inode number. Inode num?
bers are guaranteed to be unique only within a filesystem (i.e.,
the same inode numbers may be used by different filesystems,
which is the reason that hard links may not cross filesystem

boundaries). This field contains the file's inode number.

File type and mode

stat.st_mode; statx.stx_mode

See the discussion of file type and mode, below.

Link count

stat.st_nlink; statx.stx_nlink

This field contains the number of hard links to the file. Addi?

tional links to an existing file are created using link(2).

User ID

st_uid stat.st_uid; statx.stx_uid

This field records the user ID of the owner of the file. For

newly created files, the file user ID is the effective user ID

of the creating process. The user ID of a file can be changed

using chown(2).

Group ID

stat.st_gid; statx.stx_gid

The inode records the ID of the group owner of the file. For

newly created files, the file group ID is either the group ID of

the parent directory or the effective group ID of the creating

process, depending on whether or not the set-group-ID bit is set

on the parent directory (see below). The group ID of a file can

be changed using chown(2).

Device represented by this inode

stat.st_rdev; statx.stx_rdev_minor and statx.stx_rdev_major

If this file (inode) represents a device, then the inode records

the major and minor ID of that device.

File size

stat.st_size; statx.stx_size

This field gives the size of the file (if it is a regular file

or a symbolic link) in bytes. The size of a symbolic link is

the length of the pathname it contains, without a terminating

null byte.

Preferred block size for I/O

stat.st_blksize; statx.stx_blksize

This field gives the "preferred" blocksize for efficient filesystem I/O. (Writing to a file in smaller chunks may cause an inefficient read-modify-rewrite.)

Number of blocks allocated to the file

stat.st_blocks; statx.stx_size

This field indicates the number of blocks allocated to the file, 512-byte units, (This may be smaller than st_size/512 when the file has holes.)

The POSIX.1 standard notes that the unit for the st_blocks mem? ber of the stat structure is not defined by the standard. On many implementations it is 512 bytes; on a few systems, a dif? ferent unit is used, such as 1024. Furthermore, the unit may differ on a per-filesystem basis.

Last access timestamp (atime)

stat.st_atime; statx.stx_atime

This is the file's last access timestamp. It is changed by file accesses, for example, by execve(2), mknod(2), pipe(2), utime(2), and read(2) (of more than zero bytes). Other inter? faces, such as mmap(2), may or may not update the atime time? stamp

Some filesystem types allow mounting in such a way that file and/or directory accesses do not cause an update of the atime timestamp. (See noatime, nodiratime, and relatime in mount(8), and related information in mount(2).) In addition, the atime timestamp is not updated if a file is opened with the O_NOATIME flag; see open(2).

File creation (birth) timestamp (btime)

(not returned in the stat structure); statx.stx_btime

The file's creation timestamp. This is set on file creation and not changed subsequently.

The btime timestamp was not historically present on UNIX systems and is not currently supported by most Linux filesystems.

Last modification timestamp (mtime)

stat.st_mtime; statx.stx_mtime

This is the file's last modification timestamp. It is changed by file modifications, for example, by mknod(2), truncate(2), utime(2), and write(2) (of more than zero bytes). Moreover, the mtime timestamp of a directory is changed by the creation or deletion of files in that directory. The mtime timestamp is not changed for changes in owner, group, hard link count, or mode.

Last status change timestamp (ctime)

stat.st_ctime; statx.stx_ctime

This is the file's last status change timestamp. It is changed by writing or by setting inode information (i.e., owner, group, link count, mode, etc.).

The timestamp fields report time measured with a zero point at the Epoch, 1970-01-02 00:00:00 +0000, UTC (see time(7)).

Nanosecond timestamps are supported on XFS, JFS, Btrfs, and ext4 (since Linux 2.6.23). Nanosecond timestamps are not supported in ext2, ext3, and Reiserfs. In order to return timestamps with nanosecond precision, the timestamp fields in the stat and statx structures are defined as structures that include a nanosecond component. See stat(2) and statx(2) for details. On filesystems that do not support subsecond timestamps, the nanosecond fields in the stat and statx structures are returned with the value 0.

The file type and mode

The stat.st_mode field (for statx(2), the statx.stx_mode field) con? tains the file type and mode.

POSIX refers to the stat.st_mode bits corresponding to the mask S_IFMT (see below) as the file type, the 12 bits corresponding to the mask 07777 as the file mode bits and the least significant 9 bits (0777) as the file permission bits.

The following mask values are defined for the file type:

S_IFMT 0170000 bit mask for the file type bit field

S_IFSOCK 0140000 socket

S_IFLNK 0120000 symbolic link

S_IFREG 0100000 regular file

S_IFBLK 0060000 block device

S_IFDIR 0040000 directory

S_IFCHR 0020000 character device

S_IFIFO 0010000 FIFO

Thus, to test for a regular file (for example), one could write:

```
stat(pathname, &sb);
if ((sb.st_mode & S_IFMT) == S_IFREG) {
    /* Handle regular file */
}
```

Because tests of the above form are common, additional macros are de? fined by POSIX to allow the test of the file type in st_mode to be written more concisely:

S_ISREG(m) is it a regular file?

S_ISDIR(m) directory?

S_ISCHR(m) character device?

S_ISBLK(m) block device?

S_ISFIFO(m) FIFO (named pipe)?

S_ISLNK(m) symbolic link? (Not in POSIX.1-1996.)

S_ISSOCK(m) socket? (Not in POSIX.1-1996.)

The preceding code snippet could thus be rewritten as:

```
stat(pathname, &sb);
if (S_ISREG(sb.st_mode)) {
    /* Handle regular file */
}
```

The definitions of most of the above file type test macros are provided if any of the following feature test macros is defined: _BSD_SOURCE (in glibc 2.19 and earlier), _SVID_SOURCE (in glibc 2.19 and earlier), or _DEFAULT_SOURCE (in glibc 2.20 and later). In addition, definitions of all of the above macros except S_IFSOCK and S_ISSOCK() are provided if _XOPEN_SOURCE is defined.

The definition of S_IFSOCK can also be exposed either by defining

_XOPEN_SOURCE with a value of 500 or greater or (since glibc 2.24) by defining both _XOPEN_SOURCE and _XOPEN_SOURCE_EXTENDED.

The definition of S_ISSOCK() is exposed if any of the following feature test macros is defined: _BSD_SOURCE (in glibc 2.19 and earlier), _DE? FAULT_SOURCE (in glibc 2.20 and later), _XOPEN_SOURCE with a value of 500 or greater, _POSIX_C_SOURCE with a value of 200112L or greater, or (since glibc 2.24) by defining both _XOPEN_SOURCE and _XOPEN_SOURCE_EX? TENDED.

The following mask values are defined for the file mode component of the st_mode field:

S_ISUID	04000	set-user-ID bit (see execve(2))
S_ISGID	02000	set-group-ID bit (see below)
S_ISVTX	01000	sticky bit (see below)
S_IRWXU	00700	owner has read, write, and execute permission
S_IRUSR	00400	owner has read permission
S_IWUSR	00200	owner has write permission
S_IXUSR	00100	owner has execute permission
S_IRWXG	00070	group has read, write, and execute permission
S_IRGRP	00040	group has read permission
S_IWGRP	00020	group has write permission
S_IXGRP	00010	group has execute permission
S_IRWXO	00007	others (not in group) have read, write, and execute permission
S_IROTH	00004	others have read permission
S_IWOTH	00002	others have write permission
S_IXOTH	00001	others have execute permission

The set-group-ID bit (S_ISGID) has several special uses. For a direc? tory, it indicates that BSD semantics are to be used for that direc? tory: files created there inherit their group ID from the directory, not from the effective group ID of the creating process, and directo? ries created there will also get the S_ISGID bit set. For an exe? cutable file, the set-group-ID bit causes the effective group ID of a process that executes the file to change as described in execve(2).

For a file that does not have the group execution bit (S_IXGRP) set, the set-group-ID bit indicates mandatory file/record locking.

The sticky bit (S_ISVTX) on a directory means that a file in that di? rectory can be renamed or deleted only by the owner of the file, by the owner of the directory, and by a privileged process.

CONFORMING TO

If you need to obtain the definition of the blkcnt_t or blksize_t types from <sys/stat.h>, then define _XOPEN_SOURCE with the value 500 or greater (before including any header files).

POSIX.1-1990 did not describe the S_IFMT, S_IFSOCK, S_IFLNK, S_IFREG, S_IFBLK, S_IFDIR, S_IFCHR, S_IFIFO, S_ISVTX constants, but instead specified the use of the macros S_ISDIR(), and so on. The S_IF* con? stants are present in POSIX.1-2001 and later.

The S_ISLNK() and S_ISSOCK() macros were not in POSIX.1-1996, but both are present in POSIX.1-2001; the former is from SVID 4, the latter from SUSv2.

UNIX V7 (and later systems) had S_IREAD, S_IWRITE, S_IEXEC, where POSIX prescribes the synonyms S_IRUSR, S_IWUSR, S_IXUSR.

NOTES

For pseudofiles that are autogenerated by the kernel, the file size (stat.st_size; statx.stx_size) reported by the kernel is not accurate. For example, the value 0 is returned for many files under the /proc di? rectory, while various files under /sys report a size of 4096 bytes, even though the file content is smaller. For such files, one should simply try to read as many bytes as possible (and append '\0' to the returned buffer if it is to be interpreted as a string).

SEE ALSO

stat(1), stat(2), statx(2), symlink(7)

COLOPHON

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