# IEEE P1282

# ROCK RIDGE
# INTERCHANGE PROTOCOL

# DRAFT STANDARD VERSION 1.12

**Adopted 1994-07-08**

**Standard for Information Technology --**
**Interchange of ISO 9945-1:1990 Filesystems**
**via the ISO 9660:1988 File Structure.**

**IEEE CD-ROM FILE SYSTEM FORMAT WORKING GROUP**
**cdfsf@ymi.com**

*Note to Reviewers: Notes in italics are not intended for inclusion in the final document.*

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# 1. PREFACE

## 1.1 Purpose and Scope

Producers and users of POSIX compliant systems and software have faced a significant barrier to their effectively using CD-ROM technology for software distribution and information publishing -- ISO 9660 alone provides inadequate support for delivery of POSIX file system information. The Rock Ridge Group was formed to generate a mechanism for utilizing the System Use fields provided by the ISO 9660 standard to record complete POSIX file system semantics. This specification utilizes the System Use Sharing Protocol, developed concurrently with this document, for recording this information.

## 1.2 Summary of Sections

- Section 1 Contains the Preface.
- Section 2 Contains an overview of the Rock Ridge Interchange Protocol.
- Section 3 Contains an overview of the notation used in this document.
- Section 4 Contains the Rock Ridge Interchange Protocol.
- Section 5 Contains the Bibliography.

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## 2. OVERVIEW

The Rock Ridge Interchange Protocol (RRIP) specifies an extension to the ISO 9660 standard for CD-ROM which enables the recording of sufficient information to support POSIX File System semantics. The RRIP utilizes the System Use Sharing Protocol (SUSP) to specify the definition of a set of System Use Entries for this purpose.

The RRIP specifies the definition of a set of System Use Entries for recording:

- uid, gid, and permissions
- file mode bits, file types, setuid, setgid, and sticky bit
- file links
- sparse files
- device nodes
- symbolic links
- POSIX file names
- reconstruction of deep Directory Hierarchies
- time stamps
- file serial number

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# 3. TERMINOLOGY AND NOTATION

It is assumed that the IEEE P1282 Rock Ridge Interchange Protocol is being recorded within an ISO 9660-compliant volume using the IEEE P1281 System Use Sharing Protocol (SUSP).

Unless defined herein, or otherwise specified, terms shall be as defined in IEEE P1281, ISO 9660, or IEEE 1003.1:1990 documents. In case of a conflict in terminology between these three documents, priority will be given to the first document in the list which defines the term in question.

The term "System Use Area" as used in this document shall refer to the System Use field of an ISO 9660 Directory Record as well as any associated SUSP Continuation Areas.

The following notation is used in this document:

## 3.1 References

References to the IEEE P1282 Rock Ridge Interchange Protocol (this document) shall be of the form "RRIP". References to specific clauses shall be of the form "1.2.3" where 1.2.3 specifies a particular clause of the standard (1.2.3 in this example).

References to the IEEE P1281 System Use Sharing Protocol shall be of the form "SUSP" where SUSP:1.2.3 specifies a particular clause of the standard (1.2.3 in this example).

*Note: References to "IEEE P1281" and "IEEE P1282" will, on adoption as IEEE standards, become "IEEE 1281" and "IEEE 1282".*

References to a specific clause (for example, clause 1.2.3) of the ISO 9660 standard shall be of the form ISO 9660:1.2.3.

References to a specific clause (for example, clause 1.2.3) of IEEE 1003.1:1990 (POSIX)shall be of the form POSIX:1.2.3.

## 3.2 Decimal and Hexadecimal Notation

Numbers in decimal notation are represented by decimal digits, namely 0 to 9.

Numbers in hexadecimal notation are represented by hexadecimal digits, namely 0 to 9 and A to F, in parentheses. For example, the hexadecimal number 7F will be written as (7F).

## 3.3 Abbreviations

The abbreviation B represents one byte (eight bits).

The abbreviation K represents the value 1024, e.g. the decimal number 4096 may be written as 4K.

The abbreviation M represents the value 1,048,576.

The abbreviation G represents the value of K * M. The abbreviation T represents the value of M * M.

### 3.4 File Naming Conventions

In all fields defined in ISO 9660, the character set to be used shall be as specified in ISO 9660. The character set to be used in the System Use Entries defined herein shall depend upon whether the entries are recorded in a Directory Hierarchy (defined in ISO 9660:6.8.2) associated with a Primary Volume Descriptor or in one associated with a Supplementary Volume Descriptor.

#### 3.4.1 Primary Volume Descriptor File Naming Convention

Within a Directory Hierarchy identified by a Primary Volume Descriptor of an ISO 9660 volume, "SL" Component Content (see 4.1.3.1) and "NM" Name Content (see 4.1.4) shall be as defined in POSIX:2.2.2.32 and shall use the portable filename character set as defined in POSIX:2.2.2.60.

#### 3.4.2 Supplementary Volume Descriptor File Naming Convention

Within a Directory Hierarchy identified by a Supplementary Volume Descriptor of an ISO 9660 volume, the character set used in the System Use Entries defined for the RRIP shall be the coded graphic character sets identified by the escape sequences in the Supplementary Volume Descriptor (see ISO 9660:7.4.2).

# 4. ROCK RIDGE INTERCHANGE PROTOCOL

The Rock Ridge Interchange Protocol (RRIP) utilizes System Use Areas as defined in the System Use Sharing Protocol (SUSP). The System Use Area of each Directory Record is used to record POSIX file system information. The System Use Sharing Protocol is used for recording information in each of these areas.

## 4.1 System Use Entries Provided by this Specification

The RRIP defines the following System Use Entries:

- "PX" POSIX file attributes
- "PN" POSIX device number
- "SL" Symbolic link
- "NM" Alternate name
- "CL" Child link
- "PL" Parent link
- "RE" Relocated directory
- "TF" Time stamp(s) for a file
- "SF" File data in sparse file format

Additionally, this specification defines the required identification information to be recorded in an "ER" (Extensions Reference) System Use Entry for the purpose of identifying discs on which the Rock Ridge Interchange Protocol is implemented.

### 4.1.1 Description of the "PX" System Use Entry

Recording of the "PX" System Use Entry in the System Use Area of each Directory Record is mandatory. No more than one "PX" System Use Entry shall be recorded in the System Use Area of a single Directory Record.

The format of the "PX" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "PX" type System Use Entry. The bytes in this field shall be (50)(58) ("PX").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "PX" System Use Entry. The number in this field shall be 44 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "PX" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 to BP 12 - POSIX File Mode" shall have the same meaning as and may be used for the st_mode field specified in POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3. The valid values for this field are combinations of the following:

TABLE 1. POSIX File Modes

| Octal Value | Mnemonic | Meaning |
|---|---|---|
| 0000400 | S_IRUSR | read permission (owner) |
| 0000200 | S_IWUSR | write permission (owner) |
| 0000100 | S_IXUSR | execute permission (owner) |
| 0000040 | S_IRGRP | read permission (group) |
| 0000020 | S_IWGRP | write permission (group) |
| 0000010 | S_IXGRP | execute permission (group) |
| 0000004 | S_IROTH | read permission (other) |
| 0000002 | S_IWOTH | write permission (other) |
| 0000001 | S_IXOTH | execute permission (other) |
| | | |
| 0004000 | S_ISUID | set user ID on execution |
| 0002000 | S_ISGID | set group ID on execution |
| 0002000 | S_ENFMT | enforced file locking (shared w/ set group ID) |
| 0001000 | S_ISVTX | save swapped text even after use |
| | | |
| 0140000 | S_IFSOCK | socket |
| 0120000 | S_IFLNK | symbolic link |
| 0100000 | S_IFREG | regular |
| 0060000 | S_IFBLK | block special |
| 0020000 | S_IFCHR | character special |
| 0040000 | S_IFDIR | directory |
| 0010000 | S_IFIFO | pipe or FIFO |

[5] "BP 13 to BP 20 - POSIX File Links" shall be used for the st_nlink field of POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3.

[6] "BP 21 to BP 28 - POSIX File User ID" shall have the same meaning as and may be used for the st_uid field of POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3.

[7] "BP 29 to BP 36 - POSIX File Group ID" shall have the same meaning as and may be used for the st_gid field of POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3.

[8] "BP 37 to BP 44 - POSIX File Serial Number" shall have the same meaning as and may be used for the st_ino field of POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3. Directory Records which share the value of this field are defined as links (see POSIX:2.2.2.17) and, by definition, point to the same file or directory.

*Note: Use of the phrase "may be used for" in [4], [6], [7], and [8] is intended to provide for the possibility of mapping these values when used by a receiving system provided that, in the case of [8], the meaning of st_ino is preserved as a unique identifier of the file.*

FIGURE 1. "PX" System Use Entry

| | | | | | |
|---|---|---|---|---|---|
| "P" | "X" | 44 | 1 | FILE MODE | LINKS |
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5 to BP12) | (BP13 to BP20) |

| | | |
|---|---|---|
| USER ID | GROUP ID | FILE SERIAL NUMBER |
| (BP21 to BP28) | (BP29 to BP36) | (BP37 to BP44) |

### 4.1.2 Description of the "PN" System Use Entry

This System Use Entry is mandatory if the file type recorded in the "PX" File Mode field for a Directory Record indicates a character or block device. This System Use Entry, if present, shall be ignored for all other file types. No more than one "PN" System Use Entry shall be recorded in the System Use Area of a single Directory Record.

The format of the "PN" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "PN" type System Use Entry. The bytes in this field shall be (50)(4E) ("PN").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "PN" System Use Entry. The number in this field shall be 20 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "PN" System Use Entry. The number in this

field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 to BP 12 - Dev_t High" shall contain as a 32-bit number the high order 32-bits of the 64 bit device number. This field shall be recorded according to ISO 9660:7.3.3.

[5] "BP 13 to BP 20 - Dev_t Low" shall contain as a 32-bit number the low order 32 bits of the 64 bit device number. This field shall be recorded according to ISO 9660:7.3.3.

FIGURE 2. "PN" System Use Entry

| | | | | | |
|---|---|---|---|---|---|
| "P" | "N" | 20 | 1 | DEV_T HIGH | DEV_T LOW |
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5 to BP12) | (BP13 to BP20) |

### 4.1.3 Description of the "SL" System Use Entry

The purpose of the "SL" System Use Entry is to store the content of a symbolic link. This System Use Entry is mandatory if the file type recorded in the "PX" File Mode field for a Directory Record indicates a symbolic link. For other file types, this System Use Entry shall be ignored.

If multiple "SL" System Use Entries are recorded in the System Use Area of a single Directory Record, their Component Areas (see 4.1.3.1) shall be concatenated together, in the order in which they were recorded, until a CONTINUE flag with value ZERO is encountered (see 4.1.3, paragraph [4]), to obtain the entire set of Component Records for the symbolic link.

The format of the "SL" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "SL" type System Use Entry. The bytes in this field shall be (53)(4C) ("SL").

[2] "BP 3 - Length (LEN_SL)" shall specify as an 8-bit number the length in bytes of the "SL" System Use Entry. The number in this field shall be 5 plus the length of the Component Area recorded in this "SL" field. This field shall be recorded according to ISO 9660: 7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "SL" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 - Flags" shall contain bit field flags numbered 0 to 7 starting with the least significant bit as follows:

TABLE 2. "SL" Flags

| Position | Name | Interpretation |
|---|---|---|
| 0 | CONTINUE | If set to ONE, this Symbolic Link continues in next "SL" System Use Entry in this System Use Area. |
| | | If set to ZERO, this is the last "SL" System Use Entry for this Symbolic Link. |
| all others | RESERVED | Shall be set to ZERO. |

[5] "BP 6 to LEN_SL - Component Area" shall contain Component Records (see 4.1.3.1).

FIGURE 3. "SL" System Use Entry

| | | | | | |
|---|---|---|---|---|---|
| "S" | "L" | LEN_SL | 1 | FLAGS | COMPONENT AREA |
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5) | (BP6 to LEN_SL) |

#### 4.1.3.1 Description of the "SL" System Use Entry Component Record

Within an "SL" System Use Entry, each component of the pathname shall be recorded as one or more Component Records. A component shall be a filename as specified in POSIX:2.2.2.32. Recording a single component of a symbolic link may require multiple Component Records. If the component will not fit into the current Component Area, more than one Component Record shall be recorded for the component. Multiple Component Records, specifying one or more separate components of a symbolic link, may be recorded in the Component Area of a single "SL" System Use Entry.

If a single Component Record is used to record a single component of a symbolic link, the CONTINUE flag shall be set to ZERO. If multiple Component Records are used to record a single component of a symbolic link, their Component Contents shall be concatenated together, in the order in which they were recorded, until a CONTINUE flag with value ZERO is encountered, to obtain an entire component of the symbolic link. If an additional Component Record is recorded following a Component Record with CONTINUE flag of value ZERO, then this next Component Record shall be the first Component Record of the next component of the symbolic link.

Once the entire set of components is determined, the components shall be concatenated together, in the order in which they were recorded, with each pair of adjacent components separated by the appropriate component separator for the receiving system ("/" in POSIX), to obtain the entire symbolic link.

Component Records shall be recorded contiguously within each Component Area, starting in the first byte of the Component Area. The last Component Record in the Component Area of an "SL" System Use Entry may be continued in the Component Area of the next recorded "SL" System Use Entry in the same System Use Area.

Each Component Record shall have the following format:

[A] "BP 1 - Component Flags" shall contain bit field flags numbered 0 to 7, starting with the least significant bit, as follows:

TABLE 3. "SL" Component Flags

| Position | Name | Interpretation |
|---|---|---|
| 0 | CONTINUE | If set to ONE, the component recorded in this "SL" Component Record continues in next "SL" Component Record.<br>If set to ZERO, this component is not continued. |
| 1 | CURRENT | If set to ONE, this component shall refer to the current directory ("." in POSIX:2.3.6).<br>If set to ZERO, this component shall not refer to the current directory. |
| 2 | PARENT | If set to ONE, this component shall refer to the parent of the current directory (".." in POSIX:2.3.6).<br>If set to ZERO, this component shall not refer to the parent of the current directory. |
| 3 | ROOT | If set to ONE, this component shall refer to the root of the current Directory Hierarchy for this process ("/" in POSIX:2.3.6).<br>If set to ZERO, this component shall not refer to the root of the current Directory Hierarchy. |
| 4 | RESERVED | Use of this flag is implementation specific. Historically, this component has referred to the directory on which the current CD-ROM volume is mounted. |
| 5 | RESERVED | Use of this flag is implementation specific. Historically, this component has contained the network node name of the current system as defined in the uname structure of POSIX:4.4.1.2. |
| all others | RESERVED | Shall be set to ZERO. |

No more than one of "SL" Component Flag Bits 0-3 shall be set to ONE.

[B] "BP 2 - Component Length (LEN_CP)" shall specify as an 8-bit number the length in bytes of the component or portion thereof recorded in the current Component Record. This length shall not include the Component Flags byte or the LEN_CP byte. If any of the bit positions 1-5 is set, the value of this field shall be set to ZERO and no Component Content shall be recorded. This field shall be recorded according to ISO 9660 Format section 7.1.1.

[C] "BP 3 to 2 + LEN_CP - Component Content" shall contain the component or portion thereof recorded in the current Component Record. The content of this field shall be recorded according to section 3.4 of this document.

FIGURE 4. "SL" System Use Entry - Component Record

| COMPONENT FLAGS | COMP_LEN | COMPONENT CONTENT |
|---|---|---|
| (BP1) | (BP2) | (BP3 to 2+LEN_CP) |

### 4.1.4 Description of the "NM" System Use Entry

The purpose of the "NM" System Use Entry is to store the content of an Alternate Name to support POSIX-style or other names. This System Use Entry is optional. If no "NM" System Use Entry is recorded in the System Use Area of a specific Directory Record, the ISO 9660 File Identifier shall be used.

If more than one "NM" System Use Entry is recorded in the System Use Area of a single Directory Record, their Name Content fields (see 4.1.4, paragraph [5]) shall be concatenated together, in the order in which they were recorded, until a CONTINUE flag with value ZERO is encountered (see 4.1.4, paragraph [4]), to obtain the entire Alternate Name.

If the ISO 9660 Directory Record File Identifier is (00), then the CURRENT bit of the "NM" Flags field (see 4.1.4, paragraph [4]), if present, shall be set to ONE. If the ISO 9660 Directory Record File Identifier is (01), then the PARENT bit of the "NM" Flags field (see 4.1.4, paragraph [4]), if present, shall be set to ONE.

No sorting of the directory records by Alternate Names is specified by the RRIP, nor can one necessarily be imposed by originating systems or assumed by receiving systems. The ISO 9660 specifies a sorting order based upon the ISO 9660 file identifier (see ISO 9660:9.3).

The format of the "NM" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "NM" type System Use Entry. The bytes in this field shall be (4E)(4D) ("NM").

[2] "BP 3 - Length (LEN_NM)" shall specify as an 8-bit number the length in bytes of the "NM" System Use Entry. The number in this field shall be 5 plus the length of the Name Content recorded in this "NM" System Use Entry. If bit position 1, 2, or 5 of the "NM" Flags is set to ONE, the value of this field shall be 5 and no Name Content shall be recorded. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "NM" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 - Flags" shall contain bit field flags numbered 0 to 7 starting with the least significant bit as follows:

TABLE 4. "NM" Flags

| Position | Name | Interpretation |
|---|---|---|
| 0 | CONTINUE | If set to ONE, the Alternate Name continues in next "NM" System Use Entry of this System Use Area. |
| | | If set to ZERO, the Alternate Name does not continue. |
| 1 | CURRENT | If set to ONE, the Alternate Name refers to the current directory ("." in POSIX). |
| | | If set to ZERO, the Alternate Name does not refer to the current directory. |
| 2 | PARENT | If set to ONE, the Alternate Name refers to the parent of the current directory (".." in POSIX) |
| | | If set to ZERO, the Alternate Name does not refer to the parent of the current directory. |
| 3 | RESERVED | Shall be set to ZERO. |
| 4 | RESERVED | Shall be set to ZERO. |
| 5 | RESERVED | Use of this flag is implementation specific. Historically, this component has contained the network node name of the current system as defined in the uname structure of POSIX:4.4.1.2. |
| all others | RESERVED | Shall be set to ZERO. |

No more than one of "NM" Flag Bits 0, 1, and 2 shall be set to ONE.

[5] "BP 6 to LEN_NM - Name Content" shall contain the content or portion thereof of the Alternate Name. The content of this field shall be recorded according to section 3.4.

FIGURE 5. "NM" System Use Entry

| "N" | "M" | LEN_NM | 1 | FLAGS | NAME CONTENT |
|---|---|---|---|---|---|
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5) | (BP6 to LEN_NM) |

### 4.1.5 System Use Entries for Handling Deep Directory Hierarchies

ISO 9660 mandates that the number of levels in a Directory Hierarchy shall not exceed eight. Deeper directories must be reorganized to be recorded under ISO 9660. This specification includes definitions of three System Use Entries to support logical reconstruction of deep Directory Hierarchies while retaining complete ISO 9660 compliance. For each directory relocated as part of this process, all three of the System Use Entries "CL", "PL", and "RE" shall be appropriately recorded.

Figure 9 at the end of this section provides a graphical example of the relocation of Deep Directory Hierarchies.

#### 4.1.5.1 Description of the "CL" System Use Entry

The purpose of the "CL" System Use Entry is to record the new location of a directory which has been relocated.

If recorded, a "CL" System Use Entry shall be recorded in the System Use Area of a Directory Record which describes a file having the same name as, and occupying the original position in the ISO 9660 Directory Hierarchy of, the moved directory. No more than one "CL" System Use Entry shall be recorded in the System Use Area of a single Directory Record.

Except for the ISO 9660 File Identifier, the Alternate Name (recorded in an "NM" System Use Entry), and the new location of the directory, all other information stored in the directory for this file shall be ignored. The contents of this file are not specified by this document. All attributes of the moved directory shall be recorded in the first Directory Record ("." entry) of the moved directory in its new location.

The format of the "CL" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "CL" type System Use Entry. The bytes in this field shall be (43)(4C) ("CL").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "CL" System Use Entry. The number in this field shall be 12 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "CL" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 to BP 12 - Location of Child Directory" shall specify as a 32-bit number the Logical Block Number of the first Logical Block allocated to the moved directory. This field shall be recorded according to ISO 9660:7.3.3.

FIGURE 6. "CL" System Use Entry

| | | | | |
|---|---|---|---|---|
| "C" | "L" | 12 | 1 | LOCATION of CHILD DIRECTORY |
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5 to BP12) |

#### 4.1.5.2 Description of the "PL" System Use Entry

The purpose of the "PL" System Use Entry is to record the location of the original parent directory of a directory which has been relocated.

The "PL" System Use Entry shall be recorded in the System Use Area of the second Directory Record (".." entry) of each moved directory. No more than one "PL" System Use Entry shall be recorded in the System Use Area of a single Directory Record.

The format of the "PL" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "PL" type System Use Entry. The bytes in this field shall be (50)(4C) ("PL").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "PL" System Use Entry. The number in this field shall be 12 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "PL" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 to BP 12 - Location of Parent Directory" shall specify as a 32-bit number the Logical Block Number of the first Logical Block allocated to the original parent directory of the moved directory. This field shall be recorded according to ISO 9660:7.3.3.

FIGURE 7. "PL" System Use Entry

| | | | | |
|---|---|---|---|---|
| "P" (BP1) | "L" (BP2) | 12 (BP3) | 1 (BP4) | LOCATION of PARENT DIRECTORY (BP5 to BP12) |

#### 4.1.5.3 Description of the "RE" System Use Entry

The purpose of the "RE" System Use Entry is to indicate to an RRIP-compliant receiving system that the Directory Record in which an "RE" System Use Entry is recorded has been relocated from another position in the original Directory Hierarchy.

If recorded, a "RE" System Use Entry shall be recorded in the System Use Area of the Directory Record which describes the moved directory in the new parent directory of the moved directory.

The format of the "RE" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "RE" type System Use Entry. The bytes in this field shall be (52)(45) ("RE").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "RE" System Use Entry. The number in this field shall be 4 for this version. This field shall be recorded according to ISO 9660:7.1.1.

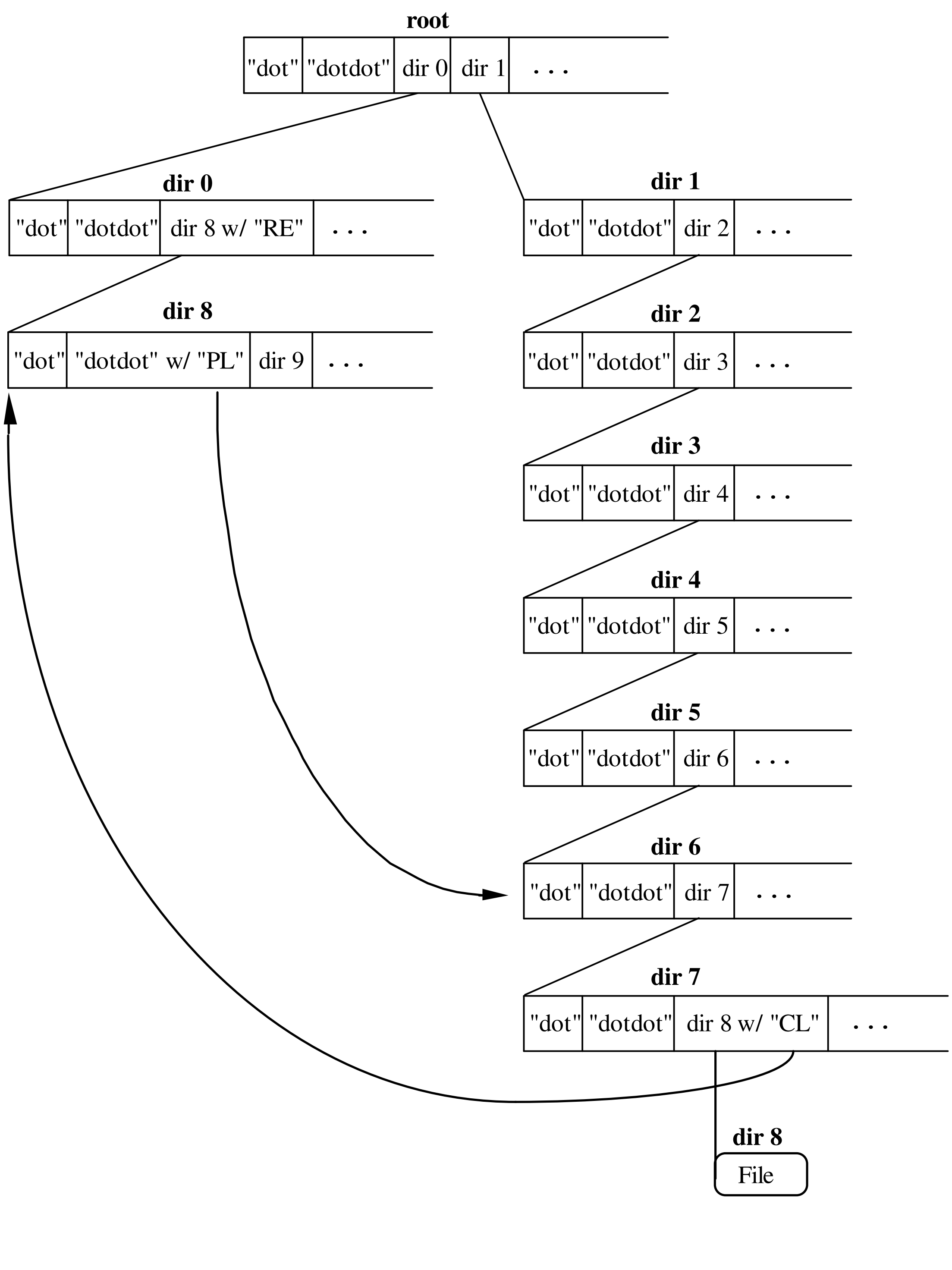
[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "RE" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

FIGURE 8. "RE" System Use Entry

| | | | |
|---|---|---|---|
| "R" (BP1) | "E" (BP2) | 4 (BP3) | 1 (BP4) |

FIGURE 9. Deep Directory



### 4.1.6 Description of the "TF" System Use Entry

The purpose of the "TF" System Use Entry is to allow the recording of time stamps related to a file. A Time Stamp is one of the following list of time stamps: Creation Time, Modification Time, Last Access Time, Last Attribute Change Time, Last Backup Time, Expiration Time, and Effective Time. Multiple Time Stamps may be recorded for a single "TF" System Use Entry and multiple "TF" System Use Entries may be recorded in the System Use Area of a single Directory Record, but each individual Time Stamp may be recorded only once in all the "TF" System Use Entries for a single Directory Record.

The format of the "TF" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "TF" type System Use Entry. The bytes in this field shall be (54)(46) ("TF").

[2] "BP 3 - Length (LEN_TF)" shall specify as an 8-bit number the length in bytes of the "TF" System Use Entry. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "TF" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 - Flags" shall contain bit field flags numbered 0 to 7 starting with the least significant bit as follows:

TABLE 5. "TF" Flags

| Position | Name | Interpretation |
|---|---|---|
| 0 | CREATION | If set to ONE, Creation Time is recorded.<br>If set to ZERO, Creation Time is not recorded. |
| 1 | MODIFY | If set to ONE, Modification Time is recorded.<br>If set to ZERO, Modification Time is not recorded. |
| 2 | ACCESS | If set to ONE, Last Access Time is recorded.<br>If set to ZERO, Last Access Time is not recorded. |
| 3 | ATTRIBUTES | If set to ONE, Last Attribute Change Time is recorded.<br>If set to ZERO, Last Attribute Change Time is not recorded. |
| 4 | BACKUP | If set to ONE, Last Backup Time is recorded.<br>If set to ZERO, Last Backup Time is not recorded. |
| 5 | EXPIRATION | If set to ONE, Expiration Time is recorded.<br>If set to ZERO, Expiration Time is not recorded. |
| 6 | EFFECTIVE | If set to ONE, Effective Time is recorded.<br>If set to ZERO, Effective Time is not recorded. |
| 7 | LONG_FORM | If set to ONE, the ISO 9660 17-byte time format is used.<br>If set to ZERO, the ISO 9660 7-byte time format is used. |

If the LONG_FORM bit is set to one, all time stamps in this "TF" System Use Entry shall be recorded using the format specified in ISO 9660:8.4.26.1. If the LONG_FORM bit is set to zero, all time stamps in this "TF" System Use Entry shall be recorded using the format specified in ISO 9660:9.1.5.

[4+N] "BP 6+(X*(N-1)) to 5+(X*N) Time Stamp" shall contain the Nth time stamp indicated in [4] as being recorded, starting with the 0th bit and working sequentially through the list of recordable time stamps. The LONG_FORM bit does not indicate the presence or absence of any time stamp. The value of X in the expression above shall be 17 if the LONG_FORM bit is set to 1, and 7 otherwise.

The recorded time for each of the time stamps recorded in this field shall be local time. If recorded, CREATION, Creation Time, has the same meaning as in ISO 9660:9.5.4.

If recorded, MODIFY, File Modification Date and Time, has the same meaning as in ISO 9660:9.5.5. This field shall be used for the st_mtime field of POSIX:5.6.1.

If recorded, ACCESS, File Last Access Date and Time, shall specify the date and time of the day at which the information in the file was last accessed. This field shall be used for the st_atime field of POSIX:5.6.1.

If recorded, ATTRIBUTES, Last Attribute Change Time, shall be used for the st_ctime field of POSIX:5.6.1.

If recorded, BACKUP, Last Backup Time, shall provide a time stamp for the most recent backup of this file. The utilization of this information is not restricted by this specification.

If recorded, EXPIRE, File Expiration Date and Time, has the same meaning as in ISO 9660:9.5.6.

If recorded, EFFECT, File Effective Date and Time, has the same meaning as in ISO 9660:9.5.7.

FIGURE 10. "TF" System Use Entry

| | | | | | |
|---|---|---|---|---|---|
| "T" (BP1) | "F" (BP2) | LEN_TF (BP3) | 1 (BP4) | FLAGS (BP5) | TIME STAMPS (BP6 TO LEN_TF) |

### 4.1.7 Description of the "SF" System Use Entry

The purpose of the "SF" System Use Entry is to indicate that the file identified by the current Directory Record is stored as a "sparse" file, and to provide additional information which is necessary to retrieve the file contents. No more than one "SF" System Use Entry shall be recorded in the System Use Area of a single Directory Record.

The "SF" System Use Entry is designed to provide support for the encoding and delivery of "sparse files" in a platform-independent manner. The sparse file encoding allocates physical blocks only if the corresponding logical block contains non-zero data.

The format of the "SF" System Use Entry is as follows:

[1] "BP 1 to BP 2 - Signature Word" shall indicate that the System Use Entry is a "SF" type System Use Entry. The bytes in this field shall be (53)(46) ("SF").

[2] "BP 3 - Length" shall specify as an 8-bit number the length in bytes of the "SF" System Use Entry. The number in this field shall be 21 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[3] "BP 4 - System Use Entry Version" shall specify as an 8-bit number an identification of the version of the "SF" System Use Entry. The number in this field shall be 1 for this version. This field shall be recorded according to ISO 9660:7.1.1.

[4] "BP 5 to BP 12 - Virtual File Size High" shall contain as a 32-bit number the high order 32-bits of the 64 bit file size. The 64-bit Virtual File Size shall be used for the st_size field of POSIX:5.6.1. This field shall be recorded according to ISO 9660:7.3.3.

[5] "BP 13 to BP 20 - Virtual File Size Low" shall contain as a 32-bit number the low order 32 bits of the 64 bit file size. This field shall be recorded according to ISO 9660:7.3.3.

[6] "BP 21 - Table Depth" shall specify as an 8-bit number the depth of the First Index Block, and therefore the maximum virtual size of the file. To determine the Table Depth of the First Index Block for a file, consult Table 6.

TABLE 6. Determination of Table Depth from Maximum Virtual File Size

| Maximum Virtual File Size | Depth |
|---|---|
| 16M TB | 7 |
| 64K TB | 6 |
| 256 TB | 5 |
| 1 TB | 4 |
| 4 GB | 3 |
| 16 MB | 2 |
| 64 KB | 1 |

FIGURE 11. "SF" System Use Entry

| "S" | "F" | 21 | 1 | SIZE HIGH | SIZE LOW | TABLE DEPTH |
|---|---|---|---|---|---|---|
| (BP1) | (BP2) | (BP3) | (BP4) | (BP5 to BP12) | (BP13 to BP20) | (BP21) |

#### 4.1.7.1 Encoding and Recording of Sparse Files

Sparse Files are encoded within the File Section as specified in ISO 9660:6.4.2. The Directory Record Data Length as specified in ISO 9660:9.1.4 shall specify the length of the file section, including the SF Header Block, all Index Blocks, and the sparse file data.

The initial (number 0) 2K byte block of the File Section shall be an SF Header Block.

The first 21 bytes of the SF Header Block contain a copy of the SF System Use Entry. All unused bytes in the SF Header Block are reserved and shall be set to (00).

The second (number 1) 2K byte block of the File Section shall be the first Index Block. The depth of this Index Block shall be the same as the value of Table Depth of the SF System Use Entry for this file. Each Index Block of the encoded file shall hold 256 table entries.

Each Table Entry of an Index Block shall be eight bytes, recording a 32 bit number as specified in ISO 9660:7.3.3.

The value of each Table Entry is interpreted as a set of bit fields numbered 0 to 31 starting with the least significant bit as follows:

TABLE 7. Sparse File Index Block Table Entry Bit Fields

| Bits | Name | Interpretation |
|---|---|---|
| 0-23 | BLOCK | 24 bit logical block number. |
| | | If the TABLE bit is set to ONE, this number is the 2K byte block offset from the first block of the File Section to the next Index Block. If the depth of the current Index Block is N then the depth of this next Index Block shall be N-1. |
| | | If the TABLE bit is set to ZERO, this number is the 256 byte block offset from the first block of the File Section to the contiguous region of data referenced by this Table Entry. |
| | | If the EMPTY bit is set to ONE, this block number shall be zero. |
| 24-29 | RESERVED | Shall be set to ZERO. |
| 30 | TABLE | If set to ONE, this Table Entry's BLOCK pointer references a 2K block of 256 Table Entries. The TABLE bit may not be set to ONE in any Table Entry in an Index Block of depth 1. |
| | | If set to ZERO, this Table Entry references a contiguous region of data. |
| 31 | EMPTY | If set to ONE, this Table Entry specifies a logical file region of zeros. |
| | | If set to ZERO, this Table Entry does not specify a logical file region of zeros. |

The TABLE and EMPTY bits may not both be set to ONE.

Each Table Entry can contain a pointer to another Index Block, can specify a virtual data block containing all zeros, or can point to actual data. Any Table Entry which has the TABLE bit set to ONE has a block pointer which refers to a logical 2K block (relative to the start of the File Section) containing another Index Block. Any Table Entry with the EMPTY bit set to ONE represents a logical file region of zeros. If the TABLE bit and the EMPTY bit are both set to ZERO, then the BLOCK field of the Table Entry is a block number referencing the first 256 byte logical block of a contiguous region of data.

The depth of the Index Block determines the size of the referenced contiguous region of data or the logical file region of zeros.

TABLE 8. Table Depth vs. Size of Data Reference

| Depth | Size of Data Reference |
|---|---|
| 7 | 64K TB |
| 6 | 256 TB |
| 5 | 1 TB |
| 4 | 4 GB |
| 3 | 16 MB |
| 2 | 64 KB |
| 1 | 256 B |

The positions of the 256 byte data blocks referenced by Table Entries shall be numbered with data block number 0 being coincident with the first 256 bytes of block 0 of the encoded file. Thus the first 2K byte block of the file, which actually is the "SF" Header Block, would consume data block positions 0 to 7, and data block 495 (= 61*8 + 7) would be bytes 1792 to 2047 located in the 61st physical 2K byte block of the encoded file. Though the data may be efficiently recorded in sequentially numbered blocks, ordered according to increasing address of the recorded data, such ordering is not required.

### 4.2 Required Recording and Consistency

A "PX" System Use Entry shall be recorded in each Directory Record.

All recorded instances of "PX" System Use Entries with the same File Serial Number shall be identical. All recorded instances of "TF" System Use Entries in Directory Records with the same "PX" File Serial Number shall be identical.

### 4.3 Specification of the ER System Use Entry Values for RRIP

The Extension Version number for the version of the RRIP defined herein shall be 1. The content of the Extension Identifier field shall be "IEEE_P1282". The Identifier Length shall be 10.

The recommended content of the Extension Descriptor is "THE IEEE P1282 PROTOCOL PROVIDES SUPPORT FOR POSIX FILE SYSTEM SEMANTICS." The corresponding Description Length is 73.

The recommended content of the Extension Source is "PLEASE CONTACT THE IEEE STANDARDS DEPARTMENT, PISCATAWAY, NJ, USA FOR THE P1282 SPECIFICATION." The corresponding Source Length is 94.
*Note: Upon adoption as an IEEE standard, these lengths will each decrease by 1.*

# 5. BIBLIOGRAPHY

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