SYSTEM V APPLICATION BINARY INTERFACE

Intel386™ Architecture Processor Supplement

Fourth Edition

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ACKNOWLEDGEMENTS

"We acknowledge the contributions of the 88OPEN Consortium Ltd., portions of whose *System V ABI Implementation Guide for the M88000 Processor* and the *System V ABI M88000 Processor Networking Supplement* have been incorporated in this section of the ABI with permission."

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1 INTRODUCTION

The Intel386 Architecture and the System V ABI

The *System V Application Binary Interface*, or ABI, defines a system interface for compiled application programs. Its purpose is to establish a standard binary interface for application programs on systems that implement the interfaces defined in the *System V Interface Definition, Edition 4*. This includes systems that have implemented UnixWare® 2.0. M

This document is a supplement to the generic *System V ABI*, and it contains information specific to System V implementations built on the Intel386 processor architecture. Together, these two specifications, the generic *System V ABI* and the *Intel386 Architecture System V ABI Supplement* (hereafter referred to as the *Intel386 ABI*), constitute a complete *System V Application Binary Interface* specification for systems that implement the processor architecture of the Intel386 microprocessors.

Note that, because the Intel486 and Pentium processor are compatible members of the Intel386 architecture, this *Intel386 ABI* also applies to any system built with the Intel486 or the Pentium processor chips. M M

How to Use the Intel386 Architecture ABI Supplement

This document is a supplement to the generic *System V ABI* and contains information referenced in the generic specification that may differ when System V is implemented on different processors. Therefore, the generic ABI is the prime reference document, and this supplement is provided to fill gaps in that specification.

As with the *System V ABI*, this specification references other publicly-available reference documents, especially the Intel *80386 Programmer's Reference Manual*. All the information referenced by this supplement should be considered part of this specification, and just as binding as the requirements and data explicitly included here.

Evolution of the ABI Specification

The *System V Application Binary Interface* will evolve over time to address new technology and market requirements, and will be reissued at intervals of approximately three years. Each new edition of the specification is likely to contain extensions and additions that will increase the potential capabilities of applications that are written to conform to the ABI.

As with the *System V Interface Definition*, the ABI will implement **Level 1** and **Level 2** support for its constituent parts. **Level 1** support indicates that a portion of the specification will continue to be supported indefinitely, while **Level 2** support means that a portion of the specification may be withdrawn or altered after the next edition of the ABI is made available. That is, a portion of the specification moved to **Level 2** support in an edition of the ABI specification will remain in effect at least until the following edition of the specification is published.

These **Level 1** and **Level 2** classifications and qualifications apply to this Supplement, as well as to the generic specification. All components of the ABI and of this supplement have **Level 1** support unless they are explicitly labelled as **Level 2**.

The following documents may be of interest to the reader of this specification:

- *i486 MICROPROCESSOR Programmer's Reference Manual* (Intel Literature order number 240486)

- *80386 Programmer's Reference Manual* (Intel Literature order number 230985)
- *80387 Programmer's Reference Manual* (Intel Literature order number 231917)
- *UnixWare® 2.0 Command Reference (a-l)*
- *UnixWare® 2.0 Command Reference (m-z)*
- *UnixWare® 2.0 Operating System API Reference: System Calls*
- *UnixWare® 2.0 Operating System API Reference: Library Functions*
- *UnixWare® 2.0 System Administration: Volumes I and II*
- *System V Interface Definition, Edition 4*

NOTE

Diffmarkings have been retained in the text of this book to indicate in which revisions of System V certain modifications were made to the *ABI*.

A "G" character in the right hand margin indicates a change in the *ABI* made in UNIX System V Release 4.2.

A "M" character in the right hand margin indicates a change in the *ABI* made in UnixWare® 2.0. M

2 SOFTWARE INSTALLATION

Software Distribution Formats

Physical Distribution Media

Approved media for physical distribution of ABI-conforming software are listed below. Inclusion of a particular medium on this list does not require an ABI-conforming system to accept that medium. For example, a conforming system may install all software through its network connection and accept none of the listed media.

- 1.44MB 3 1/2" floppy disk: quad-density, double-sided, 80 tracks/side, 18 sectors/track, 512 bytes/sector.
- 1.2MB 5 1/4" floppy disk: quad-density, double-sided, 80 tracks/side, 15 sectors/track, 512 bytes/sector.
- 360KB 5 1/4" floppy disk: double-density, double-sided, 40 tracks/side, 9 sectors/track, 512 bytes/sector.
- 60 MB quarter-inch cartridge tape in QIC-24 format. G
- CD-ROM optical disks. G
- 150 MB quarter-inch tape.

CAUTION The use of 360KB 5 1/4" floppy disk, and 60 MB quarter inch cartridge tape as media for application distribution is moved to Level 2 as of January 1, 1993. G

File System Formats

Every file system storage volume must conform to a supported format. Two formats are supported: s5 and ufs.

s5 File System

The first physical block on the medium should be empty, and the second contains the device's *superblock*. The third contains an inode list, and remaining blocks on the device contain data. The *superblock* has the following format:

```
#define NICFREE             50
#define NICINOD             100

struct filsys {
        u_short   s_isize;
        daddr_t   s_fsize;
        short              s_nfree;
        daddr_t   s_free[NICFREE];
        short              s_ninode;
        ushort_t  s_inode[NICINOD];
        char               s_flock;
        char               s_ilock;
        char               s_fmod;
        char               s_ronly;
        time_t             s_time;
        short              s_dinfo[4];
        daddr_t   s_tfree;
        ushort_t  s_tinode;
        char               s_fname[6];
        char               s_fpack[6];
        long               s_fill[12];
        long               s_state;
        long               s_magic;
        long               s_type;
};

#define FsMAGIC    0xfd187e20

#define Fs1b               1
#define Fs2b               2
#define Fs4b               3

#define FsOKAY     0x7c269d38
#define FsACTIVE   0x5e72d81a
#define FsBAD              0xcb096f43
#define FsBADBLK   0xbadbc14b
```

s_type indicates the file system type. Currently, three types of file systems are supported: the original 512-byte logical block, the 1024-byte logical block, and the 2048-byte logical block. *s_magic* is used to distinguish the original 512-byte oriented file systems from the newer file systems. If this field is not equal to the magic number, `fsMAGIC`, the type is assumed to be `fs1b`, otherwise the *s_type* field is used.

s_state indicates the state of the file system. A cleanly unmounted, undamaged file system is indicated by the `FsOKAY` state. After a file system has been mounted for update, the state changes to `FsACTIVE`.

s_isize is the address of the first data block after the i-list; the i-list starts just after the super-block, namely in block 2; thus the i-list is *s_isize*–2 blocks long.

s_fsize is the first block not potentially available for allocation to a file.

The free list for each volume is maintained as follows. The *s_free* array contains up to 49 numbers of free blocks. *s_free*[0] is the block number of the head of a chain of blocks constituting the free list. The first long in each free-chain block is the number (up to 50) of free-block numbers listed in the next 50 longs of this chain member. The first of these 50 blocks is the link to the next member of the chain.

s_tfree is the total free blocks available in the file system.

s_ninode is the number of free i-numbers in the *s_inode* array.

s_tinode is the total free i-nodes available in the file system.

s_flock and *s_ilock* are flags maintained in the core copy of the file system. *s_fmod* is a flag that indicates that the super-block has changed and should be copied to the disk during the next periodic update of file system information.

s_ronly is a read-only flag to indicate write-protection.

s_time is the last time the super-block of the file system was changed, and is the number of seconds that have elapsed since 00:00 Jan. 1, 1970 (GMT).

s_fname is the name of the file system and *s_fpack* is the name of the pack.

I-numbers begin at 1, and the storage for i-nodes begins in block 2. I-node 1 is reserved for future use. I-node 2 is reserved for the root directory of the file system, but no other i-number has a built-in meaning. Each i-node represents one file.

UFS File System

In the UFS file system, the first physical block on the device should be empty, and the second contains the *superblock* for the file system. Remaining blocks contain data.

The ufs *superblock* contains an *fs* data structure. This structure, and other relevant data objects are defined below.

```
struct csum {
        long          cs_ndir;
        long          cs_nbfree;
        long          cs_nifree;
        long          cs_nffree;
};

struct fs {
        struct fs     *fs_link;
        struct fs     *fs_rlink;
        daddr_t       fs_sblkno;
        daddr_t       fs_cblkno;
        daddr_t       fs_iblkno;
        daddr_t       fs_dblkno;
        long          fs_cgoffset;
        long          fs_cgmask;
        time_t        fs_time;
        long          fs_size;
        long          fs_dsize;
        long          fs_ncg;
        long          fs_bsize;
        long          fs_fsize;
        long          fs_frag;
        long          fs_minfree;
        long          fs_rotdelay;
        long          fs_rps;
        long          fs_bmask;
        long          fs_fmask;
        long          fs_bshift;
        long          fs_fshift;
        long          fs_maxcontig;
        long          fs_maxbpg;
        long          fs_fragshift;
        long          fs_fsbtodb;
        long          fs_sbsize;
        long          fs_csmask;
        long          fs_csshift;
        long          fs_nindir;
        long          fs_inopb;
        long          fs_nspf;
        long          fs_optim;
        long          fs_state;
        long          fs_sparecon[2];
        long          fs_id[2];
        daddr_t       fs_csaddr;
        long          fs_cssize;
        long          fs_cgsize;
        long          fs_ntrak;
        long          fs_nsect;
        long          fs_spc;
        long          fs_ncyl;
```

(continued on next page)

```
        long         fs_cpg;
        long         fs_ipg;
        long         fs_fpg;
        struct csum  fs_cstotal;
        char         fs_fmod;
        char         fs_clean;
        char         fs_ronly;
        char         fs_flags;
        char         fs_fsmnt[MAXMNTLEN];
        long         fs_cgrotor;
        struct csum  *fs_csp[MAXCSBUFS];
        long         fs_cpc;
        short        fs_postbl[MAXCPG][NRPOS];
        long         fs_magic;
        u_char       fs_rotbl[1];
};

struct cg {
        struct cg    *cg_link;
        struct cg    *cg_rlink;
        time_t       cg_time;
        long         cg_cgx;
        short        cg_ncyl;
        short        cg_niblk;
        long         cg_ndblk;
        struct csum  cg_cs;
        long         cg_rotor;
        long         cg_frotor;
        long         cg_irotor;
        long         cg_frsum[MAXFRAG];
        long         cg_btot[MAXCPG];
        short        cg_b[MAXCPG][NRPOS];
        char         cg_iused[MAXIPG/NBBY];
        long         cg_magic;
        u_char       cg_free[1];
};

#define FS_MAGIC        0x011954
#define BBSIZE          8192
#define SBSIZE          8192
#define BBLOCK          ((daddr_t)(0))
#define SBLOCK          ((daddr_t)(BBLOCK + BBSIZE / DEV_BSIZE))
#define UFSROOTINO      ((ino_t)2)
#define LOSTFOUNDINO    (UFSROOTINO + 1)
#define NRPOS           8
#define MAXIPG          2048
#define MINBSIZE        4096
#define MAXCPG          32
#define MAXMNTLEN       512
#define MAXCSBUFS       32
#define FS_OPTTIME      0
```

(continued on next page)

```
#define FS_OPTSPACE     1
#define MAXBPC          (SBSIZE - sizeof (struct fs))
#define CG_MAGIC        0x090255
```

CAUTION The distribution of software in filesystem format is Level 2 as of January 1, 1993. G

3 LOW-LEVEL SYSTEM INFORMATION

Machine Interface

Processor Architecture

The Intel *80386 Programmer's Reference Manual* (Intel Literature order number 230985) and the Intel *80387 Programmer's Reference Manual* (Intel Literature order number 231917) together define the processor architecture. The architecture of the combined Intel386 / Intel 387 processors is hereafter referred to as the Intel386 architecture. Programs intended to execute directly on the processor use the instruction set, instruction encodings, and instruction semantics of the architecture. Three points deserve explicit mention.

- A program may assume all documented instructions exist.
- A program may assume all documented instructions work.
- A program may use only the instructions defined by the architecture.

In other words, *from a program's perspective*, the execution environment provides a complete and working implementation of the Intel386 architecture.

This does not imply that the underlying implementation provides all instructions in hardware, only that the instructions perform the specified operations and produce the specified results. The ABI neither places performance constraints on systems nor specifies what instructions must be implemented in hardware. A software emulation of the architecture could conform to the ABI.

Some processors might support the Intel386 architecture as a subset, providing additional instructions or capabilities. Programs that use those capabilities explicitly do not conform to the Intel386 ABI. Executing those programs on machines without the additional capabilities gives undefined behavior.

Data Representation

Within this specification, the term *halfword* refers to a 16-bit object, the term *word* refers to a 32-bit object, and the term *doubleword* refers to a 64-bit object.

Fundamental Types

Figure 3-1 shows the correspondence between ANSI C's scalar types and the processor's.

Figure 3-1: Scalar Types

Type	C	`sizeof`	Alignment (bytes)	Intel386 Architecture
Integral	`char` `signed char`	1	1	signed byte
	`unsigned char`	1	1	unsigned byte
	`short` `signed short`	2	2	signed halfword
	`unsigned short`	2	2	unsigned halfword

	`int`
	`signed int`
	`long`
	`signed long`
	`enum`
		4	4	signed word

	`unsigned int` `unsigned long`	4	4	unsigned word
Pointer	*any-type* `*` *any-type* `(*)()`	4	4	unsigned word
Floating-point	`float`	4	4	single-precision (IEEE)
	`double`	8	4	double-precision (IEEE)
	`long double`	12	4	extended-precision (IEEE)

NOTE The Intel386 architecture does not require doubleword alignment for double-precision values. Nevertheless, for data structure compatibility with other Intel architectures, compilers may provide a method to align double-precision values on doubleword boundaries.

CAUTION A compiler that provides the doubleword alignment mentioned above can generate code (data structures and function calling sequences) that do not conform to the Intel386 ABI. Programs built with the doubleword alignment facility can thus violate conformance to the Intel386 ABI. See ‘‘Aggregates and Unions’’ below and ‘‘Function Calling Sequence’’ later in this chapter for more information.

A null pointer (for all types) has the value zero.

The Intel386 architecture does not require all data access to be properly aligned. For example, double-precision values occupy 1 doubleword (8-bytes), and their natural alignment is a word boundary, meaning their addresses are multiples of 4. Compilers should allocate independent data objects with the proper alignment; examples include global arrays of double-precision variables, FORTRAN `COMMON` blocks, and unconstrained stack objects. However, some language facilities (such as FORTRAN `EQUIVALENCE` statements) may create objects with only byte alignment. Consequently, arbitrary data accesses, such as pointers dereference or reference arguments, might or might not be properly aligned. Accessing misaligned data will be slower than accessing properly aligned data, but otherwise there is no difference.

Aggregates and Unions

Aggregates (structures and arrays) and unions assume the alignment of their most strictly aligned component. The size of any object, including aggregates and unions, is always a multiple of the object’s alignment. An array uses the same alignment as its elements. Structure and union objects can require padding to meet size and alignment constraints. The contents of any padding is undefined. G

- An entire structure or union object is aligned on the same boundary as its most strictly aligned member.
- Each member is assigned to the lowest available offset with the appropriate alignment. This may require *internal padding*, depending on the previous member.
- A structure’s size is increased, if necessary, to make it a multiple of the alignment. This may require *tail padding*, depending on the last member.

NOTE ABI conformant code may not read or modify anything marked reserved or padding. M

In the following examples, members' byte offsets appear in the upper right corners.

Figure 3-2: Structure Smaller Than a Word

```
struct {
    char   c;
};
```

Byte aligned, `sizeof` is 1

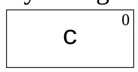


Figure 3-3: No Padding

```
struct {
    char   c;
    char   d;
    short  s;
    long   n;
};
```

Word aligned, `sizeof` is 8

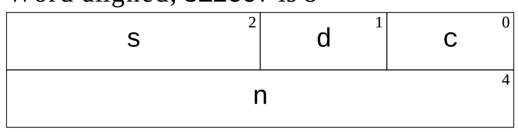


Figure 3-4: Internal Padding

```
struct {
    char   c;
    short  s;
};
```

Halfword aligned, `sizeof` is 4

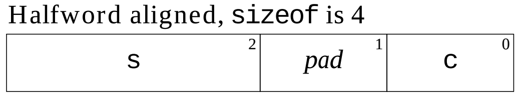
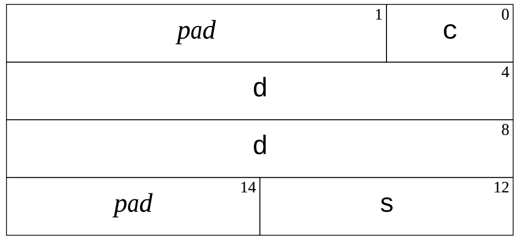


Figure 3-5: Internal and Tail Padding

```
struct {
    char   c;
    double d;
    short  s;
};
```

Word aligned, `sizeof` is 16

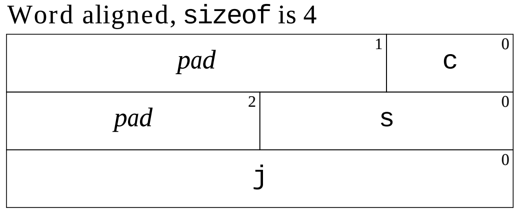


NOTE	The Intel386 architecture does not require doubleword alignment for double-precision values. Nevertheless, for data structure compatibility with other Intel architectures, compilers may provide a method to align double-precision values on doubleword boundaries.
CAUTION	A compiler that provides the doubleword alignment mentioned above would arrange the preceding structure differently. Programs built with the double-word alignment facility would not conform to the Intel386 ABI, and they would not be data-compatible with conforming Intel386 programs.

Figure 3-6: `union` **Allocation**

```
union {
    char   c;
    short  s;
    int    j;
};
```

Word aligned, `sizeof` is 4



Bit-Fields

C `struct` and `union` definitions may have *bit-fields*, which define integral objects with a specified number of bits.

Figure 3-7: Bit-Field Ranges

Bit-field Type	Width w	Range
`signed char`	1 to 8	-2^{w-1} to $2^{w-1}-1$
`char`		0 to 2^w-1
`unsigned char`		0 to 2^w-1
`signed short`	1 to 16	-2^{w-1} to $2^{w-1}-1$
`short`		0 to 2^w-1
`unsigned short`		0 to 2^w-1
`signed int`	1 to 32	-2^{w-1} to $2^{w-1}-1$
`int`		0 to 2^w-1
`enum`		0 to 2^w-1
`unsigned int`		0 to 2^w-1
`signed long`	1 to 32	-2^{w-1} to $2^{w-1}-1$
`long`		0 to 2^w-1
`unsigned long`		0 to 2^w-1

‘‘Plain’’ bit-fields (that is, those neither `signed` nor `unsigned`) always have non-negative values. Although they may have type `char`, `short`, `int`, or `long` (which can have negative values), these bit-fields have the same range as a bit-field of the same size with the corresponding `unsigned` type. Bit-fields obey the same size and alignment rules as other structure and union members, with the following additions:

- Bit-fields are allocated from right to left (least to most significant).
- A bit-field must entirely reside in a storage unit appropriate for its declared type. Thus a bit-field never crosses its unit boundary.
- Bit-fields may share a storage unit with other `struct`/`union` members, including members that are not bit-fields. Of course, `struct` members occupy different parts of the storage unit.
- Unnamed bit-fields’ types do not affect the alignment of a structure or union, although individual bit-fields’ member offsets obey the alignment constraints.

The following examples show `struct` and `union` members' byte offsets in the upper right corners; bit numbers appear in the lower corners.

Figure 3-8: Bit Numbering

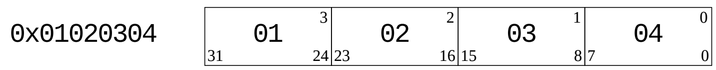


Figure 3-9: Right-to-Left Allocation

```
struct {
    int    j:5;
    int    k:6;
    int    m:7;
};
```

Word aligned, `sizeof` is 4

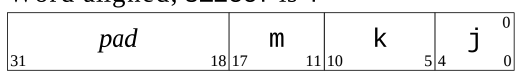


Figure 3-10: Boundary Alignment

```
struct {
    short  s:9;
    int    j:9;
    char   c;
    short  t:9;
    short  u:9;
    char   d;
};
```

Word aligned, `sizeof` is 12

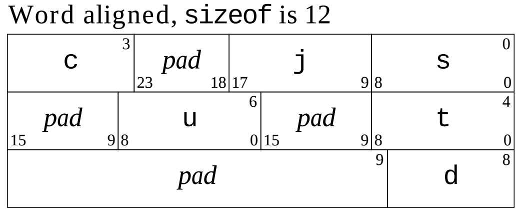


Figure 3-11: Storage Unit Sharing

```
struct {
    char   c;
    short  s:8;
};
```

Halfword aligned, `sizeof` is 2

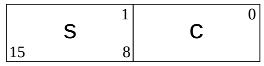


Figure 3-12: `union` **Allocation**

```
union {
    char   c;
    short  s:8;
};
```

Halfword aligned, `sizeof` is 2

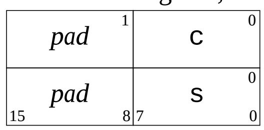
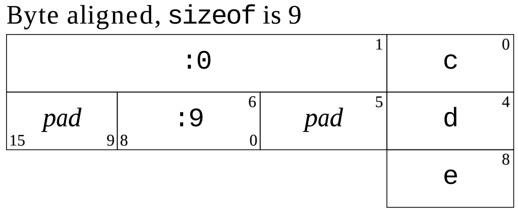


Figure 3-13: Unnamed Bit-Fields

```
struct {
    char   c;
    int    :0;
    char   d;
    short  :9;
    char   e;
    char   :0;
};
```

Byte aligned, `sizeof` is 9



As the examples show, `int` bit-fields (including `signed` and `unsigned`) pack more densely than smaller base types. One can use `char` and `short` bit-fields to force particular alignments, but `int` is generally more efficient.

Function Calling Sequence

This section discusses the standard function calling sequence, including stack frame layout, register usage, parameter passing, and so on. The system libraries described in Chapter 6 require this calling sequence.

NOTE The standard calling sequence *requirements* apply only to global functions. Local functions that are not reachable from other compilation units may use different conventions. Nonetheless, it is recommended that all functions use the standard calling sequence when possible.

NOTE C programs follow the conventions given here. For specific information on the implementation of C, see ‘‘Coding Examples’’ in this chapter.

Registers and the Stack Frame

The Intel386 architecture provides a number of registers. All the integer registers and all the floating-point registers are global to all procedures in a running program.

Brief register descriptions appear in Figure 3-14 more complete information appears later.

Figure 3-14: Processor Registers

Type	Name	Usage	
General	`%eax`	Return value	
	`%edx`	Dividend register (divide operations)	
	`%ecx`	Count register (shift and string operations)	
	`%ebx`	Local register variable	
	`%ebp`	Stack frame pointer (optional)	G
	`%esi`	Local register variable	
	`%edi`	Local register variable	
	`%esp`	Stack pointer	
Floating-point	`%st(0)`	floating-point stack top, return value	
	`%st(1)`	floating-point next to stack top	
	. . .		
	`%st(7)`	floating-point stack bottom	

In addition to registers, each function has a frame on the run-time stack. This stack grows downward from high addresses. Figure 3-15 shows the stack frame organization.

Figure 3-15: Standard Stack Frame

Position	Contents	Frame	
`4`*n*`+8(%ebp)`	argument word *n*	Previous	*High addresses*
	. . .		
`8(%ebp)`	argument word 0		
`4(%ebp)`	return address	Current	
`0(%ebp)`	previous `%ebp` (optional)		
`-4(%ebp)`	unspecified		
	. . .		
`0(%esp)`	variable size		*Low addresses*

Several key points about the stack frame deserve mention.

- The stack is word aligned. Although the architecture does not require any alignment of the stack, software convention and the operating system requires that the stack be aligned on a word boundary. G G

- Argument words are pushed onto the stack in reverse order (that is, the rightmost argument in C call syntax has the highest address), preserving the stack's word alignment. All incoming arguments appear on the stack, residing in the stack frame of the caller.
- An argument's size is increased, if necessary, to make it a multiple of words. This may require tail padding, depending on the size of the argument.
- Other areas depend on the compiler and the code being compiled. The standard calling sequence does not define a maximum stack frame size, nor does it restrict how a language system uses the ''unspecified'' area of the standard stack frame.

All registers on the Intel386 are global and thus visible to both a calling and a called function. Registers `%ebp`, `%ebx`, `%edi`, `%esi`, and `%esp` ''belong'' to the calling function. In other words, a called function must preserve these registers' values for its caller. Remaining registers ''belong'' to the called function. If a calling function wants to preserve such a register value across a function call, it must save the value in its local stack frame.

Some registers have assigned roles in the standard calling sequence:

`%esp` — The *stack pointer* holds the limit of the current stack frame, which is the address of the stack's bottom-most, valid word. At all times, the stack pointer should point to a word-aligned area.

`%ebp` — The *frame pointer* optionally holds a base address for the current stack frame. Consequently, a function has registers pointing to both ends of its frame. Incoming arguments reside in the previous frame, referenced as positive offsets from `%ebp`, while local variables reside in the current frame, referenced as negative offsets from `%ebp`. A function must preserve this register's value for its caller. G

`%eax` — *Integral and pointer return values* appear in `%eax`. A function that returns a `struct` or `union` value places the address of the result in `%eax`. Otherwise this is a scratch register.

`%ebx` — As described below, this register serves as the *global offset table base register* for position-independent code. For absolute code, `%ebx` serves as a local register and has no specified role in the function calling sequence. In either case, a function must preserve the register value for the caller.

`%esi` and `%edi` — These *local registers* have no specified role in the function calling sequence. A function must preserve their values for the caller.

`%ecx` and `%edx` — *Scratch registers* have no specified role in the standard calling sequence. Functions do not have to preserve their values for the caller.

`%st(0)` — *Floating-point return values* appear on the top of the floating-point register stack; there is no difference in the representation of single- or double-precision values in floating-point registers. If the function does not return a floating-point value, then this register must be empty. This register must be empty before G
entry to a function.

`%st(1)` through `%st(7)`
Floating-point scratch registers have no specified role in the standard calling sequence. These registers must be empty before entry and upon exit from a function.

EFLAGS — The *flags register* contains the system flags, such as the direction flag and the carry flag. The direction flag must be set to the ‘‘forward’’ (that is, zero) direction before entry and upon exit from a function. Other user flags have no specified role in the standard calling sequence and are not preserved.

Floating-Point Control Word
The Intel387 *control word* contains the floating-point flags, such as the rounding mode and exception masking. *

Signals can interrupt processes [see `signal`(BA_OS)]. Functions called during signal handling have no unusual restrictions on their use of registers. Moreover, if a signal handling function returns, the process resumes its original execution path with registers restored to their original values. Thus, programs and compilers may freely use all registers without the danger of signal handlers changing their values.

Functions Returning Scalars or No Value

A function that returns an integral or pointer value places its result in register `%eax`.

A floating-point return value appears on the top of the Intel387 register stack. The caller then must remove the value from the Intel387 stack, even if it doesn’t use the value. Failure of either side to meet its obligations leads to undefined program behavior. The standard calling sequence does not include any method to detect such failures nor to detect return value type mismatches. Therefore the user must declare all functions properly. There is no difference in the representation of single-, double- or extended-precision values in floating-point registers.

Functions that return no value (also called procedures or `void` functions) put no particular value in any register.

A `call` instruction pushes the address of the next instruction (the return address) onto the stack. The `ret` instruction pops the address off the stack and effectively continues execution at the next instruction after the `call` instruction. A function that returns a scalar or no value must preserve the caller's registers as described earlier. Additionally, the called function must remove the return address from the stack, leaving the stack pointer (`%esp`) with the value it had before the `call` instruction was executed.

To illustrate, the following function prologue allocates 80 bytes of local stack space and saves the local registers `%ebx`, `%esi`, and `%edi`.

Figure 3-16: Function Prologue

```
prologue:
        pushl  %ebp          / save frame pointer
        movl   %esp, %ebp    / set new frame pointer
        subl   $80, %esp     / allocate stack space
        pushl  %edi          / save local register
        pushl  %esi          / save local register
        pushl  %ebx          / save local register
```

An epilogue for the example that restores the state for the caller. This example returns the value in `%edi` by moving it to `%eax`.

Figure 3-17: Function Epilogue

```
        movl   %edi, %eax    / set up return value
epilogue:
        popl   %ebx          / restore local register
        popl   %esi          / restore local register
        popl   %edi          / restore local register
        leave                / restore frame pointer
        ret                  / pop return address
```

NOTE Although some functions can be optimized to eliminate the save and restore of the frame pointer, the general case uses the standard prologue and epilogue.

Sections below describe where arguments appear on the stack. The examples are written as if the function prologue described above had been used.

Position-independent code uses the `%ebx` register to hold the address of the global offset table. If a function needs the global offset table's address, either directly or indirectly, it is responsible for computing the value. See ''Coding Examples'' later in this chapter and ''Dynamic Linking'' in Chapter 5 for more information.

Functions Returning Structures or Unions

If a function returns a structure or union, then the caller provides space for the return value and places its address on the stack as argument word zero. In effect, this address becomes a ''hidden'' first argument. Having the caller supply the return object's space allows re-entrancy.

NOTE Structures and unions in this context have fixed sizes. The ABI does not specify how to handle variable sized objects.

A function that returns a structure or union also sets `%eax` to the value of the original address of the caller's area before it returns. Thus when the caller receives control again, the address of the returned object resides in register `%eax` and can be used to access the object. Both the calling and the called functions must cooperate to pass the return value successfully:

- The calling function must supply space for the return value and pass its address in the stack frame;
- The called function must use the address from the frame and copy the return value to the object so supplied;
- The called function must remove this address from the stack before returning.

Failure of either side to meet its obligations leads to undefined program behavior. The standard function calling sequence does not include any method to detect such failures nor to detect structure and union type mismatches. Therefore the user must declare all functions properly.

Figure 3-18 illustrates the stack contents when the function receives control (after the `call` instruction) and when the calling function again receives control (after the `ret` instruction).

Figure 3-18: Stack Contents for Functions Returning `struct/union`

Position	After `call`	After `ret`	Position
`4`*n*`+4(%esp)`	argument word *n*	argument word *n*	`4`*n*`-4(%esp)`
	. . .	. . .	
`8(%esp)`	argument word 1	argument word 1	`0(%esp)`
`4(%esp)`	value address	*undefined*	
`0(%esp)`	return address		

To illustrate, the following function prologue allocates 80 bytes of local stack space and saves the local registers `%ebx`, `%esi`, and `%edi`. Additionally, it removes the ''hidden'' argument from the stack and saves it in the highest word of the local stack frame.

Figure 3-19: Function Prologue (Returning `struct/union`)

```
prologue:
        popl   %eax             / pop return address
        xchgl  %eax, 0(%esp)   / swap return address
                                   / and return value address
        pushl  %ebp             / save frame pointer
        movl   %esp, %ebp       / set new frame pointer
        subl   $80, %esp        / allocate local space
        pushl  %edi             / save local register
        pushl  %esi             / save local register
        pushl  %ebx             / save local register
        movl   %eax, -4(%ebp) / save return value address
```

An epilogue for the example that restores the state for the caller.

Figure 3-20: Function Epilogue

```
epilogue:
        movl   -4(%ebp), %eax       / set up return value
        popl   %ebx                  / restore local register
        popl   %esi                  / restore local register
        popl   %edi                  / restore local register
        leave                        / restore frame pointer
        ret                          / pop return address
```

NOTE

Although some functions can be optimized to eliminate the save and restore of the frame pointer, the general case uses the standard prologue and epilogue.

Sections below describe where arguments appear on the stack. The examples are written as if the function prologue described above had been used.

Position-independent code uses the `%ebx` register to hold the address of the global offset table. If a function needs the global offset table's address, either directly or indirectly, it is responsible for computing the value. See ''Coding Examples'' later in this chapter and ''Dynamic Linking'' in Chapter 5 for more information.

Integral and Pointer Arguments

As mentioned, a function receives all its arguments through the stack; the last argument is pushed first. In the standard calling sequence, the first argument is at offset `8(%ebp)`, the second argument is at offset `12(%ebp)`, and so on. Functions pass all integer-valued arguments as words, expanding or padding signed or unsigned bytes and halfwords as needed.

Figure 3-21: Integral and Pointer Arguments

Call	Argument	Stack address
	`1`	`8(%ebp)`
`g(1, 2, 3,`	`2`	`12(%ebp)`
`(void *)0);`	`3`	`16(%ebp)`
	`(void *)0`	`20(%ebp)`

Floating-Point Arguments

The stack also holds floating-point arguments: single-precision values use one word, double-precision use two, and extended-precision use three. See ''Coding Examples'' for information about floating-point arguments and variable argument lists. The example below uses only double-precision arguments. Single- and extended-precision arguments behave as specified above.

Figure 3-22: Floating-Point Arguments

Call	Argument	Stack address
`h(1.414, 1, 2.998e10);`	word 0, `1.414`	`8(%ebp)`
	word 1, `1.414`	`12(%ebp)`
	`1`	`16(%ebp)`
	word 0, `2.998e10`	`20(%ebp)`
	word 1, `2.998e10`	`24(%ebp)`

NOTE The Intel386 architecture does not require doubleword alignment for double-precision values. Nevertheless, for data structure compatibility with other Intel architectures, compilers may provide a method to align double-precision values on doubleword boundaries.

CAUTION A compiler that provides the doubleword alignment mentioned above would have to maintain doubleword alignment for the stack. Moreover, the arguments in the preceding example would appear in different positions. Programs built with the doubleword alignment facility would not conform to the Intel386 ABI, and their function calling sequence would not be compatible with conforming Intel386 programs.

Structure and Union Arguments

As described in the data representation section, structures and unions can have byte, halfword, or word alignment, depending on the constituents. An argument's size is increased, if necessary, to make it a multiple of words. This may require tail padding, depending on the size of the argument. To ensure that data in the stack is properly aligned, the stack pointer should always point to a word boundary. Structure and union arguments are pushed onto the stack in the same manner as integral arguments, described above. This provides call-by-value semantics, letting the called function modify its arguments without affecting the calling function's object.

Figure 3-23: Structure and Union Arguments

Call	Argument	Callee
`i(1, s);`	`1`	`8(%ebp)`
	word 0, `s`	`12(%ebp)`
	word 1, `s`	`16(%ebp)`
	...	...

Operating System Interface

Virtual Address Space

Processes execute in a 32-bit virtual address space. Memory management translates virtual addresses to physical addresses, hiding physical addressing and letting a process run anywhere in the system's real memory. Processes typically begin with three logical segments, commonly called text, data, and stack. As Chapter 5 describes, dynamic linking creates more segments during execution, and a process can create additional segments for itself with system services.

Page Size

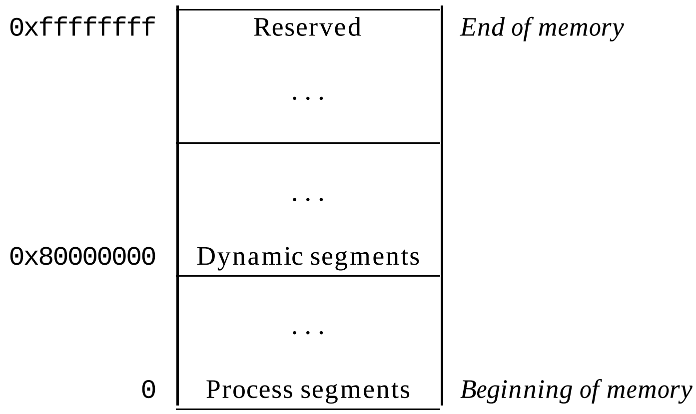
Memory is organized by pages, which are the system's smallest units of memory allocation. Page size can vary from one system to another, depending on the processor, memory management unit and system configuration. Processes may call `sysconf`(BA_OS) to determine the system's current page size. *

Virtual Address Assignments

Conceptually, processes have the full 32-bit address space available. In practice, however, several factors limit the size of a process.

- The system reserves a configuration-dependent amount of virtual space.
- The system reserves a configuration dependent amount of space per process. G
- A process whose size exceeds the system's available, combined physical memory and secondary storage cannot run. Although some physical memory must be present to run any process, the system can execute processes that are bigger than physical memory, paging them to and from secondary storage. Nonetheless, both physical memory and secondary storage are shared resources. System load, which can vary from one program execution to the next, affects the available amounts.

Figure 3-24: Virtual Address Configuration



CAUTION Programs that dereference null pointers are erroneous. although an imple- G
mentation is not obliged to detect such erroneous behavior. Such pro- G
grams may or may not fail on a particular system. To enhance portability, programmers are strongly cautioned not to rely on this behavior.

Process segments
: Processes' loadable segments and stack may begin at `0`. The exact addresses depend on the executable file format [see further information below and in Chapters 4 and 5]. Processes can control the amount of virtual memory allotted for stack space, as described below.

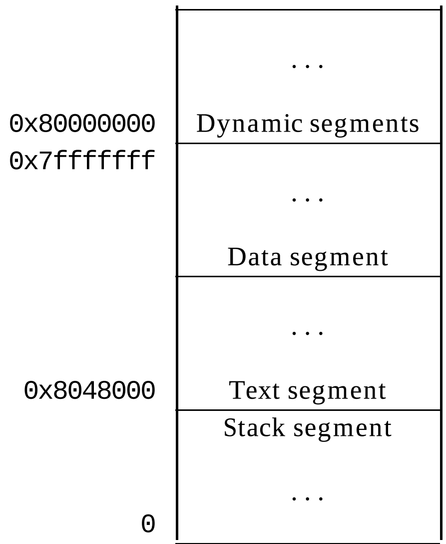
Dynamic segments
: A process's dynamic segments reside below the reserved area.

Reserved
: A reserved area resides at the top of virtual space.

As the figure shows, the system reserves the high end of virtual address space, with a process's dynamic segments below that. Although the exact boundary between the reserved area and a process depends on the system's configuration, the reserved area shall not consume more than 1 GB of the address space. Thus the user virtual address range has a minimum upper bound of `0xc0000000`. Individual systems may reserve less space, increasing processes' virtual memory range.

Although applications may control their memory assignments, the typical arrangement appears below.

Figure 3-25: Conventional Segment Arrangements



The process's text segment resides at `0x8048000`. The data segment follows immediately, and dynamic segments occupy the higher range. When applications let the system choose addresses for dynamic segments (including shared object segments), it chooses high addresses. This leaves the ''middle'' of the address spectrum available for dynamic memory allocation with facilities such as `malloc`(BA_OS). Processes should *not* depend on finding their dynamic segments at particular virtual addresses. Facilities exist to let the system choose dynamic segment virtual addresses. The stack resides immediately below the text segment, growing toward lower addresses. This arrangement provides a little over 128 MB for the stack and about 2 GB for text and data.

Managing the Process Stack

Section ''Process Initialization'' in this chapter describes the initial stack contents. Stack addresses can change from one system to the next—even from one process execution to the next on the same system. Processes, therefore, should *not* depend on finding their stack at a particular virtual address.

A tunable configuration parameter controls the system maximum stack size. A process also can use `setrlimit`(BA_OS), to set its own maximum stack size, up to the system limit. On the Intel386, the stack segment has read and write permissions.

Coding Guidelines

Operating system facilities, such as `mmap`(KE_OS), allow a process to establish address mappings in two ways. First, the program can let the system choose an address. Second, the program can force the system to use an address the program supplies. This second alternative can cause application portability problems, because the requested address might not always be available. Differences in virtual address space can be particularly troublesome between different architectures, but the same problems can arise within a single architecture.

Processes' address spaces typically have three segment areas that can change size from one execution to the next: the stack [through `setrlimit`(BA_OS)], the data segment [through `malloc`(BA_OS)], and the dynamic segment area [through `mmap`(KE_OS)]. Changes in one area may affect the virtual addresses available for another. Consequently, an address that is available in one process execution might not be available in the next. A program that used `mmap`(KE_OS) to request a mapping at a specific address thus could appear to work in some environments and fail in others. For this reason, programs that wish to establish a mapping in their address space should let the system choose the address.

Despite these warnings about requesting specific addresses, the facility is both useful and can be used in a controlled manner. For example, a multiprocess application might map several files into the address space of each process and build relative pointers among the files' data. This could be done by having each process ask for a certain amount of memory at an address chosen by the system. After each process receives its own, private address from the system, it would map the desired files into memory, at specific addresses within the original area. This collection of mappings could be at different addresses in each process but their *relative* positions would be fixed. Without the ability to ask for specific addresses, the application could not build shared data structures, because the relative positions for files in each process would be unpredictable.

Processor Execution Modes

Four execution modes exist in the Intel386 architecture: ring 3 (or user mode) and three privileged rings. User processes run in user mode ring (the least privileged). The operating system kernel runs in a privileged mode ring, although the ABI does not specify which one. A program executes the `lcall` instruction through a system call gate to change execution modes, and thus the `lcall` instruction provides the low-level interface to system calls. For the Intel386, one low-level interface is defined: `_exit`(BA_OS).

To ensure a process has a way to terminate itself, the system treats `_exit` as a special case. The ABI does not specify the implementation of other system services. Instead, programs should use the system libraries that Chapter 6 describes. Programs with other embedded `lcall` instructions do not conform to the ABI.

Figure 3-26: `_exit` **System Trap**

```
        .globl _exit
_exit:
        movl   $1, %eax
        lcall  $7, $0
```

Exception Interface

As the Intel386 architecture manuals describe, the processor changes mode to handle *exceptions*, which may be synchronous, floating-point / coprocessor, or asynchronous. Synchronous and floating-point / coprocessor exceptions, being caused by instruction execution, can be explicitly generated by a process. This section, therefore, specifies those exception types with defined behavior. The Intel386 architecture classifies exceptions as *faults*, *traps*, and *aborts*. See the Intel *80386 Programmer's Reference Manual* for more information about their differences.

Hardware Exception Types

The operating system defines the following correspondence between hardware exceptions and the signals specified by `signal`(BA_OS).

Figure 3-27: Hardware Exceptions and Signals

Number	Exception Name	Signal
0	divide error fault	SIGFPE
1	single step trap / fault	SIGTRAP
2	nonmaskable interrupt	none
3	breakpoint trap	SIGTRAP
4	overflow trap	SIGSEGV
5	bounds check fault	SIGSEGV
6	invalid opcode fault	SIGILL
7	no coprocessor fault	SIGFPE
8	double fault abort	none
9	coprocessor overrun abort	SIGSEGV
10	invalid TSS fault	none
11	segment not present fault	none
12	stack exception fault	SIGSEGV
13	general protection fault / abort	SIGSEGV
14	page fault	SIGSEGV
15	(reserved)	
16	coprocessor error fault	SIGFPE
other	(unspecified)	SIGILL

Floating-point instructions exist in the architecture, but they may be implemented either in hardware (via the Intel387 chip) or in software (via the Intel387 emulator). In the case of ‘‘no coprocessor’’ exception, if the Intel387 emulator is configured into the kernel, the process receives no signal. Instead, the system intercepts the exception, emulates the instruction, and returns control to the process. A process receives `SIGFPE` for the ‘‘no coprocessor’’ exception only when the indicated floating-point instruction is illegal (invalid operands, and so on).

Software Trap Types

Because the `int` instruction generates traps, some hardware exceptions can be generated by software. However, the `int` instruction generates only traps and not faults; so it is not possible to match the exact hardware generated faults in software.

Process Initialization

This section describes the machine state that `exec`(BA_OS) creates for ‘‘infant’’ processes, including argument passing, register usage, stack frame layout, and so on. Programming language systems use this initial program state to establish a standard environment for their application programs. As an example, a C program begins executing at a function named `main`, conventionally declared in the following way.

Figure 3-28: Declaration for `main`

```
extern int main(int argc, char *argv[], char *envp[]);
```

Briefly, `argc` is a non-negative argument count; `argv` is an array of argument strings, with `argv[argc]==0`; and `envp` is an array of environment strings, also terminated by a null pointer.

Although this section does not describe C program initialization, it gives the information necessary to implement the call to `main` or to the entry point for a program in any other language.

Special Registers

As the Intel386 architecture defines, several state registers control and monitor the processor: the Machine Status Word register (MSW, also known as register `%cr0`), EFLAGS register, the floating-point status register, and the floating-point control register. Application programs cannot access the full EFLAGS register directly; because they run in the processor’s *user mode*, and the instructions to write some of the bits of the EFLAGS register are privileged. Nonetheless, a program has access to many of the flags in the EFLAGS register. Flags identified with an ‘‘*’’ below are not modifiable by a user mode process, they either have unspecified values or do not affect user program behavior. At process initialization, the EFLAGS register contains the following values.

Figure 3-29: EFLAGS Register Fields

Flag	Value	Note
CF	unspecified	Carry flag
PF	unspecified	Parity flag
AF	unspecified	Auxiliary carry flag
ZF	unspecified	Zero flag
SF	unspecified	Sign flag
TF	unspecified	Trap flag
IF*	unspecified	Interrupt enable
DF	0	Direction flag low to high
OF	unspecified	Overflow flag
IOPL*	unspecified	I/O privilege level
NT*	unspecified	Nested task
RF*	unspecified	Resume flag
VM*	unspecified	Virtual 8086 mode

The Intel386 architecture defines floating-point instructions, and those instructions work whether the processor has a hardware floating-point unit or not. (A system may provide hardware or software floating-point facilities.) Consequently, the contents of the MSW register is not specified, letting the system set it according to the hardware configuration. In any case, however, the processor presents a working floating-point implementation, including the Intel387 status and control word registers with the following values at process initialization.

Figure 3-30: Floating-Point Control Word

Field	Value	Note	
IC	1	Affine infinity (for compatibility)	
RC	00	Round to nearest or even	
PC	11	53-bit (double precision)	G
PM	1	Precision masked	
UM	1	Underflow masked	
OM	1	Overflow	G
ZM	1	Zero divide	G
DM	1	Denormalized operand masked	
IM	1	Invalid operation	G

CAUTION The initial floating-point state should be changed with care. In particular, G
many floating-point routines may produce undefined behavior if the preci- G
sion control is set to less than 53 bits. The _fpstart routine (see Chapter 6) G
changes the precision control to 64 bits and sets all exceptions to be G
asked. This is the default state required for conformance to the ANSI C
standard and to the IEEE 754 Floating-point standard.

Process Stack and Registers

When a process receives control, its stack holds the arguments and environment from `exec`(BA_OS).

Figure 3-31: Initial Process Stack

	Unspecified	*High addresses*
	Information block, including argument strings, environment strings, auxiliary information . . . (size varies)	
	Unspecified	
	Null auxiliary vector entry	
	Auxiliary vector . . . (2-word entries)	
	0 word	
	Environment pointers . . . (one word each)	
	0 word	
`4(%esp)`	Argument pointers . . . (*Argument count* words)	
`0(%esp)`	Argument count	
	Undefined	*Low addresses*

Argument strings, environment strings, and the auxiliary information appear in no specific order within the information block; the system makes no guarantees about their arrangement. The system also may leave an unspecified amount of memory between the null auxiliary vector entry and the beginning of the information block.

General and floating-point register values are unspecified at process entry, with the exceptions appearing below. Consequently, a program that requires registers to have specific values must set them explicitly during process initialization. It should *not* rely on the operating system to set all registers to 0.

`%ebp` The content of this register is unspecified at process initialization time, but the user code should mark the deepest stack frame by setting the frame pointer to zero. No other frame's `%ebp` should have a zero value.

`%esp` Performing its usual job, the stack pointer holds the address of the bottom of the stack, which is guaranteed to be word aligned.

`%edx` In a conforming program, this register contains a function pointer that the application should register with `atexit`(BA_OS). This function is used for shared object termination code [see ''Dynamic Linking'' in Chapter 5 of the *System V ABI*].

`%cs`, `%ds`, `%es`, `%ss`
The segment registers are initialized so that the user process can address the code, data, and stack segments using a 32-bit virtual address. A program that alters their values does not conform to the ABI and has undefined behavior.

Every process has a stack, but the system defines *no* fixed stack address. Furthermore, a program's stack address can change from one system to another—even from one process invocation to another. Thus the process initialization code must use the stack address in `%esp`. Data in the stack segment at addresses below the stack pointer contain undefined values.

Whereas the argument and environment vectors transmit information from one application program to another, the auxiliary vector conveys information from the operating system to the program. This vector is an array of the following structures, interpreted according to the `a_type` member.

Figure 3-32: Auxiliary Vector

```
typedef struct
{
      int   a_type;
      union {
            long  a_val;
            void  *a_ptr;
            void  (*a_fcn)();
      } a_un;
} auxv_t;
```

Figure 3-33: Auxiliary Vector Types, a_type

Name	Value	a_un	
AT_NULL	0	ignored	
AT_IGNORE	1	ignored	
AT_EXECFD	2	a_val	
AT_PHDR	3	a_ptr	
AT_PHENT	4	a_val	
AT_PHNUM	5	a_val	
AT_PAGESZ	6	a_val	
AT_BASE	7	a_ptr	
AT_FLAGS	8	a_val	
AT_ENTRY	9	a_ptr	
AT_LIBPATH	10	a_val	M
AT_FPHW	11	a_val	M
AT_INTP_DEVICE	12	a_val	M
AT_INTP_INODE	13	a_val	M

AT_NULL The auxiliary vector has no fixed length; instead its last entry's a_type member has this value.

AT_IGNORE — This type indicates the entry has no meaning. The corresponding value of a_un is undefined.

AT_EXECFD — As Chapter 5 describes, exec(BA_OS) may pass control to an interpreter program. When this happens, the system places either an entry of type AT_EXECFD or one of type AT_PHDR in the auxiliary vector. The entry for type AT_EXECFD uses the a_val member to contain a file descriptor open to read the application program's object file.

AT_PHDR — Under some conditions, the system creates the memory image of the application program before passing control to the interpreter program. When this happens, the a_ptr member of the AT_PHDR entry tells the interpreter where to find the program header table in the memory image. If the AT_PHDR entry is present, entries of types AT_PHENT, AT_PHNUM, and AT_ENTRY must also be present. See Chapter 5 in both the System V ABI and the processor supplement for more information about the program header table.

AT_PHENT — The a_val member of this entry holds the size, in bytes, of one entry in the program header table to which the AT_PHDR entry points.

AT_PHNUM — The a_val member of this entry holds the number of entries in the program header table to which the AT_PHDR entry points.

AT_PAGESZ — If present, this entry's a_val member gives the system page size, in bytes. The same information also is available through sysconf(BA_OS).

AT_BASE — The a_ptr member of this entry holds the base address at which the interpreter program was loaded into memory. See ''Program Header'' in the System V ABI for more information about the base address.

AT_FLAGS — If present, the a_val member of this entry holds one-bit flags. Bits with undefined semantics are set to zero.

AT_ENTRY — The a_ptr member of this entry holds the entry point of the application program to which the interpreter program should transfer control.

AT_LIBPATH — The a_val member of this entry is non-zero if the dynamic linker should examine LD_LIBRARY_PATH when searching for shared objects of the process based on the security considerations in the Shared Object Dependency section in Chapter 5 of the gABI.

AT_FPHW The a_val member of this entry will be set to

Figure 3-34: AT_FPHW values

Value	Meaning
0	if no floating point support exists
1	if floating point software emulation exists
2	if it has a 80287 chip
3	if it has a 80387 chip or a 80487 chip

AT_INTP_DEVICE

The a_val member of this entry holds the device number of the file from which the dynamic linker is loaded.

AT_INTP_INODE

The a_val member of this entry holds the inode of the file from which the dynamic linker is loaded.

Other auxiliary vector types are reserved. No flags are currently defined for AT_FLAGS, on the Intel386 architecture.

To illustrate, suppose an example process receives two arguments.

- echo
- abi

It also inherits two environment strings (this example is not intended to show a fully configured execution environment).

- HOME=/home/dir
- PATH=/usr/bin:

Its one non-null auxiliary vector entry holds a file descriptor.

- {AT_EXECFD, 13}

The resulting stack resides below 0x8048000, growing toward lower addresses.

Figure 3-35: Example Process Stack

Address					
	n	:	\0	*pad*	*High addresses*
	r	/	b	i	
	=	/	u	s	
0x8047ff0	P	A	T	H	
	d	i	r	\0	
	o	m	e	/	
	E	=	/	h	
0x8047fe0	\0	H	O	M	
	\0	a	b	i	
	e	c	h	o	
	0				
0x8047fd0	0				
	13				
	2				Auxiliary vector
	0				
0x8047fc0	0x8047ff0				
	0x8047fe1				Environment vector
	0				
	0x8047fdd				
0x8047fb0	0x8047fd8				Argument vector
0(%esp), 0x8047fac	2				Argument count
	Undefined				*Low addresses*

Coding Examples

This section discusses example code sequences for fundamental operations such as calling functions, accessing static objects, and transferring control from one part of a program to another. Previous sections discuss how a program may use the machine or the operating system, and they specify what a program may and may not assume about the execution environment. Unlike previous material, the information here illustrates how operations *may* be done, not how they *must* be done.

As before, examples use the ANSI C language. Other programming languages may use the same conventions displayed below, but failure to do so does *not* prevent a program from conforming to the ABI. Two main object code models are available.

- *Absolute code*. Instructions can hold absolute addresses under this model. To execute properly, the program must be loaded at a specific virtual address, making the program's absolute addresses coincide with the process's virtual addresses.
- *Position-independent code*. Instructions under this model hold relative addresses, *not* absolute addresses. Consequently, the code is not tied to a specific load address, allowing it to execute properly at various positions in virtual memory.

Following sections describe the differences between these models. Code sequences for the models (when different) appear together, allowing easier comparison.

NOTE Examples below show code fragments with various simplifications. They are intended to explain addressing modes, not to show optimal code sequences nor to reproduce compiler output.

NOTE When other sections of this document show assembly language code sequences, they typically show only the absolute versions. Information in this section explains how position-independent code would alter the examples.

Code Model Overview

When the system creates a process image, the executable file portion of the process has fixed addresses, and the system chooses shared object library virtual addresses to avoid conflicts with other segments in the process. To maximize text sharing, shared objects conventionally use position-independent code, in which instructions contain no absolute addresses. Shared object text segments can be loaded at various virtual addresses without having to change the segment images. Thus multiple processes can share a single shared object text segment, even though the segment resides at a different virtual address in each process.

Position-independent code relies on two techniques.

- Control transfer instructions hold offsets relative to the extended instruction pointer (EIP). An EIP-relative branch or function call computes its destination address in terms of the current instruction pointer, *not* relative to any absolute address.
- When the program requires an absolute address, it computes the desired value. Instead of embedding absolute addresses in the instructions, the compiler generates code to calculate an absolute address during execution.

Because the Intel386 architecture provides EIP-relative call and branch instructions, compilers can satisfy the first condition easily.

A *global offset table* provides information for address calculation. Position-independent object files (executable and shared object files) have this table in their data segment. When the system creates the memory image for an object file, the table entries are relocated to reflect the absolute virtual addresses as assigned for an individual process. Because data segments are private for each process, the table entries can change—unlike text segments, which multiple processes share.

Assembly language examples below show the explicit notation needed for position-independent code.

name`@GOT(%ebx)`
: This expression denotes an `%ebx`-relative reference to the global offset table entry for the symbol *name*. The `%ebx` register contains the absolute address of the global offset table, as explained below.

name`@GOTOFF(%ebx)`
: This expression denotes an `%ebx`-relative reference to the symbol *name*. Again, `%ebx` holds the global offset table address. Note this expression references *name*, not the global offset table entry for *name*.

name@PLT — This expression denotes an EIP-relative reference to the procedure linkage table entry for the symbol *name*.

_GLOBAL_OFFSET_TABLE_ — The symbol _GLOBAL_OFFSET_TABLE_ is used to access the global offset table. When an instruction uses the symbol, it sees the offset between the current instruction and the global offset table as the symbol value.

Position-Independent Function Prologue

This section describes the function prologue for position-independent code. A function's prologue allocates the local stack space, saves any registers it must preserve, and sets register %ebx to the global offset table's address. Because %ebx is private for each function and preserved across function calls, a function calculates its value once at the entry.

Figure 3-36: Calculating Global Offset Table Address

```
        call   .L1
.L1:    popl   %ebx
        addl   $_GLOBAL_OFFSET_TABLE_+[.-.L1], %ebx
```

These three lines accomplish the following.

1. The call instruction pushes the *absolute* address of the next instruction onto the stack.
2. Consequently, the popl instruction pops the absolute address of .L1 into register %ebx.
3. The last instruction computes the desired absolute value into %ebx. This works because _GLOBAL_OFFSET_TABLE_ in the expression gives the distance from the addl instruction to the global offset table; [.-.L1] gives the distance from .L1 to the addl instruction. Adding their sum to the absolute address of .L1, already in %ebx, gives the absolute address of the global offset table.

This computation can be added to the standard function prologue, giving the standard prologue for position-independent code. To illustrate, the following function prologue allocates 80 bytes of local stack space and saves the local registers `%ebx`, `%esi`, and `%edi`.

Figure 3-37: Position-Independent Function Prologue

```
prologue:
      pushl  %ebp
      movl   %esp, %ebp
      subl   $80, %esp
      pushl  %edi
      pushl  %esi
      pushl  %ebx
      call   .L1
.L1:  popl   %ebx
      addl   $_GLOBAL_OFFSET_TABLE_+[.-.L1], %ebx
```

Position-independent and absolute code use the same function epilogue.

Data Objects

This discussion excludes stack-resident objects, because programs always compute their virtual addresses relative to the stack and frame pointers. Instead, this section describes objects with static storage duration.

In the Intel386 architecture, all memory reference instructions can address any location within the 32-bit address space. Symbolic references in absolute code put the symbols' values—or absolute virtual addresses—into instructions.

Figure 3-38: Absolute Data Access

C	Assembly
`extern int src;`	`.globl   src, dst, ptr`
`extern int dst;`	
`extern int *ptr;`	
`ptr = &dst;`	`movl     $dst, ptr`
`*ptr = src;`	`movl     ptr, %eax`
	`movl     src, %edx`
	`movl     %edx, (%eax)`

Position-independent instructions cannot contain absolute addresses. Instead, instructions that reference symbols hold the symbols' offsets into the global offset table. Combining the offset with the global offset table address in `%ebx` gives the absolute address of the table entry holding the desired address.

Figure 3-39: Position-Independent Data Access

C	Assembly
`extern int src;`	`.globl   src, dst, ptr`
`extern int dst;`	
`extern int *ptr;`	
`ptr = &dst;`	`movl     ptr@GOT(%ebx), %eax`
	`movl     dst@GOT(%ebx), %edx`
	`movl     %edx, (%eax)`
`*ptr = src;`	`movl     ptr@GOT(%ebx), %eax`
	`movl     (%eax), %eax`
	`movl     src@GOT(%ebx), %edx`
	`movl     (%edx), %edx`
	`movl     %edx, (%eax)`

Finally, position-independent references to static data may be optimized. Because `%ebx` holds a known address, the global offset table, a program may use it as a base register. External references should use the global offset table entry, because dynamic linking may bind the entry to a definition outside the current object file's scope.

Figure 3-40: Position-Independent Static Data Access

C	Assembly
`static int src;`	
`static int dst;`	
`static int *ptr;`	
`ptr = &dst;`	`leal ptr@GOTOFF(%ebx), %eax`
	`leal dst@GOTOFF(%ebx), %edx`
	`movl %edx, (%eax)`
`*ptr = src;`	`movl ptr@GOTOFF(%ebx), %eax`
	`movl src@GOTOFF(%ebx), %edx`
	`movl %edx, (%eax)`

Function Calls

Programs use the `call` instruction to make direct function calls. A `call` instruction's destination is an EIP-relative value that can reach any address in the 32-bit virtual space. Even when the code for a function resides in a shared object, the caller uses the same assembly language instruction sequence, although in that case control passes from the original call, through an indirection sequence, to the desired destination. See ''Procedure Linkage Table'' in Chapter 5 for more information on the indirection sequence.

Figure 3-41: Absolute Direct Function Call

C	Assembly
`extern void function();`	`.globl function`
`function();`	`call function`

Dynamic linking may redirect a function call outside the current object file's scope; so position-independent calls should use the procedure linkage table explicitly.

Figure 3-42: Position-Independent Direct Function Call

C	Assembly
`extern void function();` `function();`	`.globl   function` `call     function@PLT`

Indirect function calls use the indirect `call` instruction.

Figure 3-43: Absolute Indirect Function Call

C:

```
extern void (*ptr)();
extern void name();
ptr = name;

(*ptr)();
```

Assembly:

```
.globl   ptr, name;

movl     $name, ptr

call     *ptr
```

For position-independent code, the global offset table supplies absolute addresses for all required symbols, whether the symbols name objects or functions.

Figure 3-44: Position-Independent Indirect Function Call

C:

```
extern void (*ptr)();
extern void name();
ptr = name;



(*ptr)();
```

Assembly:

```
.globl   ptr, name

movl     ptr@GOT(%ebx), %eax
movl     name@GOT(%ebx), %edx
movl     %edx, (%eax)

movl     ptr@GOT(%ebx), %eax
call     *(%eax)
```

Branching

Programs use branch instructions to control their execution flow. As defined by the Intel386 architecture, branch instructions hold an EIP-relative value with a signed 32-bit range, allowing a jump to any location within the virtual address space.

Figure 3-45: Branch Instruction, All Models

C	Assembly

`label:`
`        . . .`
`        goto label;`
	`.L01:`
	`        . . .`
	`        jmp     .L01`

C `switch` statements provide multiway selection. When the `case` labels of a `switch` statement satisfy grouping constraints, the compiler implements the selection with an address table. The following examples use several simplifying conventions to hide irrelevant details:

- The selection expression resides in register `%eax`;
- `case` label constants begin at zero;
- `case` labels, `default`, and the address table use assembly names `.Lcase`*i*, `.Ldef`, and `.Ltab`, respectively.

Address table entries for absolute code contain virtual addresses; the selection code extracts an entry's value and jumps to that address. Position-independent table entries hold offsets; the selection code computes a destination's absolute address.

Figure 3-46: Absolute `switch` **Code**

C	Assembly

<pre>switch (j)
{
case 0:
    . . .
case 2:
    . . .
case 3:
    . . .
default:
    . . .
}</pre>
	<pre> cmpl $3, %eax
	        ja .Ldef
	        jmp *.Ltab(,%eax,4)
	.Ltab: .long .Lcase0
	        .long .Ldef
	        .long .Lcase2
	        .long .Lcase3</pre>

Figure 3-47: Position-Independent `switch` **Code**

C	Assembly

<pre>switch (j)
{
case 0:
    . . .
case 2:
    . . .
case 3:
    . . .
default:
    . . .
}</pre>
	<pre> cmpl $3, %eax
	        ja .Ldef
	        leal .Ltab@GOTOFF(%ebx), %edx
	        movl (%edx,%eax,4), %eax
	        movl .Ltab@GOTOFF(%ebx,%eax,4), %eax
	        call .Ljmp
	.Ljmp:
	        popl %ecx
	        addl %ecx, %eax
	        jmp *%eax
	.Ltab:
	        .long .Lcase0 - .Ljmp
	        .long .Ldef - .Ljmp
	        .long .Lcase2 - .Ljmp
	        .long .Lcase3 - .Ljmp</pre>

C Stack Frame

Figure 3-48 shows the C stack frame organization. It conforms to the standard
stack frame with designated roles for unspecified areas in the standard frame. M
This represents one possible organization of the C stack frame. Usage of %ebp as a M
frame pointer, the exact positions of the callee saved registers, and space for local M
storage is implementation specific.

Figure 3-48: C Stack Frame

Base	Offset	Contents	
%ebp	$4n$+8	argument word *n*	*High addresses*
		. . .	
	8	argument word 0	
	4	return address	
%ebp	0	caller's %ebp	
%ebp	–4	*x* words local space: automatic variables, temporaries,	
%ebp	$-4x$	etc.	
%esp	12		
%esp	8	caller's %edi	
	4	caller's %esi	
%esp	0	caller's %ebx	*Low addresses*

A C stack frame doesn't normally change size during execution. The exception is dynamically allocated stack memory, discussed below. By convention, a function allocates automatic (local) variables in the middle of its frame and references them as negative offsets from %ebp. Its incoming arguments reside in the previous frame, referenced as positive offsets from %ebp. If necessary, a function saves the values of %edi, %esi, and %ebx in the positions shown and restores their values before returning to the caller. The positions may be different from the diagram above, depending on which of these three registers the function saves and restores.

Variable Argument List

Previous sections describe the rules for passing arguments. Unfortunately, some otherwise portable C programs depend on the argument passing scheme, implicitly assuming that 1) all arguments reside on the stack, and 2) arguments appear in increasing order on the stack. Programs that make these assumptions never have been portable, but they have worked on many machines, including the Intel386. Nonetheless, portable C programs should use the facilities defined in the header files `<stdarg.h>` or `<varargs.h>` to deal with variable argument lists.

Allocating Stack Space Dynamically

Unlike some other languages, C does not need dynamic stack allocation *within* a stack frame. Frames are allocated dynamically on the program stack, depending on program execution, but individual stack frames can have static sizes. Nonetheless, the architecture supports dynamic allocation for those languages that require it, and the standard calling sequence and stack frame support it as well. Thus languages that need dynamic stack frame sizes can call C functions, and vice versa.

Figure 3-48 shows the layout of the C stack frame. The double line divides the area referenced from `%ebp` from the area referenced from `%esp`. Dynamic space is allocated below the line, as a downward growing heap whose size changes as required. Typical C functions have no space in the heap. All areas above the heap in the current frame have a known size to the compiler. Dynamic stack allocation thus takes the following steps.

1. Stack frames are word aligned; dynamic allocation should preserve this property. Thus the program rounds (up) the desired byte count to a multiple of 4.
2. The program decreases the stack pointer by the rounded byte count, increasing its frame size. At this point, the ‘‘new’’ space resides just below the register save area at the bottom of the stack.
3. The program copies the register save area (three or fewer words) to the bottom of the stack, effectively moving the new space up into the frame.

NOTE The register save area is reserved and should not be used for purposes outside of this document. G

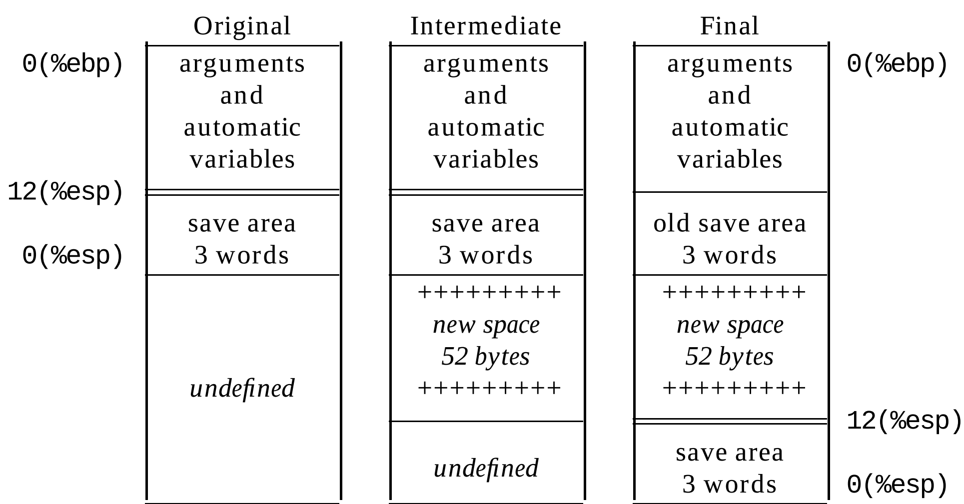
Even in the presence of signals, dynamic allocation is ‘‘safe.’’ If a signal interrupts allocation, one of three things can happen.

- The signal handler can return. The process then resumes the dynamic allocation from the point of interruption.
- The signal handler can execute a non-local goto, or `longjmp` [see `setjmp`(BA_LIB)]. This resets the process to a new context in a previous stack frame, automatically discarding the dynamic allocation.
- The process can terminate.

Regardless of when the signal arrives during dynamic allocation, the result is a consistent (though possibly dead) process.

To illustrate, assume a program wants to allocate 50 bytes, and it has saved three registers in the bottom of the frame. The first step is rounding 50 to 52, making it a multiple of 4. Figure 3-49 shows how the stack frame changes.

Figure 3-49: Dynamic Stack Allocation



New space starts at `12(%esp)`. As described, every dynamic allocation in *this* function will return a new area starting at `12(%esp)`, leaving previous heap objects untouched (other functions could have different heap addresses).

Consequently, the compiler should compute the absolute address for each area, avoiding relative references. Otherwise, future allocations in the same frame would destroy the heap's integrity.

Existing stack objects reside at fixed offsets from the frame pointer (%ebp). Dynamic allocation preserves those offsets, because the frame pointer does not change and the objects relative to it do not move. Objects relative to the stack pointer (%esp) move, but their %esp-relative positions do not change. Accordingly, compilers arrange not to publicize the absolute address of any object in the bottom half of the stack frame (in a way that violates the scope rules). %esp-relative references stay valid after dynamic allocation, but absolute addresses do not.

No special code is needed to free dynamically allocated stack memory. The function return resets the stack pointer and removes the entire stack frame, including the heap, from the stack. Naturally, a program should not reference heap objects after they have gone out of scope.

4 OBJECT FILES

ELF Header

Machine Information

For file identification in e_ident, the Intel386 architecture requires the following values.

Figure 4-1: Intel386 Identification, e_ident

Position	Value
e_ident[EI_CLASS]	ELFCLASS32
e_ident[EI_DATA]	ELFDATA2LSB

Processor identification resides in the ELF header's e_machine member and must have the value EM_386.

The ELF header's e_flags member holds bit flags associated with the file. The Intel386 architecture defines no flags; so this member contains zero.

Sections

Special Sections

Various sections hold program and control information. Sections in the list below are used by the system and have the indicated types and attributes.

Figure 4-2: Special Sections

Name	Type	Attributes
.got	SHT_PROGBITS	SHF_ALLOC + SHF_WRITE
.plt	SHT_PROGBITS	SHF_ALLOC + SHF_EXECINSTR

.got — This section holds the global offset table. See ‘‘Coding Examples’’ in Chapter 3 and ‘‘Global Offset Table’’ in Chapter 5 for more information.

.plt — This section holds the procedure linkage table. See ‘‘Procedure Linkage Table’’ in Chapter 5 for more information.

Symbol Table

Symbol Values

If an executable file contains a reference to a function defined in one of its associated shared objects, the symbol table section for that file will contain an entry for that symbol. The `st_shndx` member of that symbol table entry contains `SHN_UNDEF`. This signals to the dynamic linker that the symbol definition for that function is not contained in the executable file itself. If that symbol has been allocated a procedure linkage table entry in the executable file, and the `st_value` member for that symbol table entry is non-zero, the value will contain the virtual address of the first instruction of that procedure linkage table entry. Otherwise, the `st_value` member contains zero. This procedure linkage table entry address is used by the dynamic linker in resolving references to the address of the function. See ‘‘Function Addresses’’ in Chapter 5 for details.

Relocation

Relocation Types

Relocation entries describe how to alter the following instruction and data fields (bit numbers appear in the lower box corners).

Figure 4-3: Relocatable Fields

31	*word32*	0

word32 This specifies a 32-bit field occupying 4 bytes with arbitrary byte alignment. These values use the same byte order as other word values in the Intel386 architecture.

0x01020304	31	01	3	02	2	03	1	04	0 / 0

Calculations below assume the actions are transforming a relocatable file into either an executable or a shared object file. Conceptually, the link editor merges one or more relocatable files to form the output. It first decides how to combine and locate the input files, then updates the symbol values, and finally performs the relocation. Relocations applied to executable or shared object files are similar and accomplish the same result. Descriptions below use the following notation.

`A` This means the addend used to compute the value of the relocatable field.

`B` This means the base address at which a shared object has been loaded into memory during execution. Generally, a shared object file is built with a 0 base virtual address, but the execution address will be different. See ''Program Header'' in the System V ABI for more information about the base address.

`G` This means the offset into the global offset table at which the address of the relocation entry's symbol will reside during execution. See ''Coding Examples'' in Chapter 3 and ''Global Offset Table'' in Chapter 5 for more information.

GOT This means the address of the global offset table. See ''Coding Examples'' in Chapter 3 and ''Global Offset Table'' in Chapter 5 for more information.

L This means the place (section offset or address) of the procedure linkage table entry for a symbol. A procedure linkage table entry redirects a function call to the proper destination. The link editor builds the initial procedure linkage table, and the dynamic linker modifies the entries during execution. See ''Procedure Linkage Table'' in Chapter 5 for more information.

P This means the place (section offset or address) of the storage unit being relocated (computed using `r_offset`).

S This means the value of the symbol whose index resides in the relocation entry.

A relocation entry's `r_offset` value designates the offset or virtual address of the first byte of the affected storage unit. The relocation type specifies which bits to change and how to calculate their values. The Intel386 architecture uses only `Elf32_Rel` relocation entries, the field to be relocated holds the addend. In all cases, the addend and the computed result use the same byte order.

Figure 4-4: Relocation Types

Name	Value	Field	Calculation
R_386_NONE	0	none	none
R_386_32	1	*word32*	S + A
R_386_PC32	2	*word32*	S + A - P
R_386_GOT32	3	*word32*	G + A - P
R_386_PLT32	4	*word32*	L + A - P
R_386_COPY	5	none	none
R_386_GLOB_DAT	6	*word32*	S
R_386_JMP_SLOT	7	*word32*	S
R_386_RELATIVE	8	*word32*	B + A
R_386_GOTOFF	9	*word32*	S + A - GOT
R_386_GOTPC	10	*word32*	GOT + A - P

Some relocation types have semantics beyond simple calculation.

R_386_GOT32 This relocation type computes the distance from the base of the global offset table to the symbol's global offset table entry. It additionally instructs the link editor to build a global offset table.

R_386_PLT32 — This relocation type computes the address of the symbol's procedure linkage table entry and additionally instructs the link editor to build a procedure linkage table.

R_386_COPY — The link editor creates this relocation type for dynamic linking. Its offset member refers to a location in a writable segment. The symbol table index specifies a symbol that should exist both in the current object file and in a shared object. During execution, the dynamic linker copies data associated with the shared object's symbol to the location specified by the offset.

R_386_GLOB_DAT — This relocation type is used to set a global offset table entry to the address of the specified symbol. The special relocation type allows one to determine the correspondence between symbols and global offset table entries.

R_386_JMP_SLOT — The link editor creates this relocation type for dynamic linking. Its offset member gives the location of a procedure linkage table entry. The dynamic linker modifies the procedure linkage table entry to transfer control to the designated symbol's address [see ''Procedure Linkage Table'' in Chapter 5].

R_386_RELATIVE — The link editor creates this relocation type for dynamic linking. Its offset member gives a location within a shared object that contains a value representing a relative address. The dynamic linker computes the corresponding virtual address by adding the virtual address at which the shared object was loaded to the relative address. Relocation entries for this type must specify 0 for the symbol table index.

R_386_GOTOFF — This relocation type computes the difference between a symbol's value and the address of the global offset table. It additionally instructs the link editor to build the global offset table.

R_386_GOTPC — This relocation type resembles R_386_PC32, except it uses the address of the global offset table in its calculation. The symbol referenced in this relocation normally is _GLOBAL_OFFSET_TABLE_, which additionally instructs the link editor to build the global offset table.

5 PROGRAM LOADING AND DYNAMIC LINKING

Program Loading

As the system creates or augments a process image, it logically copies a file's segment to a virtual memory segment. When—and if—the system physically reads the file depends on the program's execution behavior, system load, and so on. A process does not require a physical page unless it references the logical page during execution, and processes commonly leave many pages unreferenced. Therefore delaying physical reads frequently obviates them, improving system performance. To obtain this efficiency in practice, executable and shared object files must have segment images whose file offsets and virtual addresses are congruent, modulo the page size.

Virtual addresses and file offsets for the Intel386 architecture segments are congruent modulo 4 KB (`0x1000`) or larger powers of 2. Because 4 KB is the maximum page size, the files will be suitable for paging regardless of physical page size.

Figure 5-1: Executable File

File Offset	File	Virtual Address
`0`	ELF header	
	Program header table	
	Other information	

`0x100`	Text segment
	. . .
	`0x2be00` bytes
		`0x8048100`
		
		`0x8073eff`

`0x2bf00`	Data segment
	. . .
	`0x4e00` bytes
		`0x8074f00`
		
		`0x8079cff`

`0x30d00`	Other information . . .	

Figure 5-2: Program Header Segments

Member	Text	Data
p_type	PT_LOAD	PT_LOAD
p_offset	0x100	0x2bf00
p_vaddr	0x8048100	0x8074f00
p_paddr	unspecified	unspecified
p_filesz	0x2be00	0x4e00
p_memsz	0x2be00	0x5e24
p_flags	PF_R + PF_X	PF_R + PF_W + PF_X
p_align	0x1000	0x1000

Although the example's file offsets and virtual addresses are congruent modulo 4 KB for both text and data, up to four file pages hold impure text or data (depending on page size and file system block size).

- The first text page contains the ELF header, the program header table, and other information.
- The last text page holds a copy of the beginning of data.
- The first data page has a copy of the end of text.
- The last data page may contain file information not relevant to the running process.

Logically, the system enforces the memory permissions as if each segment were complete and separate; segments' addresses are adjusted to ensure each logical page in the address space has a single set of permissions. In the example above, the region of the file holding the end of text and the beginning of data will be mapped twice: at one virtual address for text and at a different virtual address for data.

The end of the data segment requires special handling for uninitialized data, which the system defines to begin with zero values. Thus if a file's last data page includes information not in the logical memory page, the extraneous data must be set to zero, not the unknown contents of the executable file. ''Impurities'' in the other three pages are not logically part of the process image; whether the system expunges them is unspecified. The memory image for this program follows, assuming 4 KB (0x1000) pages.

Figure 5-3: Process Image Segments

Virtual Address	Contents	Segment
`0x8048000`	*Header padding* `0x100` bytes	
`0x8048100`	Text segment ... `0x2be00` bytes	Text
`0x8073f00`	*Data padding* `0x100` bytes	
`0x8074000`	*Text padding* `0xf00` bytes	
`0x8074f00`	Data segment ... `0x4e00` bytes	
`0x8079d00`	Uninitialized data `0x1024` zero bytes	Data
`0x807ad24`	*Page padding* `0x2dc` zero bytes	

One aspect of segment loading differs between executable files and shared objects. Executable file segments typically contain absolute code (see ‘‘Coding Examples’’ in Chapter 3). To let the process execute correctly, the segments must reside at the virtual addresses used to build the executable file. Thus the system uses the `p_vaddr` values unchanged as virtual addresses.

On the other hand, shared object segments typically contain position-independent code. This lets a segment’s virtual address change from one process to another, without invalidating execution behavior. Though the system chooses virtual addresses for individual processes, it maintains the segments’ *relative positions*. Because position-independent code uses relative addressing between segments, the difference between virtual addresses in memory must match the difference between virtual addresses in the file. The following table shows possible shared object virtual address assignments for several processes, illustrating constant relative positioning. The table also illustrates the base address computations.

Figure 5-4: Example Shared Object Segment Addresses

Source	Text	Data	Base Address
File	`0x200`	`0x2a400`	`0x0`
Process 1	`0x80000200`	`0x8002a400`	`0x80000000`
Process 2	`0x80081200`	`0x800ab400`	`0x80081000`
Process 3	`0x900c0200`	`0x900ea400`	`0x900c0000`
Process 4	`0x900c6200`	`0x900f0400`	`0x900c6000`

Dynamic Linking

Dynamic Section

Dynamic section entries give information to the dynamic linker. Some of this information is processor-specific, including the interpretation of some entries in the dynamic structure.

`DT_PLTGOT` On the Intel386 architecture, this entry's `d_ptr` member gives the address of the first entry in the global offset table. As mentioned below, the first three global offset table entries are reserved, and two are used to hold procedure linkage table information.

Global Offset Table

Position-independent code cannot, in general, contain absolute virtual addresses. Global offset tables hold absolute addresses in private data, thus making the addresses available without compromising the position-independence and shara-bility of a program's text. A program references its global offset table using position-independent addressing and extracts absolute values, thus redirecting position-independent references to absolute locations.

Initially, the global offset table holds information as required by its relocation entries [see ''Relocation'' in Chapter 4]. After the system creates memory segments for a loadable object file, the dynamic linker processes the relocation entries, some of which will be type `R_386_GLOB_DAT` referring to the global offset table. The dynamic linker determines the associated symbol values, calculates their absolute addresses, and sets the appropriate memory table entries to the proper values. Although the absolute addresses are unknown when the link editor builds an object file, the dynamic linker knows the addresses of all memory segments and can thus calculate the absolute addresses of the symbols contained therein.

If a program requires direct access to the absolute address of a symbol, that symbol will have a global offset table entry. Because the executable file and shared objects have separate global offset tables, a symbol's address may appear in several tables. The dynamic linker processes all the global offset table relocations before giving control to any code in the process image, thus ensuring the absolute addresses are available during execution.

The table's entry zero is reserved to hold the address of the dynamic structure, referenced with the symbol _DYNAMIC. This allows a program, such as the dynamic linker, to find its own dynamic structure without having yet processed its relocation entries. This is especially important for the dynamic linker, because it must initialize itself without relying on other programs to relocate its memory image. On the Intel386 architecture, entries one and two in the global offset table also are reserved. ''Procedure Linkage Table'' below describes them.

The system may choose different memory segment addresses for the same shared object in different programs; it may even choose different library addresses for different executions of the same program. Nonetheless, memory segments do not change addresses once the process image is established. As long as a process exists, its memory segments reside at fixed virtual addresses.

A global offset table's format and interpretation are processor-specific. For the Intel386 architecture, the symbol _GLOBAL_OFFSET_TABLE_ may be used to access the table.

Figure 5-5: Global Offset Table

```
extern Elf32_Addr   _GLOBAL_OFFSET_TABLE_[];
```

The symbol _GLOBAL_OFFSET_TABLE_ may reside in the middle of the .got section, allowing both negative and non-negative ''subscripts'' into the array of addresses.

Function Addresses

References to the address of a function from an executable file and the shared objects associated with it might not resolve to the same value. References from within shared objects will normally be resolved by the dynamic linker to the virtual address of the function itself. References from within the executable file to a function defined in a shared object will normally be resolved by the link editor to the address of the procedure linkage table entry for that function within the executable file.

To allow comparisons of function addresses to work as expected, if an executable file references a function defined in a shared object, the link editor will place the address of the procedure linkage table entry for that function in its associated symbol table entry. [See ''Symbol Values'' in Chapter 4]. The dynamic linker treats such symbol table entries specially. If the dynamic linker is searching for a symbol, and encounters a symbol table entry for that symbol in the executable file, it normally follows the rules below.

1. If the `st_shndx` member of the symbol table entry is not `SHN_UNDEF`, the dynamic linker has found a definition for the symbol and uses its `st_value` member as the symbol's address.
2. If the `st_shndx` member is `SHN_UNDEF` and the symbol is of type `STT_FUNC` and the `st_value` member is not zero, the dynamic linker recognizes this entry as special and uses the `st_value` member as the symbol's address.
3. Otherwise, the dynamic linker considers the symbol to be undefined within the executable file and continues processing.

Some relocations are associated with procedure linkage table entries. These entries are used for direct function calls rather than for references to function addresses. These relocations are not treated in the special way described above because the dynamic linker must not redirect procedure linkage table entries to point to themselves.

Procedure Linkage Table

Much as the global offset table redirects position-independent address calculations to absolute locations, the procedure linkage table redirects position-independent function calls to absolute locations. The link editor cannot resolve execution transfers (such as function calls) from one executable or shared object to another. Consequently, the link editor arranges to have the program transfer control to entries in the procedure linkage table. On the Intel386 architecture, procedure linkage tables reside in shared text, but they use addresses in the private global offset table. The dynamic linker determines the destinations' absolute addresses and modifies the global offset table's memory image accordingly. The dynamic linker thus can redirect the entries without compromising the position-independence and sharability of the program's text. Executable files and shared object files have separate procedure linkage tables.

Figure 5-6: Absolute Procedure Linkage Table

```
.PLT0: pushl  got_plus_4
       jmp    *got_plus_8
       nop; nop
       nop; nop
.PLT1: jmp    *name1_in_GOT
       pushl  $offset
       jmp    .PLT0@PC
.PLT2: jmp    *name2_in_GOT
       pushl  $offset
       jmp    .PLT0@PC
       ...
```

Figure 5-7: Position-Independent Procedure Linkage Table

```
.PLT0: pushl  4(%ebx)
       jmp    *8(%ebx)
       nop; nop
       nop; nop
.PLT1: jmp    *name1@GOT(%ebx)
       pushl  $offset
       jmp    .PLT0@PC
.PLT2: jmp    *name2@GOT(%ebx)
       pushl  $offset
       jmp    .PLT0@PC
       ...
```

NOTE As the figures show, the procedure linkage table instructions use different operand addressing modes for absolute code and for position-independent code. Nonetheless, their interfaces to the dynamic linker are the same.

Following the steps below, the dynamic linker and the program ‘‘cooperate’’ to resolve symbolic references through the procedure linkage table and the global offset table.

1. When first creating the memory image of the program, the dynamic linker sets the second and the third entries in the global offset table to special values. Steps below explain more about these values.

2. If the procedure linkage table is position-independent, the address of the global offset table must reside in `%ebx`. Each shared object file in the process image has its own procedure linkage table, and control transfers to a procedure linkage table entry only from within the same object file. Consequently, the calling function is responsible for setting the global offset table base register before calling the procedure linkage table entry.

3. For illustration, assume the program calls `name1`, which transfers control to the label `.PLT1`.

4. The first instruction jumps to the address in the global offset table entry for `name1`. Initially, the global offset table holds the address of the following `pushl` instruction, not the real address of `name1`.

5. Consequently, the program pushes a relocation offset (*offset*) on the stack. The relocation offset is a 32-bit, non-negative byte offset into the relocation table. The designated relocation entry will have type `R_386_JMP_SLOT`, and its offset will specify the global offset table entry used in the previous `jmp` instruction. The relocation entry also contains a symbol table index, thus telling the dynamic linker what symbol is being referenced, `name1` in this case.

6. After pushing the relocation offset, the program then jumps to `.PLT0`, the first entry in the procedure linkage table. The `pushl` instruction places the value of the second global offset table entry (*got_plus_4* or `4(%ebx)`) on the stack, thus giving the dynamic linker one word of identifying information. The program then jumps to the address in the third global offset table entry (*got_plus_8* or `8(%ebx)`), which transfers control to the dynamic linker.

7. When the dynamic linker receives control, it unwinds the stack, looks at the designated relocation entry, finds the symbol’s value, stores the ‘‘real’’ address for `name1` in its global offset table entry, and transfers control to the desired destination.

8. Subsequent executions of the procedure linkage table entry will transfer directly to `name1`, without calling the dynamic linker a second time. That is, the `jmp` instruction at `.PLT1` will transfer to `name1`, instead of ‘‘falling through’’ to the `pushl` instruction.

The `LD_BIND_NOW` environment variable can change dynamic linking behavior. If its value is non-null, the dynamic linker evaluates procedure linkage table entries before transferring control to the program. That is, the dynamic linker processes relocation entries of type `R_386_JMP_SLOT` during process initialization. Otherwise, the dynamic linker evaluates procedure linkage table entries lazily, delaying symbol resolution and relocation until the first execution of a table entry.

NOTE Lazy binding generally improves overall application performance, because unused symbols do not incur the dynamic linking overhead. Nevertheless, two situations make lazy binding undesirable for some applications. First, the initial reference to a shared object function takes longer than subsequent calls, because the dynamic linker intercepts the call to resolve the symbol. Some applications cannot tolerate this unpredictability. Second, if an error occurs and the dynamic linker cannot resolve the symbol, the dynamic linker will terminate the program. Under lazy binding, this might occur at arbitrary times. Once again, some applications cannot tolerate this unpredictability. By turning off lazy binding, the dynamic linker forces the failure to occur during process initialization, before the application receives control.

Program Interpreter G

There is one valid program interpreter for programs conforming to the Intel386 ABI: G

`/usr/lib/libc.so.1` G

6 LIBRARIES

Shared Library Names M

The version number of the libraries named in the *System V Generic ABI* is specified M
below. M

Figure 6-1: Shared Library Names M

Library Reference Name	
`libc.so.1`	M
`libthread.so.1`	M
`libdl.so.1`	M
`libnsl.so.1`	M
`libX11.so.5.0`	M
`libXt.so.5.0`	M
`libXext.so.5.0`	M
`libXm.so.1.2`	M
`libMrm.so.1.2`	M

Additional Entry Points

The following routines are included in the **libc** library to provide entry points for the required source-level interface listed in the *System V ABI*. A description and syntax symmary for each function follows the table. M

Figure 6-2: `libc` **Additional Required Entry Points**

`_fxstat`	`_lxstat`	`_xmknod`	`_xstat`	`nuname`
`_nuname`				

`int _fxstat(int, int, struct stat *);`

The semantics of this function are identical to those of the `fstat`(BA_OS) function described in the *System V Interface Definition, Edition 4*. Its only difference is that it requires an extra first argument whose value must be 2.

`int _lxstat(int, char *, struct stat *);`

The semantics of this function are identical to those of the `lstat`(BA_OS) function described in the *System V Interface Definition, Edition 4*. Its only difference is that it requires an extra first argument whose value must be 2.

`int nuname(struct utsname *);`

The semantics and syntax of this function are identical to those of the `uname`(BA_OS) function described in the *System V Interface Definition, Edition 4*. The symbol `_nuname` is also available with

Definition, *Edition 4*. Its only difference is that it requires an extra first argument whose value must be 2.

Support Routines

Besides operating system services, **libc** contains the following processor-specific support routines. M

Figure 6-3: `libc`**, Support Routines**

```
_fpstart   _ _fpstart   sbrk   _sbrk
```

`char *sbrk(int incr);`

This function adds *incr* bytes to the *break value* and changes the allocated space accordingly. *Incr* can be negative, in which case the amount of allocated space is decreased. The break value is the address of the first allocation beyond the end of the data segment. The amount of allocated space increases as the break value increases. Newly allocated space is set to zero. If, however, the same memory space is reallocated to the same process, its contents are undefined. Upon successful completion, `sbrk` returns the old break value. Otherwise, it returns `-1` and sets `errno` to indicate the error. The symbol `_sbrk` is also available with the same semantics.

`void __fpstart(void);`

This function calls `_fpstart()`, to initialize the floating-point environment.

`void _fpstart(void);`

This function initializes the floating-point execution environment. It sets _fp_hw to the appropriate value. It sets the rounding mode to ‘‘nearest.’’ It also resets the Intel387 control word to the default state.

Global Data Symbols

The `libc` library requires that some globel external data objects be defined for the routines to work properly. In addition to the corresponding data symbols listed in the *System V ABI*, the following symbols must be provided in the system library on all ABI-conforming systems implemented with the Intel386 architecture. Declarations for the data objects listed below can be found in the Data Definitions section of this chapter or immediately following the table. M

Figure 6-4: `libc`**, Global External Data Symbols**

`__flt_rounds`	`_fp_hw`	`__huge_val`

`extern int _fp_hw;`

This variable describes the floating-point hardware available. If the value is zero, no floating-point support is present. If the value is 1, the floating-point support is provided by an Intel387 software emulator. If the value is 2, an 80287 chip is available. If the value is 3, an Intel387 chip is available. System software sets the value appropriately, before transferring control to `main`.

Application Constraints

As described above, `libc` provides symbols for applications. In a few cases, however, an application is obliged to provide symbols for the library. In addition to the application-provided symbols listed in this section of the *System V ABI*, conforming applications on the Intel386 architecture are also required to provide the following symbols. M

`extern _end;`

This symbol refers neither to a routine nor to a location with interesting contents. Instead, its address must correspond to the beginning of a program's dynamic allocation area, called the heap. Typically, the heap begins immediately after the data segment of the program's executable file.

`extern const int _lib_version;`

This variable's value specifies the compilation and execution mode for the program. If the value is zero, the program wants to preserve the semantics of older (pre-ANSI) C, where conflicts exist with ANSI. Otherwise, the value is non-zero, and the program wants ANSI C semantics.

System Data Interfaces

Data Definitions

This section contains standard data definitions that describe system data. These files are referred to by their names in angle brackets: <*name.h*> and <sys / *name.h*>. Included in these data definitions are macro definitions and data definitions.

The data objects described in this section are part of the interface between an ABI-conforming application and the underlying ABI-conforming system where it will run. While an ABI-conforming system must provide these interfaces, it is not required to contain the actual data definitions referenced here. Programmers should observe that the sources of the structures defined in these data definitions are defined in SVID.

ANSI C serves as the ABI reference programming language, and data definitions are specificed in ANSI C format. The C language is used here as a convenient notation. Using a C language description of these data objects does *not* preclude
their use by other programming languages. M

Reentrancy Considerations M

New conventions have been added to accomodate the new requirements of reen- M
trancy. Some historic binary code sequences are inherently non-reentrant. Unless M
great care is taken, multi-threaded applications cannot safely use such sequences. M
The most portable (i.e. those guaranteed to work in all cases) are those that are M
marked as reentrant in this chapter. For the ABI, this sometimes requires that two M
definitions exist for these interfaces, one that is reentrant and one that is not. M
These are indicated by comments that define which of the alternate definitions is M
reentrant. These alternatives are not selected at run-time, but are intended to be M
bound at application build time.

NOTE All information presented in the figures marked with * are new to the Fourth M
Edition of the psABI.

Figure 6-5: <aio.h>*

```
struct  aiocb {
        int             aio_fildes;
        volatile void*  aio_buf;
        size_t          aio_nbytes;
        off_t           aio_offset;
        int             aio_reqprio;
        struct sigevent aio_sigevent;
        int             aio_lio_opcode;
        ssize_t         ;
        int             ;
        int             ;
        void            ;
        int             ;
} ;

#define AIO_CANCELED    (0)
#define AIO_ALLDONE     (1)
#define AIO_NOTCANCELED (2)

#define LIO_NOWAIT      (0)
#define LIO_WAIT        (1)
#define LIO_NOP         (0)
#define LIO_READ        (1)
#define LIO_WRITE       (2)
```

Figure 6-6: <assert.h>

```
extern void __assert(const char *, const char *, int);
#define assert(EX) (void)((EX)||(__assert(#EX, __FILE__, __LINE__), 0))
```

Figure 6-7: `<ctype.h>`

```
#define _U   01
#define _L   02
#define _N   04
#define _S   010
#define _P   020
#define _C   040
#define _B   0100
#define _X   0200

extern unsigned char      __ctype[];

#define isalpha(c)  ((__ctype+1)[c]&(_U|_L))
#define isupper(c)  ((__ctype+1)[c]&_U)
#define islower(c)  ((__ctype+1)[c]&_L)
#define isdigit(c)  ((__ctype+1)[c]&_N)
#define isxdigit(c) ((__ctype+1)[c]&_X)
#define isalnum(c)  ((__ctype+1)[c]&(_U|_L|_N))
#define isspace(c)  ((__ctype+1)[c]&_S)
#define ispunct(c)  ((__ctype+1)[c]&_P)
#define isprint(c)  ((__ctype+1)[c]&(_P|_U|_L|_N|_B))
#define isgraph(c)  ((__ctype+1)[c]&(_P|_U|_L|_N))
#define iscntrl(c)  ((__ctype+1)[c]&_C)
#define isascii(c)  (!((c)&~0177))
#define _toupper(c) ((__ctype+258)[c])
#define _tolower(c) ((__ctype+258)[c])
#define toascii(c)  ((c)&0177)
```

CAUTION The data definitions in ctype.h are moved to Level 2 as of January 1, 1993. In order to correctly function in an internationalized environment, applica- M
tions are encouraged to use the functions in libc instead.

Figure 6-8: `<dirent.h>`

```
typedef struct {
      int          dd_fd;
      int          dd_loc;
      int          dd_size;
      char         *dd_buf;
} DIR;

struct dirent {
      ino_t        d_ino;
      off_t        d_off;
      unsigned short      d_reclen;
      char         d_name[1];
};
```

Figure 6-9: `<dlfcn.h>`*

```
#define RTLD_LAZY       1
#define RTLD_NOW        2
#define RTLD_GLOBAL     4
```

Figure 6-10: `<elf.h>*, Part 1 of 6`

```
#define ELF32_FSZ_ADDR    4
#define ELF32_FSZ_HALF    2
#define ELF32_FSZ_OFF     4
#define ELF32_FSZ_SWORD   4
#define ELF32_FSZ_WORD    4

#define EI_NIDENT   16

typedef struct {
      unsigned chare_ident[EI_NIDENT];
      Elf32_Half   e_type;
      Elf32_Half   e_machine;
      Elf32_Word   e_version;
      Elf32_Addr   e_entry;
      Elf32_Off    e_phoff;
      Elf32_Off    e_shoff;
      Elf32_Word   e_flags;
      Elf32_Half   e_ehsize;
      Elf32_Half   e_phentsize;
      Elf32_Half   e_phnum;
      Elf32_Half   e_shentsize;
      Elf32_Half   e_shnum;
      Elf32_Half   e_shstrndx;
} Elf32_Ehdr;

#define ELFMAG0           0x7f
#define ELFMAG1           'E'
#define ELFMAG2           'L'
#define ELFMAG3           'F'
#define ELFMAG            "\177ELF"
#define SELFMAG           4
```

Figure 6-11: `<elf.h>*, Part 2 of 6`

```
#define EI_MAG0          0
#define EI_MAG1          1
#define EI_MAG2          2
#define EI_MAG3          3
#define EI_CLASS         4
#define EI_DATA          5
#define EI_VERSION       6
#define EI_PAD           7

#define ELFCLASSNONE     0
#define ELFCLASS32       1
#define ELFCLASS64       2
#define ELFCLASSNUM      3
#define ELFDATANONE      0
#define ELFDATA2LSB      1
#define ELFDATA2MSB      2
#define ELFDATANUM       3

#define ET_NONE          0
#define ET_REL           1
#define ET_EXEC          2
#define ET_DYN           3
#define ET_CORE          4
#define ET_NUM           5

#define      ET_LOPROC    0xff00
#define      ET_HIPROC    0xffff

#define EM_NONE          0
#define EM_M32           1
#define EM_SPARC         2
#define EM_386           3
#define EM_68K           4
#define EM_88K           5
#define EM_486           6
#define EM_860           7
#define EM_NUM           8
```

Figure 6-12: `<elf.h>*, Part 3 of 6`

```
#define EV_NONE          0
#define EV_CURRENT       1
#define EV_NUM           2

typedef struct {
      Elf32_Word   p_type;
      Elf32_Off    p_offset;
      Elf32_Addr   p_vaddr;
      Elf32_Addr   p_paddr;
      Elf32_Word   p_filesz;
      Elf32_Word   p_memsz;
      Elf32_Word   p_flags;
      Elf32_Word   p_align;
} Elf32_Phdr;

#define PT_NULL          0
#define PT_LOAD          1
#define PT_DYNAMIC       2
#define PT_INTERP        3
#define PT_NOTE          4
#define PT_SHLIB         5
#define PT_PHDR          6
#define PT_NUM           7

#define PT_LOPROC   0x70000000
#define PT_HIPROC   0x7fffffff

#define PF_R        0x4
#define PF_W        0x2
#define PF_X        0x1

#define PF_MASKPROC 0xf0000000
```

Figure 6-13: `<elf.h>*, Part 4 of 6`

```
typedef struct {
      Elf32_Word   sh_name;
      Elf32_Word   sh_type;
      Elf32_Word   sh_flags;
      Elf32_Addr   sh_addr;
      Elf32_Off    sh_offset;
      Elf32_Word   sh_size;
      Elf32_Word   sh_link;
      Elf32_Word   sh_info;
      Elf32_Word   sh_addralign;
      Elf32_Word   sh_entsize;
} Elf32_Shdr;

#define SHT_NULL          0
#define SHT_PROGBITS      1
#define SHT_SYMTAB        2
#define SHT_STRTAB        3
#define SHT_RELA          4
#define SHT_HASH          5
#define SHT_DYNAMIC       6
#define SHT_NOTE          7
#define SHT_NOBITS        8
#define SHT_REL           9
#define SHT_SHLIB         10
#define SHT_DYNSYM        11
#define SHT_NUM           12

#define SHT_LOUSER  0x80000000
#define SHT_HIUSER  0xffffffff
#define      SHT_LOPROC   0x70000000
#define      SHT_HIPROC   0x7fffffff
#define SHF_MASKPROC      0xf0000000

#define SHF_WRITE         0x1
#define SHF_ALLOC         0x2
#define SHF_EXECINSTR     0x4
```

Figure 6-14: `<elf.h>*, Part 5 of 6`

```
#define SHN_UNDEF         0
#define SHN_LORESERVE     0xff00
#define SHN_ABS           0xfff1
#define SHN_COMMON        0xfff2
#define SHN_HIRESERVE     0xffff
#define SHN_LOPROC        0xff00
#define SHN_HIPROC        0xff1f

typedef struct {
      Elf32_Word          st_name;
      Elf32_Addr          st_value;
      Elf32_Word          st_size;
      unsigned char       st_info;
      unsigned char       st_other;
      Elf32_Half          st_shndx;
} Elf32_Sym;

#define STN_UNDEF   0

#define ELF32_ST_BIND(info)             ((info) >> 4)
#define ELF32_ST_TYPE(info)             ((info) & 0xf)
#define ELF32_ST_INFO(bind,type) (((bind)<<4)+((type)&0xf))

#define STB_LOCAL   0
#define STB_GLOBAL  1
#define STB_WEAK    2
#define STB_NUM     3
#define STB_LOPROC  13
#define STB_HIPROC  15
```

Figure 6-15: <elf.h>*, Part 6 of 6

```
#define STT_NOTYPE  0
#define STT_OBJECT  1
#define STT_FUNC    2
#define STT_SECTION 3
#define STT_FILE    4
#define STT_NUM     5
#define STT_LOPROC  13
#define STT_HIPROC  15

typedef struct {
      Elf32_Addr   r_offset;
      Elf32_Word   r_info;
} Elf32_Rel;

typedef struct {
      Elf32_Addr   r_offset;
      Elf32_Word   r_info;
      Elf32_Sword  r_addend;
} Elf32_Rela;

#define ELF32_R_SYM(info) ((info)>>8)
#define ELF32_R_TYPE(info)((unsigned char)(info))
#define ELF32_R_INFO(sym,type)  (((sym)<<8)+(unsigned char)(type))
```

Figure 6-16: `<errno.h>`**, Part 1 of 3**

```
#define EPERM           1
#define ENOENT          2
#define ESRCH           3
#define EINTR           4
#define EIO             5
#define ENXIO           6
#define E2BIG           7
#define ENOEXEC         8
#define EBADF           9
#define ECHILD          10
#define EAGAIN          11
#define ENOMEM          12
#define EACCES          13
#define EFAULT          14
#define ENOTBLK         15
#define EBUSY           16
#define EEXIST          17
#define EXDEV           18
#define ENODEV          19
#define ENOTDIR         20
#define EISDIR          21
#define EINVAL          22
#define ENFILE          23
#define EMFILE          24
#define ENOTTY          25
#define ETXTBSY         26
#define EFBIG           27
```

Figure 6-17: `<errno.h>`**, Part 2 of 3**

```
#define ENOSPC          28
#define ESPIPE          29
#define EROFS           30
#define EMLINK          31
#define EPIPE           32
#define EDOM            33
#define ERANGE          34
#define ENOMSG          35
#define EIDRM           36
#define ECHRNG          37
#define EL2NSYNC        38
#define EL3HLT          39
#define EL3RST          40
#define ELNRNG          41
#define EUNATCH         42
#define ENOCSI          43
#define EL2HLT          44
#define EDEADLK         45
#define ENOLCK          46
#define ENOSTR          60
#define ENODATA         61
#define ETIME           62
#define ENOSR           63
#define ENONET          64
#define ENOPKG          65
#define EREMOTE         66
#define ENOLINK         67
```

Figure 6-18: `<errno.h>`**, Part 3 of 3**

```
#define EADV                68
#define ESRMNT              69
#define ECOMM               70
#define EPROTO              71
#define EMULTIHOP           74
#define EBADMSG             77
#define ENAMETOOLONG        78
#define EOVERFLOW           79
#define ENOTUNIQ            80
#define EBADFD              81
#define EREMCHG             82
#define ENOSYS              89
#define ELOOP               90
#define ERESTART            91
#define ESTRPIPE            92
#define ENOTEMPTY           93
#define EUSERS              94
#define ECONNABORTED        130                         G
#define CONNRESET           131                         G
#define ECONNREFUSED                    146             G
#define EINPROGRESS         150                         M
#define ESTALE              151
#define ECANCELED           158                         M

/* Non-reentrant */                                     M
extern int errno;                                       M

/* Reentrant */                                         M
#define errno   (*__thr_errno())                        M
```

Figure 6-19: `<fcntl.h>`**, Part 1 of 2**

```
#define O_RDONLY          0
#define O_WRONLY          1
#define O_RDWR            2
#define O_NDELAY          0x04
#define O_APPEND          0x08
#define O_SYNC            0x10
#define O_NONBLOCK        0x80
#define O_CREAT           0x100
#define O_TRUNC           0x200
#define O_EXCL            0x400
#define O_NOCTTY          0x800

#define F_DUPFD           0
#define F_GETFD           1
#define F_SETFD           2
#define F_GETFL           3
#define F_SETFL           4
#define F_GETLK           14
#define F_SETLK           6
#define F_SETLKW          7
```

Figure 6-20: `<fcntl.h>`**, Part 2 of 2**

```
typedef struct flock {
       short  l_type;
       short  l_whence;
       off_t  l_start;
       off_t  l_len;
       long   l_sysid;
       pid_t  l_pid;
       long   pad[4];
} flock_t;

#define F_RDLCK             01
#define F_WRLCK             02
#define F_UNLCK             03

#define O_ACCMODE           3
#define FD_CLOEXEC          1
```

Figure 6-21: `<float.h>`**, Single-Precision**

```
extern int          __flt_rounds;
#define FLT_ROUNDS          __flt_rounds

#define FLT_RADIX           2
#define FLT_MANT_DIG        24
#define FLT_EPSILON         1.19209290E-07F
#define FLT_DIG             6
#define FLT_MIN_EXP         (-125)
#define FLT_MIN             1.17549435E-38F
#define FLT_MIN_10_EXP      (-37)
#define FLT_MAX_EXP         (+128)
#define FLT_MAX             3.40282347E+38F
#define FLT_MAX_10_EXP      (+38)
```

Figure 6-22: `<float.h>`**, Double-Precision**

```
#define DBL_MANT_DIG      53
#define DBL_EPSILON       2.2204460492503131E-16
#define DBL_DIG           15
#define DBL_MIN_EXP       (-1021)
#define DBL_MIN           2.2250738585072014E-308
#define DBL_MIN_10_EXP    (-307)
#define DBL_MAX_EXP       (+1024)
#define DBL_MAX           1.7976931348623157E+308
#define DBL_MAX_10_EXP    (+308)
```

Figure 6-23: `<float.h>`**, Extended-Precision**

```
#define LDBL_MANT_DIG     64                          G
#define LDBL_EPSILON      1.084202172485504434e-19    G
#define LDBL_DIG          18                          G
#define LDBL_MIN_EXP      -16381                      G
#define LDBL_MIN          3.362103143112093506e-4932  G
#define LDBL_MIN_10_EXP   -4931                       G
#define LDBL_MAX_EXP      16384                       G
#define LDBL_MAX          1.189731495347231765e+4932  G
#define LDBL_MAX_10_EXP   4932                        G
```

Figure 6-24: `<fmtmsg.h>`**, Part 1 of 2**

```
#define MM_NULL          0L

#define MM_HARD          0x00000001L
#define MM_SOFT          0x00000002L
#define MM_FIRM          0x00000004L
#define MM_RECOVER       0x00000100L
#define MM_NRECOV        0x00000200L
#define MM_APPL          0x00000008L
#define MM_UTIL          0x00000010L
#define MM_OPSYS         0x00000020L
#define MM_PRINT         0x00000040L
#define MM_CONSOLE       0x00000080L
```

Figure 6-25: `<fmtmsg.h>`**, Part 2 of 2**

```
#define MM_NOSEV          0
#define MM_HALT           1
#define MM_ERROR          2
#define MM_WARNING        3
#define MM_INFO           4

#define MM_NULLLBL        ((char *) NULL)
#define MM_NULLSEV        MM_NOSEV
#define MM_NULLMC         MM_NULL
#define MM_NULLTXT        ((char *) NULL)
#define MM_NULLACT        ((char *) NULL)
#define MM_NULLTAG        ((char *) NULL)

#define MM_NOTOK          -1
#define MM_OK             0x00
#define MM_NOMSG          0x01
#define MM_NOCON          0x04
```

Figure 6-26: `<fnmatch.h>*`

```
#define FNM_PATHNAME      0x001
#define FNM_PERIOD        0x002
#define FNM_NOESCAPE      0x004
#define FNM_BADRANGE      0x008
#define FNM_EXTENDED      0x020

#define FNM_NOSYS         (-1)
#define FNM_NOMATCH       (-2)
```

Figure 6-27: `<ftw.h>`

```
#define FTW_F             0
#define FTW_D             1
#define FTW_DNR           2
#define FTW_NS            3
#define FTW_SL            4
#define FTW_DP            6
#define FTW_SLN           7

#define FTW_PHYS          01
#define FTW_MOUNT         02
#define FTW_CHDIR         04
#define FTW_DEPTH         010

struct FTW {
      int   quit;
      int   base;
      int   level;
};

#define FTW_SKD           1
#define FTW_FOLLOW        2
#define FTW_PRUNE         4
```

Figure 6-28: `<glob.h>*`

```
#define GLOB_APPEND        0x0001
#define GLOB_DOOFFS        0x0002
#define GLOB_ERR           0x0004
#define GLOB_MARK          0x0008
#define GLOB_NOCHECK       0x0010
#define GLOB_NOSORT        0x0020
#define GLOB_NOESCAPE      0x0040
#define GLOB_OKAYDOT       0x0200
#define GLOB_BADRANGE      0x0400
#define GLOB_EXTENDED      0x1000

#define GLOB_NOSYS         (-1)
#define GLOB_ABORTED       (-2)
#define GLOB_NOSPACE       (-3)
#define GLOB_NOMATCH       (-4)

typedef struct
{
      void         *;
      char         **gl_pathv;
      size_t       gl_pathc;
      size_t       gl_offs;
} glob_t;
```

Figure 6-29: `<grp.h>`

```
struct group {
       char   *gr_name;
       char   *gr_passwd;
       gid_t  gr_gid;
       char   **gr_mem;
};
```

Figure 6-30: `<iconv.h>*`

```
typedef void *iconv_t;
```

Figure 6-31: `<sys/ipc.h>`

```
struct ipc_perm {
      uid_t       uid;
      gid_t       gid;
      uid_t       cuid;
      gid_t       cgid;
      mode_t      mode;
      ulong       seq;
      key_t       key;
      long        pad[4];
};

#define IPC_CREAT   0001000
#define IPC_EXCL    0002000
#define IPC_NOWAIT  0004000

#define IPC_PRIVATE (key_t)0

#define IPC_RMID          10
#define IPC_SET           11
#define IPC_STAT          12
```

Figure 6-32: `<langinfo.h>`**, Part 1 of 2**

```
#define DAY_1           1
#define DAY_2           2
#define DAY_3           3
#define DAY_4           4
#define DAY_5           5
#define DAY_6           6
#define DAY_7           7

#define ABDAY_1         8
#define ABDAY_2         9
#define ABDAY_3         10
#define ABDAY_4         11
#define ABDAY_5         12
#define ABDAY_6         13
#define ABDAY_7         14

#define MON_1           15
#define MON_2           16
#define MON_3           17
#define MON_4           18
#define MON_5           19
#define MON_6           20
#define MON_7           21
#define MON_8           22
#define MON_9           23
#define MON_10          24
#define MON_11          25
#define MON_12          26
```

Figure 6-33: `<langinfo.h>`**, Part 2 of 2**

```
#define ABMON_1         27
#define ABMON_2         28
#define ABMON_3         29
#define ABMON_4         30
#define ABMON_5         31
#define ABMON_6         32
#define ABMON_7         33
#define ABMON_8         34
#define ABMON_9         35
#define ABMON_10        36
#define ABMON_11        37
#define ABMON_12        38

#define RADIXCHAR       39
#define THOUSEP         40
#define YESSTR          41
#define NOSTR           42
#define CRNCYSTR        43

#define D_T_FMT         44
#define D_FMT           45
#define T_FMT           46
#define AM_STR          47
#define PM_STR          48
#define CODESET         49
#define T_FMT_AMPM      50
#define ERA             51
#define ERA_D_FMT       52
#define ERA_D_T_FMT     53
#define ERA_T_FMT       54
#define ALT_DIGITS      55
#define YESEXPR         56
#define NOEXPR          57
```

M
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M
M

Figure 6-34: `<limits.h>`**, Part 1 of 2**

```
#define CHAR_BIT          8
#define SCHAR_MIN         (-128)
#define SCHAR_MAX         127
#define UCHAR_MAX         255
#define MB_LEN_MAX        5

#define CHAR_MIN          SCHAR_MIN
#define CHAR_MAX          SCHAR_MAX

#define SHRT_MIN          (-32768)
#define SHRT_MAX          32767
#define USHRT_MAX         65535
#define INT_MIN           (-2147483647-1)
#define INT_MAX           2147483647
#define UINT_MAX          4294967295
#define LONG_MIN          (-2147483647-1)
#define LONG_MAX          2147483647
#define ULONG_MAX         4294967295

#define ARG_MAX           *
#define LINK_MAX          *
#define MAX_CANON         *
#define MAX_INPUT         *
#define NGROUPS_MAX       *
#define PATH_MAX          *
#define PIPE_BUF          *
#define TMP_MAX           *
#define PASS_MAX          *
#define CHILD_MAX         *

/* starred values vary and should be
      retrieved using sysconf() or pathconf() */
```

Figure 6-35: `<limits.h>`**, Part 2 of 2**

```
#define NL_ARGMAX        9
#define NL_LANGMAX       14
#define NL_MSGMAX        32767
#define NL_NMAX          1
#define NL_SETMAX        255
#define NL_TEXTMAX       255
#define NZERO            20

#define WORD_BIT         32
#define LONG_BIT         32

#define DBL_DIG          15
#define DBL_MAX          1.7976931348623157E+308
#define DBL_MIN          2.2250738585072014E-308
#define FLT_DIG          6
#define FLT_MAX          3.40282347E+38F
#define FLT_MIN          1.17549435E-38F

#define FCHR_MAX         1048576
```

Figure 6-36: `<locale.h>`

```
struct lconv {
      char   *decimal_point;
      char   *thousands_sep;
      char   *grouping;
      char   *int_curr_symbol;
      char   *currency_symbol;
      char   *mon_decimal_point;
      char   *mon_thousands_sep;
      char   *mon_grouping;
      char   *positive_sign;
      char   *negative_sign;
      char   int_frac_digits;
      char   frac_digits;
      char   p_cs_precedes;
      char   p_sep_by_space;
      char   n_cs_precedes;
      char   n_sep_by_space;
      char   p_sign_posn;
      char   n_sign_posn;
};

#define LC_CTYPE         0
#define LC_NUMERIC       1
#define LC_TIME          2
#define LC_COLLATE       3
#define LC_MONETARY      4
#define LC_MESSAGES      5
#define LC_ALL           6
```

Figure 6-37: `<lwpsynch.h>*`

```
typedef volatile struct {
      char          wanted;
      _simplelock_t       lock;
} lwp_mutex_t;

typedef volatile struct {
      char          wanted;
} lwp_cond_t;
```

Figure 6-38: `<machlock.h>*`

```
typedef volatile unsigned char _simplelock_t;
```

Figure 6-39: `<math.h>`

```
extern const double __huge_val;
#define HUGE_VAL    __huge_val
```

G
G

Figure 6-40: `<sys/mman.h>`

```
#define PROT_READ         0x1
#define PROT_WRITE        0x2
#define PROT_EXEC         0x4
#define PROT_NONE         0x0

#define MAP_SHARED        1
#define MAP_PRIVATE       2
#define MAP_FIXED         0x10

#define MS_SYNC           0x0
#define MS_ASYNC          0x1
#define MS_INVALIDATE     0x2

#define PROC_TEXT   (PROT_EXEC | PROT_READ)                          G
#define PROC_DATA   (PROT_READ | PROT_WRITE | PROT_EXEC)             G

#define SHARED            0x10                                       G
#define PRIVATE           0x20                                       G

#define      MC_SYNC            1                                    G
#define      MC_LOCK            2                                    G
#define      MC_UNLOCK    3                                          G
#define      MC_LOCKAS    5                                          G
#define      MC_UNLOCKAS  6                                          G

#define      MCL_CURRENT  0x1                                        G
#define      MCL_FUTURE   0x2                                        G
```

Figure 6-41: `<sys/mod.h>*`

```
#define VOID               void
#define MAXPATHLEN         1024
#define MODMAXLINKINFOLEN  32

struct modspecific_stat {
      char   mss_linkinfo[MODMAXLINKINFOLEN];
      int    mss_type;
      int    mss_p0[2];
      int    mss_p1[2];
};

#define MODMAXLINK          4

struct modstatus {
      int                ms_id;
      VOID               *ms_base;
      unsigned int       ms_size;
      int                ms_rev;
      char               ms_path[MAXPATHLEN];
      time_t             ms_unload_delay;
      int                ms_refcnt;
      int                ms_depcnt;
      struct modspecific_stat   ms_msinfo[MODMAXLINK];
};
```

Figure 6-42: `<sys/mount.h>`

```
#define MS_RDONLY          0x01
#define MS_FSS             0x02
#define MS_DATA            0x04
#define MS_HADBAD          0x08

#define MS_NOSUID          0x10
#define MS_REMOUNT         0x20
#define MS_NOTRUNC         0x40
```

Figure 6-43: `<sys/msg.h>`

```
#define MSG_NOERROR       010000

struct msqid_ds {
      struct ipc_perm    msg_perm;
      struct msg   *msg_first;
      struct msg   *msg_last;
      ulong        msg_cbytes;
      ulong        msg_qnum;
      ulong        msg_qbytes;
      pid_t        msg_lspid;
      pid_t        msg_lrpid;
      time_t       msg_stime;
      long         msg_pad1;
      time_t       msg_rtime;
      long         msg_pad2;
      time_t       msg_ctime;
      long         msg_pad3;
      long         msg_pad4[4];
};

struct msg {
      struct msg   *msg_next;
      long         msg_type;
      ushort       msg_ts;
      short        msg_spot;
};
```

Figure 6-44: `<netconfig.h>`**, Part 1 of 2**

G

```
struct netconfig {
       char                 *nc_netid;
       unsigned long        nc_semantics;
       unsigned long        nc_flag;
       char                 *nc_protofmly;
       char                 *nc_proto;
       char                 *nc_device;
       unsigned long        nc_nlookups;
       char                 **nc_lookups;
       unsigned long        nc_unused[8];
};

#define NC_TPI_CLTS                 1
#define NC_TPI_COTS                 2
#define NC_TPI_COTS_ORD             3
#define NC_TPI_RAW                  4

#define NC_NOFLAG                   00
#define NC_VISIBLE                  01
```

Figure 6-45: `<netconfig.h>`**, Part 2 of 2**

```
#define NC_NOPROTOFMLY      "-"
#define NC_LOOPBACK         "loopback"
#define NC_INET             "inet"
#define NC_IMPLINK          "implink"
#define NC_PUP              "pup"
#define NC_CHAOS            "chaos"
#define NC_NS               "ns"
#define NC_NBS              "nbs"
#define NC_ECMA             "ecma"
#define NC_DATAKIT          "datakit"
#define NC_CCITT            "ccitt"
#define NC_SNA              "sna"
#define NC_DECNET           "decnet"
#define NC_DLI              "dli"
#define NC_LAT              "lat"
#define NC_HYLINK           "hylink"
#define NC_APPLETALK        "appletalk"
#define NC_NIT              "nit"
#define NC_IEEE802          "ieee802"
#define NC_OSI              "osi"
#define NC_X25              "x25"
#define NC_OSINET           "osinet"
#define NC_GOSIP            "gosip"
#define NC_NETWARE          "netware"                  M

#define NC_NOPROTO          "-"
#define NC_TCP              "tcp"
#define NC_UDP              "udp"
#define NC_ICMP             "icmp"
#define NC_IPX              "ipx"                      M
#define NC_SPX              "spx"                      M
```

Figure 6-46: `<netdir.h>`**, Part 1 of 2**

```
struct nd_addrlist {
      int                 n_cnt;
      struct netbuf       *n_addrs;
};

struct nd_hostservlist {
      int                 h_cnt;
      struct nd_hostserv  *h_hostservs;
};

struct nd_hostserv {
      char         *h_host;
      char         *h_serv;
};

#define ND_HOSTSERV              0
#define ND_HOSTSERVLIST          1
#define ND_ADDR                  2
#define ND_ADDRLIST              3

#define ND_BADARG                -2
#define ND_NOMEM                 -1
#define ND_OK                    0
#define ND_NOHOST                1
#define ND_NOSERV                2
#define ND_NOSYM                 3
#define ND_OPEN                  4
#define ND_ACCESS                5
#define ND_UKNWN                 6
#define ND_NOCTRL                7
#define ND_FAILCTRL              8
#define ND_SYSTEM                9
#define ND_NOERRMEM              10                        M
#define ND_NOLIB                 11                        M
#define ND_XTIERROR              12                        M
#define ND_BADSTATE              13                        M
```

Figure 6-47: `<netdir.h>`**, Part 2 of 2**

```
#define ND_SET_BROADCAST         1
#define ND_SET_RESERVEDPORT      2
#define ND_CHECK_RESERVEDPORT    3
#define ND_MERGEADDR             4
#define ND_CLEAR_BROADCAST       5                M
#define ND_SET_REUSEADDR         6                M
#define ND_CLEAR_REUSEADDR       7                M

#define HOST_SELF                "\\1"
#define HOST_ANY                 "\\2"
#define HOST_BROADCAST           "\\3"
```

Figure 6-48: `<nl_types.h>`

```
#define NL_SETD           1

typedef int  nl_item;
typedef void *nl_catd;
```

Figure 6-49: `<sys/param.h>`

```
#define CANBSIZ           256
#define HZ                100
#define TICK              10000000

#define NGROUPS_UMIN      0

#define NBPSCTR           512

#define MAXPATHLEN        1024
#define MAXSYMLINKS       20
#define MAXNAMELEN        256

#define NADDR             13

#define PIPE_MAX          5120

#define NBBY              8

#define MAXFRAG           8
```

Figure 6-50: `<poll.h>`

```
struct pollfd {
      int    fd;
      short  events;
      short  revents;
};

#define POLLIN              0x0001
#define POLLPRI             0x0002
#define POLLOUT             0x0004
#define POLLRDNORM          0x0040
#define POLLWRNORM          POLLOUT
#define POLLRDBAND          0x0080
#define POLLWRBAND          0x0100

#define POLLNORM            POLLRDNORM

#define POLLERR             0x0008
#define POLLHUP             0x0010
#define POLLNVAL            0x0020
```

Figure 6-51: `<sys/priocntl.h>*`

```
#define PC_GETCID         0
#define PC_GETCLINFO            1
#define PC_SETPARMS       2
#define PC_GETPARMS       3

#define PC_CLNULL         -1

#define PC_CLNMSZ   16
#define PC_CLINFOSZ (32 / sizeof(long))
#define PC_CLPARMSZ (32 / sizeof(long))

typedef struct pcinfo {
      id_t   pc_cid;
      char   pc_clname[PC_CLNMSZ];
      long   pc_clinfo[PC_CLINFOSZ];
} pcinfo_t;

typedef struct pcparms {
      id_t   pc_cid;
      long   pc_clparms[PC_CLPARMSZ];
} pcparms_t;
```

Figure 6-52: `<sys/procset.h>`

```
#define P_INITPID         1
#define P_INITUID         0
#define P_INITPGID        0

typedef enum idtype {
      P_PID,
      P_PPID,
      P_PGID,
      P_SID,
      P_CID,
      P_UID,
      P_GID,
      P_ALL
} idtype_t;

typedef enum idop {
      POP_DIFF,
      POP_AND,
      POP_OR,
      POP_XOR
} idop_t;


typedef struct procset {
      idop_t       p_op;
      idtype_t     p_lidtype;
      id_t         p_lid;
      idtype_t     p_ridtype;
      id_t         p_rid;
} procset_t;
```

Figure 6-53: <pwd.h>

```
struct passwd {
      char          *pw_name;
      char          *pw_passwd;
      uid_t         pw_uid;
      gid_t         pw_gid;
      char          *pw_age;
      char          *pw_comment;
      char          *pw_gecos;
      char          *pw_dir;
      char          *pw_shell;
};
```

Figure 6-54: `<regex.h>*, Part 1 of 2`

```
#define REG_NOTBOL        0x000001
#define REG_NOTEOL        0x000002
#define REG_NONEMPTY      0x000004

#define REG_OR            0x000001
#define REG_PLUS          0x000002
#define REG_QUEST         0x000004
#define REG_BRACES        0x000008
#define REG_PARENS        0x000010
#define REG_ANCHORS       0x000020
#define REG_NOBACKREF     0x000040
#define REG_NOAUTOQUOTE   0x000080

#define REG_EXTENDED      (REG_OR | REG_PLUS | REG_QUEST |
             REG_BRACES | REG_PARENS | REG_ANCHORS |
             REG_NOBACKREF | REG_NOAUTOQUOTE)
#define REG_ICASE         0x000100
#define REG_NOSUB         0x000200
#define REG_NEWLINE       0x000400
#define REG_ONESUB        0x000800
#define REG_BADRANGE      0x004000
#define REG_ANGLES        0x040000
#define REG_ESCNL         0x080000
#define REG_OLDBRE  (REG_BADRANGE | REG_ANGLES | REG_ESCNL)
```

Figure 6-55: `<regex.h>*, Part 2 of 2`

```
#define REG_ENOSYS        (-1)
#define REG_NOMATCH       1
#define REG_BADPAT        2
#define REG_ECOLLATE      3
#define REG_ECTYPE        4
#define REG_EESCAPE       7
#define REG_ESUBREG       8
#define REG_EBRACK        9
#define REG_NOPAT         12
#define REG_EPAREN        13
#define REG_EBRACE        14
#define REG_BADBR         15
#define REG_ERANGE        16
#define REG_ESPACE        17
#define REG_BADRPT        18

typedef struct
{
      size_t       re_nsub;
      unsigned long      re_flags;
      void         *[4];
} regex_t;

typedef ssize_t regoff_t;

typedef struct
{
      regoff_t     rm_so;
      regoff_t     rm_eo;
} regmatch_t;
```

Figure 6-56: `<sys/resource.h>`

```
#define RLIMIT_CPU          0
#define RLIMIT_FSIZE        1
#define RLIMIT_DATA         2
#define RLIMIT_STACK        3
#define RLIMIT_CORE         4
#define RLIMIT_NOFILE       5
#define RLIMIT_VMEM         6
#define RLIM_NLIMITS        7
#define RLIMIT_AS           RLIMIT_VMEM
#define RLIM_INFINITY       0x7fffffff

typedef unsigned long       rlim_t;

struct rlimit {
      rlim_t       rlim_cur;
      rlim_t       rlim_max;
};
```

Figure 6-57: `<rpc.h>`**, Part 1 of 16**

```
#define bool_t            int
#define enum_t            int

enum xdr_op {
      XDR_ENCODE=0,
      XDR_DECODE=1,
      XDR_FREE=2
};

typedef bool_t      (*xdrproc_t)();

typedef struct {
      enum xdr_op  x_op;
      struct xdr_ops {
            bool_t (*x_getlong)();
            bool_t (*x_putlong)();
            bool_t (*x_getbytes)();
            bool_t (*x_putbytes)();
            u_int  (*x_getpostn)();
            bool_t (*x_setpostn)();
            long * (*x_inline)();
            void   (*x_destroy)();
      } *x_ops;
      caddr_t      x_public;
      caddr_t      x_private;
      caddr_t      x_base;
      int          x_handy;
} XDR;
```

Figure 6-58: `<rpc.h>`**, Part 2 of 16**

```
#define xdr_getpos(xdrs)                                    \
      (*(xdrs)->x_ops->x_getpostn)(xdrs)
#define xdr_setpos(xdrs, pos)                               \
      (*(xdrs)->x_ops->x_setpostn)(xdrs, pos)
#define xdr_inline(xdrs, len)                               \
      (*(xdrs)->x_ops->x_inline)(xdrs, len)
#define xdr_destroy(xdrs)                             \
      (*(xdrs)->x_ops->x_destroy)(xdrs)

#define NULL_xdrproc_t    ((xdrproc_t)0)
struct xdr_discrim {
      int          value;
      xdrproc_t    proc;
};
```

Figure 6-59: `<rpc.h>`**, Part 3 of 16**

```
#define MAX_AUTH_BYTES          400
#define MAXNETNAMELEN           255
#define HEXKEYBYTES             48

enum auth_stat {
      AUTH_OK=0,
      AUTH_BADCRED=1,
      AUTH_REJECTEDCRED=2,
      AUTH_BADVERF=3,
      AUTH_REJECTEDVERF=4,
      AUTH_TOOWEAK=5,
      AUTH_INVALIDRESP=6,
      AUTH_FAILED=7
};

typedef u_long     u_int32                                    M

union des_block {
      struct {
            u_int32             high;                         M
            u_int32             low;                          M
      } key;
      char   c[8];
};
typedef union des_block         des_block;
```

Figure 6-60: `<rpc.h>`**, Part 4 of 16**

```
struct opaque_auth {
      enum_t       oa_flavor;
      caddr_t      oa_base;
      u_int        oa_length;
};

typedef struct {
      struct opaque_auth  ah_cred;
      struct opaque_auth  ah_verf;
      union des_block     ah_key;
      struct auth_ops {
            void   (*ah_nextverf)();
            int    (*ah_marshal)();
            int    (*ah_validate)();
            int    (*ah_refresh)();
            void   (*ah_destroy)();
      } *ah_ops;
      caddr_t      ah_private;
} AUTH;

#define auth_destroy(auth)       \
            ((*((auth)->ah_ops->ah_destroy))(auth))

#define AUTH_NONE         0
#define AUTH_NULL         0
#define AUTH_SYS          1
#define AUTH_UNIX         AUTH_SYS
#define AUTH_SHORT        2
#define AUTH_DES          3
#define AUTH_ESV          200004
```

M

Figure 6-61: `<rpc.h>`**, Part 5 of 16**

```
enum clnt_stat {
        RPC_SUCCESS=0,
        RPC_CANTENCODEARGS=1,
        RPC_CANTDECODERES=2,
        RPC_CANTSEND=3,
        RPC_CANTRECV=4,
        RPC_TIMEDOUT=5,
        RPC_INTR=18,
        RPC_UDERROR=23,
        RPC_VERSMISMATCH=6,
        RPC_AUTHERROR=7,
        RPC_PROGUNAVAIL=8,
        RPC_PROGVERSMISMATCH=9,
        RPC_PROCUNAVAIL=10,
        RPC_CANTDECODEARGS=11,
        RPC_SYSTEMERROR=12,
        RPC_UNKNOWNHOST=13,
        RPC_UNKNOWNPROTO=17,
        RPC_UNKNOWNADDR=19,
        RPC_NOBROADCAST=21,
        RPC_RPCBFAILURE=14,
        RPC_PROGNOTREGISTERED=15,
        RPC_N2AXLATEFAILURE=22,
        RPC_TLIERROR=20,
        RPC_FAILED=16
};
#define RPC_PMAPFAILURE   RPC_RPCBFAILURE
```

Figure 6-62: `<rpc.h>`**, Part 6 of 16**

```
struct rpc_err {
	enum clnt_stat	re_status;
	union {
		struct {
			int	errno;
			int	t_errno;
		} RE_err;
		enum auth_stat	RE_why;
		struct {
			u_long	low;
			u_long	high;
		} RE_vers;
		struct {
			long	s1;
			long	s2;
		} RE_lb;
	} ru;
};
typedef struct {
	AUTH	*cl_auth;
	struct clnt_ops {
		enum clnt_stat	(*cl_call)();
		void		(*cl_abort)();
		void		(*cl_geterr)();
		bool_t		(*cl_freeres)();
		void		(*cl_destroy)();
		bool_t		(*cl_control)();
	} *cl_ops;
	caddr_t		cl_private;
	char		*cl_netid;
	char		*cl_tp;
} CLIENT;
```

Figure 6-63: `<rpc.h>`**, Part 7 of 16**

```
#define FEEDBACK_REXMIT1  1
#define FEEDBACK_OK       2

#define clnt_call(rh, proc, xargs, argsp, xres, resp, secs)\
      ((*(rh)->cl_ops->cl_call)                        \
      (rh, proc, xargs, argsp, xres, resp, secs))
#define clnt_abort(rh)                                 \
      ((*(rh)->cl_ops->cl_abort)(rh))
#define clnt_geterr(rh, errp)                          \
      ((*(rh)->cl_ops->cl_geterr)(rh, errp))
#define clnt_freeres(rh,xres,resp)                     \
      ((*(rh)->cl_ops->cl_freeres)(rh,xres,resp))
#define clnt_control(cl, rq, in)                       \
      ((*(cl)->cl_ops->cl_control)(cl, rq, in))
#define clnt_destroy(rh)                               \
      ((*(rh)->cl_ops->cl_destroy)(rh))

#define CLSET_TIMEOUT           1
#define CLGET_TIMEOUT           2
#define CLGET_SERVER_ADDR       3
#define CLGET_FD                6
#define CLGET_SVC_ADDR          7
#define CLSET_FD_CLOSE          8
#define CLSET_FD_NCLOSE         9
#define CLSET_RETRY_TIMEOUT     4
#define CLGET_RETRY_TIMEOUT     5
```

Figure 6-64: `<rpc.h>`**, Part 8 of 16**

```
typedef struct {                                        M
        enum    clnt_stat       cf_stat;                M
        struct  rpc_err         cf_error;               M
} rpc_createerr_t;                                      M

extern  rpc_createerr_t         rpc_createerr;          M
```

Figure 6-65: `<rpc.h>`**, Part 9 of 16**

```
enum msg_type {
      CALL=0,
      REPLY=1
};

enum reply_stat {
      MSG_ACCEPTED=0,
      MSG_DENIED=1
};

enum accept_stat {
      SUCCESS=0,
      PROG_UNAVAIL=1,
      PROG_MISMATCH=2,
      PROC_UNAVAIL=3,
      GARBAGE_ARGS=4,
      SYSTEM_ERR=5
};

enum reject_stat {
      RPC_MISMATCH=0,
      AUTH_ERROR=1
};
```

Figure 6-66: `<rpc.h>`**, Part 10 of 16**

```
struct accepted_reply {
      struct opaque_auth        ar_verf;
      enum accept_stat          ar_stat;
      union {
            struct {
                  u_long        low;
                  u_long        high;
            } AR_versions;
            struct {
                  caddr_t       where;
                  xdrproc_t     proc;
            } AR_results;

      } ru;
};

struct rejected_reply {
      enum reject_stat    rj_stat;
      union {
            struct {
                  u_long        low;
                  u_long        high;
            } RJ_versions;
            enum auth_stat      RJ_why;
      } ru;
};
```

Figure 6-67: <rpc.h>**, Part 11 of 16**

```
struct reply_body {
      enum reply_stat     rp_stat;
      union {
            struct accepted_reply RP_ar;
            struct rejected_reply RP_dr;
      } ru;
};

struct call_body {
      u_long              cb_rpcvers;
      u_long              cb_prog;
      u_long              cb_vers;
      u_long              cb_proc;
      struct opaque_auth  cb_cred;
      struct opaque_auth  cb_verf;
};

struct rpc_msg {
      u_long              rm_xid;
      enum msg_type       rm_direction;
      union {
            struct call_body    RM_cmb;
            struct reply_body   RM_rmb;
      } ru;
};
```

Figure 6-68: `<rpc.h>`**, Part 12 of 16**

```
struct authsys_parms {
      u_long       aup_time;
      char         *aup_machname;
      uid_t        aup_uid;
      gid_t        aup_gid;
      u_int        aup_len;
      gid_t        *aup_gids;
};
```

Figure 6-69: `<rpc.h>`**, Part 13 of 16**

```
enum authdes_namekind {
      ADN_FULLNAME,
      ADN_NICKNAME
};

struct authdes_fullname {
      char                   *name;
      des_block              key;
      u_long                 window;
};

struct authdes_cred {
      enum authdes_namekind     adc_namekind;
      struct authdes_fullname   adc_fullname;
      u_long                    adc_nickname;
};
```

Figure 6-70: `<rpc.h>`**, Part 14 of 16**

```
enum xprt_stat {
      XPRT_DIED,
      XPRT_MOREREQS,
      XPRT_IDLE
};

typedef struct {
      int                   xp_fd;
      u_short               xp_port;
      struct xp_ops {
            bool_t          (*xp_recv)();
            enum xprt_stat        (*xp_stat)();
            bool_t          (*xp_getargs)();
            bool_t          (*xp_reply)();
            bool_t          (*xp_freeargs)();
            void            (*xp_destroy)();
      } *xp_ops;
      int                   xp_addrlen;
      char                  *xp_tp;
      char                  *xp_netid;
      struct netbuf         xp_ltaddr;
      struct netbuf         xp_rtaddr;
      char                  xp_raddr[16];
      struct opaque_auth    xp_verf;
      caddr_t               xp_p1;
      caddr_t               xp_p2;
      caddr_t               xp_p3;
      int                   xp_type;
} SVCXPRT;
```

M

Figure 6-71: `<rpc.h>`**, Part 15 of 16**

```
#define svc_getrpccaller(x) (&(x)->xp_rtaddr)
#define svc_getargs(xprt, xargs, argsp)             \
      (*(xprt)->xp_ops->xp_getargs)((xprt), (xargs), (argsp))
#define svc_freeargs(xprt, xargs, argsp)            \
      (*(xprt)->xp_ops->xp_freeargs)((xprt), (xargs), (argsp))
#define svc_destroy(xprt)                           \
      (*(xprt)->xp_ops->xp_destroy)(xprt)

struct svc_req {
      u_long             rq_prog;
      u_long             rq_vers;
      u_long             rq_proc;
      struct opaque_auth rq_cred;
      caddr_t            rq_clntcred;
      SVCXPRT            *rq_xprt;
};


#define FD_SETSIZE      1024                                    M
#define NBBY 8                                                  M

typedef long    fd_mask;                                        M
#define NFDBITS (sizeof(fd_mask) * NBBY)                        M
#define howmany(x, y)   (((x)+((y)-1))/(y))                     M

typedef struct fd_set {                                         M
        fd_mask fds_bits[howmany(FD_SETSIZE, NFDBITS)];         M
} fd_set;                                                       M

extern fd_set svc_fdset;
```

Figure 6-72: `<rpc.h>`**, Part 16 of 16**

```
struct rpcb {
      u_long        r_prog;
      u_long        r_vers;
      char          *r_netid;
      char          *r_addr;
      char          *r_owner;
};
typedef struct rpcb RPCB;

struct rpcblist {
      RPCB                rpcb_map;
      struct rpcblist     *rpcb_next;
};
```

Figure 6-73: `<rtpriocntl.h>*`

```
typedef struct rtparms {
      short  rt_pri;
      ulong  rt_tqsecs;
      long   rt_tqnsecs;
} rtparms_t;

typedef struct rtinfo {
      short  rt_maxpri;
} rtinfo_t;

#define RT_NOCHANGE -1
#define RT_TQINF    -2
#define RT_TQDEF    -3
```

Figure 6-74: `<search.h>`

```
typedef enum { FIND, ENTER } ACTION;
typedef struct entry { char *key; void *data; } ENTRY;
typedef enum { preorder, postorder, endorder, leaf } VISIT;
```

Figure 6-75: <sys/sem.h>

```
#define SEM_UNDO    010000
#define GETNCNT     3
#define GETPID      4
#define GETVAL      5
#define GETALL      6
#define GETZCNT     7
#define SETVAL      8
#define SETALL      9

struct semid_ds {
      struct ipc_perm     sem_perm;
      struct sem   *sem_base;
      ushort       sem_nsems;
      time_t       sem_otime;
      long         sem_pad1;
      time_t       sem_ctime;
      long         sem_pad2;
      long         sem_pad3[4];
};

struct sem {
      ushort       semval;
      pid_t        sempid;
      ushort       semncnt;
      ushort       semzcnt;
};

struct sembuf {
      ushort       sem_num;
      short        sem_op;
      short        sem_flg;
};
```

Figure 6-76: `<setjmp.h>`

```
#define _SIGJBLEN         128
#define _JBLEN            10

typedef int  jmp_buf[_JBLEN];
typedef int  sigjmp_buf[_SIGJBLEN];
```

Figure 6-77: `<sys/shm.h>`

```
#define SHMLBA            ((1)<<12)

#define SHM_RDONLY        010000
#define SHM_RND           020000

struct shmid_ds {
       struct ipc_perm     shm_perm;
       int          shm_segsz;
       struct anon_map     *shm_amp;
       ushort       shm_lkcnt;
       pid_t        shm_lpid;
       pid_t        shm_cpid;
       ulong        shm_nattch;
       ulong        shm_cnattch;
       time_t       shm_atime;
       long         shm_pad1;
       time_t       shm_dtime;
       long         shm_pad2;
       time_t       shm_ctime;
       long         shm_pad3;
       long         shm_pad4[4];
};
```

Figure 6-78: `<signal.h>`**, Part 1 of 3**

```
#define SIGHUP          1
#define SIGINT          2
#define SIGQUIT         3
#define SIGILL          4
#define SIGTRAP         5
#define SIGIOT          6
#define SIGABRT         6
#define SIGEMT          7
#define SIGFPE          8
#define SIGKILL         9
#define SIGBUS          10
#define SIGSEGV         11
#define SIGSYS          12
#define SIGPIPE         13
#define SIGALRM         14
#define SIGTERM         15
#define SIGUSR1         16
#define SIGUSR2         17
#define SIGCLD          18
#define SIGCHLD         18
#define SIGPWR          19
#define SIGWINCH        20
#define SIGURG          21
#define SIGPOLL         22
#define SIGIO           22
#define SIGSTOP         23
#define SIGTSTP         24
#define SIGCONT         25
#define SIGTTIN         26
#define SIGTTOU         27
#define SIGVTALRM       28
#define SIGPROF         29
```

Figure 6-79: `<signal.h>`**, Part 2 of 3**

```
#define SIGXCPU                  30
#define SIGXFSZ                  31

#define SIG_DFL           (void(*)())0
#define SIG_ERR           (void(*)())-1
#define SIG_IGN           (void(*)())1
#define SIG_HOLD          (void(*)())2

#define SIG_BLOCK         1
#define SIG_UNBLOCK       2
#define SIG_SETMASK       3

typedef struct {                                   M
      unsigned int      sa_sigbits[4];             M
} sigset_t;                                        M

struct sigaction {
      int          sa_flags;
      void         (*sa_handler)();
      sigset_t     sa_mask;
      int          sa_resv[2];
};

#define SA_NOCLDSTOP      0x00020000
#define SA_ONSTACK        0x00000001
#define SA_RESETHAND      0x00000002
#define SA_RESTART        0x00000004
#define SA_SIGINFO        0x00000008
#define SA_NODEFER        0x00000010
#define SA_NOCLDWAIT      0x00010000
```

Figure 6-80: `<signal.h>`**, Part 3 of 3**

```
#define SS_ONSTACK        0x00000001
#define SS_DISABLE        0x00000002

struct sigaltstack {
       char   *ss_sp;
       int    ss_size;
       int    ss_flags;
};

typedef struct sigaltstack       stack_t;
```

Figure 6-81: `<sys/siginfo.h>`**, Part 1 of 5**

```
#define ILL_ILLOPC        1
#define ILL_ILLOPN        2
#define ILL_ILLADR        3
#define ILL_ILLTRP        4
#define ILL_PRVOPC        5
#define ILL_PRVREG        6
#define ILL_COPROC        7
#define ILL_BADSTK        8

#define FPE_INTDIV        1
#define FPE_INTOVF        2
#define FPE_FLTDIV        3
#define FPE_FLTOVF        4
#define FPE_FLTUND        5
#define FPE_FLTRES        6
#define FPE_FLTINV        7
#define FPE_FLTSUB        8
```

Figure 6-82: `<sys/siginfo.h>`**, Part 2 of 5**

```
#define SEGV_MAPERR       1
#define SEGV_ACCERR       2

#define BUS_ADRALN        1
#define BUS_ADRERR        2
#define BUS_OBJERR        3

#define TRAP_BRKPT        1
#define TRAP_TRACE        2

#define CLD_EXITED        1
#define CLD_KILLED        2
#define CLD_DUMPED        3
#define CLD_TRAPPED       4
#define CLD_STOPPED       5
#define CLD_CONTINUED     6

#define POLL_IN           1
#define POLL_OUT          2
#define POLL_MSG          3
#define POLL_ERR          4
#define POLL_PRI          5
#define POLL_HUP          6

#define SI_MAXSZ          128
#define SI_PAD            ((SI_MAXSZ / sizeof(int)) - 3)
```

Figure 6-83: <sys/siginfo.h>**, Part 3 of 5**

```
typedef struct siginfo {
        int     si_signo;
        int     si_code;
        int     si_errno;
        union {
                int     _pad[SI_PAD];
                struct {
                        pid_t  _pid;
                        union {
                                struct {
                                        uid_t  _uid;
                                } _kill;
                                struct {
                                        clock_t     _utime;
                                        int         _status;
                                        clock_t     _stime;
                                } _cld;
                        } _pdata;
                } _proc;
                struct {
                        caddr_t     _addr;
                } _fault;
                struct {
                        int     _fd;
                        long    _band;
                } _file;
        } _data;
} siginfo_t;
```

Figure 6-84: <sys/siginfo.h>**, Part 4 of 5**

```
#define si_pid          _data._proc._pid
#define si_status       _data._proc._pdata._cld._status
#define si_stime        _data._proc._pdata._cld._stime
#define si_utime        _data._proc._pdata._cld._utime
#define si_uid          _data._proc._pdata._kill._uid
#define si_addr         _data._fault._addr
#define si_fd           _data._file._fd
#define si_band         _data._file._band
```

Figure 6-85: <sys/siginfo.h>*, Part 5 of 5

```
union sigval {
        int     sival_int;
        void    *sival_ptr;
};

union notifyinfo {
        int             nisigno;
        void            (*nifunc)(union sigval);
};

struct sigevent {
        int             sigev_notify;
        union notifyinfo sigev_notifyinfo;
        union sigval    sigev_value;
};

#define SIGEV_NONE      1
#define SIGEV_SIGNAL    2
#define SIGEV_CALLBACK  3
```

Figure 6-86: `<sys/stat.h>`**, Part 1 of 2**

```
#define _ST_FSTYPSZ       16

struct stat {
       dev_t         st_dev;
       long          st_pad1[3];
       ino_t         st_ino;
       mode_t        st_mode;
       nlink_t       st_nlink;
       uid_t         st_uid;
       gid_t         st_gid;
       dev_t         st_rdev;
       long          st_pad2[2];
       off_t         st_size;
       long          st_pad3;
       timestruc_t   st_atim;
       timestruc_t   st_mtim;
       timestruc_t   st_ctim;
       long          st_blksize;
       long          st_blocks;
       char          st_fstype[_ST_FSTYPSZ];
       long          st_pad4[8];
};
#define st_atime    st_atim.tv_sec
#define st_mtime    st_mtim.tv_sec
#define st_ctime    st_ctim.tv_sec
```

Figure 6-87: `<sys/stat.h>`**, Part 2 of 2**

```
#define S_IFMT              0xF000
#define S_IFIFO             0x1000
#define S_IFCHR             0x2000
#define S_IFDIR             0x4000
#define S_IFBLK             0x6000
#define S_IFREG             0x8000
#define S_IFLNK             0xA000

#define S_ISUID             0x800
#define S_ISGID             0x400
#define S_ISVTX             0x200

#define S_IRWXU             00700
#define S_IRUSR             00400
#define S_IWUSR             00200
#define S_IXUSR             00100
#define S_IRWXG             00070
#define S_IRGRP             00040
#define S_IWGRP             00020
#define S_IXGRP             00010
#define S_IRWXO             00007
#define S_IROTH             00004
#define S_IWOTH             00002
#define S_IXOTH             00001

#define S_ISFIFO(mode)      ((mode&0xF000) == 0x1000)
#define S_ISCHR(mode)       ((mode&0xF000) == 0x2000)
#define S_ISDIR(mode)       ((mode&0xF000) == 0x4000)
#define S_ISBLK(mode)       ((mode&0xF000) == 0x6000)
#define S_ISREG(mode)       ((mode&0xF000) == 0x8000)
```

Figure 6-88: <sys/statvfs.h>

```
#define FSTYPSZ     16

typedef struct statvfs {
      u_long       f_bsize;
      u_long       f_frsize;
      u_long       f_blocks;
      u_long       f_bfree;
      u_long       f_bavail;
      u_long       f_files;
      u_long       f_ffree;
      u_long       f_favail;
      u_long       f_fsid;
      char         f_basetype[FSTYPSZ];
      u_long       f_flag;
      u_long       f_namemax;
      char         f_fstr[32];
      u_long       f_filler[16];
} statvfs_t;

#define ST_RDONLY   0x01
#define ST_NOSUID   0x02
#define ST_NOTRUNC  0x04
```

Figure 6-89: `<stdarg.h>`

```
typedef void                 *va_list;                                G
extern  void                  va_end(va_list);                        G
#define va_start(list, name) (void) (list = (void *)((char *)&...))   G
#define va_arg(list, mode)   ((mode *)(list = (char *)list + \        G
                              sizeof(mode)))[-1]                      G
#define va_end(list)         (void)0                                  G
```

NOTE The construction &... is a syntactic extension to ANSI C and may not be supported by all C compilers. The intended semantics are to set list to the address on the stack of the first incoming argument in the variable part of the argument list. See "Function Calling Sequence" in Chapter 3. G G

Figure 6-90: `<stddef.h>`

```
typedef int              ptrdiff_t;
typedef unsigned int     size_t;
#define NULL             0
typedef long             wchar_t;

#define offsetof(s, m)   (size_t)(&(((s *)0)->m))
```

Figure 6-91: `<stdio.h>`**, Part 1 of 2**

```
typedef unsigned int      size_t;
typedef long              fpos_t;

#define NULL              0

#define BUFSIZ            1024

#define _IOFBF            0000
#define _IOLBF            0100
#define _IONBF            0004
#define _IOEOF            0020
#define _IOERR            0040

#define EOF               (-1)

#define FOPEN_MAX         60
#define FILENAME_MAX      1024

#define L_ctermid         9
#define L_cuserid         9
#define P_tmpdir          "/var/tmp/"
#define L_tmpnam          25

#define stdin             (&__iob[0])
#define stdout            (&__iob[1])
#define stderr            (&__iob[2])
```

Figure 6-92: <stdio.h>**, Part 2 of 2**

```
typedef struct {
      int                 _cnt;
      unsigned char       *_ptr;
      unsigned char       *_base;
      unsigned char       _flag;
      unsigned char       _file; ††
} FILE;

extern FILE        __iob[];                                          G

#define clearerr(p) ((void)((p)->_flag &= ~(_IOERR | _IOEOF))) †
#define feof(p)     ((p)->_flag & _IOEOF)
#define ferror(p)   ((p)->_flag & _IOERR)
#define fileno(p)   (p)->_file  †

/* Non reentrant */                                                  M
#define getc_unlocked(p)     (--(p)->_cnt < 0 ? _ _filbuf(p)         M
             : (int)*(p)->_ptr++)                                    M
#define putc_unlocked(x, p)  (--(p)->_cnt < 0 ? _ _flsbuf(x, p)      M
             : (int)(*(p)->_ptr++ = (x)))                            M
#define getchar_unlocked()   getc_unlocked(stdin)                    M
#define putchar_unlocked(x)  putc_unlocked((x), stdout)              M

#define getc(p)     (--(p)->_cnt < 0 ? _ _filbuf(p)                  M
             : (int)*(p)->_ptr++)                                    M
#define putc(x, p)  (--(p)->_cnt < 0 ? _ _flsbuf(x, p)               M
             : (int)(*(p)->_ptr++ = (x)))                            M
#define getchar()   getc(stdin)                                      M
#define putchar(x)  putc((x), stdout)                                M

/* Reentrant versions available as functions only */                 M
```

† These macro definitions are moved to Level 2 as of January 1, 1993.

†† The `_file` member of the `FILE` struct is moved to Level 2 as of January 1, 1993.

NOTE The macros `clearerr`, and `fileno` will be removed as a source interface in a future release supporting multi-processing. Applications should transition to the function equivalents of these macros in libc. Binary portability will be supported for existing applications.

CAUTION The constant `_NFILE` has been removed. It should still appear in stdio.h, but may be removed in a future version of the header file. Applications may not be able to depend on `fopen()` failing on an attempt to open more than `_NFILE` files.

Figure 6-93: `<stdlib.h>`

```
typedef struct {
      int    quot;
      int    rem;
} div_t;

typedef struct {
      long   quot;
      long   rem;
} ldiv_t;

typedef unsigned int      size_t;

#define NULL              0

#define EXIT_FAILURE      1
#define EXIT_SUCCESS      0
#define RAND_MAX          32767

extern unsigned char      __ctype[];
#define MB_CUR_MAX        (int)__ctype[520]
```

Figure 6-94: `<stropts.h>`**, Part 1 of 6**

```
#define SNDZERO          0x001
#define SNDPIPE          0x002

#define RNORM            0x000
#define RMSGD            0x001
#define RMSGN            0x002
#define RMODEMASK        0x003
#define RPROTDAT         0x004
#define RPROTDIS         0x008
#define RPROTNORM        0x010

#define FLUSHR           0x01
#define FLUSHW           0x02
#define FLUSHRW          0x03
#define FLUSHBAND        0x04
```

Figure 6-95: `<stropts.h>`**, Part 2 of 6**

```
#define S_INPUT            0x0001
#define S_HIPRI            0x0002
#define S_OUTPUT           0x0004
#define S_MSG              0x0008
#define S_ERROR            0x0010
#define S_HANGUP           0x0020
#define S_RDNORM           0x0040
#define S_WRNORM           S_OUTPUT
#define S_RDBAND           0x0080
#define S_WRBAND           0x0100
#define S_BANDURG          0x0200

#define RS_HIPRI           0x01

#define MSG_HIPRI          0x01
#define MSG_ANY            0x02
#define MSG_BAND           0x04

#define MORECTL            1
#define MOREDATA           2

#define MUXID_ALL          (-1)

#define ANYMARK            0x01
#define LASTMARK           0x02
```

Figure 6-96: `<stropts.h>`**, Part 3 of 6**

```
#define STR             ('S'<<8)
#define I_NREAD         (STR|01)
#define I_PUSH          (STR|02)
#define I_POP           (STR|03)
#define I_LOOK          (STR|04)
#define I_FLUSH         (STR|05)
#define I_SRDOPT        (STR|06)
#define I_GRDOPT        (STR|07)
#define I_STR           (STR|010)
#define I_SETSIG        (STR|011)
```

Figure 6-97: `<stropts.h>`**, Part 4 of 6**

```
#define I_FLUSHBAND       (STR|034)
#define I_CKBAND          (STR|035)
#define I_GETBAND         (STR|036)
#define I_ATMARK          (STR|037)
#define I_SETCLTIME       (STR|040)
#define I_GETCLTIME       (STR|041)
#define I_CANPUT          (STR|042)
```

Figure 6-98: `<stropts.h>`**, Part 5 of 6**

```
struct strioctl {
      int    ic_cmd;
      int    ic_timout;
      int    ic_len;
      char   *ic_dp;
};

struct strbuf {
      int    maxlen;
      int    len;
      char   *buf;
};

struct strpeek {
      struct strbuf       ctlbuf;
      struct strbuf       databuf;
      long                flags;
};

struct strfdinsert {
      struct strbuf       ctlbuf;
      struct strbuf       databuf;
      long                flags;
      int                 fildes;
      int                 offset;
};
```

Figure 6-99: `<stropts.h>`**, Part 6 of 6**

```
struct strrecvfd {
      int    fd;
      uid_t  uid;
      gid_t  gid;
      char   fill[8];
};

#define FMNAMESZ    8

struct str_mlist {
      char   l_name[FMNAMESZ+1];
};

struct str_list {
      int                  sl_nmods;
      struct str_mlist     *sl_modlist;
};

struct bandinfo {
      unsigned char        bi_pri;
      int                  bi_flag;
};
```

Figure 6-100: `<synch.h>*, Part 1 of 3`

```
#define USYNC_THREAD    0
#define USYNC_PROCESS   1

typedef struct thrq_elt thrq_elt_t;

struct thrq_elt {
      thrq_elt_t *thrq_next;
      thrq_elt_t *thrq_prev;
 };

typedef volatile struct {
      lwp_mutex_t  m_lmutex;
      long         m_type;
      lwp_mutex_t  m_sync_lock;
      thrq_elt_t   m_sleepq;
      long         filler;
} mutex_t;

typedef volatile struct {
      lwp_cond_t   c_lcond;
      long         c_type;
      thrq_elt_t   *c_syncq;
      lwp_mutex_t  c_sync_lock;
} cond_t;
```

Figure 6-101: `<synch.h>*`, Part 2 of 3

```
typedef volatile struct {
      mutex_t      s_mutex;
      cond_t       s_cond;
      short        s_count;
      short        s_wakecnt;
      int          s_type;
} sema_t;

typedef volatile struct rwcv rwcv_t;

struct rwcv {
      cond_t rwcv_cond;
      rwcv_t *rwcv_next;
      char   rwcv_rw;
      char   rwcv_wakeup;
      short  rwcv_readerwanted;
} ;

typedef volatile struct rwlock rwlock_t;

struct rwlock {
      mutex_t      rw_mutex;
      lwp_cond_t   rw_lwpcond;
      int          rw_type;
      short        rw_readers;
      char         rw_writer;
      char         rw_wrwakeup;
      short        rw_writerwanted;
      short        rw_rdwakecnt;
      rwcv_t       *rw_cvqhead;
      rwcv_t       *rw_cvqtail;
      long         pad[4];
} ;
```

Figure 6-102: `<synch.h>*`, Part 3 of 3

```
typedef volatile struct {
      mutex_t      rm_mutex;
      pid_t        rm_pid;
      thread_t     rm_owner;
      int          rm_depth;
      long         filler;
} rmutex_t;

typedef volatile struct barrier barrier_t;

struct barrier {
      mutex_t      b_lock;
      int          b_type;
      unsigned int b_count;
      unsigned int b_waiting;
      unsigned int b_generation;
      cond_t       b_cond;
} ;
```

Figure 6-103: `<sys/sysi86.h>`

```
#define SI86FPHW          40

#define FP_NO             0
#define FP_SW             1
#define FP_HW             2
#define FP_287            2
#define FP_387            3
```

Figure 6-104: `<termios.h>`**, Part 1 of 10**

```
#define _POSIX_VDISABLE   0

#define CTRL(c)           ((c)&037)
#define IBSHIFT           16
#define NCC               8
#define NCCS              19

typedef unsigned long     tcflag_t;
typedef unsigned char     cc_t;
typedef unsigned long     speed_t;

struct termios {
      tcflag_t     c_iflag;
      tcflag_t     c_oflag;
      tcflag_t     c_cflag;
      tcflag_t     c_lflag;
      cc_t         c_cc[NCCS];
};
```

Figure 6-105: `<termios.h>`**, Part 2 of 10**

```
#define VINTR           0
#define VQUIT           1
#define VERASE          2
#define VKILL           3
#define VEOF            4
#define VEOL            5
#define VEOL2           6
#define VMIN            4
#define VTIME           5
#define VSWTCH          7
#define VSTART          8
#define VSTOP           9
#define VSUSP           10
#define VDSUSP          11
#define VREPRINT        12
#define VDISCARD        13
#define VWERASE         14
#define VLNEXT          15
```

Figure 6-106: `<termios.h>`**, Part 3 of 10**

```
#define CNUL            0
#define CDEL            0177
#define CESC            '\\'
#define CINTR           0177
#define CQUIT           034
#define CERASE          '#'
#define CKILL           '@'
#define CEOT            04
#define CEOL            0
#define CEOL2           0
#define CEOF            04
#define CSTART          021
#define CSTOP           023
#define CSWTCH          032
#define CNSWTCH         0
#define CSUSP           CTRL('z')
#define CDSUSP          CTRL('y')
#define CRPRNT          CTRL('r')
#define CFLUSH          CTRL('o')
#define CWERASE         CTRL('w')
#define CLNEXT          CTRL('v')
```

Figure 6-107: `<termios.h>`**, Part 4 of 10**

```
#define IGNBRK          0000001
#define BRKINT          0000002
#define IGNPAR          0000004
#define PARMRK          0000010
#define INPCK           0000020
#define ISTRIP          0000040
#define INLCR           0000100
#define IGNCR           0000200
#define ICRNL           0000400
#define IUCLC           0001000
#define IXON            0002000
#define IXANY           0004000
#define IXOFF           0010000
#define IMAXBEL         0020000
#define DOSMODE         0100000
```

Figure 6-108: `<termios.h>`**, Part 5 of 10**

```
#define OPOST                  0000001
#define OLCUC                  0000002
#define ONLCR                  0000004
#define OCRNL                  0000010
#define ONOCR                  0000020
#define ONLRET                 0000040
#define OFILL                  0000100
#define OFDEL                  0000200
#define NLDLY                  0000400
#define NL0                    0
#define NL1                    0000400
#define CRDLY                  0003000
#define CR0                    0
#define CR1                    0001000
#define CR2                    0002000
#define CR3                    0003000
#define TABDLY                 0014000
```

Figure 6-109: `<termios.h>`**, Part 6 of 10**

```
#define TAB0                 0
#define TAB1                 0004000
#define TAB2                 0010000
#define TAB3                 0014000
#define XTABS                0014000
#define BSDLY                0020000
#define BS0                  0
#define BS1                  0020000
#define VTDLY                0040000
#define VT0                  0
#define VT1                  0040000
#define FFDLY                0100000
#define FF0                  0
#define FF1                  0100000
#define PAGEOUT              0200000
#define WRAP                 0400000
```

Figure 6-110: `<termios.h>`**, Part 7 of 10**

```
#define CBAUD          0000017
#define CSIZE          0000060
#define CS5            0
#define CS6            0000020
#define CS7            0000040
#define CS8            0000060
#define CSTOPB         0000100
#define CREAD          0000200
#define PARENB         0000400
#define PARODD         0001000
#define HUPCL          0002000
#define CLOCAL         0004000
#define RCV1EN         0010000
#define XMT1EN         0020000
#define LOBLK          0040000
#define XCLUDE         0100000
#define CIBAUD         03600000
#define PAREXT         04000000
```

Figure 6-111: `<termios.h>`**, Part 8 of 10**

```
#define ISIG                  0000001
#define ICANON                0000002
#define XCASE                 0000004
#define ECHO                  0000010
#define ECHOE                 0000020
#define ECHOK                 0000040
#define ECHONL                0000100
#define NOFLSH                0000200
#define TOSTOP                0000400
#define ECHOCTL               0001000
#define ECHOPRT               0002000
#define ECHOKE                0004000
#define DEFECHO               0010000
#define FLUSHO                0020000
#define PENDIN                0040000
#define IEXTEN                0100000
```

Figure 6-112: `<termios.h>`**, Part 9 of 10**

```
#define TIOC                ('T'<<8)

#define TCGETA              (TIOC|1)
#define TCSETA              (TIOC|2)
#define TCSETAW             (TIOC|3)
#define TCSETAF             (TIOC|4)
#define TCSBRK              (TIOC|5)
#define TCXONC              (TIOC|6)
#define TCFLSH              (TIOC|7)

#define TIOCGWINSZ          (TIOC|104)
#define TIOCSWINSZ          (TIOC|103)

#define TCGETS              (TIOC|13)
#define TCSETS              (TIOC|14)
#define TCSANOW             (('T'<<8)|14)
#define TCSETSW             (TIOC|15)
#define TCSADRAIN           (('T'<<8)|15)
#define TCSETSF             (TIOC|16)
#define TCSAFLUSH           (('T'<<8)|16)
```

Figure 6-113: `<termios.h>`**, Part 10 of 10**

```
#define TCIFLUSH          0
#define TCOFLUSH          1
#define TCIOFLUSH         2

#define TCOOFF            0
#define TCOON             1
#define TCIOFF            2
#define TCION             3

#define B0                0
#define B50               1
#define B75               2
#define B110              3
#define B134              4
#define B150              5
#define B200              6
#define B300              7
#define B600              8
#define B1200             9
#define B1800             10
#define B2400             11
#define B4800             12
#define B9600             13
#define B19200            14
#define B38400            15

struct winsize {
      unsigned short      ws_row;
      unsigned short      ws_col;
      unsigned short      ws_xpixel;
      unsigned short      ws_ypixel;
};
```

Figure 6-114: `<thread.h>*, Part 1 of 2`

```
#define THR_SUSPENDED 0x1
#define THR_BOUND     0x2
#define THR_INCR_CONC 0x4
#define THR_DETACHED  0x8
#define THR_DAEMON    0x10
#define SCHED_TS      1
#define SCHED_OTHER   1
#define SCHED_FIFO    2
#define SCHED_RR      3

typedef      id_t   thread_t;

#define POLICY_PARAM_SZ          PC_CLPARMSZ
```

Figure 6-115: <thread.h>*, Part 2 of 2

```
typedef struct {
      id_t   policy;
      long   policy_params[POLICY_PARAM_SZ];
} sched_param_t;

struct ts_param {
      int    prio;
};

struct fifo_param {
      int     prio;
};

struct rr_param {
      int     prio;
};

typedef unsigned int thread_key_t;
```

Figure 6-116: <sys/ticlts.h>

```
#define TCL_BADADDR       1
#define TCL_BADOPT        2
#define TCL_NOPEER        3
#define TCL_PEERBADSTATE  4
#define TCL_DEFAULTADDRSZ 4
```

Figure 6-117: `<sys/ticots.h>`

```
#define TCO_NOPEER              ECONNREFUSED
#define TCO_PEERNOROOMONQ       ECONNREFUSED
#define TCO_PEERBADSTATE        ECONNREFUSED
#define TCO_PEERINITIATED       ECONNRESET
#define TCO_PROVIDERINITIATED   ECONNABORTED
#define TCO_DEFAULTADDRSZ       4
```

Figure 6-118: `<sys/ticotsord.h>`

```
#define TCOO_NOPEER              1
#define TCOO_PEERNOROOMONQ       2
#define TCOO_PEERBADSTATE        3
#define TCOO_PEERINITIATED       4
#define TCOO_PROVIDERINITIATED   5
#define TCOO_DEFAULTADDRSZ       4
```

NOTE

The sys/tihdr.h and sys/timod.h headers previously included in this document were unneccessary as they did not contain user level information and have therefore been removed from this document. M

Figure 6-119: `<time.h>`*

```
struct timespec {
      time_t       tv_sec;
      long         tv_nsec;
} ;
```

Figure 6-120: `<sys/time.h>`

```
typedef long clock_t;
typedef long time_t;
typedef unsigned int size_t;                                M

typedef struct timespec {                                   M
      time_t       tv_sec;                                  M
      long         tv_nsec;                                 M
} timestruc_t;                                              M

#define CLOCKS_PER_SEC          1000000

struct tm {
      int    tm_sec;
      int    tm_min;
      int    tm_hour;
      int    tm_mday;
      int    tm_mon;
      int    tm_year;
      int    tm_wday;
      int    tm_yday;
      int    tm_isdst;
};

extern char *tzname[2];

#define CLK_TCK     _sysconf(3)

extern long timezone;
extern int daylight;
```

Figure 6-121: `<sys/times.h>`

```
struct tms {
      clock_t      tms_utime;
      clock_t      tms_stime;
      clock_t      tms_cutime;
      clock_t      tms_cstime;
};
```

NOTE

This edition introduces the xti.h header which contains the same information as the current tiuser.h. The new xti.h header is a superset of the previous edition's tiuser.h. M M M

tiuser.h has been moved to Level 2 and will be removed in future editions of

Figure 6-122: <tiuser.h>**, Error Return Values**

```
#define TBADADDR        1
#define TBADOPT         2
#define TACCES          3
#define TBADF           4
#define TNOADDR         5
#define TOUTSTATE       6
#define TBADSEQ         7
#define TSYSERR         8
#define TLOOK           9
#define TBADDATA        10
#define TBUFOVFLW       11
#define TFLOW           12
#define TNODATA         13
#define TNODIS          14
#define TNOUDERR        15
#define TBADFLAG        16
#define TNOREL          17
#define TNOTSUPPORT     18
#define TSTATECHNG      19
#define TNOSTRUCTYPE    20                  M
#define TBADNAME        21                  M
#define TBADQLEN        22                  M
#define TADDRBUSY       23                  M
#define TINDOUT         24                  M
#define TPROVMISMATCH   25                  M
#define TRESQLEN        26                  M
#define TRESADDR        27                  M
#define TQFULL          28                  M
#define TPROTO          29                  M
```

Figure 6-123: `<tiuser.h>`**, Event Bitmasks**

```
#define T_LISTEN          0x0001
#define T_CONNECT         0x0002
#define T_DATA            0x0004
#define T_EXDATA          0x0008
#define T_DISCONNECT      0x0010
#define T_ERROR           0x0020
#define T_UDERR           0x0040
#define T_ORDREL          0x0080
#define T_GODATA          0x0100
#define T_GOEXDATA        0x0200
#define T_EVENTS          0x03ff
```

M
M
M

Figure 6-124: `<tiuser.h>`**, Flags**

```
#define T_MORE            0x001
#define T_EXPEDITED       0x002
#define T_NEGOTIATE       0x004
#define T_CHECK           0x008
#define T_DEFAULT         0x010
#define T_SUCCESS         0x020
#define T_FAILURE         0x040
```

Figure 6-125: `<tiuser.h>`**, Service Types**

```
#define T_COTS            01
#define T_COTS_ORD        02
#define T_CLTS            03
```

Figure 6-126: `<tiuser.h>`**, Values for flags field in t_info structure**

```
#define T_SENDZERO      0x0000001
```

M

Figure 6-127: `<tiuser.h>`**, Transport Interface Data Structures, 1 of 2**

```
struct t_info {
       long   addr;
       long   options;
       long   tsdu;
       long   etsdu;
       long   connect;
       long   discon;
       long   servtype;
       long   flags;
};

struct netbuf {
       unsigned int        maxlen;
       unsigned int        len;
       char                *buf;
};

struct t_bind {
       struct netbuf       addr;
       unsigned            qlen;
};

struct t_optmgmt {
       struct netbuf       opt;
       long                flags;
};
```

M

NOTE Applications invoking TLI binary interfaces to t_open or t_getinfo will see the t_info structure without the flags member. Those applications invoking the XTI versions of t_open or t_getinfo will see the t_info structure with the flags member. M M

Figure 6-128: `<tiuser.h>`**, Transport Interface Data Structures, 2 of 2**

```
struct t_discon {
      struct netbuf      udata;
      int                reason;
      int                sequence;
};

struct t_call {
      struct netbuf      addr;
      struct netbuf      opt;
      struct netbuf      udata;
      int                sequence;
};

struct t_unitdata {
      struct netbuf      addr;
      struct netbuf      opt;
      struct netbuf      udata;
};

struct t_uderr {
      struct netbuf      addr;
      struct netbuf      opt;
      long               error;
};
```

Figure 6-129: `<tiuser.h>`**, Structure Types**

```
#define T_BIND          1
#define T_OPTMGMT       2
#define T_CALL          3
#define T_DIS           4
#define T_UNITDATA      5
#define T_UDERROR       6
#define T_INFO          7
```

Figure 6-130: `<tiuser.h>`**, Fields of Structures**

```
#define T_ADDR          0x01
#define T_OPT           0x02
#define T_UDATA         0x04
#define T_ALL           0xffff
```

M

NOTE Differences between XTI and TLI have forced the value of T_ALL to change. The previous edition's T_ALL value will not produce the same results as the new T_ALL. M

Figure 6-131: `<tiuser.h>`**, Transport Interface States**

```
#define T_UNINIT          0
#define T_UNBND           1
#define T_IDLE            2
#define T_OUTCON          3
#define T_INCON           4
#define T_DATAXFER        5
#define T_OUTREL          6
#define T_INREL           7
#define T_FAKE            8
#define T_NOSTATES        9
```

Figure 6-132: `<tiuser.h>`**, User-level Events**

```
#define T_OPEN          0
#define T_BIND          1
#define T_OPTMGMT       2
#define T_UNBIND        3
#define T_CLOSE         4
#define T_SNDUDATA      5
#define T_RCVUDATA      6
#define T_RCVUDERR      7
#define T_CONNECT1      8
#define T_CONNECT2      9
#define T_RCVCONNECT    10
#define T_LISTN         11
#define T_ACCEPT1       12
#define T_ACCEPT2       13
#define T_ACCEPT3       14
#define T_SND           15
#define T_RCV           16
#define T_SNDDIS1       17
#define T_SNDDIS2       18
#define T_RCVDIS1       19
#define T_RCVDIS2       20
#define T_RCVDIS3       21
#define T_SNDREL        22
#define T_RCVREL        23
#define T_PASSCON       24
#define T_NOEVENTS      25
```

Figure 6-133: `<tspriocntl.h>*`

```
typedef struct tsparms {
      short  ts_uprilim;
      short  ts_upri;
} tsparms_t;


typedef struct tsinfo {
      short  ts_maxupri;
} tsinfo_t;

#define      TS_NOCHANGE  -32768
```

Figure 6-134: `<sys/types.h>`

```
typedef unsigned char     uchar_t;
typedef unsigned short    ushort_t;
typedef unsigned int      uint_t;
typedef unsigned long     ulong_t;

typedef char *            caddr_t;
typedef long              daddr_t;
typedef long              off_t;
typedef long              id_t;
typedef int               key_t;
typedef ulong_t           mode_t;
typedef long              uid_t;
typedef uid_t             gid_t;
typedef ulong_t           nlink_t;
typedef ulong_t           dev_t;
typedef ulong_t           ino_t;
typedef long              pid_t;
typedef uint_t            size_t;
typedef long              time_t;
typedef long              clock_t;

typedef unsigned short    ushort;
typedef unsigned long     ulong;

typedef unsigned char     u_char;
typedef unsigned short    u_short;
typedef unsigned int      u_int;
typedef unsigned long     u_long;
```

Figure 6-135: `<ucontext.h>`**, Part 1 of 2**

```
typedef int         greg_t;
#define NGREG       19
typedef greg_t      gregset_t[NGREG];

#define SS          18
#define UESP        17
#define EFL         16
#define CS          15
#define EIP         14
#define ERR         13
#define TRAPNO      12
#define EAX         11
#define ECX         10
#define EDX         9
#define EBX         8
#define ESP         7
#define EBP         6
#define ESI         5
#define EDI         4
#define DS          3
#define ES          2
#define FS          1
#define GS          0
```

Figure 6-136: <ucontext.h>**, Part 2 of 2**

```
typedef struct fpregset {
      union {
            struct fpchip_state {
                  int    state[27];
                  int    status;
            } fpchip_state;
            struct fp_emul_space {
                  char   fp_emul[246];
                  char   fp_epad[2];
            } fp_emul_space;
            int    f_fpregs[62];
      } fp_reg_set;
      long  f_wregs[33];
} fpregset_t;

typedef struct {
      gregset_t    gregs;
      fpregset_t   fpregs;
} mcontext_t;

typedef struct ucontext {
      u_long       uc_flags;
      struct ucontext     *uc_link;
      sigset_t     uc_sigmask;
      stack_t      uc_stack;
      mcontext_t   uc_mcontext;
      long         uc_filler[5];
} ucontext_t;
```

Figure 6-137: `<sys/uio.h>`

```
typedef struct iovec {
      caddr_t      iov_base;
      int          iov_len;
} iovec_t;
```

Figure 6-138: `<ulimit.h>`

```
#define UL_GETFSIZE       1
#define UL_SETFSIZE       2
```

Figure 6-139: `<unistd.h>`**, Part 1 of 2**

```
#define R_OK                    4
#define W_OK                    2
#define X_OK                    1
#define F_OK                    0

#define F_ULOCK                 0
#define F_LOCK                  1
#define F_TLOCK                 2
#define F_TEST                  3

#define SEEK_SET                0
#define SEEK_CUR                1
#define SEEK_END                2

#define _SC_ARG_MAX             1
#define _SC_CHILD_MAX           2
#define _SC_CLK_TCK             3
```

Figure 6-139: <unistd.h>**, Part 1 of 2** (continued)

```
#define _SC_NGROUPS_MAX          4
#define _SC_OPEN_MAX             5
#define _SC_JOB_CONTROL          6
#define _SC_SAVED_IDS            7
#define _SC_VERSION              8
#define _SC_PASS_MAX             9
#define _SC_LOGNAME_MAX          10
#define _SC_PAGESIZE             11
#define _SC_XOPEN_VERSION        12

#define _CS_PATH                1                      M
#define _CS_HOSTNAME            2                      M
#define _CS_RELEASE             3                      M
#define _CS_VERSION             4                      M
#define _CS_MACHINE             5                      M
#define _CS_ARCHITECTURE        6                      M
#define _CS_HW_SERIAL           7                      M
#define _CS_HW_PROVIDER         8                      M
#define _CS_SRPC_DOMAIN         9                      M
#define _CS_SYSNAME             11                     M
```

Figure 6-140: `<unistd.h>`**, Part 2 of 2**

```
#define _PC_LINK_MAX            1
#define _PC_MAX_CANON           2
#define _PC_MAX_INPUT           3
#define _PC_NAME_MAX            4
#define _PC_PATH_MAX            5
#define _PC_PIPE_BUF            6
#define _PC_NO_TRUNC            7
#define _PC_VDISABLE            8
#define _PC_CHOWN_RESTRICTED    9

#define _POSIX_JOB_CONTROL      1
#define _POSIX_SAVED_IDS        1
#define _POSIX_VDISABLE         0

#define _POSIX_VERSION          *
#define _XOPEN_VERSION          *

/* starred values vary and should be
      retrieved using sysconf() or pathconf() */

#define STDIN_FILENO            0
#define STDOUT_FILENO           1
#define STDERR_FILENO           2
```

Figure 6-141: `<utime.h>`

```
struct utimbuf {
      time_t      actime;
      time_t      modtime;
};
```

Figure 6-142: `<sys/utsname.h>`

```
#define SYS_NMLN    257

struct utsname {
        char   sysname[SYS_NMLN];
        char   nodename[SYS_NMLN];
        char   release[SYS_NMLN];
        char   version[SYS_NMLN];
        char   machine[SYS_NMLN];
};
```

Figure 6-143: `<wait.h>`

```
#define WEXITED              0001
#define WTRAPPED             0002
#define WSTOPPED             0004
#define WCONTINUED           0010
#define WUNTRACED            0004
#define WNOHANG              0100
#define WNOWAIT              0200

#define WCONTFLG             0177777
#define WCOREFLG             0200

#define WWORD(stat)          ((int)((stat))&0177777)

#define WSTOPFLG             0177
#define WSIGMASK             0177
#define WLOBYTE(stat) ((int)((stat)&0377))
#define WHIBYTE(stat) ((int)(((stat)>>8)&0377))

#define WIFEXITED(stat)      (WLOBYTE(stat)==0)
#define WIFSIGNALED(stat)    (WLOBYTE(stat)>0&&WHIBYTE(stat)==0)
#define WIFSTOPPED(stat)     (WLOBYTE(stat)==WSTOPFLG&&WHIBYTE(stat)!=0)

#define WIFCONTINUED(stat)   (WWORD(stat)==WCONTFLG)

#define WEXITSTATUS(stat)    WHIBYTE(stat)
#define WTERMSIG(stat)       (WLOBYTE(stat)&WSIGMASK)
#define WSTOPSIG(stat)       WHIBYTE(stat)

#define WCOREDUMP(stat)      ((stat)&WCOREFLG)
```

Figure 6-144: `<wchar.h>`

```
typedef long wchar_t;
typedef unsigned int      size_t;
typedef long wint_t;

typedef struct
{
      wchar_t      ;
      wchar_t      ;
} mbstate_t;

#define NULL 0
#define WEOF (-1)

#define WCHAR_MAX   2147483647

#define WCHAR_MIN   (-2147483647-1)

#define mbrlen(x, n, p)   mbrtowc((wchar_t *)0, x, n, p)
```

Figure 6-145: `<wctype.h>*, Part 1 of 3`

```
typedef long        wint_t;
typedef unsigned long     wctype_t;

#define WEOF (-1)

#define      _U    01
#define      _L    02
#define      _N    04
#define      _S    010
#define      _P    020
#define      _C    040
#define      _B    0100
#define      _X    0200

#define      _E1   0x00000100
#define      _E2   0x00000200
#define      _E3   0x00000400
#define      _E4   0x00000800
#define      _E5   0x00001000
#define      _E6   0x00002000
#define      _E7   0x00004000
#define      _E8   0x00008000
#define      _E9   0x00010000
#define      _E10  0x00020000
#define      _E11  0x00040000
#define      _E12  0x00080000
#define      _E13  0x00100000
#define      _E14  0x00200000
#define      _E15  0x00400000
#define      _E16  0x00800000
#define      _E17  0x01000000
#define      _E18  0x02000000
#define      _E19  0x04000000
#define      _E20  0x08000000
#define      _E21  0x10000000
```

Figure 6-146: `<wctype.h>*, Part 2 of 3`

```
#define _PD_ALNUM   (_U | _L | _N)
#define _PD_ALPHA   (_U | _L)
#define _PD_BLANK   (_B)
#define _PD_CNTRL   (_C)
#define _PD_DIGIT   (_N)
#define _PD_GRAPH   (_P | _U | _L | _N | _E1 |
                          _E2 | _E5 | _E6)
#define _PD_LOWER   (_L)
#define _PD_PRINT   (_P | _U | _L | _N | _B |
                          _E1 | _E2 | _E5 | _E6)
#define _PD_PUNCT   (_P)
#define _PD_SPACE   (_S)
#define _PD_UPPER   (_U)
#define _PD_XDIGIT  (_X)

#define iswalnum(c)       __isw(c, _PD_ALNUM)
#define iswalpha(c)       __isw(c, _PD_ALPHA)
#define iswcntrl(c)       __isw(c, _PD_CNTRL)
#define iswdigit(c)       __isw(c, _PD_DIGIT)
#define iswgraph(c)       __isw(c, _PD_GRAPH)
#define iswlower(c)       __isw(c, _PD_LOWER)
#define iswprint(c)       __isw(c, _PD_PRINT)
#define iswpunct(c)       __isw(c, _PD_PUNCT)
#define iswspace(c)       __isw(c, _PD_SPACE)
#define iswupper(c)       __isw(c, _PD_UPPER)
#define iswxdigit(c)      __isw(c, _PD_XDIGIT)
#define towlower(c)       __tow(c, _PD_UPPER)
#define towupper(c)       __tow(c, _PD_LOWER)
#define isphonogram(c)    __isx(c, _E1)
#define isideogram(c)     __isx(c, _E2)
#define isenglish(c)      __isx(c, _E3)
#define isnumber(c)       __isx(c, _E4)
#define isspecial(c)      __isx(c, _E5)
```

Figure 6-147: `<wctype.h>*, Part 3 of 3`

```
#define iscodeset0(c)     (((c) & ~(wchar_t)0xff) == 0)
#define iscodeset1(c)     (((c) >> 28) == 0x3)
#define iscodeset2(c)     (((c) >> 28) == 0x1)
#define iscodeset3(c)     (((c) >> 28) == 0x2)

inline int __isw(wint_t c, wctype_t t){
      if (c > 255)
            return (__iswctype(c, t));
      return (1 + __ctype)[c] & t ;
}

inline int __isx(wint_t c, wctype_t t){
      return (c > 255 && __iswctype(c, t));
}

inline wint_t __tow(wint_t c, wctype_t t){
      if (c > 255)
            return (__trwctype(c, t));
      if ((1 + __ctype)[c] & t )
            return (258 + __ctype)[c];
      return (c);
}
```

NOTE

The construction inline is a syntactic extension to ANSI C and may not be supported by all C compilers. The intended semantics are to behave like regular preprocessor function like macros except parameter names are local and expressions giving their initial values are evaluated exactly once. M M

Figure 6-148: <wordexp.h>*

```
#define WRDE_APPEND       0001                M
#define WRDE_DOOFFS       0002                M
#define WRDE_NOCMD        0004                M
#define WRDE_REUSE        0010                M
#define WRDE_SHOWERR      0020                M
#define WRDE_UNDEF        0040                M

#define WRDE_NOSYS        (-1)                M
#define WRDE_BADCHAR      (-2)                M
#define WRDE_BADVAL       (-3)                M
#define WRDE_CMDSUB       (-4)                M
#define WRDE_NOSPACE      (-5)                M
#define WRDE_SYNTAX       (-6)                M

typedef struct                                M
{                                             M
       size_t we_wordc;                       M
       char   **we_wordv;                     M
       size_t we_offs;                        M
} wordexp_t;                                  M
```

X Window Data Definitions

NOTE *This section is new to the Third Edition of this document, but will not be marked with the "G" diff-mark.*

This section contains standard data definitions that describe system data for the optional X Window System libraries listed in the Generic ABI. These data definitions are referred to by their names in angle brackets: <*name.h*> and <sys/*name.h*>. Included in these data definitions are macro definitions and structure definitions. While an ABI-conforming system may provide X11 and X Toolkit Intrinsics interfaces, it need not contain the actual data definitions referenced here. Programmers should observe that the sources of the structures defined in these data definitions are defined in SVID or the appropriate X Consortium documentation (see chapter 10 in the Generic ABI).

Figure 6-149: <X11/Atom.h>**, Part 1 of 3**

```
#define XA_PRIMARY              ((Atom) 1)
#define XA_SECONDARY            ((Atom) 2)
#define XA_ARC                  ((Atom) 3)
#define XA_ATOM                 ((Atom) 4)
#define XA_BITMAP               ((Atom) 5)
#define XA_CARDINAL             ((Atom) 6)
#define XA_COLORMAP             ((Atom) 7)
#define XA_CURSOR               ((Atom) 8)
#define XA_CUT_BUFFER0          ((Atom) 9)
#define XA_CUT_BUFFER1          ((Atom) 10)
#define XA_CUT_BUFFER2          ((Atom) 11)
#define XA_CUT_BUFFER3          ((Atom) 12)
#define XA_CUT_BUFFER4          ((Atom) 13)
#define XA_CUT_BUFFER5          ((Atom) 14)
#define XA_CUT_BUFFER6          ((Atom) 15)
#define XA_CUT_BUFFER7          ((Atom) 16)
#define XA_DRAWABLE             ((Atom) 17)
#define XA_FONT                 ((Atom) 18)
#define XA_INTEGER              ((Atom) 19)
#define XA_PIXMAP               ((Atom) 20)
#define XA_POINT                ((Atom) 21)
#define XA_RECTANGLE            ((Atom) 22)
#define XA_RESOURCE_MANAGER     ((Atom) 23)
#define XA_RGB_COLOR_MAP        ((Atom) 24)
#define XA_RGB_BEST_MAP         ((Atom) 25)
#define XA_RGB_BLUE_MAP         ((Atom) 26)
#define XA_RGB_DEFAULT_MAP      ((Atom) 27)
#define XA_RGB_GRAY_MAP         ((Atom) 28)
#define XA_RGB_GREEN_MAP        ((Atom) 29)
#define XA_RGB_RED_MAP          ((Atom) 30)
#define XA_STRING               ((Atom) 31)
#define XA_VISUALID             ((Atom) 32)
```

Figure 6-150: `<X11/Atom.h>`**, Part 2 of 3**

```
#define XA_WINDOW                  ((Atom) 33)
#define XA_WM_COMMAND              ((Atom) 34)
#define XA_WM_HINTS                ((Atom) 35)
#define XA_WM_CLIENT_MACHINE       ((Atom) 36)
#define XA_WM_ICON_NAME            ((Atom) 37)
#define XA_WM_ICON_SIZE            ((Atom) 38)
#define XA_WM_NAME                 ((Atom) 39)
#define XA_WM_NORMAL_HINTS         ((Atom) 40)
#define XA_WM_SIZE_HINTS           ((Atom) 41)
#define XA_WM_ZOOM_HINTS           ((Atom) 42)
#define XA_MIN_SPACE               ((Atom) 43)
#define XA_NORM_SPACE              ((Atom) 44)
#define XA_MAX_SPACE               ((Atom) 45)
#define XA_END_SPACE               ((Atom) 46)
#define XA_SUPERSCRIPT_X           ((Atom) 47)
#define XA_SUPERSCRIPT_Y           ((Atom) 48)
#define XA_SUBSCRIPT_X             ((Atom) 49)
#define XA_SUBSCRIPT_Y             ((Atom) 50)
#define XA_UNDERLINE_POSITION      ((Atom) 51)
#define XA_UNDERLINE_THICKNESS     ((Atom) 52)
#define XA_STRIKEOUT_ASCENT        ((Atom) 53)
#define XA_STRIKEOUT_DESCENT       ((Atom) 54)
#define XA_ITALIC_ANGLE            ((Atom) 55)
#define XA_X_HEIGHT                ((Atom) 56)
#define XA_QUAD_WIDTH              ((Atom) 57)
#define XA_WEIGHT                  ((Atom) 58)
#define XA_POINT_SIZE              ((Atom) 59)
#define XA_RESOLUTION              ((Atom) 60)
#define XA_COPYRIGHT               ((Atom) 61)
#define XA_NOTICE                  ((Atom) 62)
#define XA_FONT_NAME               ((Atom) 63)
#define XA_FAMILY_NAME             ((Atom) 64)
```

Figure 6-151: `<X11/Atom.h>`**, Part 3 of 3**

```
#define XA_FULL_NAME            ((Atom) 65)
#define XA_CAP_HEIGHT           ((Atom) 66)
#define XA_WM_CLASS             ((Atom) 67)
#define XA_WM_TRANSIENT_FOR     ((Atom) 68)
#define XA_LAST_PREDEFINED      ((Atom) 68)
```

Figure 6-152: `<X11/Composite.h>`

```
extern WidgetClass compositeWidgetClass;
```

Figure 6-153: `<X11/Constraint.h>`

```
extern WidgetClass constraintWidgetClass;
```

Figure 6-154: `<X11/Core.h>`

```
extern WidgetClass coreWidgetClass;
```

Figure 6-155: `<X11/cursorfont.h>`**, Part 1 of 3**

```
#define XC_num_glyphs           154
#define XC_X_cursor             0
#define XC_arrow                2
#define XC_based_arrow_down     4
#define XC_based_arrow_up       6
#define XC_boat                 8
#define XC_bogosity             10
#define XC_bottom_left_corner   12
#define XC_bottom_right_corner  14
#define XC_bottom_side          16
#define XC_bottom_tee           18
#define XC_box_spiral           20
#define XC_center_ptr           22
#define XC_circle               24
#define XC_clock                26
#define XC_coffee_mug           28
#define XC_cross                30
#define XC_cross_reverse        32
#define XC_crosshair            34
#define XC_diamond_cross        36
#define XC_dot                  38
#define XC_dotbox               40
#define XC_double_arrow         42
#define XC_draft_large          44
#define XC_draft_small          46
#define XC_draped_box           48
#define XC_exchange             50
#define XC_fleur                52
#define XC_gobbler              54
#define XC_gumby                56
#define XC_hand1                58
#define XC_hand2                60
```

Figure 6-156: `<X11/cursorfont.h>`**, Part 2 of 3**

```
#define XC_heart                 62
#define XC_icon                  64
#define XC_iron_cross            66
#define XC_left_ptr              68
#define XC_left_side             70
#define XC_left_tee              72
#define XC_leftbutton            74
#define XC_ll_angle              76
#define XC_lr_angle              78
#define XC_man                   80
#define XC_middlebutton          82
#define XC_mouse                 84
#define XC_pencil                86
#define XC_pirate                88
#define XC_plus                  90
#define XC_question_arrow        92
#define XC_right_ptr             94
#define XC_right_side            96
#define XC_right_tee             98
#define XC_rightbutton           100
#define XC_rtl_logo              102
#define XC_sailboat              104
#define XC_sb_down_arrow         106
#define XC_sb_h_double_arrow     108
#define XC_sb_left_arrow         110
#define XC_sb_right_arrow        112
#define XC_sb_up_arrow           114
#define XC_sb_v_double_arrow     116
#define XC_shuttle               118
#define XC_sizing                120
#define XC_spider                122
#define XC_spraycan              124
```

Figure 6-157: `<X11/cursorfont.h>`**, Part 3 of 3**

```
#define XC_star                    126
#define XC_target                  128
#define XC_tcross                  130
#define XC_top_left_arrow          132
#define XC_top_left_corner         134
#define XC_top_right_corner        136
#define XC_top_side                138
#define XC_top_tee                 140
#define XC_trek                    142
#define XC_ul_angle                144
#define XC_umbrella                146
#define XC_ur_angle                148
#define XC_watch                   150
#define XC_xterm                   152
```

Figure 6-158: `<X11/Intrinsic.h>`**, Part 1 of 6**

```
typedef char *String;

#define XtNumber(arr)\
      ((Cardinal) (sizeof(arr) / sizeof(arr[0])))

typedef void              *Widget;
typedef Widget            *WidgetList;
typedef void              *CompositeWidget;
typedef void              *WidgetClass;
typedef XtActionsRec      *XtActionList;

typedef void              *XtAppContext;
typedef unsigned long     XtValueMask;
typedef unsigned long     XtIntervalId;
typedef unsigned long     XtInputId;
typedef unsigned long     XtWorkProcId;
typedef unsigned int      XtGeometryMask;
typedef unsigned long     XtGCMask;
typedef unsigned long     Pixel;
typedef int               XtCacheType;
#define      XtCacheNone        0x001
#define      XtCacheAll         0x002
#define      XtCacheByDisplay   0x003
#define      XtCacheRefCount    0x100

typedef char              Boolean;
typedef long              XtArgVal;
typedef unsigned char     XtEnum;

typedef unsigned int      Cardinal;
typedef unsigned short    Dimension;
typedef short             Position;

typedef void              *XtPointer;
```

Figure 6-159: `<X11/Intrinsic.h>`**, Part 2 of 6**

```
typedef void              *XtTranslations;
typedef void              *XtAccelerators;
typedef unsigned int      Modifiers;

#define XtCWQueryOnly     (1 << 7)
#define XtSMDontChange    5

typedef void *XtCacheRef;
typedef void *XtActionHookId;
typedef unsigned long     EventMask;
typedef en
```

Figure 6-160: `<X11/Intrinsic.h>`**, Part 3 of 6**

```
#define XtInputNoneMask         0L
#define XtInputReadMask         (1L<<0)
#define XtInputWriteMask        (1L<<1)
#define XtInputExceptMask       (1L<<2)

typedef struct {
      XtGeometryMask request_mode;
      Position     x, y;
      Dimension    width, height, border_width;
      Widget sibling;
} XtWidgetGeometry;

typedef struct {
      String       name;
      XtArgVal     value;
} Arg, *ArgList;

typedef XtPointer   XtVarArgsList;

typedef struct {
      XtCallbackProc     callback;
      XtPointer          closure;
} XtCallbackRec, *XtCallbackList;

typedef enum {
      XtCallbackNoList,
      XtCallbackHasNone,
      XtCallbackHasSome
} XtCallbackStatus;

typedef struct {
      Widget       shell_widget;
      Widget       enable_widget;
} XtPopdownIDRec, *XtPopdownID;
```

Figure 6-161: <X11/Intrinsic.h>**, Part 4 of 6**

```
typedef enum {
      XtGeometryYes,
      XtGeometryNo,
      XtGeometryAlmost,
      XtGeometryDone
} XtGeometryResult;

typedef enum {
      XtGrabNone,
      XtGrabNonexclusive,
      XtGrabExclusive
} XtGrabKind;

typedef struct {
      String        resource_name;
      String        resource_class;
      String        resource_type;
      Cardinal      resource_size;
      Cardinal      resource_offset;
      String        default_type;
      XtPointer     default_addr;
} XtResource, *XtResourceList;

typedef struct {
      char          match;
      String        substitution;
} SubstitutionRec, *Substitution;

typedef Boolean           (*XtFilePredicate);
typedef XtPointer         XtRequestId;

extern XtConvertArgRec const colorConvertArgs[];
extern XtConvertArgRec const screenConvertArg[];
```

Figure 6-162: `<X11/Intrinsic.h>`**, Part 5 of 6**

```
#define XtAllEvents   ((EventMask) -1L)
#define XtIMXEvent                  1
#define XtIMTimer                   2
#define XtIMAlternateInput          4
#define XtIMAll (XtIMXEvent | XtIMTimer | XtIMAlternateInput)

#define XtOffsetOf(s_type,field) XtOffset(s_type*,field)
#define XtNew(type) ((type *) XtMalloc((unsigned) sizeof(type)))
#define XT_CONVERT_FAIL             (Atom)0x80000001

#define XtIsRectObj(object) \
       (_XtCheckSubclassFlag(object,(XtEnum)0x02))
#define XtIsWidget(object) \
       (_XtCheckSubclassFlag(object,(XtEnum)0x04))
#define XtIsComposite(widget) \
       (_XtCheckSubclassFlag(widget,(XtEnum)0x08))
#define XtIsConstraint(widget) \
       (_XtCheckSubclassFlag(widget,(XtEnum)0x10))
#define XtIsShell(widget) \
       (_XtCheckSubclassFlag(widget,(XtEnum)0x20))
#define XtIsOverrideShell(widget) \
       (_XtIsSubclassOf(widget,(WidgetClass)overrideShellWidgetClass,\
       (WidgetClass)shellWidgetClass, (XtEnum)0x20))
#define XtIsWMShell(widget) \
       (_XtCheckSubclassFlag(widget,(XtEnum)0x40))
#define XtIsVendorShell(widget)     \
       (_XtIsSubclassOf(widget,(WidgetClass)vendorShellWidgetClass,\
       (WidgetClass)wmShellWidgetClass,(XtEnum)0x40))
#define XtIsTransientShell(widget) \
       (_XtIsSubclassOf(widget,(WidgetClass)transientShellWidgetClass,\
       (WidgetClass)wmShellWidgetClass, (XtEnum)0x40))
#define XtIsTopLevelShell(widget)\
       (_XtCheckSubclassFlag(widget, (XtEnum)0x80))
#define XtIsApplicationShell(widget)\
       (_XtIsSubclassOf(widget,(WidgetClass)applicationShellWidgetClass,\
       (WidgetClass)topLevelShellWidgetClass, (XtEnum)0x80))
```

Figure 6-163: <X11/Intrinsic.h>**, Part 6 of 6**

```
#define XtSetArg(arg,n,d)\
        ((void)( (arg).name = (n), (arg).value = (XtArgVal)(d) ))
#define XtOffset(p_type,field)\
        ((Cardinal) (((char *) (&(((p_type)NULL)->field))) - ((char *) NULL)))

#define XtVaNestedList              "XtVaNestedList"
#define XtVaTypedArg         "XtVaTypedArg"
#define XtUnspecifiedPixmap  ((Pixmap)2)
#define XtUnspecifiedShellInt       (-1)
#define XtUnspecifiedWindow  ((Window)2)
#define XtUnspecifiedWindowGroup ((Window)3)
#define XtDefaultForeground  "XtDefaultForeground"
#define XtDefaultBackground  "XtDefaultBackground"
#define XtDefaultFont        "XtDefaultFont"
#define XtDefaultFontSet            "XtDefaultFontSet"
```

Figure 6-164: <X11/Object.h>

```
extern WidgetClass objectClass;
```

Figure 6-165: <X11/RectObj.h>

```
extern WidgetClass rectObjClass;
```

Figure 6-166: `<X11/extensions/shape.h>`*****

```
#define ShapeSet                0
#define ShapeUnion              1
#define ShapeIntersect          2
#define ShapeSubtract           3
#define ShapeInvert             4

#define ShapeBounding           0
#define ShapeClip               1

#define ShapeNotifyMask         (1L << 0)
#define ShapeNotify             0
```

Figure 6-167: `<X11/Shell.h>`

```
extern WidgetClass shellWidgetClass;
extern WidgetClass overrideShellWidgetClass;
extern WidgetClass wmShellWidgetClass;
extern WidgetClass transientShellWidgetClass;
extern WidgetClass topLevelShellWidgetClass;
extern WidgetClass applicationShellWidgetClass;
```

Figure 6-168: `<X11/Vendor.h>`

```
extern WidgetClass vendorShellWidgetClass;
```

Figure 6-169: <X11/X.h>**, Part 1 of 12**

```
typedef unsigned long XID;

typedef XID Window;
typedef XID Drawable;
typedef XID Font;
typedef XID Pixmap;
typedef XID Cursor;
typedef XID Colormap;
typedef XID GContext;
typedef XID KeySym;

typedef unsigned long Atom;
typedef unsigned long VisualID;
typedef unsigned long Time;
typedef unsigned char KeyCode;

#define AllTemporary      0L
#define AnyButton         0L
#define AnyKey            0L
#define AnyPropertyType   0L
#define CopyFromParent    0L
#define CurrentTime       0L
#define InputFocus        1L
#define NoEventMask       0L
#define None              0L
#define NoSymbol          0L
#define ParentRelative    1L
#define PointerWindow     0L
#define PointerRoot       1L
```

Figure 6-170: `<X11/X.h>`**, Part 2 of 12**

```
#define KeyPressMask              (1L<<0)
#define KeyReleaseMask            (1L<<1)
#define ButtonPressMask           (1L<<2)
#define ButtonReleaseMask         (1L<<3)
#define EnterWindowMask           (1L<<4)
#define LeaveWindowMask           (1L<<5)
#define PointerMotionMask         (1L<<6)
#define PointerMotionHintMask     (1L<<7)
#define Button1MotionMask         (1L<<8)
#define Button2MotionMask         (1L<<9)
#define Button3MotionMask         (1L<<10)
#define Button4MotionMask         (1L<<11)
#define Button5MotionMask         (1L<<12)
#define ButtonMotionMask          (1L<<13)
#define KeymapStateMask           (1L<<14)
#define ExposureMask              (1L<<15)
#define VisibilityChangeMask      (1L<<16)
#define StructureNotifyMask       (1L<<17)
#define ResizeRedirectMask        (1L<<18)
#define SubstructureNotifyMask    (1L<<19)
#define SubstructureRedirectMask (1L<<20)
#define FocusChangeMask           (1L<<21)
#define PropertyChangeMask        (1L<<22)
#define ColormapChangeMask        (1L<<23)
#define OwnerGrabButtonMask       (1L<<24)
```

Figure 6-171: `<X11/X.h>`**, Part 3 of 12**

```
#define KeyPress                2
#define KeyRelease              3
#define ButtonPress             4
#define ButtonRelease           5
#define MotionNotify            6
#define EnterNotify             7
#define LeaveNotify             8
#define FocusIn                 9
#define FocusOut                10
#define KeymapNotify            11
#define Expose                  12
#define GraphicsExpose          13
#define NoExpose                14
#define VisibilityNotify        15
#define CreateNotify            16
#define DestroyNotify           17
#define UnmapNotify             18
#define MapNotify               19
#define MapRequest              20
#define ReparentNotify          21
#define ConfigureNotify         22
#define ConfigureRequest        23
#define GravityNotify           24
#define ResizeRequest           25
#define CirculateNotify         26
#define CirculateRequest        27
#define PropertyNotify          28
#define SelectionClear          29
#define SelectionRequest        30
#define SelectionNotify         31
#define ColormapNotify          32
#define ClientMessage           33
#define MappingNotify           34
#define LASTEvent               35
          /* must be bigger than any event # */
```

Figure 6-172: `<X11/X.h>`**, Part 4 of 12**

```
#define ShiftMask          (1<<0)
#define LockMask           (1<<1)
#define ControlMask        (1<<2)
#define Mod1Mask           (1<<3)
#define Mod2Mask           (1<<4)
#define Mod3Mask           (1<<5)
#define Mod4Mask           (1<<6)
#define Mod5Mask           (1<<7)

#define Button1Mask        (1<<8)
#define Button2Mask        (1<<9)
#define Button3Mask        (1<<10)
#define Button4Mask        (1<<11)
#define Button5Mask        (1<<12)
#define AnyModifier        (1<<15)

#define Button1                  1
#define Button2                  2
#define Button3                  3
#define Button4                  4
#define Button5                  5

#define NotifyNormal             0
#define NotifyGrab               1
#define NotifyUngrab             2
#define NotifyWhileGrabbed       3
#define NotifyHint               1
#define NotifyAncestor           0
#define NotifyVirtual            1
#define NotifyInferior           2
#define NotifyNonlinear          3
#define NotifyNonlinearVirtual   4
#define NotifyPointer            5
#define NotifyPointerRoot        6
#define NotifyDetailNone         7
```

Figure 6-173: <X11/X.h>**, Part 5 of 12**

```
#define VisibilityUnobscured          0
#define VisibilityPartiallyObscured   1
#define VisibilityFullyObscured       2

#define PlaceOnTop              0
#define PlaceOnBottom           1

#define PropertyNewValue        0
#define PropertyDelete          1

#define ColormapUninstalled     0
#define ColormapInstalled       1

#define GrabModeSync            0
#define GrabModeAsync           1

#define GrabSuccess             0
#define AlreadyGrabbed          1
#define GrabInvalidTime         2
#define GrabNotViewable         3
#define GrabFrozen              4

#define AsyncPointer            0
#define SyncPointer             1
#define ReplayPointer           2
#define AsyncKeyboard           3
#define SyncKeyboard            4
#define ReplayKeyboard          5
#define AsyncBoth               6
#define SyncBoth                7

#define RevertToNone            (int)None
#define RevertToPointerRoot     (int)PointerRoot
#define RevertToParent          2
```

Figure 6-174: `<X11/X.h>`**, Part 6 of 12**

```
#define Success           0
#define BadRequest        1
#define BadValue          2
#define BadWindow         3
#define BadPixmap         4
#define BadAtom           5
#define BadCursor         6
#define BadFont           7
#define BadMatch          8
#define BadDrawable       9
#define BadAccess         10
#define BadAlloc          11
#define BadColor          12
#define BadGC             13
#define BadIDChoice       14
#define BadName           15
#define BadLength         16
#define BadImplementation 17

#define InputOutput       1
#define InputOnly         2

#define CWBackPixmap      (1L<<0)
#define CWBackPixel       (1L<<1)
#define CWBorderPixmap    (1L<<2)
#define CWBorderPixel     (1L<<3)
#define CWBitGravity      (1L<<4)
#define CWWinGravity      (1L<<5)
#define CWBackingStore    (1L<<6)
#define CWBackingPlanes   (1L<<7)
#define CWBackingPixel    (1L<<8)
#define CWOverrideRedirect(1L<<9)
#define CWSaveUnder       (1L<<10)
#define CWEventMask       (1L<<11)
#define CWDontPropagate   (1L<<12)
#define CWColormap        (1L<<13)
#define CWCursor          (1L<<14)
```

Figure 6-175: `<X11/X.h>`**, Part 7 of 12**

```
#define CWX                  (1<<0)
#define CWY                  (1<<1)
#define CWWidth              (1<<2)
#define CWHeight             (1<<3)
#define CWBorderWidth        (1<<4)
#define CWSibling            (1<<5)
#define CWStackMode          (1<<6)

#define ForgetGravity               0
#define NorthWestGravity            1
#define NorthGravity                2
#define NorthEastGravity            3
#define WestGravity                 4
#define CenterGravity               5
#define EastGravity                 6
#define SouthWestGravity            7
#define SouthGravity                8
#define SouthEastGravity            9
#define StaticGravity               10
#define UnmapGravity                0

#define NotUseful                   0
#define WhenMapped                  1
#define Always                      2

#define IsUnmapped                  0
#define IsUnviewable                1
#define IsViewable                  2

#define SetModeInsert               0
#define SetModeDelete               1

#define DestroyAll                  0
#define RetainPermanent             1
#define RetainTemporary             2
```

Figure 6-176: `<X11/X.h>`**, Part 8 of 12**

```
#define Above            0
#define Below            1
#define TopIf            2
#define BottomIf         3
#define Opposite         4
#define RaiseLowest      0
#define LowerHighest     1
#define PropModeReplace  0
#define PropModePrepend  1
#define PropModeAppend   2

#define GXclear          0x0
#define GXand            0x1
#define GXandReverse     0x2
#define GXcopy           0x3
#define GXandInverted    0x4
#define GXnoop           0x5
#define GXxor            0x6
#define GXor             0x7
#define GXnor            0x8
#define GXequiv          0x9
#define GXinvert         0xa
#define GXorReverse      0xb
#define GXcopyInverted   0xc
#define GXorInverted     0xd
#define GXnand           0xe
#define GXset            0xf

#define LineSolid        0
#define LineOnOffDash    1
#define LineDoubleDash   2
#define CapNotLast       0
#define CapButt          1
#define CapRound         2
#define CapProjecting    3
```

Figure 6-177: <X11/X.h>**, Part 9 of 12**

```
#define JoinMiter        0
#define JoinRound        1
#define JoinBevel        2

#define FillSolid        0
#define FillTiled        1
#define FillStippled     2
#define FillOpaqueStippled3

#define EvenOddRule      0
#define WindingRule      1

#define ClipByChildren   0
#define IncludeInferiors 1

#define Unsorted         0
#define YSorted          1
#define YXSorted         2
#define YXBanded         3

#define CoordModeOrigin  0
#define CoordModePrevious 1

#define Complex          0
#define Nonconvex        1
#define Convex           2

#define ArcChord         0
#define ArcPieSlice      1
```

Figure 6-178: `<X11/X.h>`**, Part 10 of 12**

```
#define GCFunction              (1L<<0)
#define GCPlaneMask             (1L<<1)
#define GCForeground            (1L<<2)
#define GCBackground            (1L<<3)
#define GCLineWidth             (1L<<4)
#define GCLineStyle             (1L<<5)
#define GCCapStyle              (1L<<6)
#define GCJoinStyle             (1L<<7)
#define GCFillStyle             (1L<<8)
#define GCFillRule              (1L<<9)
#define GCTile                  (1L<<10)
#define GCStipple               (1L<<11)
#define GCTileStipXOrigin       (1L<<12)
#define GCTileStipYOrigin       (1L<<13)
#define GCFont                  (1L<<14)
#define GCSubwindowMode         (1L<<15)
#define GCGraphicsExposures     (1L<<16)
#define GCClipXOrigin           (1L<<17)
#define GCClipYOrigin           (1L<<18)
#define GCClipMask              (1L<<19)
#define GCDashOffset            (1L<<20)
#define GCDashList              (1L<<21)
#define GCArcMode               (1L<<22)

#define FontLeftToRight         0
#define FontRightToLeft         1

#define XYBitmap                0
#define XYPixmap                1
#define ZPixmap                 2

#define AllocNone               0
#define AllocAll                1

#define DoRed                   (1<<0)
#define DoGreen                 (1<<1)
#define DoBlue                  (1<<2)
```

Figure 6-179: <X11/X.h>**, Part 11 of 12**

```
#define CursorShape             0
#define TileShape               1
#define StippleShape            2

#define AutoRepeatModeOff       0
#define AutoRepeatModeOn        1
#define AutoRepeatModeDefault   2

#define LedModeOff              0
#define LedModeOn               1

#define KBKeyClickPercent       (1L<<0)
#define KBBellPercent           (1L<<1)
#define KBBellPitch             (1L<<2)
#define KBBellDuration          (1L<<3)
#define KBLed                   (1L<<4)
#define KBLedMode               (1L<<5)
#define KBKey                   (1L<<6)
#define KBAutoRepeatMode        (1L<<7)

#define MappingSuccess          0
#define MappingBusy             1
#define MappingFailed           2

#define MappingModifier         0
#define MappingKeyboard         1
#define MappingPointer          2
#define DontPreferBlanking      0
#define PreferBlanking          1
#define DefaultBlanking         2

#define DontAllowExposures      0
#define AllowExposures          1
#define DefaultExposures        2
```

Figure 6-180: <X11/X.h>**, Part 12 of 12**

```
#define ScreenSaverReset  0
#define ScreenSaverActive 1

#define EnableAccess      1
#define DisableAccess     0
#define StaticGray        0
#define GrayScale         1

#define StaticColor       2
#define PseudoColor       3
#define TrueColor         4
#define DirectColor       5

#define LSBFirst          0
#define MSBFirst          1
```

Figure 6-181: <X11/Xcms.h>**, Part 1 of 5**

```
#define XcmsFailure                     0
#define XcmsSuccess                     1
#define XcmsSuccessWithCompression      2

#define XcmsUndefinedFormat      (XcmsColorFormat)0x00000000
#define XcmsCIEXYZFormat         (XcmsColorFormat)0x00000001
#define XcmsCIEuvYFormat         (XcmsColorFormat)0x00000002
#define XcmsCIExyYFormat         (XcmsColorFormat)0x00000003
#define XcmsCIELabFormat         (XcmsColorFormat)0x00000004
#define XcmsCIELuvFormat         (XcmsColorFormat)0x00000005
#define XcmsTekHVCFormat         (XcmsColorFormat)0x00000006
#define XcmsRGBFormat            (XcmsColorFormat)0x80000000
#define XcmsRGBiFormat           (XcmsColorFormat)0x80000001

#define XcmsInitNone             0x00
#define XcmsInitSuccess          0x01

typedef unsigned int XcmsColorFormat;

typedef double XcmsFloat;

typedef struct {
      unsigned short red;
      unsigned short green;
      unsigned short blue;
} XcmsRGB;
```

Figure 6-182: <X11/Xcms.h>**, Part 2 of 5**

```
typedef struct {
      XcmsFloat red;
      XcmsFloat green;
      XcmsFloat blue;
} XcmsRGBi;

typedef struct {
      XcmsFloat X;
      XcmsFloat Y;
      XcmsFloat Z;
} XcmsCIEXYZ;

typedef struct {
      XcmsFloat u_prime;
      XcmsFloat v_prime;
      XcmsFloat Y;
} XcmsCIEuvY;

typedef struct {
      XcmsFloat x;
      XcmsFloat y;
      XcmsFloat Y;
} XcmsCIExyY;

typedef struct {
      XcmsFloat L_star;
      XcmsFloat a_star;
      XcmsFloat b_star;
} XcmsCIELab;
```

Figure 6-183: `<X11/Xcms.h>`**, Part 3 of 5**

```
typedef struct {
      XcmsFloat L_star;
      XcmsFloat u_star;
      XcmsFloat v_star;
} XcmsCIELuv;

typedef struct {
      XcmsFloat H;
      XcmsFloat V;
      XcmsFloat C;
} XcmsTekHVC;

typedef struct {
      XcmsFloat pad0;
      XcmsFloat pad1;
      XcmsFloat pad2;
      XcmsFloat pad3;
} XcmsPad;
```

Figure 6-184: <X11/Xcms.h>**, Part 4 of 5**

```
typedef struct {
      union {
            XcmsRGB      RGB;
            XcmsRGBi     RGBi;
            XcmsCIEXYZ   CIEXYZ;
            XcmsCIEuvY   CIEuvY;
            XcmsCIExyY   CIExyY;
            XcmsCIELab   CIELab;
            XcmsCIELuv   CIELuv;
            XcmsTekHVC   TekHVC;
            XcmsPad      Pad;
      }     spec;
      unsigned longpixel;
      XcmsColorFormat    format;
} XcmsColor;

typedef struct {
      XcmsColor          screenWhitePt;
      XPointer           functionSet;
      XPointer           screenData;
      unsigned char      state;
      char               pad[3];
} XcmsPerScrnInfo;

typedef void *XcmsCCC;

typedef Status (*XcmsConversionProc)();
typedef XcmsConversionProc *XcmsFuncListPtr;
```

Figure 6-185: <X11/Xcms.h>**, Part 5 of 5**

```
typedef struct {
      char                        *prefix;
      XcmsColorFormat             id;
      XcmsParseStringProc         parseString;
      XcmsFuncListPtr             to_CIEXYZ;
      XcmsFuncListPtr             from_CIEXYZ;
      int                         inverse_flag;
} XcmsColorSpace;

typedef struct {
      XcmsColorSpace              **DDColorSpaces;
      XcmsScreenInitProc          screenInitProc;
      XcmsScreenFreeProc          screenFreeProc;
} XcmsFunctionSet;
```

Figure 6-186: `<X11/Xlib.h>`**, Part 1 of 27**

```
typedef void *XPointer;

#define Bool                        int
#define Status                      int
#define True                        1
#define False                       0
#define QueuedAlready               0
#define QueuedAfterReading          1
#define QueuedAfterFlush            2

#define AllPlanes                   ((unsigned long)~0L)
```

Figure 6-187: `<X11/Xlib.h>`**, Part 2 of 27**

```
typdef void XExtData;

typdef void XExtCodes;

typedef struct {
        int depth;
        int bits_per_pixel;
        int scanline_pad;
} XPixmapFormatValues;
```

Figure 6-188: `<X11/Xlib.h>`**, Part 3 of 27**

```
typedef struct {
      int function;
      unsigned long plane_mask;
      unsigned long foreground;
      unsigned long background;
      int line_width;
      int line_style;
      int cap_style;
      int join_style;
      int fill_style;
      int fill_rule;
      int arc_mode;
      Pixmap tile;
      Pixmap stipple;
      int ts_x_origin;
      int ts_y_origin;
      Font font;
      int subwindow_mode;
      Bool graphics_exposures;
      int clip_x_origin;
      int clip_y_origin;
      Pixmap clip_mask;
      int dash_offset;
      char dashes;
} XGCValues;

typedef void *GC;

typedef struct _dummy Visual;
```

Figure 6-189: `<X11/Xlib.h>`**, Part 4 of 27**

```
typedef struct _dummy Screen;

typedef struct {
	Pixmap background_pixmap;
	unsigned long background_pixel;
	Pixmap border_pixmap;
	unsigned long border_pixel;
	int bit_gravity;
	int win_gravity;
	int backing_store;
	unsigned long backing_planes;
	unsigned long backing_pixel;
	Bool save_under;
	long event_mask;
	long do_not_propagate_mask;
	Bool override_redirect;
	Colormap colormap;
	Cursor cursor;
} XSetWindowAttributes;
```

Figure 6-190: <X11/Xlib.h>**, Part 5 of 27**

```
typedef struct _dummy ScreenFormat;

typedef struct {
      int x, y;
      int width, height;
      int border_width;
      int depth;
      Visual *visual;
      Window root;
      int class;
      int bit_gravity;
      int win_gravity;
      int backing_store;
      unsigned long backing_planes;
      unsigned long backing_pixel;
      Bool save_under;
      Colormap colormap;
      Bool map_installed;
      int map_state;
      long all_event_masks;
      long your_event_mask;
      long do_not_propagate_mask;
      Bool override_redirect;
      Screen *screen;
} XWindowAttributes;
```

Figure 6-191: <X11/Xlib.h>**, Part 6 of 27**

```
typedef struct {
        int family;
        int length;
        char *address;
} XHostAddress;

typedef struct _XImage {
        int width, height;
        int xoffset;
        int format;
        char *data;
        int byte_order;
        int bitmap_unit;
        int bitmap_bit_order;
        int bitmap_pad;
        int depth;
        int bytes_per_line;
        int bits_per_pixel;
        unsigned long red_mask;
        unsigned long green_mask;
        unsigned long blue_mask;
        XPointer obdata;
        struct funcs {
                struct _XImage *(*create_image)();
                int (*destroy_image)();
                unsigned long (*get_pixel)();
                int (*put_pixel)();
                struct _XImage *(*sub_image)();
                int (*add_pixel)();
        } f;
} XImage;
```

Figure 6-192: `<X11/Xlib.h>`**, Part 7 of 27**

```
typedef struct {
        int x, y;
        int width, height;
        int border_width;
        Window sibling;
        int stack_mode;
} XWindowChanges;

typedef struct {
        unsigned long pixel;
        unsigned short red, green, blue;
        char flags;
        char pad;
} XColor;

typedef struct {
        short x1, y1, x2, y2;
} XSegment;

typedef struct {
        short x, y;
} XPoint;

typedef struct {
        short x, y;
        unsigned short width, height;
} XRectangle;

typedef struct {
        short x, y;
        unsigned short width, height;
        short angle1, angle2;
} XArc;
```

Figure 6-193: `<X11/Xlib.h>`**, Part 8 of 27**

```
typedef struct {
      int key_click_percent;
      int bell_percent;
      int bell_pitch;
      int bell_duration;
      int led;
      int led_mode;
      int key;
      int auto_repeat_mode;
} XKeyboardControl;

typedef struct {
      int key_click_percent;
      int bell_percent;
      unsigned int bell_pitch, bell_duration;
      unsigned long led_mask;
      int global_auto_repeat;
      char auto_repeats[32];
} XKeyboardState;
typedef struct {
      Time time;
      short x, y;
} XTimeCoord;

typedef struct {
      int          max_keypermod;
      KeyCode      *modifiermap;
} XModifierKeymap;

typedef struct _dummy Display;
```

Figure 6-194: `<X11/Xlib.h>`**, Part 9 of 27**

```
typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Window root;
	Window subwindow;
	Time time;
	int x, y;
	int x_root, y_root;
	unsigned int state;
	unsigned int keycode;
	Bool same_screen;
} XKeyEvent;
typedef XKeyEvent XKeyPressedEvent;
typedef XKeyEvent XKeyReleasedEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Window root;
	Window subwindow;
	Time time;
	int x, y;
	int x_root, y_root;
	unsigned int state;
	unsigned int button;
	Bool same_screen;
} XButtonEvent;
typedef XButtonEvent XButtonPressedEvent;
typedef XButtonEvent XButtonReleasedEvent;
```

Figure 6-195: `<X11/Xlib.h>`**, Part 10 of 27**

```
typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Window root;
	Window subwindow;
	Time time;
	int x, y;
	int x_root, y_root;
	unsigned int state;
	char is_hint;
	Bool same_screen;
} XMotionEvent;
typedef XMotionEvent XPointerMovedEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Window root;
	Window subwindow;
	Time time;
	int x, y;
	int x_root, y_root;
	int mode;
	int detail;
	Bool same_screen;
	Bool focus;
	unsigned int state;
} XCrossingEvent;
```

Figure 6-196: `<X11/Xlib.h>`**, Part 11 of 27**

```
typedef XCrossingEvent XEnterWindowEvent;
typedef XCrossingEvent XLeaveWindowEvent;
typedef struct {
        int type;
        unsigned long serial;
        Bool send_event;
        Display *display;
        Window window;
        int mode;
        int detail;
} XFocusChangeEvent;
typedef XFocusChangeEvent XFocusInEvent;
typedef XFocusChangeEvent XFocusOutEvent;

typedef struct {
        int type;
        unsigned long serial;
        Bool send_event;
        Display *display;
        Window window;
        char key_vector[32];
} XKeymapEvent;

typedef struct {
        int type;
        unsigned long serial;
        Bool send_event;
        Display *display;
        Window window;
        int x, y;
        int width, height;
        int count;
} XExposeEvent;
```

Figure 6-197: `<X11/Xlib.h>`**, Part 12 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Drawable drawable;
      int x, y;
      int width, height;
      int count;
      int major_code;
      int minor_code;
} XGraphicsExposeEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Drawable drawable;
      int major_code;
      int minor_code;
} XNoExposeEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window window;
      int state;
} XVisibilityEvent;
```

Figure 6-198: `<X11/Xlib.h>`**, Part 13 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window parent;
      Window window;
      int x, y;
      int width, height;
      int border_width;
      Bool override_redirect;
} XCreateWindowEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window event;
      Window window;
} XDestroyWindowEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window event;
      Window window;
      Bool from_configure;
} XUnmapEvent;
```

Figure 6-199: `<X11/Xlib.h>`**, Part 14 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window event;
      Window window;
      Bool override_redirect;
} XMapEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window parent;
      Window window;
} XMapRequestEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window event;
      Window window;
      Window parent;
      int x, y;
      Bool override_redirect;
} XReparentEvent;
```

Figure 6-200: `<X11/Xlib.h>`**, Part 15 of 27**

```
typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window event;
	Window window;
	int x, y;
	int width, height;
	int border_width;
	Window above;
	Bool override_redirect;
} XConfigureEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window event;
	Window window;
	int x, y;
} XGravityEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	int width, height;
} XResizeRequestEvent;
```

Figure 6-201: `<X11/Xlib.h>`**, Part 16 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window parent;
      Window window;
      int x, y;
      int width, height;
      int border_width;
      Window above;
      int detail;
      unsigned long value_mask;
} XConfigureRequestEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window event;
      Window window;
      int place;
} XCirculateEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window parent;
      Window window;
      int place;
} XCirculateRequestEvent;
```

Figure 6-202: `<X11/Xlib.h>`**, Part 17 of 27**

```
typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Atom atom;
	Time time;
	int state;
} XPropertyEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window window;
	Atom selection;
	Time time;
} XSelectionClearEvent;

typedef struct {
	int type;
	unsigned long serial;
	Bool send_event;
	Display *display;
	Window owner;
	Window requestor;
	Atom selection;
	Atom target;
	Atom property;
	Time time;
} XSelectionRequestEvent;
```

Figure 6-203: `<X11/Xlib.h>`**, Part 18 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window requestor;
      Atom selection;
      Atom target;
      Atom property;
      Time time;
} XSelectionEvent;

typedef struct {
      int type;
      Display *display;
      XID resourceid;
      unsigned long serial;
      unsigned char error_code;
      unsigned char request_code;
      unsigned char minor_code;
} XErrorEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window window;
      Atom message_type;
      int format;
      union {
            char b[20];
            short s[10];
            long l[5];
      } data;
} XClientMessageEvent;
```

Figure 6-204: `<X11/Xlib.h>`**, Part 19 of 27**

```
typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window window;
      Colormap colormap;
      Bool new;
      int state;
} XColormapEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window window;
      int request;
      int first_keycode;
      int count;
} XMappingEvent;

typedef struct {
      int type;
      unsigned long serial;
      Bool send_event;
      Display *display;
      Window window;
} XAnyEvent;
```

Figure 6-205: <X11/Xlib.h>**, Part 20 of 27**

```
typedef union _XEvent {
       int                         type;
       XAnyEvent                   xany;
       XKeyEvent                   xkey;
       XButtonEvent                xbutton;
       XMotionEvent                xmotion;
       XCrossingEvent              xcrossing;
       XFocusChangeEvent           xfocus;
       XExposeEvent                xexpose;
       XGraphicsExposeEvent        xgraphicsexpose;
       XNoExposeEvent              xnoexpose;
       XVisibilityEvent            xvisibility;
       XCreateWindowEvent          xcreatewindow;
       XDestroyWindowEvent         xdestroywindow;
       XUnmapEvent                 xunmap;
       XMapEvent                   xmap;
       XMapRequestEvent            xmaprequest;
       XReparentEvent              xreparent;
       XConfigureEvent             xconfigure;
       XGravityEvent               xgravity;
       XResizeRequestEvent         xresizerequest;
       XConfigureRequestEvent      xconfigurerequest;
       XCirculateEvent             xcirculate;
       XCirculateRequestEvent      xcirculaterequest;
       XPropertyEvent              xproperty;
       XSelectionClearEvent        xselectionclear;
       XSelectionRequestEvent      xselectionrequest;
       XSelectionEvent             xselection;
       XColormapEvent              xcolormap;
       XClientMessageEvent         xclient;
       XMappingEvent               xmapping;
       XErrorEvent                 xerror;
       XKeymapEvent                xkeymap;
       long                        pad[24];
} XEvent;
```

Figure 6-206: `<X11/Xlib.h>`**, Part 21 of 27**

```
typedef struct {
       short  lbearing;
       short  rbearing;
       short  width;
       short  ascent;
       short  descent;
       unsigned short attributes;
} XCharStruct;

typedef struct {
       Atom name;
       unsigned long card32;
} XFontProp;

typedef struct {
       XExtData     *ext_data;
       Font         fid;
       unsigned     direction;
       unsigned     min_char_or_byte2;
       unsigned     max_char_or_byte2;
       unsigned     min_byte1;
       unsigned     max_byte1;
       Bool         all_chars_exist;
       unsigned     default_char;
       int          n_properties;
       XFontProp    *properties;
       XCharStruct  min_bounds;
       XCharStruct  max_bounds;
       XCharStruct  *per_char;
       int          ascent;
       int          descent;
} XFontStruct;
```

Figure 6-207: <X11/Xlib.h>**, Part 22 of 27**

```
typedef struct {
      char *chars;
      int nchars;
      int delta;
      Font font;
} XTextItem;

typedef struct {
      unsigned char byte1;
      unsigned char byte2;
} XChar2b;

typedef struct {
      XChar2b *chars;
      int nchars;
      int delta;
      Font font;
} XTextItem16;

typedef union {
      Display *display;
      GC gc;
      Visual *visual;
      Screen *screen;
      ScreenFormat *pixmap_format;
      XFontStruct *font;
} XEDataObject;

typedef struct {
      XRectangle   max_ink_extent;
      XRectangle   max_logical_extent;
} XFontSetExtents;

typedef struct _dummy XFontSet;
```

Figure 6-208: <X11/Xlib.h>**, Part 23 of 27**

```
typedef struct {
      char          *chars;
      int           nchars;
      int           delta;
      XFontSet      *font_set;
} XmbTextItem;

typedef struct {
      wchar_t       *chars;
      int           nchars;
      int           delta;
      XFontSet      font_set;
} XwcTextItem;

typedef void (*XIMProc)();

typedef void *XIM;
typ
```

Figure 6-209: `<X11/Xlib.h>`**, Part 24 of 27**

```
#define XNVaNestedList           "XNVaNestedList"
#define XNQueryInputStyle        "queryInputStyle"
#define XNClientWindow           "clientWindow"
#define XNInputStyle             "inputStyle"
#define XNFocusWindow            "focusWindow"
#define XNResourceName           "resourceName"
#define XNResourceClass          "resourceClass"
#define XNGeometryCallback       "geometryCallback"
#define XNFilterEvents           "filterEvents"
#define XNPreeditStartCallback   "preeditStartCallback"
#define XNPreeditDoneCallback    "preeditDoneCallback"
#define XNPreeditDrawCallback    "preeditDrawCallback"
#define XNPreeditCaretCallback   "preeditCaretCallback"
#define XNPreeditAttributes      "preeditAttributes"
#define XNStatusStartCallback    "statusStartCallback"
#define XNStatusDoneCallback     "statusDoneCallback"
#define XNStatusDrawCallback     "statusDrawCallback"
#define XNStatusAttributes       "statusAttributes"
#define XNArea                   "area"
#define XNAreaNeeded             "areaNeeded"
#define XNSpotLocation           "spotLocation"
#define XNColormap               "colorMap"
#define XNStdColormap            "stdColorMap"
#define XNForeground             "foreground"
#define XNBackground             "background"
#define XNBackgroundPixmap       "backgroundPixmap"
#define XNFontSet                "fontSet"
#define XNLineSpace              "lineSpace"
#define XNCursor                 "cursor"
```

Figure 6-210: `<X11/Xlib.h>`**, Part 25 of 27**

```
#define XBufferOverflow   -1
#define XLookupNone       1
#define XLookupChars      2
#define XLookupKeySym     3
#define XLookupBoth       4

typedef XPointer XVaNestedList;

typedef struct {
      XPointer client_data;
      XIMProc callback;
} XIMCallback;

typedef unsigned long XIMFeedback;

#define XIMReverse        1
#define XIMUnderline      (1<<1)
#define XIMHighlight      (1<<2)
#define XIMPrimary        (1<<5)
#define XIMSecondary      (1<<6)
#define XIMTertiary       (1<<7)

typedef struct _XIMText {
      unsigned short length;
      XIMFeedback *feedback;
      Bool encoding_is_wchar;
      union {
            char *multi_byte;
            wchar_t *wide_char;
      } string;
} XIMText;
```

Figure 6-211: `<X11/Xlib.h>`**, Part 26 of 27**

```
typedef struct _XIMPreeditDrawCallbackStruct {
      int caret;
      int chg_first;
      int chg_length;
      XIMText *text;
} XIMPreeditDrawCallbackStruct;

typedef enum {
      XIMForwardChar, XIMBackwardChar,
      XIMForwardWord, XIMBackwardWord,
      XIMCaretUp, XIMCaretDown,
      XIMNextLine, XIMPreviousLine,
      XIMLineStart, XIMLineEnd,
      XIMAbsolutePosition,
      XIMDontChange
} XIMCaretDirection;

typedef enum {
      XIMIsInvisible,
      XIMIsPrimary,
      XIMIsSecondary
} XIMCaretStyle;

typedef struct _XIMPreeditCaretCallbackStruct {
      int position;
      XIMCaretDirection direction;
      XIMCaretStyle style;
} XIMPreeditCaretCallbackStruct;
```

Figure 6-212: <X11/Xlib.h>**, Part 27 of 27**

```
typedef enum {
      XIMTextType,
      XIMBitmapType
} XIMStatusDataType;

typedef struct _XIMStatusDrawCallbackStruct {
      XIMStatusDataType type;
      union {
            XIMText *text;
            Pixmap bitmap;
      } data;
} XIMStatusDrawCallbackStruct;
```

Figure 6-213: `<X11/Xresource.h>`**, Part 1 of 2**

```
typedef int           XrmQuark, *XrmQuarkList;
#define NULLQUARK     ((XrmQuark) 0)

typedef enum {XrmBindTightly, XrmBindLoosely} \
              XrmBinding, *XrmBindingList;

typedef XrmQuark                    XrmName;
typedef XrmQuarkList                XrmNameList;
typedef XrmQuark                    XrmClass;
typedef XrmQuarkList                XrmClassList;
typedef XrmQuark                    XrmRepresentation;

#define XrmStringToName(string)           XrmStringToQuark(string)
#define XrmStringToNameList(str, name)    XrmStringToQuarkList(str, name)
#define XrmStringToClass(class)           XrmStringToQuark(class)
#define XrmStringToClassList(str,class)   XrmStringToQuarkList(str, class)
#define XrmStringToRepresentation(string) XrmStringToQuark(string)

typedef struct {
       unsigned int         size;
       XPointer             addr;
} XrmValue, *XrmValuePtr;

typedef void                *XrmHashBucket;
typedef XrmHashBucket       *XrmHashTable;
typedef XrmHashTable         XrmSearchList[];
typedef void                *XrmDatabase;

#define XrmEnumAllLevels            0
#define XrmEnumOneLevel             1
```

Figure 6-214: `<X11/Xresource.h>`**, Part 2 of 2**

```
typedef enum {
       XrmoptionNoArg,
       XrmoptionIsArg,
       XrmoptionStickyArg,
       XrmoptionSepArg,
       XrmoptionResArg,
       XrmoptionSkipArg,
       XrmoptionSkipLine,
       XrmoptionSkipNArgs
} XrmOptionKind;

typedef struct {
       char                *option;
       char                *specifier;
       XrmOptionKind       argKind;
       XPointer            value;
} XrmOptionDescRec, *XrmOptionDescList;
```

Figure 6-215: `<X11/Xutil.h>`**, Part 1 of 5**

```
#define NoValue      0x0000
#define XValue 0x0001
#define YValue 0x0002
#define WidthValue   0x0004
#define HeightValue  0x0008
#define AllValues    0x000F
#define XNegative    0x0010
#define YNegative    0x0020

typedef struct {
       long flags;
       int x, y;
       int width, height;
       int min_width, min_height;
       int max_width, max_height;
       int width_inc, height_inc;
       struct {
              int x;
              int y;
       } min_aspect, max_aspect;
       int base_width, base_height;
       int win_gravity;
} XSizeHints;

#define USPosition   (1L << 0)
#define USSize (1L << 1)
#define PPosition    (1L << 2)
#define PSize        (1L << 3)
#define PMinSize     (1L << 4)
#define PMaxSize     (1L << 5)
#define PResizeInc   (1L << 6)
#define PAspect      (1L << 7)
#define PBaseSize    (1L << 8)
#define PWinGravity  (1L << 9)
#define PAllHints (PPosition|PSize|PMinSize|PMaxSize|PResizeInc|PAspect)
```

Figure 6-216: <X11/Xutil.h>**, Part 2 of 5**

```
typedef struct {
        long   flags;
        Bool   input;
        int    initial_state;
        Pixmap icon_pixmap;
        Window icon_window;
        int    icon_x, icon_y;
        Pixmap icon_mask;
        XID    window_group;
} XWMHints;

#define InputHint           (1L << 0)
#define StateHint           (1L << 1)
#define IconPixmapHint      (1L << 2)
#define IconWindowHint      (1L << 3)
#define IconPositionHint    (1L << 4)
#define IconMaskHint  (1L << 5)
#define WindowGroupHint     (1L << 6)
#define AllHints (InputHint|StateHint|
        IconPixmapHint|IconWindowHint|
        IconPositionHint|IconMaskHint|WindowGroupHint)

#define WithdrawnState      0
#define NormalState         1
#define IconicState         3

typedef struct {
        unsigned char       *value;
        Atom                encoding;
        int                 format;
        unsigned long       nitems;
} XTextProperty;

#define XNoMemory                  -1
#define XLocaleNotSupported  -2
#define XConverterNotFound         -3
```

Figure 6-217: `<X11/Xutil.h>`**, Part 3 of 5**

```
typedef int XContext;

typedef enum {
        XStringStyle,
        XCompoundTextStyle,
        XTextStyle,
        XStdICCTextStyle
} XICCEncodingStyle;

typedef struct {
        int min_width, min_height;
        int max_width, max_height;
        int width_inc, height_inc;
} XIconSize;

typedef struct {
        char *res_name;
        char *res_class;
} XClassHint;

#define XDestroyImage(ximage)
        ((*((ximage)->f.destroy_image))((ximage)))
#define XGetPixel(ximage, x, y)
        ((*((ximage)->f.get_pixel))((ximage), (x), (y)))
#define XPutPixel(ximage, x, y, pixel)
        ((*((ximage)->f.put_pixel))((ximage), (x), (y), (pixel)))
#define XSubImage(ximage, x, y, width, height)
        ((*((ximage)->f.sub_image))((ximage), (x), (y), (width), (height)))
#define XAddPixel(ximage, value)
        ((*((ximage)->f.add_pixel))((ximage), (value)))

typedef struct _XComposeStatus {
        XPointer compose_ptr;
        int chars_matched;
} XComposeStatus;
```

Figure 6-218: <X11/Xutil.h>**, Part 4 of 5**

```
#define IsKeypadKey(keysym)
        (((unsigned)(keysym) >= XK_KP_Space) && \
        ((unsigned)(keysym) <= XK_KP_Equal))
#define IsCursorKey(keysym)
        (((unsigned)(keysym) >= XK_Home) && \
        ((unsigned)(keysym) < XK_Select))
#define IsPFKey(keysym)
        (((unsigned)(keysym) >= XK_KP_F1) && \
        ((unsigned)(keysym) <= XK_KP_F4))
#define IsFunctionKey(keysym)
        (((unsigned)(keysym) >= XK_F1) && ((unsigned)(keysym) <= XK_F35))
#define IsMiscFunctionKey(keysym)
        (((unsigned)(keysym) >= XK_Select) && \
        ((unsigned)(keysym) <= XK_Break))
#define IsModifierKey(keysym)
        ((((unsigned)(keysym) >= XK_Shift_L) && \
        ((unsigned)(keysym) <= XK_Hyper_R))
        || ((unsigned)(keysym) == XK_Mode_switch)
        || ((unsigned)(keysym) == XK_Num_Lock))

typedef void *Region;

#define RectangleOut  0
#define RectangleIn          1
#define RectanglePart 2

typedef struct {
        Visual *visual;
        VisualID visualid;
        int     screen;
        int     depth;
        int     class;
        unsigned long red_mask;
        unsigned long green_mask;
        unsigned long blue_mask;
        int     colormap_size;
        int     bits_per_rgb;
} XVisualInfo;
```

Figure 6-219: `<X11/Xutil.h>`**, Part 5 of 5**

```
#define VisualNoMask         0x0
#define VisualIDMask         0x1
#define VisualScreenMask            0x2
#define VisualDepthMask             0x4
#define VisualClassMask             0x8
#define VisualRedMaskMask           0x10
#define VisualGreenMaskMask  0x20
#define VisualBlueMaskMask          0x40
#define VisualColormapSizeMask      0x80
#define VisualBitsPerRGBMask 0x100
#define VisualAllMask        0x1FF

typedef struct {
       Colormap             colormap;
       unsigned long        red_max;
       unsigned long        red_mult;
       unsigned long        green_max;
       unsigned long        green_mult;
       unsigned long        blue_max;
       unsigned long        blue_mult;
       unsigned long        base_pixel;
       VisualID             visualid;
       XID                  killid;
} XStandardColormap;

#define ReleaseByFreeingColormap ((XID) 1L)
#define BitmapSuccess        0
#define BitmapOpenFailed            1
#define BitmapFileInvalid           2
#define BitmapNoMemory              3
#define XCSUCCESS                   0
#define XCNOMEM                     1
#define XCNOENT                     2
#define XUniqueContext()     ((XContext) XrmUniqueQuark())
```

M

Motif 1.2 Data Definitions

This section contains standard data definitions that describe system data for the optional Motif 1.2 libraries. These data definitions are referred to by their names in angle brackets: <*name.h*> and <sys / *name.h*>. Included in these data definitions are macro definitions and structure definitions. While an ABI-conforming system may provide Motif 1.2 interfaces, it need not contain the actual data definitions referenced here. Programmers should observe that the sources of the structures defined in these data definitions are defined in SVID or the appropriate Motif documentation (see chapter 10 in the Generic ABI).

Figure 6-220: <Xm/ArrowB.h>*

```
typedef struct _XmArrowButtonClassRec * XmArrowButtonWidgetClass;
typedef struct _XmArrowButtonRec      * XmArrowButtonWidget;
```

Figure 6-221: <Xm/ArrowBG.h>*

```
typedef struct _XmArrowButtonGadgetClassRec * XmArrowButtonGadgetClass;
typedef struct _XmArrowButtonGadgetRec      * XmArrowButtonGadget;
```

Figure 6-222: <Xm/BulletinB.h>*

```
typedef struct _XmBulletinBoardClassRec * XmBulletinBoardWidgetClass;
typedef struct _XmBulletinBoardRec      * XmBulletinBoardWidget;
```

Figure 6-223: <Xm/CascadeB.h>*

```
typedef struct _XmCascadeButtonRec      * XmCascadeButtonWidget;
typedef struct _XmCascadeButtonClassRec * XmCascadeButtonWidgetClass;
```

Figure 6-224: `<Xm/CascadeBG.h>`*

```
typedef struct _XmCascadeButtonGadgetClassRec    * XmCascadeButtonGadgetClass;
typedef struct _XmCascadeButtonGadgetRec         * XmCascadeButtonGadget;
typedef struct _XmCascadeButtonGCacheObjRec      * XmCascadeButtonGCacheObject;
```

Figure 6-225: `<Xm/Command.h>`*

```
typedef struct _XmCommandClassRec * XmCommandWidgetClass;
typedef struct _XmCommandRec      * XmCommandWidget;
```

Figure 6-226: `<Xm/CutPaste.h>`*

```
#define XmClipboardFail         0
#define XmClipboardSuccess      1
#define XmClipboardTruncate     2
#define XmClipboardLocked       4
#define XmClipboardBadFormat    5
#define XmClipboardNoData       6
#define ClipboardFail           0

#define ClipboardSuccess        1
#define ClipboardTruncate       2
#define ClipboardLocked         4
#define ClipboardBadFormat      5
#define ClipboardNoData         6

typedef struct {
       long DataId;
       long PrivateId;
} XmClipboardPendingRec, *XmClipboardPendingList;
```

Figure 6-227: `<Xm/DialogS.h>`*

```
typedef struct _XmDialogShellClassRec       * XmDialogShellWidgetClass;
typedef struct _XmDialogShellRec            * XmDialogShellWidget;
```

Figure 6-228: `<Xm/Display.h>`*

```
enum {
        XmDRAG_NONE,
        XmDRAG_DROP_ONLY,
        XmDRAG_PREFER_PREREGISTER,
        XmDRAG_PREREGISTER,
        XmDRAG_PREFER_DYNAMIC,
        XmDRAG_DYNAMIC,
        XmDRAG_PREFER_RECEIVER
};

typedef struct _XmDisplayRec *XmDisplay;
typedef struct _XmDisplayClassRec *XmDisplayClass;
```

Figure 6-229: `<Xm/DragC.h>`***, Part 1 of 4**

```
#define XmDROP_MOVE     (1L << 0)
#define XmDROP_COPY     (1L << 1)
#define XmDROP_LINK     (1L << 2)

#define XmHELP                   2
typedef unsigned int    XmID;

#define _XA_MOTIF_DROP "_MOTIF_DROP"
#define _XA_DRAG_FAILURE "_MOTIF_DRAG_FAILURE"
#define _XA_DRAG_SUCCESS "_MOTIF_DRAG_SUCCESS"

enum{   XmTOP_LEVEL_ENTER,              XmTOP_LEVEL_LEAVE,
        XmDRAG_MOTION,                  XmDROP_SITE_ENTER,
        XmDROP_SITE_LEAVE,              XmDROP_START,
        XmDROP_FINISH,                  XmDRAG_DROP_FINISH,
        XmOPERATION_CHANGED
        } ;

enum{   XmDROP,                         XmDROP_HELP,
        XmDROP_CANCEL,                  XmDROP_INTERRUPT
        } ;
```

Figure 6-230: `<Xm/DragC.h>`**, Part 2 of 4**

```
#define XmDROP_NOOP     0L

enum{   XmBLEND_ALL,                      XmBLEND_STATE_SOURCE,
        XmBLEND_JUST_SOURCE,              XmBLEND_NONE
        } ;

enum{   XmDROP_FAILURE,                   XmDROP_SUCCESS
        } ;

enum{   XmCR_TOP_LEVEL_ENTER,             XmCR_TOP_LEVEL_LEAVE,
        XmCR_DRAG_MOTION,                 XmCR_DROP_SITE_ENTER,
        XmCR_DROP_SITE_LEAVE,             XmCR_DROP_START,
        XmCR_DROP_FINISH,                 XmCR_DRAG_DROP_FINISH,
        XmCR_OPERATION_CHANGED,
        _XmNUMBER_DND_CB_REASONS
        } ;

typedef struct _XmDragContextClassRec   *XmDragContextClass;
typedef struct _XmDragContextRec        *XmDragContext;

typedef struct _XmAnyICCCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
}XmAnyICCCallbackStruct, *XmAnyICCCallback;

typedef struct _XmTopLevelEnterCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    Screen              *screen;
    Window              window;
    Position            x, y;
    unsigned char       dragProtocolStyle;
    Atom                iccHandle;
}XmTopLevelEnterCallbackStruct, *XmTopLevelEnterCallback;
```

Figure 6-231: `<Xm/DragC.h>`**, Part 3 of 4**

```
typedef struct _XmTopLevelLeaveCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    Screen              *screen;
    Window              window;
}XmTopLevelLeaveCallbackStruct, *XmTopLevelLeaveCallback;

typedef struct _XmDropSiteEnterCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    unsigned char       operation;
    unsigned char       operations;
    unsigned char       dropSiteStatus;
    Position            x, y;
}XmDropSiteEnterCallbackStruct, *XmDropSiteEnterCallback;

typedef struct _XmDropSiteLeaveCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
}XmDropSiteLeaveCallbackStruct, *XmDropSiteLeaveCallback;

typedef struct _XmDragMotionCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    unsigned char       operation;
    unsigned char       operations;
    unsigned char       dropSiteStatus;
    Position            x, y;
}XmDragMotionCallbackStruct, *XmDragMotionCallback;
```

Figure 6-232: `<Xm/DragC.h>`***, Part 4 of 4**

```
typedef struct _XmOperationChangedCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    unsigned char       operation;
    unsigned char       operations;
    unsigned char       dropSiteStatus;
}XmOperationChangedCallbackStruct, *XmOperationChangedCallback;

typedef struct _XmDropStartCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    unsigned char       operation;
    unsigned char       operations;
    unsigned char       dropSiteStatus;
    unsigned char       dropAction;
    Position            x, y;
    Window              window;
    Atom                iccHandle;
}XmDropStartCallbackStruct, *XmDropStartCallback;

typedef struct _XmDropFinishCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
    unsigned char       operation;
    unsigned char       operations;
    unsigned char       dropSiteStatus;
    unsigned char       dropAction;
    unsigned char       completionStatus;
}XmDropFinishCallbackStruct, *XmDropFinishCallback;
typedef struct _XmDragDropFinishCallbackStruct{
    int                 reason;
    XEvent              *event;
    Time                timeStamp;
}XmDragDropFinishCallbackStruct, *XmDragDropFinishCallback;
```

Figure 6-233: <Xm/DragIcon.h>*

```
enum {
        XmATTACH_NORTH_WEST,
        XmATTACH_NORTH,
        XmATTACH_NORTH_EAST,
        XmATTACH_EAST,
        XmATTACH_SOUTH_EAST,
        XmATTACH_SOUTH,
        XmATTACH_SOUTH_WEST,
        XmATTACH_WEST,
        XmATTACH_CENTER,
        XmATTACH_HOT
};

typedef struct _XmDragIconRec *XmDragIconObject;
typedef struct _XmDragIconClassRec *XmDragIconObjectClass;
```

Figure 6-234: <Xm/DragOverS.h>*

```
typedef struct _XmDragOverShellRec              *XmDragOverShellWidget;
typedef struct _XmDragOverShellClassRec         *XmDragOverShellWidgetClass;
```

Figure 6-235: `<Xm/DrawingA.h>`*

```
typedef struct _XmDrawingAreaClassRec * XmDrawingAreaWidgetClass;
typedef struct _XmDrawingAreaRec      * XmDrawingAreaWidget;
```

Figure 6-236: `<Xm/DrawnB.h>`*

```
typedef struct _XmDrawnButtonClassRec *XmDrawnButtonWidgetClass;
typedef struct _XmDrawnButtonRec      *XmDrawnButtonWidget;
```

Figure 6-237: `<Xm/DropSMgr.h>`***, Part 1 of 2**

```
#define XmCR_DROP_SITE_LEAVE_MESSAGE   1
#define XmCR_DROP_SITE_ENTER_MESSAGE   2
#define XmCR_DROP_SITE_MOTION_MESSAGE  3
#define XmCR_DROP_MESSAGE              4

#define XmNO_DROP_SITE                 1
#define XmINVALID_DROP_SITE            2
#define XmVALID_DROP_SITE              3

enum { XmDRAG_UNDER_NONE, XmDRAG_UNDER_PIXMAP,
    XmDRAG_UNDER_SHADOW_IN, XmDRAG_UNDER_SHADOW_OUT,
    XmDRAG_UNDER_HIGHLIGHT };

enum { XmDROP_SITE_SIMPLE, XmDROP_SITE_COMPOSITE,
    XmDROP_SITE_SIMPLE_CLIP_ONLY = 128,
    XmDROP_SITE_COMPOSITE_CLIP_ONLY };

enum { XmABOVE, XmBELOW };

enum { XmDROP_SITE_ACTIVE, XmDROP_SITE_INACTIVE };

typedef struct _XmDragProcCallbackStruct {
      int                 reason;
      XEvent *            event;
      Time                timeStamp;
      Widget              dragContext;
      Position            x, y;
      unsigned char       dropSiteStatus;
      unsigned char       operation;
      unsigned char       operations;
      Boolean             animate;
} XmDragProcCallbackStruct, * XmDragProcCallback;
```

Figure 6-238: `<Xm/DropSMgr.h>`***, Part 2 of 2**

```
typedef struct _XmDropProcCallbackStruct {
      int                 reason;
      XEvent *            event;
      Time                timeStamp;
      Widget              dragContext;
      Position            x, y;
      unsigned char       dropSiteStatus;
      unsigned char       operation;
      unsigned char       operations;
      unsigned char       dropAction;
} XmDropProcCallbackStruct, * XmDropProcCallback;

typedef struct _XmDropSiteVisualsRec {
      Pixel               background;
      Pixel               foreground;
      Pixel               topShadowColor;
      Pixmap              topShadowPixmap;
      Pixel               bottomShadowColor;
      Pixmap              bottomShadowPixmap;
      Dimension           shadowThickness;
      Pixel               highlightColor;
      Pixmap              highlightPixmap;
      Dimension           highlightThickness;
      Dimension           borderWidth;
} XmDropSiteVisualsRec, * XmDropSiteVisuals;

typedef struct _XmDropSiteManagerClassRec *XmDropSiteManagerObjectClass;
typedef struct _XmDropSiteManagerRec *XmDropSiteManagerObject;
```

Figure 6-239: `<Xm/DropTrans.h>`*

```
#define XmTRANSFER_FAILURE 0
#define XmTRANSFER_SUCCESS 1

typedef struct _XmDropTransferClassRec * XmDropTransferObjectClass;
typedef struct _XmDropTransferRec      * XmDropTransferObject;


typedef struct _XmDropTransferEntryRec {
        XtPointer       client_data;
        Atom            target;
} XmDropTransferEntryRec, * XmDropTransferEntry;
```

Figure 6-240: `<Xm/FileSB.h>`*

```
typedef struct _XmFileSelectionBoxClassRec * XmFileSelectionBoxWidgetClass;
typedef struct _XmFileSelectionBoxRec      * XmFileSelectionBoxWidget;
```

Figure 6-241: `<Xm/Form.h>`*

```
typedef struct _XmFormClassRec * XmFormWidgetClass;
typedef struct _XmFormRec      * XmFormWidget;
```

Figure 6-242: `<Xm/Frame.h>`*****

```
typedef struct _XmFrameClassRec * XmFrameWidgetClass;
typedef struct _XmFrameRec      * XmFrameWidget;
```

Figure 6-243: `<Xm/Label.h>`*****

```
typedef struct _XmLabelClassRec     * XmLabelWidgetClass;
typedef struct _XmLabelRec          * XmLabelWidget;
```

Figure 6-244: `<Xm/LabelG.h>`*****

```
typedef struct _XmLabelGadgetClassRec * XmLabelGadgetClass;
typedef struct _XmLabelGadgetRec      * XmLabelGadget;
typedef struct _XmLabelGCacheObjRec   * XmLabelGCacheObject;
```

Figure 6-245: `<Xm/List.h>`*

```
#define XmINITIAL       0
#define XmADDITION      1
#define XmMODIFICATION  2

typedef struct _XmListClassRec * XmListWidgetClass;
typedef struct _XmListRec      * XmListWidget;
```

Figure 6-246: `<Xm/MainW.h>`*

```
typedef struct _XmMainWindowClassRec * XmMainWindowWidgetClass;
typedef struct _XmMainWindowRec      * XmMainWindowWidget;
```

Figure 6-247: `<Xm/MenuShell.h>`*

```
typedef struct _XmMenuShellClassRec       * XmMenuShellWidgetClass;
typedef struct _XmMenuShellWidgetRec      * XmMenuShellWidget;
```

Figure 6-248: `<Xm/MessageB.h>`*

```
typedef struct _XmMessageBoxClassRec * XmMessageBoxWidgetClass;
typedef struct _XmMessageBoxRec      * XmMessageBoxWidget;
```

Figure 6-249: `<Mrm/MrmPublic.h>`**, Part 1 of 3**

```
#define MrmSUCCESS                 1
#define MrmCREATE_NEW              3
#define MrmINDEX_RETRY             5
#define MrmINDEX_GT                7
#define MrmINDEX_LT                9
#define MrmPARTIAL_SUCCESS         11

#define MrmFAILURE                 0
#define MrmNOT_FOUND               2
#define MrmEXISTS                  4
#define MrmNUL_GROUP               6
#define MrmNUL_TYPE                8
#define MrmWRONG_GROUP             10
#define MrmWRONG_TYPE              12
#define MrmOUT_OF_RANGE            14
#define MrmBAD_RECORD              16
#define MrmNULL_DATA               18
#define MrmBAD_DATA_INDEX          20
#define MrmBAD_ORDER               22
#define MrmBAD_CONTEXT             24
#define MrmNOT_VALID               26
#define MrmBAD_BTREE               28
#define MrmBAD_WIDGET_REC          30
#define MrmBAD_CLASS_TYPE          32
#define MrmNO_CLASS_NAME           34
#define MrmTOO_MANY                36
#define MrmBAD_IF_MODULE           38
#define MrmNULL_DESC               40
#define MrmOUT_OF_BOUNDS           42
#define MrmBAD_COMPRESS            44
#define MrmBAD_ARG_TYPE            46
#define MrmNOT_IMP                 48
#define MrmNULL_INDEX              50
#define MrmBAD_KEY_TYPE            52
#define MrmBAD_CALLBACK            54
```

Figure 6-250: `<Mrm/MrmPublic.h>`***, Part 2 of 3**

```
#define MrmNULL_ROUTINE          56
#define MrmVEC_TOO_BIG           58
#define MrmBAD_HIERARCHY         60
#define MrmBAD_CLASS_CODE        62
#define MrmDISPLAY_NOT_OPENED    63
#define MrmEOF                   64
#define MrmUNRESOLVED_REFS       65
#define MrmNcreateCallback       "createCallback"
#define MrmCR_CREATE             XmCR_CREATE

#define MrmwcUnknown             1

#define MrmRtypeMin              1
#define MrmRtypeInteger          1
#define MrmRtypeBoolean          2
#define MrmRtypeChar8            3
#define MrmRtypeChar8Vector      4
#define MrmRtypeCString          5
#define MrmRtypeCStringVector    6
#define MrmRtypeFloat            7
#define MrmRtypeCallback         9
#define MrmRtypePixmapImage      10
#define MrmRtypePixmapDDIF       11
#define MrmRtypeResource         12
#define MrmRtypeNull             13
#define MrmRtypeAddrName         14
#define MrmRtypeIconImage        15
#define MrmRtypeFont             16
#define MrmRtypeFontList         17
#define MrmRtypeColor            18
#define MrmRtypeColorTable       19
#define MrmRtypeAny              20
#define MrmRtypeTransTable       21
#define MrmRtypeClassRecName     22
#define MrmRtypeIntegerVector    23
```

Figure 6-251: `<Mrm/MrmPublic.h>`***, Part 3 of 3**

```
#define MrmRtypeXBitmapFile     24
#define MrmRtypeCountedVector   25
#define MrmRtypeKeysym          26
#define MrmRtypeSingleFloat     27
#define MrmRtypeWideCharacter   28
#define MrmRtypeFontSet         29
#define MrmRtypeMax             30
typedef short int            MrmCode ;
typedef unsigned char        MrmSCode ;
typedef unsigned short int   MrmOffset ;
typedef short int            MrmType ;
typedef unsigned short int   MrmSize ;
typedef short int            MrmCount ;
typedef unsigned char        MrmFlag ;
typedef long int             MrmResource_id ;
typedef short int            MrmGroup ;

#define MrmMaxResourceSize      65535
#define MrmOsOpenParamVersion    1
typedef struct  {
        Cardinal                version;
        char                    *default_fname;
        union {
            unsigned long       related_nam;
            Boolean             clobber_flg;
        } nam_flg;
        Display                 *display;
} MrmOsOpenParam, *MrmOsOpenParamPtr ;

typedef struct MrmHierarchyDescStruct *MrmHierarchy;
typedef struct {
        String          name ;
        XtPointer       value ;
} MRMRegisterArg, MrmRegisterArg, *MrmRegisterArglist ;

#define URMwcUnknown    1
```

Figure 6-252: `<Xm/MwmUtil.h>`***, Part 1 of 3**

```
typedef struct
{
    long        flags;
    long        functions;
    long        decorations;
    int         input_mode;
    long        status;
} MotifWmHints;

typedef MotifWmHints    MwmHints;

#define MWM_HINTS_FUNCTIONS     (1L << 0)
#define MWM_HINTS_DECORATIONS   (1L << 1)
#define MWM_HINTS_INPUT_MODE    (1L << 2)
#define MWM_HINTS_STATUS        (1L << 3)

#define MWM_FUNC_ALL            (1L << 0)
#define MWM_FUNC_RESIZE         (1L << 1)
#define MWM_FUNC_MOVE           (1L << 2)
#define MWM_FUNC_MINIMIZE       (1L << 3)
#define MWM_FUNC_MAXIMIZE       (1L << 4)
#define MWM_FUNC_CLOSE          (1L << 5)

#define MWM_DECOR_ALL           (1L << 0)
#define MWM_DECOR_BORDER        (1L << 1)
#define MWM_DECOR_RESIZEH       (1L << 2)
#define MWM_DECOR_TITLE         (1L << 3)
#define MWM_DECOR_MENU          (1L << 4)
#define MWM_DECOR_MINIMIZE      (1L << 5)
#define MWM_DECOR_MAXIMIZE      (1L << 6)

#define MWM_INPUT_MODELESS                      0
#define MWM_INPUT_PRIMARY_APPLICATION_MODAL     1
#define MWM_INPUT_SYSTEM_MODAL                  2
#define MWM_INPUT_FULL_APPLICATION_MODAL        3
```

Figure 6-253: `<Xm/MwmUtil.h>`***, Part 2 of 3**

```
#define MWM_TEAROFF_WINDOW       (1L << 0)
#define MWM_INPUT_APPLICATION_MODAL     MWM_INPUT_PRIMARY_APPLICATION_MODAL

typedef struct
{
    long        flags;
    Window      wm_window;
} MotifWmInfo;

typedef MotifWmInfo     MwmInfo;

#define MWM_INFO_STARTUP_STANDARD       (1L << 0)
#define MWM_INFO_STARTUP_CUSTOM         (1L << 1)

typedef struct
{
    CARD32      flags;
    CARD32      functions;
    CARD32      decorations;
    INT32       inputMode;
    CARD32      status;
} PropMotifWmHints;

typedef PropMotifWmHints        PropMwmHints;

#define PROP_MOTIF_WM_HINTS_ELEMENTS    5
#define PROP_MWM_HINTS_ELEMENTS         PROP_MOTIF_WM_HINTS_ELEMENTS

#define _XA_MOTIF_WM_HINTS      "_MOTIF_WM_HINTS"
#define _XA_MWM_HINTS           _XA_MOTIF_WM_HINTS

#define _XA_MOTIF_WM_MESSAGES   "_MOTIF_WM_MESSAGES"
#define _XA_MWM_MESSAGES        _XA_MOTIF_WM_MESSAGES

#define _XA_MOTIF_WM_OFFSET     "_MOTIF_WM_OFFSET"
```

Figure 6-254: <Xm/MwmUtil.h>***, Part 3 of 3**

```
#define _XA_MOTIF_WM_MENU       "_MOTIF_WM_MENU"
#define _XA_MWM_MENU            _XA_MOTIF_WM_MENU

typedef struct
{
    CARD32 flags;
    CARD32 wmWindow;
} PropMotifWmInfo;

typedef PropMotifWmInfo PropMwmInfo;

#define PROP_MOTIF_WM_INFO_ELEMENTS     2
#define PROP_MWM_INFO_ELEMENTS          PROP_MOTIF_WM_INFO_ELEMENTS

#define _XA_MOTIF_WM_INFO       "_MOTIF_WM_INFO"
#define _XA_MWM_INFO            _XA_MOTIF_WM_INFO

#define _XA_MOTIF_BINDINGS      "_MOTIF_BINDINGS"
```

Figure 6-255: <Xm/PanedW.h>*****

```
typedef struct _XmPanedWindowClassRec   *XmPanedWindowWidgetClass;
typedef struct _XmPanedWindowRec        *XmPanedWindowWidget;
```

Figure 6-256: <Xm/PushB.h>*

```
typedef struct _XmPushButtonClassRec *XmPushButtonWidgetClass;
typedef struct _XmPushButtonRec      *XmPushButtonWidget;
```

Figure 6-257: <Xm/PushBG.h>*

```
typedef struct _XmPushButtonGadgetClassRec   *XmPushButtonGadgetClass;
typedef struct _XmPushButtonGadgetRec        *XmPushButtonGadget;
typedef struct _XmPushButtonGCacheObjRec     *XmPushButtonGCacheObject;
```

Figure 6-258: <Xm/RepType.h>*

```
#define XmREP_TYPE_INVALID              0x1FFF

typedef unsigned short XmRepTypeId ;

typedef struct
{
    String rep_type_name ;
    String *value_names ;
    unsigned char *values ;
    unsigned char num_values ;
    Boolean reverse_installed ;
    XmRepTypeId rep_type_id ;
    }XmRepTypeEntryRec, *XmRepTypeEntry, XmRepTypeListRec, *XmRepTypeList ;
```

Figure 6-259: <Xm/RowColumn.h>*

```
typedef struct _XmRowColumnClassRec * XmRowColumnWidgetClass;
typedef struct _XmRowColumnRec      * XmRowColumnWidget;
```

Figure 6-260: <Xm/Scale.h>*

```
typedef struct _XmScaleClassRec * XmScaleWidgetClass;
typedef struct _XmScaleRec      * XmScaleWidget;
```

Figure 6-261: <Xm/Screen.h>*

```
typedef struct _XmScreenRec      *XmScreen;
typedef struct _XmScreenClassRec *XmScreenClass;
```

Figure 6-262: <Xm/ScrollBar.h>*

```
typedef struct _XmScrollBarClassRec * XmScrollBarWidgetClass;
typedef struct _XmScrollBarRec      * XmScrollBarWidget;
```

Figure 6-263: <Xm/ScrolledW.h>*

```
typedef struct _XmScrolledWindowClassRec * XmScrolledWindowWidgetClass;
typedef struct _XmScrolledWindowRec      * XmScrolledWindowWidget;
```

Figure 6-264: <Xm/SelectioB.h>*

```
typedef struct _XmSelectionBoxClassRec * XmSelectionBoxWidgetClass;
typedef struct _XmSelectionBoxRec      * XmSelectionBoxWidget;
```

Figure 6-265: <Xm/SeparatoG.h>*

```
typedef struct _XmSeparatorGadgetClassRec * XmSeparatorGadgetClass;
typedef struct _XmSeparatorGadgetRec      * XmSeparatorGadget;
typedef struct _XmSeparatorGCacheObjRec   * XmSeparatorGCacheObject;
```

Figure 6-266: <Xm/Separator.h>*

```
typedef struct _XmSeparatorClassRec * XmSeparatorWidgetClass;
typedef struct _XmSeparatorRec      * XmSeparatorWidget;
```

Figure 6-267: `<Xm/Text.h>`*****

```
typedef struct _XmTextSourceRec *XmTextSource;
typedef struct _XmTextClassRec  *XmTextWidgetClass;
typedef struct _XmTextRec       *XmTextWidget;
```

Figure 6-268: `<Xm/TextF.h>`*****

```
typedef struct _XmTextFieldClassRec *XmTextFieldWidgetClass;
typedef struct _XmTextFieldRec      *XmTextFieldWidget;
```

Figure 6-269: `<Xm/ToggleB.h>`*****

```
typedef struct _XmToggleButtonClassRec *XmToggleButtonWidgetClass;
typedef struct _XmToggleButtonRec      *XmToggleButtonWidget;
```

Figure 6-270: `<Xm/ToggleBG.h>`*****

```
typedef struct _XmToggleButtonGadgetClassRec     *XmToggleButtonGadgetClass;
typedef struct _XmToggleButtonGadgetRec          *XmToggleButtonGadget;
typedef struct _XmToggleButtonGCacheObjRec       *XmToggleButtonGCacheObject;
```

Figure 6-271: `<Xm/VendorS.h>`*****

```
typedef struct _XmVendorShellRec      *XmVendorShellWidget;
typedef struct _XmVendorShellClassRec *XmVendorShellWidgetClass;
```

Figure 6-272: `<Xm/VirtKeys.h>`***, Part 1 of 2**

```
#define _OSF_Keysyms

#define osfXK_BackSpace          0x1004FF08
#define osfXK_Insert             0x1004FF63
#define osfXK_Delete             0x1004FFFF
#define osfXK_Copy               0x1004FF02
#define osfXK_Cut                0x1004FF03
#define osfXK_Paste              0x1004FF04

#define osfXK_AddMode            0x1004FF31
#define osfXK_PrimaryPaste       0x1004FF32
#define osfXK_QuickPaste         0x1004FF33

#define osfXK_PageLeft           0x1004FF40
#define osfXK_PageUp             0x1004FF41
#define osfXK_PageDown           0x1004FF42
#define osfXK_PageRight          0x1004FF43
```

Figure 6-273: `<Xm/VirtKeys.h>`***, Part 2 of 2**

```
#define osfXK_EndLine      0x1004FF57
#define osfXK_BeginLine    0x1004FF58

#define osfXK_Activate     0x1004FF44
#define osfXK_MenuBar      0x1004FF45

#define osfXK_Clear        0x1004FF0B
#define osfXK_Cancel       0x1004FF69
#define osfXK_Help         0x1004FF6A
#define osfXK_Menu         0x1004FF67
#define osfXK_Select       0x1004FF60
#define osfXK_Undo         0x1004FF65

#define osfXK_Left         0x1004FF51
#define osfXK_Up           0x1004FF52
#define osfXK_Right        0x1004FF53
#define osfXK_Down         0x1004FF54
```

Figure 6-274: `<Xm/Xm.h>`***, Part 1 of 14**

```
#define XmUNSPECIFIED_PIXMAP           2

#define XmSTRING_OS_CHARSET            XmSTRING_ISO8859_1
#define XmFALLBACK_CHARSET             XmSTRING_ISO8859_1

#define XmDEFAULT_FONT                 _XmSDEFAULT_FONT
#define XmDEFAULT_BACKGROUND           _XmSDEFAULT_BACKGROUND
#define XmDEFAULT_DARK_THRESHOLD       20
#define XmDEFAULT_LIGHT_THRESHOLD      90
#define XmDEFAULT_FOREGROUND_THRESHOLD  70

typedef enum{ XmFONT_IS_FONT, XmFONT_IS_FONTSET } XmFontType;

enum{   XmSTRING_DIRECTION_L_TO_R,      XmSTRING_DIRECTION_R_TO_L
        } ;
#define XmSTRING_DIRECTION_DEFAULT  ((XmStringDirection) 255)

typedef unsigned char * XmString;
typedef XmString *      XmStringTable;
typedef char *          XmStringCharSet;
typedef unsigned char   XmStringComponentType;
typedef unsigned char   XmStringDirection;

typedef struct _XmFontListRec       *XmFontListEntry;
typedef struct _XmFontListRec       *XmFontList;
typedef struct __XmStringContextRec *_XmStringContext;
typedef struct __XmStringRec        *_XmString;
typedef struct _XmtStringContextRec *XmStringContext;
typedef struct _XmFontListContextRec *XmFontContext;

enum{   XmSTRING_COMPONENT_UNKNOWN,     XmSTRING_COMPONENT_CHARSET,
        XmSTRING_COMPONENT_TEXT,        XmSTRING_COMPONENT_DIRECTION,
        XmSTRING_COMPONENT_SEPARATOR,   XmSTRING_COMPONENT_LOCALE_TEXT
        } ;
```

Figure 6-275: `<Xm/Xm.h>`***, Part 2 of 14**

```
#define XmSTRING_COMPONENT_END          ((XmStringComponentType) 126)
#define XmSTRING_COMPONENT_USER_BEGIN   ((XmStringComponentType) 128)
#define XmSTRING_COMPONENT_USER_END     ((XmStringComponentType) 255)

typedef struct _XmPrimitiveClassRec * XmPrimitiveWidgetClass;
typedef struct _XmPrimitiveRec      * XmPrimitiveWidget;

typedef struct _XmGadgetClassRec * XmGadgetClass;
typedef struct _XmGadgetRec      * XmGadget;

typedef struct _XmManagerClassRec * XmManagerWidgetClass;
typedef struct _XmManagerRec      * XmManagerWidget;

enum{   XmCHANGE_ALL,                   XmCHANGE_NONE,
        XmCHANGE_WIDTH,                 XmCHANGE_HEIGHT
        } ;

enum{   XmPIXELS,                       Xm100TH_MILLIMETERS,
        Xm1000TH_INCHES,                Xm100TH_POINTS,
        Xm100TH_FONT_UNITS
        } ;

enum{   XmDESTROY,                      XmUNMAP,
        XmDO_NOTHING
        } ;

enum{   XmEXPLICIT,                     XmPOINTER
        } ;

enum{   XmNONE,                         XmTAB_GROUP,
        XmSTICKY_TAB_GROUP,             XmEXCLUSIVE_TAB_GROUP
        } ;

#define XmDYNAMIC_DEFAULT_TAB_GROUP     ((XmNavigationType) 255)
```

Figure 6-276: `<Xm/Xm.h>`***, Part 3 of 14**

```
enum{                           XmBELL = 1
        } ;

enum{   XmNO_ORIENTATION,                   XmVERTICAL,
        XmHORIZONTAL
        } ;

enum{   XmWORK_AREA,                        XmMENU_BAR,
        XmMENU_PULLDOWN,                    XmMENU_POPUP,
        XmMENU_OPTION
        } ;

enum{   XmNO_PACKING,                       XmPACK_TIGHT,
        XmPACK_COLUMN,                      XmPACK_NONE
        } ;

enum{   XmALIGNMENT_CONTENTS_TOP = 3,
        XmALIGNMENT_CONTENTS_BOTTOM
        } ;

enum{   XmTEAR_OFF_ENABLED,                 XmTEAR_OFF_DISABLED
        } ;

enum{   XmUNPOST,                           XmUNPOST_AND_REPLAY
        } ;

enum{   XmLAST_POSITION = -1,               XmFIRST_POSITION
        } ;

enum{   XmALIGNMENT_BEGINNING,              XmALIGNMENT_CENTER,
        XmALIGNMENT_END
        } ;
```

Figure 6-277: `<Xm/Xm.h>`***, Part 4 of 14**

```
enum{   XmALIGNMENT_BASELINE_TOP,
        XmALIGNMENT_BASELINE_BOTTOM = 2, XmALIGNMENT_WIDGET_TOP,
        XmALIGNMENT_WIDGET_BOTTOM
        } ;

enum{   XmFRAME_GENERIC_CHILD,          XmFRAME_WORKAREA_CHILD,
        XmFRAME_TITLE_CHILD
        } ;

enum{   XmN_OF_MANY = 1,                XmONE_OF_MANY
        } ;

enum{   XmATTACH_NONE,                  XmATTACH_FORM,
        XmATTACH_OPPOSITE_FORM,         XmATTACH_WIDGET,
        XmATTACH_OPPOSITE_WIDGET,       XmATTACH_POSITION,
        XmATTACH_SELF
        } ;

enum{   XmRESIZE_NONE,                  XmRESIZE_GROW,
        XmRESIZE_ANY
        } ;
```

Figure 6-278: `<Xm/Xm.h>`***, Part 5 of 15**

```
enum{   XmCR_NONE,                        XmCR_HELP,
        XmCR_VALUE_CHANGED,               XmCR_INCREMENT,
        XmCR_DECREMENT,                   XmCR_PAGE_INCREMENT,
        XmCR_PAGE_DECREMENT,              XmCR_TO_TOP,
        XmCR_TO_BOTTOM,                   XmCR_DRAG,
        XmCR_ACTIVATE,                    XmCR_ARM,
        XmCR_DISARM,                      XmCR_MAP = 16,
        XmCR_UNMAP,                       XmCR_FOCUS,
        XmCR_LOSING_FOCUS,                XmCR_MODIFYING_TEXT_VALUE,
        XmCR_MOVING_INSERT_CURSOR,        XmCR_EXECUTE,
        XmCR_SINGLE_SELECT,               XmCR_MULTIPLE_SELECT,
        XmCR_EXTENDED_SELECT,             XmCR_BROWSE_SELECT,
        XmCR_DEFAULT_ACTION,              XmCR_CLIPBOARD_DATA_REQUEST,
        XmCR_CLIPBOARD_DATA_DELETE,       XmCR_CASCADING,
        XmCR_OK,                          XmCR_CANCEL,
        XmCR_APPLY = 34,                  XmCR_NO_MATCH,
        XmCR_COMMAND_ENTERED,             XmCR_COMMAND_CHANGED,
        XmCR_EXPOSE,                      XmCR_RESIZE,
        XmCR_INPUT,                       XmCR_GAIN_PRIMARY,
        XmCR_LOSE_PRIMARY,                XmCR_CREATE,
        XmCR_TEAR_OFF_ACTIVATE,           XmCR_TEAR_OFF_DEACTIVATE,
        XmCR_OBSCURED_TRAVERSAL
        } ;

typedef struct
{
    int     reason;
    XEvent  *event;
} XmAnyCallbackStruct;

typedef struct
{
    int     reason;
    XEvent  *event;
    int     click_count;
} XmArrowButtonCallbackStruct;
```

Figure 6-279: `<Xm/Xm.h>`***, Part 6 of 14**

```
typedef struct
{
    int     reason;
    XEvent  *event;
    Window  window;
} XmDrawingAreaCallbackStruct;

typedef struct
{
    int     reason;
    XEvent  *event;
    Window  window;
    int     click_count;
} XmDrawnButtonCallbackStruct;

typedef struct
{
    int     reason;
    XEvent  *event;
    int     click_count;
} XmPushButtonCallbackStruct;

typedef struct
{
    int     reason;
    XEvent  *event;
    Widget  widget;
    char    *data;
    char    *callbackstruct;
} XmRowColumnCallbackStruct;
```

Figure 6-280: `<Xm/Xm.h>`***, Part 7 of 14**

```
typedef struct
{
   int reason;
   XEvent * event;
   int value;
   int pixel;
} XmScrollBarCallbackStruct;

typedef struct
{
   int reason;
   XEvent * event;
   int set;
} XmToggleButtonCallbackStruct;

typedef struct
{
   int       reason;
   XEvent    *event;
   XmString  item;
   int       item_length;
   int       item_position;
   XmString  *selected_items;
   int       selected_item_count;
   int       *selected_item_positions;
   char      selection_type;
} XmListCallbackStruct;

typedef struct
{
    int reason;
    XEvent      *event;
    XmString    value;
    int         length;
} XmSelectionBoxCallbackStruct;
```

Figure 6-281: `<Xm/Xm.h>`***, Part 8 of 14**

```
typedef struct
{
    int reason;
    XEvent      *event;
    XmString    value;
    int         length;
} XmCommandCallbackStruct;

typedef struct
{
    int         reason;
    XEvent      *event;
    XmString    value;
    int         length;
    XmString    mask;
    int         mask_length;
    XmString    dir ;
    int         dir_length ;
    XmString    pattern ;
    int         pattern_length ;
} XmFileSelectionBoxCallbackStruct;

typedef struct
{
   int reason;
   XEvent * event;
   int value;
} XmScaleCallbackStruct;

enum{   XmMULTICLICK_DISCARD,           XmMULTICLICK_KEEP
        } ;

enum{   XmSHADOW_IN = 7,                XmSHADOW_OUT
        } ;
```

Figure 6-282: `<Xm/Xm.h>`***, Part 9 of 14**

```
enum{   XmARROW_UP,                     XmARROW_DOWN,
        XmARROW_LEFT,                   XmARROW_RIGHT
        } ;

enum{   XmNO_LINE,                      XmSINGLE_LINE,
        XmDOUBLE_LINE,                  XmSINGLE_DASHED_LINE,
        XmDOUBLE_DASHED_LINE,           XmSHADOW_ETCHED_IN,
        XmSHADOW_ETCHED_OUT,            XmSHADOW_ETCHED_IN_DASH,
        XmSHADOW_ETCHED_OUT_DASH,       XmINVALID_SEPARATOR_TYPE
        } ;

enum{   XmPIXMAP = 1,                   XmSTRING
        } ;

enum{   XmWINDOW,
        XmCURSOR = 2
        } ;

enum{   XmMAX_ON_TOP,                   XmMAX_ON_BOTTOM,
        XmMAX_ON_LEFT,                  XmMAX_ON_RIGHT
        } ;

enum{   XmSINGLE_SELECT,                XmMULTIPLE_SELECT,
        XmEXTENDED_SELECT,              XmBROWSE_SELECT
        } ;

enum{   XmSTATIC,                       XmDYNAMIC
        } ;

enum{   XmVARIABLE,                     XmCONSTANT,
        XmRESIZE_IF_POSSIBLE
        } ;

enum{   XmAUTOMATIC,                    XmAPPLICATION_DEFINED
        } ;
```

Figure 6-283: `<Xm/Xm.h>`***, Part 10 of 14**

```
enum{  XmAS_NEEDED = 1
        } ;

#define SW_TOP          1
#define SW_BOTTOM       0
#define SW_LEFT         2
#define SW_RIGHT        0

#define XmTOP_LEFT      (SW_TOP | SW_LEFT)
#define XmBOTTOM_LEFT   (SW_BOTTOM  | SW_LEFT)
#define XmTOP_RIGHT     (SW_TOP | SW_RIGHT)
#define XmBOTTOM_RIGHT  (SW_BOTTOM  | SW_RIGHT)

enum{   XmCOMMAND_ABOVE_WORKSPACE,      XmCOMMAND_BELOW_WORKSPACE
        } ;

enum{   XmMULTI_LINE_EDIT,              XmSINGLE_LINE_EDIT
        } ;

typedef enum{
        XmTEXT_FORWARD,
        XmTEXT_BACKWARD
        } XmTextDirection;

typedef long XmTextPosition;
typedef Atom XmTextFormat;

#define XmFMT_8_BIT     ((XmTextFormat) XA_STRING)
#define XmFMT_16_BIT    ((XmTextFormat) 2)

#define FMT8BIT         XmFMT_8_BIT
#define FMT16BIT        XmFMT_16_BIT
```

Figure 6-284: `<Xm/Xm.h>`**, Part 11 of 14**

```
typedef enum{
        XmSELECT_POSITION,              XmSELECT_WHITESPACE,
        XmSELECT_WORD,                  XmSELECT_LINE,
        XmSELECT_ALL,                   XmSELECT_PARAGRAPH
        } XmTextScanType ;

typedef enum{
        XmHIGHLIGHT_NORMAL,             XmHIGHLIGHT_SELECTED,
        XmHIGHLIGHT_SECONDARY_SELECTED
        } XmHighlightMode ;

typedef struct {
    char *ptr;
    int length;
    XmTextFormat format;
} XmTextBlockRec, *XmTextBlock;

typedef struct
{
    int reason;
    XEvent  *event;
    Boolean doit;
    long currInsert, newInsert;
    long startPos, endPos;
    XmTextBlock text;
} XmTextVerifyCallbackStruct, *XmTextVerifyPtr;

typedef struct {
    wchar_t *wcsptr;
    int length;
} XmTextBlockRecWcs, *XmTextBlockWcs;
```

Figure 6-285: `<Xm/Xm.h>`**, Part 12 of 14**

```
typedef struct
{
    int reason;
    XEvent  *event;
    Boolean doit;
    long currInsert, newInsert;
    long startPos, endPos;
    XmTextBlockWcs text;
} XmTextVerifyCallbackStructWcs, *XmTextVerifyPtrWcs;

#define XmTextGetTopPosition                XmTextGetTopCharacter
#define XmTextSetTopPosition                XmTextSetTopCharacter

#define XmCOPY_FAILED           0
#define XmCOPY_SUCCEEDED        1
#define XmCOPY_TRUNCATED        2

enum{   XmDIALOG_NONE,                  XmDIALOG_APPLY_BUTTON,
        XmDIALOG_CANCEL_BUTTON,         XmDIALOG_DEFAULT_BUTTON,
        XmDIALOG_OK_BUTTON,             XmDIALOG_FILTER_LABEL,
        XmDIALOG_FILTER_TEXT,           XmDIALOG_HELP_BUTTON,
        XmDIALOG_LIST,                  XmDIALOG_LIST_LABEL,
        XmDIALOG_MESSAGE_LABEL,         XmDIALOG_SELECTION_LABEL,
        XmDIALOG_SYMBOL_LABEL,          XmDIALOG_TEXT,
        XmDIALOG_SEPARATOR,             XmDIALOG_DIR_LIST,
        XmDIALOG_DIR_LIST_LABEL
        } ;

#define XmDIALOG_HISTORY_LIST           XmDIALOG_LIST
#define XmDIALOG_PROMPT_LABEL           XmDIALOG_SELECTION_LABEL
#define XmDIALOG_VALUE_TEXT             XmDIALOG_TEXT
#define XmDIALOG_COMMAND_TEXT           XmDIALOG_TEXT
#define XmDIALOG_FILE_LIST              XmDIALOG_LIST
#define XmDIALOG_FILE_LIST_LABEL        XmDIALOG_LIST_LABEL
```

Figure 6-286: `<Xm/Xm.h>`***, Part 13 of 14**

```
enum{   XmDIALOG_MODELESS,               XmDIALOG_PRIMARY_APPLICATION_MODAL,
        XmDIALOG_FULL_APPLICATION_MODAL,XmDIALOG_SYSTEM_MODAL
        } ;

#define XmDIALOG_APPLICATION_MODAL      XmDIALOG_PRIMARY_APPLICATION_MODAL

enum{   XmPLACE_TOP,                     XmPLACE_ABOVE_SELECTION,
        XmPLACE_BELOW_SELECTION
        } ;

#define XmFILE_DIRECTORY (1 << 0)
#define XmFILE_REGULAR   (1 << 1)
#define XmFILE_ANY_TYPE  (XmFILE_DIRECTORY | XmFILE_REGULAR)

enum{   XmDIALOG_WORK_AREA,              XmDIALOG_PROMPT,
        XmDIALOG_SELECTION,              XmDIALOG_COMMAND,
        XmDIALOG_FILE_SELECTION
        } ;

enum{   XmDIALOG_TEMPLATE,               XmDIALOG_ERROR,
        XmDIALOG_INFORMATION,            XmDIALOG_MESSAGE,
        XmDIALOG_QUESTION,               XmDIALOG_WARNING,
        XmDIALOG_WORKING
        } ;

typedef enum{
        XmVISIBILITY_UNOBSCURED,         XmVISIBILITY_PARTIALLY_OBSCURED,
        XmVISIBILITY_FULLY_OBSCURED
        } XmVisibility ;

typedef enum{
        XmTRAVERSE_CURRENT,              XmTRAVERSE_NEXT,
        XmTRAVERSE_PREV,                 XmTRAVERSE_HOME,
        XmTRAVERSE_NEXT_TAB_GROUP,       XmTRAVERSE_PREV_TAB_GROUP,
        XmTRAVERSE_UP,                   XmTRAVERSE_DOWN,
        XmTRAVERSE_LEFT,                 XmTRAVERSE_RIGHT
        } XmTraversalDirection ;
```

Figure 6-287: `<Xm/Xm.h>`***, Part 14 of 14**

```
typedef struct _XmTraverseObscuredCallbackStruct
{       int                     reason ;
        XEvent *                event ;
        Widget                  traversal_destination ;
        XmTraversalDirection    direction ;
        } XmTraverseObscuredCallbackStruct ;

typedef unsigned char   XmNavigationType;
typedef unsigned char XmButtonType;
typedef XmButtonType * XmButtonTypeTable;
typedef KeySym * XmKeySymTable;
typedef XmStringCharSet * XmStringCharSetTable;

enum{   XmPUSHBUTTON = 1,               XmTOGGLEBUTTON,
        XmRADIOBUTTON,                  XmCASCADEBUTTON,
        XmSEPARATOR,                    XmDOUBLE_SEPARATOR,
        XmTITLE
        } ;
#define XmCHECKBUTTON                   XmTOGGLEBUTTON

typedef struct _XmSecondaryResourceDataRec{
    XmResourceBaseProc  base_proc;
    XtPointer           client_data;
    String              name;
    String              res_class;
    XtResourceList      resources;
    Cardinal            num_resources;
}XmSecondaryResourceDataRec, *XmSecondaryResourceData;
typedef long XmOffset;
typedef XmOffset *XmOffsetPtr;
```

Figure 6-288: `<Xm/XmStrDefs.h>`***, Part 1 of 34**

```
#define XmS ""
#define XmCAccelerator "Accelerator"
#define XmCAcceleratorText "AcceleratorText"
#define XmCAdjustLast "AdjustLast"
#define XmCAdjustMargin "AdjustMargin"
#define XmCAlignment "Alignment"
#define XmCAllowOverlap "AllowOverlap"
#define XmCAnimationMask "AnimationMask"
#define XmCAnimationPixmap "AnimationPixmap"
#define XmCAnimationPixmapDepth "AnimationPixmapDepth"
#define XmCAnimationStyle "AnimationStyle"
#define XmCApplyLabelString "ApplyLabelString"
#define XmCArmCallback "ArmCallback"
#define XmCArmColor "ArmColor"
#define XmCArmPixmap "ArmPixmap"
#define XmCArrowDirection "ArrowDirection"
#define XmCAttachment "Attachment"
#define XmCAudibleWarning "AudibleWarning"
#define XmCAutoShowCursorPosition "AutoShowCursorPosition"
#define XmCAutoUnmanage "AutoUnmanage"
#define XmCAutomaticSelection "AutomaticSelection"
#define XmCAvailability "Availability"
#define XmCBackgroundPixmap "BackgroundPixmap"
#define XmCBlendModel "BlendModel"
#define XmCBlinkRate "BlinkRate"
#define XmCBottomShadowColor "BottomShadowColor"
#define XmCBottomShadowPixmap "BottomShadowPixmap"
#define XmCButtonAcceleratorText "ButtonAcceleratorText"
#define XmCButtonAccelerators "ButtonAccelerators"
#define XmCButtonCount "ButtonCount"
#define XmCButtonFontList "ButtonFontList"
#define XmCButtonMnemonicCharSets "ButtonMnemonicCharSets"
#define XmCButtonMnemonics "ButtonMnemonics"
#define XmCButtonSet "ButtonSet"
#define XmCButtonType "ButtonType"
```

Figure 6-289: `<Xm/XmStrDefs.h>`***, Part 2 of 34**

```
#define XmCButtons "Buttons"
#define XmCCancelLabelString "CancelLabelString"
#define XmCChildHorizontalAlignment "ChildHorizontalAlignment"
#define XmCChildHorizontalSpacing "ChildHorizontalSpacing"
#define XmCChildPlacement "ChildPlacement"
#define XmCChildType "ChildType"
#define XmCChildVerticalAlignment "ChildVerticalAlignment"
#define XmCChildren "Children"
#define XmCClientData "ClientData"
#define XmCClipWindow "ClipWindow"
#define XmCColumns "Columns"
#define XmCCommandWindow "CommandWindow"
#define XmCCommandWindowLocation "CommandWindowLocation"
#define XmCConvertProc "ConvertProc"
#define XmCCursorBackground "CursorBackground"
#define XmCCursorForeground "CursorForeground"
#define XmCCursorPosition "CursorPosition"
#define XmCCursorPositionVisible "CursorPositionVisible"
#define XmCDarkThreshold "DarkThreshold"
#define XmCDecimalPoints "DecimalPoints"
#define XmCDefaultButtonShadowThickness "DefaultButtonShadowThickness"
#define XmCDefaultButtonType "DefaultButtonType"
#define XmCDefaultCopyCursorIcon "DefaultCopyCursorIcon"
#define XmCDefaultFontList "DefaultFontList"
#define XmCDefaultInvalidCursorIcon "DefaultInvalidCursorIcon"
#define XmCDefaultLinkCursorIcon "DefaultLinkCursorIcon"
#define XmCDefaultMoveCursorIcon "DefaultMoveCursorIcon"
#define XmCDefaultNoneCursorIcon "DefaultNoneCursorIcon"
#define XmCDefaultPosition "DefaultPosition"
#define XmCDefaultSourceCursorIcon "DefaultSourceCursorIcon"
#define XmCDefaultValidCursorIcon "DefaultValidCursorIcon"
#define XmCDeleteResponse "DeleteResponse"
#define XmCDesktopParent "DesktopParent"
#define XmCDialogStyle "DialogStyle"
#define XmCDialogTitle "DialogTitle"
```

Figure 6-290: `<Xm/XmStrDefs.h>`***, Part 3 of 34**

```
#define XmCDialogType "DialogType"
#define XmCDirListItemCount "DirListItemCount"
#define XmCDirListItems "DirListItems"
#define XmCDirListLabelString "DirListLabelString"
#define XmCDirMask "DirMask"
#define XmCDirSearchProc "DirSearchProc"
#define XmCDirSpec "DirSpec"
#define XmCDirectory "Directory"
#define XmCDirectoryValid "DirectoryValid"
#define XmCDisarmCallback "DisarmCallback"
#define XmCDoubleClickInterval "DoubleClickInterval"
#define XmCDragContextClass "DragContextClass"
#define XmCDragDropFinishCallback "DragDropFinishCallback"
#define XmCDragIconClass "DragIconClass"
#define XmCDragInitiatorProtocolStyle "DragInitiatorProtocolStyle"
#define XmCDragMotionCallback "DragMotionCallback"
#define XmCDragOperations "DragOperations"
#define XmCDragOverMode "DragOverMode"
#define XmCDragProc "DragProc"
#define XmCDragReceiverProtocolStyle "DragReceiverProtocolStyle"
#define XmCDropProc "DropProc"
#define XmCDropRectangles "DropRectangles"
#define XmCDropSiteActivity "DropSiteActivity"
#define XmCDropSiteEnterCallback "DropSiteEnterCallback"
#define XmCDropSiteLeaveCallback "DropSiteLeaveCallback"
#define XmCDropSiteManagerClass "DropSiteManagerClass"
#define XmCDropSiteOperations "DropSiteOperations"
#define XmCDropSiteType "DropSiteType"
#define XmCDropStartCallback "DropStartCallback"
#define XmCDropTransferClass "DropTransferClass"
#define XmCDropTransfers "DropTransfers"
#define XmCEditable "Editable"
#define XmCEntryBorder "EntryBorder"
#define XmCEntryClass "EntryClass"
#define XmCExportTargets "ExportTargets"
```

Figure 6-291: `<Xm/XmStrDefs.h>`***, Part 4 of 34**

```
#define XmCExposeCallback "ExposeCallback"
#define XmCExtensionType "ExtensionType"
#define XmCFileListItemCount "FileListItemCount"
#define XmCFileListItems "FileListItems"
#define XmCFileListLabelString "FileListLabelString"
#define XmCFileSearchProc "FileSearchProc"
#define XmCFileTypeMask "FileTypeMask"
#define XmCFillOnArm "FillOnArm"
#define XmCFillOnSelect "FillOnSelect"
#define XmCFilterLabelString "FilterLabelString"
#define XmCFontList "FontList"
#define XmCForegroundThreshold "ForegroundThreshold"
#define XmCHelpLabelString "HelpLabelString"
#define XmCHighlightColor "HighlightColor"
#define XmCHighlightOnEnter "HighlightOnEnter"
#define XmCHighlightPixmap "HighlightPixmap"
#define XmCHighlightThickness "HighlightThickness"
#define XmCHorizontalFontUnit "HorizontalFontUnit"
#define XmCHorizontalScrollBar "HorizontalScrollBar"
#define XmCHot "Hot"
#define XmCICCHandle "ICCHandle"
#define XmCImportTargets "ImportTargets"
#define XmCIncrement "Increment"
#define XmCIncremental "Incremental"
#define XmCIndicatorOn "IndicatorOn"
#define XmCIndicatorSize "IndicatorSize"
#define XmCIndicatorType "IndicatorType"
#define XmCInitialDelay "InitialDelay"
#define XmCInitialFocus "InitialFocus"
#define XmCInputCreate "InputCreate"
#define XmCInputMethod "InputMethod"
#define XmCInvalidCursorForeground "InvalidCursorForeground"
#define XmCIsAligned "IsAligned"
#define XmCIsHomogeneous "IsHomogeneous"
#define XmCItemCount "ItemCount"
```

Figure 6-292: <Xm/XmStrDefs.h>***, Part 5 of 34**

```
#define XmCItems "Items"
#define XmCKeyboardFocusPolicy "KeyboardFocusPolicy"
#define XmCLabelFontList "LabelFontList"
#define XmCLabelInsensitivePixmap "LabelInsensitivePixmap"
#define XmCLabelPixmap "LabelPixmap"
#define XmCLabelString "LabelString"
#define XmCLabelType "LabelType"
#define XmCLightThreshold "LightThreshold"
#define XmCListLabelString "ListLabelString"
#define XmCListMarginHeight "ListMarginHeight"
#define XmCListMarginWidth "ListMarginWidth"
#define XmCListSizePolicy "ListSizePolicy"
#define XmCListSpacing "ListSpacing"
#define XmCListUpdated "ListUpdated"
#define XmCLogicalParent "LogicalParent"
#define XmCMainWindowMarginHeight "MainWindowMarginHeight"
#define XmCMainWindowMarginWidth "MainWindowMarginWidth"
#define XmCMappingDelay "MappingDelay"
#define XmCMarginBottom "MarginBottom"
#define XmCMarginHeight "MarginHeight"
#define XmCMarginLeft "MarginLeft"
#define XmCMarginRight "MarginRight"
#define XmCMarginTop "MarginTop"
#define XmCMarginWidth "MarginWidth"
#define XmCMask "Mask"
#define XmCMaxItems "MaxItems"
#define XmCMaxLength "MaxLength"
#define XmCMaxValue "MaxValue"
#define XmCMaximum "Maximum"
#define XmCMenuBar "MenuBar"
#define XmCMenuPost "MenuPost"
#define XmCMenuWidget "MenuWidget"
#define XmCMessageProc "MessageProc"
#define XmCMessageWindow "MessageWindow"
#define XmCMinimizeButtons "MinimizeButtons"
```

Figure 6-293: `<Xm/XmStrDefs.h>`***, Part 6 of 34**

```
#define XmCMinimum "Minimum"
#define XmCMnemonic "Mnemonic"
#define XmCMnemonicCharSet "MnemonicCharSet"
#define XmCMoveOpaque "MoveOpaque"
#define XmCMultiClick "MultiClick"
#define XmCMustMatch "MustMatch"
#define XmCMwmDecorations "MwmDecorations"
#define XmCMwmFunctions "MwmFunctions"
#define XmCMwmInputMode "MwmInputMode"
#define XmCMwmMenu "MwmMenu"
#define XmCMwmMessages "MwmMessages"
#define XmCNavigationType "NavigationType"
#define XmCNeedsMotion "NeedsMotion"
#define XmCNoMatchString "NoMatchString"
#define XmCNoResize "NoResize"
#define XmCNoneCursorForeground "NoneCursorForeground"
#define XmCNotifyProc "NotifyProc"
#define XmCNumChildren "NumChildren"
#define XmCNumColumns "NumColumns"
#define XmCNumDropRectangles "NumDropRectangles"
#define XmCNumDropTransfers "NumDropTransfers"
#define XmCNumExportTargets "NumExportTargets"
#define XmCNumImportTargets "NumImportTargets"
#define XmCOffset "Offset"
#define XmCOkLabelString "OkLabelString"
#define XmCOperationChangedCallback "OperationChangedCallback"
#define XmCOperationCursorIcon "OperationCursorIcon"
#define XmCOptionLabel "OptionLabel"
#define XmCOptionMnemonic "OptionMnemonic"
#define XmCOutputCreate "OutputCreate"
#define XmCPacking "Packing"
#define XmCPageIncrement "PageIncrement"
#define XmCPaneMaximum "PaneMaximum"
#define XmCPaneMinimum "PaneMinimum"
#define XmCPattern "Pattern"
```

Figure 6-294: `<Xm/XmStrDefs.h>`**, Part 7 of 34**

```
#define XmCPendingDelete "PendingDelete"
#define XmCPopupEnabled "PopupEnabled"
#define XmCPositionIndex "PositionIndex"
#define XmCPostFromButton "PostFromButton"
#define XmCPostFromCount "PostFromCount"
#define XmCPostFromList "PostFromList"
#define XmCPreeditType "PreeditType"
#define XmCProcessingDirection "ProcessingDirection"
#define XmCPromptString "PromptString"
#define XmCProtocolCallback "ProtocolCallback"
#define XmCPushButtonEnabled "PushButtonEnabled"
#define XmCQualifySearchDataProc "QualifySearchDataProc"
#define XmCRadioAlwaysOne "RadioAlwaysOne"
#define XmCRadioBehavior "RadioBehavior"
#define XmCRecomputeSize "RecomputeSize"
#define XmCRectangles "Rectangles"
#define XmCRepeatDelay "RepeatDelay"
#define XmCResizeCallback "ResizeCallback"
#define XmCResizeHeight "ResizeHeight"
#define XmCResizePolicy "ResizePolicy"
#define XmCResizeWidth "ResizeWidth"
#define XmCRowColumnType "RowColumnType"
#define XmCRows "Rows"
#define XmCRubberPositioning "RubberPositioning"
#define XmCSashHeight "SashHeight"
#define XmCSashIndent "SashIndent"
#define XmCSashWidth "SashWidth"
#define XmCScaleHeight "ScaleHeight"
#define XmCScaleMultiple "ScaleMultiple"
#define XmCScaleWidth "ScaleWidth"
#define XmCScroll "Scroll"
#define XmCScrollBarDisplayPolicy "ScrollBarDisplayPolicy"
#define XmCScrollBarPlacement "ScrollBarPlacement"
#define XmCScrollSide "ScrollSide"
#define XmCScrolledWindowMarginHeight "ScrolledWindowMarginHeight"
```

Figure 6-295: `<Xm/XmStrDefs.h>`***, Part 8 of 34**

```
#define XmCScrolledWindowMarginWidth "ScrolledWindowMarginWidth"
#define XmCScrollingPolicy "ScrollingPolicy"
#define XmCSelectColor "SelectColor"
#define XmCSelectInsensitivePixmap "SelectInsensitivePixmap"
#define XmCSelectPixmap "SelectPixmap"
#define XmCSelectThreshold "SelectThreshold"
#define XmCSelectedItemCount "SelectedItemCount"
#define XmCSelectedItems "SelectedItems"
#define XmCSelectionArrayCount "SelectionArrayCount"
#define XmCSelectionLabelString "SelectionLabelString"
#define XmCSelectionPolicy "SelectionPolicy"
#define XmCSeparatorOn "SeparatorOn"
#define XmCSeparatorType "SeparatorType"
#define XmCSet "Set"
#define XmCShadowThickness "ShadowThickness"
#define XmCShadowType "ShadowType"
#define XmCShellUnitType "ShellUnitType"
#define XmCShowArrows "ShowArrows"
#define XmCShowAsDefault "ShowAsDefault"
#define XmCShowSeparator "ShowSeparator"
#define XmCShowValue "ShowValue"
#define XmCSimpleCheckBox "SimpleCheckBox"
#define XmCSimpleMenuBar "SimpleMenuBar"
#define XmCSimpleOptionMenu "SimpleOptionMenu"
#define XmCSimplePopupMenu "SimplePopupMenu"
#define XmCSimplePulldownMenu "SimplePulldownMenu"
#define XmCSimpleRadioBox "SimpleRadioBox"
#define XmCSizePolicy "SizePolicy"
#define XmCSliderSize "SliderSize"
#define XmCSource "Source"
#define XmCSourceCursorIcon "SourceCursorIcon"
#define XmCSourceIsExternal "SourceIsExternal"
#define XmCSourcePixmapIcon "SourcePixmapIcon"
#define XmCSourceWidget "SourceWidget"
#define XmCSourceWindow "SourceWindow"
```

Figure 6-296: `<Xm/XmStrDefs.h>`***, Part 9 of 34**

```
#define XmCSpacing "Spacing"
#define XmCStartTime "StartTime"
#define XmCStateCursorIcon "StateCursorIcon"
#define XmCStringDirection "StringDirection"
#define XmCTearOffModel "TearOffModel"
#define XmCTextFontList "TextFontList"
#define XmCTextString "TextString"
#define XmCTextValue "TextValue"
#define XmCTitleString "TitleString"
#define XmCTopCharacter "TopCharacter"
#define XmCTopItemPosition "TopItemPosition"
#define XmCTopLevelEnterCallback "TopLevelEnterCallback"
#define XmCTopLevelLeaveCallback "TopLevelLeaveCallback"
#define XmCTopShadowColor "TopShadowColor"
#define XmCTopShadowPixmap "TopShadowPixmap"
#define XmCTransferProc "TransferProc"
#define XmCTransferStatus "TransferStatus"
#define XmCTraversalOn "TraversalOn"
#define XmCTraversalType "TraversalType"
#define XmCTreeUpdateProc "TreeUpdateProc"
#define XmCTroughColor "TroughColor"
#define XmCUnitType "UnitType"
#define XmCUnpostBehavior "UnpostBehavior"
#define XmCUnselectPixmap "UnselectPixmap"
#define XmCUpdateSliderSize "UpdateSliderSize"
#define XmCUseAsyncGeometry "UseAsyncGeometry"
#define XmCUserData "UserData"
#define XmCValidCursorForeground "ValidCursorForeground"
#define XmCValueChangedCallback "ValueChangedCallback"
#define XmCValueWcs "ValueWcs"
#define XmCVerifyBell "VerifyBell"
#define XmCVerticalAlignment "VerticalAlignment"
#define XmCVerticalFontUnit "VerticalFontUnit"
#define XmCVerticalScrollBar "VerticalScrollBar"
```

Figure 6-297: `<Xm/XmStrDefs.h>`***, Part 10 of 34**

```
#define XmCVisibleItemCount "VisibleItemCount"
#define XmCVisibleWhenOff "VisibleWhenOff"
#define XmCVisualPolicy "VisualPolicy"
#define XmCWhichButton "WhichButton"
#define XmCWordWrap "WordWrap"
#define XmCWorkWindow "WorkWindow"
#define XmCXmString "XmString"
#define XmNaccelerator "accelerator"
#define XmNacceleratorText "acceleratorText"
#define XmNactivateCallback "activateCallback"
#define XmNadjustLast "adjustLast"
#define XmNadjustMargin "adjustMargin"
#define XmNalignment "alignment"
#define XmNallowOverlap "allowOverlap"
#define XmNallowResize "allowResize"
#define XmNanimationMask "animationMask"
#define XmNanimationPixmap "animationPixmap"
#define XmNanimationPixmapDepth "animationPixmapDepth"
#define XmNanimationStyle "animationStyle"
#define XmNapplyCallback "applyCallback"
#define XmNapplyLabelString "applyLabelString"
#define XmNarmCallback "armCallback"
#define XmNarmColor "armColor"
#define XmNarmPixmap "armPixmap"
#define XmNarrowDirection "arrowDirection"
#define XmNattachment "attachment"
#define XmNaudibleWarning "audibleWarning"
#define XmNautoShowCursorPosition "autoShowCursorPosition"
#define XmNautoUnmanage "autoUnmanage"
#define XmNautomaticSelection "automaticSelection"
#define XmNavailability "availability"
#define XmNblendModel "blendModel"
#define XmNblinkRate "blinkRate"
#define XmNbottomAttachment "bottomAttachment"
#define XmNbottomOffset "bottomOffset"
```

Figure 6-298: `<Xm/XmStrDefs.h>`***, Part 11 of 34**

```
#define XmNbottomPosition "bottomPosition"
#define XmNbottomShadowColor "bottomShadowColor"
#define XmNbottomShadowPixmap "bottomShadowPixmap"
#define XmNbottomWidget "bottomWidget"
#define XmNbrowseSelectionCallback "browseSelectionCallback"
#define XmNbuttonAcceleratorText "buttonAcceleratorText"
#define XmNbuttonAccelerators "buttonAccelerators"
#define XmNbuttonCount "buttonCount"
#define XmNbuttonFontList "buttonFontList"
#define XmNbuttonMnemonicCharSets "buttonMnemonicCharSets"
#define XmNbuttonMnemonics "buttonMnemonics"
#define XmNbuttonSet "buttonSet"
#define XmNbuttonType "buttonType"
#define XmNbuttons "buttons"
#define XmNcancelButton "cancelButton"
#define XmNcancelCallback "cancelCallback"
#define XmNcancelLabelString "cancelLabelString"
#define XmNcascadePixmap "cascadePixmap"
#define XmNcascadingCallback "cascadingCallback"
#define XmNchildHorizontalAlignment "childHorizontalAlignment"
#define XmNchildHorizontalSpacing "childHorizontalSpacing"
#define XmNchildPlacement "childPlacement"
#define XmNchildPosition "childPosition"
#define XmNchildType "childType"
#define XmNchildVerticalAlignment "childVerticalAlignment"
#define XmNclientData "clientData"
#define XmNclipWindow "clipWindow"
#define XmNcolumns "columns"
#define XmNcommand "command"
#define XmNcommandChangedCallback "commandChangedCallback"
#define XmNcommandEnteredCallback "commandEnteredCallback"
#define XmNcommandWindow "commandWindow"
#define XmNcommandWindowLocation "commandWindowLocation"
#define XmNconvertProc "convertProc"
#define XmNcursorBackground "cursorBackground"
```

Figure 6-299: `<Xm/XmStrDefs.h>`***, Part 12 of 34**

```
#define XmNcursorForeground "cursorForeground"
#define XmNcursorPosition "cursorPosition"
#define XmNcursorPositionVisible "cursorPositionVisible"
#define XmNdarkThreshold "darkThreshold"
#define XmNdecimalPoints "decimalPoints"
#define XmNdecrementCallback "decrementCallback"
#define XmNdefaultActionCallback "defaultActionCallback"
#define XmNdefaultButton "defaultButton"
#define XmNdefaultButtonShadowThickness "defaultButtonShadowThickness"
#define XmNdefaultButtonType "defaultButtonType"
#define XmNdefaultCopyCursorIcon "defaultCopyCursorIcon"
#define XmNdefaultFontList "defaultFontList"
#define XmNdefaultInvalidCursorIcon "defaultInvalidCursorIcon"
#define XmNdefaultLinkCursorIcon "defaultLinkCursorIcon"
#define XmNdefaultMoveCursorIcon "defaultMoveCursorIcon"
#define XmNdefaultNoneCursorIcon "defaultNoneCursorIcon"
#define XmNdefaultPosition "defaultPosition"
#define XmNdefaultSourceCursorIcon "defaultSourceCursorIcon"
#define XmNdefaultValidCursorIcon "defaultValidCursorIcon"
#define XmNdeleteResponse "deleteResponse"
#define XmNdesktopParent "desktopParent"
#define XmNdialogStyle "dialogStyle"
#define XmNdialogTitle "dialogTitle"
#define XmNdialogType "dialogType"
#define XmNdirListItemCount "dirListItemCount"
#define XmNdirListItems "dirListItems"
#define XmNdirListLabelString "dirListLabelString"
#define XmNdirMask "dirMask"
#define XmNdirSearchProc "dirSearchProc"
#define XmNdirSpec "dirSpec"
#define XmNdirectory "directory"
#define XmNdirectoryValid "directoryValid"
#define XmNdisarmCallback "disarmCallback"
#define XmNdoubleClickInterval "doubleClickInterval"
#define XmNdragCallback "dragCallback"
```

Figure 6-300: `<Xm/XmStrDefs.h>`***, Part 13 of 34**

```
#define XmNdragContextClass "dragContextClass"
#define XmNdragDropFinishCallback "dragDropFinishCallback"
#define XmNdragIconClass "dragIconClass"
#define XmNdragInitiatorProtocolStyle "dragInitiatorProtocolStyle"
#define XmNdragMotionCallback "dragMotionCallback"
#define XmNdragOperations "dragOperations"
#define XmNdragOverMode "dragOverMode"
#define XmNdragProc "dragProc"
#define XmNdragReceiverProtocolStyle "dragReceiverProtocolStyle"
#define XmNdropFinishCallback "dropFinishCallback"
#define XmNdropProc "dropProc"
#define XmNdropRectangles "dropRectangles"
#define XmNdropSiteActivity "dropSiteActivity"
#define XmNdropSiteEnterCallback "dropSiteEnterCallback"
#define XmNdropSiteLeaveCallback "dropSiteLeaveCallback"
#define XmNdropSiteManagerClass "dropSiteManagerClass"
#define XmNdropSiteOperations "dropSiteOperations"
#define XmNdropSiteType "dropSiteType"
#define XmNdropStartCallback "dropStartCallback"
#define XmNdropTransferClass "dropTransferClass"
#define XmNdropTransfers "dropTransfers"
#define XmNeditMode "editMode"
#define XmNeditable "editable"
#define XmNentryAlignment "entryAlignment"
#define XmNentryBorder "entryBorder"
#define XmNentryCallback "entryCallback"
#define XmNentryClass "entryClass"
#define XmNentryVerticalAlignment "entryVerticalAlignment"
#define XmNexportTargets "exportTargets"
#define XmNexposeCallback "exposeCallback"
#define XmNextendedSelectionCallback "extendedSelectionCallback"
#define XmNextensionType "extensionType"
#define XmNfileListItemCount "fileListItemCount"
#define XmNfileListItems "fileListItems"
#define XmNfileListLabelString "fileListLabelString"
```

Figure 6-301: `<Xm/XmStrDefs.h>`***, Part 14 of 34**

```
#define XmNfileSearchProc "fileSearchProc"
#define XmNfileTypeMask "fileTypeMask"
#define XmNfillOnArm "fillOnArm"
#define XmNfillOnSelect "fillOnSelect"
#define XmNfilterLabelString "filterLabelString"
#define XmNfocusCallback "focusCallback"
#define XmNfocusMovedCallback "focusMovedCallback"
#define XmNfocusPolicyChanged "focusPolicyChanged"
#define XmNfontList "fontList"
#define XmNforegroundThreshold "foregroundThreshold"
#define XmNfractionBase "fractionBase"
#define XmNgainPrimaryCallback "gainPrimaryCallback"
#define XmNhelpCallback "helpCallback"
#define XmNhelpLabelString "helpLabelString"
#define XmNhighlightColor "highlightColor"
#define XmNhighlightOnEnter "highlightOnEnter"
#define XmNhighlightPixmap "highlightPixmap"
#define XmNhighlightThickness "highlightThickness"
#define XmNhistoryItemCount "historyItemCount"
#define XmNhistoryItems "historyItems"
#define XmNhistoryMaxItems "historyMaxItems"
#define XmNhistoryVisibleItemCount "historyVisibleItemCount"
#define XmNhorizontalFontUnit "horizontalFontUnit"
#define XmNhorizontalScrollBar "horizontalScrollBar"
#define XmNhorizontalSpacing "horizontalSpacing"
#define XmNhotX "hotX"
#define XmNhotY "hotY"
#define XmNiccHandle "iccHandle"
#define XmNimportTargets "importTargets"
#define XmNincrement "increment"
#define XmNincrementCallback "incrementCallback"
#define XmNincremental "incremental"
#define XmNindicatorOn "indicatorOn"
#define XmNindicatorSize "indicatorSize"
#define XmNindicatorType "indicatorType"
```

Figure 6-302: `<Xm/XmStrDefs.h>`***, Part 15 of 34**

```
#define XmNinitialDelay "initialDelay"
#define XmNinitialFocus "initialFocus"
#define XmNinputCallback "inputCallback"
#define XmNinputCreate "inputCreate"
#define XmNinputMethod "inputMethod"
#define XmNinvalidCursorForeground "invalidCursorForeground"
#define XmNisAligned "isAligned"
#define XmNisHomogeneous "isHomogeneous"
#define XmNitemCount "itemCount"
#define XmNitems "items"
#define XmNkeyboardFocusPolicy "keyboardFocusPolicy"
#define XmNlabelFontList "labelFontList"
#define XmNlabelInsensitivePixmap "labelInsensitivePixmap"
#define XmNlabelPixmap "labelPixmap"
#define XmNlabelString "labelString"
#define XmNlabelType "labelType"
#define XmNleftAttachment "leftAttachment"
#define XmNleftOffset "leftOffset"
#define XmNleftPosition "leftPosition"
#define XmNleftWidget "leftWidget"
#define XmNlightThreshold "lightThreshold"
#define XmNlineSpace "lineSpace"
#define XmNlistItemCount "listItemCount"
#define XmNlistItems "listItems"
#define XmNlistLabelString "listLabelString"
#define XmNlistMarginHeight "listMarginHeight"
#define XmNlistMarginWidth "listMarginWidth"
#define XmNlistSizePolicy "listSizePolicy"
#define XmNlistSpacing "listSpacing"
#define XmNlistUpdated "listUpdated"
#define XmNlistVisibleItemCount "listVisibleItemCount"
#define XmNlogicalParent "logicalParent"
#define XmNlosePrimaryCallback "losePrimaryCallback"
#define XmNlosingFocusCallback "losingFocusCallback"
#define XmNmainWindowMarginHeight "mainWindowMarginHeight"
```

Figure 6-303: `<Xm/XmStrDefs.h>`***, Part 16 of 34**

```
#define XmNmainWindowMarginWidth "mainWindowMarginWidth"
#define XmNmapCallback "mapCallback"
#define XmNmappingDelay "mappingDelay"
#define XmNmargin "margin"
#define XmNmarginBottom "marginBottom"
#define XmNmarginHeight "marginHeight"
#define XmNmarginLeft "marginLeft"
#define XmNmarginRight "marginRight"
#define XmNmarginTop "marginTop"
#define XmNmarginWidth "marginWidth"
#define XmNmask "mask"
#define XmNmaxLength "maxLength"
#define XmNmaximum "maximum"
#define XmNmenuAccelerator "menuAccelerator"
#define XmNmenuBar "menuBar"
#define XmNmenuCursor "menuCursor"
#define XmNmenuHelpWidget "menuHelpWidget"
#define XmNmenuHistory "menuHistory"
#define XmNmenuPost "menuPost"
#define XmNmessageAlignment "messageAlignment"
#define XmNmessageProc "messageProc"
#define XmNmessageString "messageString"
#define XmNmessageWindow "messageWindow"
#define XmNminimizeButtons "minimizeButtons"
#define XmNminimum "minimum"
#define XmNmnemonic "mnemonic"
#define XmNmnemonicCharSet "mnemonicCharSet"
#define XmNmodifyVerifyCallback "modifyVerifyCallback"
#define XmNmodifyVerifyCallbackWcs "modifyVerifyCallbackWcs"
#define XmNmotionVerifyCallback "motionVerifyCallback"
#define XmNmoveOpaque "moveOpaque"
#define XmNmultiClick "multiClick"
#define XmNmultipleSelectionCallback "multipleSelectionCallback"
#define XmNmustMatch "mustMatch"
#define XmNmwmDecorations "mwmDecorations"
```

Figure 6-304: `<Xm/XmStrDefs.h>`***, Part 17 of 34**

```
#define XmNmwmFunctions "mwmFunctions"
#define XmNmwmInputMode "mwmInputMode"
#define XmNmwmMenu "mwmMenu"
#define XmNmwmMessages "mwmMessages"
#define XmNnavigationType "navigationType"
#define XmNneedsMotion "needsMotion"
#define XmNnoMatchCallback "noMatchCallback"
#define XmNnoMatchString "noMatchString"
#define XmNnoResize "noResize"
#define XmNnoneCursorForeground "noneCursorForeground"
#define XmNnotifyProc "notifyProc"
#define XmNnumColumns "numColumns"
#define XmNnumDropRectangles "numDropRectangles"
#define XmNnumDropTransfers "numDropTransfers"
#define XmNnumExportTargets "numExportTargets"
#define XmNnumImportTargets "numImportTargets"
#define XmNnumRectangles "numRectangles"
#define XmNoffsetX "offsetX"
#define XmNoffsetY "offsetY"
#define XmNokCallback "okCallback"
#define XmNokLabelString "okLabelString"
#define XmNoperationChangedCallback "operationChangedCallback"
#define XmNoperationCursorIcon "operationCursorIcon"
#define XmNoptionLabel "optionLabel"
#define XmNoptionMnemonic "optionMnemonic"
#definl i
```

Figure 6-305: `<Xm/XmStrDefs.h>`***, Part 18 of 34**

```
#define XmNpositionIndex "positionIndex"
#define XmNpostFromButton "postFromButton"
#define XmNpostFromCount "postFromCount"
#define XmNpostFromList "postFromList"
#define XmNpreeditType "preeditType"
#define XmNprocessingDirection "processingDirection"
#define XmNpromptString "promptString"
#define XmNprotocolCallback "protocolCallback"
#define XmNpushButtonEnabled "pushButtonEnabled"
#define XmNqualifySearchDataProc "qualifySearchDataProc"
#define XmNradioAlwaysOne "radioAlwaysOne"
#define XmNradioBehavior "radioBehavior"
#define XmNrealizeCallback "realizeCallback"
#define XmNrecomputeSize "recomputeSize"
#define XmNrectangles "rectangles"
#define XmNrefigureMode "refigureMode"
#define XmNrepeatDelay "repeatDelay"
#define XmNresizable "resizable"
#define XmNresizeCallback "resizeCallback"
#define XmNresizeHeight "resizeHeight"
#define XmNresizePolicy "resizePolicy"
#define XmNresizeWidth "resizeWidth"
#define XmNrightAttachment "rightAttachment"
#define XmNrightOffset "rightOffset"
#define XmNrightPosition "rightPosition"
#define XmNrightWidget "rightWidget"
#define XmNrowColumnType "rowColumnType"
#define XmNrows "rows"
#define XmNrubberPositioning "rubberPositioning"
#define XmNsashHeight "sashHeight"
#define XmNsashIndent "sashIndent"
#define XmNsashShadowThickness "sashShadowThickness"
#define XmNsashWidth "sashWidth"
#define XmNscaleHeight "scaleHeight"
#define XmNscaleMultiple "scaleMultiple"
```

Figure 6-306: `<Xm/XmStrDefs.h>`***, Part 19 of 34**

```
#define XmNscaleWidth "scaleWidth"
#define XmNscrollBarDisplayPolicy "scrollBarDisplayPolicy"
#define XmNscrollBarPlacement "scrollBarPlacement"
#define XmNscrollHorizontal "scrollHorizontal"
#define XmNscrollLeftSide "scrollLeftSide"
#define XmNscrollTopSide "scrollTopSide"
#define XmNscrollVertical "scrollVertical"
#define XmNscrolledWindowMarginHeight "scrolledWindowMarginHeight"
#define XmNscrolledWindowMarginWidth "scrolledWindowMarginWidth"
#define XmNscrollingPolicy "scrollingPolicy"
#define XmNselectColor "selectColor"
#define XmNselectInsensitivePixmap "selectInsensitivePixmap"
#define XmNselectPixmap "selectPixmap"
#define XmNselectThreshold "selectThreshold"
#define XmNselectedItemCount "selectedItemCount"
#define XmNselectedItems "selectedItems"
#define XmNselectionArrayCount "selectionArrayCount"
#define XmNselectionLabelString "selectionLabelString"
#define XmNselectionPolicy "selectionPolicy"
#define XmNseparatorOn "separatorOn"
#define XmNseparatorType "separatorType"
#define XmNset "set"
#define XmNshadow "shadow"
#define XmNshadowThickness "shadowThickness"
#define XmNshadowType "shadowType"
#define XmNshellUnitType "shellUnitType"
#define XmNshowArrows "showArrows"
#define XmNshowAsDefault "showAsDefault"
#define XmNshowSeparator "showSeparator"
#define XmNshowValue "showValue"
#define XmNsimpleCallback "simpleCallback"
#define XmNsingleSelectionCallback "singleSelectionCallback"
#define XmNsizePolicy "sizePolicy"
#define XmNskipAdjust "skipAdjust"
#define XmNsliderSize "sliderSize"
```

Figure 6-307: `<Xm/XmStrDefs.h>`***, Part 20 of 34**

```
#define XmNsource "source"
#define XmNsourceCursorIcon "sourceCursorIcon"
#define XmNsourceIsExternal "sourceIsExternal"
#define XmNsourcePixmapIcon "sourcePixmapIcon"
#define XmNsourceWidget "sourceWidget"
#define XmNsourceWindow "sourceWindow"
#define XmNspacing "spacing"
#define XmNspotLocation "spotLocation"
#define XmNstartTime "startTime"
#define XmNstateCursorIcon "stateCursorIcon"
#define XmNstringDirection "stringDirection"
#define XmNsubMenuId "subMenuId"
#define XmNsymbolPixmap "symbolPixmap"
#define XmNtearOffMenuActivateCallback "tearOffMenuActivateCallback"
#define XmNtearOffMenuDeactivateCallback "tearOffMenuDeactivateCallback"
#define XmNtearOffModel "tearOffModel"
#define XmNtextAccelerators "textAccelerators"
#define XmNtextColumns "textColumns"
#define XmNtextFontList "textFontList"
#define XmNtextString "textString"
#define XmNtextTranslations "textTranslations"
#define XmNtextValue "textValue"
#define XmNtitleString "titleString"
#define XmNtoBottomCallback "toBottomCallback"
#define XmNtoPositionCallback "toPositionCallback"
#define XmNtoTopCallback "toTopCallback"
#define XmNtopAttachment "topAttachment"
#define XmNtopCharacter "topCharacter"
#define XmNtopItemPosition "topItemPosition"
#define XmNtopLevelEnterCallback "topLevelEnterCallback"
#define XmNtopLevelLeaveCallback "topLevelLeaveCallback"
#define XmNtopOffset "topOffset"
#define XmNtopPosition "topPosition"
#define XmNtopShadowColor "topShadowColor"
#define XmNtopShadowPixmap "topShadowPixmap"
```

Figure 6-308: `<Xm/XmStrDefs.h>`***, Part 21 of 34**

```
#define XmNtopWidget "topWidget"
#define XmNtransferProc "transferProc"
#define XmNtransferStatus "transferStatus"
#define XmNtraversalCallback "traversalCallback"
#define XmNtraversalOn "traversalOn"
#define XmNtraversalType "traversalType"
#define XmNtraverseObscuredCallback "traverseObscuredCallback"
#define XmNtreeUpdateProc "treeUpdateProc"
#define XmNtroughColor "troughColor"
#define XmNunitType "unitType"
#define XmNunmapCallback "unmapCallback"
#define XmNunpostBehavior "unpostBehavior"
#define XmNunselectPixmap "unselectPixmap"
#define XmNupdateSliderSize "updateSliderSize"
#define XmNuseAsyncGeometry "useAsyncGeometry"
#define XmNuserData "userData"
#define XmNvalidCursorForeground "validCursorForeground"
#define XmNvalueChangedCallback "valueChangedCallback"
#define XmNvalueWcs "valueWcs"
#define XmNverifyBell "verifyBell"
#define XmNverticalFontUnit "verticalFontUnit"
#define XmNverticalScrollBar "verticalScrollBar"
#define XmNverticalSpacing "verticalSpacing"
#define XmNvisibleItemCount "visibleItemCount"
#define XmNvisibleWhenOff "visibleWhenOff"
#define XmNvisualPolicy "visualPolicy"
#define XmNwhichButton "whichButton"
#define XmNwordWrap "wordWrap"
#define XmNworkWindow "workWindow"
#define XmRAlignment "Alignment"
#define XmRAnimationMask "AnimationMask"
#define XmRAnimationPixmap "AnimationPixmap"
#define XmRAnimationStyle "AnimationStyle"
#define XmRArrowDirection "ArrowDirection"
#define XmRAtomList "AtomList"
```

Figure 6-309: `<Xm/XmStrDefs.h>`***, Part 22 of 34**

```
#define XmRAttachment "Attachment"
#define XmRAudibleWarning "AudibleWarning"
#define XmRAvailability "Availability"
#define XmRBackgroundPixmap "BackgroundPixmap"
#define XmRBlendModel "BlendModel"
#define XmRBooleanDimension "BooleanDimension"
#define XmRBottomShadowPixmap "BottomShadowPixmap"
#define XmRButtonType "ButtonType"
#define XmRCallbackProc "CallbackProc"
#define XmRChar "Char"
#define XmRCharSetTable "CharSetTable"
#define XmRChildHorizontalAlignment "ChildHorizontalAlignment"
#define XmRChildPlacement "ChildPlacement"
#define XmRChildType "ChildType"
#define XmRChildVerticalAlignment "ChildVerticalAlignment"
#define XmRCommandWindowLocation "CommandWindowLocation"
#define XmRCompoundText "CompoundText"
#define XmRDefaultButtonType "DefaultButtonType"
#define XmRDeleteResponse "DeleteResponse"
#define XmRDialogStyle "DialogStyle"
#define XmRDialogType "DialogType"
#define XmRDoubleClickInterval "DoubleClickInterval"
#define XmRDragInitiatorProtocolStyle "DragInitiatorProtocolStyle"
#define XmRDragReceiverProtocolStyle "DragReceiverProtocolStyle"
#define XmRDropSiteActivity "DropSiteActivity"
#define XmRDropSiteOperations "DropSiteOperations"
#define XmRDropSiteType "DropSiteType"
#define XmRDropTransfers "DropTransfers"
#define XmRExtensionType "ExtensionType"
#define XmRFileTypeMask "FileTypeMask"
#define XmRFontList "FontList"
#define XmRGadgetPixmap "GadgetPixmap"
#define XmRHighlightPixmap "HighlightPixmap"
#define XmRHorizontalDimension "HorizontalDimension"
#define XmRHorizontalInt "HorizontalInt"
```

Figure 6-310: `<Xm/XmStrDefs.h>`***, Part 23 of 34**

```
#define XmRHorizontalPosition "HorizontalPosition"
#define XmRIconAttachment "IconAttachment"
#define XmRImportTargets "ImportTargets"
#define XmRIndicatorType "IndicatorType"
#define XmRItemCount "ItemCount"
#define XmRItems "Items"
#define XmRKeySym "KeySym"
#define XmRKeySymTable "KeySymTable"
#define XmRKeyboardFocusPolicy "KeyboardFocusPolicy"
#define XmRLabelType "LabelType"
#define XmRListMarginHeight "ListMarginHeight"
#define XmRListMarginWidth "ListMarginWidth"
#define XmRListSizePolicy "ListSizePolicy"
#define XmRListSpacing "ListSpacing"
#define XmRManBottomShadowPixmap "ManBottomShadowPixmap"
#define XmRManForegroundPixmap "ManForegroundPixmap"
#define XmRManHighlightPixmap "ManHighlightPixmap"
#define XmRManTopShadowPixmap "ManTopShadowPixmap"
#define XmRMenuWidget "MenuWidget"
#define XmRMnemonic "Mnemonic"
#define XmRMultiClick "MultiClick"
#define XmRNavigationType "NavigationType"
#define XmRPacking "Packing"
#define XmRPrimForegroundPixmap "PrimForegroundPixmap"
#define XmRProc "Proc"
#define XmRProcessingDirection "ProcessingDirection"
#define XmRRectangleList "RectangleList"
#define XmRResizePolicy "ResizePolicy"
#define XmRRowColumnType "RowColumnType"
#define XmRScrollBarDisplayPolicy "ScrollBarDisplayPolicy"
#define XmRScrollBarPlacement "ScrollBarPlacement"
#define XmRScrollingPolicy "ScrollingPolicy"
#define XmRSelectedItemCount "SelectedItemCount"
#define XmRSelectedItems "SelectedItems"
#define XmRSelectionPolicy "SelectionPolicy"
```

Figure 6-311: `<Xm/XmStrDefs.h>`***, Part 24 of 34**

```
#define XmRSelectionType "SelectionType"
#define XmRSeparatorType "SeparatorType"
#define XmRShadowType "ShadowType"
#define XmRShellHorizDim "ShellHorizDim"
#define XmRShellHorizPos "ShellHorizPos"
#define XmRShellUnitType "ShellUnitType"
#define XmRShellVertDim "ShellVertDim"
#define XmRShellVertPos "ShellVertPos"
#define XmRSizePolicy "SizePolicy"
#define XmRStringDirection "StringDirection"
#define XmRTearOffModel "TearOffModel"
#define XmRTopShadowPixmap "TopShadowPixmap"
#define XmRTransferStatus "TransferStatus"
#define XmRTraversalType "TraversalType"
#define XmRUnitType "UnitType"
#define XmRUnpostBehavior "UnpostBehavior"
#define XmRValueWcs "ValueWcs"
#define XmRVerticalAlignment "VerticalAlignment"
#define XmRVerticalDimension "VerticalDimension"
#define XmRVerticalInt "VerticalInt"
#define XmRVerticalPosition "VerticalPosition"
#define XmRVirtualBinding "VirtualBinding"
#define XmRVisibleItemCount "VisibleItemCount"
#define XmRVisualPolicy "VisualPolicy"
#define XmRWhichButton "WhichButton"
#define XmRXmBackgroundPixmap "XmBackgroundPixmap"
#define XmRXmString "XmString"
#define XmRXmStringCharSet "XmStringCharSet"
#define XmRXmStringTable "XmStringTable"
#define XmVosfActivate "osfActivate"
#define XmVosfAddMode "osfAddMode"
#define XmVosfBackSpace "osfBackSpace"
#define XmVosfBeginLine "osfBeginLine"
#define XmVosfCancel "osfCancel"
#define XmVosfClear "osfClear"
```

Figure 6-312: `<Xm/XmStrDefs.h>`***, Part 25 of 34**

```
#define XmVosfCopy "osfCopy"
#define XmVosfCut "osfCut"
#define XmVosfDelete "osfDelete"
#define XmVosfDown "osfDown"
#define XmVosfEndLine "osfEndLine"
#define XmVosfHelp "osfHelp"
#define XmVosfInsert "osfInsert"
#define XmVosfLeft "osfLeft"
#define XmVosfMenu "osfMenu"
#define XmVosfMenuBar "osfMenuBar"
#define XmVosfPageDown "osfPageDown"
#define XmVosfPageLeft "osfPageLeft"
#define XmVosfPageRight "osfPageRight"
#define XmVosfPageUp "osfPageUp"
#define XmVosfPaste "osfPaste"
#define XmVosfPrimaryPaste "osfPrimaryPaste"
#define XmVosfQuickPaste "osfQuickPaste"
#define XmVosfRight "osfRight"
#define XmVosfSelect "osfSelect"
#define XmVosfUndo "osfUndo"
#define XmVosfUp "osfUp"
#define XmSFONTLIST_DEFAULT_TAG_STRING "FONTLIST_DEFAULT_TAG_STRING"
#define XmSXmFONTLIST_DEFAULT_TAG_STRING "XmFONTLIST_DEFAULT_TAG_STRING"
#define _XmConst /**/

#define XmSTRING_DEFAULT_CHARSET        XmS
#define XmSTRING_ISO8859_1              "ISO8859-1"
#define XmFONTLIST_DEFAULT_TAG          XmSFONTLIST_DEFAULT_TAG_STRING
#define XmFONTLIST_DEFAULT_TAG_STRING   XmSXmFONTLIST_DEFAULT_TAG_STRING

#define XmVaCASCADEBUTTON               "cascadeButton"
#define XmVaCHECKBUTTON                 "checkButton"
#define XmVaDOUBLE_SEPARATOR            "doubleSeparator"
#define XmVaPUSHBUTTON                  "pushButton"
#define XmVaRADIOBUTTON                 "radioButton"
```

Figure 6-313: `<Xm/XmStrDefs.h>`***, Part 26 of 34**

```
#define XmVaSEPARATOR                    "separator"
#define XmVaSINGLE_SEPARATOR             "singleSeparator"
#define XmVaTOGGLEBUTTON                 "checkButton"
#define XmVaTITLE                        XtNtitle

#define XtCKeyboardFocusPolicy           XmCKeyboardFocusPolicy
#define XtCShellUnitType                 XmCShellUnitType
#define XtNkeyboardFocusPolicy           XmNkeyboardFocusPolicy
#define XtNshellUnitType                 XmNshellUnitType
#define XtRKeyboardFocusPolicy           XmRKeyboardFocusPolicy

#define XmRPrimBottomShadowPixmap        XmRBottomShadowPixmap
#define XmRPrimHighlightPixmap           XmRHighlightPixmap
#define XmRPrimTopShadowPixmap           XmRTopShadowPixmap

#define XmCAccelerators                  XtCAccelerators
#define XmCAllowShellResize              XtCAllowShellResize
#define XmCArgc                          XtCArgc
#define XmCArgv                          XtCArgv
#define XmCBackground                    XtCBackground
#define XmCBaseHeight                    XtCBaseHeight
#define XmCBaseHeight                    XtCBaseHeight
#define XmCBaseWidth                     XtCBaseWidth
#define XmCBaseWidth                     XtCBaseWidth
#define XmCBitmap                        XtCBitmap
#define XmCBoolean                       XtCBoolean
#define XmCBorderColor                   XtCBorderColor
#define XmCBorderWidth                   XtCBorderWidth
#define XmCCallback                      XtCCallback
#define XmCColor                         XtCColor
#define XmCColormap                      XtCColormap
#define XmCCreatePopupChildProc          XtCCreatePopupChildProc
#define XmCCursor                        XtCCursor
#define XmCDepth                         XtCDepth
#define XmCDimension                     XtRDimension
```

Figure 6-314: <Xm/XmStrDefs.h>***, Part 27 of 34**

```
#define XmCEditMode                      XtREditMode
#define XmCEditType                      XtCEditType
#define XmCEventBindings                 XtCEventBindings
#define XmCFile                          XtCFile
#define XmCFont                          XtCFont
#define XmCFontSet                       XtCFontSet
#define XmCForeground                    XtCForeground
#define XmCFraction                      XtCFraction
#define XmCFunction                      XtCFunction
#define XmCGeometry                      XtCGeometry
#define XmCHSpace                        XtCHSpace
#define XmCHeight                        XtCHeight
#define XmCHeightInc                     XtCHeightInc
#define XmCIconMask                      XtCIconMask
#define XmCIconName                      XtCIconName
#define XmCIconNameEncoding              XtCIconNameEncoding
#define XmCIconPixmap                    XtCIconPixmap
#define XmCIconWindow                    XtCIconWindow
#define XmCIconX                         XtCIconX
#define XmCIconY                         XtCIconY
#define XmCIconic                        XtCIconic
#define XmCIndex                         XtCIndex
#define XmCInitialResourcesPersistent   XtCInitialResourcesPersistent
#define XmCInitialState                  XtCInitialState
#define XmCInput                         XtCInput
#define XmCInsertPosition                XtCInsertPosition
#define XmCInterval                      XtCInterval
#define XmCJustify                       XtCJustify
#define XmCLabel                         XtCLabel
#define XmCLength                        XtCLength
#define XmCMappedWhenManaged             XtCMappedWhenManaged
#define XmCMargin                        XtCMargin
#define XmCMaxAspectX                    XtCMaxAspectX
#define XmCMaxAspectY                    XtCMaxAspectY
#define XmCMaxHeight                     XtCMaxHeight
```

Figure 6-315: `<Xm/XmStrDefs.h>`***, Part 28 of 34**

```
#define XmCMaxWidth                       XtCMaxWidth
#define XmCMenuEntry                      XtCMenuEntry
#define XmCMinAspectX                     XtCMinAspectX
#define XmCMinAspectY                     XtCMinAspectY
#define XmCMinHeight                      XtCMinHeight
#define XmCMinWidth                       XtCMinWidth
#define XmCNotify                         XtCNotify
#define XmCOrientation                    XtCOrientation
#define XmCOverrideRedirect               XtCOverrideRedirect
#define XmCParameter                      XtCParameter
#define XmCPixmap                         XtCPixmap
#define XmCPosition                       XtCPosition
#define XmCReadOnly                       XtCReadOnly
#define XmCResize                         XtCResize
#define XmCReverseVideo                   XtCReverseVideo
#define XmCSaveUnder                      XtCSaveUnder
#define XmCScreen                         XtCScreen
#define XmCScrollDCursor                  XtCScrollDCursor
#define XmCScrollHCursor                  XtCScrollHCursor
#define XmCScrollLCursor                  XtCScrollLCursor
#define XmCScrollProc                     XtCScrollProc
#define XmCScrollRCursor                  XtCScrollRCursor
#define XmCScrollUCursor                  XtCScrollUCursor
#define XmCScrollVCursor                  XtCScrollVCursor
#define XmCSelection                      XtCSelection
#define XmCSelectionArray                 XtCSelectionArray
#define XmCSensitive                      XtCSensitive
#define XmCSpace                          XtCSpace
#define XmCString                         XtCString
#define XmCTextOptions                    XtCTextOptions
#define XmCTextPosition                   XtCTextPosition
#define XmCTextSink                       XtCTextSink
#define XmCTextSource                     XtCTextSource
#define XmCThickness                      XtCThickness
#define XmCThumb                          XtCThumb
```

Figure 6-316: `<Xm/XmStrDefs.h>`***, Part 29 of 34**

```
#define XmCTitle                        XtCTitle
#define XmCTitleEncoding                XtCTitleEncoding
#define XmCTransient                    XtCTransient
#define XmCTransientFor                 XtCTransientFor
#define XmCTranslations                 XtCTranslations
#define XmCVSpace                       XtCVSpace
#define XmCValue                        XtCValue
#define XmCVisual                       XtCVisual
#define XmCWaitForWm                    XtCWaitForWm
#define XmCWidget                       XtRWidget
#define XmCWidth                        XtCWidth
#define XmCWidthInc                     XtCWidthInc
#define XmCWinGravity                   XtCWinGravity
#define XmCWindow                       XtCWindow
#define XmCWindowGroup                  XtCWindowGroup
#define XmCWmTimeout                    XtCWmTimeout
#define XmCX                            XtCX
#define XmCY                            XtCY
#define XmNaccelerators                 XtNaccelerators
#define XmNallowShellResize             XtNallowShellResize
#define XmNancestorSensitive            XtNancestorSensitive
#define XmNargc                         XtNargc
#define XmNargv                         XtNargv
#define XmNbackground                   XtNbackground
#define XmNbackgroundPixmap             XtNbackgroundPixmap
#define XmNbaseHeight                   XtNbaseHeight
#define XmNbaseHeight                   XtNbaseHeight
#define XmNbaseWidth                    XtNbaseWidth
#define XmNbaseWidth                    XtNbaseWidth
#define XmNbitmap                       XtNbitmap
#define XmNborder                       XtNborder
#define XmNborderColor                  XtNborderColor
#define XmNborderPixmap                 XtNborderPixmap
#define XmNborderWidth                  XtNborderWidth
#define XmNcallback                     XtNcallback
```

Figure 6-317: `<Xm/XmStrDefs.h>`***, Part 30 of 34**

```
#define XmNchildren                        XtNchildren
#define XmNcolormap                        XtNcolormap
#define XmNcreatePopupChildProc            XtNcreatePopupChildProc
#define XmNdepth                           XtNdepth
#define XmNdestroyCallback                 XtNdestroyCallback
#define XmNeditType                        XtNeditType
#define XmNfile                            XtNfile
#define XmNfont                            XtNfont
#define XmNfontSet                         XtNfontSet
#define XmNforceBars                       XtNforceBars
#define XmNforeground                      XtNforeground
#define XmNfunction                        XtNfunction
#define XmNgeometry                        XtNgeometry
#define XmNheight                          XtNheight
#define XmNheightInc                       XtNheightInc
#define XmNhighlight                       XtNhighlight
#define XmNiconMask                        XtNiconMask
#define XmNiconName                        XtNiconName
#define XmNiconNameEncoding                XtNiconNameEncoding
#define XmNiconPixmap                      XtNiconPixmap
#define XmNiconWindow                      XtNiconWindow
#define XmNiconX                           XtNiconX
#define XmNiconY                           XtNiconY
#define XmNiconic                          XtNiconic
#define XmNindex                           XtNindex
#define XmNinitialResourcesPersistent      XtNinitialResourcesPersistent
#define XmNinitialState                    XtNinitialState
#define XmNinnerHeight                     XtNinnerHeight
#define XmNinnerWidth                      XtNinnerWidth
#define XmNinnerWindow                     XtNinnerWindow
#define XmNinput                           XtNinput
#define XmNinsertPosition                  XtNinsertPosition
#define XmNinternalHeight                  XtNinternalHeight
#define XmNinternalWidth                   XtNinternalWidth
#define XmNjumpProc                        XtNjumpProc
```

Figure 6-318: `<Xm/XmStrDefs.h>`***, Part 31 of 34**

```
#define XmNjustify                      XtNjustify
#define XmNlength                       XtNlength
#define XmNlowerRight                   XtNlowerRight
#define XmNmappedWhenManaged            XtNmappedWhenManaged
#define XmNmaxAspectX                   XtNmaxAspectX
#define XmNmaxAspectY                   XtNmaxAspectY
#define XmNmaxHeight                    XtNmaxHeight
#define XmNmaxWidth                     XtNmaxWidth
#define XmNmenuEntry                    XtNmenuEntry
#define XmNminAspectX                   XtNminAspectX
#define XmNminAspectY                   XtNminAspectY
#define XmNminHeight                    XtNminHeight
#define XmNminWidth                     XtNminWidth
#define XmNname                         XtNname
#define XmNnotify                       XtNnotify
#define XmNnumChildren                  XtNnumChildren
#define XmNorientation                  XtNorientation
#define XmNoverrideRedirect             XtNoverrideRedirect
#define XmNparameter                    XtNparameter
#define XmNpixmap                       XtNpixmap
#define XmNpopdownCallback              XtNpopdownCallback
#define XmNpopupCallback                XtNpopupCallback
#define XmNresize                       XtNresize
#define XmNreverseVideo                 XtNreverseVideo
#define XmNsaveUnder                    XtNsaveUnder
#define XmNscreen                       XtNscreen
#define XmNscrollDCursor                XtNscrollDCursor
#define XmNscrollHCursor                XtNscrollHCursor
#define XmNscrollLCursor                XtNscrollLCursor
#define XmNscrollProc                   XtNscrollProc
#define XmNscrollRCursor                XtNscrollRCursor
#define XmNscrollUCursor                XtNscrollUCursor
#define XmNscrollVCursor                XtNscrollVCursor
#define XmNselection                    XtNselection
#define XmNselectionArray               XtNselectionArray
```

Figure 6-319: `<Xm/XmStrDefs.h>`***, Part 32 of 34**

```
#define XmNsensitive                        XtNsensitive
#define XmNshown                            XtNshown
#define XmNspace                            XtNspace
#define XmNstring                           XtNstring
#define XmNtextOptions                      XtNtextOptions
#define XmNtextSink                         XtNtextSink
#define XmNtextSource                       XtNtextSource
#define XmNthickness                        XtNthickness
#define XmNthumb                            XtNthumb
#define XmNthumbProc                        XtNthumbProc
#define XmNtitle                            XtNtitle
#define XmNtitleEncoding                    XtNtitleEncoding
#define XmNtop                              XtNtop
#define XmNtransient                        XtNtransient
#define XmNtransientFor                     XtNtransientFor
#define XmNtransientFor                     XtNtransientFor
#define XmNtranslations                     XtNtranslations
#define XmNupdate                           XtNupdate
#define XmNuseBottom                        XtNuseBottom
#define XmNuseRight                         XtNuseRight
#define XmNvalue                            XtNvalue
#define XmNvisual                           XtNvisual
#define XmNwaitForWm                        XtNwaitForWm
#define XmNwidth                            XtNwidth
#define XmNwidthInc                         XtNwidthInc
#define XmNwinGravity                       XtNwinGravity
#define XmNwindow                           XtNwindow
#define XmNwindowGroup                      XtNwindowGroup
#define XmNwmTimeout                        XtNwmTimeout
#define XmNx                                XtNx
#define XmNy                                XtNy
#define XmRAcceleratorTable                 XtRAcceleratorTable
#define XmRAtom                             XtRAtom
#define XmRBitmap                           XtRBitmap
#define XmRBool                             XtRBool
```

Figure 6-320: `<Xm/XmStrDefs.h>`***, Part 33 of 34**

```
#define XmRBoolean                        XtRBoolean
#define XmRCallProc                       XtRCallProc
#define XmRCallback                       XtRCallback
#define XmRCardinal                       XtRCardinal
#define XmRColor                          XtRColor
#define XmRColormap                       XtRColormap
#define XmRCursor                         XtRCursor
#define XmRDimension                      XtRDimension
#define XmRDisplay                        XtRDisplay
#define XmREditMode                       XtREditMode
#define XmREnum                           XtREnum
#define XmRFile                           XtRFile
#define XmRFloat                          XtRFloat
#define XmRFont                           XtRFont
#define XmRFontSet                        XtRFontSet
#define XmRFontStruct                     XtRFontStruct
#define XmRFunction                       XtRFunction
#define XmRGeometry                       XtRGeometry
#define XmRImmediate                      XtRImmediate
#define XmRInitialState                   XtRInitialState
#define XmRInt                            XtRInt
#define XmRJustify                        XtRJustify
#define XmRLongBoolean                    XtRLongBoolean
#define XmROrientation                    XtROrientation
#define XmRObject                         XtRObject
#define XmRPixel                          XtRPixel
#define XmRPixmap                         XtRPixmap
#define XmRPointer                        XtRPointer
#define XmRPosition                       XtRPosition
#define XmRScreen                         XtRScreen
#define XmRShort                          XtRShort
#define XmRString                         XtRString
#define XmRStringArray                    XtRStringArray
#define XmRStringTable                    XtRStringTable
#define XmRTextPosition                   XtCTextPosition
```

Figure 6-321: `<Xm/XmStrDefs.h>`***, Part 34 of 34**

```
#define XmRTranslationTable              XtRTranslationTable
#define XmRUnsignedChar                  XtRUnsignedChar
#define XmRVisual                        XtRVisual
#define XmRWidget                        XtRWidget
#define XmRWidgetClass                   XtRWidgetClass
#define XmRWidgetList                    XtRWidgetList
#define XmRWindow                        XtRWindow
```

TCP/IP Data Definitions

NOTE *This section is new to the Third Edition of this document, but will not be marked with the "G" diff-mark.*

This section contains standard data definitions that describe system data for the optional TCP / IP Interfaces. These data definitions are referred to by their names in angle brackets: <*name.h*> and <sys / *name.h*>. Included in these data definitions are macro definitions and structure definitions. While an ABI-conforming system may provide TCP / IP interfaces, it need not contain the actual data definitions referenced here. Programmers should observe that the sources of the structures defined in these data definitions are defined in SVID.

Figure 6-322: `<netinet/in.h>`

```
#define      IPPROTO_IP   0
#define      IPPROTO_TCP  6

struct in_addr {
      union {
            struct { u_char s_b1,s_b2,s_b3,s_b4; } S_un_b;
            struct { u_short s_w1,s_w2; } S_un_w;
            u_long S_addr;
      } S_un;
#define      s_addr       S_un.S_addr
};

#define      INADDR_ANY                (u_long)0x00000000
#define      INADDR_LOOPBACK           (u_long)0x7F000001
#define      INADDR_BROADCAST          (u_long)0xffffffff

#define      IN_SET_LOOPBACK_ADDR(a) \
      {(a)->sin_addr.s_addr = htonl(INADDR_LOOPBACK); \
      (a)->sin_family = AF_INET;}

struct sockaddr_in {
      short        sin_family;
      u_short      sin_port;
      struct in_addr     sin_addr;
      char         sin_zero[8];
};

#define      IP_OPTIONS   1
```

Figure 6-323: `<netinet/ip.h>`

```
#define      IPOPT_EOL          0
#define      IPOPT_NOP          1
#define      IPOPT_LSRR         131
#define      IPOPT_SSRR         137
```

Figure 6-324: `<netinet/tcp.h>`

```
#define      TCP_NODELAY  0x01
```

7 DEVELOPMENT ENVIRONMENT

Development Commands

NOTE THE FACILITIES AND INTERFACES DESCRIBED IN THIS SECTION ARE OPTIONAL COMPONENTS OF THE *System V Application Binary Interface*.

NOTE *This section is new to the Third Edition of this document, but will not be marked with the "G" diff-mark.*

The Development Environment for Intel386 implementations of UnixWare® 2.0 will contain all of the development commands required by the System V ABI, namely; M

`as`	`cc`	`ld`
`m4`	`lex`	`yacc`

Each command accepts all of the options required by the System V ABI, as defined in the SD_CMD section of the *System V Interface Definition, Edition 4*.

PATH Access to Development Tools

The development environment for the Intel386 System V implementations is accessible using the system default value for PATH. The default if no options are given to the `cc` command is to use the libraries and object file formats that are required for ABI compliance.

Software Packaging Tools

The development environment for i386 implementations of the System V ABI shall include each of the following commands as defined in the AS_CMD section of - *System V Interface Definition, Edition 4*.

`pkgproto` `pkgtrans` `pkgmk`

System Headers

Systems that do not have an ABI Development Environment may not have system header files. If an ABI Development Environment is supported, system header files will be included with the Development Environment. The primary source for contents of header files is always the *System V Interface Definition, Edition 4*. In those cases where SVID Fourth Edition doesn't specify the contents of system headers, Chapter 6 "Data Definitions" of this document shall define the associations of data elements to system headers for compilation. For greatest source portability, applications should only depend on header file contents defined in SVID.

Static Archives

Level 1 interfaces defined in *System V Interface Definition, Edition 4*, for each of the following libraries, may be statically linked safely into applications. The resulting executable will not be made non-compliant to the ABI solely because of the static linkage of such members in the executable.

`libcurses` `libm`

The archive `libcurses.a` is located in /usr/lib on conforming i386 development M
environments. The archive `libm.a` is located in /usr/lib on conforming i386 development environments.

8 EXECUTION ENVIRONMENT

Application Environment

> **NOTE** *This section is new to the Third Edition of this document, but will not be marked with the "G" diff-mark.*

This section specifies the execution environment information available to application programs running on an i386 ABI-conforming computer.

The /dev Subtree

All networking device files described in the Generic ABI shall be supported on all i386 ABI-conforming computers. In addition, the following device files are required to be present on all i386 ABI-conforming computers.

`/dev/null` This device file is a special ‘‘null’’ device that may be used to test programs or provide a data sink. This file is writable by all processes.

`/dev/tty` This device file is a special one that directs all output to the controlling TTY of the current process group. This file is readable and writable by all processes.

`/dev/sxtXX`
`/dev/ttyXX` These device files, where XX represents a two-digit integer, represent device entries for terminal sessions. All these device files must be examined by the `ttyname()` call. Applications must not have the device names of individual terminals hard-coded within them. The `sxt` entries are optional in the system but, if present must be included in the library routine’s search.

The following device files are required to be present on all i386 ABI-conforming computers that support the corresponding hardware devices.

`/dev/lpX` This device file is the lineprinter device. The letter ‘‘X’’ represents a one-digit integer that identifies the particular lineprinter device.

`/dev/dsk/`
`/dev/rdsk/` These directories contain the raw and block disk device files. They are of the form:

```
f[01][t]
f[01][35][dh][t]
c#t#d#s#
```

where ’c’ is followed by a controller number,
’t’ is followed by a target number,
’d’ is followed by a disk unit number,
’s’ is followed by a disk slice number.

`/dev/rmt/` These directories contain the raw and block tape device files. The devices guaranteed to be in this directory are:

```
ctape1
ntape1
```

`/dev/cdrom/`
`/dev/rcdrom/` These directories contain the raw and block CD-ROM disk device files. They are of the form:

```
c#t#l#
c#t#l#
cdrom#
```

The letter ’c’ is followed by a controller number. The letter ’t’ is followed by a target number on the controller. The letter ’l’ is followed by a logical unit number on the target. The device "cdrom" is followed by a sequential number as nodes are created.

No leading zeroes are used in the numbers (target four is t4 not t04). The numbering for ’c’, ’t’ and ’l’ begins at zero and the numbering for ’n’ begins at one.

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