

Link 3C. Dynamic Linking Overview

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1 Dynamic Linking Overview

- Based on
- Dynamic Linking Examples
- Relocatable Object Files (main.o)
- PIC Relocatable Object Files (swap.o)
- Shared Object Library File (libswap.so.1.0.1)
- Executable Object Files (p2)

"Self-service Linux: Mastering the Art of Problem Determination",

Mark Wilding

"Computer Architecture: A Programmer's Perspective",

Bryant & O'Hallaron

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Compiling 32-bit program on 64-bit gcc

- `gcc -v`
- `gcc -m32 t.c`
- `sudo apt-get install gcc-multilib`
- `sudo apt-get install g++-multilib`
- `-m32`
- `gcc-multilib`
- `g++-multilib`

Dynamic Linking Examples

- 1 Example Program
- 2 Dynamic Linking Procedures
- 3 Dynamic Linking Commands

Example Program

```
// main.c -----  
  
void swap();  
  
int buf[2] = {1, 2};  
  
int main()  
{  
    int tmp;  
  
    swap();  
  
    return 0;  
}  
  
// swap.c -----  
  
extern int buf[];  
  
int *p0 = &buf[0];  
int *p1;  
  
void swap()  
{  
    int tmp;  
  
    p1 = &buf[1];  
  
    tmp = *p0;  
    *p0 = *p1;  
    *p1 = tmp;  
  
}
```

Dynamic Linking Commands

```
gcc -m32 -c -fPIC swap.c
gcc -m32 -shared -Wl,-soname,libswap.so.1 -o libswap.so.1.0.1 swap.o

ln -s libswap.so.1 libswap.so
ldconfig -n .

gcc -m32 -c main.c
gcc -m32 -o p2 main.o -L./ -lswap

LD_LIBRARY_PATH=$LD_LIBRARY_PATH:./

./p2
```

Relocatable Object Files (main.o)

- 1 main.o ELF Header
- 2 main.o Section Header
- 3 main.o Section
- 4 main.o Symbol Table

main.o (1) ELF Header

ELF Header:

```
Magic: 7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
Class: ELF32
Data: 2's complement, little endian
Version: 1 (current)
OS/ABI: UNIX - System V
ABI Version: 0
Type: REL (Relocatable file)
Machine: Intel 80386
Version: 0x1
Entry point address: 0x0
Start of program headers: 0 (bytes into file)
Start of section headers: 728 (bytes into file)
Flags: 0x0
Size of this header: 52 (bytes)
Size of program headers: 0 (bytes)
Number of program headers: 0
Size of section headers: 40 (bytes)
Number of section headers: 14
Section header string table index: 13
```

main.o (2) Section Header

Section Headers:

[Nr]	Name	Type	Addr	Off	Size	ES	Flg	Lk	Inf	Al
[0]		NULL	00000000	000000	000000	00		0	0	0
[1]	.group	GROUP	00000000	000034	000008	04		11	12	4
[2]	.text	PROGBITS	00000000	00003c	00002c	00	AX	0	0	1
[3]	.rel.text	REL	00000000	000234	000018	08	I	11	2	4
[4]	.data	PROGBITS	00000000	000068	000008	00	WA	0	0	4
[5]	.bss	NOBITS	00000000	000070	000000	00	WA	0	0	1
[6]	.text.__x86.get_p	PROGBITS	00000000	000070	000004	00	AXG	0	0	1
[7]	.comment	PROGBITS	00000000	000074	00002b	01	MS	0	0	1
[8]	.note.GNU-stack	PROGBITS	00000000	00009f	000000	00		0	0	1
[9]	.eh_frame	PROGBITS	00000000	0000a0	000060	00	A	0	0	4
[10]	.rel.eh_frame	REL	00000000	00024c	000010	08	I	11	9	4
[11]	.symtab	SYMTAB	00000000	000100	0000f0	10		12	10	4
[12]	.strtab	STRTAB	00000000	0001f0	000042	00		0	0	1
[13]	.shstrtab	STRTAB	00000000	00025c	00007a	00		0	0	1

Key to Flags:

W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
L (link order), O (extra OS processing required), G (group), T (TLS),
C (compressed), x (unknown), o (OS specific), E (exclude),
p (processor specific)

main.o (3) Sections

```
COMDAT group section [ 1] '.group' [__x86.get_pc_thunk.ax] contains 1 sections
[Index]   Name
[ 6]     .text.__x86.get_pc_thunk.ax
```

There are no program headers in this file.

There is no dynamic section in this file.

Relocation section '.rel.text' at offset 0x234 contains 3 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00000010	00000c02	R_386_PC32	00000000	__x86.get_pc_thunk.ax
00000015	00000d0a	R_386_GOTPC	00000000	_GLOBAL_OFFSET_TABLE_
0000001c	00000e04	R_386_PLT32	00000000	swap

Relocation section '.rel.eh_frame' at offset 0x24c contains 2 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00000020	00000202	R_386_PC32	00000000	.text
00000054	00000502	R_386_PC32	00000000	.text.__x86.get_pc_thu

The decoding of unwind sections for machine type Intel 80386 is not currently supported.

main.o (4) Symbol Table

Symbol table '.symtab' contains 15 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000000	0	FILE	LOCAL	DEFAULT	ABS	main.c
2:	00000000	0	SECTION	LOCAL	DEFAULT	2	
3:	00000000	0	SECTION	LOCAL	DEFAULT	4	
4:	00000000	0	SECTION	LOCAL	DEFAULT	5	
5:	00000000	0	SECTION	LOCAL	DEFAULT	6	
6:	00000000	0	SECTION	LOCAL	DEFAULT	8	
7:	00000000	0	SECTION	LOCAL	DEFAULT	9	
8:	00000000	0	SECTION	LOCAL	DEFAULT	7	
9:	00000000	0	SECTION	LOCAL	DEFAULT	1	
10:	00000000	8	OBJECT	GLOBAL	DEFAULT	4	buf
11:	00000000	44	FUNC	GLOBAL	DEFAULT	2	main
12:	00000000	0	FUNC	GLOBAL	HIDDEN	6	__x86.get_pc_thunk.ax
13:	00000000	0	NOTYPE	GLOBAL	DEFAULT	UND	_GLOBAL_OFFSET_TABLE_
14:	00000000	0	NOTYPE	GLOBAL	DEFAULT	UND	swap

No version information found in this file.

PIC Relocatable Object Files (swap.o)

- 1 swap.o ELF Header
- 2 swap.o Section Header
- 3 swap.o Section
- 4 swap.o Symbol Table

swap.o (1) ELF Header

ELF Header:

```
Magic: 7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
Class: ELF32
Data: 2's complement, little endian
Version: 1 (current)
OS/ABI: UNIX - System V
ABI Version: 0
Type: REL (Relocatable file)
Machine: Intel 80386
Version: 0x1
Entry point address: 0x0
Start of program headers: 0 (bytes into file)
Start of section headers: 836 (bytes into file)
Flags: 0x0
Size of this header: 52 (bytes)
Size of program headers: 0 (bytes)
Number of program headers: 0
Size of section headers: 40 (bytes)
Number of section headers: 16
Section header string table index: 15
```

swap.o (2) Section Header

Section Headers:

[Nr]	Name	Type	Addr	Off	Size	ES	Flg	Lk	Inf	Al
[0]		NULL	00000000	000000	000000	00		0	0	0
[1]	.group	GROUP	00000000	000034	000008	04		13	15	4
[2]	.text	PROGBITS	00000000	00003c	000052	00	AX	0	0	1
[3]	.rel.text	REL	00000000	000264	000040	08	I	13	2	4
[4]	.data	PROGBITS	00000000	00008e	000000	00	WA	0	0	1
[5]	.bss	NOBITS	00000000	00008e	000000	00	WA	0	0	1
[6]	.data.rel	PROGBITS	00000000	000090	000004	00	WA	0	0	4
[7]	.rel.data.rel	REL	00000000	0002a4	000008	08	I	13	6	4
[8]	.text._x86.get_p	PROGBITS	00000000	000094	000004	00	AXG	0	0	1
[9]	.comment	PROGBITS	00000000	000098	00002b	01	MS	0	0	1
[10]	.note.GNU-stack	PROGBITS	00000000	0000c3	000000	00		0	0	1
[11]	.eh_frame	PROGBITS	00000000	0000c4	00004c	00	A	0	0	4
[12]	.rel.eh_frame	REL	00000000	0002ac	000010	08	I	13	11	4
[13]	.symtab	SYMTAB	00000000	000110	000110	10		14	11	4
[14]	.strtab	STRTAB	00000000	000220	000043	00		0	0	1
[15]	.shstrtab	STRTAB	00000000	0002bc	000088	00		0	0	1

Key to Flags:

W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
L (link order), O (extra OS processing required), G (group), T (TLS),
C (compressed), x (unknown), o (OS specific), E (exclude),
p (processor specific)

swap.o (3) Sections

```
COMDAT group section [ 1] '.group' [__x86.get_pc_thunk.ax] contains 1 sections
[Index]   Name
[ 8]     .text.__x86.get_pc_thunk.ax
```

There are no program headers in this file.

There is no dynamic section in this file.

Relocation section '.rel.text' at offset 0x264 contains 8 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00000007	0000f02	R_386_PC32	00000000	__x86.get_pc_thunk.ax
0000000c	0000100a	R_386_GOTPC	00000000	_GLOBAL_OFFSET_TABLE_
00000012	0000d2b	R_386_GOT32X	00000004	p1
00000018	0000c2b	R_386_GOT32X	00000000	buf
00000023	0000b2b	R_386_GOT32X	00000000	p0
00000030	0000d2b	R_386_GOT32X	00000004	p1
00000038	0000b2b	R_386_GOT32X	00000000	p0
00000044	0000d2b	R_386_GOT32X	00000004	p1

Relocation section '.rel.data.rel' at offset 0x2a4 contains 1 entry:

Offset	Info	Type	Sym.Value	Sym. Name
00000000	0000c01	R_386_32	00000000	buf

Relocation section '.rel.eh_frame' at offset 0x2ac contains 2 entries:

swap.o (4) Symbol Table

Symbol table '.symtab' contains 17 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000000	0	FILE	LOCAL	DEFAULT	ABS	swap.c
2:	00000000	0	SECTION	LOCAL	DEFAULT	2	
3:	00000000	0	SECTION	LOCAL	DEFAULT	4	
4:	00000000	0	SECTION	LOCAL	DEFAULT	5	
5:	00000000	0	SECTION	LOCAL	DEFAULT	6	
6:	00000000	0	SECTION	LOCAL	DEFAULT	8	
7:	00000000	0	SECTION	LOCAL	DEFAULT	10	
8:	00000000	0	SECTION	LOCAL	DEFAULT	11	
9:	00000000	0	SECTION	LOCAL	DEFAULT	9	
10:	00000000	0	SECTION	LOCAL	DEFAULT	1	
11:	00000000	4	OBJECT	GLOBAL	DEFAULT	6	p0
12:	00000000	0	NOTYPE	GLOBAL	DEFAULT	UND	buf
13:	00000004	4	OBJECT	GLOBAL	DEFAULT	COM	p1
14:	00000000	82	FUNC	GLOBAL	DEFAULT	2	swap
15:	00000000	0	FUNC	GLOBAL	HIDDEN	8	__x86.get_pc_thunk.ax
16:	00000000	0	NOTYPE	GLOBAL	DEFAULT	UND	_GLOBAL_OFFSET_TABLE_

No version information found in this file.

Executable Object Files (libswap.so.1.0.1)

- 1 libswap.so.1.0.1 ELF Header
- 2 libswap.so.1.0.1 Section Header
- 3 libswap.so.1.0.1 Program Header
- 4 libswap.so.1.0.1 Section to Segment Mapping
- 5 libswap.so.1.0.1 Dynamic Sections
- 6 libswap.so.1.0.1 Misc Sections
- 7 libswap.so.1.0.1 Symbol Table
- 8 libswap.so.1.0.1 Others

libswap.so.1.0.1 (1) ELF Header

ELF Header:

```
Magic: 7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
Class: ELF32
Data: 2's complement, little endian
Version: 1 (current)
OS/ABI: UNIX - System V
ABI Version: 0
Type: DYN (Shared object file)
Machine: Intel 80386
Version: 0x1
Entry point address: 0x390
Start of program headers: 52 (bytes into file)
Start of section headers: 5668 (bytes into file)
Flags: 0x0
Size of this header: 52 (bytes)
Size of program headers: 32 (bytes)
Number of program headers: 7
Size of section headers: 40 (bytes)
Number of section headers: 24
Section header string table index: 23
```

libswap.so.1.0.1 (2) Section Header (a)

Section Headers:

[Nr]	Name	Type	Addr	Off	Size	ES	Flg	Lk	Inf	Al
[0]		NULL	00000000	000000	000000	00		0	0	0
[1]	.note.gnu.build-id	NOTE	00000114	000114	000024	00	A	0	0	4
[2]	.gnu.hash	GNU_HASH	00000138	000138	000044	04	A	3	0	4
[3]	.dynsym	DYNSYM	0000017c	00017c	0000e0	10	A	4	1	4
[4]	.dynstr	STRTAB	0000025c	00025c	000095	00	A	0	0	1
[5]	.rel.dyn	REL	000002f4	0002f4	000058	08	A	3	0	4
[6]	.init	PROGBITS	0000034c	00034c	000023	00	AX	0	0	4
[7]	.plt	PROGBITS	00000370	000370	000010	04	AX	0	0	16
[8]	.plt.got	PROGBITS	00000380	000380	000010	08	AX	0	0	8
[9]	.text	PROGBITS	00000390	000390	000153	00	AX	0	0	16
[10]	.fini	PROGBITS	000004e4	0004e4	000014	00	AX	0	0	4
[11]	.eh_frame_hdr	PROGBITS	000004f8	0004f8	00002c	00	A	0	0	4
[12]	.eh_frame	PROGBITS	00000524	000524	000088	00	A	0	0	4
[13]	.init_array	INIT_ARRAY	00001f2c	000f2c	000004	04	WA	0	0	4
[14]	.fini_array	FINI_ARRAY	00001f30	000f30	000004	04	WA	0	0	4
[15]	.dynamic	DYNAMIC	00001f34	000f34	0000b0	08	WA	4	0	4
[16]	.got	PROGBITS	00001fe4	000fe4	00001c	04	WA	0	0	4
[17]	.got.plt	PROGBITS	00002000	001000	00000c	04	WA	0	0	4
[18]	.data	PROGBITS	0000200c	00100c	000008	00	WA	0	0	4
[19]	.bss	NOBITS	00002014	001014	000008	00	WA	0	0	4
[20]	.comment	PROGBITS	00000000	001014	00002a	01	MS	0	0	1

libswap.so.1.0.1 (3) Section Header (b)

[21]	.symtab	SYMTAB	00000000	001040	000360	10	22	41	4
[22]	.strtab	STRTAB	00000000	0013a0	0001c1	00	0	0	1
[23]	.shstrtab	STRTAB	00000000	001561	0000c2	00	0	0	1

Key to Flags:

W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
L (link order), O (extra OS processing required), G (group), T (TLS),
C (compressed), x (unknown), o (OS specific), E (exclude),
p (processor specific)

There are no section groups in this file.

libswap.so.1.0.1 (4) Program Header

Program Headers:

Type	Offset	VirtAddr	PhysAddr	FileSiz	MemSiz	Flg	Align
LOAD	0x000000	0x00000000	0x00000000	0x005ac	0x005ac	R E	0x1000
LOAD	0x000f2c	0x00001f2c	0x00001f2c	0x000e8	0x000f0	RW	0x1000
DYNAMIC	0x000f34	0x00001f34	0x00001f34	0x000b0	0x000b0	RW	0x4
NOTE	0x000114	0x00000114	0x00000114	0x00024	0x00024	R	0x4
GNU_EH_FRAME	0x0004f8	0x000004f8	0x000004f8	0x0002c	0x0002c	R	0x4
GNU_STACK	0x000000	0x00000000	0x00000000	0x00000	0x00000	RW	0x10
GNU_RELRO	0x000f2c	0x00001f2c	0x00001f2c	0x000d4	0x000d4	R	0x1

libswap.so.1.0.1 (5) Section to Segment Mapping

Section to Segment mapping:

Segment Sections...

```
00      .note.gnu.build-id .gnu.hash .dynsym .dynstr .rel.dyn .init .plt .plt.got
01      .init_array .fini_array .dynamic .got .got.plt .data .bss
02      .dynamic
03      .note.gnu.build-id
04      .eh_frame_hdr
05
06      .init_array .fini_array .dynamic .got
```

libswap.so.1.0.1 (6) Dynamic Sections

Dynamic section at offset 0xf34 contains 18 entries:

Tag	Type	Name/Value
0x0000000e	(SONAME)	Library soname: [libswap.so.1]
0x0000000c	(INIT)	0x34c
0x0000000d	(FINI)	0x4e4
0x00000019	(INIT_ARRAY)	0x1f2c
0x0000001b	(INIT_ARRAYSZ)	4 (bytes)
0x0000001a	(FINI_ARRAY)	0x1f30
0x0000001c	(FINI_ARRAYSZ)	4 (bytes)
0x6ffffef5	(GNU_HASH)	0x138
0x00000005	(STRTAB)	0x25c
0x00000006	(SYMTAB)	0x17c
0x0000000a	(STRSZ)	149 (bytes)
0x0000000b	(SYMENT)	16 (bytes)
0x00000003	(PLTGOT)	0x2000
0x00000011	(REL)	0x2f4
0x00000012	(RELSZ)	88 (bytes)
0x00000013	(RELENT)	8 (bytes)
0x6fffffff	(RELCOUNT)	3
0x00000000	(NULL)	0x0

Relocation section '.rel.dyn' at offset 0x2f4 contains 11 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00001f2c	00000008	R_386_RELATIVE		
00001f30	00000008	R_386_RELATIVE		
0000200c	00000008	R_386_RELATIVE		
00001fe4	00000606	R_386_GLOB_DAT	00002010	p0
00001fe8	00000106	R_386_GLOB_DAT	00000000	__cxa_finalize
00001fec	00000b06	R_386_GLOB_DAT	00002018	p1
00001ff0	00000206	R_386_GLOB_DAT	00000000	_ITM_registerTMCloneTa
00001ff4	00000306	R_386_GLOB_DAT	00000000	_ITM_deregisterTMClone
00001ff8	00000406	R_386_GLOB_DAT	00000000	buf
00002010	00000401	R_386_32	00000000	buf
00001ffc	00000506	R_386_GLOB_DAT	00000000	__gmon_start__

The decoding of unwind sections for machine type Intel 80386 is not currently supported

libswap.so.1.0.1 (8) Symbol Table .dynsym Sections

Symbol table '.dynsym' contains 14 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	__cxa_finalize
2:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	_ITM_registerTMCloneTable
3:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	_ITM_deregisterTMCloneTab
4:	00000000	0	NOTYPE	GLOBAL	DEFAULT	UND	buf
5:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	__gmon_start__
6:	00002010	4	OBJECT	GLOBAL	DEFAULT	18	p0
7:	0000048d	82	FUNC	GLOBAL	DEFAULT	9	swap
8:	00002014	0	NOTYPE	GLOBAL	DEFAULT	18	_edata
9:	0000201c	0	NOTYPE	GLOBAL	DEFAULT	19	_end
10:	0000034c	0	FUNC	GLOBAL	DEFAULT	6	_init
11:	00002018	4	OBJECT	GLOBAL	DEFAULT	19	p1
12:	00002014	0	NOTYPE	GLOBAL	DEFAULT	19	__bss_start
13:	000004e4	0	FUNC	GLOBAL	DEFAULT	10	_fini

libswap.so.1.0.1 (9) Symbol Table .symtab (a)

Symbol table '.symtab' contains 54 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000114	0	SECTION	LOCAL	DEFAULT	1	
2:	00000138	0	SECTION	LOCAL	DEFAULT	2	
3:	0000017c	0	SECTION	LOCAL	DEFAULT	3	
4:	0000025c	0	SECTION	LOCAL	DEFAULT	4	
5:	000002f4	0	SECTION	LOCAL	DEFAULT	5	
6:	0000034c	0	SECTION	LOCAL	DEFAULT	6	
7:	00000370	0	SECTION	LOCAL	DEFAULT	7	
8:	00000380	0	SECTION	LOCAL	DEFAULT	8	
9:	00000390	0	SECTION	LOCAL	DEFAULT	9	
10:	000004e4	0	SECTION	LOCAL	DEFAULT	10	
11:	000004f8	0	SECTION	LOCAL	DEFAULT	11	
12:	00000524	0	SECTION	LOCAL	DEFAULT	12	
13:	00001f2c	0	SECTION	LOCAL	DEFAULT	13	
14:	00001f30	0	SECTION	LOCAL	DEFAULT	14	
15:	00001f34	0	SECTION	LOCAL	DEFAULT	15	
16:	00001fe4	0	SECTION	LOCAL	DEFAULT	16	
17:	00002000	0	SECTION	LOCAL	DEFAULT	17	
18:	0000200c	0	SECTION	LOCAL	DEFAULT	18	
19:	00002014	0	SECTION	LOCAL	DEFAULT	19	
20:	00000000	0	SECTION	LOCAL	DEFAULT	20	

libswap.so.1.0.1 (10) Symbol Table .symtab (b)

21:	00000000	0	FILE	LOCAL	DEFAULT	ABS	crtstuff.c
22:	000003a0	0	FUNC	LOCAL	DEFAULT	9	deregister_tm_clones
23:	000003e0	0	FUNC	LOCAL	DEFAULT	9	register_tm_clones
24:	00000430	0	FUNC	LOCAL	DEFAULT	9	__do_global_dtors_aux
25:	00002014	1	OBJECT	LOCAL	DEFAULT	19	completed.7281
26:	00001f30	0	OBJECT	LOCAL	DEFAULT	14	__do_global_dtors_aux_fin
27:	00000480	0	FUNC	LOCAL	DEFAULT	9	frame_dummy
28:	00001f2c	0	OBJECT	LOCAL	DEFAULT	13	__frame_dummy_init_array_
29:	00000000	0	FILE	LOCAL	DEFAULT	ABS	swap.c
30:	00000000	0	FILE	LOCAL	DEFAULT	ABS	crtstuff.c
31:	000005a8	0	OBJECT	LOCAL	DEFAULT	12	__FRAME_END__
32:	00000000	0	FILE	LOCAL	DEFAULT	ABS	
33:	00001f34	0	OBJECT	LOCAL	DEFAULT	15	__DYNAMIC
34:	00002014	0	OBJECT	LOCAL	DEFAULT	18	__TMC_END__
35:	000004df	0	FUNC	LOCAL	DEFAULT	9	__x86.get_pc_thunk.ax
36:	0000200c	0	OBJECT	LOCAL	DEFAULT	18	__dso_handle
37:	00000489	0	FUNC	LOCAL	DEFAULT	9	__x86.get_pc_thunk.dx
38:	00000390	4	FUNC	LOCAL	DEFAULT	9	__x86.get_pc_thunk.bx
39:	000004f8	0	NOTYPE	LOCAL	DEFAULT	11	__GNU_EH_FRAME_HDR
40:	00002000	0	OBJECT	LOCAL	DEFAULT	17	__GLOBAL_OFFSET_TABLE_

libswap.so.1.0.1 (11) Symbol Table .symtab (c)

```
41: 00002010      4 OBJECT GLOBAL DEFAULT   18 p0
42: 00000000      0 NOTYPE WEAK   DEFAULT   UND __cxa_finalize
43: 0000048d     82 FUNC   GLOBAL DEFAULT    9 swap
44: 0000034c      0 FUNC   GLOBAL DEFAULT    6 _init
45: 00002018      4 OBJECT GLOBAL DEFAULT   19 p1
46: 00000000      0 NOTYPE WEAK   DEFAULT   UND _ITM_registerTMCloneTable
47: 00000000      0 NOTYPE WEAK   DEFAULT   UND _ITM_deregisterTMCloneTab
48: 00002014      0 NOTYPE GLOBAL DEFAULT   19 __bss_start
49: 000004e4      0 FUNC   GLOBAL DEFAULT   10 _fini
50: 00000000      0 NOTYPE GLOBAL DEFAULT   UND buf
51: 00002014      0 NOTYPE GLOBAL DEFAULT   18 _edata
52: 0000201c      0 NOTYPE GLOBAL DEFAULT   19 _end
53: 00000000      0 NOTYPE WEAK   DEFAULT   UND __gmon_start__
```

Histogram for '.gnu.hash' bucket list length (total of 3 buckets):

Length	Number	% of total	Coverage
0	0	(0.0%)	
1	1	(33.3%)	12.5%
2	0	(0.0%)	12.5%
3	1	(33.3%)	50.0%
4	1	(33.3%)	100.0%

No version information found in this file.

Displaying notes found in: .note.gnu.build-id

Owner	Data size	Description
GNU	0x00000014	NT_GNU_BUILD_ID (unique build ID bitstring)
Build ID: 9e2b2bea085b7ed0e63fc422497cd93b6d84da15		

Executable Object Files (p2)

- 1 p ELF Header
- 2 p Section Header
- 3 p Program Header
- 4 p Section to Segment Mapping
- 5 p Dynamic Sections
- 6 p Misc Sections
- 7 p Symbol Table
- 8 p Others

p2 (1) ELF Header

ELF Header:

```
Magic: 7f 45 4c 46 01 01 01 00 00 00 00 00 00 00 00 00
Class: ELF32
Data: 2's complement, little endian
Version: 1 (current)
OS/ABI: UNIX - System V
ABI Version: 0
Type: DYN (Shared object file)
Machine: Intel 80386
Version: 0x1
Entry point address: 0x4a0
Start of program headers: 52 (bytes into file)
Start of section headers: 6072 (bytes into file)
Flags: 0x0
Size of this header: 52 (bytes)
Size of program headers: 32 (bytes)
Number of program headers: 9
Size of section headers: 40 (bytes)
Number of section headers: 29
Section header string table index: 28
```

p2 (2) Section Header (a)

Section Headers:

[Nr]	Name	Type	Addr	Off	Size	ES	Flg	Lk	Inf	Al
[0]		NULL	00000000	000000	000000	00		0	0	0
[1]	.interp	PROGBITS	00000154	000154	000013	00	A	0	0	1
[2]	.note.ABI-tag	NOTE	00000168	000168	000020	00	A	0	0	4
[3]	.note.gnu.build-id	NOTE	00000188	000188	000024	00	A	0	0	4
[4]	.gnu.hash	GNU_HASH	000001ac	0001ac	000040	04	A	5	0	4
[5]	.dynsym	DYNSYM	000001ec	0001ec	0000e0	10	A	6	1	4
[6]	.dynstr	STRTAB	000002cc	0002cc	0000d0	00	A	0	0	1
[7]	.gnu.version	VERSYM	0000039c	00039c	00001c	02	A	5	0	2
[8]	.gnu.version_r	VERNEED	000003b8	0003b8	000030	00	A	6	1	4
[9]	.rel.dyn	REL	000003e8	0003e8	000040	08	A	5	0	4
[10]	.rel.plt	REL	00000428	000428	000010	08	AI	5	22	4
[11]	.init	PROGBITS	00000438	000438	000023	00	AX	0	0	4
[12]	.plt	PROGBITS	00000460	000460	000030	04	AX	0	0	16
[13]	.plt.got	PROGBITS	00000490	000490	000010	08	AX	0	0	8
[14]	.text	PROGBITS	000004a0	0004a0	0001d2	00	AX	0	0	16
[15]	.fini	PROGBITS	00000674	000674	000014	00	AX	0	0	4
[16]	.rodata	PROGBITS	00000688	000688	000008	00	A	0	0	4
[17]	.eh_frame_hdr	PROGBITS	00000690	000690	00003c	00	A	0	0	4
[18]	.eh_frame	PROGBITS	000006cc	0006cc	0000fc	00	A	0	0	4
[19]	.init_array	INIT_ARRAY	00001ed0	000ed0	000004	04	WA	0	0	4
[20]	.fini_array	FINI_ARRAY	00001ed4	000ed4	000004	04	WA	0	0	4

p2 (3) Section Header (b)

[21]	.dynamic	DYNAMIC	00001ed8	000ed8	000100	08	WA	6	0	4
[22]	.got	PROGBITS	00001fd8	000fd8	000028	04	WA	0	0	4
[23]	.data	PROGBITS	00002000	001000	000010	00	WA	0	0	4
[24]	.bss	NOBITS	00002010	001010	000004	00	WA	0	0	1
[25]	.comment	PROGBITS	00000000	001010	00002a	01	MS	0	0	1
[26]	.symtab	SYMTAB	00000000	00103c	000440	10		27	43	4
[27]	.strtab	STRTAB	00000000	00147c	000240	00		0	0	1
[28]	.shstrtab	STRTAB	00000000	0016bc	0000fc	00		0	0	1

Key to Flags:

W (write), A (alloc), X (execute), M (merge), S (strings), I (info),
L (link order), O (extra OS processing required), G (group), T (TLS),
C (compressed), x (unknown), o (OS specific), E (exclude),
p (processor specific)

There are no section groups in this file.

p2 (4) Program Header

Program Headers:

Type	Offset	VirtAddr	PhysAddr	FileSiz	MemSiz	Flg	Align
PHDR	0x000034	0x00000034	0x00000034	0x00120	0x00120	R	0x4
INTERP	0x000154	0x00000154	0x00000154	0x00013	0x00013	R	0x1
[Requesting program interpreter: /lib/ld-linux.so.2]							
LOAD	0x000000	0x00000000	0x00000000	0x007c8	0x007c8	R E	0x1000
LOAD	0x000ed0	0x00001ed0	0x00001ed0	0x00140	0x00144	RW	0x1000
DYNAMIC	0x000ed8	0x00001ed8	0x00001ed8	0x00100	0x00100	RW	0x4
NOTE	0x000168	0x00000168	0x00000168	0x00044	0x00044	R	0x4
GNU_EH_FRAME	0x000690	0x00000690	0x00000690	0x0003c	0x0003c	R	0x4
GNU_STACK	0x000000	0x00000000	0x00000000	0x00000	0x00000	RW	0x10
GNU_RELRO	0x000ed0	0x00001ed0	0x00001ed0	0x00130	0x00130	R	0x1

p2 (5) Section to Segment Mapping

Section to Segment mapping:

Segment Sections...

00

01 .interp

02 .interp .note.ABI-tag .note.gnu.build-id .gnu.hash .dynsym .dynstr .gnu.v

03 .init_array .fini_array .dynamic .got .data .bss

04 .dynamic

05 .note.ABI-tag .note.gnu.build-id

06 .eh_frame_hdr

07

08 .init_array .fini_array .dynamic .got

p2 (6) Dynamic Sections (a)

Dynamic section at offset 0xed8 contains 28 entries:

Tag	Type	Name/Value
0x00000001	(NEEDED)	Shared library: [libswap.so.1]
0x00000001	(NEEDED)	Shared library: [libc.so.6]
0x0000000c	(INIT)	0x438
0x0000000d	(FINI)	0x674
0x00000019	(INIT_ARRAY)	0x1ed0
0x0000001b	(INIT_ARRAYSZ)	4 (bytes)
0x0000001a	(FINI_ARRAY)	0x1ed4
0x0000001c	(FINI_ARRAYSZ)	4 (bytes)
0x6ffffef5	(GNU_HASH)	0x1ac
0x00000005	(STRTAB)	0x2cc
0x00000006	(SYMTAB)	0x1ec
0x0000000a	(STRSZ)	208 (bytes)
0x0000000b	(SYMENT)	16 (bytes)
0x00000015	(DEBUG)	0x0
0x00000003	(PLTGOT)	0x1fd8
0x00000002	(PLTRELSZ)	16 (bytes)
0x00000014	(PLTREL)	REL
0x00000017	(JMPREL)	0x428
0x00000011	(REL)	0x3e8
0x00000012	(RELSZ)	64 (bytes)
0x00000013	(RELENT)	8 (bytes)
0x0000001e	(FLAGS)	BIND_NOW

p2 (7) Dynamic Sections (b)

0x6fffffffb (FLAGS_1)	Flags: NOW PIE
0x6fffffffe (VERNEED)	0x3b8
0x6fffffff (VERNEEDNUM)	1
0x6fffffff0 (VERSYM)	0x39c
0x6fffffffa (RELCOUNT)	4
0x00000000 (NULL)	0x0

p2 (8) Misc Sections

Relocation section '.rel.dyn' at offset 0x3e8 contains 8 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00001ed0	00000008	R_386_RELATIVE		
00001ed4	00000008	R_386_RELATIVE		
00001ff8	00000008	R_386_RELATIVE		
00002004	00000008	R_386_RELATIVE		
00001fec	00000106	R_386_GLOB_DAT	00000000	_ITM_deregisterTMClone
00001ff0	00000206	R_386_GLOB_DAT	00000000	__cxa_finalize@GLIBC_2.1.3
00001ff4	00000306	R_386_GLOB_DAT	00000000	__gmon_start__
00001ffc	00000506	R_386_GLOB_DAT	00000000	_ITM_registerTMCloneTa

Relocation section '.rel.plt' at offset 0x428 contains 2 entries:

Offset	Info	Type	Sym.Value	Sym. Name
00001fe4	00000407	R_386_JUMP_SLOT	00000000	__libc_start_main@GLIBC_2.0
00001fe8	00000607	R_386_JUMP_SLOT	00000000	swap

The decoding of unwind sections for machine type Intel 80386 is not currently supported

p2 (9) Symbol table .dynsym

Symbol table '.dynsym' contains 14 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	_ITM_deregisterTMCloneTab
2:	00000000	0	FUNC	WEAK	DEFAULT	UND	__cxa_finalize@GLIBC_2.1.3 (2)
3:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	__gmon_start__
4:	00000000	0	FUNC	GLOBAL	DEFAULT	UND	__libc_start_main@GLIBC_2.0 (3)
5:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	_ITM_registerTMCloneTable
6:	00000000	0	FUNC	GLOBAL	DEFAULT	UND	swap
7:	00002010	0	NOTYPE	GLOBAL	DEFAULT	23	_edata
8:	00002014	0	NOTYPE	GLOBAL	DEFAULT	24	_end
9:	00002008	8	OBJECT	GLOBAL	DEFAULT	23	buf
10:	0000068c	4	OBJECT	GLOBAL	DEFAULT	16	_IO_stdin_used
11:	00002010	0	NOTYPE	GLOBAL	DEFAULT	24	__bss_start
12:	00000438	0	FUNC	GLOBAL	DEFAULT	11	_init
13:	00000674	0	FUNC	GLOBAL	DEFAULT	15	_fini

p2 (9) Symbol Table .symtab (a)

Symbol table '.symtab' contains 68 entries:

Num:	Value	Size	Type	Bind	Vis	Ndx	Name
0:	00000000	0	NOTYPE	LOCAL	DEFAULT	UND	
1:	00000154	0	SECTION	LOCAL	DEFAULT	1	
2:	00000168	0	SECTION	LOCAL	DEFAULT	2	
3:	00000188	0	SECTION	LOCAL	DEFAULT	3	
4:	000001ac	0	SECTION	LOCAL	DEFAULT	4	
5:	000001ec	0	SECTION	LOCAL	DEFAULT	5	
6:	000002cc	0	SECTION	LOCAL	DEFAULT	6	
7:	0000039c	0	SECTION	LOCAL	DEFAULT	7	
8:	000003b8	0	SECTION	LOCAL	DEFAULT	8	
9:	000003e8	0	SECTION	LOCAL	DEFAULT	9	
10:	00000428	0	SECTION	LOCAL	DEFAULT	10	
11:	00000438	0	SECTION	LOCAL	DEFAULT	11	
12:	00000460	0	SECTION	LOCAL	DEFAULT	12	
13:	00000490	0	SECTION	LOCAL	DEFAULT	13	
14:	000004a0	0	SECTION	LOCAL	DEFAULT	14	
15:	00000674	0	SECTION	LOCAL	DEFAULT	15	
16:	00000688	0	SECTION	LOCAL	DEFAULT	16	
17:	00000690	0	SECTION	LOCAL	DEFAULT	17	
18:	000006cc	0	SECTION	LOCAL	DEFAULT	18	
19:	00001ed0	0	SECTION	LOCAL	DEFAULT	19	
20:	00001ed4	0	SECTION	LOCAL	DEFAULT	20	

p2 (10) Symbol Table .symtab (b)

```
21: 00001ed8      0 SECTION LOCAL  DEFAULT  21
22: 00001fd8      0 SECTION LOCAL  DEFAULT  22
23: 00002000      0 SECTION LOCAL  DEFAULT  23
24: 00002010      0 SECTION LOCAL  DEFAULT  24
25: 00000000      0 SECTION LOCAL  DEFAULT  25
26: 00000000      0 FILE     LOCAL  DEFAULT  ABS crtstuff.c
27: 000004f0      0 FUNC     LOCAL  DEFAULT  14 deregister_tm_clones
28: 00000530      0 FUNC     LOCAL  DEFAULT  14 register_tm_clones
29: 00000580      0 FUNC     LOCAL  DEFAULT  14 __do_global_ctors_aux
30: 00002010      1 OBJECT  LOCAL  DEFAULT  24 completed.7281
31: 00001ed4      0 OBJECT  LOCAL  DEFAULT  20 __do_global_ctors_aux_fin
32: 000005d0      0 FUNC     LOCAL  DEFAULT  14 frame_dummy
33: 00001ed0      0 OBJECT  LOCAL  DEFAULT  19 __frame_dummy_init_array_
34: 00000000      0 FILE     LOCAL  DEFAULT  ABS main.c
35: 00000000      0 FILE     LOCAL  DEFAULT  ABS crtstuff.c
36: 000007c4      0 OBJECT  LOCAL  DEFAULT  18 __FRAME_END__
37: 00000000      0 FILE     LOCAL  DEFAULT  ABS
38: 00001ed4      0 NOTYPE  LOCAL  DEFAULT  19 __init_array_end
39: 00001ed8      0 OBJECT  LOCAL  DEFAULT  21 _DYNAMIC
40: 00001ed0      0 NOTYPE  LOCAL  DEFAULT  19 __init_array_start
```

p2 (11) Symbol Table .symtab (c)

41:	00000690	0	NOTYPE	LOCAL	DEFAULT	17	__GNU_EH_FRAME_HDR
42:	00001fd8	0	OBJECT	LOCAL	DEFAULT	22	_GLOBAL_OFFSET_TABLE_
43:	00000670	2	FUNC	GLOBAL	DEFAULT	14	__libc_csu_fini
44:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	_ITM_deregisterTMCloneTab
45:	000004e0	4	FUNC	GLOBAL	HIDDEN	14	__x86.get_pc_thunk.bx
46:	00002000	0	NOTYPE	WEAK	DEFAULT	23	data_start
47:	00002010	0	NOTYPE	GLOBAL	DEFAULT	23	_edata
48:	00000674	0	FUNC	GLOBAL	DEFAULT	15	_fini
49:	000005d9	0	FUNC	GLOBAL	HIDDEN	14	__x86.get_pc_thunk.dx
50:	00000000	0	FUNC	WEAK	DEFAULT	UND	__cxa_finalize@@GLIBC_2.1
51:	00002000	0	NOTYPE	GLOBAL	DEFAULT	23	__data_start
52:	00000000	0	NOTYPE	WEAK	DEFAULT	UND	__gmon_start__
53:	00002004	0	OBJECT	GLOBAL	HIDDEN	23	__dso_handle
54:	0000068c	4	OBJECT	GLOBAL	DEFAULT	16	_IO_stdin_used
55:	00000000	0	FUNC	GLOBAL	DEFAULT	UND	__libc_start_main@@GLIBC_
56:	00000610	93	FUNC	GLOBAL	DEFAULT	14	__libc_csu_init
57:	00002014	0	NOTYPE	GLOBAL	DEFAULT	24	_end
58:	000004a0	0	FUNC	GLOBAL	DEFAULT	14	_start
59:	00000688	4	OBJECT	GLOBAL	DEFAULT	16	_fp_hw
60:	00002008	8	OBJECT	GLOBAL	DEFAULT	23	buf
61:	00002010	0	NOTYPE	GLOBAL	DEFAULT	24	__bss_start
62:	000005dd	44	FUNC	GLOBAL	DEFAULT	14	main
63:	00000609	0	FUNC	GLOBAL	HIDDEN	14	__x86.get_pc_thunk.ax
64:	00002010	0	OBJECT	GLOBAL	HIDDEN	23	__TMC_END__

Histogram for '.gnu.hash' bucket list length (total of 3 buckets):

Length	Number	% of total	Coverage
0	0	(0.0%)	
1	1	(33.3%)	14.3%
2	0	(0.0%)	14.3%
3	2	(66.7%)	100.0%

Version symbols section '.gnu.version' contains 14 entries:

```
Addr: 0000000000000039c  Offset: 0x00039c  Link: 5 (.dynsym)
000:  0 (*local*)          0 (*local*)          2 (GLIBC_2.1.3)      0 (*local*)
004:  3 (GLIBC_2.0)         0 (*local*)          0 (*local*)          1 (*global*)
008:  1 (*global*)         1 (*global*)         1 (*global*)         1 (*global*)
00c:  1 (*global*)         1 (*global*)         1 (*global*)         1 (*global*)
```

Version needs section '.gnu.version_r' contains 1 entry:

```
Addr: 0x000000000000003b8  Offset: 0x0003b8  Link: 6 (.dynstr)
000000: Version: 1  File: libc.so.6  Cnt: 2
0x0010:  Name: GLIBC_2.0  Flags: none  Version: 3
0x0020:  Name: GLIBC_2.1.3  Flags: none  Version: 2
```

Displaying notes found in: .note.ABI-tag

Owner	Data size	Description
GNU	0x00000010	NT_GNU_ABI_TAG (ABI version tag)
OS: Linux, ABI: 3.2.0		

