Link 1. Static Linking Overview

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Outline

Based on

"Self-service Linux: Mastering the Art of Problem Determination",
Mark Wilding
"Computer Architecture: A Programmer's Perspective",
Bryant & O'Hallaron

Compling 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`

Static Linking Examples

1. Example Program
2. Static Linking Procedures
3. Static 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;

}
```

Static Linking Procedures

cpp	preprocessor	main.c	main.i
cc1	compiler	main.i	main.s
as	assemble	main.s	main.o
cpp	preprocessor	swap.c	swap.i
cc1	compiler	swap.i	swap.s
as	assemble	swap.s	swap.o
ld	linker	main.o	p
		swap.o	

Static Linking Commands

```
cpp main.c main.i
cc1 main.i -O2 -m32 -o main.s
as --32 -o main.o main.s

cpp swap.c swap.i
cc1 swap.i -O2 -m32 -o swap.s
as --32 -o swap.o swap.s

gcc -o p main.o swap.o

alias cc1=/usr/lib/gcc/x86_64-linux-gnu/5/cc1

ld -m elf_i386 -o p main.o swap.o -lc --entry_main --> not working

readelf -a main.o
readelf -a swap.o
```

Intermediate and Assembly Files (main.i, main.s)

1. main.i
2. main.s

main.i

```
# 1 "main.c"
# 1 "<built-in>"
# 1 "<command-line>"
# 1 "/usr/include/stdc-predef.h" 1 3 4
# 1 "<command-line>" 2
# 1 "main.c"
void swap();

int buf[2] = {1, 2};

int main()
{
  int tmp;

  swap();

  return 0;
}
```

main.s (1)

```
        .file   "main.i"
        .section        .text.unlikely,"ax",@progbits
.LCOLDB0:
        .section        .text.startup,"ax",@progbits
.LHOTB0:
        .p2align 4,,15
        .globl  main
        .type   main, @function
main:
.LFB0:
        .cfi_startproc
        leal    4(%esp), %ecx
        .cfi_def_cfa 1, 0
        andl    $-16, %esp
        pushl   -4(%ecx)
        pushl   %ebp
        .cfi_escape 0x10,0x5,0x2,0x75,0
        movl    %esp, %ebp
        pushl   %ecx
        .cfi_escape 0xf,0x3,0x75,0x7c,0x6
```

main.s (2)

```
        subl    $4, %esp
        call    swap
        addl    $4, %esp
        xorl    %eax, %eax
        popl    %ecx
        .cfi_restore 1
        .cfi_def_cfa 1, 0
        popl    %ebp
        .cfi_restore 5
        leal    -4(%ecx), %esp
        .cfi_def_cfa 4, 4
        ret
        .cfi_endproc
.LFE0:
        .size   main, .-main
        .section        .text.unlikely
.LCOLDE0:
        .section        .text.startup
```

main.s (3)

```
.LHOTE0:
        .globl  buf
        .data
        .align 4
        .type   buf, @object
        .size   buf, 8
buf:
        .long   1
        .long   2
        .ident  "GCC: (Ubuntu 5.4.0-6ubuntu1~16.04.4) 5.4.0 20160609"
        .section        .note.GNU-stack,"",@progbits
```

Intermediate and Assembly Files (swap.i, swap.s)

1. swap.i
2. swap.s

swap.i

```
# 1 "swap.c"
# 1 "<built-in>"
# 1 "<command-line>"
# 1 "/usr/include/stdc-predef.h" 1 3 4
# 1 "<command-line>" 2
# 1 "swap.c"
extern int buf[];

int *p0 = &buf[0];
int *p1;

void swap()
{
  int tmp;

  p1 = &buf[1];

  tmp = *p0;
  *p0 = *p1;
  *p1 = tmp;

}
```

swap.s (1)

```
        .file   "swap.i"
        .section        .text.unlikely,"ax",@progbits
.LCOLDB0:
        .text
.LHOTB0:
        .p2align 4,,15
        .globl  swap
        .type   swap, @function
swap:
.LFB0:
        .cfi_startproc
        movl    p0, %eax
        movl    buf+4, %ecx
        movl    $buf+4, p1
        movl    (%eax), %edx
        movl    %ecx, (%eax)
        movl    %edx, buf+4
        ret
        .cfi_endproc
.LFE0:
        .size   swap, .-swap
        .section        .text.unlikely
```

swap.s (2)

```
.LCOLDE0:
        .text
.LHOTE0:
        .comm   p1,4,4
        .globl  p0
        .data
        .align 4
        .type   p0, @object
        .size   p0, 4
p0:
        .long   buf
        .ident  "GCC: (Ubuntu 5.4.0-6ubuntu1~16.04.4) 5.4.0 20160609"
        .section        .note.GNU-stack,"",@progbits
```

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:          584 (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: 11
```

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] .text             PROGBITS        00000000 000034 000000 00  AX  0   0  1
  [ 2] .data             PROGBITS        00000000 000034 000008 00  WA  0   0  4
  [ 3] .bss              NOBITS          00000000 00003c 000000 00  WA  0   0  1
  [ 4] .text.unlikely    PROGBITS        00000000 00003c 000000 00  AX  0   0  1
  [ 5] .text.startup     PROGBITS        00000000 000040 000021 00  AX  0   0 16
  [ 6] .rel.text.startup REL             00000000 0001c4 000008 08   I 12   5  4
  [ 7] .comment          PROGBITS        00000000 000061 000035 01  MS  0   0  1
  [ 8] .note.GNU-stack   PROGBITS        00000000 000096 000000 00      0   0  1
  [ 9] .eh_frame         PROGBITS        00000000 000098 000044 00   A  0   0  4
  [10] .rel.eh_frame     REL             00000000 0001cc 000008 08   I 12   9  4
  [11] .shstrtab         STRTAB          00000000 0001d4 000074 00      0   0  1
  [12] .symtab           SYMTAB          00000000 0000dc 0000d0 10     13  10  4
  [13] .strtab           STRTAB          00000000 0001ac 000016 00      0   0  1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings)
  I (info), L (link order), G (group), T (TLS), E (exclude), x (unknown)
  O (extra OS processing required) o (OS specific), p (processor specific)
```

main.o (3) Sections

```
There are no section groups in this file.

There are no program headers in this file.

Relocation section '.rel.text.startup' at offset 0x1c4 contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
00000012  00000b02 R_386_PC32        00000000   swap

Relocation section '.rel.eh_frame' at offset 0x1cc contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
00000020  00000602 R_386_PC32        00000000   .text.startup

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

main.o (4) Symbol Table

```
Symbol table '.symtab' contains 13 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 00000000     0 FILE    LOCAL  DEFAULT  ABS main.i
     2: 00000000     0 SECTION LOCAL  DEFAULT    1
     3: 00000000     0 SECTION LOCAL  DEFAULT    2
     4: 00000000     0 SECTION LOCAL  DEFAULT    3
     5: 00000000     0 SECTION LOCAL  DEFAULT    4
     6: 00000000     0 SECTION LOCAL  DEFAULT    5
     7: 00000000     0 SECTION LOCAL  DEFAULT    8
     8: 00000000     0 SECTION LOCAL  DEFAULT    9
     9: 00000000     0 SECTION LOCAL  DEFAULT    7
    10: 00000000    33 FUNC    GLOBAL DEFAULT    5 main
    11: 00000000     0 NOTYPE  GLOBAL DEFAULT  UND swap
    12: 00000000     8 OBJECT  GLOBAL DEFAULT    2 buf

No version information found in this file.
```

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:          596 (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: 11
```

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] .text             PROGBITS        00000000 000040 000020 00  AX  0   0 16
  [ 2] .rel.text         REL             00000000 0001b0 000028 08   I 12   1  4
  [ 3] .data             PROGBITS        00000000 000060 000004 00  WA  0   0  4
  [ 4] .rel.data         REL             00000000 0001d8 000008 08   I 12   3  4
  [ 5] .bss              NOBITS          00000000 000064 000000 00  WA  0   0  1
  [ 6] .text.unlikely    PROGBITS        00000000 000064 000000 00  AX  0   0  1
  [ 7] .comment          PROGBITS        00000000 000064 000035 01  MS  0   0  1
  [ 8] .note.GNU-stack   PROGBITS        00000000 000099 000000 00      0   0  1
  [ 9] .eh_frame         PROGBITS        00000000 00009c 00002c 00   A  0   0  4
  [10] .rel.eh_frame     REL             00000000 0001e0 000008 08   I 12   9  4
  [11] .shstrtab         STRTAB          00000000 0001e8 00006a 00      0   0  1
  [12] .symtab           SYMTAB          00000000 0000c8 0000d0 10     13   9  4
  [13] .strtab           STRTAB          00000000 000198 000017 00      0   0  1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings)
  I (info), L (link order), G (group), T (TLS), E (exclude), x (unknown)
  O (extra OS processing required) o (OS specific), p (processor specific)
```

swap.o (3) Sections

```
There are no section groups in this file.

There are no program headers in this file.

Relocation section '.rel.text' at offset 0x1b0 contains 5 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
00000001  00000a01 R_386_32          00000000   p0
00000007  00000b01 R_386_32          00000000   buf
0000000d  00000c01 R_386_32          00000004   p1
00000011  00000b01 R_386_32          00000000   buf
0000001b  00000b01 R_386_32          00000000   buf

Relocation section '.rel.data' at offset 0x1d8 contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
00000000  00000b01 R_386_32          00000000   buf

Relocation section '.rel.eh_frame' at offset 0x1e0 contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
00000020  00000202 R_386_PC32        00000000   .text

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

swap.o (4) Symbol Table

```
Symbol table '.symtab' contains 13 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 00000000     0 FILE    LOCAL  DEFAULT  ABS swap.i
     2: 00000000     0 SECTION LOCAL  DEFAULT    1
     3: 00000000     0 SECTION LOCAL  DEFAULT    3
     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    32 FUNC    GLOBAL DEFAULT    1 swap
    10: 00000000     4 OBJECT  GLOBAL DEFAULT    3 p0
    11: 00000000     0 NOTYPE  GLOBAL DEFAULT  UND buf
    12: 00000004     4 OBJECT  GLOBAL DEFAULT  COM p1

No version information found in this file.
```

Executable Object Files (p)

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

p (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:                              EXEC (Executable file)
  Machine:                           Intel 80386
  Version:                           0x1
  Entry point address:               0x8048301
  Start of program headers:          52 (bytes into file)
  Start of section headers:          6180 (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:         31
  Section header string table index: 28
```

p (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        08048154 000154 000013 00   A  0   0  1
  [ 2] .note.ABI-tag     NOTE            08048168 000168 000020 00   A  0   0  4
  [ 3] .note.gnu.build-i NOTE            08048188 000188 000024 00   A  0   0  4
  [ 4] .gnu.hash         GNU_HASH        080481ac 0001ac 000020 04   A  5   0  4
  [ 5] .dynsym           DYNSYM          080481cc 0001cc 000040 10   A  6   1  4
  [ 6] .dynstr           STRTAB          0804820c 00020c 000045 00   A  0   0  1
  [ 7] .gnu.version      VERSYM          08048252 000252 000008 02   A  5   0  2
  [ 8] .gnu.version_r    VERNEED         0804825c 00025c 000020 00   A  6   1  4
  [ 9] .rel.dyn          REL             0804827c 00027c 000008 08   A  5   0  4
  [10] .rel.plt          REL             08048284 000284 000008 08  AI  5  24  4
  [11] .init             PROGBITS        0804828c 00028c 000023 00  AX  0   0  4
  [12] .plt              PROGBITS        080482b0 0002b0 000020 04  AX  0   0 16
  [13] .plt.got          PROGBITS        080482d0 0002d0 000008 00  AX  0   0  8
  [14] .text             PROGBITS        080482e0 0002e0 0001a2 00  AX  0   0 16
  [15] .fini             PROGBITS        08048484 000484 000014 00  AX  0   0  4
  [16] .rodata           PROGBITS        08048498 000498 000008 00   A  0   0  4
  [17] .eh_frame_hdr     PROGBITS        080484a0 0004a0 000034 00   A  0   0  4
  [18] .eh_frame         PROGBITS        080484d4 0004d4 0000e0 00   A  0   0  4
  [19] .init_array       INIT_ARRAY      08049f08 000f08 000004 00  WA  0   0  4
  [20] .fini_array       FINI_ARRAY      08049f0c 000f0c 000004 00  WA  0   0  4
```

p (3) Section Header (b)

```
  [21] .jcr              PROGBITS        08049f10 000f10 000004 00  WA  0   0  4
  [22] .dynamic          DYNAMIC         08049f14 000f14 0000e8 08  WA  6   0  4
  [23] .got              PROGBITS        08049ffc 000ffc 000004 04  WA  0   0  4
  [24] .got.plt          PROGBITS        0804a000 001000 000010 04  WA  0   0  4
  [25] .data             PROGBITS        0804a010 001010 000014 00  WA  0   0  4
  [26] .bss              NOBITS          0804a024 001024 000008 00  WA  0   0  4
  [27] .comment          PROGBITS        00000000 001024 000034 01  MS  0   0  1
  [28] .shstrtab         STRTAB          00000000 00171a 00010a 00      0   0  1
  [29] .symtab           SYMTAB          00000000 001058 000490 10     30  48  4
  [30] .strtab           STRTAB          00000000 0014e8 000232 00      0   0  1
Key to Flags:
  W (write), A (alloc), X (execute), M (merge), S (strings)
  I (info), L (link order), G (group), T (TLS), E (exclude), x (unknown)
  O (extra OS processing required) o (OS specific), p (processor specific)
```

p (4) Program Header

```
Program Headers:
  Type           Offset   VirtAddr   PhysAddr   FileSiz MemSiz  Flg Align
  PHDR           0x000034 0x08048034 0x08048034 0x00120 0x00120 R E 0x4
  INTERP         0x000154 0x08048154 0x08048154 0x00013 0x00013 R   0x1
      [Requesting program interpreter: /lib/ld-linux.so.2]
  LOAD           0x000000 0x08048000 0x08048000 0x005b4 0x005b4 R E 0x1000
  LOAD           0x000f08 0x08049f08 0x08049f08 0x0011c 0x00124 RW  0x1000
  DYNAMIC        0x000f14 0x08049f14 0x08049f14 0x000e8 0x000e8 RW  0x4
  NOTE           0x000168 0x08048168 0x08048168 0x00044 0x00044 R   0x4
  GNU_EH_FRAME   0x0004a0 0x080484a0 0x080484a0 0x00034 0x00034 R   0x4
  GNU_STACK      0x000000 0x00000000 0x00000000 0x00000 0x00000 RW  0x10
  GNU_RELRO      0x000f08 0x08049f08 0x08049f08 0x000f8 0x000f8 R   0x1
```

p (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 .jcr .dynamic .got .got.plt .data .bss
  04     .dynamic
  05     .note.ABI-tag .note.gnu.build-id
  06     .eh_frame_hdr
  07
  08     .init_array .fini_array .jcr .dynamic .got
```

p (6) Dynamic Sections (a)

```
Dynamic section at offset 0xf14 contains 24 entries:
  Tag        Type                         Name/Value
 0x00000001 (NEEDED)                     Shared library: [libc.so.6]
 0x0000000c (INIT)                       0x804828c
 0x0000000d (FINI)                       0x8048484
 0x00000019 (INIT_ARRAY)                 0x8049f08
 0x0000001b (INIT_ARRAYSZ)               4 (bytes)
 0x0000001a (FINI_ARRAY)                 0x8049f0c
 0x0000001c (FINI_ARRAYSZ)               4 (bytes)
 0x6ffffef5 (GNU_HASH)                   0x80481ac
 0x00000005 (STRTAB)                     0x804820c
 0x00000006 (SYMTAB)                     0x80481cc
 0x0000000a (STRSZ)                      69 (bytes)
 0x0000000b (SYMENT)                     16 (bytes)
```

p (7) Dynamic Sections (b)

```
Dynamic section at offset 0xf14 contains 24 entries:
  Tag        Type                         Name/Value

 0x00000003 (PLTGOT)                     0x804a000
 0x00000002 (PLTRELSZ)                   8 (bytes)
 0x00000014 (PLTREL)                     REL
 0x00000017 (JMPREL)                     0x8048284
 0x00000011 (REL)                        0x804827c
 0x00000012 (RELSZ)                      8 (bytes)
 0x00000013 (RELENT)                     8 (bytes)
 0x6ffffffe (VERNEED)                    0x804825c
 0x6fffffff (VERNEEDNUM)                 1
 0x6ffffff0 (VERSYM)                     0x8048252
 0x00000000 (NULL)                       0x0
```

p (8) Misc Sections

```
Relocation section '.rel.dyn' at offset 0x27c contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
08049ffc  00000106 R_386_GLOB_DAT    00000000   __gmon_start__

Relocation section '.rel.plt' at offset 0x284 contains 1 entries:
 Offset     Info    Type            Sym.Value  Sym. Name
0804a00c  00000207 R_386_JUMP_SLOT   00000000   __libc_start_main@GLIBC_2.0

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

Symbol table '.dynsym' contains 4 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 00000000     0 NOTYPE  WEAK   DEFAULT  UND __gmon_start__
     2: 00000000     0 FUNC    GLOBAL DEFAULT  UND __libc_start_main@GLIBC_2.0 (2)
     3: 0804849c     4 OBJECT  GLOBAL DEFAULT   16 _IO_stdin_used
```

p (9) Symbol Table (a)

```
Symbol table '.symtab' contains 73 entries:
   Num:    Value  Size Type    Bind   Vis      Ndx Name
     0: 00000000     0 NOTYPE  LOCAL  DEFAULT  UND
     1: 08048154     0 SECTION LOCAL  DEFAULT    1
     2: 08048168     0 SECTION LOCAL  DEFAULT    2
     3: 08048188     0 SECTION LOCAL  DEFAULT    3
     4: 080481ac     0 SECTION LOCAL  DEFAULT    4
     5: 080481cc     0 SECTION LOCAL  DEFAULT    5
     6: 0804820c     0 SECTION LOCAL  DEFAULT    6
     7: 08048252     0 SECTION LOCAL  DEFAULT    7
     8: 0804825c     0 SECTION LOCAL  DEFAULT    8
     9: 0804827c     0 SECTION LOCAL  DEFAULT    9
    10: 08048284     0 SECTION LOCAL  DEFAULT   10
    11: 0804828c     0 SECTION LOCAL  DEFAULT   11
    12: 080482b0     0 SECTION LOCAL  DEFAULT   12
    13: 080482d0     0 SECTION LOCAL  DEFAULT   13
    14: 080482e0     0 SECTION LOCAL  DEFAULT   14
    15: 08048484     0 SECTION LOCAL  DEFAULT   15
    16: 08048498     0 SECTION LOCAL  DEFAULT   16
    17: 080484a0     0 SECTION LOCAL  DEFAULT   17
    18: 080484d4     0 SECTION LOCAL  DEFAULT   18
    19: 08049f08     0 SECTION LOCAL  DEFAULT   19
    20: 08049f0c     0 SECTION LOCAL  DEFAULT   20
```

p (10) Symbol Table (b)

```
21: 08049f10     0 SECTION LOCAL  DEFAULT   21
22: 08049f14     0 SECTION LOCAL  DEFAULT   22
23: 08049ffc     0 SECTION LOCAL  DEFAULT   23
24: 0804a000     0 SECTION LOCAL  DEFAULT   24
25: 0804a010     0 SECTION LOCAL  DEFAULT   25
26: 0804a024     0 SECTION LOCAL  DEFAULT   26
27: 00000000     0 SECTION LOCAL  DEFAULT   27
28: 00000000     0 FILE    LOCAL  DEFAULT  ABS crtstuff.c
29: 08049f10     0 OBJECT  LOCAL  DEFAULT   21 __JCR_LIST__
30: 08048340     0 FUNC    LOCAL  DEFAULT   14 deregister_tm_clones
31: 08048370     0 FUNC    LOCAL  DEFAULT   14 register_tm_clones
32: 080483b0     0 FUNC    LOCAL  DEFAULT   14 __do_global_dtors_aux
33: 0804a024     1 OBJECT  LOCAL  DEFAULT   26 completed.7200
34: 08049f0c     0 OBJECT  LOCAL  DEFAULT   20 __do_global_dtors_aux_fin
35: 080483d0     0 FUNC    LOCAL  DEFAULT   14 frame_dummy
36: 08049f08     0 OBJECT  LOCAL  DEFAULT   19 __frame_dummy_init_array_
37: 00000000     0 FILE    LOCAL  DEFAULT  ABS main.i
38: 00000000     0 FILE    LOCAL  DEFAULT  ABS swap.i
39: 00000000     0 FILE    LOCAL  DEFAULT  ABS crtstuff.c
40: 080485b0     0 OBJECT  LOCAL  DEFAULT   18 __FRAME_END__
```

p (11) Symbol Table (c)

```
50: 08048330     4 FUNC    GLOBAL HIDDEN    14 __x86.get_pc_thunk.bx
51: 0804a010     0 NOTYPE  WEAK   DEFAULT   25 data_start
52: 0804a024     0 NOTYPE  GLOBAL DEFAULT   25 _edata
53: 0804a020     4 OBJECT  GLOBAL DEFAULT   25 p0
54: 08048484     0 FUNC    GLOBAL DEFAULT   15 _fini
55: 0804a010     0 NOTYPE  GLOBAL DEFAULT   25 __data_start
56: 00000000     0 NOTYPE  WEAK   DEFAULT  UND __gmon_start__
57: 0804a014     0 OBJECT  GLOBAL HIDDEN    25 __dso_handle
58: 0804849c     4 OBJECT  GLOBAL DEFAULT   16 _IO_stdin_used
59: 00000000     0 FUNC    GLOBAL DEFAULT  UND __libc_start_main@@GLIBC_
60: 08048420    93 FUNC    GLOBAL DEFAULT   14 __libc_csu_init
61: 0804a02c     0 NOTYPE  GLOBAL DEFAULT   26 _end
62: 08048301     0 FUNC    GLOBAL DEFAULT   14 _start
63: 08048498     4 OBJECT  GLOBAL DEFAULT   16 _fp_hw
64: 0804a018     8 OBJECT  GLOBAL DEFAULT   25 buf
65: 0804a024     0 NOTYPE  GLOBAL DEFAULT   26 __bss_start
66: 080482e0    33 FUNC    GLOBAL DEFAULT   14 main
67: 0804a028     4 OBJECT  GLOBAL DEFAULT   26 p1
68: 00000000     0 NOTYPE  WEAK   DEFAULT  UND _Jv_RegisterClasses
69: 0804a024     0 OBJECT  GLOBAL HIDDEN    25 __TMC_END__
70: 00000000     0 NOTYPE  WEAK   DEFAULT  UND _ITM_registerTMCloneTable
71: 08048400    32 FUNC    GLOBAL DEFAULT   14 swap
72: 0804828c     0 FUNC    GLOBAL DEFAULT   11 _init
```

p (12) Others

```
Histogram for '.gnu.hash' bucket list length (total of 2 buckets):
 Length  Number     % of total  Coverage
      0  1          ( 50.0%)
      1  1          ( 50.0%)    100.0%

Version symbols section '.gnu.version' contains 4 entries:
 Addr: 0000000008048252  Offset: 0x000252  Link: 5 (.dynsym)
  000:   0 (*local*)       0 (*local*)       2 (GLIBC_2.0)     1 (*global*)

Version needs section '.gnu.version_r' contains 1 entries:
 Addr: 0x000000000804825c  Offset: 0x00025c  Link: 6 (.dynstr)
  000000: Version: 1  File: libc.so.6  Cnt: 1
  0x0010:   Name: GLIBC_2.0  Flags: none  Version: 2

Displaying notes found at file offset 0x00000168 with length 0x00000020:
  Owner                 Data size       Description
  GNU                   0x00000010      NT_GNU_ABI_TAG (ABI version tag)
    OS: Linux, ABI: 2.6.32

Displaying notes found at file offset 0x00000188 with length 0x00000024:
  Owner                 Data size       Description
  GNU                   0x00000014      NT_GNU_BUILD_ID (unique build ID bitstring
    Build ID: 1574c15c3270ef63673147a7608a8d225665af50
```

SSS

SSS

SSS