- GCC-FAQ(*GCC-FAQ* (`ftp://sunsite.unc.edu/pub/Linux/docs/faqs/GCC-FAQ.html`)) O ELF F HIE H H Q E Y L F
- tsx-11(*tsx-11* (`ftp://tsx-11.mit.edu/pub/linux/packages/GCC/ELF.doc.tar.gz`)) O ELF) C H 2 ELF.doc.tar.gz ELF) C H r 2r P H r r - G P C G A1 A G g
- H J Lu H a ELF I - a s H *ELF: From The Programmer's Perspective* (`ftp://tsx-11.mit.edu/pub/linux/packages/GCC/elf.latex.tar.gz`) H J Lu O E - 1 G Y J ELF s Jsr H a F Latex H (J J Postscirpt HG
- `ld.so` Q C 1 m `dlopen(3)` e k

6 Copyright

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J Cxn (C) O Daniel Barlow<`daniel.barlow@sjc.ox.ac.uk`> < < < > > > > >

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Lud J i GI ;E;v k O i f k o Linux HOWTO I - e a s H H 6 Q 9 k ;E;v b Cxn O E,Q 5 l 9 9 J o A HOWTO i GI J BP F GI) B r 2C(k H O G- ; s k k BP9 k c b l D r o 5 G 5v2D5 l 9 2 5- (9 Linux HOWTO G O m F 5

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J C1 H 2f 9 O 2DG J B A c s k r DL F (p Jsr Ia5 5 ; H CF 9 J , i HOWTO J Cxn r I 1 F k O HOWTO r F GI 9 k W2h D F Js; F H ;WCF k i G9

If you have questions, please contact Greg Hankins, the Linux HOWTO coordinator, at `gregh@sunsite.unc.edu` via email, or at +1 404 853 9989.

A Ld, l P Linux HOWTO 3 G G k Greg Hankins O m F 5 e-mail I l 9 O `gregh@sunsite.unc.edu` EEC i +1 404 853 9989 G 9 e2fs Remy Card “ ELF C e2fsck k s k ”

- **file** (http://sable.ox.ac.uk/ jo95004/patches/file.diff) 1 ELF stripped d mixed-endian 1 L k 2
- 2 E ” (a) ELF r F 2 (E F ” k s k (`make config`) “Kernel support for ELF binaries” K ‘Y’ E (1 2)” (b) k r ELF s k - k (b) K F 1 L E K ‘no’ i ” k s k K a.out r K Makefile K 5 r 2C(k M ” Makefile `CC` `LD` `Dj5 0 h / 5`

```
LD      =ld -m i386linux
CC      =gcc -b i486-linuxaout -D__KERNEL__ -I$(TOPDIR)/include
```

(b) K k L 2r F ” H J Lu C r E F l ” Mk r ELF s k k b 2 (C ELF m i ‘ K core dump 5 k H b 2 K J) C a - MK 1.3 Mk K 3 1 k ” `ps` `l` `4 9 k f j` `psupdate` `m 0 i` namelist r 5 H k K hack k M ”

[LuCmi e b - ” 1.3.7 J Mk ELF 2 C x K h 3 l 7 Mk r ELF n . k H `make config` `Dj 9`]

- **SVGATextMode** **MG** diff r 7 F patch H 7 F E F k ” k r “ 5 7 F 5

```
--- SVGATextMode-0.7.orig/XFREE/os-support/assyntax.h  Sun Feb 26 18:58:15 1995
+++ SVGATextMode-0.7/XFREE/os-support/assyntax.h       Thu Mar 30 07:52:03 1995
@@ -211,7 +211,7 @@
 #endif /* ACK_ASSEMBLER */


-#if (defined(SYSV) || defined(SVR4)) && !defined(ACK_ASSEMBLER)
+#if (defined (__ELF__) || defined(SYSV) || defined(SVR4)) && !defined(ACK_ASSEMBLER)
 #define GLNAME(a)       a
 #else
 #define GLNAME(a)       CONCAT(_,a)
```

- **XEmacs** XEmacs 19.11 K (http://sable.ox.ac.uk/ jo95004/patches/xemacs.diff) `C / 5`

5

- linux-gcc a s 9 H K 2 2C9 k 3 H ” ELF 2 h K J 9 7 F k r C k a 1 J K 9 K l J M7 9 ” 3 a s 9 H Usenet H c ” 3 H ” MM b ” ” 3 H e Ld J 3 r Ld9 k l ” s a s 9 H X 2 2CJ K `help` `a k` `majordomo@vger.rutgers.edu` `C / @ 5`
- Bobby Shmit 1 1 7 F k *ELF upgrade experience* (`http://www.intac.com/ cully/elf.html`) web b 2 9MK J k 7 g

- (_) 0 a.out 0 0 t 4 t t _ (0 ELF 0 . F o . F L _foo foo (4 1) EXTERNAL A EXTERNAL(foo) A EXTERNAL (__ELF__ A F) 0 t _ 0 1 F 0 t
- libc5 libc 4 0c c (locale 5 l F
- – c (emacs 0 a b a s) F 1
- (X11 E5 E c) l i F ELF i i (Makefile) 1 l s

0 e F (F 0 (2 . 0 (0 l) 4– 0 ELF 1 F k (o ELF M s k k a s F l l b) e ( ) 0 F k ELF M M

4.1

- **dosemu** s (s linux-msdos a s 0 2 2 F 5) dosemu ELF F0- Makefile k M dosemu s (ftp://tsx-11.mit.edu/pub/linux/ALPHA/dosemu/)
- **Emacs** Emacs d n . 5 l Emacs . 5 s 5 F0 F M lisp F s e X s 0 F Emacs 19.29 ELF 4 - 5 FŒ5 l F k 5 d FŒ 9 (XEmacs F e 9 F 5)
- **perl 5.001** perl 5.001 “x 0 s x 0 ” 2 F 99 F b ELF 9 F s k - ” FŒ m s 0 b 1 F 9 perl 9 k F o ftp.metronet.com ftp.wpi.edu i F -
- **util-linux 2.2** cal m i F - s 2.4 0 9 b (*version 2.4* (ftp://tsx-11.mit.edu/pub/linux/packages/utils)) ” 0 l F 5
- **XFree86** XFree86 t 6 Mi i r 4 ” ELF i i r n k a 99 M F b 6 ” s 404 9 e s 0 2 5 i F 2 9 (ftp://ftp.beckman.uiuc.edu/pub/linux/X11/) k (ftp://ftp.mcc.ac.uk/pub/linux/ALPHA/XFree86-3.1.1-ELF-3/)

4.2

- **e2fsutils** Second Extended File System M F F r 6 Mi i F s k 9 k ” (http://sable.ox.ac.uk/ jo95004/patches/e2fsutils.diff) k `libfoo.so.1.0` i i ld 9 (`libfoo.so`) l 9 (`libfoo.so.1`) 9 l `LD_LIBRARY_PATH` DI b i i A s H 0 i l P `/usr/local/lib` b 0 I s / r D `libfoo.so` `libfoo.so.1` r s / r D P s s P o Y update `libfoo.so.1` i `libfoo.so.1.0` s / `ldconfig` / 0 l

```
$ su
# cp libfoo.so.1.0 /usr/local/lib
# /sbin/ldconfig
# ( cd /usr/local/lib ; ln -s libfoo.so.1 libfoo.so )
```

3.3

3 H J Lu ELF e a H H ld.so `dlopen(3)` e / o / r b 3 3 1 c r (1 a g 0 0 i r `-ldl` g s r I 1 s / /

```
#include <dlfcn.h>
#include <stdio.h>

main()
{
  void *libc;
  void (*printf_call)();

  if(libc=dlopen("/lib/libc.so.5",RTLD_LAZY))
  {
    printf_call=dlsym(libc,"printf");
    (*printf_call)("hello, world\n");
  }

}
```

3.4

gdb ELF F F J 99J F 9 (F l 9) tsx-11 `GCC G` l / H P g s gdb F E s b 1 ELF b 1 F 9 J J F E ELF s 9 a E F 9 Ld l LgE J J s

4

ELF s F F 9 J H 4 F 9 9 J F d a F b 9 9 H E 4 E (neatness) d a b H . 9 a 4 ELF F s J b l s H s (s 1 4 4J1 s - 9 (a.out 4 - F a J J (9 H 9

E E E “Hello, world” r F L gcc 3 -b i486-linuxaout g r F 3 F ” a.out H ELF 3 i , l F F

```
$ cat >hello.c
main() { printf("hello, world\n"); }
^D
$ gcc -o hello hello.c
$ file hello
hello: ELF 32-bit LSB executable i386 (386 and up) Version 1
$ ./hello
hello, world
$ gcc -o hello -b i486-linuxaout hello.c
$ file hello
hello: Linux/i386 demand-paged executable (QMAGIC) not stripped
$ ./hello
hello, world
```

2.5

5

:-)

`no such file or directory: /usr/bin/gcc`

`/usr/bin/gcc` c s h l g ELF F E ” `/lib/ld-linux.so.1` s l i / s step 3 ” r F

`not a ZMAGIC file, skipping`

i a C `ldconfig` i b G g s ld.so r H F ” b r F F a step 3 r b 8 F

`bad address`

ELF) H i , 4 F 3 i H - 1.3.0 i 1.3.3 r H F : 1.3.3 0 e ” 0 l 1.2.x r H g

3 ELF

3.1

ELF 0 0 i r :n `gcc` r `Ia` `1` `G` a.out 0 3 s `gcc -b i486-linuxaout` /

“b a.out 0 3 s i ,) H 8 . 0 i L 0 , `a.out` i ELF 3 s i ,) H 8 . 0 i L 0 2 H 8)” H Ld E g d `a.out` , `s` `G` `G` `G` `:-)`

3.2

libfoo.so r :n 4p“ E g 0 2 L

```
$ gcc -fPIC -c *.c
$ gcc -shared -Wl,-soname,libfoo.so.1 -o libfoo.so.1.0 *.o
$ ln -s libfoo.so.1.0 libfoo.so.1
$ ln -s libfoo.so.1 libfoo.so
$ export LD_LIBRARY_PATH=`pwd`:$LD_LIBRARY_PATH
```

[2 mv [lib*.so* except for libc.so* and libm.so*] /usr/i486-linuxaout/lib t libc.so* libm.so* lib*.so* r zsh h 8 - (t)csh, bash , ,]

```
cd /lib
mv *.o *.a *.sa /usr/i486-linuxaout/lib
mv [ lib*.so* except for libc.so* and libm.so* ] /usr/i486-linuxaout/lib
cd /usr/lib
mv *.o *.a *.so* *.sa /usr/i486-linuxaout/lib
cd /usr/X11R6/lib
mv *.o *.a *.so* *.sa /usr/i486-linuxaout/lib
cd /usr/local/lib
mv *.o *.a *.so* *.sa /usr/i486-linuxaout/lib
```

`/lib` `libc.so*` `libm.so*` `ld.so` `l` / `i` `i` `*` / (`*.o`) r s s `libc.so*` `libm.so*` m i `ld.so` m i

5. b 7 `/usr/lib/ldscripts` `l` / `l` o

6. `/usr/bin` (`ld86` `as86`) 4 `ld` `as` r o

7. 8 s GNU tar 7 s / s / 5 l U r 7] d , 8 8 , N i l N a libc N a 8 U r s /usr/include / N U r o , , b N l s `l`] / 5 v G , `/usr/include` `s` `l` C i i , C 8 (N(ncurses) b / N G s /usr/include 2 r C / C 7 `tar tzf` `i` 8 a `l` `l` / r o e libc-5.0.9.bin.tar.gz r G l / i 8 7 9

8. 0 e G ELF N 9 7 0 r F0 9 a , U r 4 F s 9 G- 7 0e N l Lg2 h VDU o D 4 E* 5 7F h C F 9 / s N 0 i N l - G 9 g s 0 G 9 i G 0l 5 7 7 g

9. 5 h h ELF m0 i r s 9 7 9 binutuils C 8 r s 9 7 9 `tar -xvzf binutils-2.5.21.17.bin.tar.gz -C /` `1` `l`

10. `/usr/lib/gcc-lib/`{`i486-linux, i486-linuxelf, i486-linuxaout`}`/` 2 `r` `C` / `C` `7` `e` `o` `7` `7` gcc-2.7.0.tar.gz r G l / i E8 7 9

l G * * * 0 2 4 C1 F 9 r (7 9

```
$ gcc -v
Reading specs from /usr/lib/gcc-lib/i486-linux/2.7.0/specs
gcc version 2.7.0
$ gcc -v -b i486-linuxaout
Reading specs from /usr/lib/gcc-lib/i486-linuxaout/2.7.0/specs
gcc version 2.7.0
$ ld -V
ld version cygnus/linux-2.5.2l.14 (with BFD cygnus/linux-2.5.2l.11)
  Supported emulations:
   elf_i386
   i386linux
   i386coff
```

- binutils-2.5.21.17.bin.tar.gz — Linux GNU N n i gas, ld, strings C i , G , N i G

2.4 .

2 ‘ — ’ C i ‘ C C i — ’ :-) i N ELF G 6 N L N N G G 6 N E,E F , CN F G i

1. HDD / 7 g s /usr 7 g s 1 1 g / 5/ /usr s 5 1 / i r / /usr / i n 7 / 5 7 1 i i i i /lib-aout -

   1 7 s 1

   ```
   $ ldd /sbin/* /bin/* /etc/* >/tmp/list.txt
   ```

   $ d $ /tmp/list.txt r 2 m i i 5 7 i i o l a b 7 - l i i i 7 g s i i 7 - 7 g

2. a.out N U a N G H :n

```
mkdir -p /usr/i486-linuxaout/bin
mkdir -p /usr/i486-linuxaout/include
mkdir -p /usr/i486-linuxaout/lib
mkdir /lib-aout
```

3. 3 C F G H G F E ld.so-1.7.3 1 r 3 7 3 5 1 ld.so-1.7.3/instldso.sh / r s 7 g b 7 7 r i sh instldso.sh r 1 s 3 b - b 7 2 b r i s ‘2 ‘ E G N ’ H

   - zsh H C F (zsh N s G $VERSION $ $$$ t $r 5 $7 $ $ $ $ 1 instldso.sh $r. p 5 $ $)
   - /lib/elf $ $i /lib $ 7 s / s / $r $ $ $$$ (3 - 3 N G , ELF N 3 H D 1 F i 3 F CN s)

   G

   /etc/ld.so.conf r 5 7 /usr/i486-linuxaout/lib $r2 $ (, i /lib-aout $b 2 $) /sbin/ldconfig -v $r 7 7 $7$$ 1 / $r5 7 $$$ $ / 7 $

4. libc H libm 3 N F N a.out N i i C /usr/*/lib $ $i /usr/i486-linuxaout/lib $ /lib-aout $ 7 $ /lib/ld.so $0 $ 7 $ o 7 $ $ $N 1 $$$8$ $ $0$$$1$ $ $s *

   1 $ $N 7 g s 7 $ $ $$$ $$ $ $i 2 $N3 s I $ I $ n 6 $Ng It $ $ $ $ $ $ 0 $ $

ELF Slackware k
l k F

- ld.so s l
s d l l
s ldd
libc.so.4 / k libm.so.4 i l i i i /lib
l d s b X X shape form F
l f ld.so o / i m i s
s X r h s k 5 l F k E X
a c f l / L c F

  F a.out ELF F s f F l
l ELF r L l F l / r /etc/ld.so.conf

  b o / i
i i i Linux God(tm) l G E X F d
5 r 5 (F / 5 h :-) 2sE HOWTO H k
k l G

- Linux G O ‘FSSTND(k F ‘ s)’ F ‘ E k
F ‘ O G 5 l k h F - G F ‘ k H G
2 N L G ‘/sbin/ i ’ r H h F k N N F ‘ O /sbin
l / l l i m i /bin /etc

2.3

2 (ftp://tsx-11.mit.edu/pub/linux/packages/GCC/) d
(ftp://sunsite.unc.edu/pub/Linux/GCC/) i G G b / l i
l G G . a / k i [F i
(ftp://ftp.iij.ad.jp/pub/linux/sunsite/GCC/) d
(ftp://ftp.spin.ad.jp/pub/linux/sunsite.unc.edu/GCC/)] i 5 F / 5 N
H F s h F k . / F G - k H
2 ((H F k s h N) WG l i r
s m F l l m N N H r F s G F / 5 ’ N H O
F release.*packagename* *k* *g*
g *g* *g*
k *k*

- ld.so-1.7.3.tar.gz — F E s
- libc-5.0.9.bin.tar.gz — ELF N - i i N T a G C N i i
H N C (m(t X i i), termcap, gdbm) H k E E i i
l i r H C F Wm i ‘ r s k k N , W s / k k , F C F
- gcc-2.7.0.bin.tar.gz — ELF N C s i G l / H l H r
2r k a.out N C s i b F C F

2

2.1

a.out ELF F F F
a E
a F F ‘/lib /usr/lib
s l l / r ’

linux i i o l i ‘ /lib/ld.so s i b s b
i i i d d s i i
ld.so d r d s ld.so i i r r
l o – o ld.so i i r
l / r / d l i r s / b i i r
l / l /
l
i l ld.so r o l s / r
i / o l / (Bad Thing)
l L (i l F
ELF ELF F E l F l /lib/ld-linux.so.1 ELF
i ‘ B F ld.so / 1 r ld-linux.so.1 b a.out ld.so 1
i (ldd, ldconfig, /etc/ld.so.conf) x
i 4 E 2h F ELF 4 (i i
i) a.out 4 , /usr/{bin,lib,include} a.out 4
/usr/i486-linuxaout/{bin,lib,include} /etc/ld.so.conf
i i , 8 l r 4 1 ldconfig ELF a.out F E h L
E, i i B , i i l B
, ((caveats) ‘ F

2.2 —

- ELF) 1.1.52 h , , 1.3.0 i 1.3.2 0 , F ELF 3 , s 3 1.3 F i h F 5 1.3.3 0 i Bg 1.2.10 (E 0B) Bg
- Slackware l e h boot/root / r 0 F g B , , g , b , F 0 F 1 l BIr F’‘ a
- /usr d /usr/lib r / g s c g s l g / l g /bin /sbin i , i i r / l i r g s c /lib-aout / , , 4 8e , b l l
- ELF 3 / r 1 F i /lib/elf ELF i i (L o libc.so.4), k b l s 3 l i i i r 1 g s F 3 s k k , , e 3 l / o g b d /lib/elf l /

F F1 F 3 L F 3 F F

ELF

L F

E

L E F F F

a.out F . 1 3 3 F

. (1

F) . o

(.

F F (

3 3 F (ELF a.out 3 F F 3 F 3 ELF 3 F 3 3 ELF a.out F1 F a 3 C ELF a.out 2 o F C 6MB a a L . ELF a.out B B 3 2 E F (8Mb b C E) M C F a C Emacs E E s Mosaic/Netscape N B a b) m i C F :-)

ELF Pratchett Keebler b b

b L K F F P

1.2 ELF ( )

ELF (F C N 2 N MM3 : B e m i : C Fp - 3 B Fs B b b ELF F i - MN C i i GCC ELF MN 3 N m i N 3 / b ELF N : G B N - C F 3 8 E G ELF N b 2 N MM3 B ELF 3 / N E C 3 G / N C1 8 (M a) ELF F 3 s a C MG b C F G N(Linus ELF (G B N b N G [LuCm linux 1.3.7 G kernel N ELF 2 N C :NM l 7 1.3.7 N Mk G make config N : Mk r ELF 2 k N Br 2 G G] Fs L N MM3 3 3 - 7 F k s k N g 3 E C1 :n6 G (7 7 r s m k r 1 l b l G 7 g) l l N C 3 G b 7 (i / - l 7 F N / F 2 G k 3 G 6 Mi i r 8 g s C k 3 - / `ldconfig` d `ldd` `l` i ELF G 8Ga G e 7 g s k G B C F C / C r C e G ELF G N linux r :F s k 7 M t N La b CN s N e G (a C F b 3 r C F) 3 N 8 r F s G 6/7 F k N b b CN s l G b)

1 ELF 1

ELF(Executable and Linking Format) USL(Unix System Laboratries) l U k U) Solaris System V Release 4 F Linux F a.out F F n GCC C i V i Linux G b U) C r ELF k a ELF r

V C F E 1 g s m i C F 2 x E

- ELF r i V i C 4 C1 n l F F V U k r -fPIC g s r IU1 F s k F 2 s k 1 G

```
gcc -shared -Wl,-soname,libfoo.so.y -o libfoo.so.y.x *.o
```

g b 1 s , a.out U) C G - i V i r n k f k C 4 C1 CF a.out U) C G - i V i r n k l g i V i - I k G m 4 F G F I l r F I F I l n CF k i V i g EP F P s G (C (ftp://tsx-11.mit.edu/pub/linux/packages/GCC/src/tools-2.16.tar.gz) 20 i I - e a s F)

- (m0 i I b e k r m I k) C 4 C1 G - k Perl 5 Python 5 G r CF k m0 i e I c G 5 G r super-fast MUD G b P 5 1 F l g DI2C k I L s k F b e k 2 F - F k m0 i r F 5 F0 F b b e k r m I k G 5 G r DI2C k r L F

ELF r C k b 5D r F k 2% i 5% i C k i G d C CF k G - s %I%% M h G b r f S F k %I%%r f C i P R d 5 (F 5 C k 0x ELF %i%%V%i%% %I %%%%g%s%%s%C%%s%C%s% (%%s%%%k -fPIC g s) CF k i G %%U%%C%r 5-21 k a %I%% 1 D o l k G t r 5-21 F %I%% k a G FC 80x86 CPU G F M%I%8%% a 1F6 P d h G

1.1 ELF

ELF k I k D F M 8n2r F k E

ELF F SVR4 Solaris i F o s

r F l F V4o SVR4 CF k b F18 G i C F SVR4 %%m%0%i% ELF r (P FM Linux G MM2DG k o 1 G s 4 8 %%m%0%i% %C%%%%U%) %%C% h F D Linux %%m%0%i%r MSDOS d Minix 0 %C%%% 8 MSDOS d Minix %%m%0%i%r Linux 0 %C%%% 8 k O2DGG i CF l l %%%F% % %%F% %%m%0%i%r F0 k o 1 G O s SVR4 O Linux O0 k %%%F%%

The Linux ELF HOWTO

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Linux ELF i
F L F 3 (1)
ELF (2) ELF (3)
i 2 F F