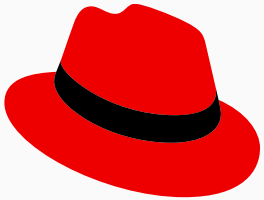


# Support for mini-debuginfo in LLDB

How to read the .gnu_debugdata section

Konrad Kleine

February 2, 2020

Red Hat

# About me

## Konrad Kleine

- Red Hat
- LLDB, C/C++, ELF, DWARF since 2019
- Before worked OpenShift since 2016

## Reach out

- https://github.com/kwk/talks/
- https://www.linkedin.com/in/konradkleine
- https://developers.redhat.com/blog/author/kkleine/
- https://twitter.com/realdonaldtrump

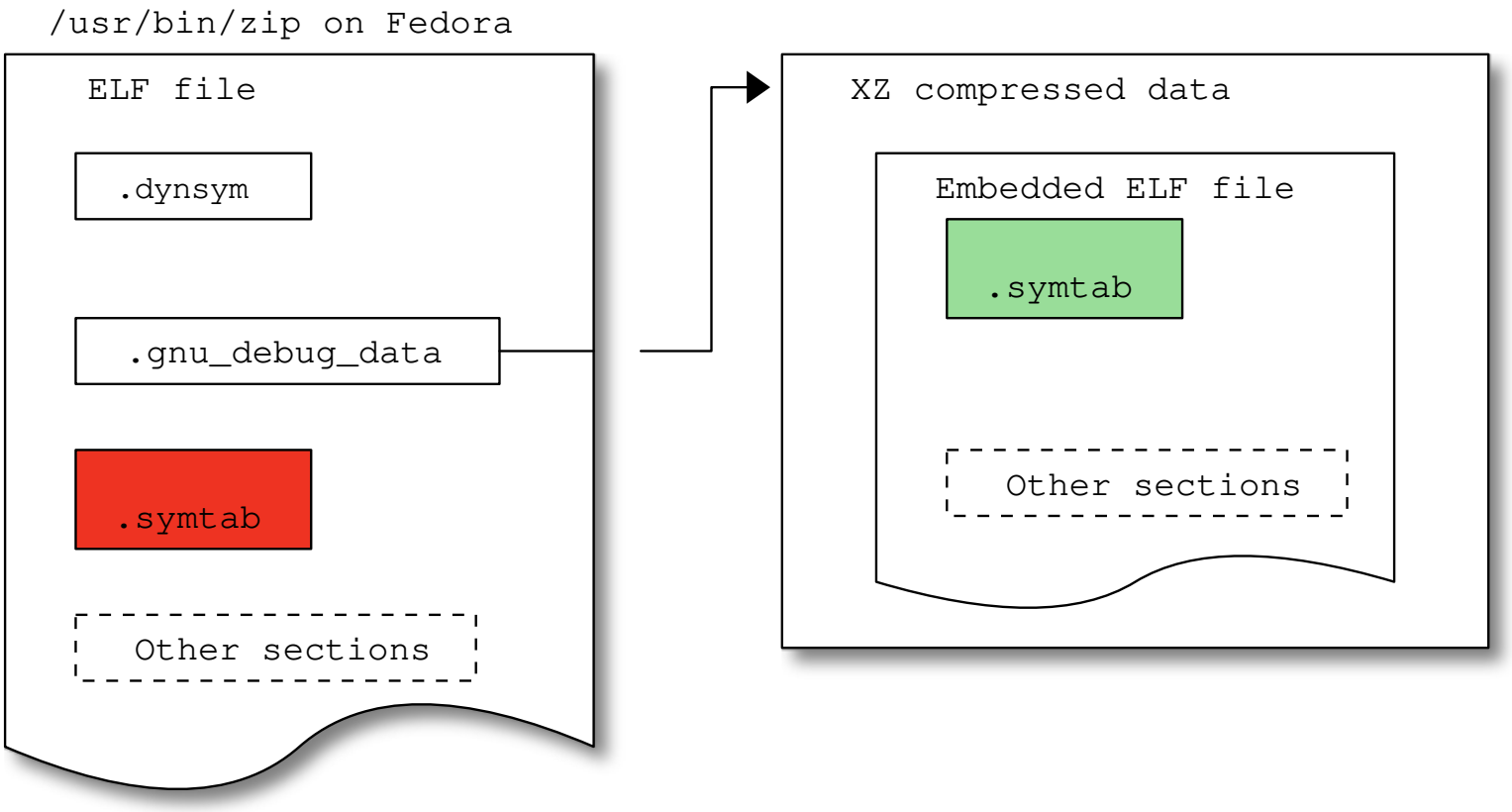
# ⌖ Overall goal and first steps

**Improve LLDB for Fedora and RHEL binaries**
when no debug symbols installed

**Take existing Fedora binary (`/usr/bin/zip`)**

- identify a symbol/function
- shootout: GDB vs. LLDB
- hurdles:
  - not from `.dynsym`
  - from within `.gnu_debugdata`

# What is the `.gnu_debugdata` section (aka mini-debuginfo)?




- **no replacement** for separate full debug info
- **extra minimal** debug info for simple backtraces
- **not related** to DWZ compression

# 🗁 Extract and uncompress `.gnu_debugdata` section to `zip.gdd`

```
~$ cp /usr/bin/zip .
~$ objcopy --dump-section .gnu_debugdata=zip.gdd.xz zip
~$ file zip.gdd.xz
zip.gdd.xz: XZ compressed data
~$ xz --decompress --keep zip.gdd.xz
~$ file zip.gdd
zip.gdd: ELF 64-bit LSB executable, x86-64, version 1 [...]
```

- `eu-readelf -Ws --elf-section` can directly access `.gnu_debugdata`

# Identify symbol in `zip.gdd` but not in main binary

```
~$ eu-readelf -s zip.gdd

Symbol table [28] '.symtab' contains 202 entries:
 82 local symbols  String table: [29] '.strtab'
  Num:            Value   Size Type    Bind   Vis          Ndx Name
    0: 0000000000000000      0 NOTYPE  LOCAL  DEFAULT    UNDEF
    1: 0000000000408db0    494 FUNC    LOCAL  DEFAULT       15 freeup
    2: 0000000000408fa0   1015 FUNC    LOCAL  DEFAULT       15 DisplayRunningStats
    3: 00000000004093a0    128 FUNC    LOCAL  DEFAULT       15 help
[...]
```

## `help` looks promising[1].

```
~$ eu-readelf --symbols /usr/bin/zip | grep help
~$
```

[1] Promising as in: we may be able to trigger it with `/usr/bin/zip --help`.

# Set and hit breakpoint on `help` with GDB 8.3[2]

```
~$ gdb --nx --args /usr/bin/zip --help
Reading symbols from /usr/bin/zip...
Reading symbols from .gnu_debugdata for /usr/bin/zip...
(No debugging symbols found in .gnu_debugdata for /usr/bin/zip)
Missing separate debuginfos, use: dnf debuginfo-install zip-3.0-25.fc31.x86_64
(gdb) b help
Breakpoint 1 at 0x4093a0
(gdb) r
Starting program: /usr/bin/zip --help

Breakpoint 1, 0x00000000004093a0 in help ()
(gdb)
```

## Success and two things to note:

1. Symbols read from `.gnu_debugdata`
2. No debug symbols installed for zip

[2] GDB 8.3 is what ships with Fedora 31

# Set and hit breakpoint on `help` with LLDB 9.0.0[3]

```
1  ~$ lldb -x /usr/bin/zip -- --help
2  (lldb) target create "/usr/bin/zip"
3  Current executable set to '/usr/bin/zip' (x86_64).
4  (lldb) settings set -- target.run-args  "--help"
5  (lldb) b help
6  Breakpoint 1: no locations (pending).
7  WARNING:  Unable to resolve breakpoint to any actual locations.
8  (lldb)
```



[3] LLDB 9.0.0 is what ships with Fedora 31

# ⚠ Let's talk `.symtab`

**Symtab**

- normally, `.dynsym` is subset
- **but** for mini-debuginfo `.dynsym` symbols are stripped[4]

**Implications for LLDB (and other tools)**

- parse `.dynsym`
  - when no `.symtab` found **or**
  - when mini-debuginfo present and smuggled in

[4] https://sourceware.org/gdb/current/onlinedocs/gdb/MiniDebugInfo.html

# ☑ Show that LLDB can now find `help` symbol

```
$ lldb -x /usr/bin/zip -- --help
(lldb) target create "/usr/bin/zip"
Current executable set to '/usr/bin/zip' (x86_64).
(lldb) settings set -- target.run-args  "--help"
(lldb) b help
Breakpoint 1: where = zip`help, address = 0x00000000004093a0
(lldb) r
Process 277525 launched: '/usr/bin/zip' (x86_64)
Process 277525 stopped
* thread #1, name = 'zip', stop reason = breakpoint 1.1
    frame #0: 0x00000000004093a0 zip`help
zip`help:
->  0x4093a0 <+0>:  pushq  %r12
    0x4093a2 <+2>:  movq   0x2af6f(%rip), %rsi        ;  + 4056
    0x4093a9 <+9>:  movl   $0x1, %edi
    0x4093ae <+14>: xorl   %eax, %eax
(lldb)
```

# Ready to ship?

# ⑦ What tests exists for mini-debuginfo?

- find symbol from `.gnu_debugdata`
- warning when decompressing `.gnu_debugdata` w/o LZMA support
- error when decompressing corrupted xz
- full example with compiled and modified code in accordance to gdb's documentation

# 🛏 fell asleep yet?

# </> Example test file in Shell test suite

## lldb/test/Shell/Breakpoint/example.c:

```
1  // REQUIRES: system-linux, lzma, xz
2  // RUN: gcc -g -o %t %s
3  // RUN: %t 1 2 3 4 | FileCheck %s
4
5  #include <stdio.h>
6  int main(int argc, char* argv[]) {
7
8    // CHECK: Number of {{.*}}: 5
9    printf("Number of arguments: %d\n", argc);
10
11   return 0;
12 }
```

```
~/llvm-project$ llvm-lit lldb/test/Shell/Breakpoint/example.c
-- Testing: 1 tests, 1 workers --
PASS: lldb-shell :: Breakpoint/example.c (1 of 1)

Testing Time: 0.20s
  Expected Passes    : 1
```

# Thank you!

Please share your feedback ★★★★★

https://submission.fosdem.org/feedback/10393