Linux Debuginfo Formats

DWARF, ELF, dwo, dwp
What are They All?

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Abstract

Many different Linux debugging tools are available - as well as the traditional debuggers (GDB, LLDB) we have checkers (Valgrind, the sanitizers), tracing tools (strace, ltrace), time-travel debuggers (rr, UDB). They all rely on debug info to map from the executable back to the source-code. Most of us know to pass the -g option to gcc to generate debuggable binaries, but there is much more to it than that.

This talk covers what exactly is in debug info, the different compiler options to control its generation, and the different kind of object files and why you might want them (e.g. split dwarf files for quicker loading). We also introduce ways to manage this information, including the new debuginfod service.

undo

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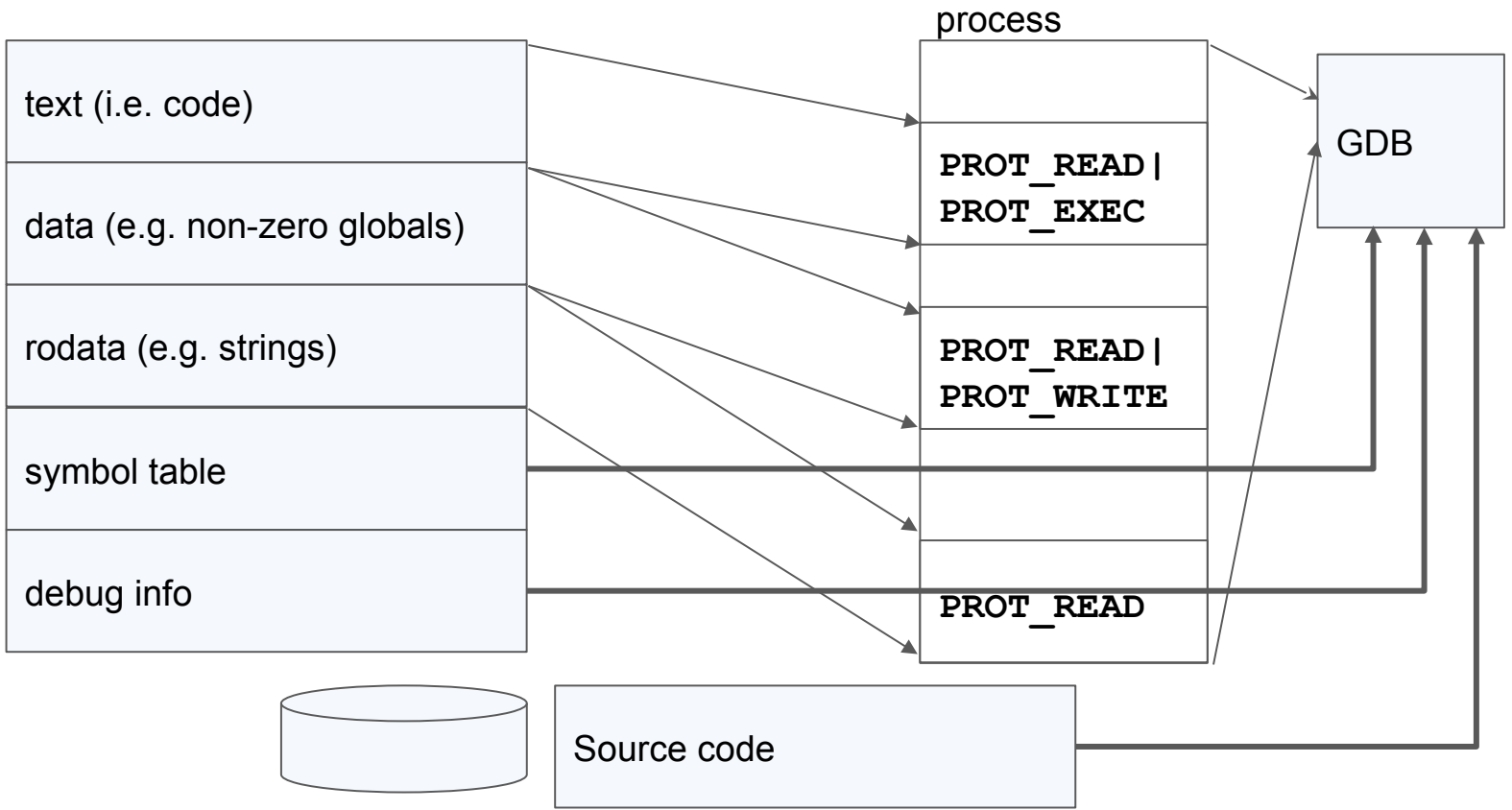
What does -g mean?

gcc -g3 hello.c => a.out



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readelf & addr2line

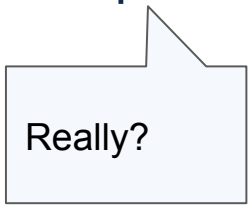
Debug info is not free

- `-g` doesn’t impact the generated code - at all.
- `-g` doesn’t increase the runtime footprint of your program (much).
- `-g` does impact the size of your binaries - a LOT.
- `-g` can increase your compile and link times.

Wait, link times?

Linker needs to apply relocations to all translation units.

This means the linker needs to parse all debug info of all translation units.



Split DWARF to the rescue

-gsplit-dwarf means:

In the resulting .dwo file, all debug info related to:

- Types, classes
- Identifiers

And in the .o, just

- Anything relative to a PC address.

“Debug symbols” vs “debug info”

Debug info

So many utilities

`readelf` `eu-readelf`

`objdump` `eu-objdump`

`dwarf-dump`

BFD

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debuginfod

debuginfod serves debug information over HTTP

(a bit like Microsoft Symbol Server)

sudo apt install debuginfod

debuginfod

DEBUGINFOD_URLS=localhost:8002 gdb a.out

debuginfod servers

https://debuginfod.elfutils.org/

Ubuntu, Debian, OpenSUSE and CentOS run debuginfod servers.

Client support in GDB, Valgrind, SystemTap

Backtrace

```
0000119d <   >:
   119d:       55              push   %ebp
   119e:       89 e5           mov    %esp,%ebp

          ...

   11ab:       5d              pop    %ebp
   11ac:       c3              ret
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undo

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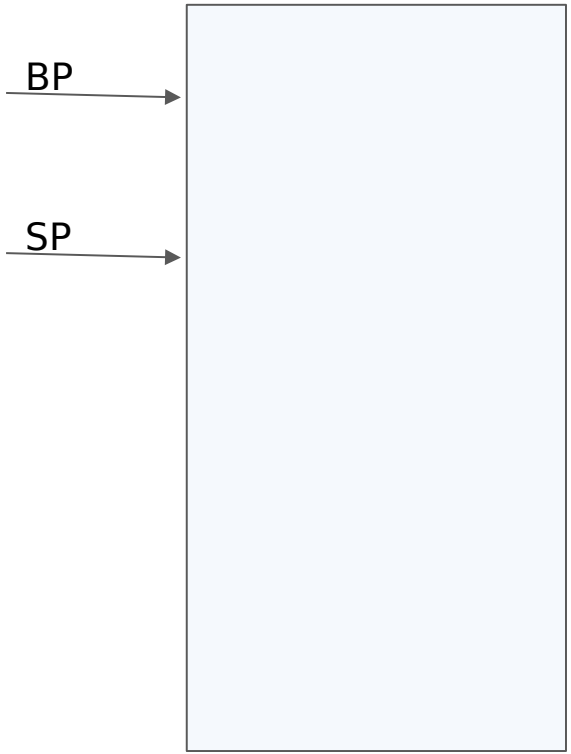

undo

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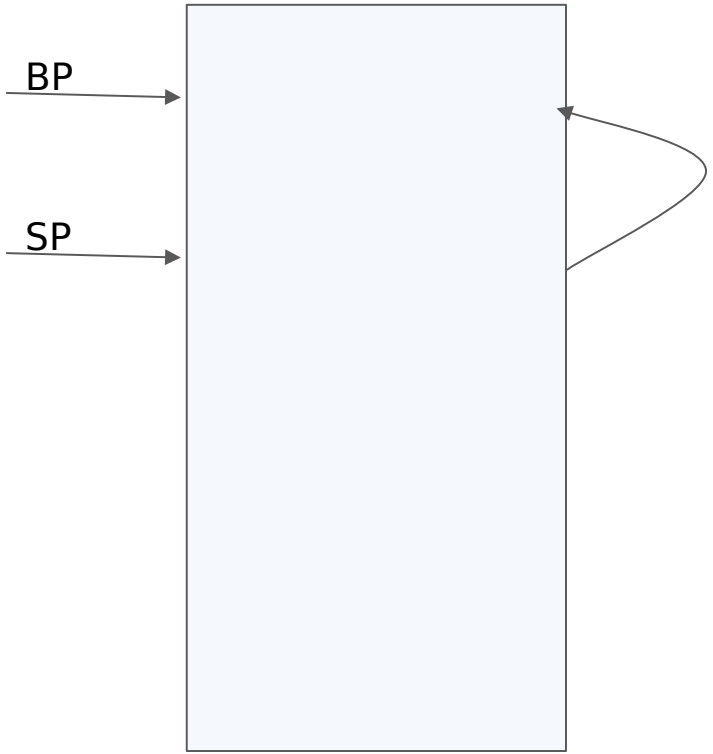

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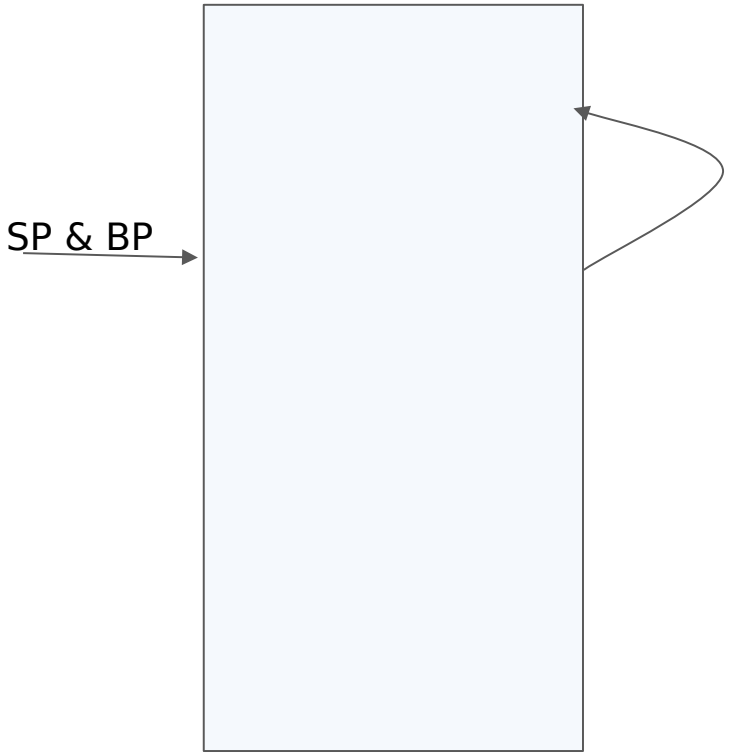

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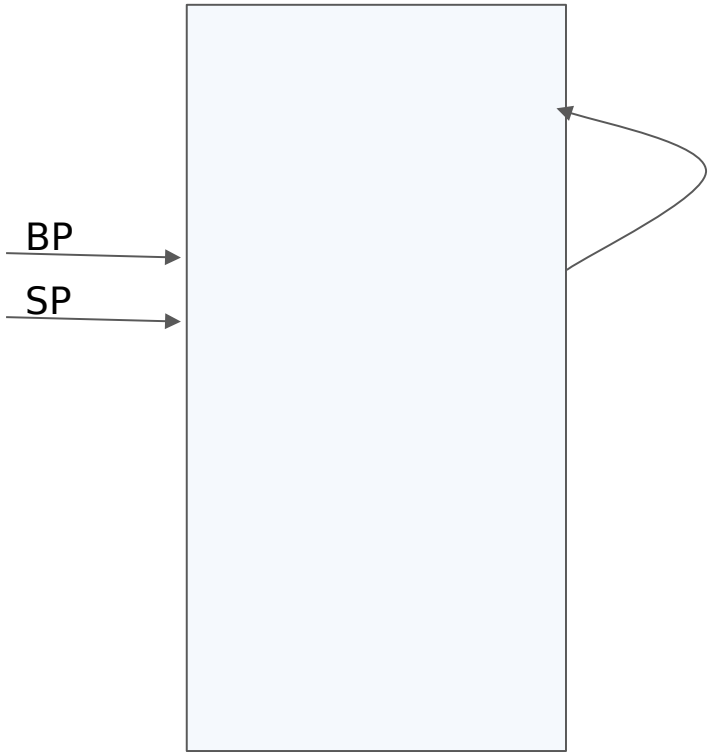

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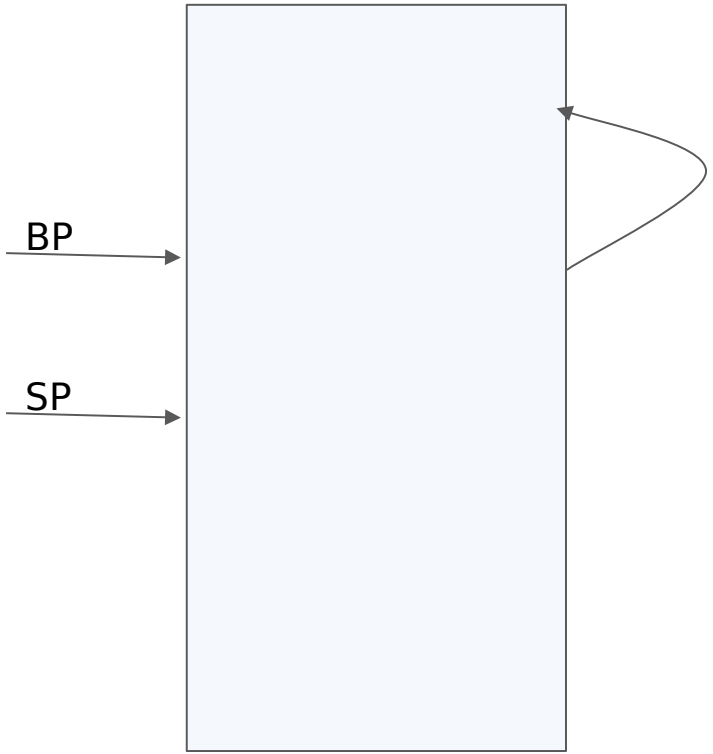

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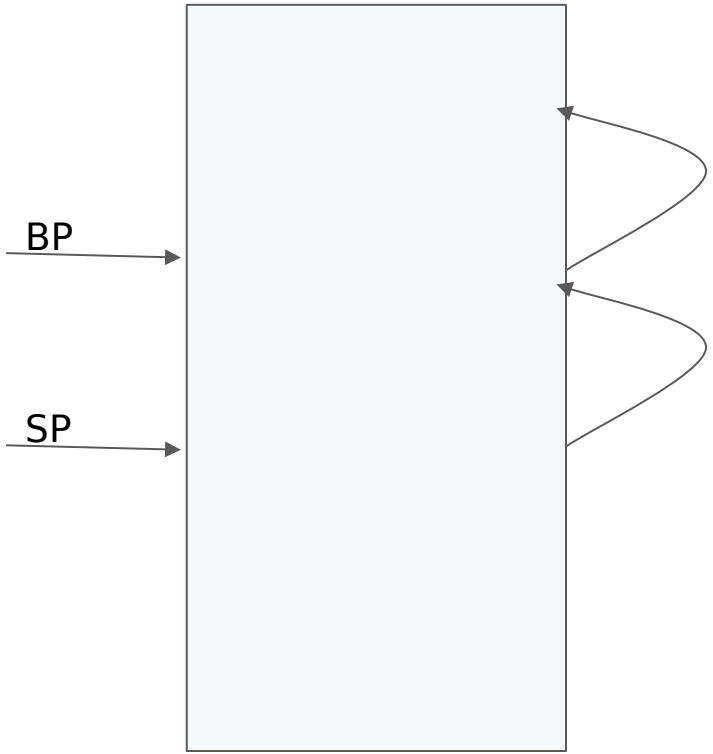

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But the compiler *knows*!

CFI - Call Frame Instructions

Can see this in the assembly generated by gcc

CFI is in both the `.debug_frame` and the `.eh_frame` sections.

gcc usually emits only `.eh_frame` (mandatory on x86-64)

- unless you say `-fno-asynchronous-unwind-tables`

@gregthelaw

undo