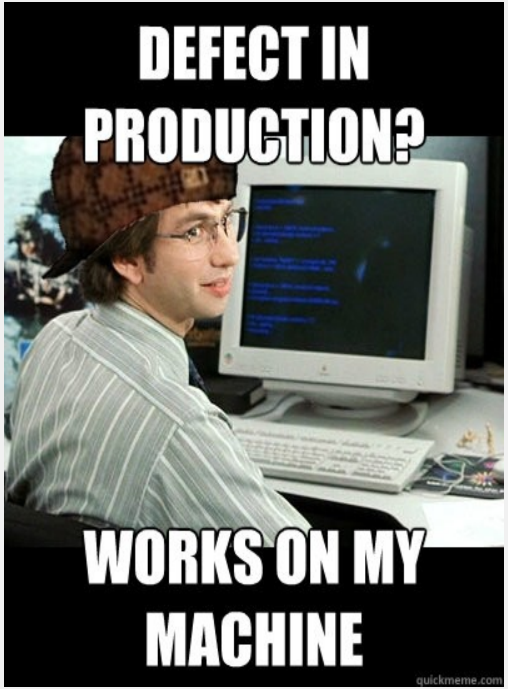
Debugging Hung Python Processes With GDB

Brian Bouterse
Principle Software Engineer, Red Hat.

Pulp (pulpproject.org)
Feb 5, 2017

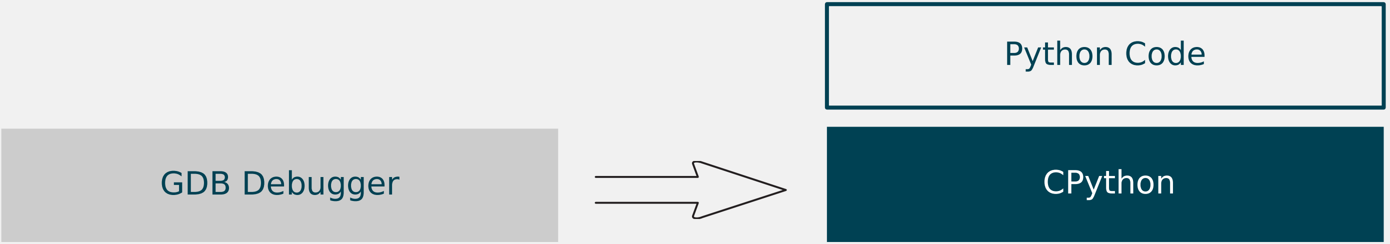
Why use GDB to debug Python software?


DEFECT IN PRODUCTION?
WORKS ON MY MACHINE
quickmeme.com

Why use GDB to debug Python software?

- Production application where pdb can't go
- Remote applications where rpdb isn't available
- Rarely occurring issues
- Deadlocking applications

Conceptual Model



example.py

```
import os
import time

def bar():
    time.sleep(30)

def foo():
    print 'pid is %s' % os.getpid()
    bar()

foo()
```

GDB Basics

- Connect to a running process: `gdb /path/to/program/ 1234`
- Connect to a running process by pid: `gdb -p <pid>`
- `c` to continue
- `Ctrl + C` to stop execution again
- `Ctrl + D` to detach (which continues)

Demo of basics + `bt`

A function call in CPython

```
#8  0x00007ff43137e666 in fast_function (nk=<optimized out>,
na=0, n=0, pp_stack=0x7ffd25b961a0, func=<function at remote
0x7ff43172d6e0>)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:4198
#9  call_function (oparg=<optimized out>,
pp_stack=0x7ffd25b961a0) at /usr/src/debug/Python-
2.7.10/Python/ceval.c:4133
#10 PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff43185fc20, for
file example.py, line 14, in <module> (),
throwflag=throwflag@entry=0)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:2755
```

Calling into the kernel

```
#0  0x00007ff4306add43 in __select_nocancel () from
/lib64/libc.so.6
#1  0x00007ff42fe2ffc0 in floatsleep (secs=<optimized out>) at
/usr/src/debug/Python-2.7.10/Modules/timemodule.c:948
#2  time_sleep (self=<optimized out>, args=<optimized out>)
at /usr/src/debug/Python-2.7.10/Modules/timemodule.c:206
#3  0x00007ff43137e8be in call_function (oparg=<optimized
out>, pp_stack=0x7ffd25b95f40) at /usr/src/debug/Python-
2.7.10/Python/ceval.c:4112
#4  PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff431738050, for
file example.py, line 6, in bar (), throwflag=throwflag@entry=0)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:2755
```

Python extensions for GDB

Thanks David Malcolm (dmalcolm)

Python extensions for GDB

- py-list Python source (if any) in current thread and Frame
- py-bt Print a Python stack trace from the GDB stack
- py-locals Print all Python locals from current thread
- py-print Print something from python namespace
- py-up and py-down Move up and down the Python stack

`py-list` output of example.py

```
(gdb) py-list
   1    import os
   2    import time
   3
   4
   5    def bar():
  >6        time.sleep(30)
   7
   8
   9    def foo():
  10        print 'pid is %s' % os.getpid()
  11        bar()
```

`py-bt` output of example.py

```
(gdb) py-bt
#4 Frame 0x7f12850d0050, for file example.py, line 6, in bar ()
    time.sleep(30)
#7 Frame 0x7f12851f7dd0, for file example.py, line 11, in foo ()
    bar()
#10 Frame 0x7f12851f7c20, for file example.py, line 14, in
<module> ()
    foo()
```

GDB and threads

- `info threads` Shows you information about threads in process
- Current thread is marked with *
- `thread <id>` Switches the current thread to <id>
- `thread apply all <COMMAND>` applies command to all threads
  - `thread apply all py-bt`
  - `thread apply all py-list`

Working with Core Dumps

- Generate a coredump with `gcore <pid>`

- Connect to a coredump with `gdb /path/to/program <core_file>`

Consider using `strace`

- trace system calls and signals
- An example call:

```
open("/dev/null", O_RDONLY) = 3
```

- An example error:

```
open("/foo/bar", O_RDONLY) = -1 ENOENT (No such file or directory)
```

strace demo

`strace python example.py`

Better Demo

Gotchas

- You need debuginfo libraries installed
  - GDB will tell you what you need
  - Your packages need to be the same as the ones gdb wants

- Optimized out Python code removes GDB's ability to see it

- Root is required to connect other user's processes

Trigger rpdb.set_trace() with a signal

- Add a signal handler which triggers rpdb.set_trace()
- Make it yourself or let rpdb do it. Recent versions have it build in.
- set_trace() can be triggered at any time by using the TRAP signal handler

```
import rpdb
rpdb.handle_trap()

# As with set_trace, you can optionally specify addr and port
rpdb.handle_trap("0.0.0.0", 54321)
```

References

- https://wiki.python.org/moin/DebuggingWithGdb
- https://fedoraproject.org/wiki/Features/EasierPythonDebugging
- https://sourceware.org/gdb/current/onlinedocs/gdb/Threads.html
- https://github.com/tamentis/rpdb#trigger-rpdb-with-signal
- http://bugs.python.org/issue8032

Contact Info

Brian Bouterse

bbouterse@redhat.com

bmbouter on freenode