

Let's write a Debugger!

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Who am I?

- Final year undergraduate at Imperial College London
- Previously at Apple and Red Hat
- Now researching different ways of operating system construction
- Low-level hacker

History of debuggers

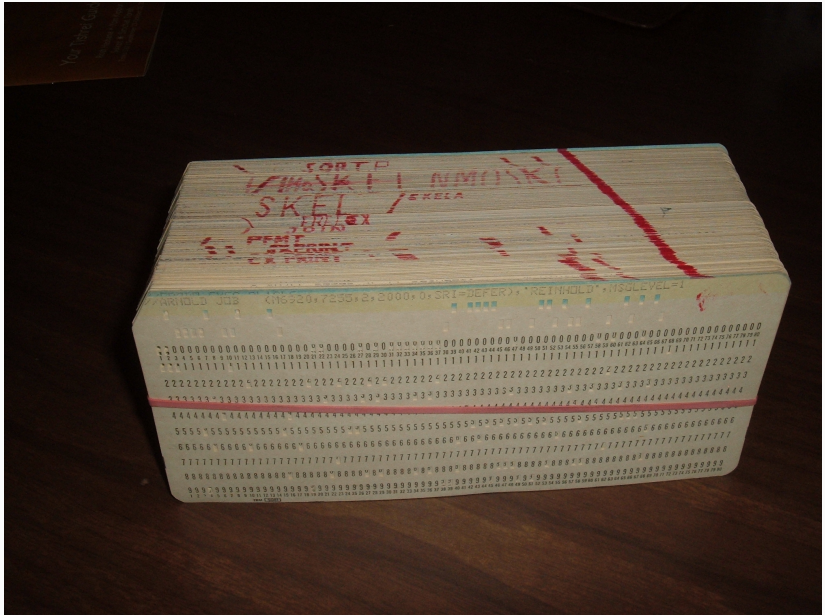
Single user machines

- One of the first computers in the world
- Small application was loaded at the top of the memory
 - single step
 - examine registers
 - read/write memory

TX-0 at MIT



Batch processing machines



Debugged by putting macro call in the punch card and generating:

- Snapshots (*register dump*)
- Core dumps (*contents of memory*)

Then came CTSS (*Compatible Time-Sharing System*), one of the first time-sharing operating systems!

Debugging suddenly became interactive.

printf-debugging

```
*ptr = 1337;  
printf("Did we crash at line %d?\n", __LINE__);  
*((int *) 0) = 1337;  
printf("Did we crash at line %d?\n", __LINE__);
```

- The first version of Unix had a debugger called, DB
- GNU had GDB and LLDB
- For Plan 9, ADB was created

These debuggers should be familiar!

Tracing processes

Most debuggers heavily rely on a system call known as ptrace.

The prototype of ptrace(2)

```
#include <sys/ptrace.h>
```

```
long ptrace(enum __ptrace_request request, pid_t pid,  
            void *addr, void *data);
```

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5. Your signal handler is called (or not if it is SIGKILL)

Implementation

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- Run until system call
- Monitoring registers
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 - `PTRACE_SINGLESTEP`

Architectural support

PTRACE_SINGLESTEP

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- `ud2` (machine code: 0x0F 0x0B)
 - Triggers #UD

PTRACE_SINGLESTEP

- `ud2` (machine code: 0x0F 0x0B)
 - Triggers #UD
- `int $3` (machine code: 0xCC)
 - Triggers #BP

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- DR4 & DR5: Obsolete aliases to DR6 & DR7
- DR6: Debug control
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 - Break on read, write, execute, or read+write
- DR7: Debug status
 - Bitmask showing which of DR0–DR3 triggered the #DB

Thanks!

Thank you for your attention!

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The \LaTeX theme is available at github.com/matze/mtheme

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