History of debuggers

Credits of slides belong to Levente Kurusa <levex@linux.com>
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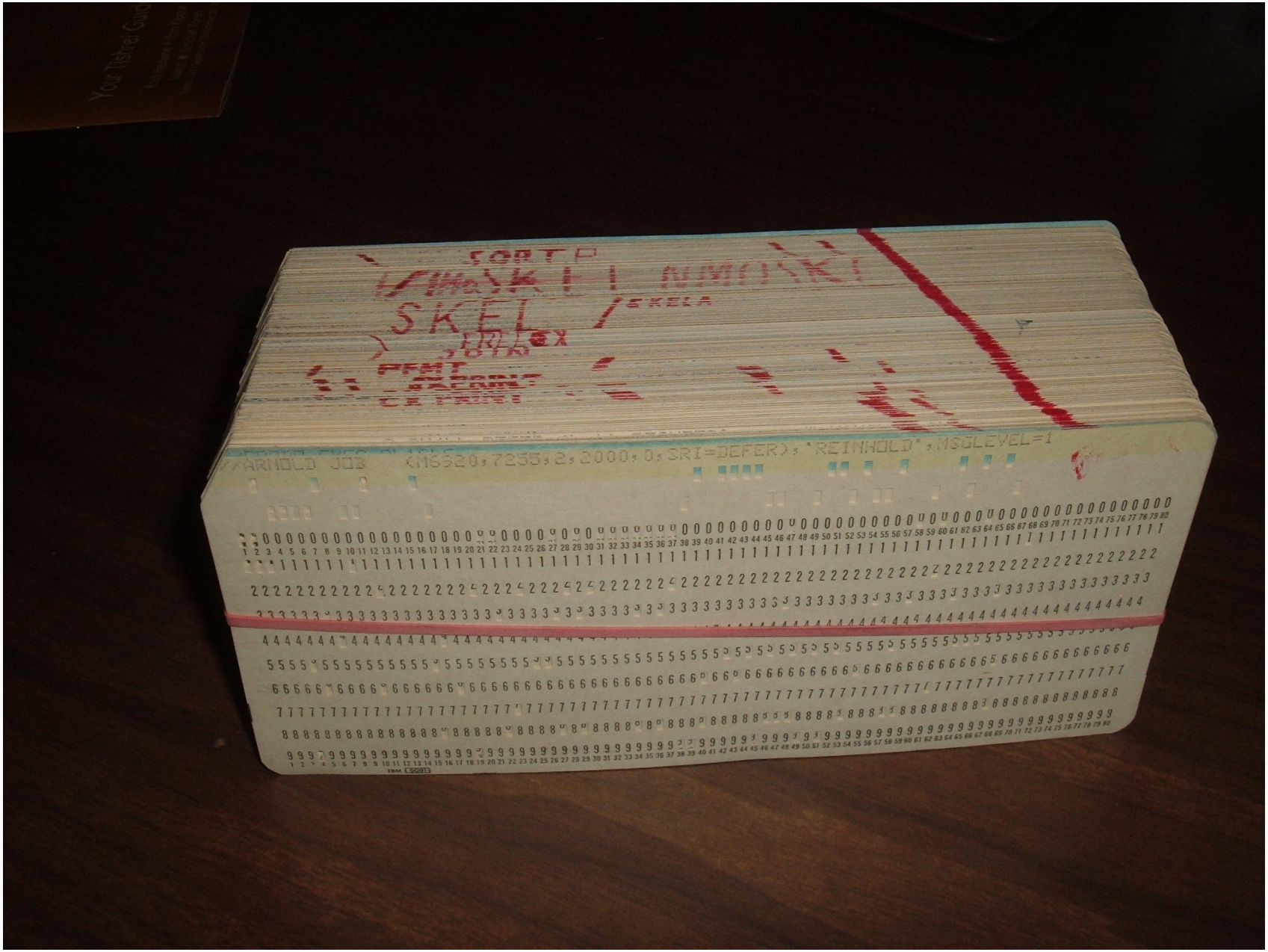
Single user machines

- 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



Batch processing machines

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

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

printf

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__);
```

Unix-es

- 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

ptrace

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`)

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- Run until system call
- Monitoring registers
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  - `PTRACE_PEEKTEXT / PTRACE_POKETEXT`
  - `PTRACE_PEEKDATA / PTRACE_POKEDATA`

Architectural support

Interrupting a process

`PTRACE_SINGLESTEP`

Interrupting a process

PTRACE_SINGLESTEP

%EFLAGS

Interrupting a process

PTRACE_SINGLESTEP

%EFLAGS.TF

Interrupting a process

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- After each instruction, trap into `#DB` interrupt
- The kernel delivers a `SIGTRAP`
- This fact is delivered via a wait-event to the debugger

Interrupting a process

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  - Triggers `#UD` – Undefined instruction exception
- `int $3` (machine code: `0xCC`)
  - Triggers `#BP` – Breakpoint exception

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- Replace with "`int $3`"
- Take note of the previous instruction
- When the breakpoint is hit, replace with the previous instruction
- Try executing the instruction again

Nota bene:

- Could have used "`ud2`"

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- `DR4` & `DR5`: Obsolete aliases to `DR6` & `DR7`