Programovanie v operačných systémoch

01 - syscalls, IO

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OS

HW intermezzo – interrupts

syscalls

HW intermezzo – IO

Input/Output

Filesystem

OS recap

Von Neumann architecture

- data and program in the same memory

OS:

- Process management
- Resource management
  - Memory
  - HW
- kernel vs userspace processes
  - kernel run with highest privileges
  - userspace process need to ask the kernel to perform some operations → syscall

Interrupts

- hardware
- software
  - ... used to "invoke OS functions"

- interrupt vector table

Invoking services in kernel - syscall

We need to

- pass parameters to kernel
- actually switch to kernel "process" / thread of execution

- software interrupt (0x80 linux, 0x23 win?)
- special instruction (`sysenter, syscall`)

Syscall example

```
write(1,"ahoj",5);
```

```
000000000040099e <main>:
...
  4009a2: ba 05 00 00 00        mov    $0x5,%edx
  4009a7: be 84 77 48 00        mov    $0x487784,%esi
  4009ac: bf 01 00 00 00        mov    $0x1,%edi
  4009b1: e8 da 1a 03 00        callq  432490 <__libc_write>
...
0000000000432490 <__libc_write>:
  432490: 83 3d 25 19 28 00 00  cmpl   $0x0,0x281925(%rip) #<__libc_multiple_threads
  432497: 75 14                 jne    4324ad <__write_nocancel+0x14>
0000000000432499 <__write_nocancel>:
  432499: b8 01 00 00 00        mov    $0x1,%eax
  43249e: 0f 05                 syscall
  4324a0: 48 3d 01 f0 ff ff     cmp    $0xfffffffffffff001,%rax
  4324a6: 0f 83 74 34 00 00     jae    435920 <__syscall_error>
  4324ac: c3                    retq
...
```

POSIX std / (g)libc (linux impl.)

- C functions for most calls
- `syscall` fallback - takes syscall number as argument
- `man syscalls` or `/usr/include/sys/syscall.h`

- return positive number on success (or just zero)
- negative number (-1) on errors
- real error code in global `errno` variable!

- not all POSIX calls map 1-1 to syscalls
- `openddir`, `readdir` vs `readdir`, `getdents`

HW communication

- IO ports
- memory mapped
- DMA

Input/Output kernel interface

- device independence
- uniform naming
- error handling, access control
- buffering
- synchronous (blocking) / asynchronous access

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- open, close, read, write, (seek, ioctl,...)
- file descriptor (handle)
- special device nodes in filesystem

Filesystem

- VFS (virtual filesystem)
- mounted "real" filesystems
- files
  - name, data, metadata
  - inode
  - `open (creat), close, read, write, stat, ...`
- directories ("folders")
  - list of entries (files, directories)
  - `open, close, readdir, getdents, ...`