CS 240
Computer Systems

#10: IPC and Networking

Sept. 28, 2021 · Wade Fagen-Ulmschneider

Threads vs. Processes

Up until now, we've discussed **threads** -- the fundamental unit of computation -- and we know they're organized into **processes**.

- Threads within a process share nearly **all** resources (exceptions are few, like the PC and their stack frames).
  AND
- Processes are almost _____ from other processes.

	Threads	Processes
Creation		
Overhead		
Context Switching		
Virtual Memory		

Case Study: Chrome

- On a given system with many tabs open, Chrome will have **dozens and dozens or processes**.
- Why?

Inter-Process Communication (IPC)

IPC is the broad terminology for all technologies that facilitate real-time communication between threads. Many approaches:

1. _____

Using a pipe within a terminal:

```
$ ps -aux | grep waf
```

Creating pipes in C:

```
int pipe(int pipefd[2]);
```

---

2. _____

Allocating shared memory in C ("malloc for shared memory"):

```
void *mmap(void *addr, size_t length, int prot, int
flags, int fd, off_t offset);
```

---

3. _____

Sending a signal within a terminal:

```
$ kill -TERM <pid>
```

Listing all available signals:

```
$ kill -l
```

Sending a signal in C:

```
int kill(pid_t pid, int sig);
```

Handling a Signal in C:

```
struct sigaction {
   void (*sa_handler)(int);
   ...
}
```

4. _____

Functions in C:

```
mqd_t mq_open(const char *name, int oflag);
int mq_send(mqd_t mqdes, const char *msg_ptr,
            size_t msg_len, unsigned int msg_prio);
ssize_t mq_receive(mqd_t mqdes, char *msg_ptr,
            size_t msg_len, unsigned int *msg_prio);
int mq_close(mqd_t mqdes);
```

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5. _____

...IPC is the strong use-case for semaphores and the only time I use them. (Other people's opinions vary. :))

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6. _____

Creating a new socket interface:

```
int socket(int domain, int type, int protocol);
```

Binding a socket interface to an address and port:

```
int bind(int sockfd, const struct sockaddr *addr,
         socklen_t addrlen);
```

Connecting to a remote socket:

```
int connect(int sockfd, const struct sockaddr *addr,
            socklen_t addrlen);
```

Begin listening for a remote socket connection:

```
int listen(int sockfd, int backlog);
```

Start a new socket channel with a remote host:

```
int accept(int sockfd, struct sockaddr *restrict addr,
           socklen_t *restrict addrlen);
```

Networking

Q: What do we expect out of networking?

...making this happen is **insanely complex**:

Hosts Routers Links Applications	Protocols Hardware Software Bit Errors	Packet Errors Link Failures Node Failures Message Delays	Out-of-Order Packets Eavesdropping ...and more...

We define common _____ -- a message format and rules for exchanging messages. You know many protocols already:

Network Packets

At the core, network data is simply a series of **0**s and **1**s, which we represent in hex. (You can view all of the network packets on your VM using `` `tcpdump -x` ``.) For example, here one of many packets used in a request for me to view **`waf.cs.illinois.edu`**:

```
00  4500 00c6 1e1f 4000  4006 152e ac16 b24c
10  12dc 95a6 bafa 0050  0f60 c9b4 356a 523f
20  8018 01f6 079e 0000  0101 080a 8146 30a0
30  31d4 daac 4745 5420  2f20 4854 5450 2f31
40  2e31 0d0a 5573 6572  2d41 6765 6e74 3a20
50  5767 6574 2f31 2e32  302e 3320 286c 696e
60  7578 2d67 6e75 290d  0a41 6363 6570 743a
70  202a 2f2a 0d0a 4163  6365 7074 2d45 6e63
80  6f64 696e 673a 2069  6465 6e74 6974 790d
90  0a48 6f73 743a 2077  6166 2e63 732e 696c
a0  6c69 6e6f 6973 2e65  6475 0d0a 436f 6e6e
b0  6563 7469 6f6e 3a20  4b65 6570 2d41 6c69
c0  7665 0d0a 0d0a
```