Lecture 21 (18 November 2014)
Authors: Hillary Do, Peter Kraft, Alex Sedlack, Michael Farrell

Signals (HD)

- Move from shell programming to network programming
- Waittimeout.c : first attempt to run a loop until time elapsed(.75 seconds) or exit loop, whichever comes first
- Flaw of code
    - Bad utilisation because it uses polling
- Utilisation is general metric that can be applied to any system
    - Fraction of some resource devoted to useful work
    - Bigger numbers are better - want high utilisation
    - Utilisation = value between 0 and 1
    - Problem: *who decides what's useful?*
- CPU: 98% utilised
    - Who knows what's useful?
    - Eddie: not useful because knows what code does (Tight loop)
    - Kernel: what is useful / not useful
        - Useful work is when process is running
        - Purpose of kernel: perform work on behalf of processes
        - Even though it may be using a lot of the computer, we may know it is not useful even though the kernel may think it is useful
        - Kernel normally doesn't look into a process to determine if the work is useful
- Blocking: increase utilisation by getting rid of useless work
    - Introduces race conditions
- Waitblock: parent process deliver signal when child process dies
    - Signal: wake up any blocked system call (slow system call)
    - Better to sleep and then wait for an interrupt because sleep won't use the CPU
    - Use system to call to do blocking, in this case, sleeping
    - wait for child to print status
    - waitblock not using CPU -> less useless work
    - Where is the race condition [bug] (scheduling leads to incorrect outcome) in the code?
        - child exits -> parent exits or child goes past x milliseconds, and parent exits at x milliseconds
        - A: child exits right before sleeping (sleep won't be interrupted)
- Sleep-Wakeup Race
    - Wake up (stop blocking) when a signal arrives. However, if signal arrives before program sleeps, program will sleep for a very long time (race condition). Solution is to use sigblock, which blocks signals temporarily, then delivers them after process is unblocked. Leaves a race condition after unblocking, but a much less dangerous one.
- Atomic Code: executes indivisibly without interruption

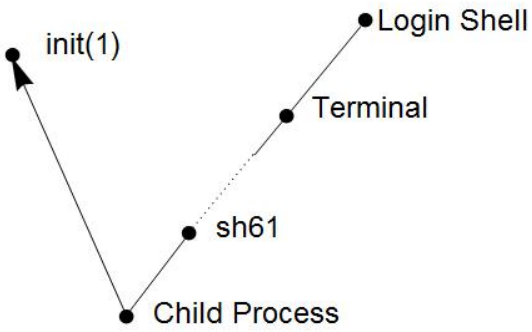
    - Two things are atomic if they execute as a unit without interruption
- *What if signal runs and then process sleeps?*
    - can only send signal when process is asleep, how to fix?
        - however can't do it with linux. Kernel programming doesn't let us disable interrupts forever
        - sigblock: blocks signals
            - *every process must be killed
            - use: block, then unblock signal before we sleep
- Fork only after wake
- Sigblock(int mask): While a signal is block, it will not be delivered, when it is unblocked it will be delivered except every process can always be killed
- select (slow system call): will get woken up after delivery of signal (pselect)
    - generic way to go to sleep for specific amount of time
    - Use pselect -> takes in a signal mask, atomically unblocks a set of signals and sleeps, combines checking for an event and going to sleep in a single operation
    - waitblock safe uses a pipe to solve this problem
    - takes in sig mask: unblock signals and sleeps
        - solves sleep wake up race by combining unblock (checking for event) and going to sleep into one atomic operation
        - can block until file system descripter is readable

        Bad code:

        ```
        if (event_not_happen)
                block forever();
        ```

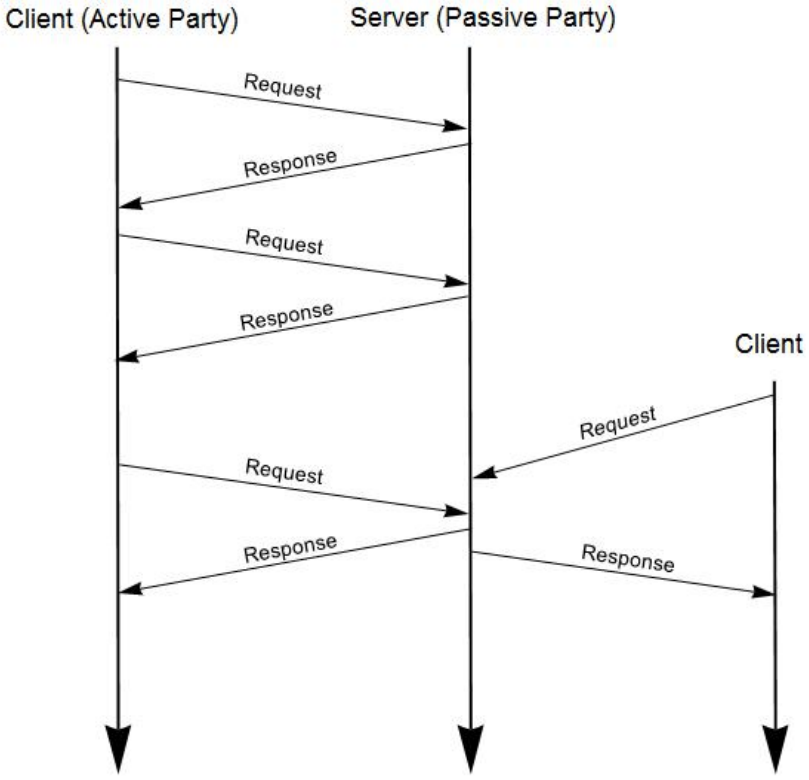
        Good code:

        ```
        set up foreground pipeline
        put fgpl in foreground;
        if (SIGINT)
                kill fg pipeline
        wait for fgpl
        ```
- What's a zombie process?
    - *nix guarantees that when a process dies, its parent can recover its final status (through waitpid). A zombie process has died, but its parent has not waited yet, so it's resources are still taking up memory
    - Expect to collect zombie processes; call wait for every child
    - Shell forks child, and parent dies -> Somebody has to wait for the child
    - init(1) -> parent dies child becomes a child of init and it loops and waits for child
    - Pstree- >shows all processes and their parents



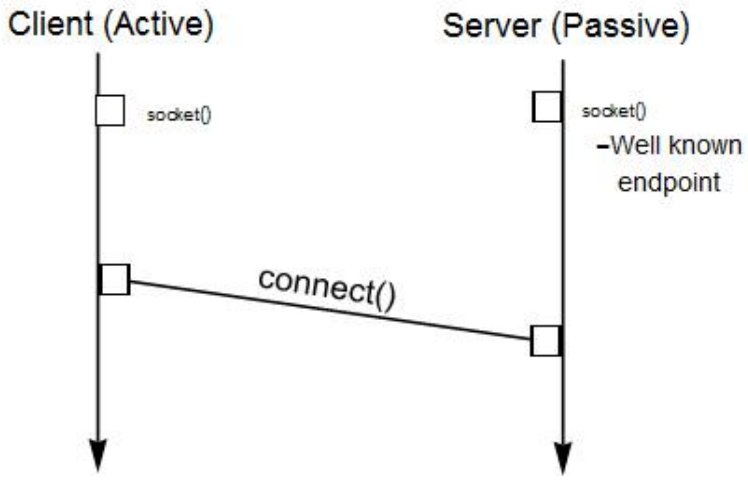
Networking: Client-Server Programming

- Message Sequence Diagram
    - time moves down
    - client = active party (sends request)
    - server = passive party (not actively contacting clients, waits for client contact)
    - client makes request -> server responds



- port 80: reserved for unencrypted web servers
- port 443: encrypted web servers
- Seems similar to a pipe but isnt a pipe
- For pipes, need parents to create parent shell before children are forked off
- To open communication, client & server need to

    - 1. each create socket
    - 2. client & server agree to create sockets (system call - connect)



- Telnet: 2 direction interactive text connection
- Need a file descriptor to represent a future channel: Socket
    - Creates an endpoint for communication
- A network file descriptor
- Client and server create sockets, and then connect binds them together
- Server must be a well known endpoint
    - To avoid race conditions, we do not use the listening socket for connections
    - Instead we use accept(listenfd)
        - Accept takes in a listenfd and returns a new fd for the connection
        - Connected socket is bound to the clients socket
    - Bad design of having serial number because when you change computers the number changes
- Telnet is very insecure, anyone can tell what you're typing, uses it to keep open
- Denial of service attack: when a user tries to make a network resource unavailable to other users