Packet Sniffing and Spoofing

Lecture 02

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Packet Sniffing

- ***Packet sniffing***: *capturing* live data as they flow across network
  1. understand network characteristics (administrator)
  2. diagnose faulty networks and configurations (administrator)
  3. reconnaissance and exploitation (attackers)

Packet Sniffing

- ***Packet sniffing***: capturing live data as they flow across network

1. understand network characteristics (administrator)
   - network traffic analysis
     - bandwidth usage; traffic pattern; protocol distribution
   - performance monitoring
     - latency; packet loss; retransmissions
   - etc.
2. diagnose faulty networks and configurations (administrator)
3. reconnaissance and exploitation (attackers)

Packet Sniffing

- ***Packet sniffing***: *capturing* live data as they flow across network

1. understand network characteristics (administrator)
2. diagnose faulty networks and configurations (administrator)
   - identifying connectivity issues
     - dropped packets; delay; route tracing
   - Etc.
3. reconnaissance and exploitation (attackers)
   - reconnaissance
     - gathering information; identifying services; unencrypted data
   - exploitation
     - session hijacking; man-in-the-middle attack; password sniffing

Packet Sniffing

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Packet Sniffing

- ***Packet sniffing***: *capturing* live data as they flow across network
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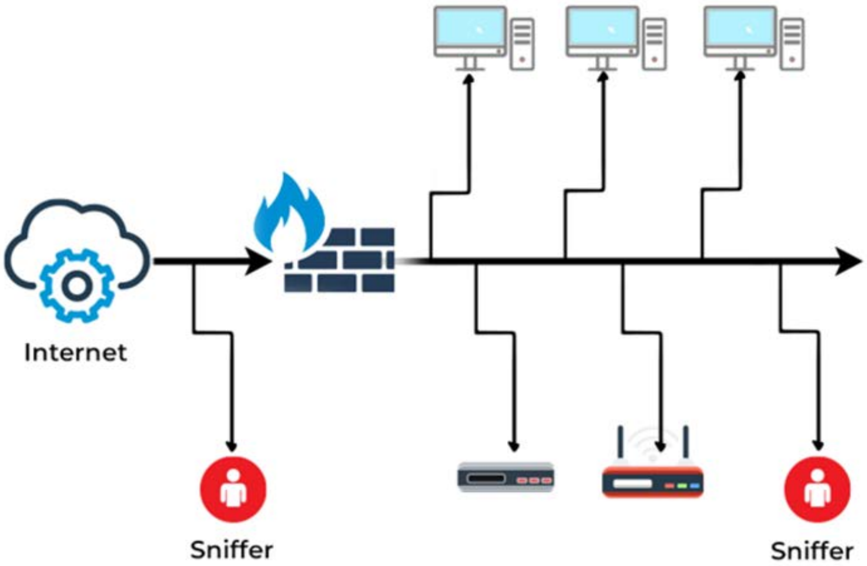
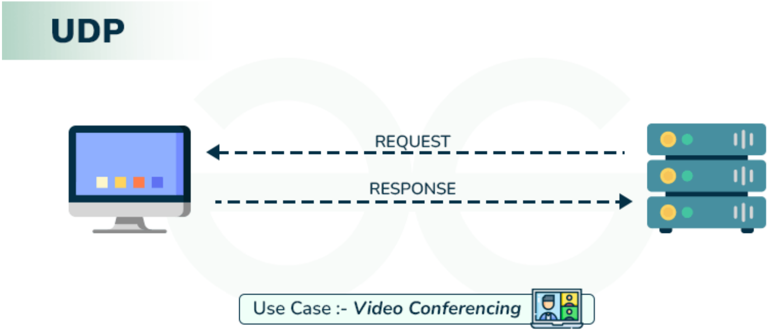
- packet sniffing tools
  ||
  packet sniffers



Receiving Packets Using Sockets

- How program normally receiving packets?
  - A UDP server program:
    1. *Socket Creation*: The program creates a network socket, which serves as an endpoint for sending and receiving data.
    2. *Binding*: The socket is bound to a specific IP address and port number, enabling the program to listen for incoming packets on that address and port.
    3. *Listening*: The program puts the socket into listening mode, waiting for incoming connections or packets.
    4. *Receiving Packets*: When packets arrive, the program receives them through the socket using functions.

Receiving Packets Using Sockets (udp_server.c)



- A UDP server program

create socket

```
// Step ①
int sock = socket(AF_INET, SOCK_DGRAM, IPPROTO_UDP);
```

return socket descriptor

socket type (e.g., datagram socket)

protocol type (e.g., UDP)

protocol family (e.g., IPv4)

provide information about server

```
// Step ②
memset((char *) &server, 0, sizeof(server));
server.sin_family = AF_INET;
server.sin_addr.s_addr = htonl(INADDR_ANY);
server.sin_port = htons(9090);

if (bind(sock, (struct sockaddr *) &server, sizeof(server)) < 0)
    error("ERROR on binding");
```

fill a block of memory with a particular value

assigns a local protocol address (IP + port #) to a socket

receive packets

```
// Step ③
while (1) {
    bzero(buf, 1500);
    recvfrom(sock, buf, 1500-1, 0,
               (struct sockaddr *) &client, &clientlen);
    printf("%s\n", buf);
}
```

erase data in buf (1,500 bytes)

- ref.: https://www.tutorialspoint.com/unix_sockets/socket_core_functions.htm

Packet Sniffing Using Raw Sockets

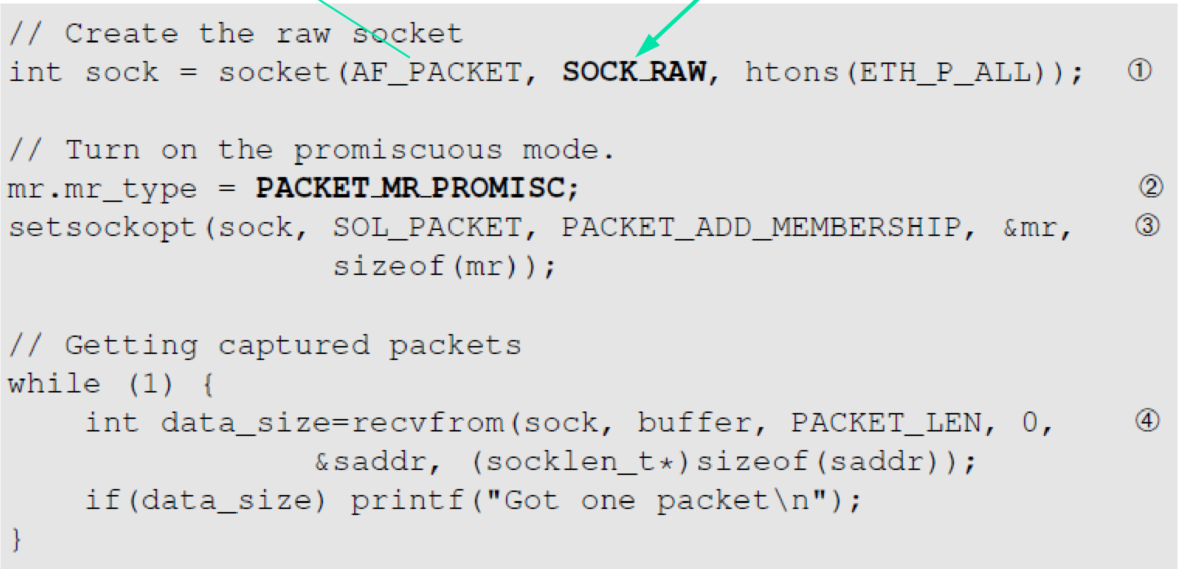
- "***Issue***" in the previous program: receiving packets that are *intended* for it
  - if the *des. IP addr.* or the *des. port #* is ***not matching***, no packets are captured
- What we want: capturing ***ALL*** packeting flowing on the cable, regardless of *des. IP addr.* or *des. port #*
  - ***raw socket***
    - allows access to the underlying transport provider
    - allows user to send and obtain packets of information from the network without interacting with OS

Packet Sniffing Using Raw Sockets

- Packet capture using ***raw socket***
  - other than setting up raw socket, the rest of the program is similar to normal socket program

protocol family (e.g., IPv4)

creating a ***raw socket***



```
// Create the raw socket
int sock = socket(AF_PACKET, SOCK_RAW, htons(ETH_P_ALL));   ①

// Turn on the promiscuous mode.
mr.mr_type = PACKET_MR_PROMISC;                             ②
setsockopt(sock, SOL_PACKET, PACKET_ADD_MEMBERSHIP, &mr,    ③
                 sizeof(mr));

// Getting captured packets
while (1) {
    int data_size=recvfrom(sock, buffer, PACKET_LEN, 0,     ④
                &saddr, (socklen_t*)sizeof(saddr));
    if(data_size) printf("Got one packet\n");
}
```

- normal socket

  kernel receives packet
  ↓
  pass packet via protocol stack
  ↓
  pass to applications

- raw socket

  kernel receives packet
  before passing to protocol stack ↓
  pass a ***copy*** of packet to socket

Packet Sniffing Using Raw Sockets

- Packet capture using ***raw socket***
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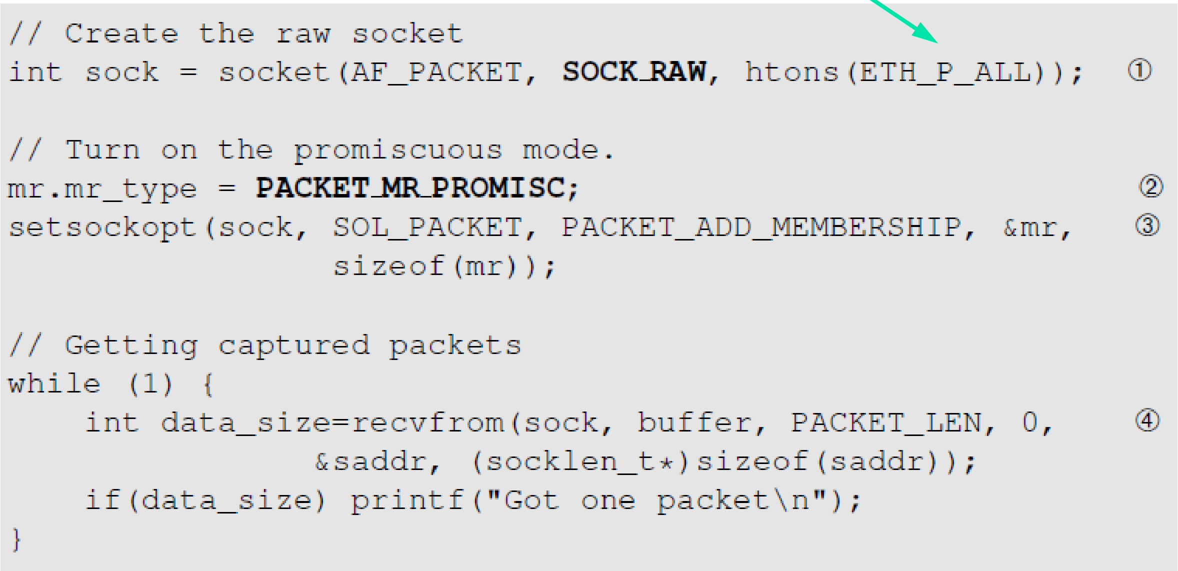
capture all types of packets (or all protocols)



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```

- for raw socket, need to specify the type of packets to receive
- protocol is specified the third arg of socket()
- *htons*(ETH_P_ALL)
  - packets of all protocols should be passed to socket
- *htons*(ETH_P_IP)
  - only IP packets will be passed to socket

Packet Sniffing Using Raw Sockets

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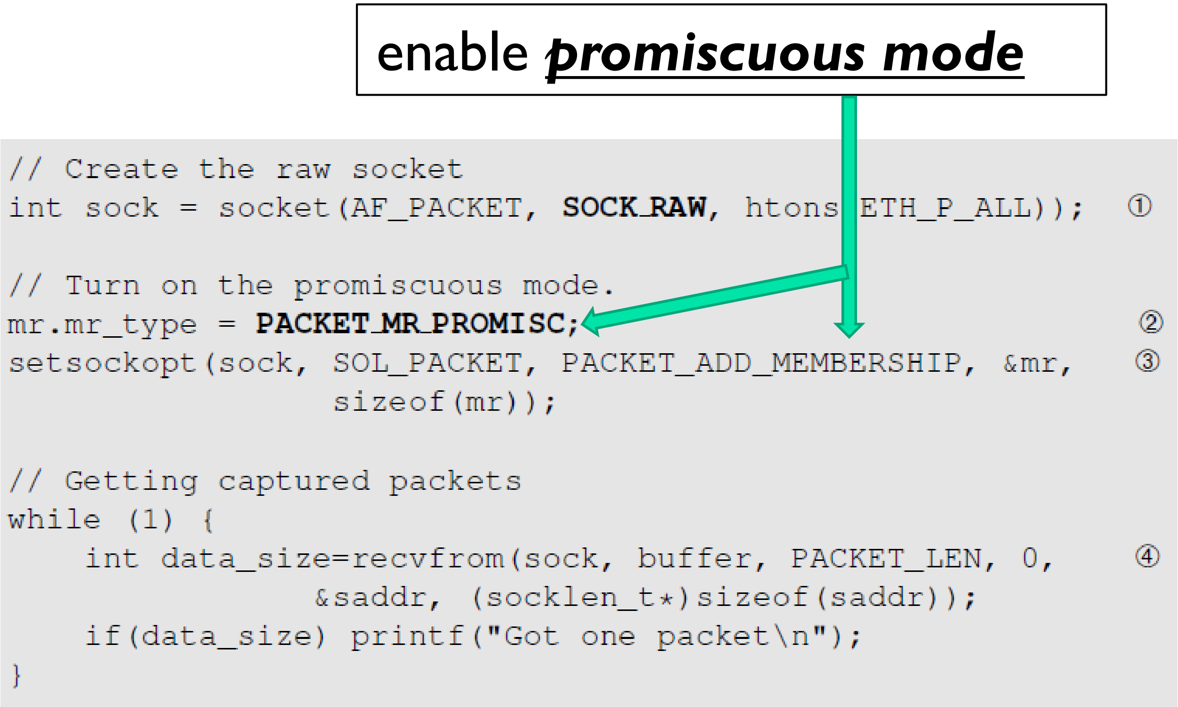

enable ***promiscuous mode***

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}
```

- get all packets coming to computer
- but if packets are not destined for us
  - cannot be captured
- turn on *promiscuous mode*
  - let in all packets on network
  - once they are in, we can get copy

Packet Sniffing Using Raw Sockets

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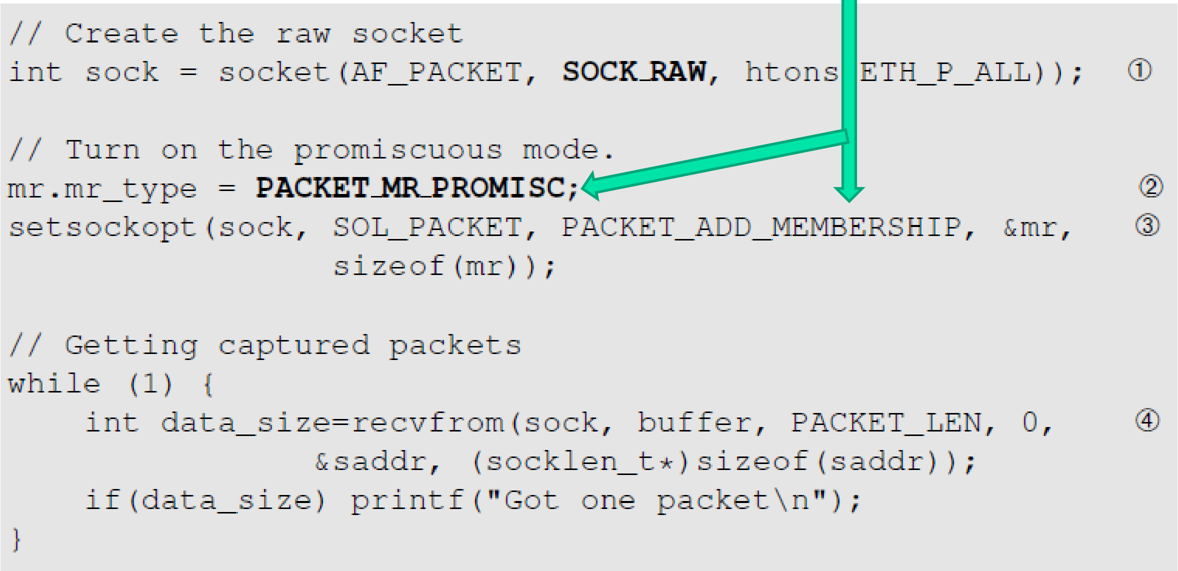
enable ***promiscuous mode***



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```

- PACKET_MR_PROMISC
  - enables receiving all packets on a shared medium (often known as "promiscuous mode")
- PACKET_ADD_MEMBERSHIP
  - to receive all frames, regardless of destination

Packet Sniffing Using Raw Sockets

- Packet capture using ***raw socket***
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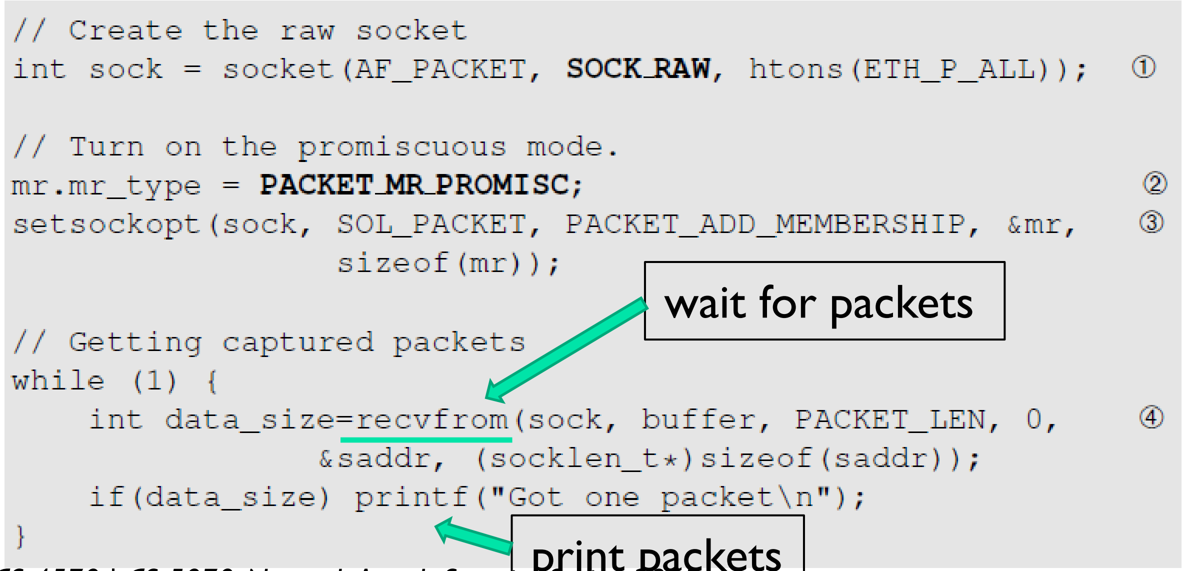
setsocketopt(): set up filters

- SO_ATTACH_FILTER option (for BPF)



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}
```

wait for packets

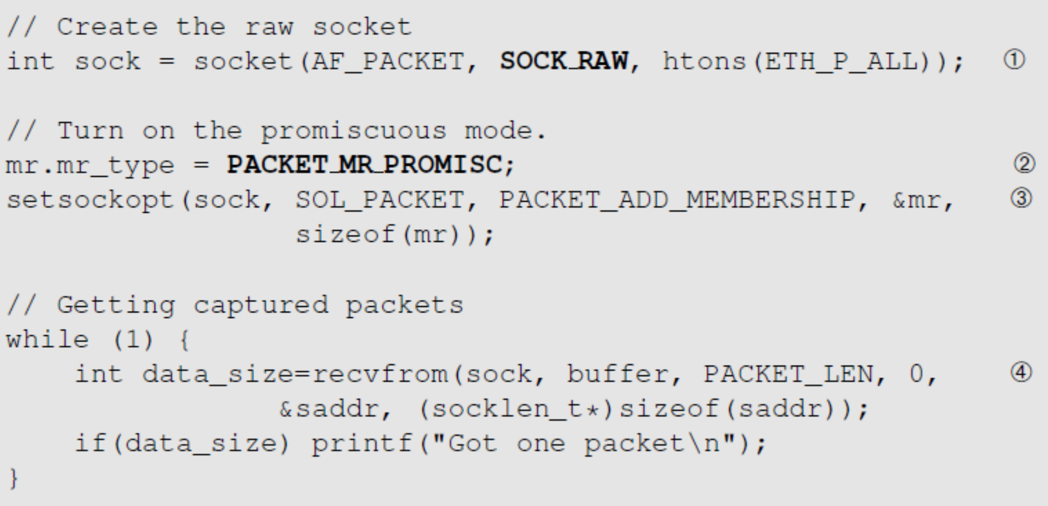
print packets

- setsocketopt():
  - set options for a socket
  - allows you to control various socket behaviors

```
int setsockopt(
   int s, // socket descriptor
   int level, // socket level
   int optname,
   char *optval,     } // socket option
   int optlen
)
```

Packet Sniffing Using Raw Sockets (sniff_raw.c)

- Summary: four major steps
  1. creating raw socket
  2. choose protocol
  3. enable promiscuous mode
  4. wait for packets



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setsockopt(sock, SOL_PACKET, PACKET_ADD_MEMBERSHIP, &mr,     ③
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// Getting captured packets
while (1) {
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                   &saddr, (socklen_t*)sizeof(saddr));
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}
```

Note:

- First, create a socket using a special socket type called SCOK_RAW.
- Second, specify what type of packet (i.e., ETH_P_ALL, ETH_P_IP) to receive.
- Third, turn on the promiscuous mode (i.e., PACKET_ADD_MEMBERSHIP, PACKET_MR_PROMISC) on the network interface card to let in all packets on the network.
- Fourth, wait for packets to arrive using recvfrom(…)

Packet Sniffing Using pcap API

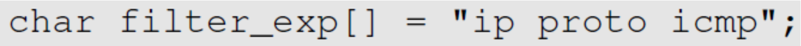
- ***pcap*** (**pa**cket **cap**ture) API provides *platform-independent interface* for accessing packets
  - specify *filtering rules* using Boolean expr.
  - translate Boolean expr. to BPF pseudo-code (used by kernel)
  - pcap API is implemented in
    - Unix as libpcap
    - Windows as WinPcap
    - Linux using raw sockets
  - *ref.*: https://www.tcpdump.org/pcap.html

Packet Sniffing Using pcap API (cont.)

ICMP (Internet Control Message Protocol) packets:

- used for network diagnostics and error-reporting

- E.g., capturing all ICMP packets using pcap
  - *goal*: print out "Got a packet" msg. once a packet is captured

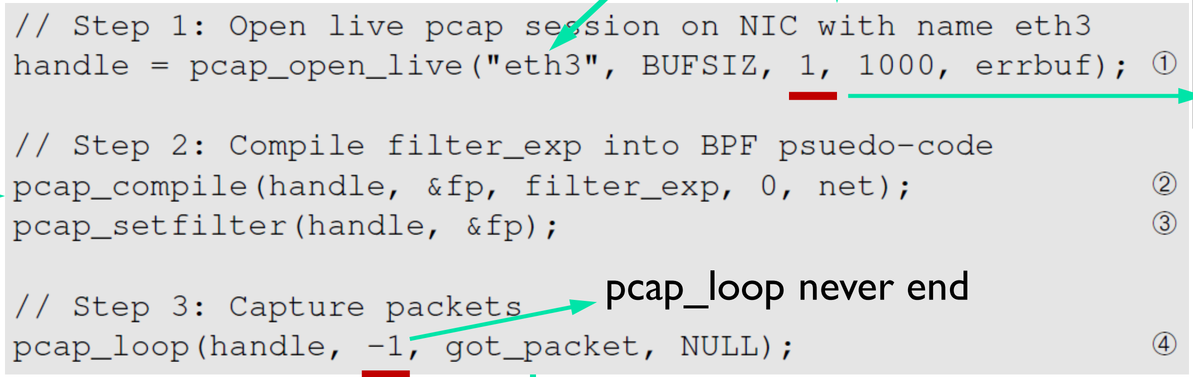


```
char filter_exp[] = "ip proto icmp";
```

network device name (*ifconfig* command to find out)

initialize raw socket, set NIC into promiscuous mode.

filter



```
// Step 1: Open live pcap session on NIC with name eth3
handle = pcap_open_live("eth3", BUFSIZ, 1, 1000, errbuf);  ①

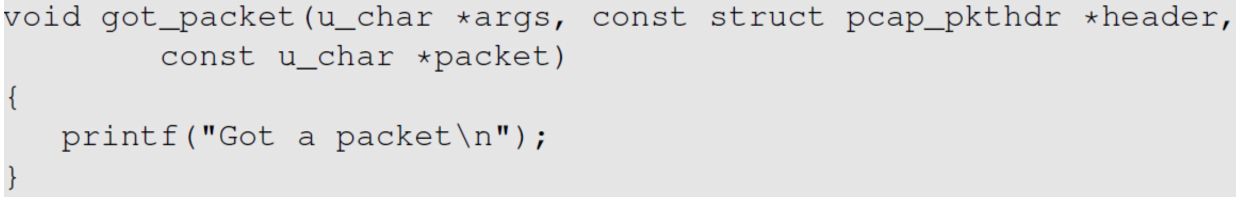
// Step 2: Compile filter_exp into BPF psuedo-code
pcap_compile(handle, &fp, filter_exp, 0, net);             ②
pcap_setfilter(handle, &fp);                               ③

// Step 3: Capture packets
pcap_loop(handle, -1, got_packet, NULL);                   ④
```

pcap_loop never end

char filter_exp[] = "ip proto icmp";

invoke this function for every captured packet



```
void got_packet(u_char *args, const struct pcap_pkthdr *header,
        const u_char *packet)
{
   printf("Got a packet\n");
}
```

Packet Sniffing Using pcap API (cont.)

- E.g., capturing all ICMP packets using pcap
  - *goal*: print out "Got a packet" msg. once a packet is captured
  - three steps:
    1. Open live pcap session: pcap_open_live(…)
       - initialize raw socket; set network device (e.g., 'enp0s3') into promiscuous mode (i.e., '1'); binds socket to the card using setsockopt(…)
    2. Set the filter: pcap_compile(…) and pcap_setfilter(…)
       - compile the specified filter exp.; set the BPF filter on the socket
    3. Capture packets: pcap_loop()
       - enter the main execution loop of pcap session
  - Compilation: $ gcc -o sniff sniff.c **-lpcap**

all letters