

UE18CS335 – COMPUTER NETWORK SECURITY

Assignment – 4 REMOTE DNS CACHE POISONING ATTACK

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Objective: - To understand the remote DNS cache poisoning attack, also called the Kaminsky DNS attack.

Lab Setup: Attacker VM: 10.0.2.5 ; Victim VM: 10.0.2.4 ; DNS Server VM: 10.0.2.14

TASK 1: CONFIGURE THE LOCAL DNS SERVER

Step 1: Configure the BIND9 Server.

Step 2: Turnoff DNSSEC

Step 3: Fix the Source Ports

```
named.conf.options
/etc/bind

options {
    directory "/var/cache/bind";

    // If there is a firewall between you and nameservers you want
    // to talk to, you may need to fix the firewall to allow multiple
    // ports to talk.  See http://www.kb.cert.org/vuls/id/800113

    // If your ISP provided one or more IP addresses for stable
    // nameservers, you probably want to use them as forwarders.
    // Uncomment the following block, and insert the addresses replacing
    // the all-0's placeholder.

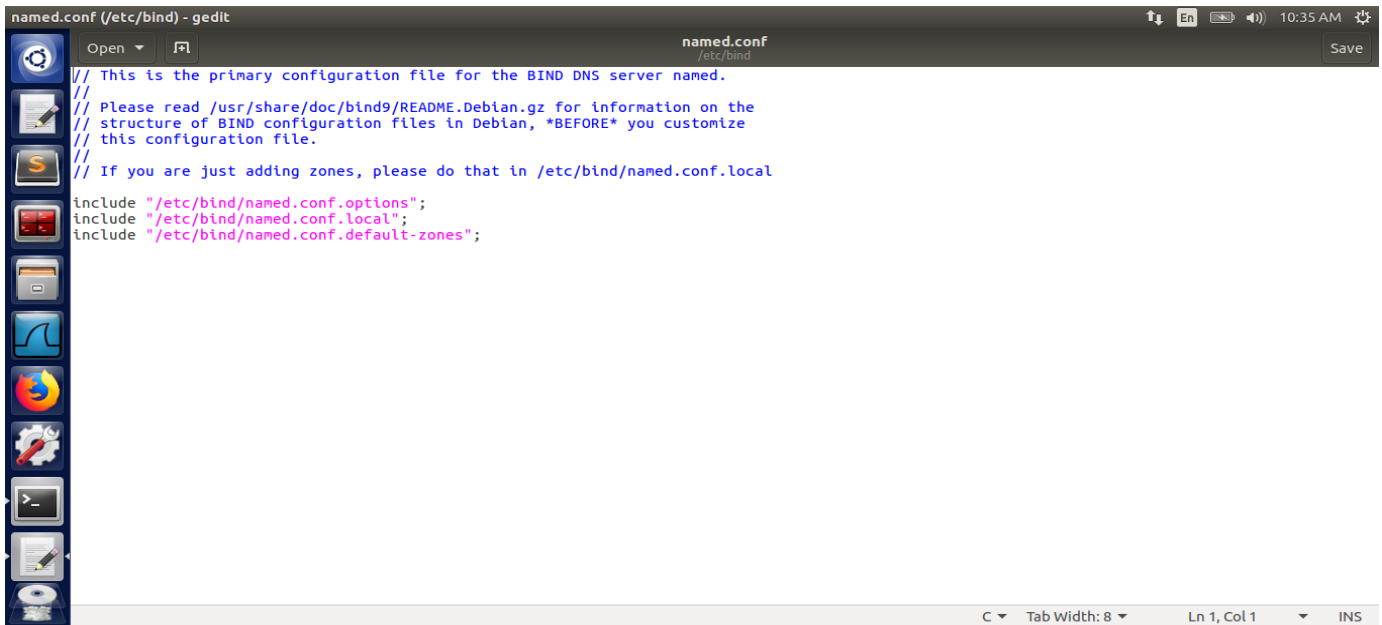
    // forwarders {
    //     0.0.0.0;
    // };

    //=====
    // If BIND logs error messages about the root key being expired,
    // you will need to update your keys.  See https://www.isc.org/bind-keys
    //=====
    // dnssec-validation auto;
    dnssec-enable no;
    dump-file "/var/cache/bind/dump.db";
    auth-nxdomain no;    # conform to RFC1035

    query-source port 33333;
    listen-on-v6 { any; };
};
```

SCREENSHOT SHOWING THE CONFIGURATIONS MADE TO named.conf.options FILE

Step 4: Remove the example.com zone



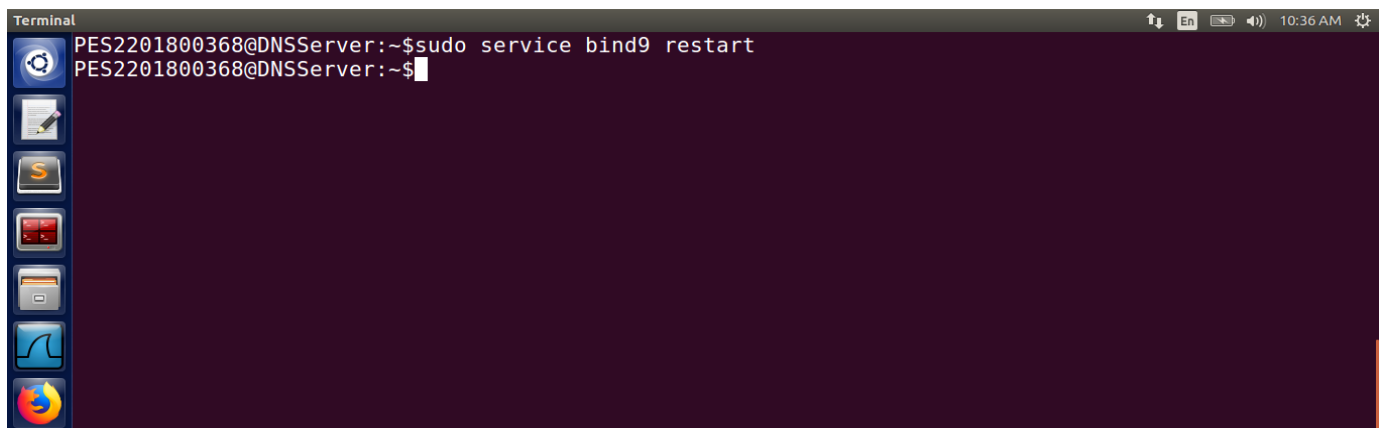
```
named.conf (/etc/bind) - gedit
named.conf
/etc/bind
Save

// This is the primary configuration file for the BIND DNS server named.
//
// Please read /usr/share/doc/bind9/README.Debian.gz for information on the
// structure of BIND configuration files in Debian, *BEFORE* you customize
// this configuration file.
//
// If you are just adding zones, please do that in /etc/bind/named.conf.local
include "/etc/bind/named.conf.options";
include "/etc/bind/named.conf.local";
include "/etc/bind/named.conf.default-zones";

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```

SCREENSHOT SHOWING THE named.conf FILE AND THE example.com ZONE REMOVED

Step 5: Start DNS server

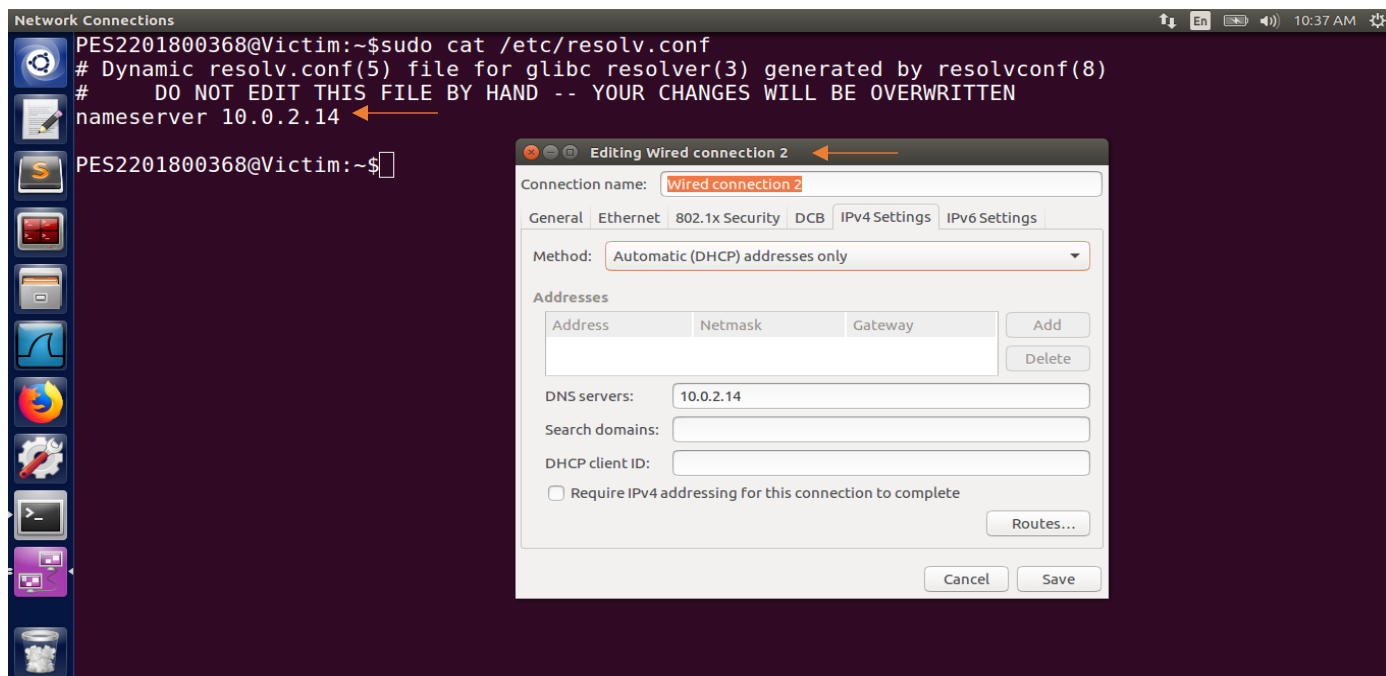


```
Terminal
PES2201800368@DNSServer:~$sudo service bind9 restart
PES2201800368@DNSServer:~$
```

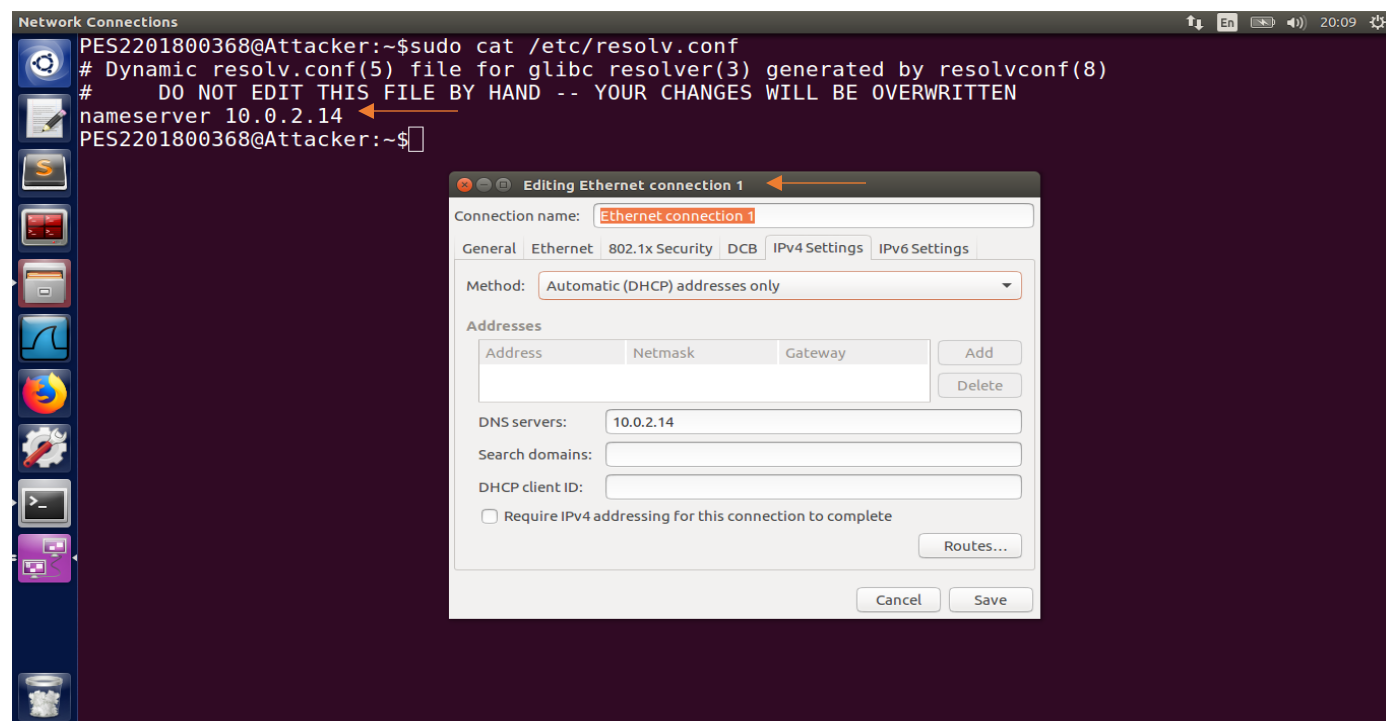
SCREENSHOT SHOWING THE SERVER RESTART

TASK 2: CONFIGURE THE VICTIM AND ATTACKER MACHINE

1. Open Edit Connection
2. Select IPv4 Settings
3. Choose Method as Automatic (DHCP) addresses only
4. Enter the IP Address of YOUR DNS Server in the DNS server field



SCREENSHOT SHOWING THE VICTIM MACHINE CONFIGURATION



SCREENSHOT SHOWING THE ATTACKER MACHINE CONFIGURATION

TASK 3.1 THE KAMINSKY ATTACK

Objective: To redirect the user to another machine B when the user tries to get to machine A using A's host name.

The Kaminsky attack:

We configure the attacker machine, so it uses the targeted DNS server as its default DNS Server as its default DNS server. The attacker machine is on the same NAT network.

Task 1.1: Spoofing DNS Request

In this task, we will spoof DNS Requests that trigger the target DNS server to send out DNS queries, so we can spoof DNS replies.

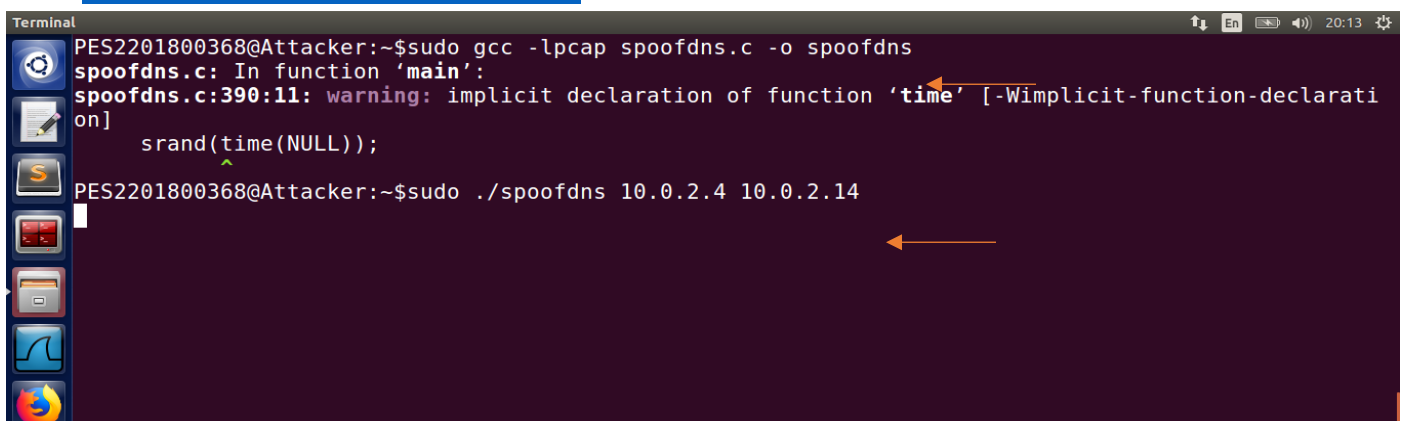
Task 1.2: Spoofing DNS Replies

In this task, we will spoof DNS Responses to the local DNS Server for each query. We will create a DNS Header with DNS Payload with the Answer, Authority and Additional section. The answer section will give the IP address of the query domain, the authoritative section fills the authoritative nameserver for the query domain. So, after the attack is successful, any query with the domain name will be directed to the Attacker's nameserver "**ns.dnslabattacker.com**".

The C Code for both the above tasks have been included in the file named spoofdns.c and is run as a part of the attack from the Attacker VM. The two files can however be separated as request and response with a small correction made in the 'while' loop which sends out responses. The line while(count<100) sends out 100 spoofed responses; in the request file this can be set to while(count<0) thereby making it never execute during the request and for the response file it can be retained as while(count<100) and run.

The C Code along with the comments for all the steps can be found here:

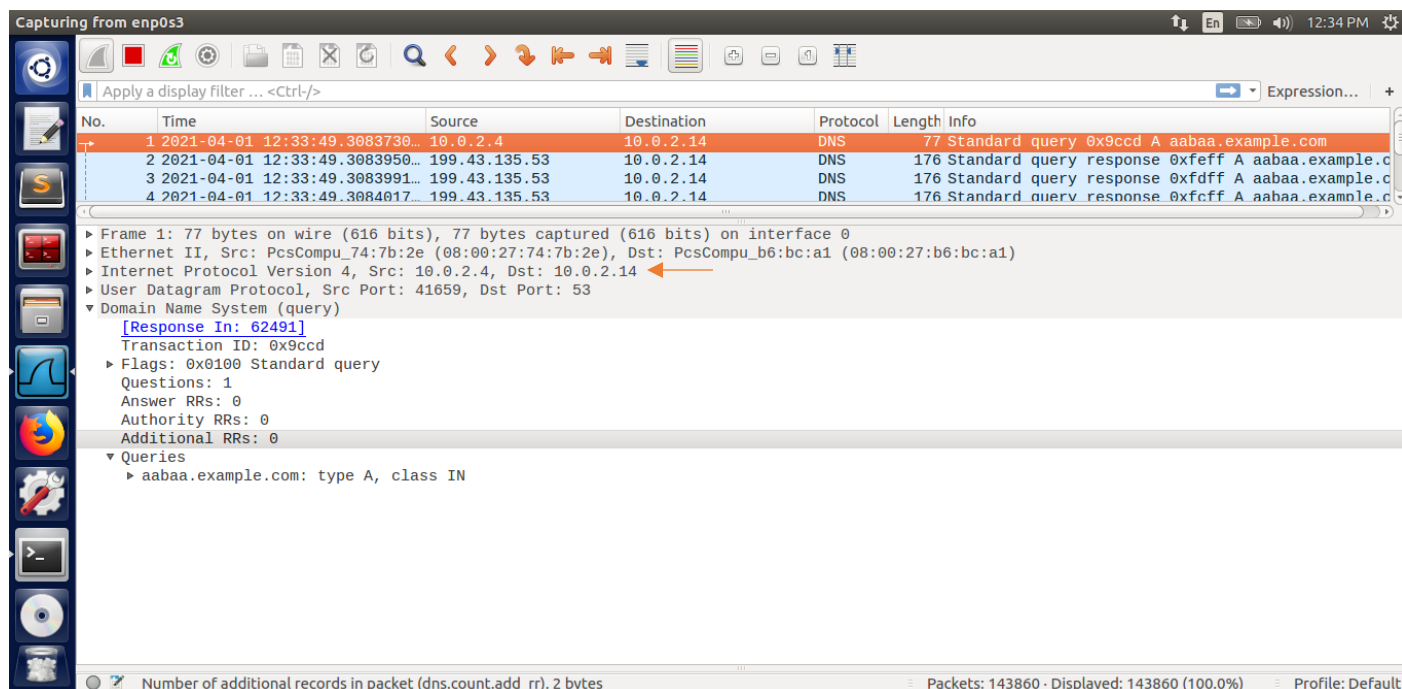
https://drive.google.com/drive/folders/1CfGykfgH0GAVO-6CvomH2vi_P6S_teDx?usp=sharing



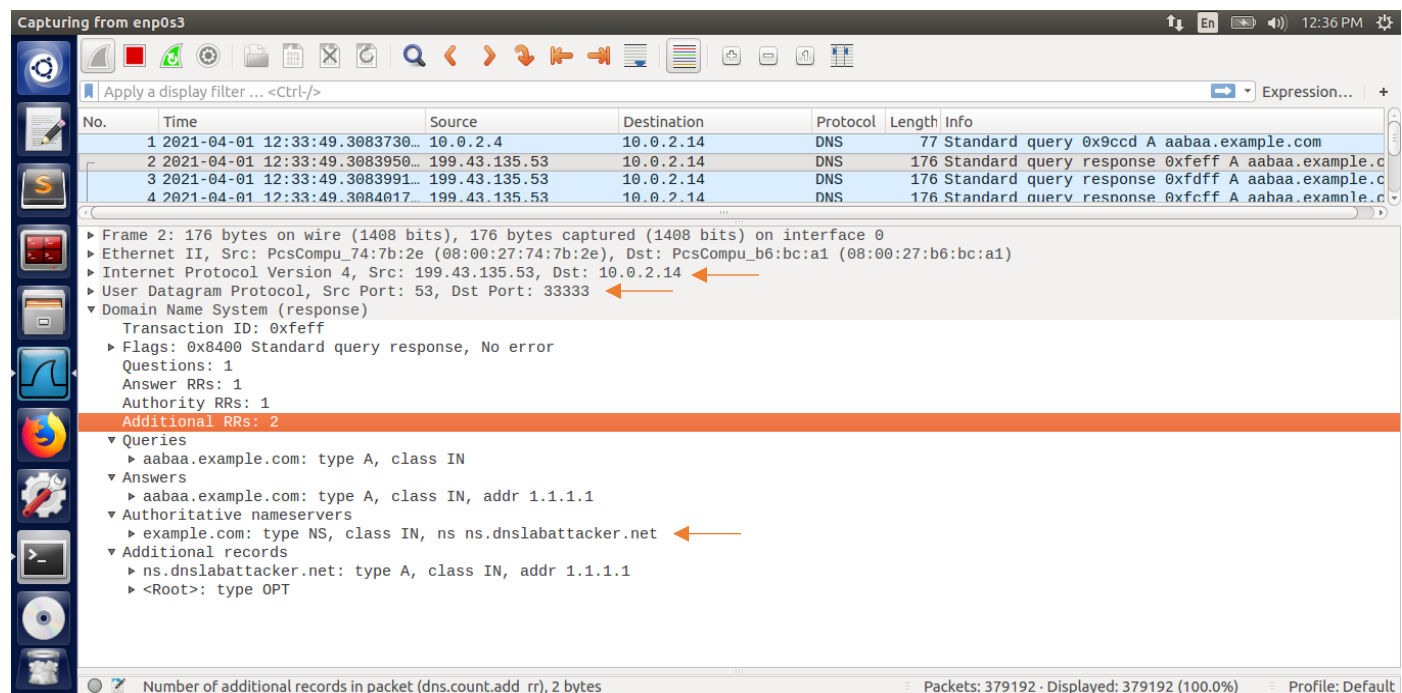
```
Terminal
PES2201800368@Attacker:~$sudo gcc -lpcap spoofdns.c -o spoofdns
spoofdns.c: In function 'main':
spoofdns.c:390:11: warning: implicit declaration of function 'time' [-Wimplicit-function-declaration]
    srand(time(NULL));
           ^
PES2201800368@Attacker:~$sudo ./spoofdns 10.0.2.4 10.0.2.14
```

SCREENSHOT SHOWING THE RUNNING OF THE ATTACK FROM THE ATTACKER VM

WIRESHARK CAPTURE WHEN THE ATTACK IS RUNNING:



WIRESHARK CAPTURE SHOWING THE INITIAL DNS REQUEST GOING FROM THE VICTIM MACHINE(10.0.2.4) TO THE DNS SERVER MACHINE(10.0.2.14)



WIRESHARK CAPTURE SHOWING THE AUTHORITATIVE NAMESERVER AS ns.dnslabattacker.com(malicious site) FOR example.com SENT AS A SPOOFED RESPONSE TO THE DNS SERVER SO THAT THE RESPONSE IS CACHED

TASK 3.2: THE KAMINSKY ATTACK

Aim: - To combine the above two tasks to perform Kaminsky Attack.

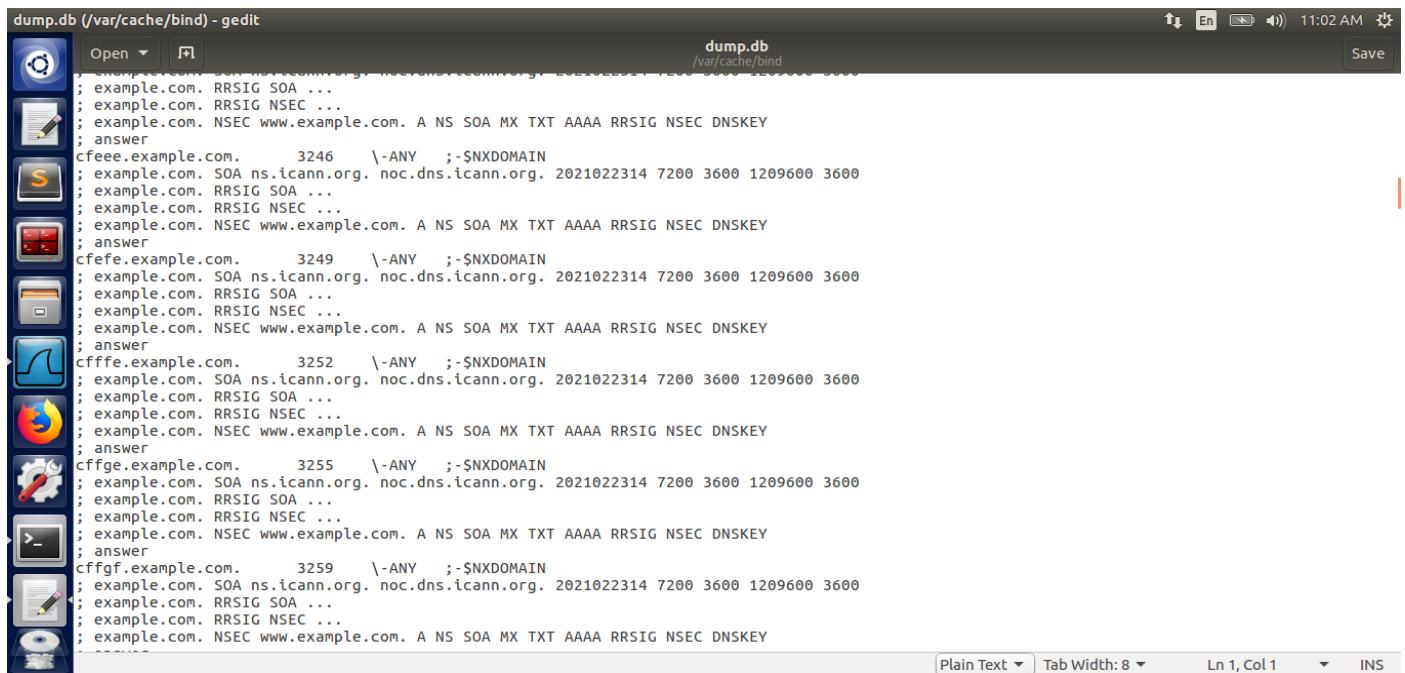
Check the DNS Cache in the DNS server machine



A terminal window titled 'Terminal' with a dark purple background. The prompt is 'PES2201800368@DNSServer:~\$'. Two commands are entered: 'sudo rndc dumpdb -cache' and 'sudo gedit /var/cache/bind/dump.db'. An orange arrow points to the second command. The system clock in the top right corner shows 10:58 AM.

```
PES2201800368@DNSServer:~$sudo rndc dumpdb -cache
PES2201800368@DNSServer:~$sudo gedit /var/cache/bind/dump.db
```

SCREENSHOT SHOWING THE COMMANDS TO CHECK THE CONTENTS OF THE CACHE



A screenshot of the gedit text editor window titled 'dump.db (/var/cache/bind) - gedit'. The window shows the contents of the DNS cache dump, which is a list of DNS records for 'example.com'. The records include RRSIG, NSEC, and NSEC3 records. The system clock in the top right corner shows 11:02 AM.

```
example.com. RRSIG SOA ...
example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
; answer
cfeee.example.com. 3246 \-ANY ;-$NXDOMAIN
; example.com. SOA ns.icann.org. noc.dns.icann.org. 2021022314 7200 3600 1209600 3600
; example.com. RRSIG SOA ...
; example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
; answer
cfefe.example.com. 3249 \-ANY ;-$NXDOMAIN
; example.com. SOA ns.icann.org. noc.dns.icann.org. 2021022314 7200 3600 1209600 3600
; example.com. RRSIG SOA ...
; example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
; answer
cffffe.example.com. 3252 \-ANY ;-$NXDOMAIN
; example.com. SOA ns.icann.org. noc.dns.icann.org. 2021022314 7200 3600 1209600 3600
; example.com. RRSIG SOA ...
; example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
; answer
cffffe.example.com. 3255 \-ANY ;-$NXDOMAIN
; example.com. SOA ns.icann.org. noc.dns.icann.org. 2021022314 7200 3600 1209600 3600
; example.com. RRSIG SOA ...
; example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
; answer
cffffe.example.com. 3259 \-ANY ;-$NXDOMAIN
; example.com. SOA ns.icann.org. noc.dns.icann.org. 2021022314 7200 3600 1209600 3600
; example.com. RRSIG SOA ...
; example.com. RRSIG NSEC ...
example.com. NSEC www.example.com. A NS SOA MX TXT AAAA RRSIG NSEC DNSKEY
```

SCREENSHOT SHOWING THE CACHE CONTENTS

```
Terminal
PES2201800368@DNSServer:~$sudo rndc dumpdb -cache
PES2201800368@DNSServer:~$sudo cat /var/cache/bind/dump.db | grep attacker
example.com. 65369 NS ns.dnslabattacker.net.
ns.dnslabattacker.net. 736 \-ANY ;-$NXDOMAIN
; ns.dnslabattacker.net [v4 TTL 735] [v6 TTL 736] [v4 nxdomain] [v6 nxdomain]
PES2201800368@DNSServer:~$
```

SCREENSHOT OF A BETTER LOOK INTO THE CACHE CONTENTS WHICH SHOWS ns.dnslabattacker.com TO BE THE NS for example.com AND HENCE PROVING THE ATTACK TO BE SUCCESSFUL

```
Terminal
PES2201800368@Victim:~$dig www.example.com
; <<>> DiG 9.10.3-P4-Ubuntu <<>> www.example.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: SERVFAIL, id: 59000
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL: 1
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.example.com. IN A
;; Query time: 1 msec
;; SERVER: 10.0.2.14#53(10.0.2.14)
;; WHEN: Fri Apr 02 10:07:32 EDT 2021
;; MSG SIZE rcvd: 44
PES2201800368@Victim:~$
```

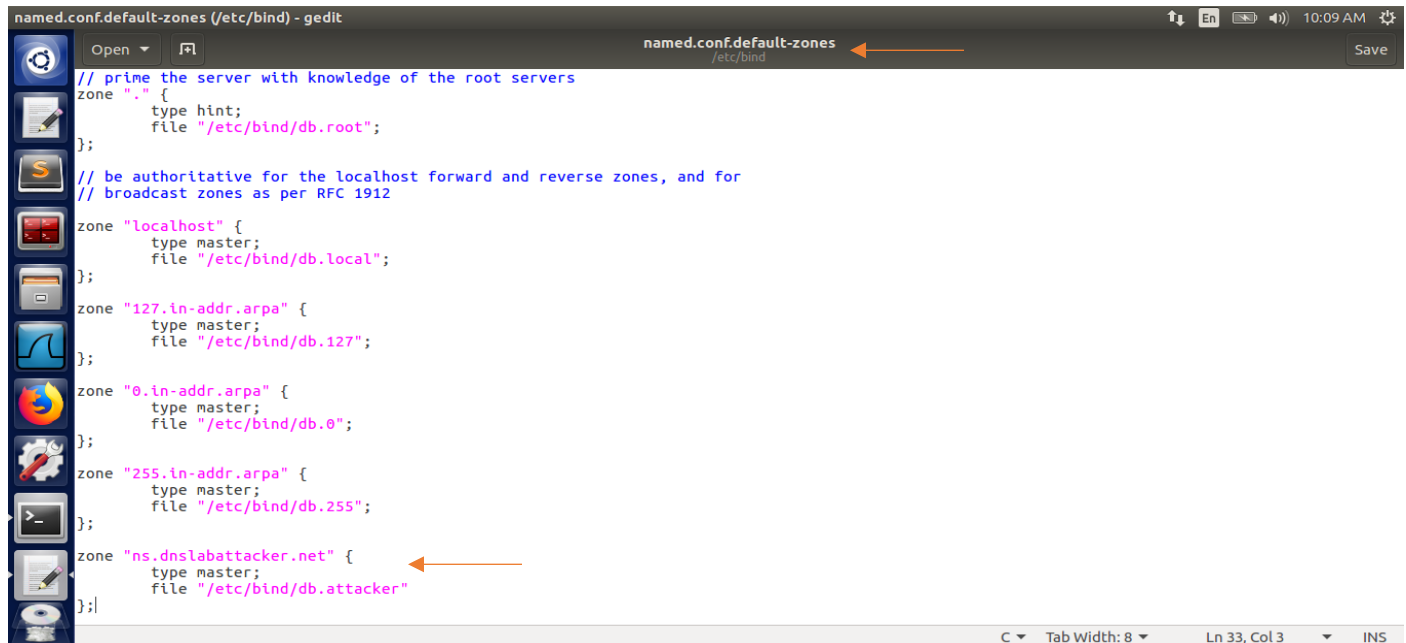
SCREENSHOT OF THE DIG COMMAND SHOWING A FAILURE AS ONLY THE QUESTION SECTION IS VISIBLE

In order to obtain the ns.dnslabattacker.net as the NS record for example.com in the dig command, we need to first configure the victim's DNS Server.

In order for the attack to work, the attacker needs their own domain name (reasons for this will become clearer after you see the explanation below). Since we do not own a real domain name, we can demonstrate the attack using our fake domain name ns.dnslabattacker.net and some extra

configuration on Target. We will basically add the **ns.dnslabattacker.net**'s IP address to Target's DNS configuration, so Target does not need to go out asking for the IP address of this hostname from a non-existing domain. In a real-world setting, the Target's query would resolve to the attacker's server, which would be registered with a DNS registrar.

We first configure the victim's DNS server and add entries into the **named.conf.default-zones** in the **/etc/bind/** folder:



```
named.conf.default-zones (/etc/bind) - gedit
named.conf.default-zones
/etc/bind
Save

// prime the server with knowledge of the root servers
zone "." {
    type hint;
    file "/etc/bind/db.root";
};

// be authoritative for the localhost forward and reverse zones, and for
// broadcast zones as per RFC 1912
zone "localhost" {
    type master;
    file "/etc/bind/db.localhost";
};

zone "127.0.0.1" {
    type master;
    file "/etc/bind/db.127";
};

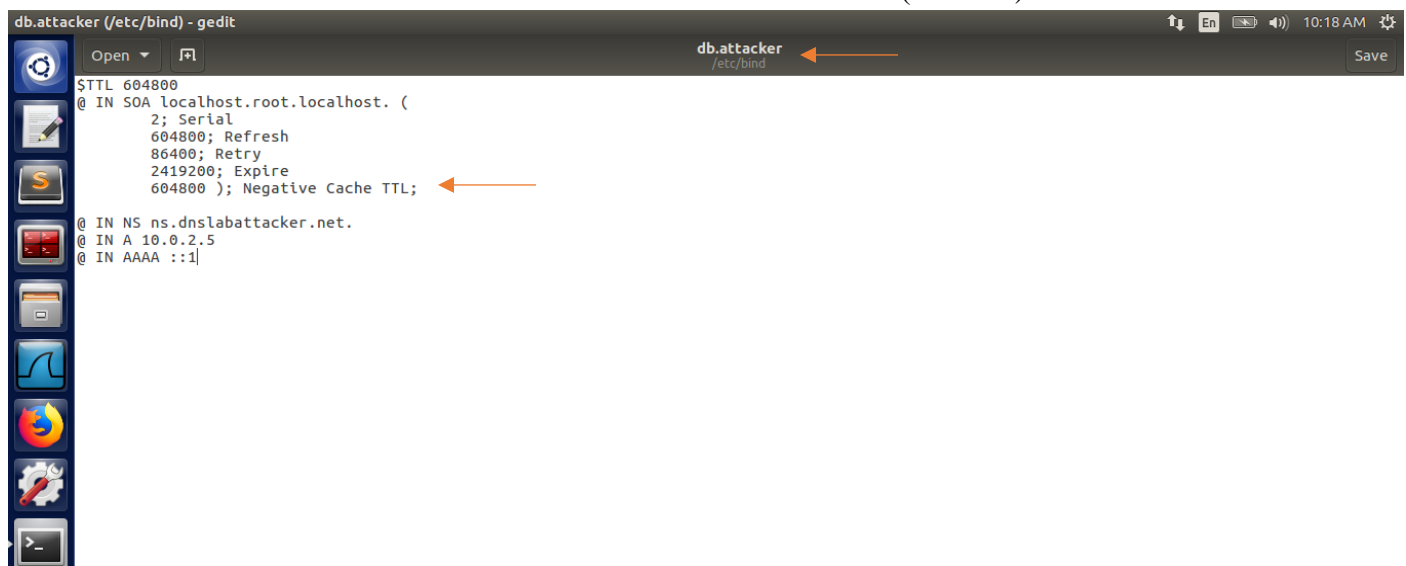
zone "0.0.0.0" {
    type master;
    file "/etc/bind/db.0";
};

zone "255.255.255.255" {
    type master;
    file "/etc/bind/db.255";
};

zone "ns.dnslabattacker.net" {
    type master;
    file "/etc/bind/db.attacker";
};
```

SCREENSHOT OF THE CONFIGURATIONS TO THE **named.conf.default-zones FILE**

We next Create the file **/etc/bind/db.attacker**, and place the following contents in it. We let the attacker's machine and **ns.dnslabattacker.net** share the machine (10.0.2.5).



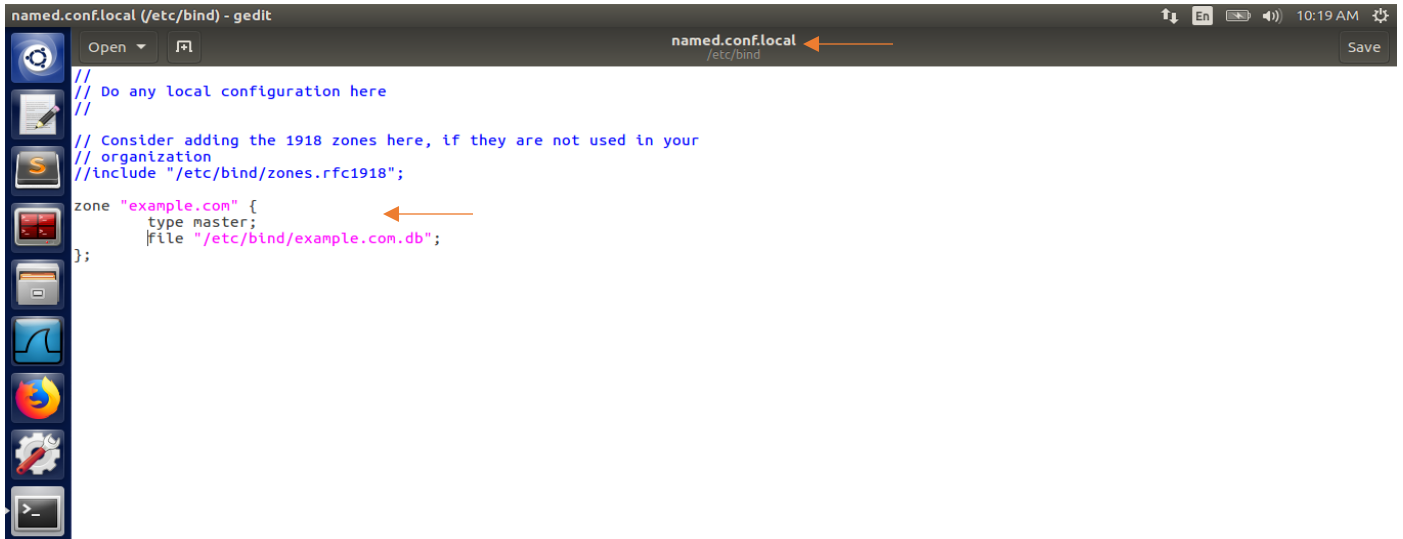
```
db.attacker (/etc/bind) - gedit
db.attacker
/etc/bind
Save

$TTL 604800
@ IN SOA localhost.root.localhost. (
    2; Serial
    604800; Refresh
    86400; Retry
    2419200; Expire
    604800 ) Negative Cache TTL;

@ IN NS ns.dnslabattacker.net.
@ IN A 10.0.2.5
@ IN AAAA ::1
```

SCREENSHOT SHOWING THE CREATION OF THE FILE NAMED **db.attacker**


We need to configure the DNS server, so it answers the queries for the domain example.com and hence the following entries are added in /etc/bind/named.conf.local



```
named.conf.local (/etc/bind) - gedit
// Do any local configuration here
// Consider adding the 1918 zones here, if they are not used in your
// organization
//include "/etc/bind/zones.rfc1918";
zone "example.com" {
    type master;
    file "/etc/bind/example.com.db";
};
```

SCREENSHOT OF THE CONFIGURATIONS MADE TO THE named.conf.local FILE

We now Create a file called /etc/bind/example.com.db, and fill it with the following contents.



```
example.com.db (/etc/bind) - gedit
$TTL 3D
@      IN SOA  ns.example.com. admin.example.com. (
        2008111001
        8H
        2H
        4W
        1D)
@      IN NS   ns.dnslabattacker.net.
@      IN MX   10 mail.example.com.
www    IN A    1.1.1.1
mail   IN A    1.1.1.2
*.example.com. IN A 1.1.1.100
```

SCREENSHOT SHOWING THE CREATION OF FILE example.com.db WITH THE ABOVE SEEN CONTENTS

When the configurations are finished, restart the DNS Server of the DNS Server VM; otherwise, the modification will not take effect. If everything is done properly, you can use the command "dig www.example.com" on the user machine. The reply would be 1.1.1.1, which is exactly we put in the above file.

```
Terminal
PES2201800368@Victim:~$dig www.example.com
; <<>> DiG 9.10.3-P4-Ubuntu <<>> www.example.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 27835
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 1, ADDITIONAL: 3
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.example.com.                IN      A
;; ANSWER SECTION:
www.example.com.                259200  IN      A      1.1.1.1
;; AUTHORITY SECTION:
example.com.                    259200  IN      NS      ns.dnslabattacker.net.
;; ADDITIONAL SECTION:
ns.dnslabattacker.net.         604800  IN      A      10.0.2.5
ns.dnslabattacker.net.         604800  IN      AAAA   ::1
;; Query time: 2 msec
;; SERVER: 10.0.2.14#53(10.0.2.14)
```

```
Terminal
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 27835
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 1, ADDITIONAL: 3
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.example.com.                IN      A
;; ANSWER SECTION:
www.example.com.                259200  IN      A      1.1.1.1
;; AUTHORITY SECTION:
example.com.                    259200  IN      NS      ns.dnslabattacker.net.
;; ADDITIONAL SECTION:
ns.dnslabattacker.net.         604800  IN      A      10.0.2.5
ns.dnslabattacker.net.         604800  IN      AAAA   ::1
;; Query time: 2 msec
;; SERVER: 10.0.2.14#53(10.0.2.14)
;; WHEN: Fri Apr 02 12:15:47 EDT 2021
;; MSG SIZE rcvd: 139
PES2201800368@Victim:~$
```

SCREENSHOTS SHOWING THE EXECUTION OF THE DIG COMMAND

Observations:

The Kaminsky Attack is also called as the remote DNS cache poisoning attack. To overcome the challenges of time of spoofing and cache effect which made remote DNS attack not feasible, Kaminsky's idea was to:

- Ask a different question every time, so caching the answer does not matter, and the local DNS server will send out a new query each time.

- Provide forged answer in the Authority section (Hijack the entire domain - Nameserver)
- To achieve the above ideas, we used the C code in order to trigger the DNS Server to send out queries and then keep sending out spoofed responses continuously, so that if one attempt fails and the actual DNS reply gets cached, the attacker need not wait for the cache to timeout for the next attempt.

The following observations can be made from the dig command:

- 1) We see that the IP address of example.com is given as 1.1.1.1 in the ANSWER SECTION according to the configurations we made in the example.com.db FILE.
- 2) We see that the NS(NameServer) for the example.com domain is seen to be ns.dnslabattacker.net in the AUTHORITY SECTION which was the main intent of our attack.
- 3) We also see that the ADDITIONAL SECTION contains the IP address 10.0.2.5 (our attacker's IP) as the IP address for ns.dnslabattacker.com so that the queries can be redirected to the attacker machine with a malicious website.
- 4) Finally all these results are coming from our victim's local DNS Server which was poisoned on account of our attack.