DNS Problems and Solutions

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Topics

- DNS purpose and role
- DNS actions and reactions
- DNS security solutions

Topic

DNS purpose and role

Internet as Territory

- But what **is** the internet?
  - "It's the largest equivalence class in the reflexive transitive symmetric closure of the relationship *can be reached by an IP packet from.*"
    - (Seth Breidbart)
- IP addresses, IP packets, underlie everything
- We overlay IP with many things, e.g., *the web*
- Most important overlay (a layer) is: DNS

DNS as Map

- Most everything we do on the Internet…
  - B2C Web, B2B Web, E-mail, I-M, <*your idea here*>
  - …relies on TCP/IP, and begins with a DNS lookup
- Mobile Internet is dominated by search…
  - …but search itself relies extensively upon DNS
- DNS has a rigorous internal structure
  - Things that are in fact related, are related in DNS
  - You can have *whois* privacy, but not DNS privacy

Criminal DNS

- The Internet has been a great accelerator of human civilization
  - Sadly, the criminals came along for the ride
- Criminals can't do Internet crime without DNS
  - Cheap throw-away domain names
  - DNS registrars and servers in bad neighborhoods
  - *Whois* privacy or simply bad *whois* data
- *DNS, to be commanded, must be obeyed*.
  - (with apologies to Francis Bacon)

So, About that Internal Structure

- Domain names are grouped into *zones*
- A *zone* has one or more *name servers*
- Each *name server* has one or more *addresses*
- Other domain names also have *addresses*
- IP *addresses* are grouped into *netblocks*
- Domain names appear in a lot of places:
  - Web – http://*domain*/
  - E-mail – somebody@*domain*

Traditional DNS Forensics

- DNS lets anybody look up a <*domain*,*type*>
  - You get back the current set of *resource records*
  - But there's no way to see the history
  - And, your query exposes your interest
- *Whois* lets you check ownership of a domain
  - But it's usually hidden/private or inaccurate
- So, Passive DNS was born

Topic

DNS actions and reactions

“…too cheap to meter”

- SpamAssassin as a teaching tool
  - Dotted quads as spamsign
- RRP and EPP: solving “the .COM problem”
  - Running a race to the bottom
- Fluidity having only one purpose
  - 30 seconds? Really?
- Fitting Sturgeon’s revelation
  - “90% of <*thing*> is crap” (optimistic)

Takedown: Far End Tactics

- Since we can't prevent it…
  - …we'll have to evolve coping strategies
- Takedown as a Service (TaaS?)
  - Yes, you can outsource this now
- A new profit center for registries like .TK
  - "Kill all you want, we'll make more!"
- Whack-a-mole as a Service (WaaS?)
  - Incrementalism breeds churn

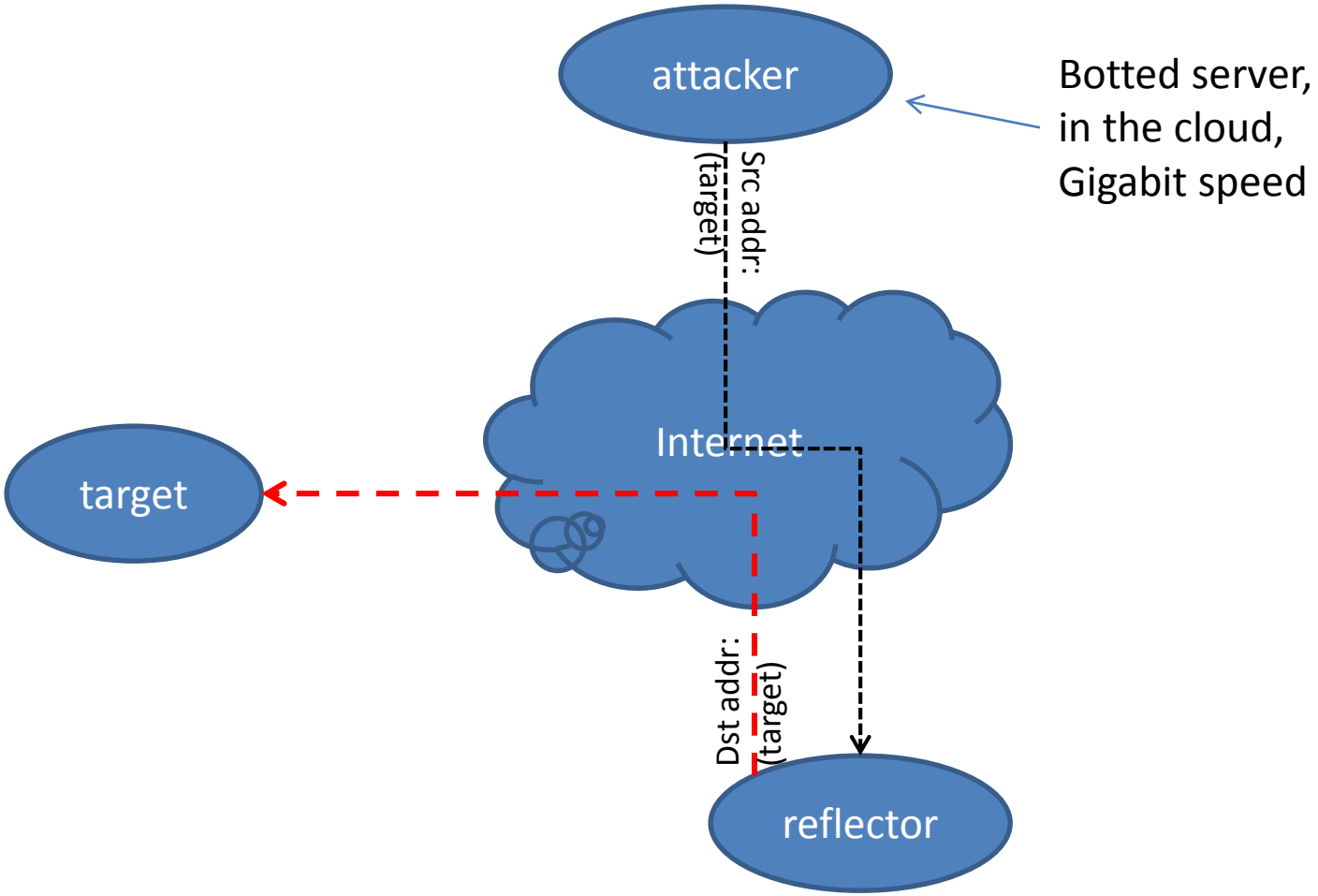
Firewalls: Near End Tactics

- Bargaining isn't possible
  - These are criminals and they want our money
- Neither Prevention nor Takedown has worked
  - Creating new untraceable names is a growth industry
- So, since we can't fight them "over there"…
  - …we end up fighting them on our own threshold
- Traditional firewalls can filter IP+port, URL
  - But the patterns are mostly in DNS now

Packet-level IP Forgery

- At the Internet's fundamental "packet" layer, anybody can claim to be anybody
  - Destination IP addresses matter, operationally
  - Source IP address do not matter, operationally
- If you run a DNS content ("authority") server, it has to be massively overprovisioned
- Because OPN's don't have SAV, your server is a purpose-built DNS DDoS reflecting amplifier

Spoofed Source Attacks



Topic

DNS Security Solutions

Owner Lookup, Show History

```
$ dnsdb_query -r vix.com/ns/vix.com
...
;; record times: 2010-07-04 16:14:12 .. 2013-05-12 00:55:59
;; count: 2221563; bailiwick: vix.com.
vix.com.  NS  ns.sql1.vix.com.
vix.com.  NS  ns1.isc-sns.net.
vix.com.  NS  ns2.isc-sns.com.
vix.com.  NS  ns3.isc-sns.info.

;; record times: 2013-10-18 06:30:10 .. 2014-02-28 18:13:10
;; count: 330; bailiwick: vix.com.
vix.com.  NS  buy.internettraffic.com.
vix.com.  NS  sell.internettraffic.com.
```

Owner Wildcards, Left Hand

```
$ dnsdb_query -r \*.vix.com/a | fgrep 24.104.150
internal.cat.lah1.vix.com.  A  24.104.150.1
ss.vix.com.                 A  24.104.150.2
gutentag.vix.com.           A  24.104.150.3
lah1z.vix.com.              A  24.104.150.4
mm.vix.com.                 A  24.104.150.11
ww.vix.com.                 A  24.104.150.12
external.cat.lah1.vix.com.  A  24.104.150.33
wireless.cat.lah1.vix.com.  A  24.104.150.65
wireless.ss.vix.com.        A  24.104.150.66
ap-kit.lah1.vix.com.        A  24.104.150.67
cat.lah1.vix.com.           A  24.104.150.225
vix.com.                    A  24.104.150.231
deadrat.lah1.vix.com.       A  24.104.150.232
ns-maps.vix.com.            A  24.104.150.232
ns.lah1.vix.com.            A  24.104.150.234
```

Owner Wildcards, Right Hand

```
$ dnsdb_query -r vixie.\*/ns
;;   zone times: 2010-08-13 16:10:10 .. 2012-12-31 17:24:50
;; count: 872; bailiwick: com.
vixie.com.  NS  ns2317.hostgator.com.
vixie.com.  NS  ns2318.hostgator.com.

;;   zone times: 2010-04-24 16:12:21 .. 2010-08-12 16:09:01
;; count: 111; bailiwick: com.
vixie.com.  NS  ns23.domaincontrol.com.
vixie.com.  NS  ns24.domaincontrol.com.

;;   zone times: 2010-10-20 20:52:43 .. 2012-03-31 20:54:04
;; count: 0; bailiwick: info.
vixie.info.  NS  ns31.domaincontrol.com.
vixie.info.  NS  ns32.domaincontrol.com.
^C
```

Data Lookup, By Name

```
$ ./dnsdb_query -n ss.vix.su/mx
vix.su.                 MX  10 ss.vix.su.
dns-ok.us.              MX   0 ss.vix.su.
mibh.com.               MX   0 ss.vix.su.
iengines.com.           MX   0 ss.vix.su.
toomanydatsuns.com.     MX   0 ss.vix.su.
farsightsecurity.com.   MX  10 ss.vix.su.
anog.net.               MX   0 ss.vix.su.
mibh.net.               MX   0 ss.vix.su.
tisf.net.               MX  10 ss.vix.su.
iengines.net.           MX   0 ss.vix.su.
al.org.                 MX   0 ss.vix.su.
vixie.org.              MX   0 ss.vix.su.
redbarn.org.            MX   0 ss.vix.su.
benedelman.org.         MX   0 ss.vix.su.
```

Data Lookup, by IP Address

```
$ dnsdb_query -r ic.fbi.gov/mx
ic.fbi.gov.  MX  10 mail.ic.fbi.gov.

$ dnsdb_query -r mail.ic.fbi.gov/a
mail.ic.fbi.gov.  A  153.31.119.142

$ dnsdb_query -i 153.31.119.142
ic.fbi.gov.           A  153.31.119.142
mail.ic.fbi.gov.      A  153.31.119.142
mail.ncijtf.fbi.gov.  A  153.31.119.142
```

Data Lookup, by IP Address Block

```
$ dnsdb_query -i 153.31.119.0/24 | grep -v infragard
vpn.dev2.leo.gov.            A  153.31.119.70
mail.leo.gov.                A  153.31.119.132
www.biometriccoe.gov.        A  153.31.119.135
www.leo.gov.                 A  153.31.119.136
cgate.leo.gov.               A  153.31.119.136
www.infraguard.net.          A  153.31.119.138
infraguard.org.              A  153.31.119.138
www.infraguard.org.          A  153.31.119.138
mx.leo.gov.                  A  153.31.119.140
ic.fbi.gov.                  A  153.31.119.142
mail.ic.fbi.gov.             A  153.31.119.142
mail.ncijtf.fbi.gov.         A  153.31.119.142
```

Technical Formatting Notes

- These slides show a DNS output conversion
  - The real output is in JSON format, i.e.:

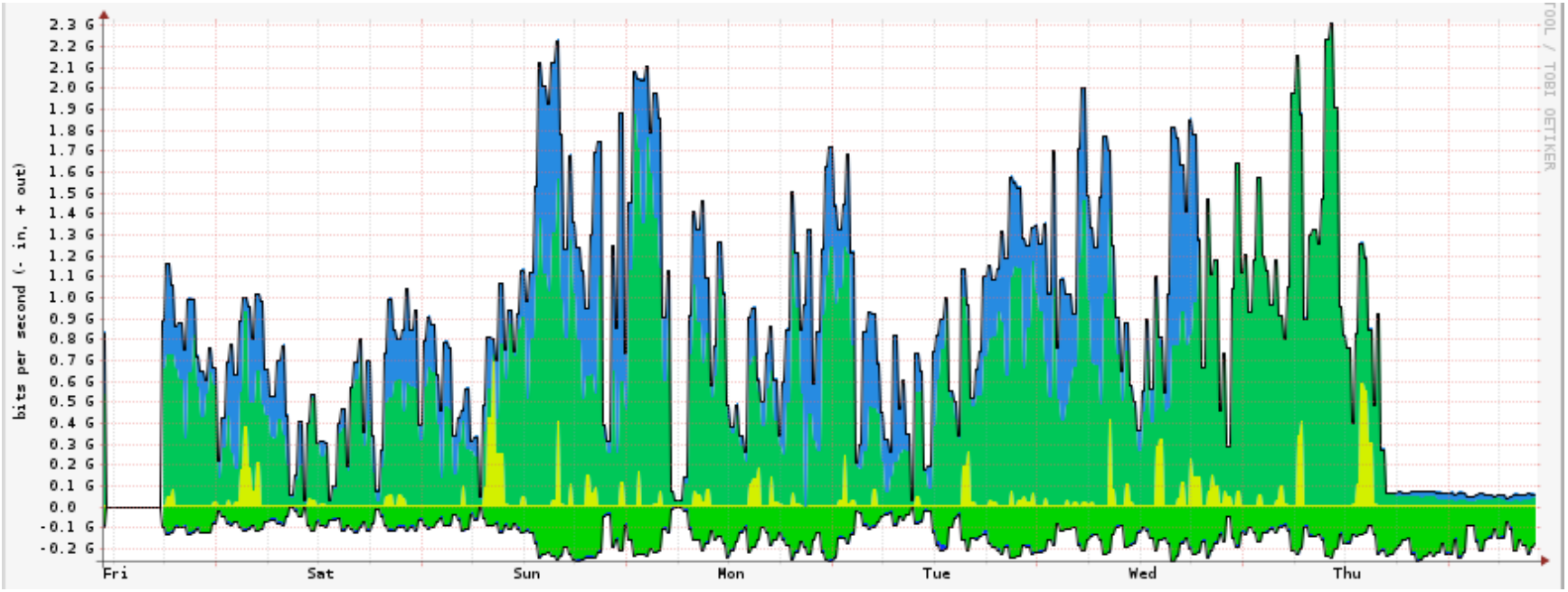
```
$ dnsdb_query -r f.root-servers.net/a/root-servers.net
;; record times: 2010-06-24 03:10:38 .. 2014-03-05 01:22:56
;; count: 715301521; bailiwick: root-servers.net.
f.root-servers.net.  A  192.5.5.241

$ dnsdb_query -r f.root-servers.net/a/root-servers.net -j
{"count": 715301521, "time_first": 1277349038, "rrtype": "A",
"rrname": "f.root-servers.net.", "bailiwick": "root-
servers.net.", "rdata": ["192.5.5.241"], "time_last": 1393982576}
```

DNS Response Rate Limiting (RRL)

- BIND and NSD now support DNS RRL, which accurately guesses what's safe to drop
  - Roughly speaking, there's a credibility limit above which repeated answers just don't make sense
- Your authority servers need this, whereas your recursive servers need to be firewalled off
  - Deliberately open recursive services, like OpenDNS and Google DNS, have 24x7 monitoring

RRL In Action: Afilias



DNS Firewalls with RPZ

- Uses DNS zones to carry DNS Firewall policy
  - RPZ = Response Policy Zones
- Pub-sub is handled by NOTIFY/TSIG/IXFR
  - Many publishers, many subscribers, one format
- Pay other publishers, or create your own
  - Or do both, plus a private exception list
- Simple failure or walled garden, as you choose
  - We call this “taking back the streets” (“the DNS”)

RPZ Capabilities

- Triggers (RR owners):
  - If the query name is $X
  - If the response contains an address in CIDR $X
  - If any NS name is $X
  - If any NS address is in CIDR $X
  - If the query source address is in CIDR $X
- Actions (RR data):
  - Synthesize NXDOMAIN
  - Synthesize CNAME
  - Synthesize NODATA
  - Synthesize an answer
  - Answer with the truth

Why Use RPZ?

- Easy stuff:
  - Block access to DGA C&C's
  - Block access to known phish/driveby
  - Block e-mail if envelope/header is spammy
- More interesting stuff:
  - Block DNS A/AAAA records in bad address space
    - E.g., import Cymru Bogons or Spamhaus DROP list
  - Block DNS records in your own address space
    - After allowing your own domains to do so, of course

RPZ Status

- Implications:
  - Controlled Balkanization
  - Open market for producers and consumers
  - Differentiated service at a global scale
  - Instantaneous takedown
- Deployment:
  - The RPZ standard is open and unencumbered
  - So far implemented only in BIND
  - Performance is pretty reasonable
  - New features will be backward compatible
  - This is not an IETF standard

Newly Observed Domains

- 60% of the spam FSI studied used a header or envelope domain name less than 24 hours old
- Most new domains are rapidly taken down
- Casa Vixie uses a 10 minute NXDOMAIN rule
- FSI NOD (5m, 10m, 30m, 1h, 3h, 6h, 12h, 24h)
  - Streams: newly active vs. newly observed
  - Feeds: RPZ (for DNS Firewalls) vs. RHSBL (for Spam Assassin)

Summary

- Massive volumes of untraceable junk domains
  - Use of Passive DNS can make forensics possible
  - Use of DNS RPZ can synthesize “takedown” locally
- Massive volumes of forged DNS queries
  - Use of DNS RRL can opt-out your authority servers
  - Use of IP ACLs can opt-out your recursive servers
- Deliberately not covered here:
  - Secure DNS (DNSSEC); TSIG; DNS Cookies; DANE

Limited Bibliography

https://www.farsightsecurity.com/
http://www.redbarn.org/dns/ratelimits
http://www.redbarn.org/internet/save
http://dnsrpz.info/