Passive DNS Replication

Florian Weimer

17th Annual FIRST Conference, Singapore, 2005

Outline

Outline

DNS as a huge table

```
www.enyo.de                  IN  A    212.9.189.164
static.enyo.de               IN  A    212.9.189.164
mail.enyo.de                 IN  A    212.9.189.167
enyo.de                      IN  MX   10 mail.enyo.de
...
www.first.org                IN  A    163.1.2.77
www.first.org                IN  A    192.25.206.20
www.first.org                IN  A    210.148.223.8
...
164.189.9.212.in-addr.arpa   IN  PTR  www.enyo.de
```

DNS summary

- You can query only by the primary key, the domain/class/type triple.
- Queries on secondary keys can be emulated if the key is encoded in a domain name (as in `164.189.9.212.in-addr.arpa`).
- There are no consistency guarantees.
- Reverse lookups (based on PTR records) are optional and not reliable: Both `www` and `static` point to `212.9.189.164`, but there is only one PTR record.

Outline

An IDS alert

- The intrusion detection system detects a botnet command:
  ```
  T 2005/04/21 18:06:33.188392
  192.0.2.166:6667 -> 212.9.189.171:1037
    :abc!DeFgH@SOME.TLA.GOV
      TOPIC #l33t :.advscan dcom135 100 5 0 -r..
  ```
- `212.9.189.171` is a compromised host on our network.
- `192.0.2.166` is the botnet controller.
- The captured command instructs `212.9.189.171` to scan for further victims.

Response to the report

- Filter `212.9.189.171`, the victim host.
- Filter `192.0.2.166`, the botnet controller.
- Contact the owner of the `212.9.189.171` machine and force him to clean it.
- . . . and hope for the best.
  - The victims continue to scan the internal network, discovering new victims.
  - Filtering the botnet controller prevents them from joining the botnet. (???)

Contacting the botnet controller

- The bot may contain one or more domain names instead of hard-coded IP addresses.
- Each domain can resolve to multiple IP addresses.
- Blocking a single IP address often does not prevent hosts from joining the botnet.
- If you know the domain name, better filters are possible.
  - You can adjust the filters when the domain name changes.
  - You can filter the domain name on your resolvers (in theory).

How to recover domain names from IP addresses

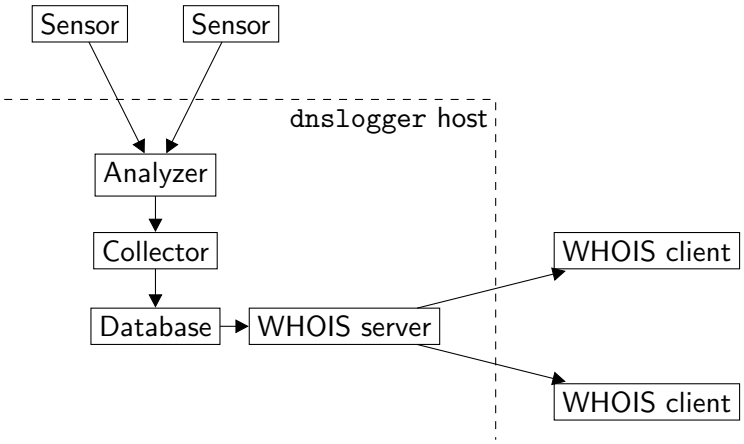
- Reverse engineer the bot.
  - Disassembling needs time and expertise.
  - And a copy of the malware.
- The security team often cannot access the caching resolvers which store a copy of the DNS record.
- Zone file transfers do not work, the traditional DNS replication mechanism, do not work.

From domain names to IP addresses

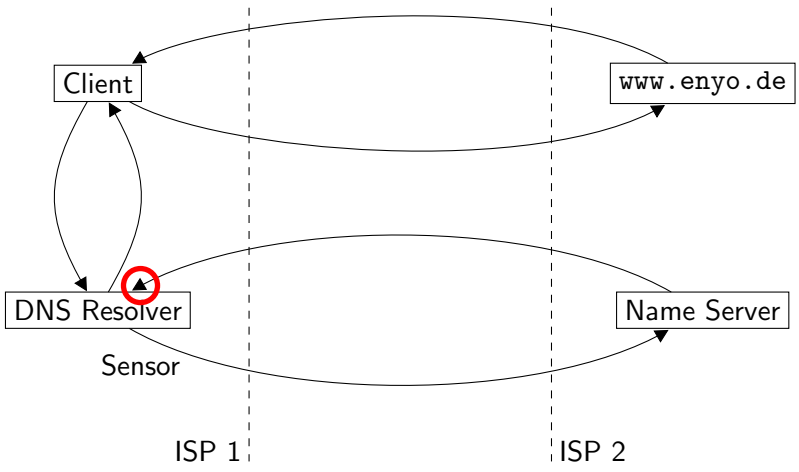
- Capture DNS packets and look for the IP address you are interested in.
- DNS caches may delay the reappearance of resource records for hours.
- Idea: Capture DNS records in advance and store them in a database for later reference.
- This leads to “passive DNS replication”.

Outline

dnslogger architecture



Sensor placement



Challenges

- Privacy concerns
- Security concerns
- Truncated and EDNS0 responses
- What about bogus DNS data captured by the sensors?
- The data rate itself is fairly low on medium-sized campus networks.
- But keeping lots of historic data is problematic.

`dnslogger` implementation

- Two sensor implementations:
  - Perl: simple and obviously correct
  - C: higher performance, fewer dependencies
- The remaining parts of the `dnslogger` software are written in Ada.
- Berkeley DB from Sleepycat is used as the underlying database technology.
  - The schema design is highly denormalized and clustered on reversed domain names.
  - All database updates are idempotent and commute, which makes replication particularly easy.

Outline

Examples

- Identify botnet controllers
- Track DNS-driven botnets (Blaster)
- Correlate domains
- Dating DNS anomalies (new or just newly discovered?)

Example: The kimble.org fiasco

First seen	Domain	Type	Data
2004-06-23 13:58:51	kimble.org	A	127.0.0.1
2004-08-07 16:14:00	kimble.org	A	207.234.155.17
2004-10-20 07:15:58	kimble.org	A	212.100.234.54
2004-10-20 16:12:56	kimble.org	A	64.203.97.121
2004-10-21 17:15:01	kimble.org	A	212.113.74.58
2004-10-21 17:45:01	kimble.org	A	195.130.152.100
2004-10-31 14:45:01	kimble.org	A	195.225.218.59
2004-11-02 23:15:01	kimble.org	A	206.132.83.2
2004-11-04 18:15:01	kimble.org	A	213.139.139.206
2004-11-21 03:15:02	kimble.org	A	216.7.173.212
2004-11-25 22:45:02	kimble.org	A	38.112.165.60

Example: Hijacking of ebay.de

First seen	Domain	Type	Data
2004-06-23 08:21:57	ebay.de	NS	crocodile.ebay.com
2004-06-23 08:21:57	ebay.de	NS	sjc-dns1.ebaydns.com
2004-06-23 08:21:57	ebay.de	NS	sjc-dns2.ebaydns.com
2004-08-28 05:34:01	ebay.de	NS	ns1.goracer.de
2004-08-28 05:34:01	ebay.de	NS	ns2.goracer.de

Example: Network Solution's "Site Finder Light"

First seen	Domain	Type	Data
2004-09-19 05:01:53	misslink.net	CNAME	†
2004-09-19 05:57:49	ns.bighornent.com	CNAME	†
2004-09-19 06:13:44	ns13.magnum-inap4.net	CNAME	†
2004-09-19 06:24:28	host2.7thgate.com	CNAME	†
2004-09-19 07:25:26	www.zydigo.com	CNAME	†
2004-09-19 08:08:33	muslimsonline.com	CNAME	†
2004-09-19 08:28:26	www.animatiehuis.com	CNAME	†
2004-09-19 08:57:19	www.urbanvoicesonline.com	CNAME	†
...			

† = resalehost.networksolutions.com

Example: Correlating domains

- An email messages references dkchaotichigh.com ("MegaPowerPills.com").
- An ordinary DNS lookup reveals that ns1.m-dns.us is used as a name server.
- Additional domains are hosted on this name server:

Domain	Type	Data
outfacegood.com	NS	ns1.m-dns.us
outregood.com	NS	ns1.m-dns.us
megalithgood.com	NS	ns1.m-dns.us
medverdigrisgood.com	NS	ns1.m-dns.us
...		

Example: Unauthorized name servers for .com

First seen	Domain	Type	Data
2004-06-24 00:52:37	com	NS	ns1.hi2000.net
2004-06-24 23:04:11	com	NS	ns1.vertical-inc.net
2004-06-30 23:26:21	com	NS	tempsvr.wam.wamusa.com
2004-07-01 04:32:18	com	NS	ns7.domainredirect.com
2004-07-05 04:18:36	com	NS	ns1.infoglobe.net
2004-07-05 07:35:14	com	NS	ns1.cntrading.com
2004-07-05 16:40:27	com	NS	ns1.spacesurfer.com
2004-07-08 00:34:29	com	NS	ns.tradenames.com
...			

Observations

- DNS usage is very localized and specific to the network in which the sensor is placed.
- For many applications, you have to run your own sensor, instead of using data collected on other networks.
- But sharing the data with others does not hurt.

Summary

- Passive DNS replication provides new ways to access and process DNS data.
- This data can support various security-related processes.
- It also provides new insights into the operation of the domain name system.

- Questions?