Darknet and Black Hole Monitoring

a Journey into Typographic Errors

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Motivation and background

- IP darkspace or black hole is
  - Routable non-used address space of an ISP (Internet Service Provider),
  - incoming traffic is unidirectional
  - and unsolicited.
- Is there any traffic in those darkspaces?
- If yes, what and why does it arrive there?
  - And on purpose or by mischance?
- What's the security impact?
- What are the security recommendations?

Origin of traffic in the black hole

- Attackers (and researchers) scan networks to find vulnerable systems (e.g. SSH brute-force)
- Backscatter traffic (e.g. from spoofed DoS)
- Self-replicating code using network as a vector (e.g. conficker, residual worms)
- Badly configured devices especially embedded devices (e.g. printers, server, routers)
  - $\rightarrow$ **Our IP-darkspace is especially suited for spelling errors from the RFC1918 (private networks) address space**

Why is there traffic

Typing/Spelling errors with RFC1918 networks

- While typing an IP address, different error categories might emerge:

Hit wrong key	19**2**.x.z.y →	19**3**.x.y.z
	172.x.y.z	1**5**2.x.y.z
Omission of number	1**9**2.x.y.z →	12.x.y.z
Doubling of keys	10.a.b.c →	10**0**.a.b.c

Research activities related to spelling errors

Spelling errors apply to text but also network configuration

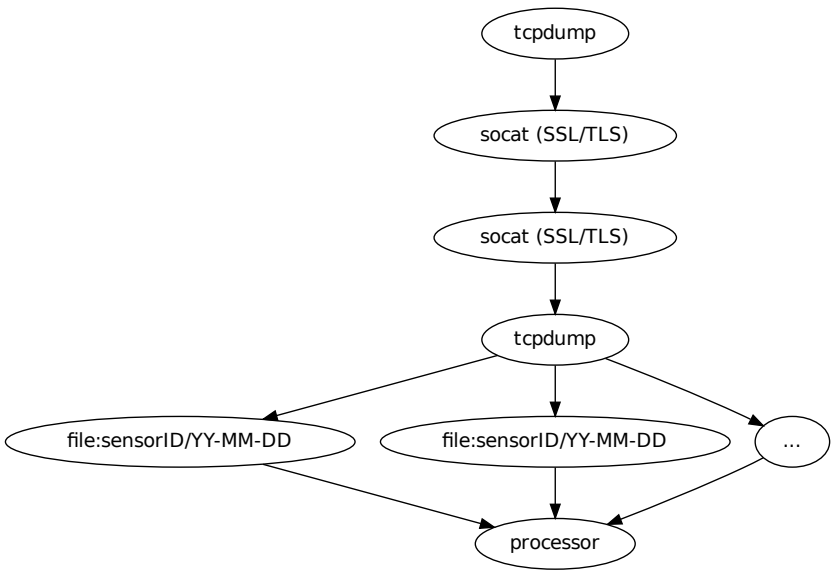
- 34% omissions of 1 character
  - Example: Network $\rightarrow$ Netork
- 23% of all errors happen on 3rd position of a word
  - Example: Text $\rightarrow$ Test)
- 94% spellings errors are single errors in word
  - And do not reappear

References

- Pollock J. J. and Zamora A., Collection and characterization of spelling errors in scientific and scholarly text. J. Amer. Soc. Inf. Sci. 34, 1, 51 58, 1983.
- Kukich K., Techniques for automatically correcting words in text. ACM Comput. Surv. 24, 4, 377-439, 1992.

IP-Darkspace: Data Collection

Implementation



- Minimal sensor collecting IP-Darkspace networks (**close to RFC1918 address space**)
- Raw pcap are captured with the full payload
- Netbeacon[a] developed to ensure consistent packet capture

[a] `www.github.com/adulau/netbeacon/`

Dataset collected and statistics

- From 2012-03-12 until Today (still active)
- Nearly 200 gigabytes of compressed raw pcap collected
- Constant stream of packets from two /22 network blocks
  - no day/night profile.
- Some peaks at 800kbit/s (e.g. often TCP RST from backscatter traffic but also from typographic errors)

General observations

- A large part of traffic is coming from badly configured devices (**RFC1918 spelling errors**)
  - Printers, embedded devices, routers or even server.
  - Trying to do name resolution on non-existing DNS servers, NTP or sending syslog messages.
- Even if the black hole is passive, payload of stateless UDP packets or even TCP (due to asymmetric routing on misspelled network) datagrams are present
- Internal network scanning and reconnaissance tool (e.g. internal network enumeration)

Observation per AS

Traffic seen in the darknet

N	Frequency	ASN
1	4596319	4134
2	1382960	4837
3	367515	3462
4	312984	4766
5	211468	4812
6	166110	9394
7	156303	9121
8	153585	4808
9	135811	9318
10	116105	4788

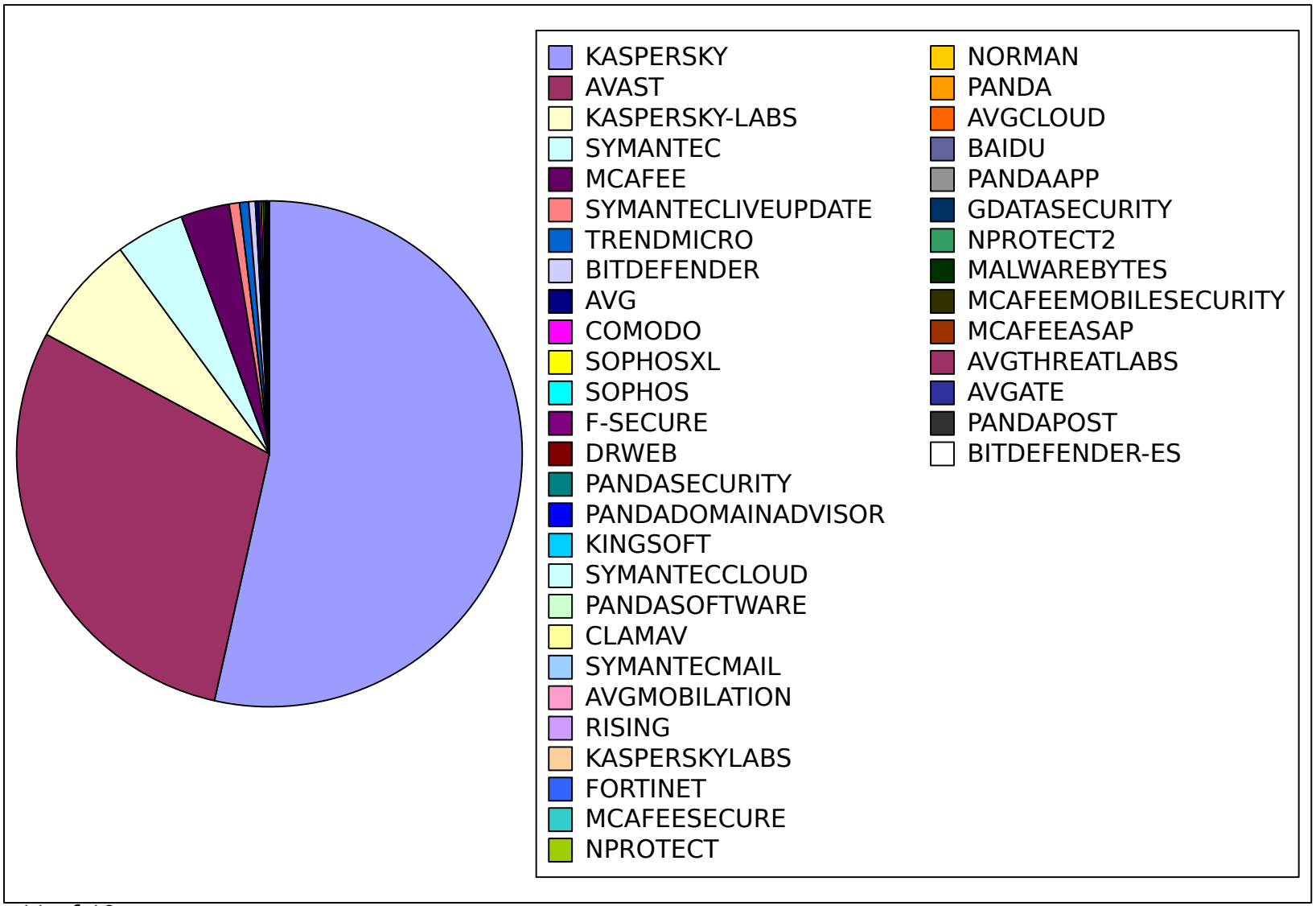
- Occurrences of activities matching the proportion of hosts in a country.
- Chinese great-wall is not filtering leaked packets.

Network reconnaissance (and potential misuse): DNS

```
3684 _msdcs.<companyname>.local
1232666 time.euro.apple.com
104 time.euro.apple.com.<mylocaldomain>
122 ocsp.tcs.terena.org
50000+ ocsp.<variousCA>
```

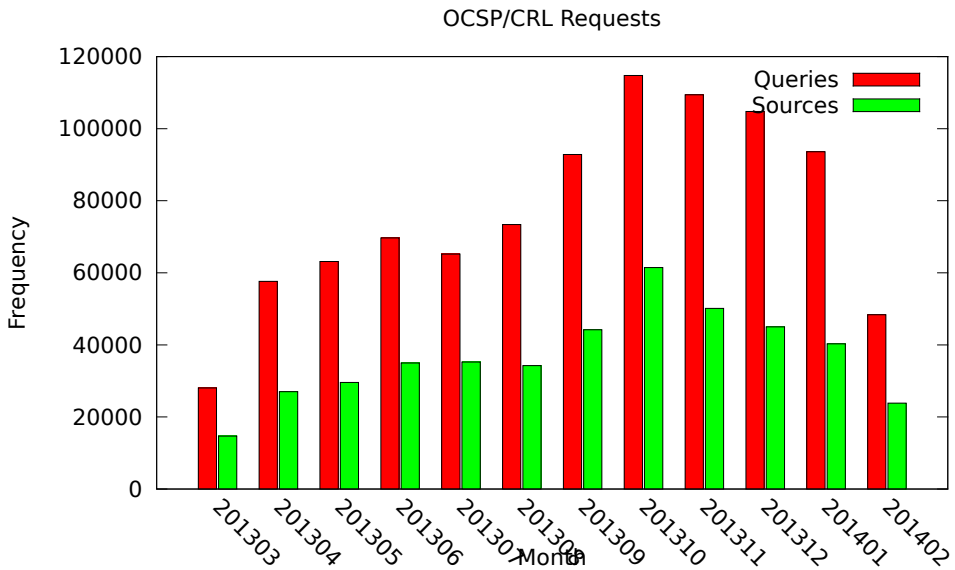
- DNS queries to an incorrect nameserver could lead to major misuse
- A single typo in a list of 3 nameservers is usually unnoticed

A/V Statistics from Misconfigured Resolvers



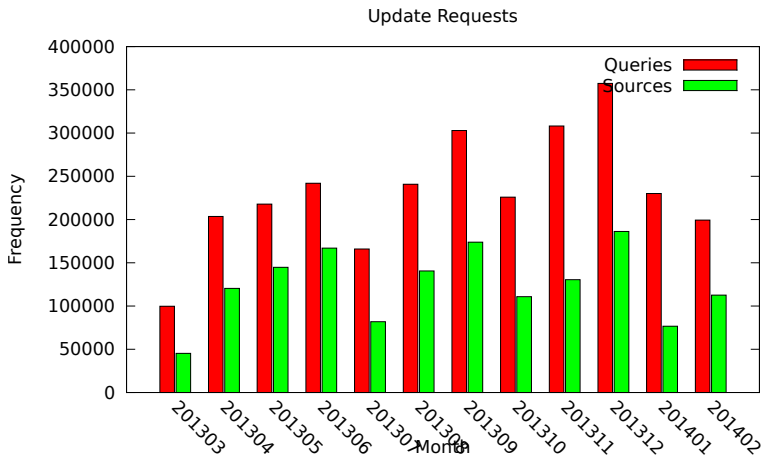
Certificate Revocation and Queries from Misconfigured Resolvers

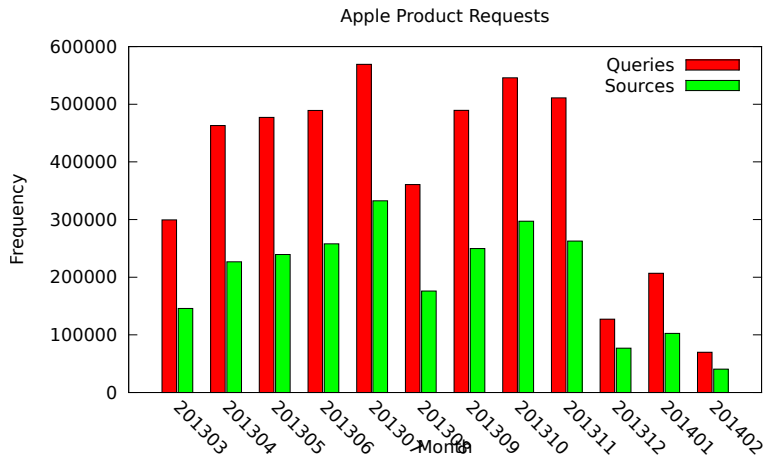
- The increase of 5% in late 2013 might be due to certificate requirements update (e.g. key size, hashing algorithm updates)
- A lot of software assumes a certificate to be valid when OCSP or CRL are not accessibles



Software Updates/Queries from Misconfigured Resolvers

- Discovering software usage (and vulnerabilities) can be easily done with passive reconnaissance
- Are the software update process ensuring the integrity of the updates?





Network Reconnaissance - How To Build Smart DNS Brute-Forcer

ASTTF.NET	HELP.163.COM	
ASUEGYI.INFO	HP_CLIENT1	
ASUS1025C	MACBOOKAIR-CAD7	
DEFAULT	MACBOOK-B5BA66	
DELICIOUS.COM	MACBOOKPRO-5357	
DELL	MAIL.AFT20.COM	And many more ...
DELL1400	S3.QHIMG.COM	
DELL335873	SERVERWEB	
DELL7777	SERVEUR	
DELL-PC	SERVICE.QQ.COM	
DELLPOP3	SMTP.163.COM	

Network Reconnaissance: NetBios Machine Types (1 week)

23	Browser Server
4	Client?
1	Client? M <ACTIVE>
21	Domain Controller
1	Domain Controller M <ACTIVE>
11	Master Browser
1	NameType=0x00 Workstation
1	NameType=0x20 Server
105	Server
26	Unknown
1	Unknown <GROUP> B <ACTIVE>
5	Unknown <GROUP> M <ACTIVE>
1322	Workstation
1	Workstation M <ACTIVE>

Printer syslog to the world

or how to tell to the world your printer status

```
2012-03-12 18:00:42
   SYSLOG lpr.error printer: offline
     or intervention needed
2012-03-23 21:51:24.985290
   SYSLOG lpr.error printer: paper out
   ...
2012-08-06 19:14:57.248337
   SYSLOG lpr.error printer: paper jam
```

- Printers are just an example out of many syslog messages from various devices
- Information leaked could be used by attackers to gain more information or improve targeted attacks

How to configure your router (without security)

Enable command logging and send the logs to a random syslog server

```
Aug 13 10:11:51 M6000-G5 command-log:[10:11:51 08-13-2012
  VtyNo: vty1  UserName: XXX IP: XXX ReturnCode: 1
  CMDLine: show subscriber interface gei-0/2/1/12.60
Aug 13 10:46:05 M6000-G5 command-log:[10:46:05 08-13-2012
  VtyNo: vty2  UserName: XXX IP: XXX  ReturnCode: 1
  CMDLine: conf t ]
Aug 13 10:46:10 M6000-G5 command-log:[10:46:10 08-13-2012
  VtyNo: vty2  UserName: XXX IP: XXX  ReturnCode: 1  CMD
Line: aaa-authentication-template 1100 ]
...
```

We will let you guess the sensitive part afterwards...

Misconfigured network interception in Iran for 2 hours?

- On April 08, 2013, a peak of ICMP time exceeded in-transit were received during 2 hours
- IP sources allocated in Iran with a nice distribution among Iranian Internet providers

```
12:29:49.255942 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.255957 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.255963 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.256144 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.256172 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.256481 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.256568 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.257086 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.257098 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.257470 IP 93.126.56.1 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.257565 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.257603 IP 80.191.114.59 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.258575 IP 178.173.128.245 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.258657 IP 178.173.128.245 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.258669 IP 178.173.128.245 > a.b.100.1: ICMP time exceeded in-transit, length 36
12:29:49.258677 IP 178.173.128.245 > a.b.100.1: ICMP time exceeded in-transit, length 36
```

Conclusions

- Security recommendations
  - **Default routing/NAT to Internet in operational network is evil**
  - Use fully qualified domain names (resolver search list is evil too)
  - Double check syslog exports via UDP (e.g. information leakage is easy)
  - Verify any default configuration with SNMP (e.g. enable by default on some embedded devices)
- Offensive usage? What does it happen if a malicious "ISP" responds to misspelled RFC1918 addresses? (e.g. DNS/NTP requests, software update or proxy request)
- Some research projects on this topic? Contact us