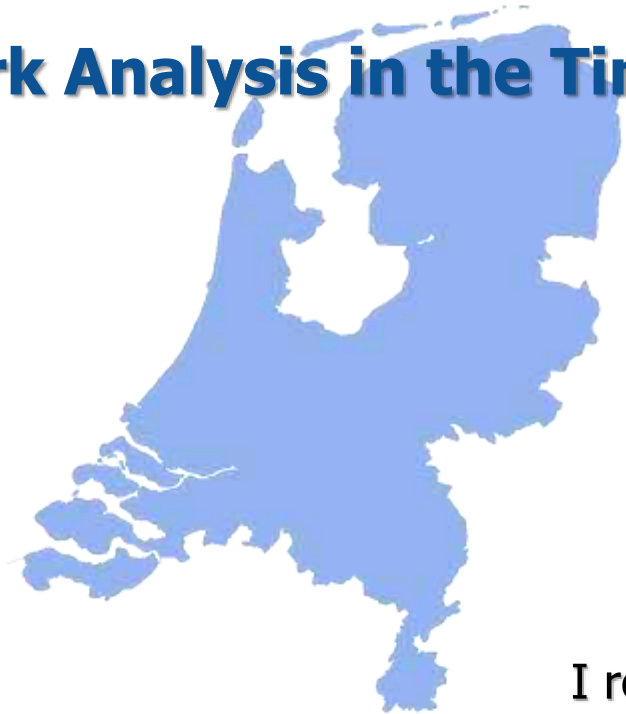
SharkFest '16 Europe

Forensic Network Analysis in the Time of APTs

October 19th 2016



Christian Landström
I read packets… | Packet-Foo

#sf16eu

Topics

- Overview on security infrastructure
- Strategies for network defense and forensics
- A look at malicious traffic incl. Demos
- How Wireshark can help
- Best Practice Proactive / Reactive

Tool-Box

Defaults:

Proxy servers with authentication

Logging, Monitoring, (SIEM)

Layers of Defense:

Firewalls / WAFs

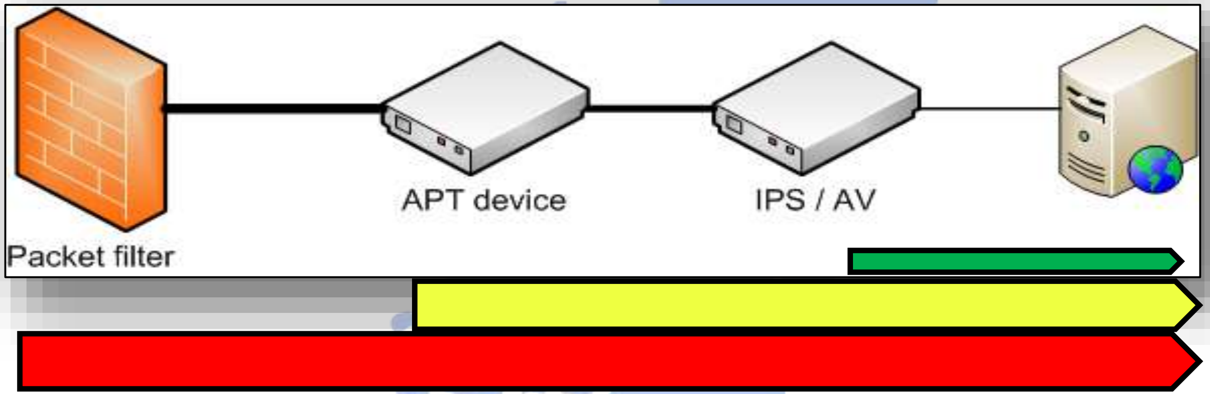
Intrusion Detection / Intrusion Prevention

NIDS/NIPS/HIDS/HIPS

Malware Sensors / Sandboxing / “APT-devices”

Typical protection for DMZ systems:

Packet filter → IPS / IDS / APT device / Sandbox → local (host-)firewall



What do companies expect

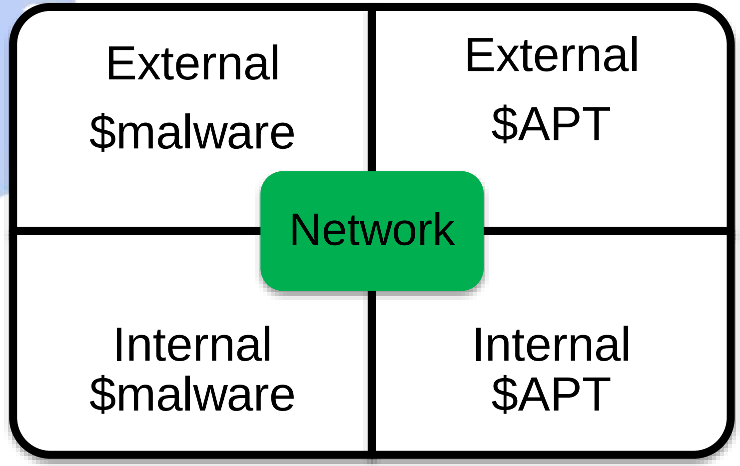
- Firewall protecting from all sorts of unwanted traffic towards internal systems
- IDS / IPS sending Alerts for all sorts of exploitation attempts and abnormal network traffic
- "APT" / Sandboxing devices to trigger on malicious code / malicious binary files
- Host IPS / Host Firewalls alerting any type of unwanted access, traffic or what not…

Overview on sec. infrastructure

- Depending on
  → area of protection
  → type of attack - leaving out inside jobs (!!!)

Malicious Traffic types:

- External: Internet facing
- Internal: non-Inet facing



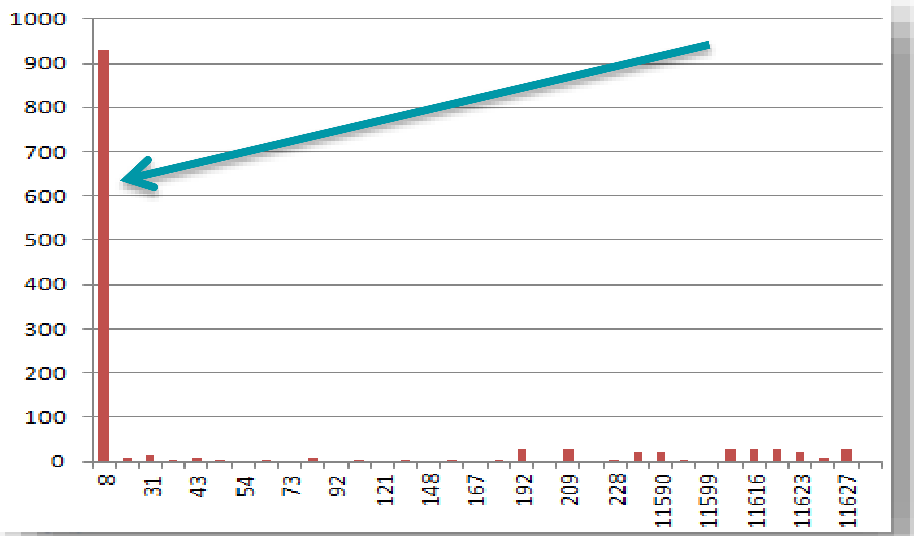
Demo #1: DMZ Service

Monitoring the request size in this example reveals some huge request resulting in a new connection initiated by the FTP Server

Source	Destination	Protocol	Size	Info
192.168.163.130	192.168.163.128	TCP	74	41779→21 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK_PERM=1 TSval=
192.168.163.128	192.168.163.130	FTP	108	Response: 220 3Com 3CDaemon FTP Server Version 2.0
192.168.163.130	192.168.163.128	FTP	1000	Request: USER 5FFy8o^Geersu!2E,ND3?[4gz)M5V,cC_MzJuMv}a]1C<*[mFI
192.168.163.128	192.168.163.130	TCP	62	1086→4444 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 SACK_PERM=1
192.168.163.1	192.168.163.128	TCP	66	56571→21 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SACK_PERM=1
192.168.163.128	192.168.163.1	FTP	96	Response: 220 3Com 3CDaemon FTP Server Version 2.0
192.168.163.1	192.168.163.128	FTP	70	Request: USER anonymous
192.168.163.128	192.168.163.1	FTP	87	Response: 331 User name ok, need password
192.168.163.1	192.168.163.128	FTP	75	Request: PASS anon@anon.anon
192.168.163.128	192.168.163.1	FTP	74	Response: 230 User logged in
192.168.163.1	192.168.163.128	FTP	60	Request: SYST
192.168.163.128	192.168.163.1	FTP	73	Response: 215 UNIX Type: L8
192.168.163.1	192.168.163.128	FTP	60	Request: FEAT
192.168.163.128	192.168.163.1	FTP	76	Response: 211- Feature listing
192.168.163.128	192.168.163.1	FTP	88	Response: MDTM

Demo #1: DMZ Service

Knowing your applications' behavior may lead to valid thresholds to reveal anomalies e.g. based on packet length, payload entropy or other factors



External perimeter defense

Perimeter defense: Monitoring all protocols

- Know your systems' configuration
- In-depth understanding of App behavior
- Monitor the events from sec. devices
- Correlate events after sec. alert

→ WebServer accessing other servers after "unsuccessful" exploit?

Demo #2: "Encrypted" sessions

Watch for protocol anomalies e.g. missing HTTP dissector information on HTTP ports containing no valid requests or malformed data

rel.Time	Source	Destination	Protocol	Size	Info
0.00000000	192.168.131.99	192.168.131.129	TCP	62	1178→80 [SYN] Seq=0 Win=64240 L
0.00027700	192.168.131.129	192.168.131.99	TCP	62	80→1178 [SYN, ACK] Seq=0 Ack=1
0.00033200	192.168.131.99	192.168.131.129	TCP	54	1178→80 [ACK] Seq=1 Ack=1 Win=6
0.01877300	192.168.131.129	192.168.131.99	TCP	58	80→1178 [PSH, ACK] Seq=1 Ack=1
0.13445500	192.168.131.99	192.168.131.129	TCP	54	1178→80 [ACK] Seq=1 Ack=5 Win=6

```
00 0c 29 94 82 d4 00 0c  29 74 9c 34 08 00 45 00   ..)..... )t.4..E.
00 2c 0b fe 40 00 40 06  a6 98 c0 a8 83 81 c0 a8   .,..@.@. ........
83 63 00 50 04 9a c2 52  31 7e fe 04 11 52 50 18   .c.P...R 1~...RP.
72 10 a2 6f 00 00 0b 01  00 00                     r..o.... ..
```

Demo #2: "Encrypted" session

Another example for pretended encrypted traffic not containing a valid SSL handshake

Sample: Using relative Sequence numbers try:

```
tshark -r <tracefile> -Y "tcp.dstport==443
and tcp.len > 0 and tcp.seq == 1 and
!ssl.record"
```

rel.Time	Source	Destination	Protocol	Size	Info
0.00000000	192.168.131.99	192.168.131.129	TCP	62	1178→443 [SYN] Seq=0
0.00027700	192.168.131.129	192.168.131.99	TCP	62	443→1178 [SYN, ACK]
0.00033200	192.168.131.99	192.168.131.129	TCP	54	1178→443 [ACK] Seq=1
0.01877300	192.168.131.129	192.168.131.99	SSL	58	Continuation Data
0.13445500	192.168.131.99	192.168.131.129	TCP	54	1178→443 [ACK] Seq=1

```
00 0c 29 94 82 d4 00 0c  29 74 9c 34 08 00 45 00   ..)..... )t.4..E.
00 2c 0b fe 40 00 40 06  a6 98 c0 a8 83 81 c0 a8   .,..@.@. ........
83 63 01 bb 04 9a c2 52  31 7e fe 04 11 52 50 18   .c.....R 1~...RP.
72 10 a1 04 00 00 0b 01  00 00                     r....... ..
```

The key question

Are you doing network forensics

a) To check whether there is something bad
b) To analyze something bad that is already known to be there

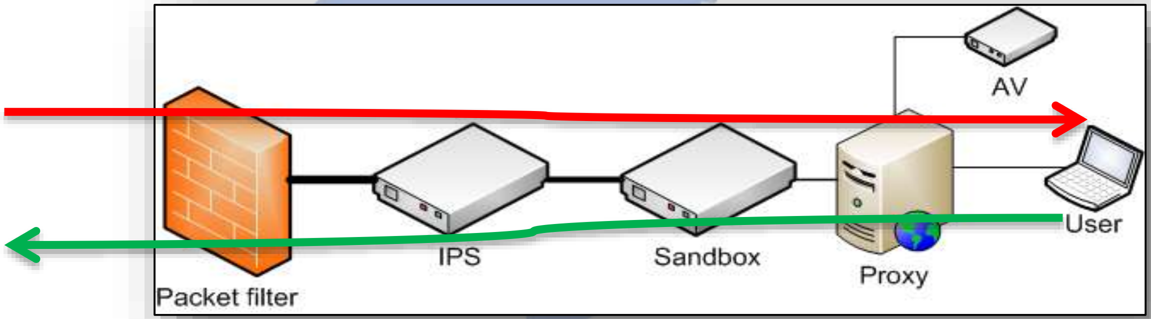
Internal I

Incoming traffic critical and monitored

But:

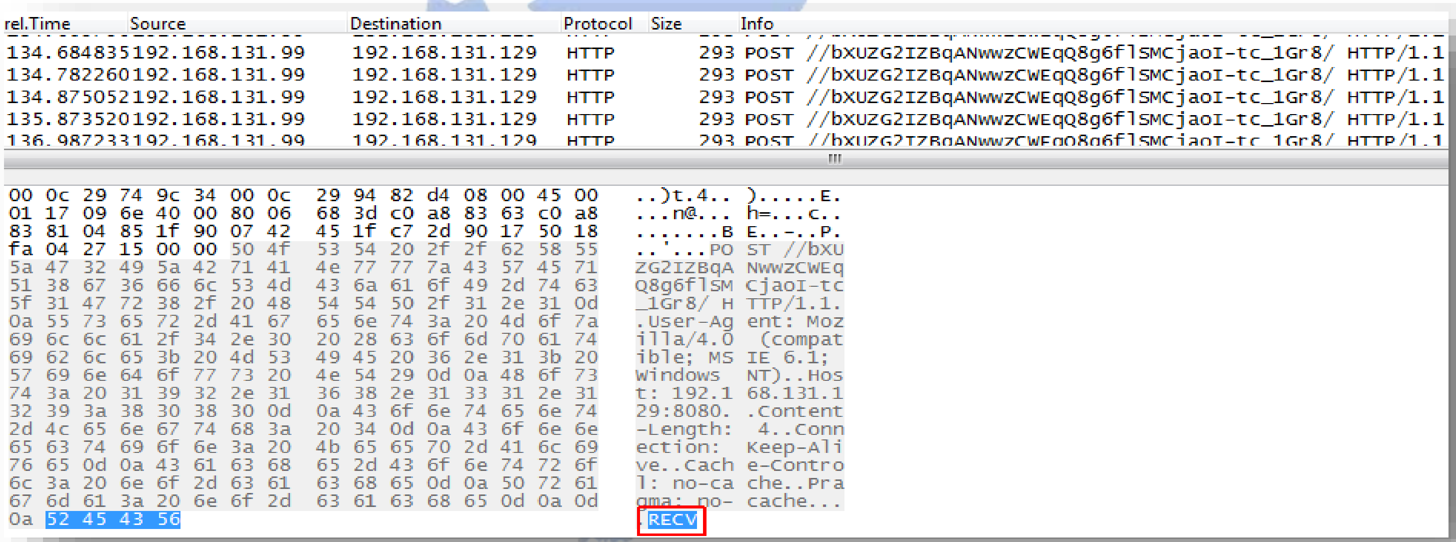
Sessions going out are trusted Mail/Web/FTP etc.

Internal traffic between "trusted devices"



Demo #3: Surfing the web

Also valid protocol requests may hint for an anomaly based on irregular behavior or other indicators



Internal II

Big issue: Lateral movement and other post-infection activities

- Internal scanning / enumeration
- Access to internal applications
- brute force attempts
- legitimate access with stolen credentials

→ Mostly depending on log files from internal sources

Baselining / Anomaly detection

Knowing your application behavior / network flows is critical to spotting malicious events

- Might be easy for default applications

  → Statistics: Conversation e.g.

- How about special applications?

Demo #4: Baselining sample

- Especially difficult if application payload types unknown or difficult to baseline

```
# tshark -r Trace1.pcap -Y udp -Tfields -e data | more
4b417947534b6753414142746157357062474674596d3841524739
e1650518e41793d5abb03d
755d021f5cf975c6342cc14f84caf5e0b863
e1680231b0aee0ecbb648c0a4b14167412cbfb16356e8b6b76db
755f02cf93f622f368d2fef70bf71c5e5f85a8e297eb79795ac04f
```

Legitimate example Skype

```
# tshark -r Trace2.pcap -Y udp -Tfields -e data | more
10a6b286d9736aae21afc2ddf005f6125f66633de613a63e46
10a6b286d9736aae21afc2ddf005f6125f66633de613a63e46
10a7
10a0b286d9736aae21afc2ddf005f6125f66633de613a63e46
10b15a78
10bf281d1581812c38ee0e0d90c18f2e5458bbc25bc030b0
10a1530e1598ba7ad499afea4ca126827f07de483537d0ad14c0be
```

Malicious example Peacomm.C malware

Baselining approaches e.g. Web

- Many approaches for finding unknown sources of malicious activity
- Sample: domain lists -> diff approach

- Cat I : Clean or already infected
- Cat II : newly infected

- Timely Diff's -> approach new infections / applications

How Wireshark can help

- Better understanding of your application behavior
- Scripted generation of baselining data
- Long-term comparison of network traces for detecting abnormal changes
- Incident Analysis Results can lead to good rules for IDS/IPS and other appliances

!! NO excuse for not having good log files !!

Where's the catch?

- Depending on the type of intrusion you're facing, different approaches are needed
- Criticality differs:
  - Standard Malware
  - Advanced Malware
  - Targeted dedicated Malware with strong external c2c and typical behaviour
  - Advanced compromise relying on classic malware
  - Advanced compromise using targeted tooling and completely unique software and leveraging max. legit looks

Demo #5: How Wireshark can help

DNS answers for localhost IP can lead to inactive c2c system

Beware: Also used for lots of valid reasons e.g. SPAM checking

```
tshark -r 127.0.0.x.pcap -Tfields -e dns.qry.name | grep -v -E
   "(<valid1>|<valid2>)" | sort | uniq -c | more
[…]
      1 xxxxxxx.mcafee.com
      1 yyyyyyy.mcafee.com
    147 <malicious1>.is-cert.com
    146 <malicious3>.ddns-ip.com
    148 <malicious4>.ddns-office.com
    148 <malicious5>.ddns.com
```

Demo #5: How Wireshark can help

Alternative: tshark –r 127.0.0.x.pcap –q –z hosts

Difference: Multiple answers containing same IP address in dns.a NOT listed

```
tshark -r 127.0.0.x.pcap -q -z hosts
[…]
127.0.0.1        {…}.ddns-ip.com
127.0.0.100      {…}.xxxxxx.mailshell.net
127.0.0.255      {…}
127.0.0.128      {…}
```

Recommendation: Malware Traffic Analysis

http://malware-traffic-analysis.net/index.html

Brad Duncan

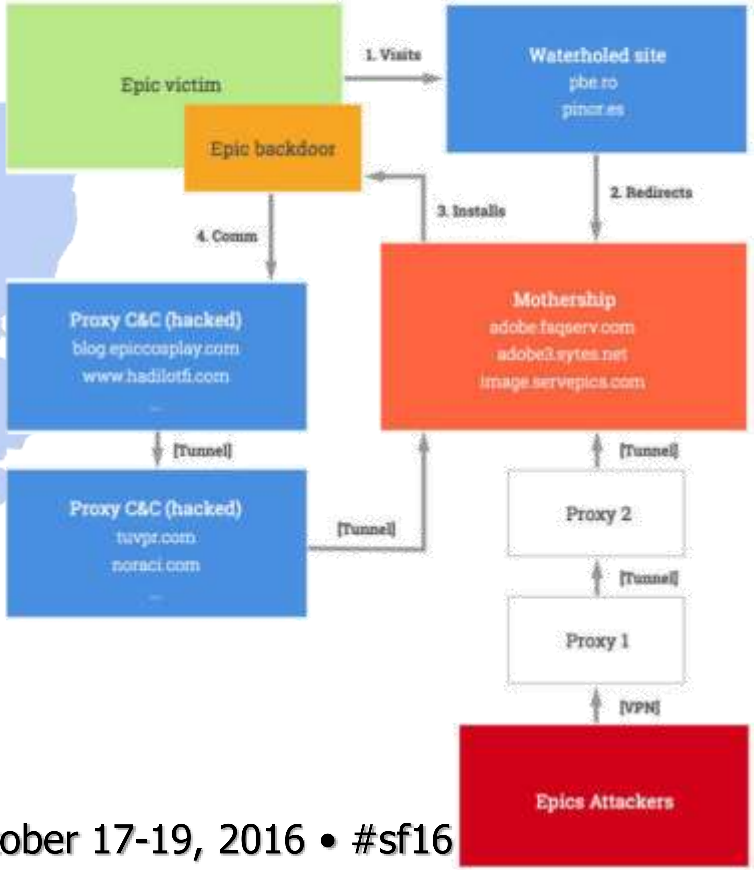
Recommendation: Network Forensics Workshop

https://www.first.org/_assets/conf2015/networkforensics_virtualbox.zip

PDF: first_2015_-_hjelmvik-_erik_-_hands-on_network_forensics_20150604

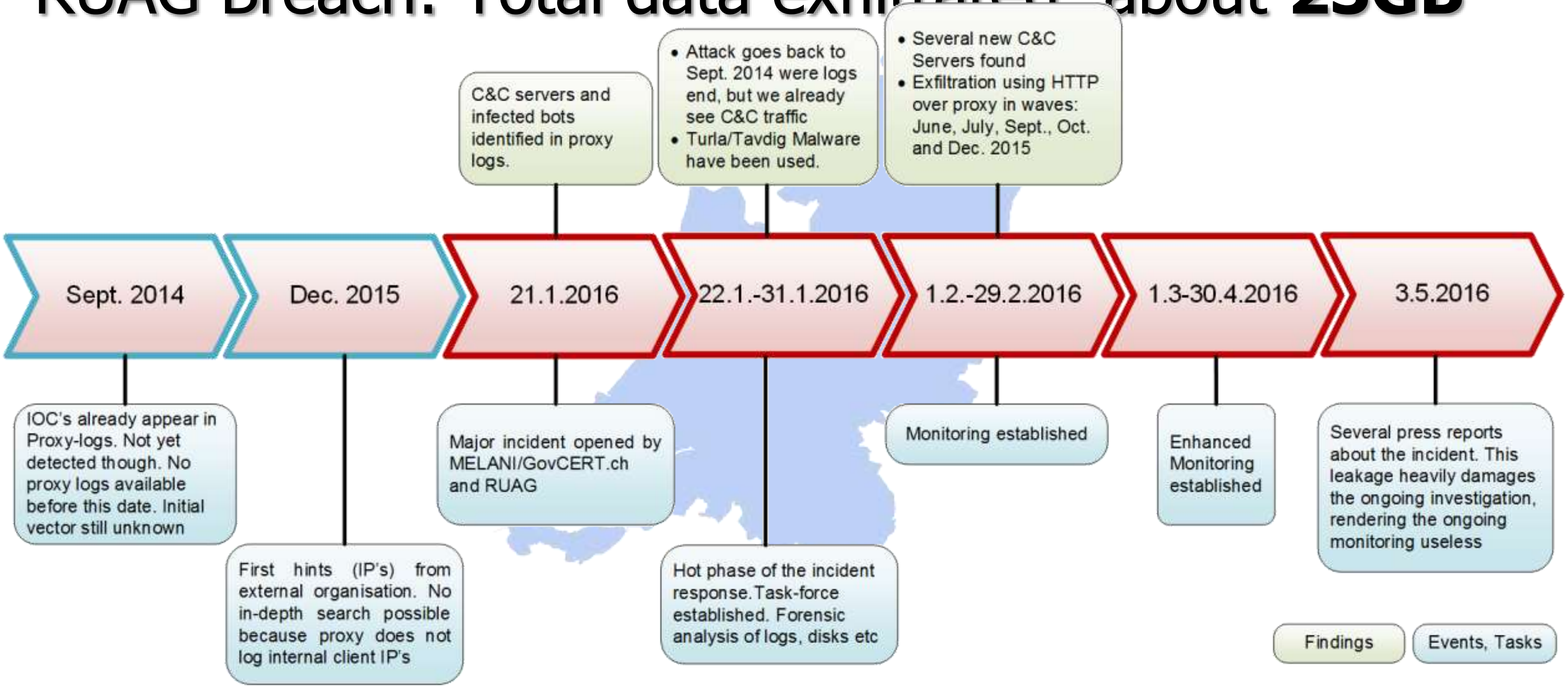
Tracing back

- Difficult at best when serious
- Image from Kaspersky Report about Epic Turla



The “Time” Factor

RUAG Breach: Total data exfiltrated: about **23GB**



Bringing it to the limit

Maximizing legitimate traffic types and applications

- e.g. Hammertoss

Check FireEye Report on APT29 -> search engine

Monitoring Networks - Proactive

- Use NetFlow/OpenFlow to monitor meta data
  - Set up alerts for unusual patterns
- Use IDS/IPS with optimized signatures
  - Reduce false positives as much as possible
- Set up Passive DNS / Passive SSL recording servers
  - Helps in tracking down name resolution and certificate history

Monitoring Networks - Reactive

- Forensic analysis on full packet captures
  - Has to be recorded before something happened, of course
  - Carefully selected locations, e.g. Internet outbreaks
- Use NetFlow/OpenFlow for meta data
  - Long term storage for forensic searches, e.g. „where did the attacker connect to from the infected system?“
- Use IDS/IPS as custom IoC alarm system
  - Write custom IDS rules for known **I**ndicators **o**f **C**ompromise from Wireshark Analysis results

Detecting malicious traffic

- Forget „silver bullets"

  → there is no "*showmethebadstuff*" filter

- Attackers may hide in plain sight (DNS, HTTP(S), FTP,...)

- Filter out positives
  - E.g. Alexa 1 Million
  - Known update sites: OS, AV, Vendors

Final Words

- Network defense is a 24/7 challenge
- Attackers only need to succeed once, defenders would need 100% success
  - Read as: it‘s not „if“ but „when“ an attack will succeed.
  - **Expect successful attacks on your network.**
- Keep searching
  - It‘s a continuous task
  - Don‘t just wait for some alarm to go off

!! Thank you for attending !!

Questions?

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