Deep Packet Inspection Challenges in a Transport Network

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GPG: 2deb 97b1 0a3c 151d b67f 1ee5 00e7 94bc 4d08 9191

Qrator Traffic Filtering Network

A global **anycast network** for traffic filtering and **DDoS** mitigation

Each point of presence:

- A properly chosen **generic hardware**
- A custom-built **DPI software**

Qrator Traffic Filtering Network

A **8 years** experience in:

- **DPI** appliance **design**
- **DPI R&D**
- Deployment and integration:
  - **ISP** networks
  - **Enterprise** networks

Qrator Traffic Filtering Network

The main purpose is **availability**

- Traffic analysis
- Monitoring and provisioning
- DDoS mitigation

DDoS Mitigation

A full OSI stack traffic analysis

L3: simple traffic **filtering**,
complex **network scanning** and mapping

L4-6: simple **flow assessment**,
complex aspects of **TCP/TLS edge cases**

L7: complex **session analysis**,
simple **Big Data** tooling

(haha, *not really*)

“L7 Packet Filtering”

An assumption:

“a simple packet-based analysis is just enough to tell malicious intent from a legitimate one, L3-L7-wise”

“L7 Packet Filtering”

This is **convenient.**

- Computational complexity
- Implied unreliability of sec. appliances
- SPAN, Netflow/IPFIX

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GoodbyeDPI

https://github.com/ValdikSS/**GoodbyeDPI**

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- **IP ID** Analysis
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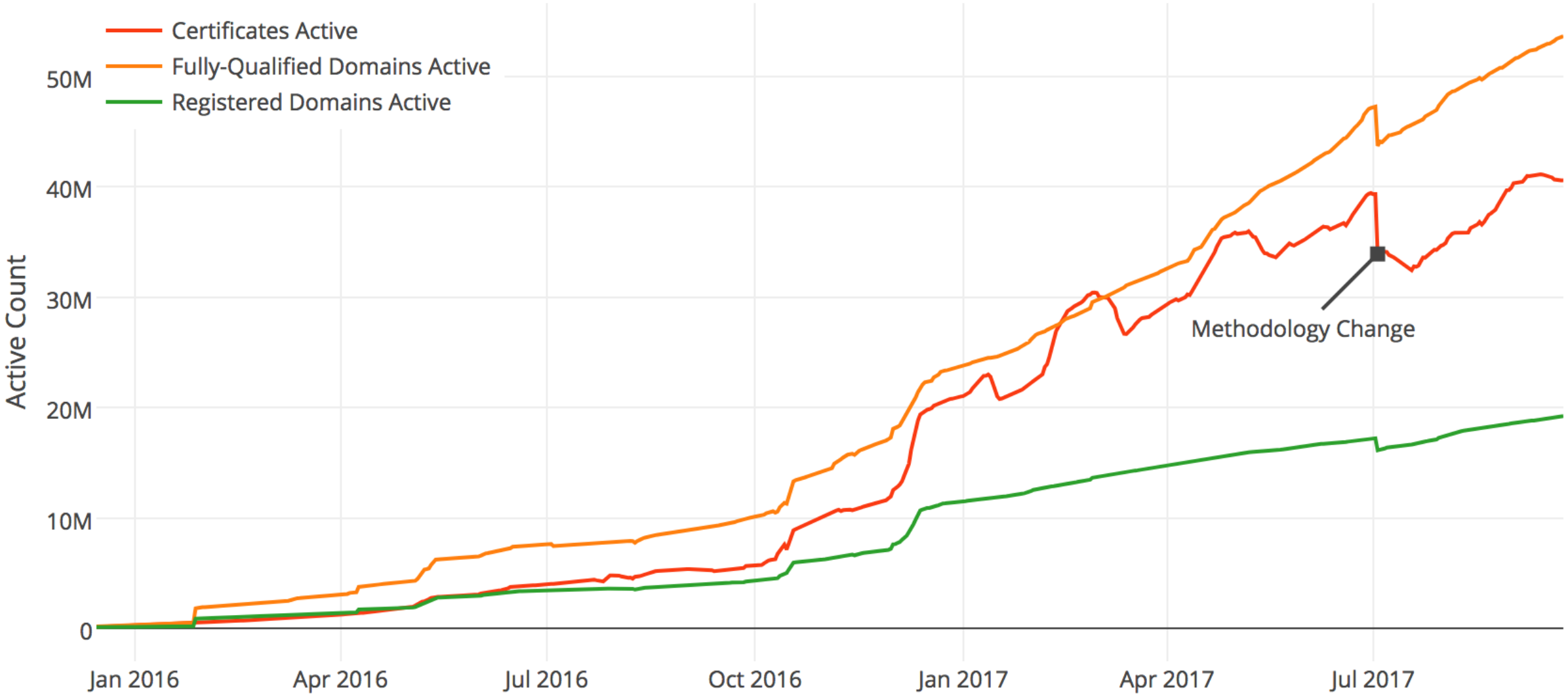
- **Game over** for most of DPI deployed by ISP

Let's Encrypt Growth



Percentage of Web Pages Loaded by Firefox Using HTTPS

(14-day moving average, source: Firefox Telemetry)

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It was ~~theoretically~~ vulnerable
even in the age of **cleartext.**

With heavy **TLS** and **PFS** deployment happening recently,

packet-based approach is **helpless** even for the means of DDoS mitigation.

Perfect Forward Secrecy

- Present in ephemeral Diffie-Hellman ciphers
- **Mandatory in TLS v1.3**
- Makes **out-of-path** analysis **impossible**
- Makes **historic data** analysis **impossible**

Perfect Forward Secrecy

Good catch for an out-of-path DPI and/or WAF

70% HTTPS requests come and go without analysis

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Good catch for an out-of-path DPI and/or WAF

70% { 60% legitimate
90% malicious } HTTPS requests come and go without analysis

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  (enough said already)
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Within an IP transport network

With comp. complexity of conn/sess. tracking

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Catastrophic backtracking

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```
(x+x+)+y
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx...x
```

$O(n^2)$ behaviour!

https://blog.codinghorror.com/regex-performance/

DPI Caveats

A DPI is commonly believed to be **a silver bullet**,

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A **single** piece of equipment
won't cope with **every** DPI goal

Even with a single goal,

there's a ***trade-off***
between the packet processing ***speed***

and the expected ***functionality***
to a certain extent.

Network design: transparent IP network

- VoIP
- Gaming
- Overlay networks

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- Enterprise VPN
- Modern Web:
  HTTP/2, MPTCP, QUIC…
- Modern Net:
  TLS v1.3, DNSSEC, CAA…

Network design: transparent IP network

DPI **breaks** this transparency.

The outcome

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- Several important applications **suffer**

Placeholder: NAT/Middleboxes

- TLS 1.3 shows increased connection failure rates in the field
  - Hard to get clear measurements, but probably the 1-10% range
  - Problem seems to be middleboxes
- Currently studying various approaches
  - Make connection look less like TLS 1.2 (PR#1051)
  - Make flight look more like TLS 1.2 (maybe like resumption?)
  - Fallback paired with middlebox fixing
  - More data needed.
- More soon (next few months)

(slides by Eric Rescorla, http://tinyurl.com/tls13ietf99)

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- Others **adapt**

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An Arms Race

- ENOG 13: the **ISP Security Roundtable**
- It takes up to **4-6 months**
  to deploy an updated network firmware
  even in case of a vulnerability discovered

4-6 months

- 2-3 months
  on the vendor side
  alone.

Илья Медведовский
17 августа ·

С одной стороны:
- 252 000 уязвимых роутеров в Интернете;
- главный приз pwn-конкурса в Гонконге в мае.
С другой:
- "Вероятно мы закроем эту уязвимость в октябре".

Циско, прекрати, зачем так быстро.

Нравится Комментарий Поделиться

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  on the vendor side
  alone.

- 2-3 months **more** to roll out the update all across the IP network.

An Arms Race

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- A modern application
  (including, but not limited to IoT and malware)

  makes heavy use of the **CI/CD** approach,
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An Arms Race → is lost at that point.

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The Day after Tomorrow

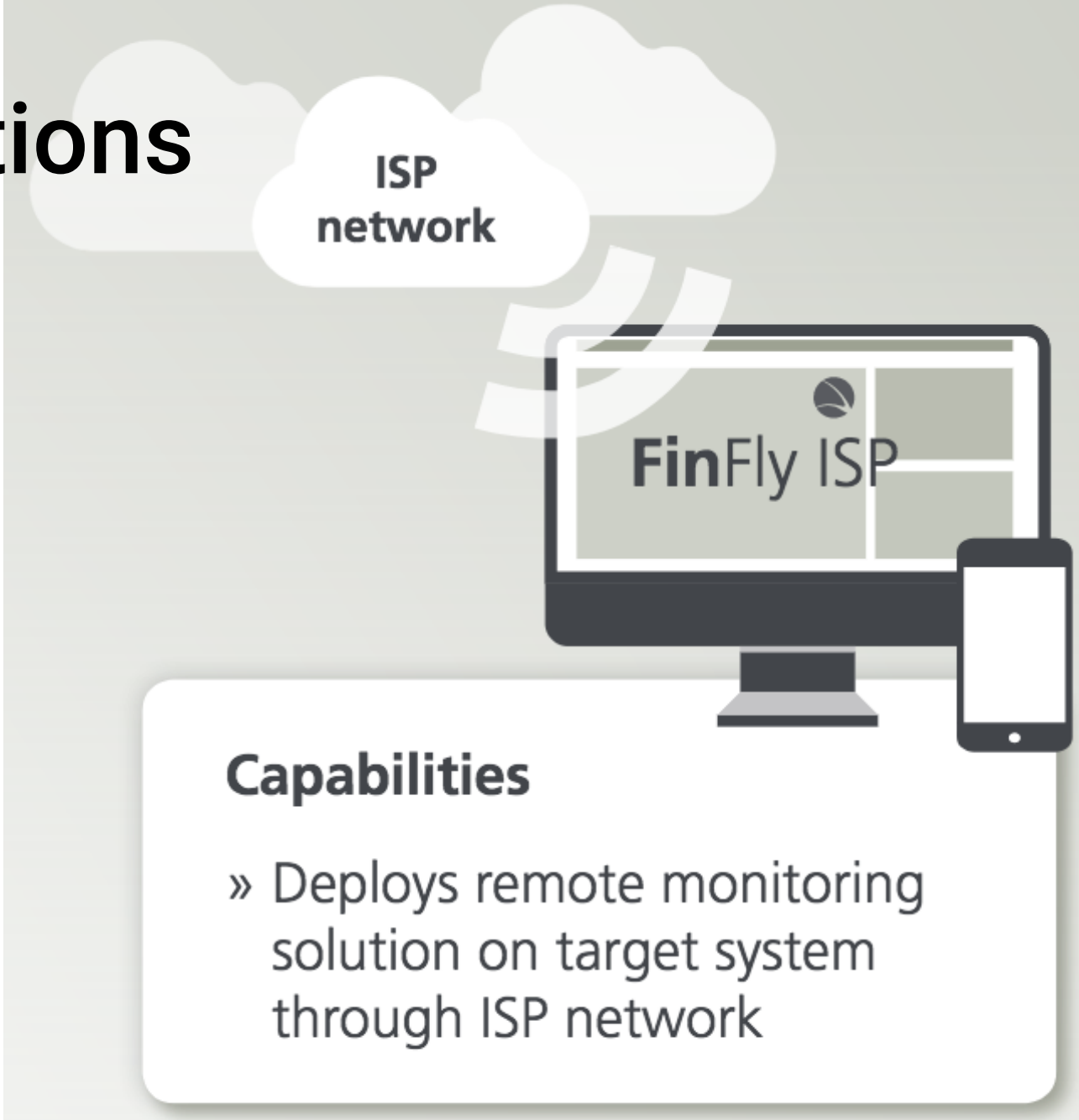
- A packet-based DPI is **unsufficient**

  It has its regions of applicability though – it's **when you're fine with 80/20 rule**:
  - Parental control
  - Simple QoS
  - Targeted advertisement
  - **General** lawful interception and copyright enforcement
- A session-based DPI is **vulnerable**
  when neither a client nor a server is under the DPI vendor control

  The implied heavy computational complexity
  renders a DPI unable to transparently handle
  every new network activity in time, as it goes.

Security Considerations

- DPI: complex solution
- Security awareness of vendors?
- FinFisher spyware as a PoC
- The risk and the implied loss potential are beyond imagination
  (i.e. a “futurological congress” scale)



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Either this, or an **unreliable IP transport**,
ad-hoc applications,
and **an inherent instability** of the **core** infrastructure.

Q&A

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