Elie Bursztein
eb@lsv.ens-cachan.fr

Probabilistic Identification for Hard to classify Protocol

Elie Bursztein
PhD Student LSV ENS-CACHAN CNRS INRIA DGA

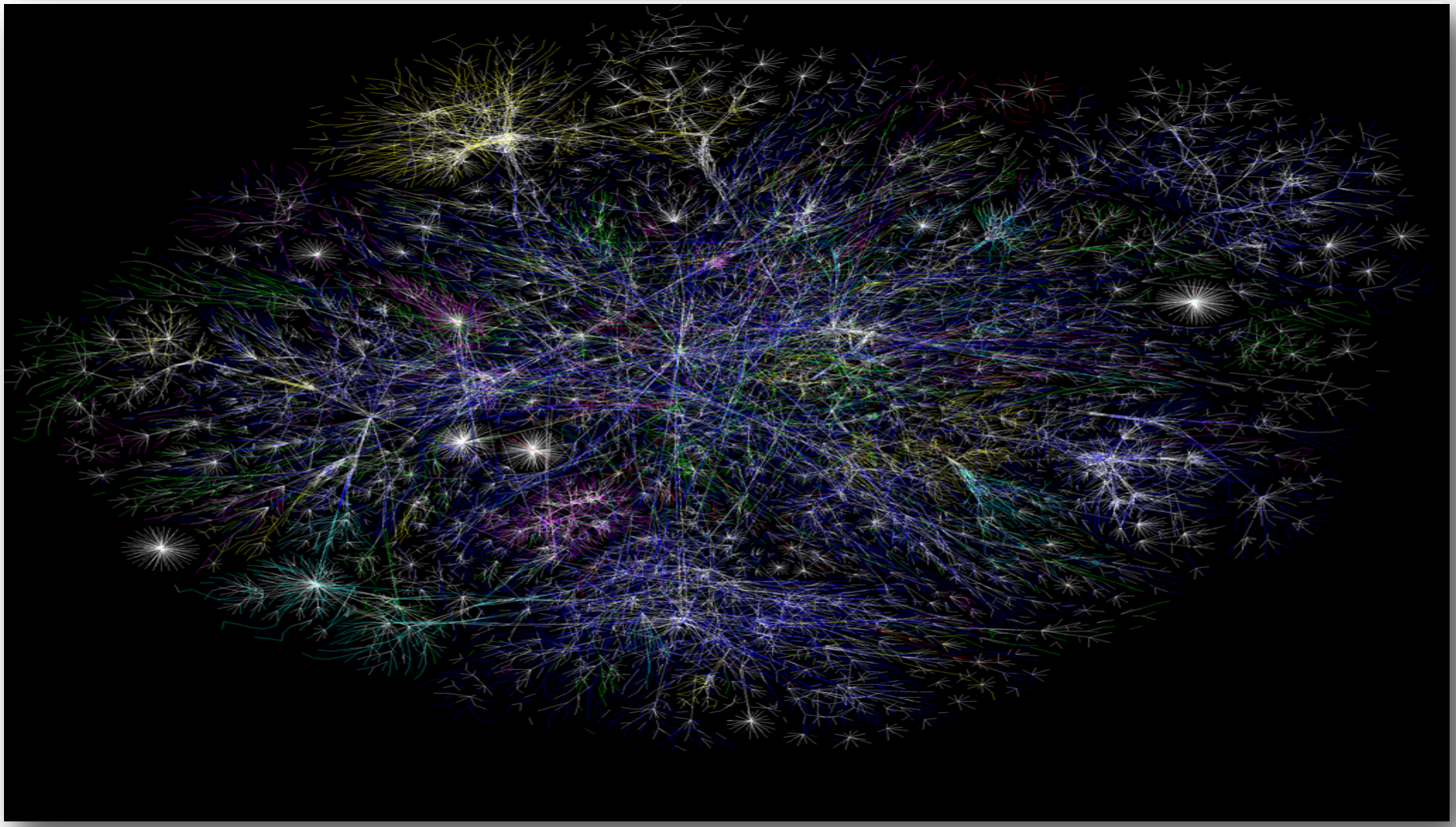
Outline

Elie Bursztein
eb@lsv.ens-cachan.fr

Introduction	• What is a hard to classify protocol ?
Payload	• Identification based on payload analysis
Classifier	• Identification based on discriminator
Combining Techniques	• Combining techniques for a better classification
Conclusion	• What is next ?

The Internet Galaxy

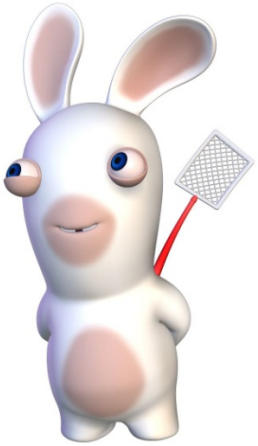
Elie Bursztein
eb@lsv.ens-cachan.fr



Opte project

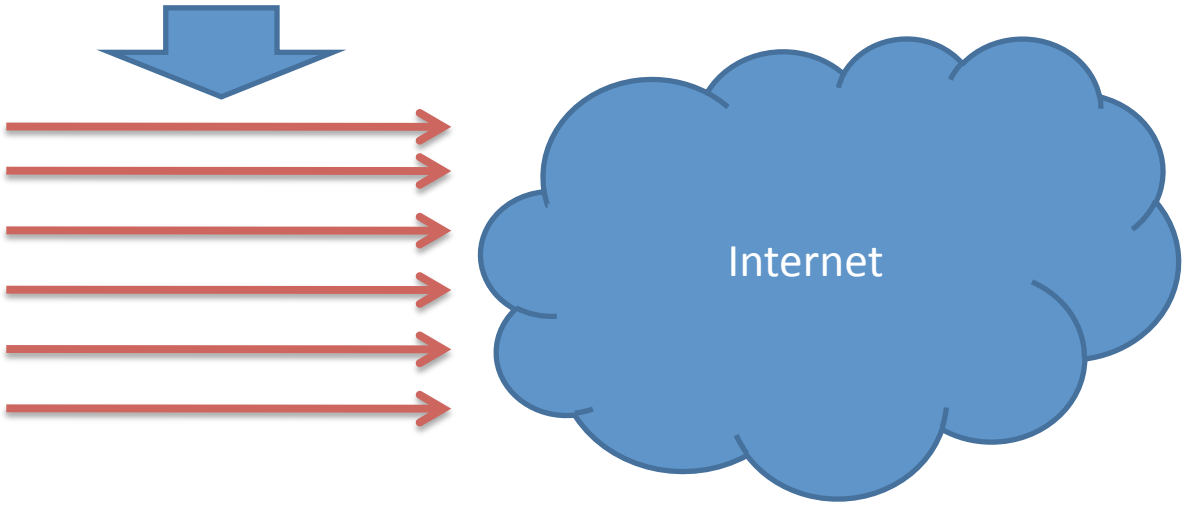
Knowing what is going on

Elie Bursztein
eb@lsv.ens-cachan.fr



Monitoring

Users



The impact of furtive protocols on a large university

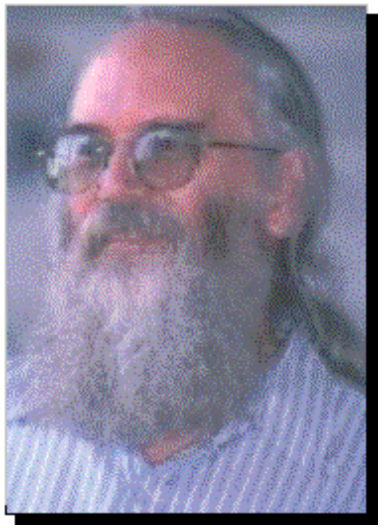
Elie Bursztein
eb@lsv.ens-cachan.fr

University of Calgary

Internet Assigned Numbers Authority (IANA)

- Founded in 1970
- Manage DNS root
- Coordinate IP and AS
- Assign a standard port to protocol

Jon Postel



Some well known ports

Elie Bursztein
eb@lsv.ens-cachan.fr

Protocol	Port
HTTP	80
POP	110
FTP	21
SMTP	25
SMB/CISF	139

But what is the default port for Emule ???

Protocols Examples

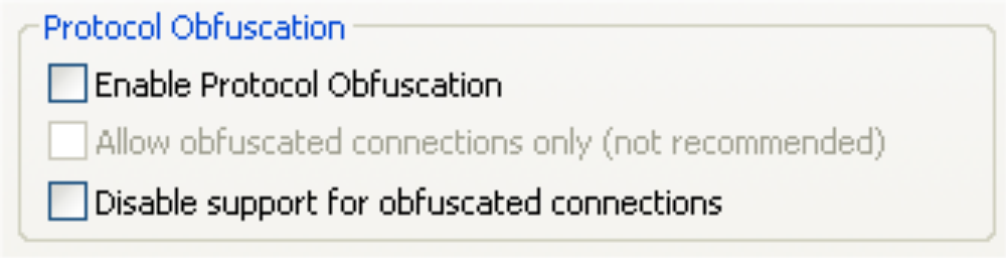
Elie Bursztein
eb@lsv.ens-cachan.fr

Easy to classify

- Use fixed port
- Have an open specification
- Well know message type and size

Hard to classify

- Use dynamic port
- Hijhack well known port
- Introduce randomness in message
- Use cryptography to avoid payload analysis



Motivation for furtive protocol

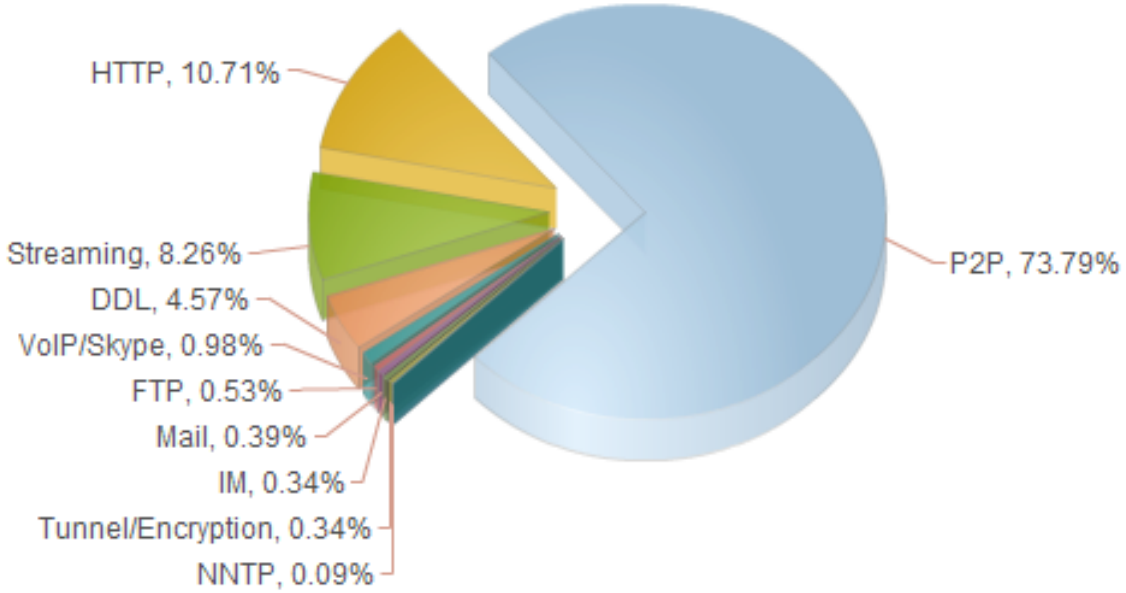
Elie Bursztein
eb@lsv.ens-cachan.fr

- Fighting coercion
- Preserving freedom of speech
- Bypass connectivity restriction
- Exchange illegal data

"This helps against situations were the eMule Protocol is unjustly discriminated or even completely blocked from a network by identifying its packets."

Traffic in Germany (2007)

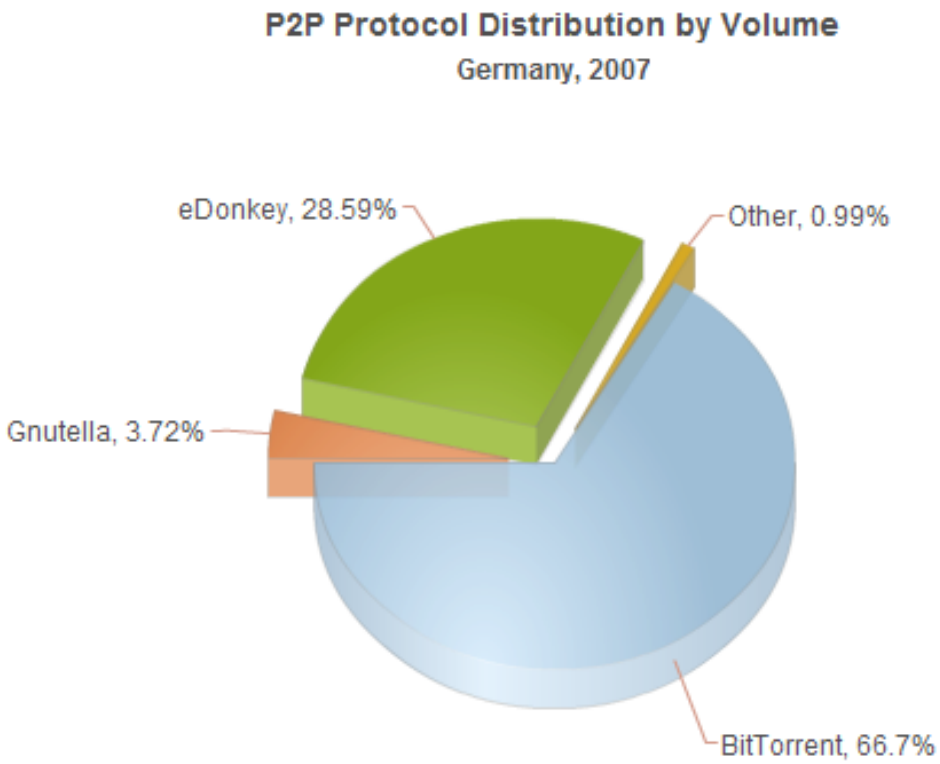
Elie Bursztein
eb@lsv.ens-cachan.fr



Ipoque

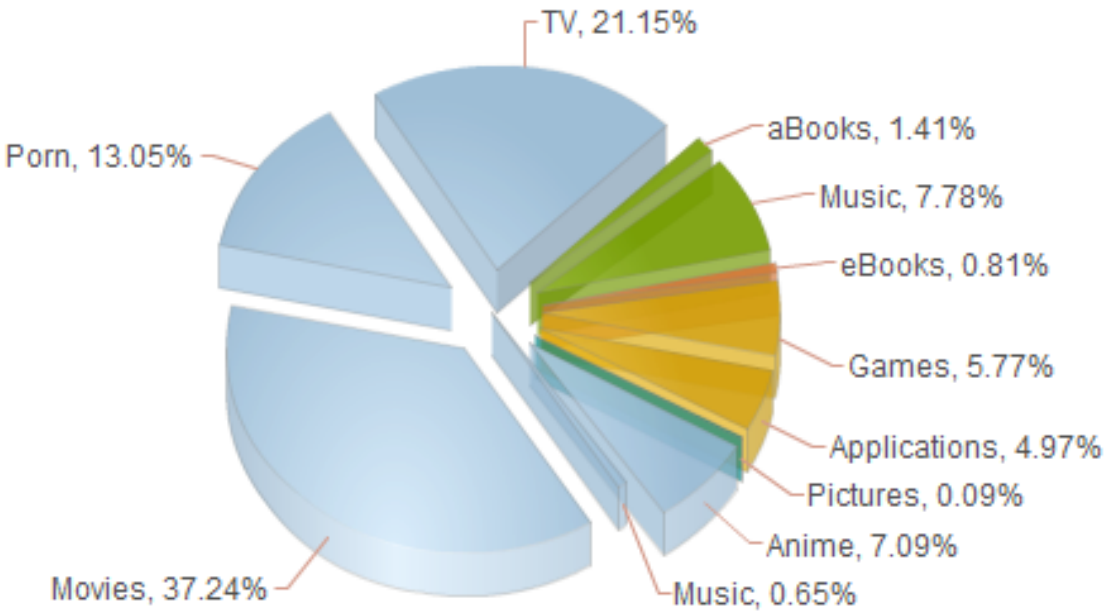
P2P repartition

Elie Bursztein
eb@lsv.ens-cachan.fr



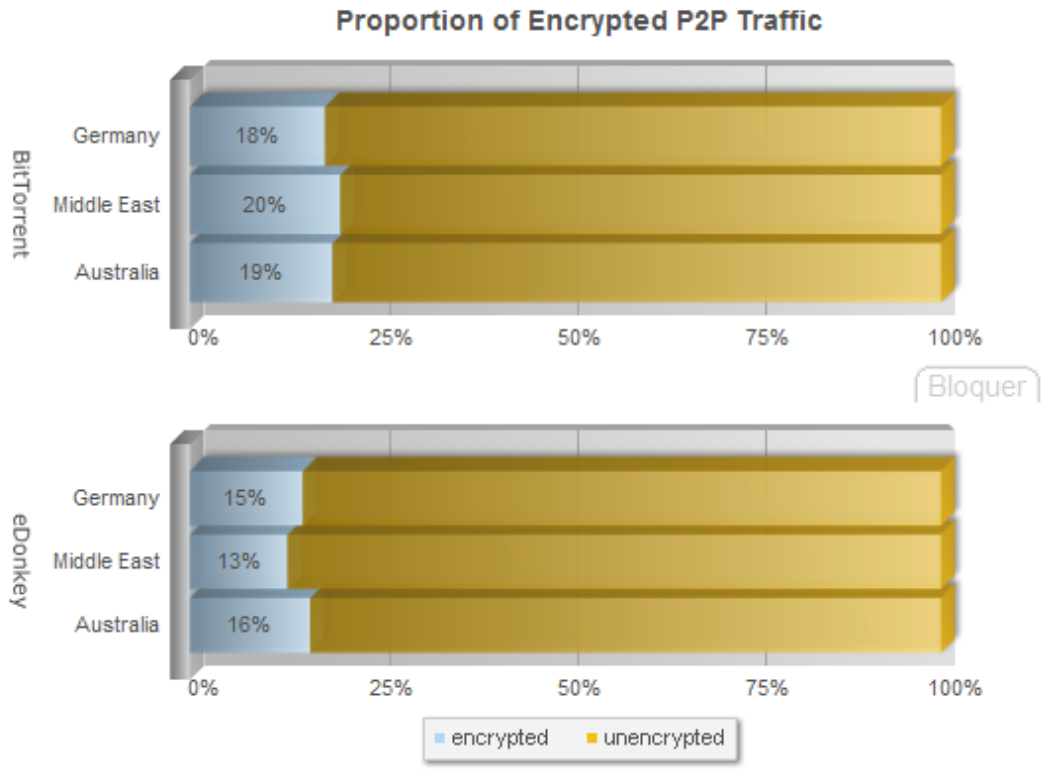
P2P usage

Elie Bursztein
eb@lsv.ens-cachan.fr



Use of cryptography

Elie Bursztein
eb@lsv.ens-cachan.fr



Payload Classification

Elie Bursztein
eb@lsv.ens-cachan.fr

- Inspect the packet payload
- Known to be the most accurate method
- Payload not always available
  - Juridical reason
  - Encryption

Example of Signature

Elie Bursztein
eb@lsv.ens-cachan.fr

- Nice signature

pcmatch ssh m/^SSH-([.\d]+)-/ i/protocol $1/ p|ssh|

- A not so nice signature

pcmatch edonkey m`^[\xc5\xd4\xe3-\xe5].?.?.?.?([\x01\x02\x05\x14\x15\x16\x18\x19
\x1a\x1b\x1c\x20\x21\x32\x33\x34\x35\x36\x38\x40\x41\x42\x43\x46\x47\x48\x49\x4a
\x4b\x4c\x4d\x4e\x4f\x50\x51\x52\x53\x54\x55\x56\x57\x58[\x60\x81\x82\x90\x91\x9
3\x96\x97\x98\x99\x9a\x9b\x9c\x9e\xa0\xa1\xa2\xa3\xa4]|\x59.....?[-~
]|\x96....$)` f/p2p/ i/eDonkey2000 or emule P2P filesharing generic signature/

Combining Payload Score

Elie Bursztein
eb@lsv.ens-cachan.fr

- Payload score use a *weighted moving average* formula:

Confidence in signature

Position of the match

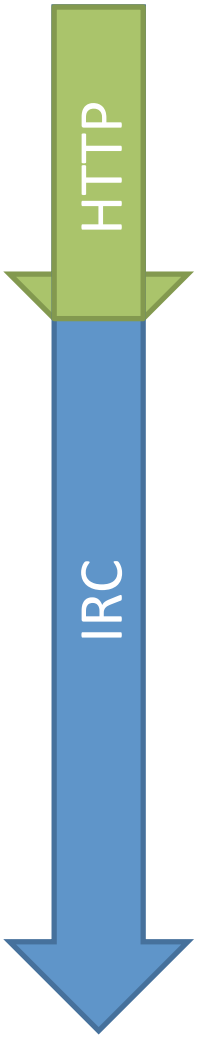
$$\mathbb{P} = \frac{D_{x_i} \times n + D_{x-1} \times (n-1) + \ldots + D_{x_1} \times (1)}{n + (n-1) + \ldots + 1}$$

Number of payload

- This formula take into account signature confidence

HTTP Tunnel

Elie Bursztein
eb@lsv.ens-cachan.fr



CONNECT irc.********.org:6667 HTTP/1.0

HTTP/1.0 200 Connection established

USER 0 0 0 ::

NICK ****

:irc.********.org 001 **** :Welcome to the ****!0@xxx

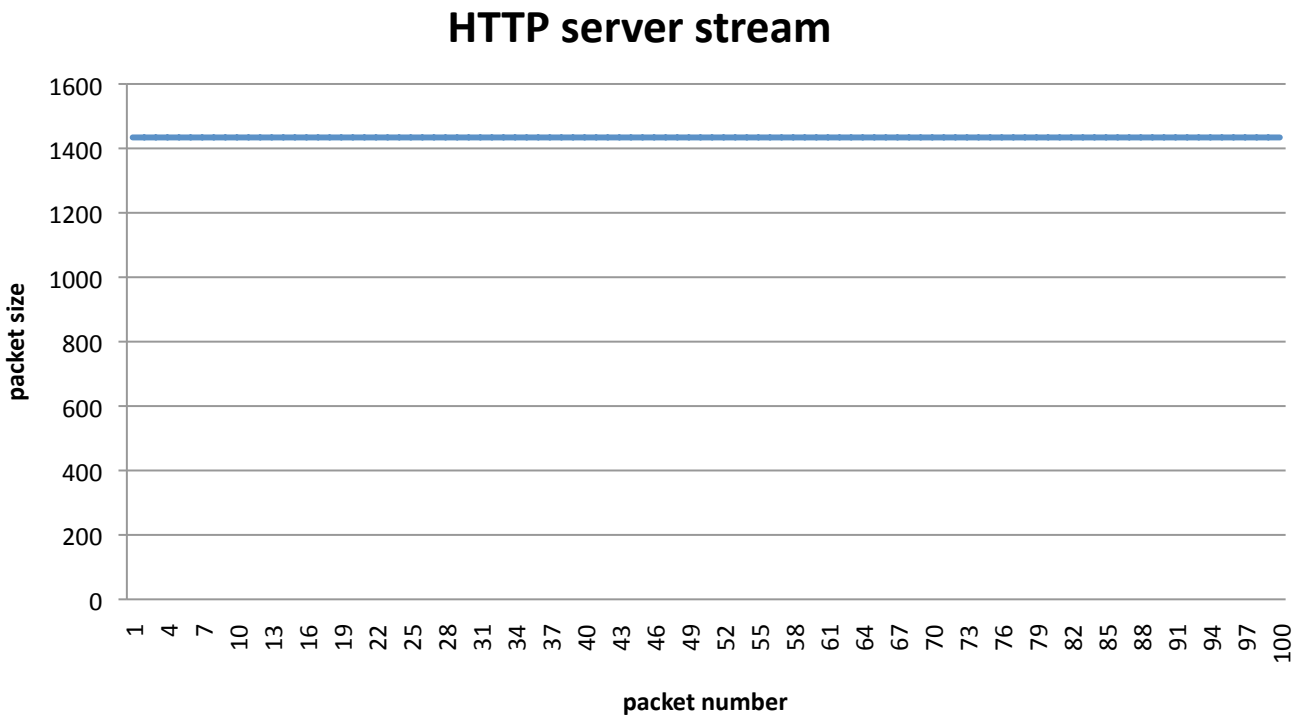
Classifier

Elie Bursztein
eb@lsv.ens-cachan.fr

- Analyze the shape of the session
- Use discriminators
  - Packet size
  - Packet delay
  - Packet Entropy

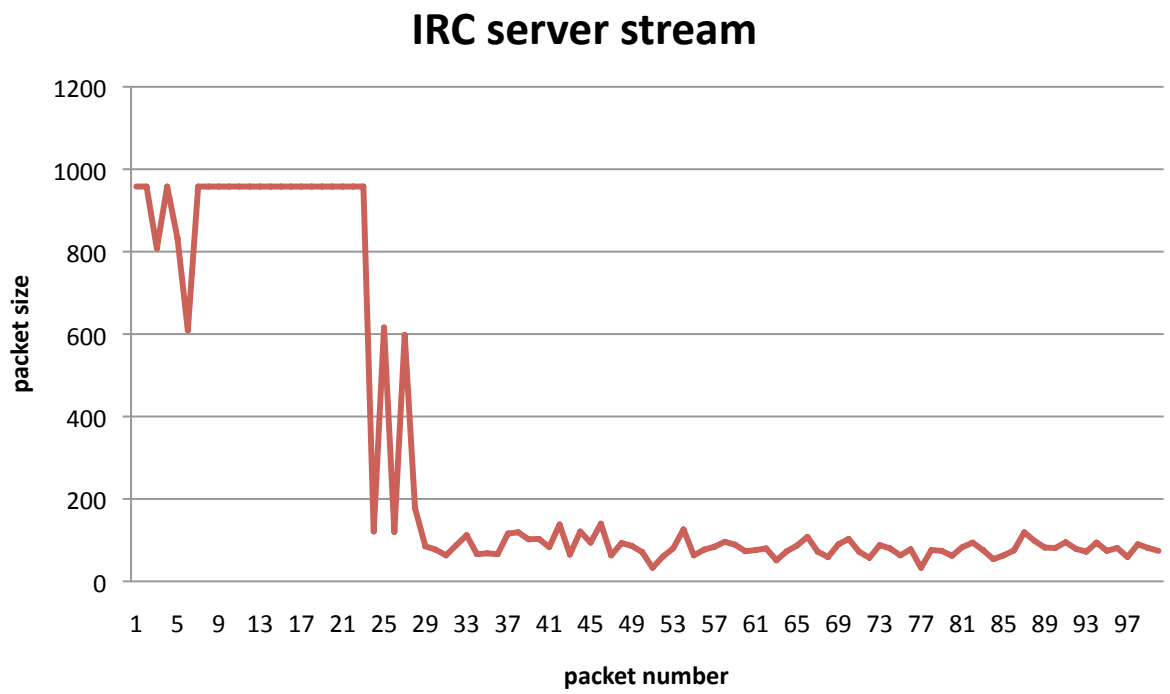
HTTP

Elie Bursztein
eb@lsv.ens-cachan.fr



IRC server Packet Size

Elie Bursztein
eb@lsv.ens-cachan.fr

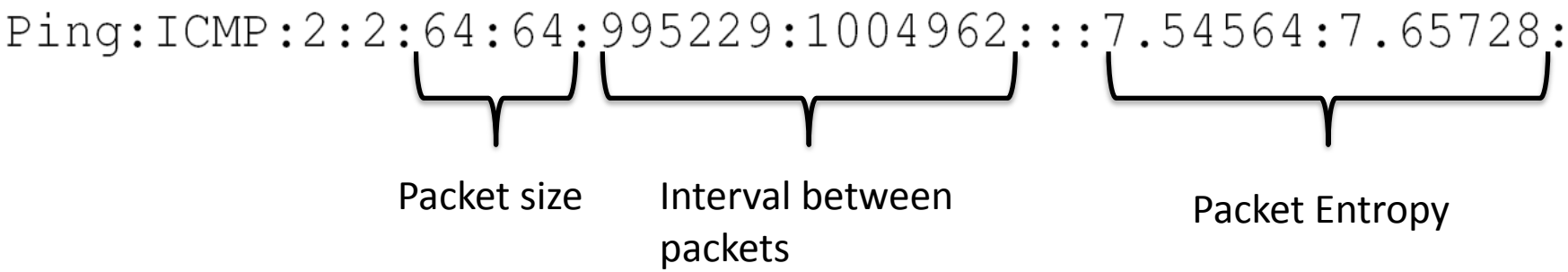


Building Profile

Elie Bursztein
eb@lsv.ens-cachan.fr

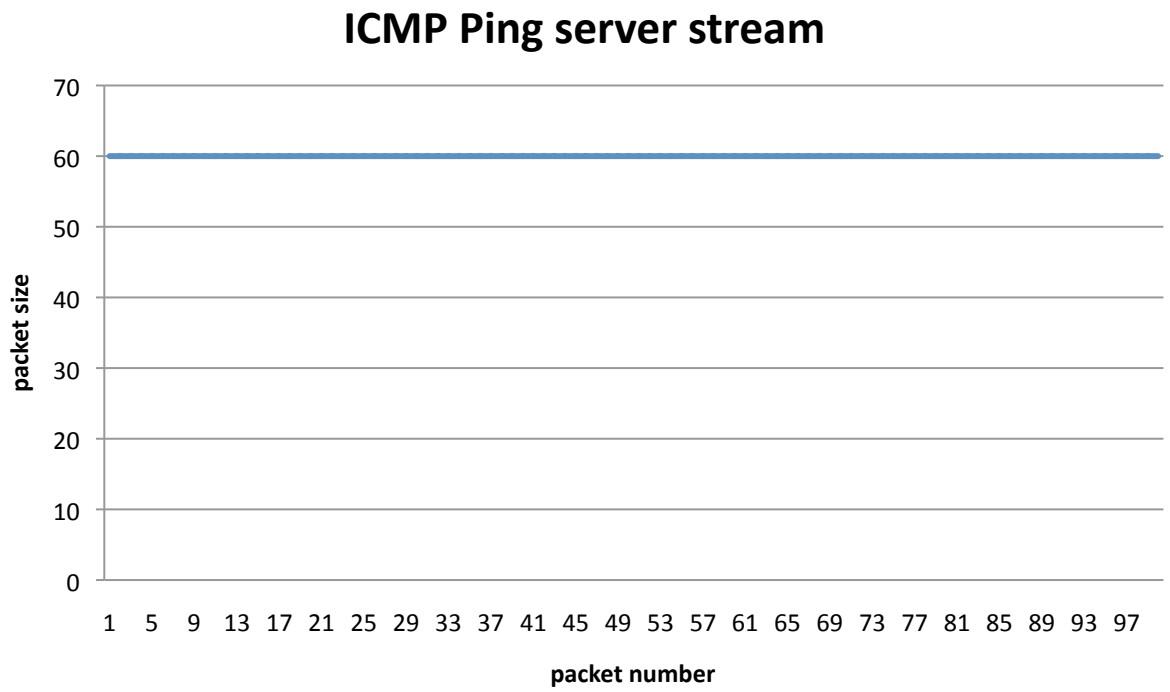
- Using 22 different set of profiles by protocol
  - A set for each packet from 1 to 10 for each stream
  - Clustering is done with the K-means algorithm
  - Lower and upper bound of each discriminator

- ICMP Ping profile



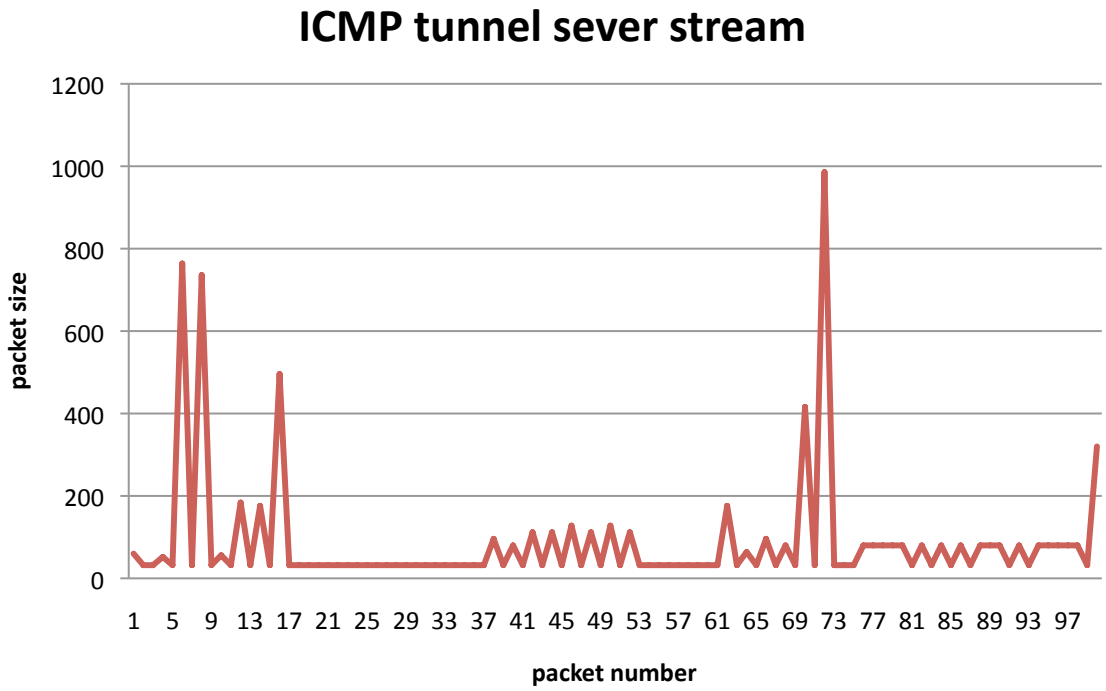
Regular ICMP Ping Reply

Elie Bursztein
eb@lsv.ens-cachan.fr



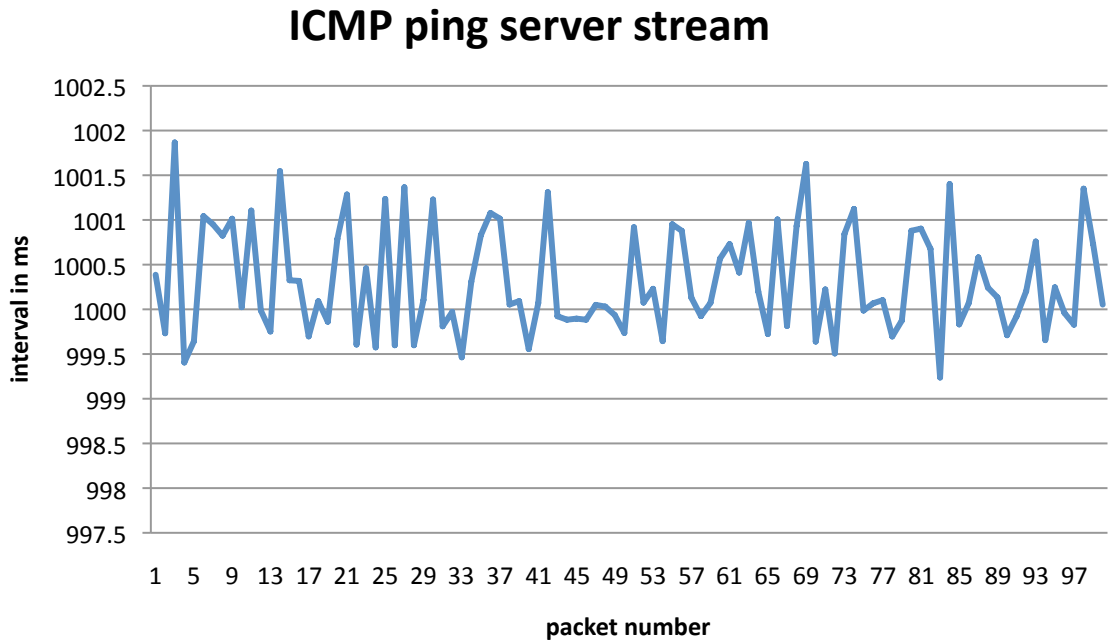
Ptunnel Server Stream

Elie Bursztein
eb@lsv.ens-cachan.fr



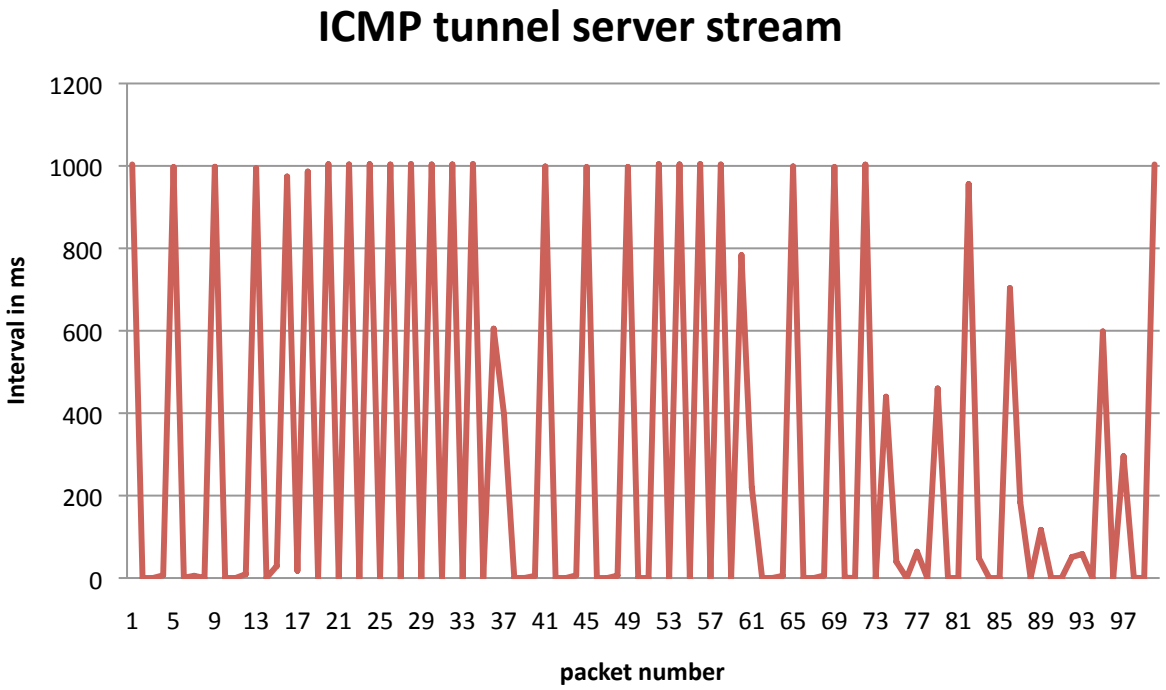
Ping reply delay between packet

Elie Bursztein
eb@lsv.ens-cachan.fr



Delay between packet in Ptunnel session

Elie Bursztein
eb@lsv.ens-cachan.fr



Combining techniques

Elie Bursztein
eb@lsv.ens-cachan.fr

- Combining techniques to obtain a better identification

Port heuristic score

Classifier score

Payload score

$$\mathbb{P}_x = \frac{\alpha\mathbb{H}_x + \beta\mathbb{C}_x + \gamma\mathbb{S}_x}{\alpha + \beta + \gamma}$$

port heuristic confidence

Classsifier confidence

Payload confidence

- Implementation use the following confidence value: 1 5 10

Example of identification

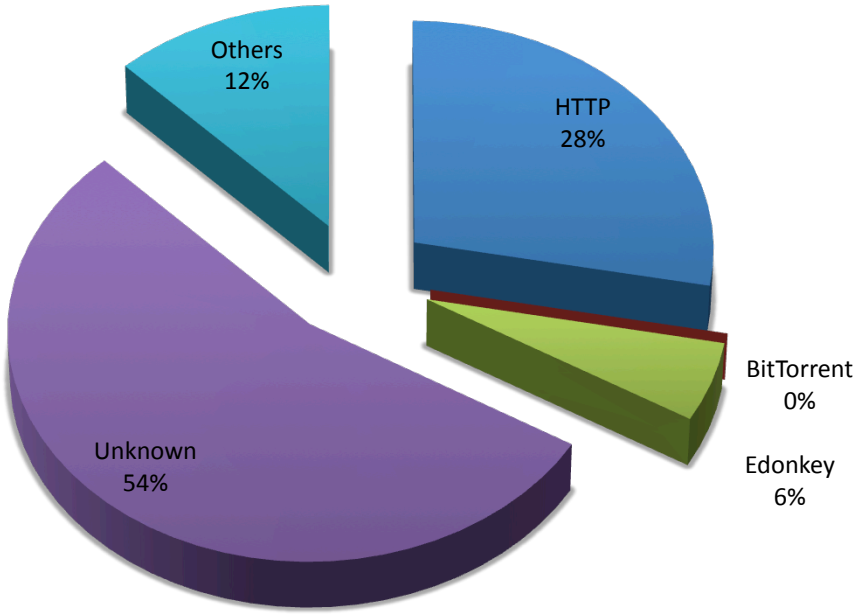
Elie Bursztein
eb@lsv.ens-cachan.fr

```
(1)http (94%): x:1052 -> y.:2080 F:0/2 R::2/0 R:0/2 E:0/0 TCP CLOSED RST
(2)[Traffic] I:1 Kb/s (3pkt) O:37 Kb/s (20pkt) [Distance] C:local S:7
(3)[Protocol]:http (1.1) HyperText Transfer Protocol - RFC 2616
(4)[File] request:www.xxx.org/vip.html Ref:"http://xxx"
(5)[File] content: extension:.html familly:text  (X)HTML
(6)[File] request:www.xxx.org/hello.gif Ref:"http://xxx"
(7)[File] content: extension:.jpg familly:image
(8)[Server] Apache httpd 2.0.52
(9)[Client] browser Internet Explorer 6.0 Windows XP
(10)[Client] proxy squid 2.5.STABLE4-20031106
(11)[Guessed protocol] http:94% Port:0% Class:100% Patt:100%
(12)[Guessed protocol] autodesk:9% Port:100% Class:n/a Patt:0%
```

$$\mathbb{P}_{http} = \frac{1 \times 0 + 5 \times 100 + 10 \times 100}{16} = 93.75$$

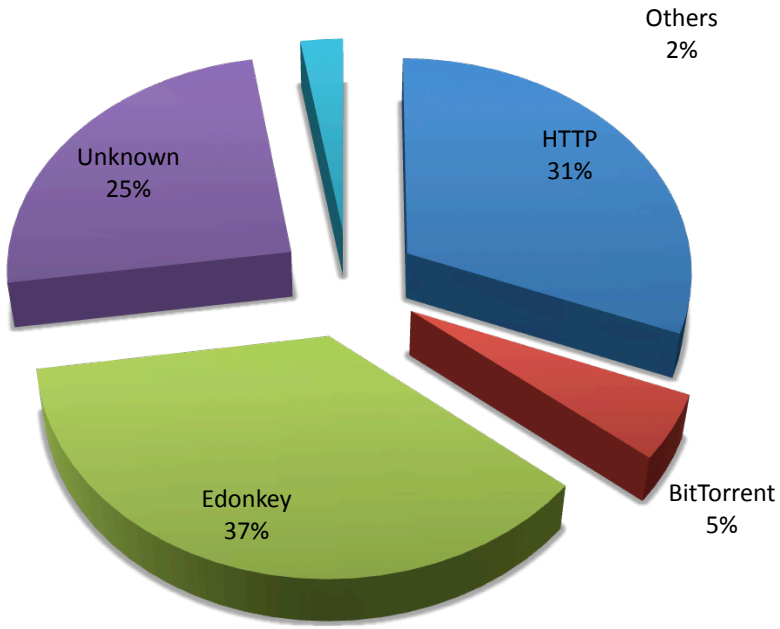
Evaluation against Residential Traffic without advanced inspection

Elie Bursztein
eb@lsv.ens-cachan.fr



Residential traffic with advanced inspection

Elie Bursztein
eb@lsv.ens-cachan.fr



Future

Elie Bursztein
eb@lsv.ens-cachan.fr

- More identification method
  - Number of connections ration (in/out)
  - Connection sequences
- When Random is too random

Conclusion

Elie Bursztein
eb@lsv.ens-cachan.fr

- Accurate classification is an increasing issue
- A lot need to be done to pace with evasion techniques

Questions

Elie Bursztein
eb@lsv.ens-cachan.fr

Elie Bursztein
eb@lsv.ens-cachan.fr