XPROBE

Building Efficient Network Discovery Tools

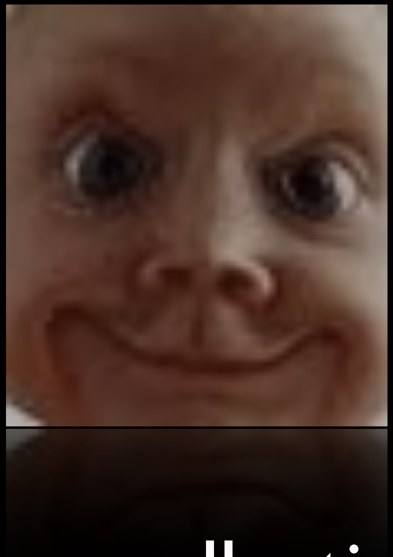
Fyodor Yarochkin

Outline

- Introduction
- Some motivating stories: real-life attacks
- Efficient network mapping with “Lazy Scan” mode
- Layer 7 extensions
- Scripting Extensions
- Data Mining and Experimental Data sharing network

Introducing presenter

- Fyodor.Y

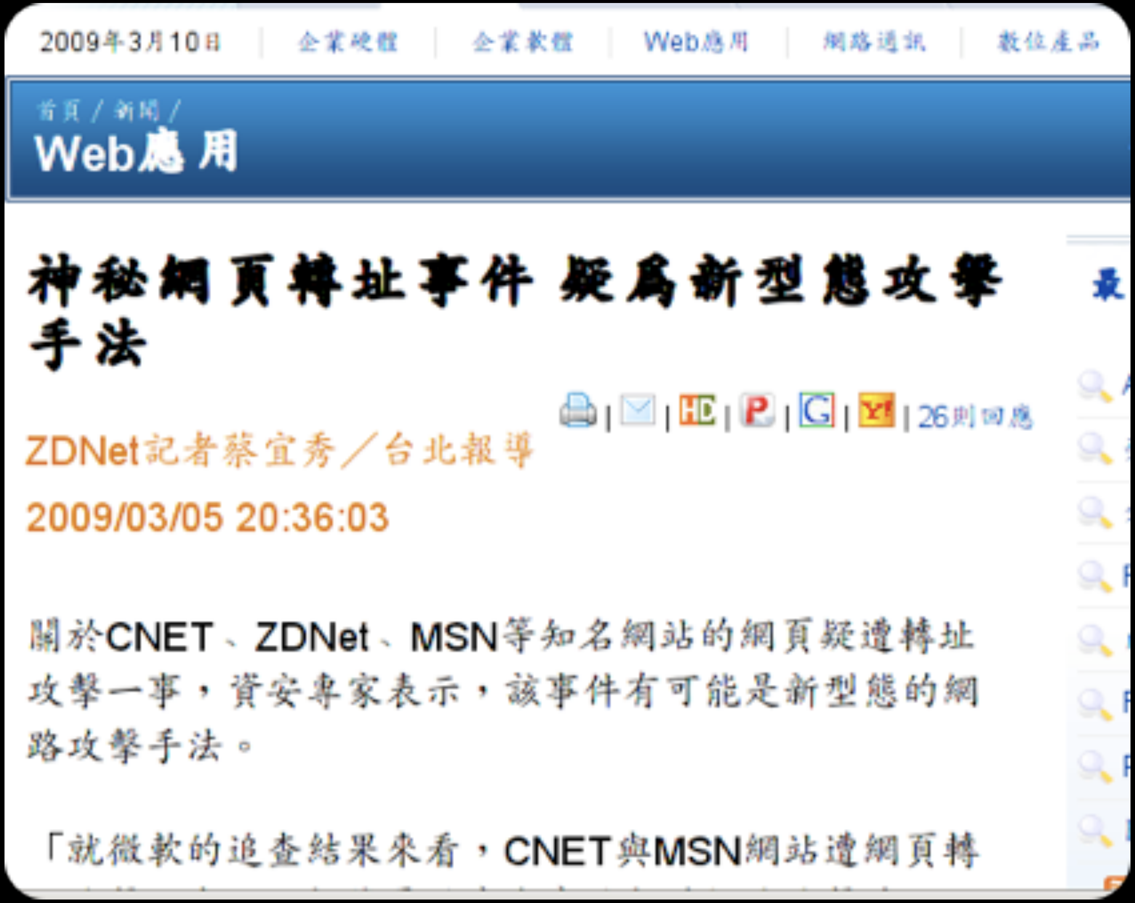


- Interests:
  - Intelligence collection/analysis
  - Network discovery and network protocols
  - AI

Attack Trends

China vs. Taiwan

briefs of cyber “wars”


2009年3月10日 | 企業硬體 | 企業軟體 | Web應用 | 網路通訊 | 數位產品
首頁 / 新聞 /
Web應用
最
26則回應

神秘網頁轉址事件 疑爲新型態攻擊手法

ZDNet記者蔡宜秀／台北報導

2009/03/05 20:36:03

關於CNET、ZDNet、MSN等知名網站的網頁疑遭轉址攻擊一事，資安專家表示，該事件有可能是新型態的網路攻擊手法。

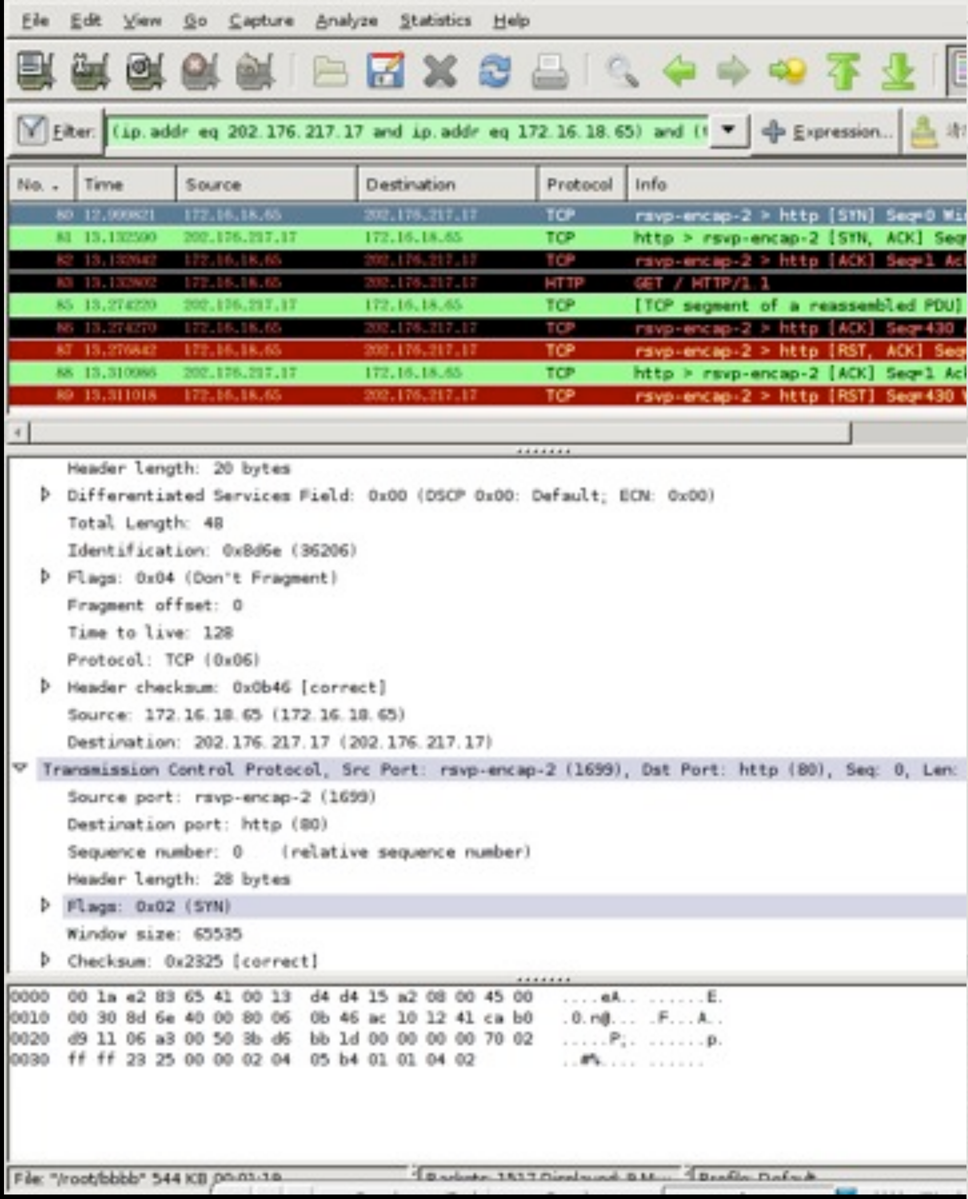
「就微軟的追查結果來看，CNET與MSN網站遭網頁轉

Mystic redirects (2009/03/05)

Attack observations

- Large number of users were redirected to malware-infected servers, while trying to visit legimate web sites hosted outside of Taiwan island (i.e. zdnet, msn.com, etc)

Traces



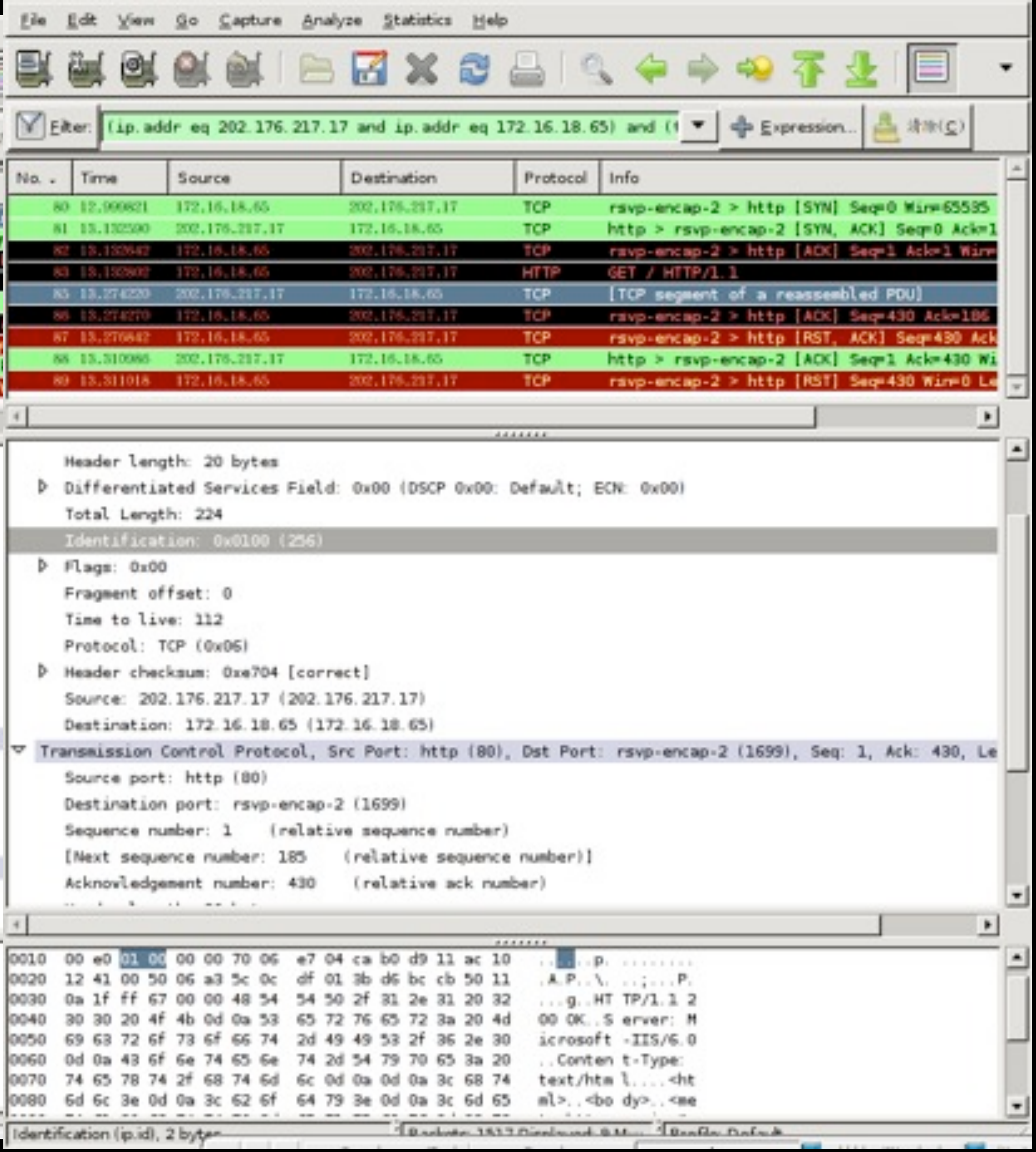
```
Filter: (ip.addr eq 202.176.217.17 and ip.addr eq 172.16.18.65) and (

No.  Time       Source          Destination     Protocol Info
80   12.999821  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [SYN] Seq=0 Wi
81   13.132590  202.176.217.17  172.16.18.65    TCP      http > rsvp-encap-2 [SYN, ACK] Seq
82   13.132642  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [ACK] Seq=1 Ac
83   13.132802  172.16.18.65    202.176.217.17  HTTP     GET / HTTP/1.1
85   13.274220  202.176.217.17  172.16.18.65    TCP      [TCP segment of a reassembled PDU]
86   13.274270  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [ACK] Seq=430
87   13.276842  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [RST, ACK] Seq
88   13.310986  202.176.217.17  172.16.18.65    TCP      http > rsvp-encap-2 [ACK] Seq=1 Ac
89   13.311018  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [RST] Seq=430 W
```

```
    Header length: 20 bytes
  ▷ Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
    Total Length: 48
    Identification: 0x8d6e (36206)
  ▷ Flags: 0x04 (Don't Fragment)
    Fragment offset: 0
    Time to live: 128
    Protocol: TCP (0x06)
  ▷ Header checksum: 0x0b46 [correct]
    Source: 172.16.18.65 (172.16.18.65)
    Destination: 202.176.217.17 (202.176.217.17)
▽ Transmission Control Protocol, Src Port: rsvp-encap-2 (1699), Dst Port: http (80), Seq: 0, Len:
    Source port: rsvp-encap-2 (1699)
    Destination port: http (80)
    Sequence number: 0    (relative sequence number)
    Header length: 28 bytes
  ▷ Flags: 0x02 (SYN)
    Window size: 65535
  ▷ Checksum: 0x2325 [correct]
```

```
0000  00 1a e2 83 65 41 00 13  d4 d4 15 a2 08 00 45 00   ....eA.. ......E.
0010  00 30 8d 6e 40 00 80 06  0b 46 ac 10 12 41 ca b0   .0.n@... .F...A..
0020  d9 11 06 a3 00 50 3b d6  bb 1d 00 00 00 00 70 02   .....P;. ......p.
0030  ff ff 23 25 00 00 02 04  05 b4 01 01 04 02         ..#%.... ......
```

File: "/root/bbbb" 544 KB 00:01:19



```
Filter: (ip.addr eq 202.176.217.17 and ip.addr eq 172.16.18.65) and (

No.  Time       Source          Destination     Protocol Info
80   12.999821  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [SYN] Seq=0 Win=65535
81   13.132590  202.176.217.17  172.16.18.65    TCP      http > rsvp-encap-2 [SYN, ACK] Seq=0 Ack=1
82   13.132642  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [ACK] Seq=1 Ack=1 Win=
83   13.132802  172.16.18.65    202.176.217.17  HTTP     GET / HTTP/1.1
85   13.274220  202.176.217.17  172.16.18.65    TCP      [TCP segment of a reassembled PDU]
86   13.274270  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [ACK] Seq=430 Ack=186
87   13.276842  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [RST, ACK] Seq=430 Ack
88   13.310986  202.176.217.17  172.16.18.65    TCP      http > rsvp-encap-2 [ACK] Seq=1 Ack=430 Wi
89   13.311018  172.16.18.65    202.176.217.17  TCP      rsvp-encap-2 > http [RST] Seq=430 Win=0 Le
```

```
    Header length: 20 bytes
  ▷ Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
    Total Length: 224
    Identification: 0x0100 (256)
  ▷ Flags: 0x00
    Fragment offset: 0
    Time to live: 112
    Protocol: TCP (0x06)
  ▷ Header checksum: 0xe704 [correct]
    Source: 202.176.217.17 (202.176.217.17)
    Destination: 172.16.18.65 (172.16.18.65)
▽ Transmission Control Protocol, Src Port: http (80), Dst Port: rsvp-encap-2 (1699), Seq: 1, Ack: 430, Le
    Source port: http (80)
    Destination port: rsvp-encap-2 (1699)
    Sequence number: 1    (relative sequence number)
    [Next sequence number: 185    (relative sequence number)]
    Acknowledgement number: 430    (relative ack number)
```

```
0010  00 e0 01 00 00 00 70 06  e7 04 ca b0 d9 11 ac 10   ......p. ........
0020  12 41 00 50 06 a3 5c 0c  df 01 3b d6 bc cb 50 11   .A.P..\. ..;...P.
0030  0a 1f ff 67 00 00 48 54  54 50 2f 31 2e 31 20 32   ...g..HT TP/1.1 2
0040  30 30 20 4f 4b 0d 0a 53  65 72 76 65 72 3a 20 4d   00 OK..S erver: M
0050  69 63 72 6f 73 6f 66 74  2d 49 49 53 2f 36 2e 30   icrosoft -IIS/6.0
0060  0d 0a 43 6f 6e 74 65 6e  74 2d 54 79 70 65 3a 20   ..Conten t-Type: 
0070  74 65 78 74 2f 68 74 6d  6c 0d 0a 0d 0a 3c 68 74   text/htm l....<ht
0080  6d 6c 3e 0d 0a 3c 62 6f  64 79 3e 0d 0a 3c 6d 65   ml>..<bo dy>..<me
```

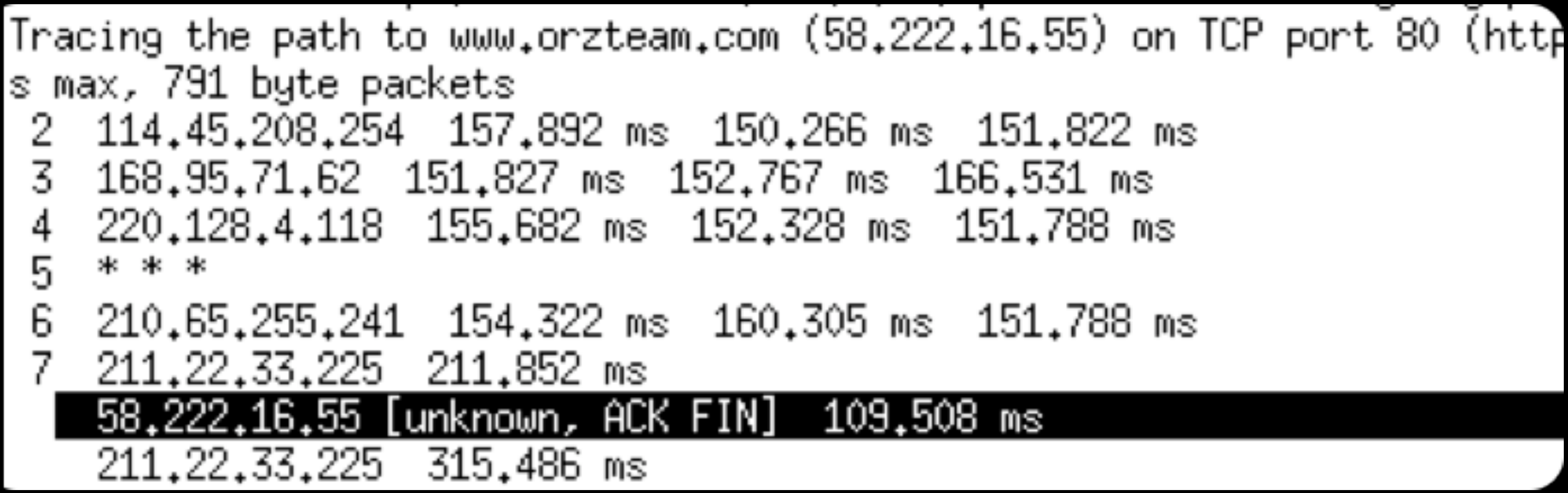
Identification (ip.id), 2 bytes

Guess..

- A node was compromised somewhere en-route. TCP connections were non-blindly hijacked...

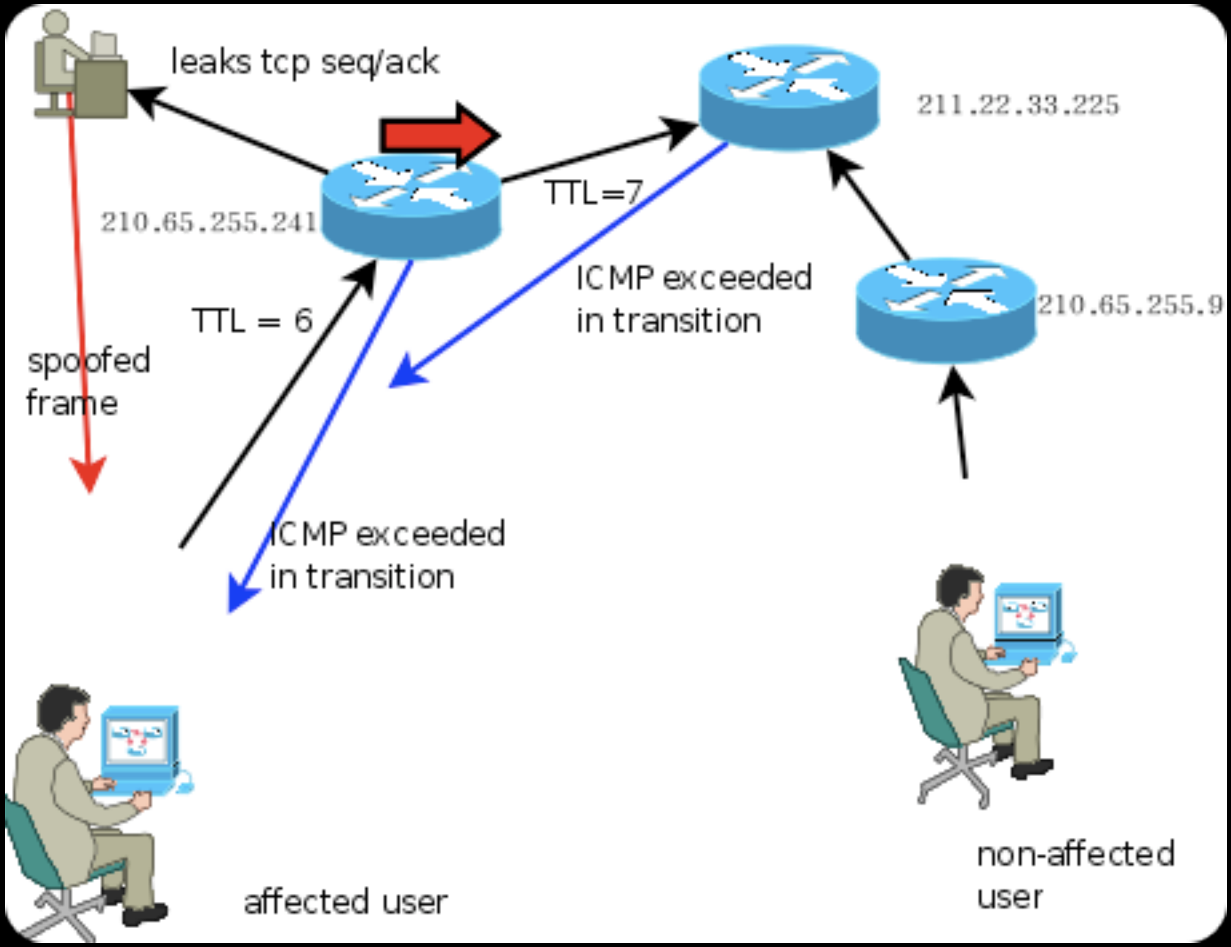
Tracing “ghost” node(s)

- some “spaghetti” to quickly discover the node



```
Tracing the path to www.orzteam.com (58.222.16.55) on TCP port 80 (http
s max, 791 byte packets
 2  114.45.208.254  157.892 ms  150.266 ms  151.822 ms
 3  168.95.71.62  151.827 ms  152.767 ms  166.531 ms
 4  220.128.4.118  155.682 ms  152.328 ms  151.788 ms
 5  * * *
 6  210.65.255.241  154.322 ms  160.305 ms  151.788 ms
 7  211.22.33.225  211.852 ms
    58.222.16.55 [unknown, ACK FIN]  109.508 ms
    211.22.33.225  315.486 ms
```

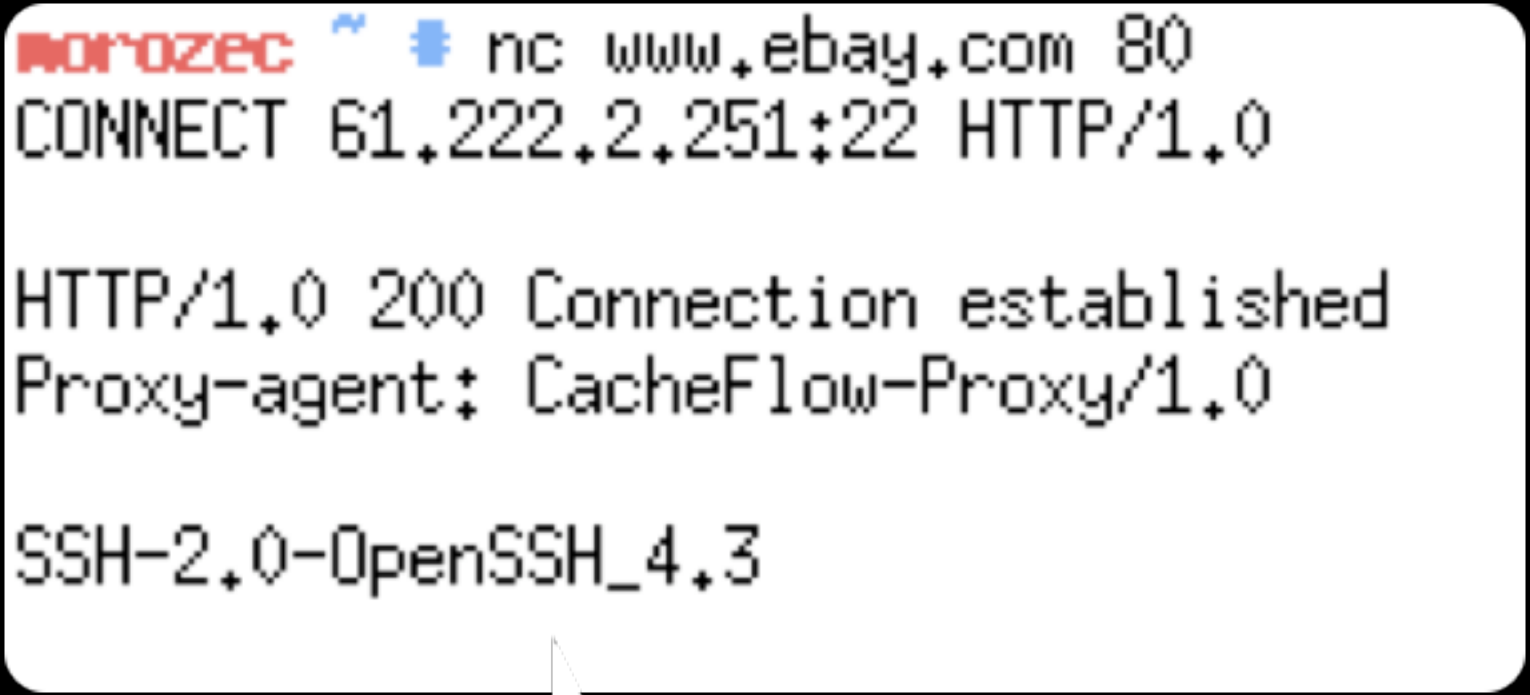
Discovered attack scenario



Lesson learnt

- Large number of target nodes are to be probed in order to identify potential ‘en-route’ attacks.
- We need a high-performance network discovery tool, capable of operating at Layer7
- we need automated tracing capability

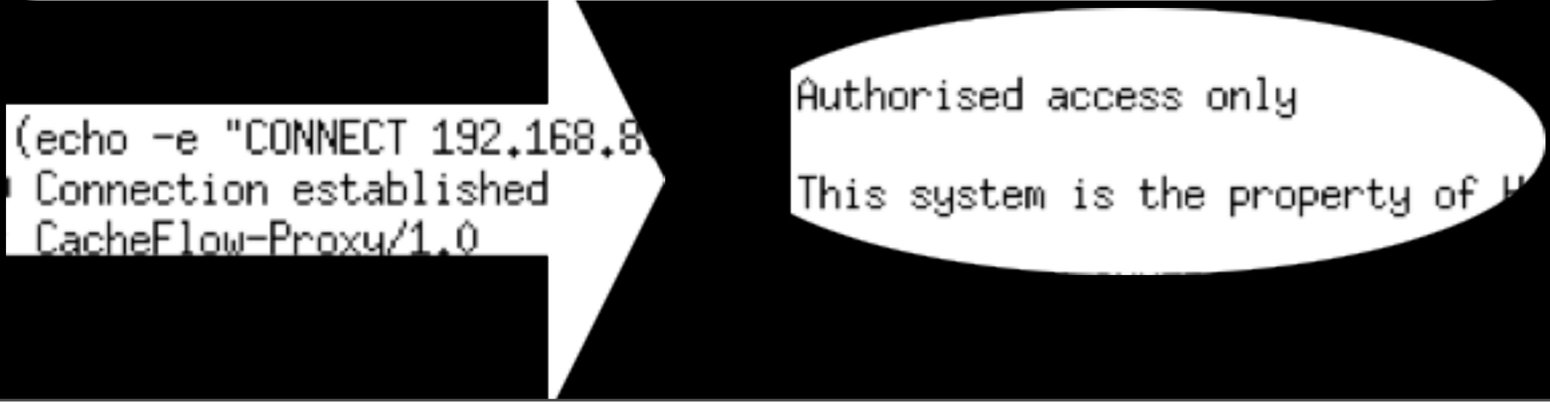
more stuff @L7...



```
morozec ~ $ nc www.ebay.com 80
CONNECT 61.222.2.251:22 HTTP/1.0

HTTP/1.0 200 Connection established
Proxy-agent: CacheFlow-Proxy/1.0

SSH-2.0-OpenSSH_4.3
```



```
(echo -e "CONNECT 192.168.8
 Connection established
 CacheFlow-Proxy/1.0
```

```
Authorised access only

This system is the property of H
```

Motivation

- we need more application-level probes

And..

- we could actually correlate L7 data with network probing results

but ..

- we need to minimize network load, because L7 might mean “lots of traffic”

Also..

- Time is another player. We want to be able to monitor network fluctuations in time

So, the Xprobe

now “NG”

Xprobe

- The historical note:
  - Xprobe project started as remote fingngerprinting tool to probe remote systems using ICMP protocol queries.
  - Other protocols support was added later. Fuzzy fingerprinting mechanism was introduced to improve precision

Further motivation

- Exploring other protocols running on the top of IP
- Bulk scanning
- Probing "en-route" systems
- Migrating to IPv6
- Honeypots/Nets
- Improving precision by cross-correlation over time

On the top of IP

- SCTP/Sigtrans gateways
- IPv4 to IPv6 gateways
- ...

“en route” findings

- Caching systems, transparent proxies etc.
- L7 switches
- Reactive IDS/IPS
- Application Firewalls
- Active spoofing attacks ..

Honeypots

- Virtual Machines
- Virtual Networks
- Incomplete Services

Bulk Scanning

- Probing “en-route” devices by large-range scans
- IPv6

Data cross-correlation

- Currently correlating data between L7 and network layers.

Current Improvements

Minimizing Network Load

- Information Gain metrics
- “Lazy-Mode” execution
- “Target” driven execution
- New Scan engine (in progress)

Improving Precision

- Cross correlation between L7 and below

Improving Usability

- Language Extensions: Python (xprobepy)

Information Gain

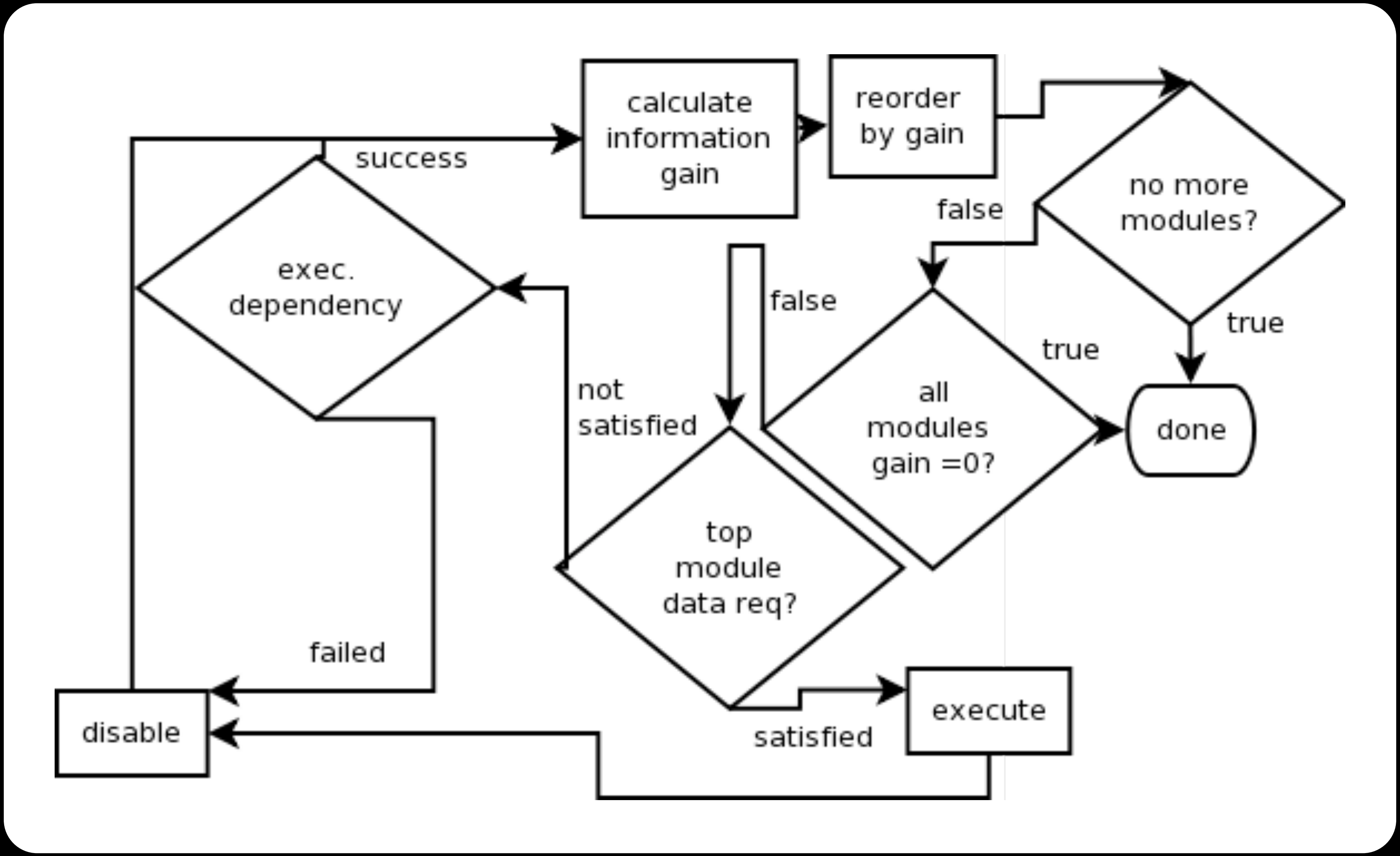
Information gain

- A “score” calculated for a probe, characterizing how much “information” the probe is going to bring

Benefits

- Highest information gain probes are executed first
- “0” information gain probes are not executed (unless are part of dependency)
- Possible to optimally minimize network overhead by executing “top X”/target

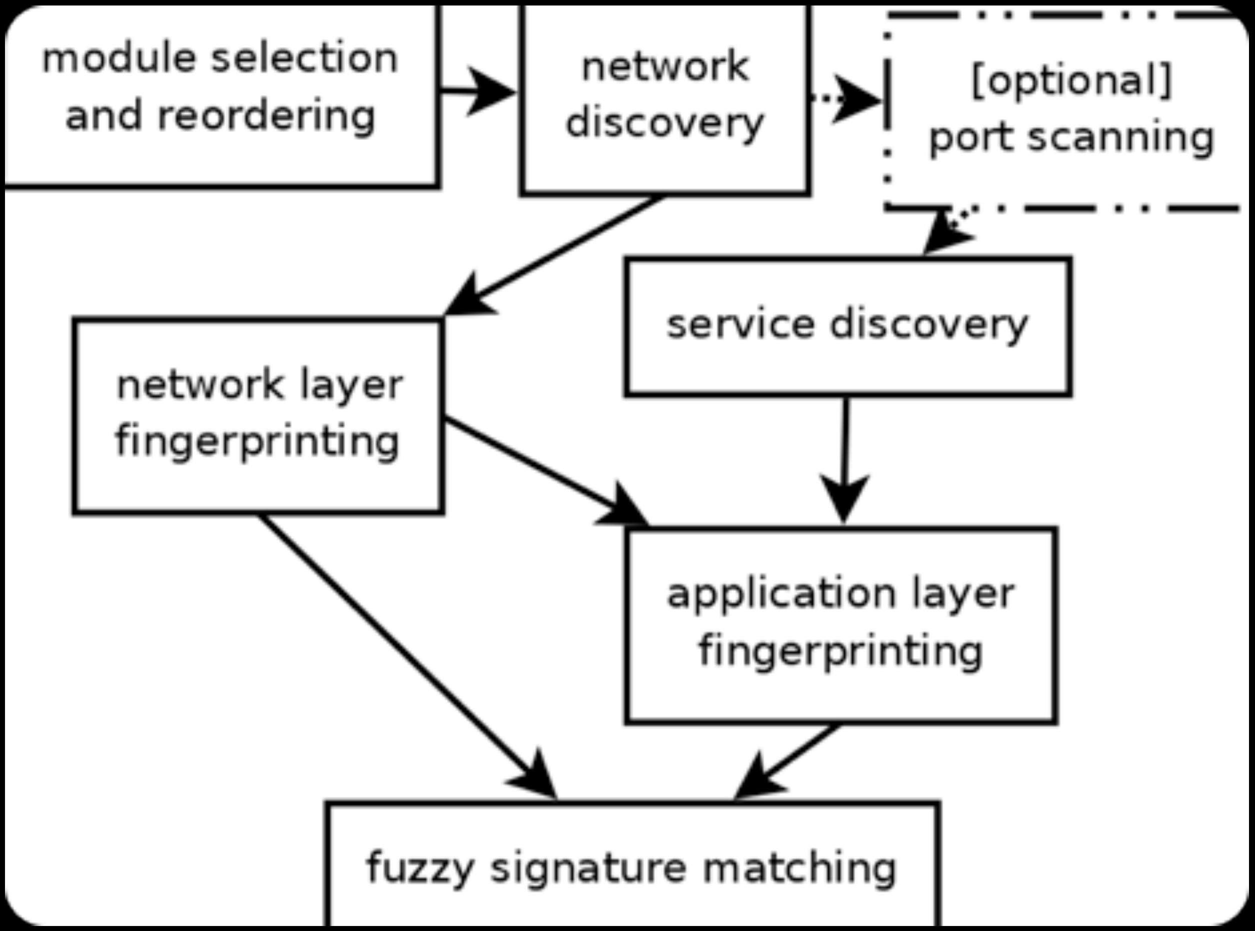
Algorithm


calculate information gain
reorder by gain
success
no more modules?
false
exec. dependency
false
true
true
all modules gain =0?
done
not satisfied
top module data req?
failed
execute
disable
satisfied

Lazy scan
and target-driven
execution

discovery process optimizations

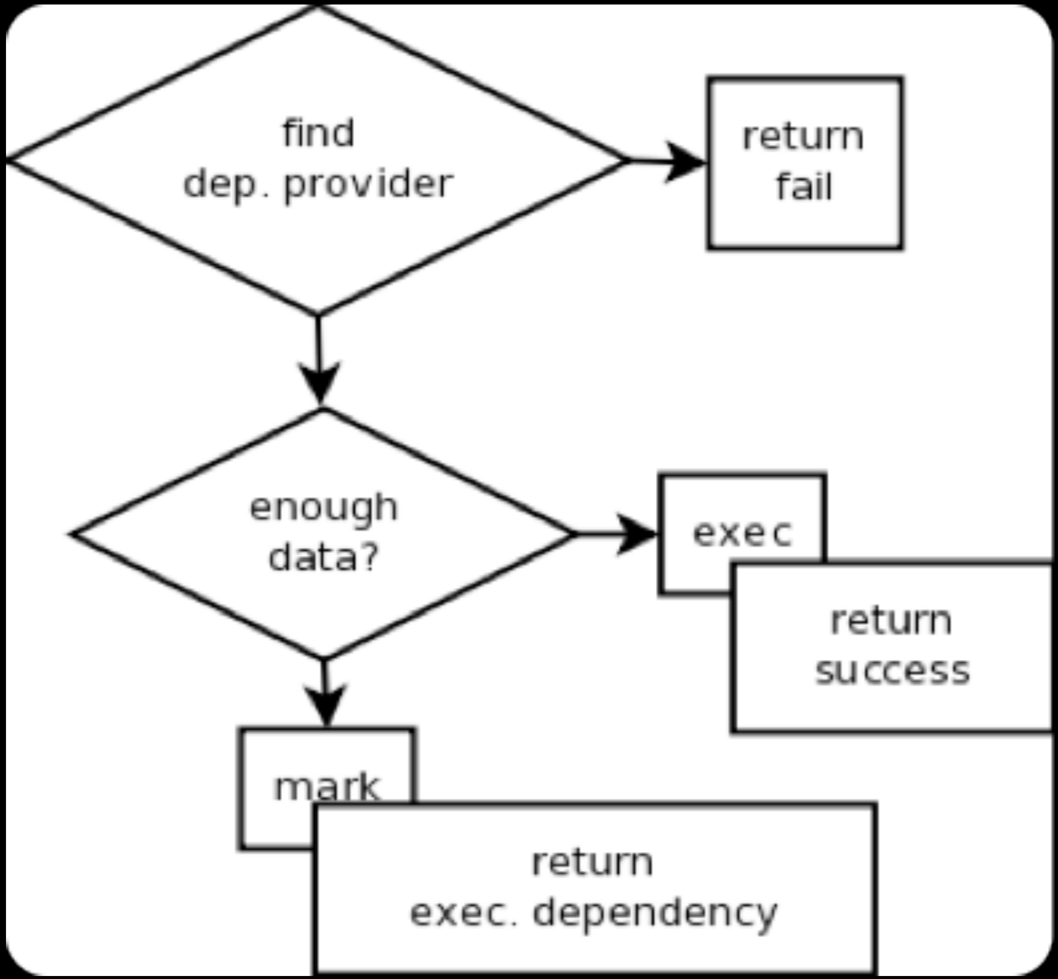
Architecture, briefly..


module selection and reordering
network discovery
[optional] port scanning
network layer fingerprinting
service discovery
application layer fingerprinting
fuzzy signature matching

Data dependency chains

- Each module is characterized with type of data it “requires” and “provides”

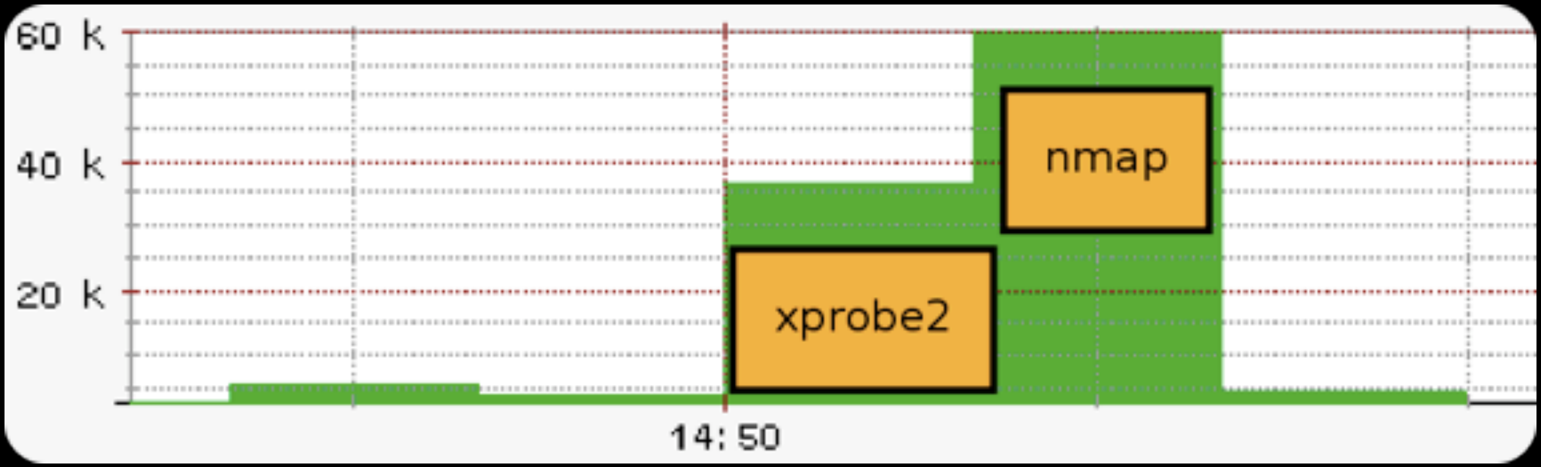
Data Dependency based execution



No “portscan” per se

- This technically makes port scanning “AS IS” unnecessary
- Significally reduces tool “noise” on the wire

Wire "noise" rough comparision



Benefits of Data Chaining

- Probe focused execution (by specifying "intended" probe)
- Restrictions can be set:
  - no more than X queries/target
  - use only "normalized" packets

Negative impact

- You still may not know about certain ports and applications running on the target system.

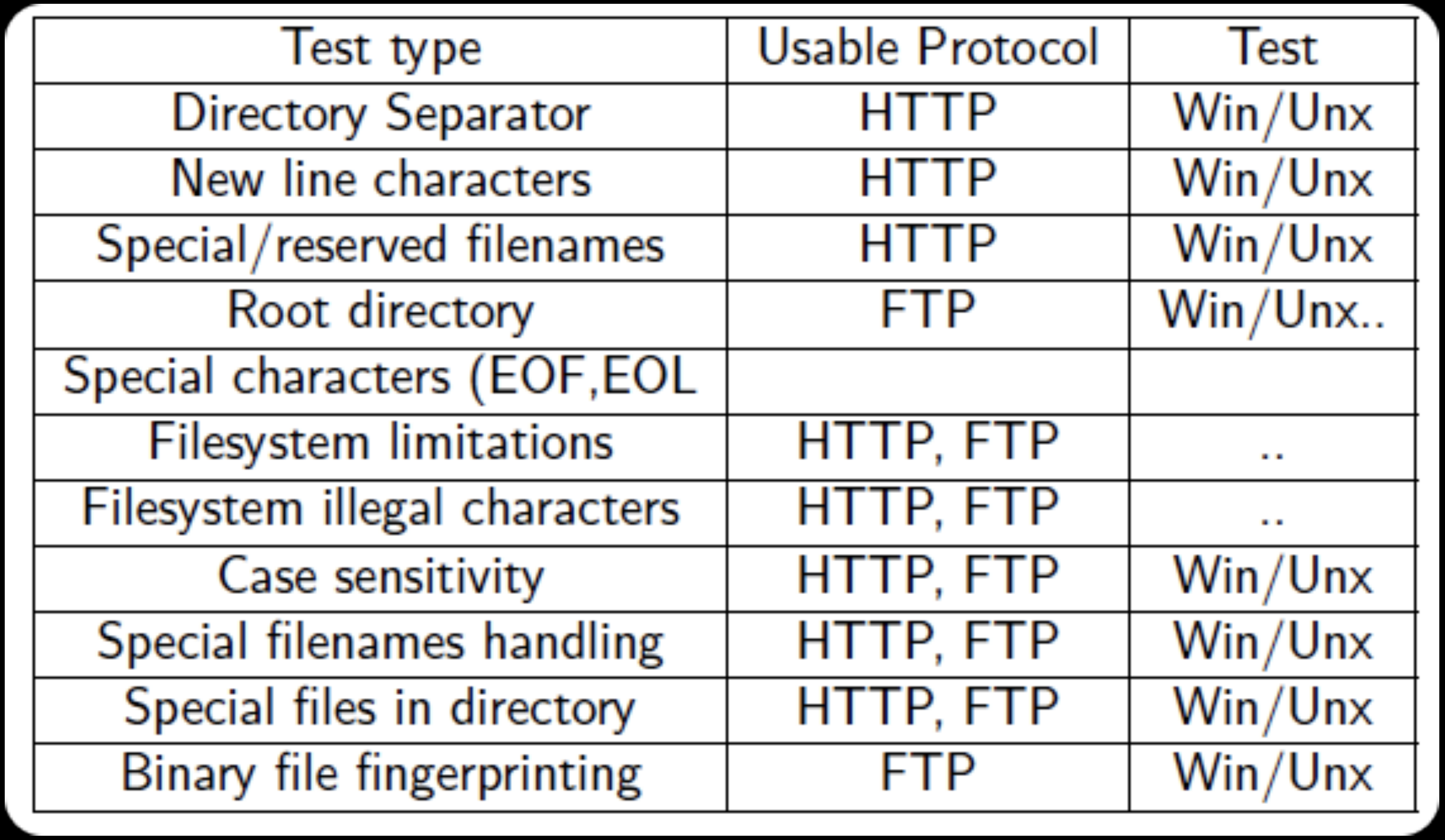
Application level

Application level

- Improving fingerprinting precision
- “en-route” interaction
- Honeypots

L7 fingerprinting

- Underlying OS can be probed via L7 tests and correlated with other data



Test type	Usable Protocol	Test
Directory Separator	HTTP	Win/Unx
New line characters	HTTP	Win/Unx
Special/reserved filenames	HTTP	Win/Unx
Root directory	FTP	Win/Unx..
Special characters (EOF,EOL		
Filesystem limitations	HTTP, FTP	..
Filesystem illegal characters	HTTP, FTP	..
Case sensitivity	HTTP, FTP	Win/Unx
Special filenames handling	HTTP, FTP	Win/Unx
Special files in directory	HTTP, FTP	Win/Unx
Binary file fingerprinting	FTP	Win/Unx

Honeypots

VM tricks

- Possible to identify VMs (not all) by TCP stream analysis

Network level tricks

- Analyzing MAC addresses, when available

Application Level Tricks

- We can probe for incomplete implementations of L7 protocols

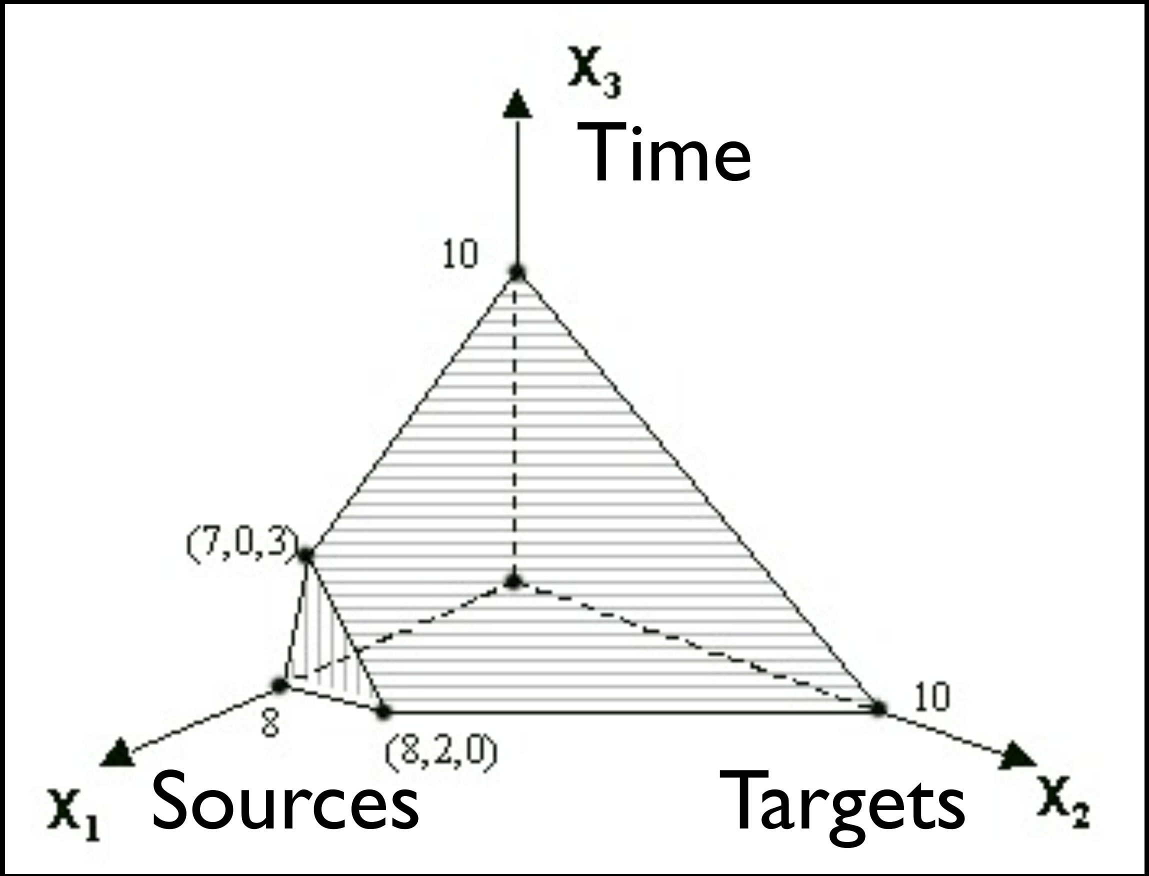
Current Developments

Work in progress

- Language bindings
- L7 modules
- new engine
- en-route modules

Future Plans

- By designing distributed data sharing network it’d be possible to collect Multi-dimensional data



IPv6 Action plan

- Local node discovery: straightforward (multicast)
- Remote segments: DNS, text file parsing, “educated” guessing, search engine, beforementioned networking capability

Availability

http://xprobe.sourceforge.net
(git push in a couple of days)
http://github.com/fygrave/xprobepy
(due Mid of July)

Questions

if you have no questions, feel free to throw your shoe ;-)
jk

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(o-zero-o)