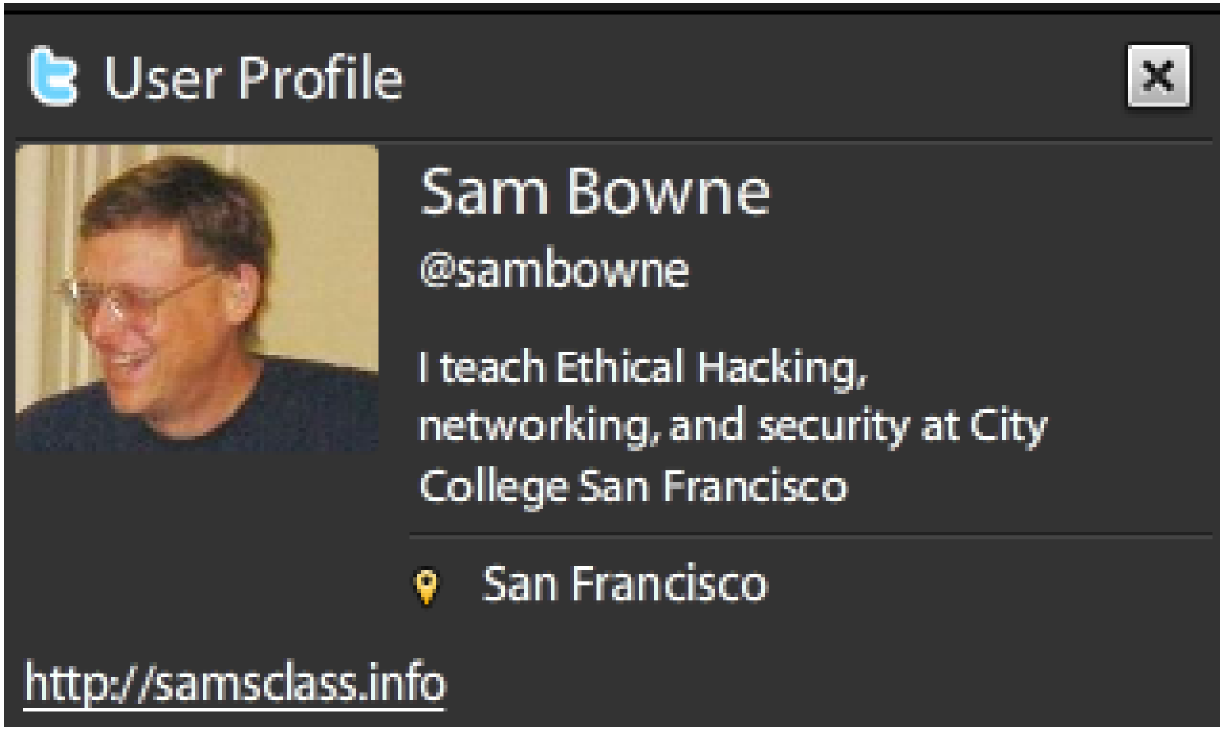
Layer 7 DoS Attacks and Defenses

LayerOne, 2011

Bio



User Profile

Sam Bowne

@sambowne

I teach Ethical Hacking, networking, and security at City College San Francisco

San Francisco

http://samsclass.info

Summary

- The DoS Circus
- Layer 4 DDoS: Thousands of attackers bring down one site
- Layer 7 DoS: One attacker brings down one site
- Link-Local DoS: IPv6 RA Attack: One attacker brings down a whole network

The DoS Circus

Characters

Wikileaks

- Published <1000 US Gov't diplomatic cables from a leak of 250,000
- Distributed an encrypted "Insurance" file by BitTorrent
  - Widely assumed to contain the complete, uncensored leaked data
  - Encrypted with AES-256--no one is ever getting in there without the key
  - Key to be released if Assange is jailed or killed, but he is in UK now resisting extradition to Sweden and the key has not been released

Anonymous

A CORPORATION SHOULD NOT OWN A RELIGION AND ITS FOLLOWERS
Ask Me Why I'm Wearing A MASK
HAS
SORED
CH"
OLOGY

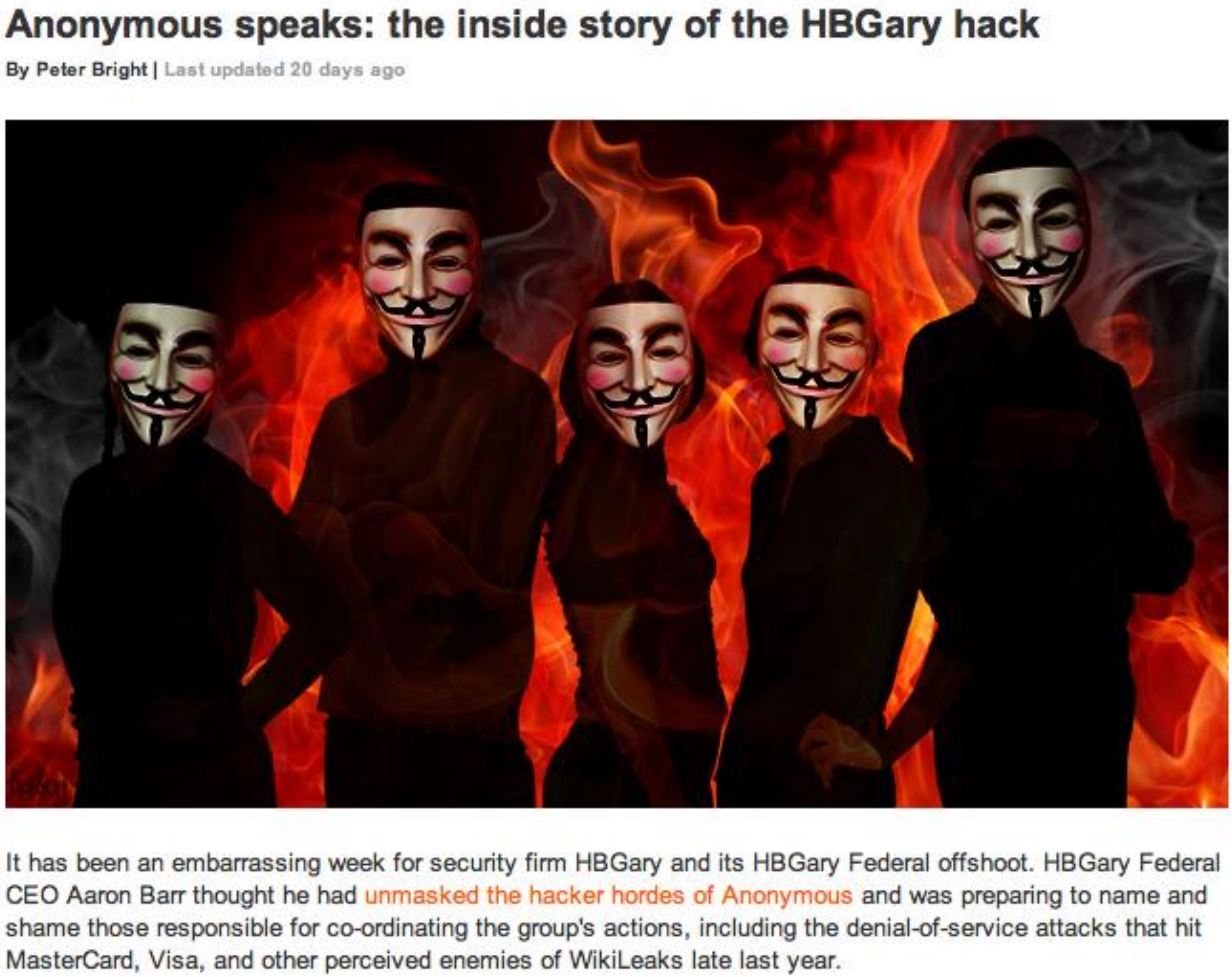
Operation Payback

- 4chan's Anonymous group
  - Attacked Scientology websites in 2008
  - Attacked the RIAA and other copyright defenders
  - Using the Low Orbit Ion Cannon with HiveMind (DDoS)
    - "Opt-in Botnet"

HB Gary Federal

- Aaron Barr
  - Developed a questionable way to track people down online
  - By correlating Twitter, Facebook, and other postings
  - Announced in Financial Times that he had located the “leaders” of Anonymous and would reveal them in a few days

Aaron Barr



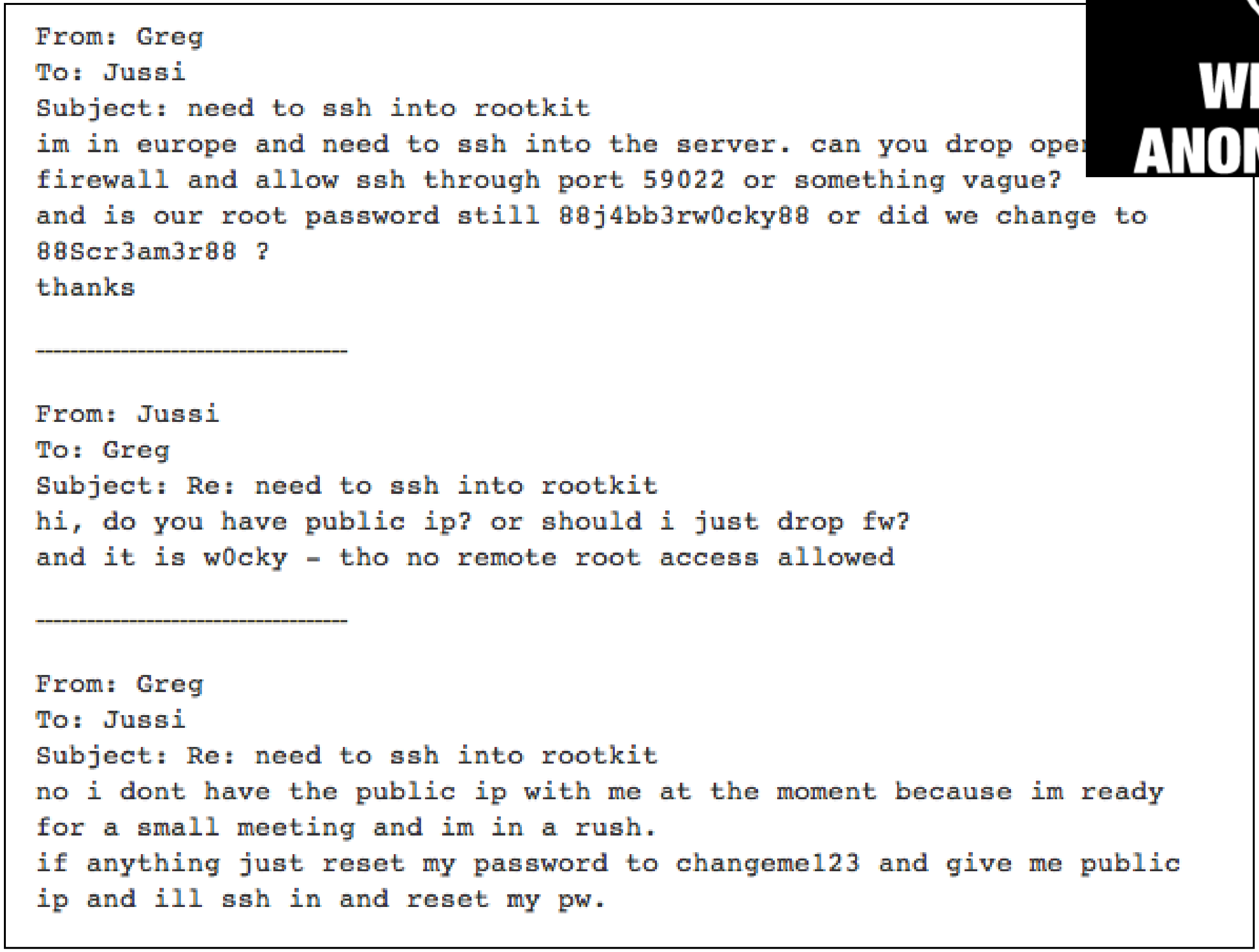
Anonymous speaks: the inside story of the HBGary hack

By Peter Bright | Last updated 20 days ago

It has been an embarrassing week for security firm HBGary and its HBGary Federal offshoot. HBGary Federal CEO Aaron Barr thought he had unmasked the hacker hordes of Anonymous and was preparing to name and shame those responsible for co-ordinating the group's actions, including the denial-of-service attacks that hit MasterCard, Visa, and other perceived enemies of WikiLeaks late last year.

Social Engineering & SQLi

WE ARE ANONYMOUS



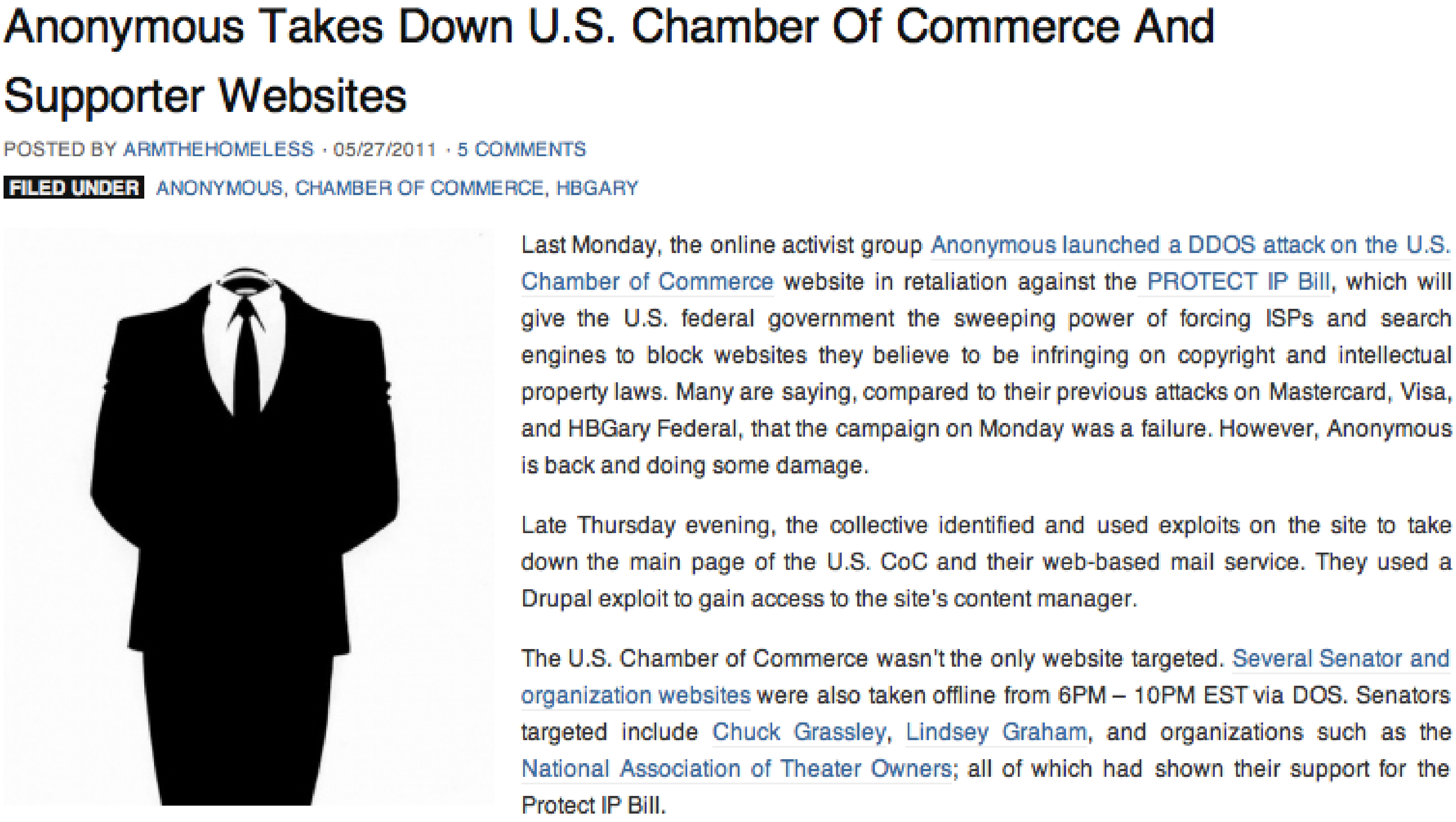
```
From: Greg
To: Jussi
Subject: need to ssh into rootkit
im in europe and need to ssh into the server. can you drop ope
firewall and allow ssh through port 59022 or something vague?
and is our root password still 88j4bb3rw0cky88 or did we change to
88Scr3am3r88 ?
thanks

-----------------------------------

From: Jussi
To: Greg
Subject: Re: need to ssh into rootkit
hi, do you have public ip? or should i just drop fw?
and it is w0cky - tho no remote root access allowed

-----------------------------------

From: Greg
To: Jussi
Subject: Re: need to ssh into rootkit
no i dont have the public ip with me at the moment because im ready
for a small meeting and im in a rush.
if anything just reset my password to changeme123 and give me public
ip and ill ssh in and reset my pw.
```

- http://tinyurl.com/4gesrcj

Leaked HB Gary Emails

- For Bank of America
- Discredit Wikileaks
- Intimidate Journalist Glenn Greenwald
- For the Chamber of Commerce
- Discredit the watchdog group US Chamber Watch
- Using fake social media accounts
- For the US Air Force
- Spread propaganda with fake accounts
- http://tinyurl.com/4anofw8

Drupal Exploit



Anonymous Takes Down U.S. Chamber Of Commerce And Supporter Websites

POSTED BY ARMTHEHOMELESS · 05/27/2011 · 5 COMMENTS

FILED UNDER ANONYMOUS, CHAMBER OF COMMERCE, HBGARY

Last Monday, the online activist group Anonymous launched a DDOS attack on the U.S. Chamber of Commerce website in retaliation against the PROTECT IP Bill, which will give the U.S. federal government the sweeping power of forcing ISPs and search engines to block websites they believe to be infringing on copyright and intellectual property laws. Many are saying, compared to their previous attacks on Mastercard, Visa, and HBGary Federal, that the campaign on Monday was a failure. However, Anonymous is back and doing some damage.

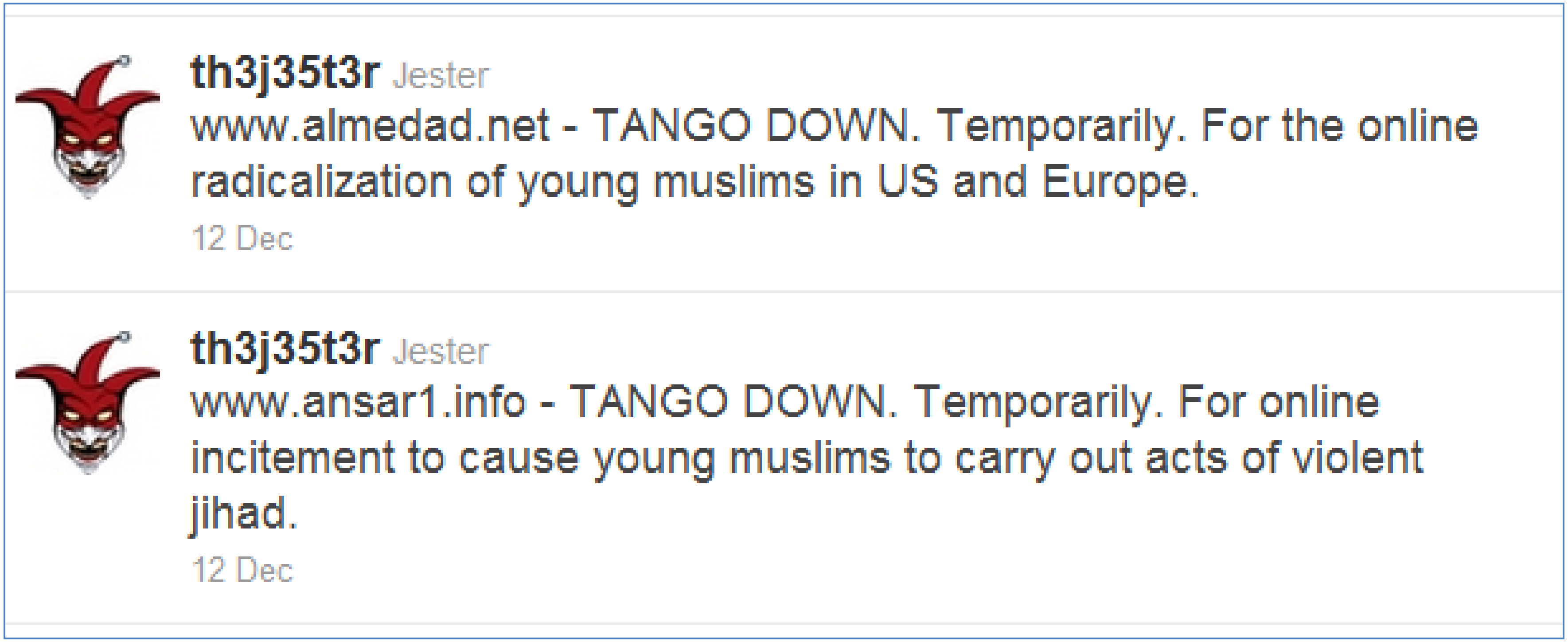
Late Thursday evening, the collective identified and used exploits on the site to take down the main page of the U.S. CoC and their web-based mail service. They used a Drupal exploit to gain access to the site's content manager.

The U.S. Chamber of Commerce wasn't the only website targeted. Several Senator and organization websites were also taken offline from 6PM – 10PM EST via DOS. Senators targeted include Chuck Grassley, Lindsey Graham, and organizations such as the National Association of Theater Owners; all of which had shown their support for the Protect IP Bill.

Th3j35t3r

- "Hacktivist for Good"
- Claims to be ex-military
- Originally performed DoS attacks on Jihadist sites
  - Bringing them down for brief periods, such as 30 minutes
  - Announces his attacks on Twitter, discusses them on a blog and live on irc.2600.net

Jester's Tweets from Dec 2010



th3j35t3r Jester

www.almedad.net - TANGO DOWN. Temporarily. For the online radicalization of young muslims in US and Europe.

12 Dec

th3j35t3r Jester

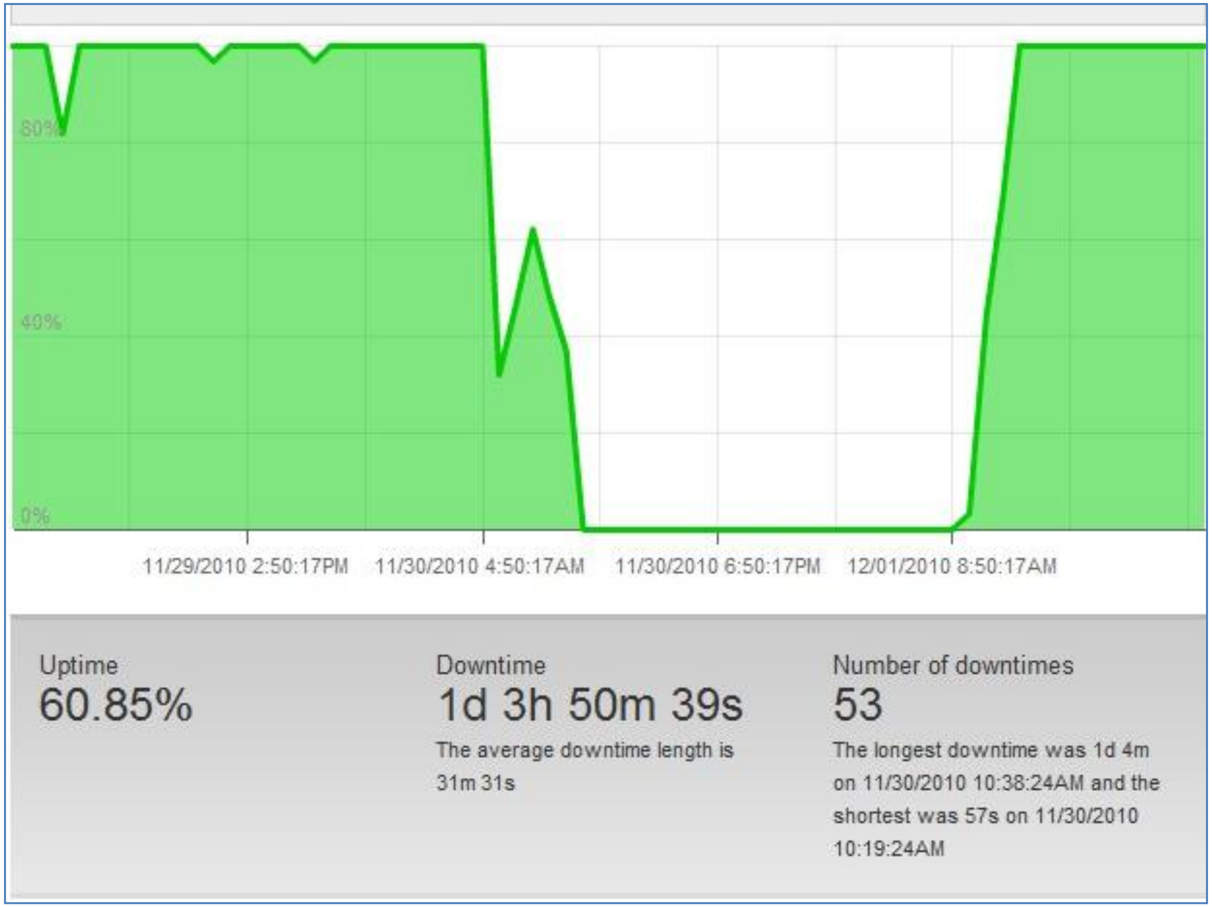
www.ansar1.info - TANGO DOWN. Temporarily. For online incitement to cause young muslims to carry out acts of violent jihad.

12 Dec

Th3j35t3r v. Wikileaks

- He brought down Wikileaks single-handed for more than a day
  - I was chatting with him in IRC while he did it, and he proved it was him by briefly pausing the attack

Wikileaks Outage



Uptime
60.85%

Downtime
1d 3h 50m 39s
The average downtime length is 31m 31s

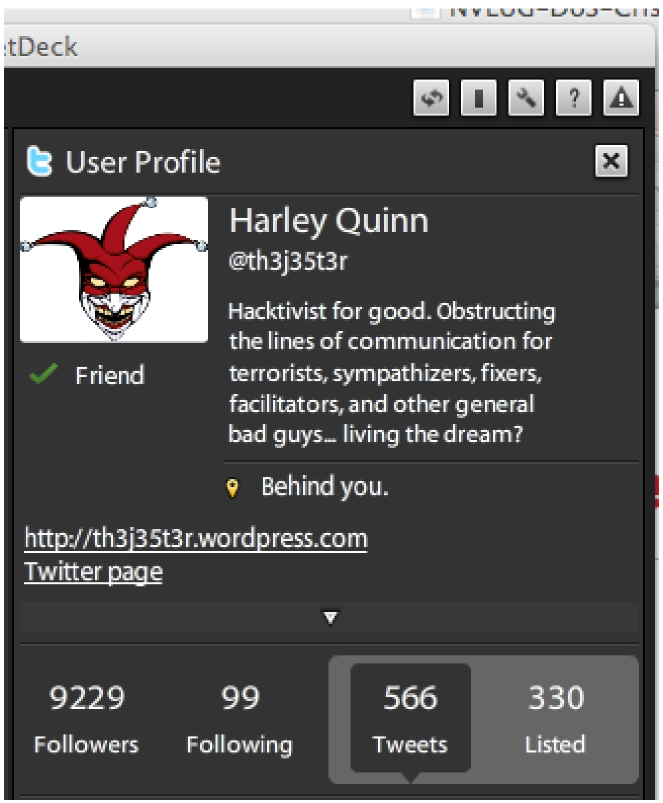
Number of downtimes
53
The longest downtime was 1d 4m on 11/30/2010 10:38:24AM and the shortest was 57s on 11/30/2010 10:19:24AM

- One attacker, no botnet

Th3j35t3r

- After his Wikileaks attack
    - He battled Anonymous
    - He claims to have trojaned a tool the Anons downloaded
    - He claims to pwn Anon insiders now

Jester's Tweets



User Profile

Harley Quinn
@th3j35t3r

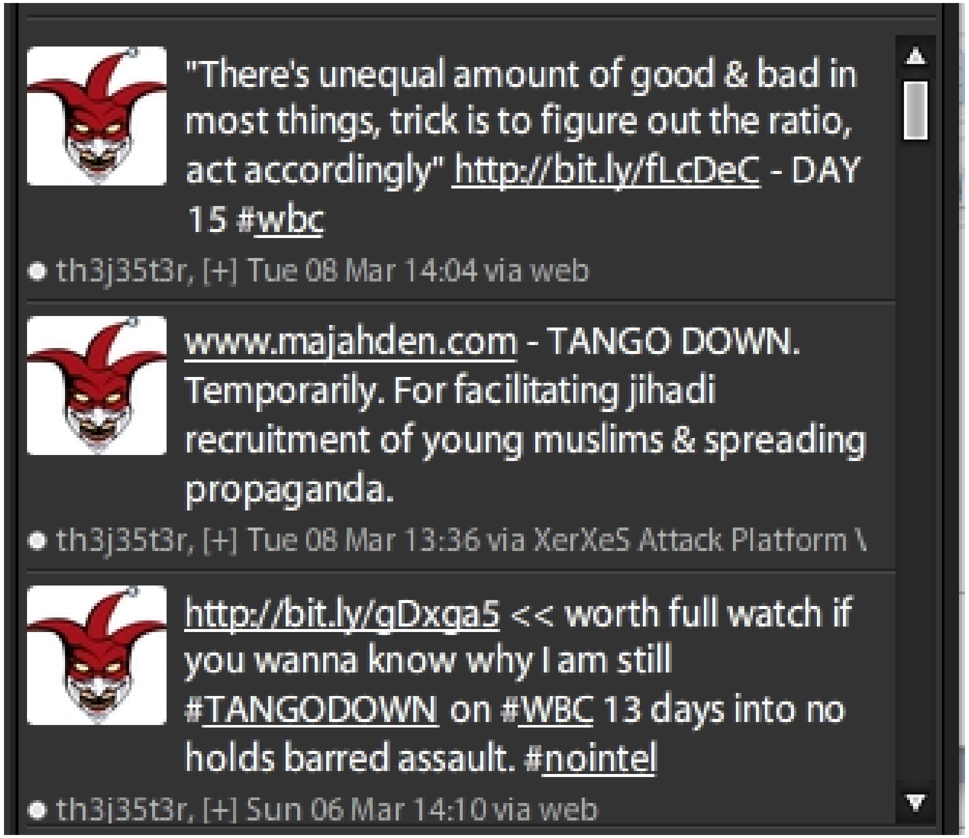
Hacktivist for good. Obstructing the lines of communication for terrorists, sympathizers, fixers, facilitators, and other general bad guys... living the dream?

✓ Friend

Behind you.

http://th3j35t3r.wordpress.com
Twitter page

9229 Followers
99 Following
566 Tweets
330 Listed



"There's unequal amount of good & bad in most things, trick is to figure out the ratio, act accordingly" http://bit.ly/fLcDeC - DAY 15 #wbc

● th3j35t3r, [+] Tue 08 Mar 14:04 via web

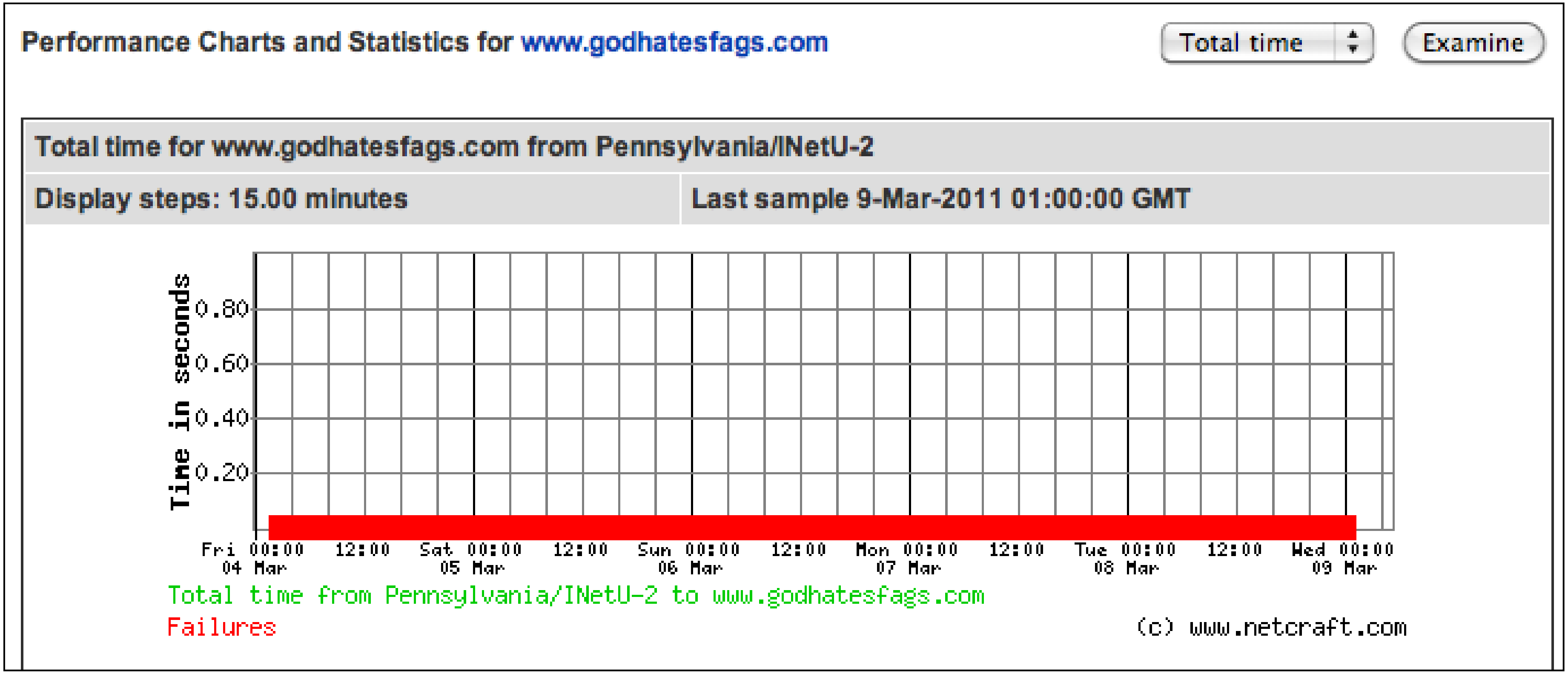
www.majahden.com - TANGO DOWN. Temporarily. For facilitating jihadi recruitment of young muslims & spreading propaganda.

● th3j35t3r, [+] Tue 08 Mar 13:36 via XerXeS Attack Platform \

http://bit.ly/gDxga5 << worth full watch if you wanna know why I am still #TANGODOWN on #WBC 13 days into no holds barred assault. #nointel

● th3j35t3r, [+] Sun 06 Mar 14:10 via web

Westboro Baptist Outage



Performance Charts and Statistics for www.godhatesfags.com

Total time for www.godhatesfags.com from Pennsylvania/INetU-2

Display steps: 15.00 minutes

Last sample 9-Mar-2011 01:00:00 GMT

- 4 sites held down for 8 weeks
- From a single 3G cell phone
  - http://tinyurl.com/4vggluu

Layer 4 DDoS

Many Attackers – One Target

Bandwidth Consumption

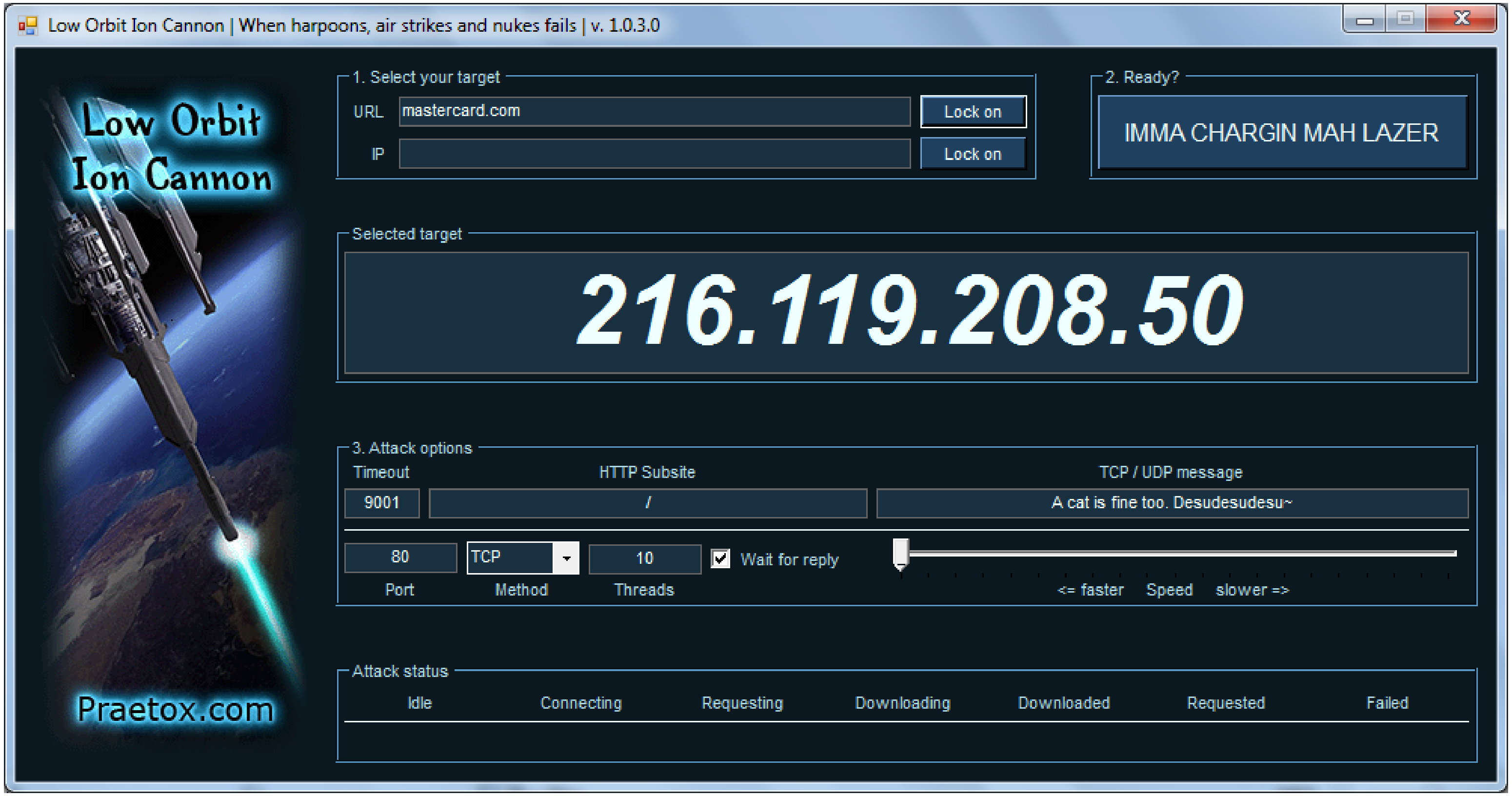
Companies that Refused Service to Wikileaks

- Amazon
- Paypal
- Mastercard
- Visa
- Many others

Low Orbit Ion Cannon

- Primitive DDoS Attack, controlled via IRC
- Sends thousands of packets per second from the attacker directly to the target
- Like throwing a brick through a window
- Takes thousands of participants to bring down a large site
    - They tried but failed to bring down Amazon

Low Orbit Ion Cannon



Low Orbit Ion Cannon | When harpoons, air strikes and nukes fails | v. 1.0.3.0

1. Select your target

URL: mastercard.com

IP:

2. Ready?

Selected target: 216.119.208.50

3. Attack options

Timeout: 9001

HTTP Subsite: /

TCP / UDP message: A cat is fine too. Desudesudesu~

Port: 80

Method: TCP

Threads: 10

☑ Wait for reply

Attack status

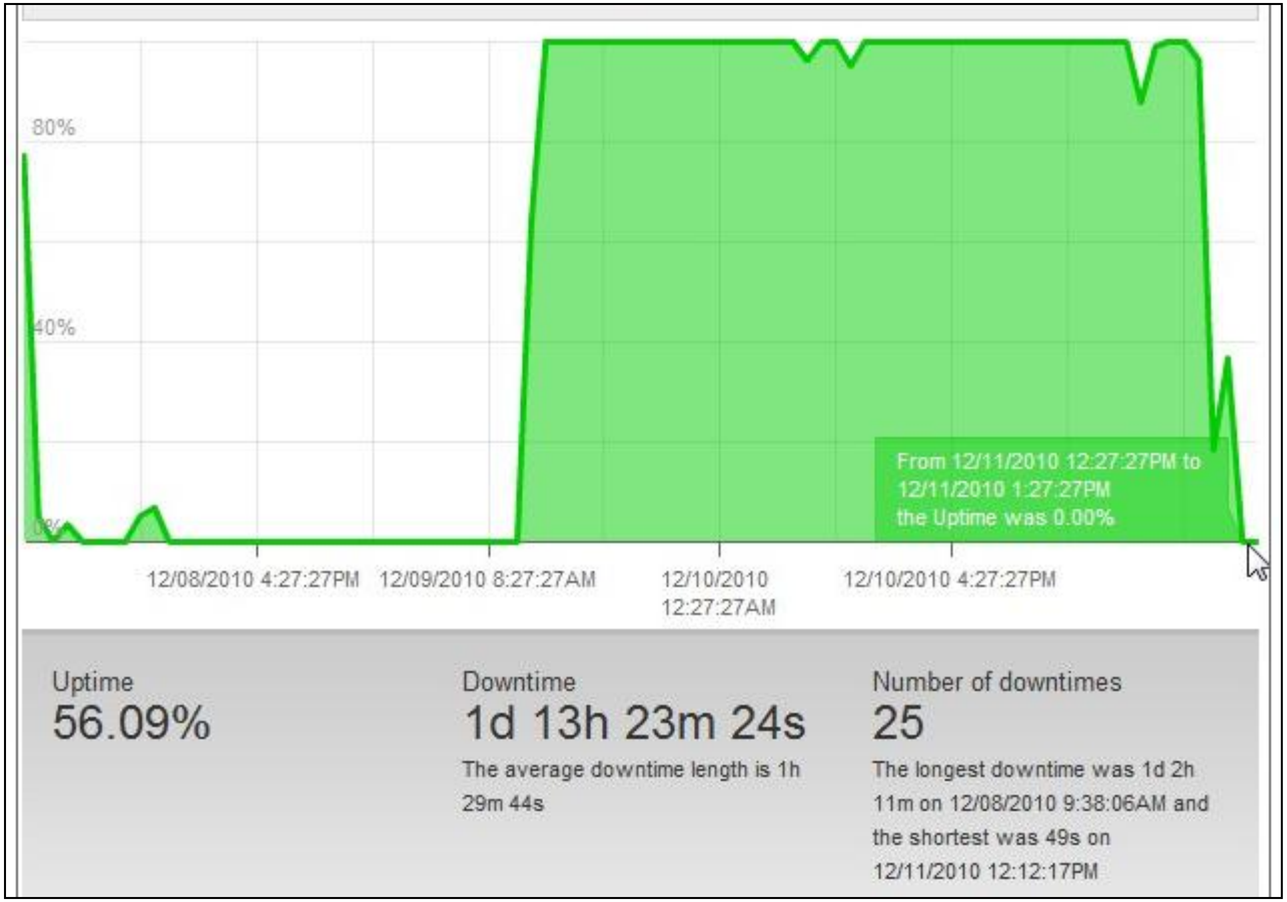
Idle | Connecting | Requesting | Downloading | Downloaded | Requested | Failed

Operation Payback v. Mastercard

- Brought down Visa, Mastercard, and many other sites
  - Easily tracked, and easily blocked
  - High bandwidth, cannot be run through anonymizer
  - Dutch police have already arrested two participants

Mastercard Outage

WE ARE
ANONYMOUS



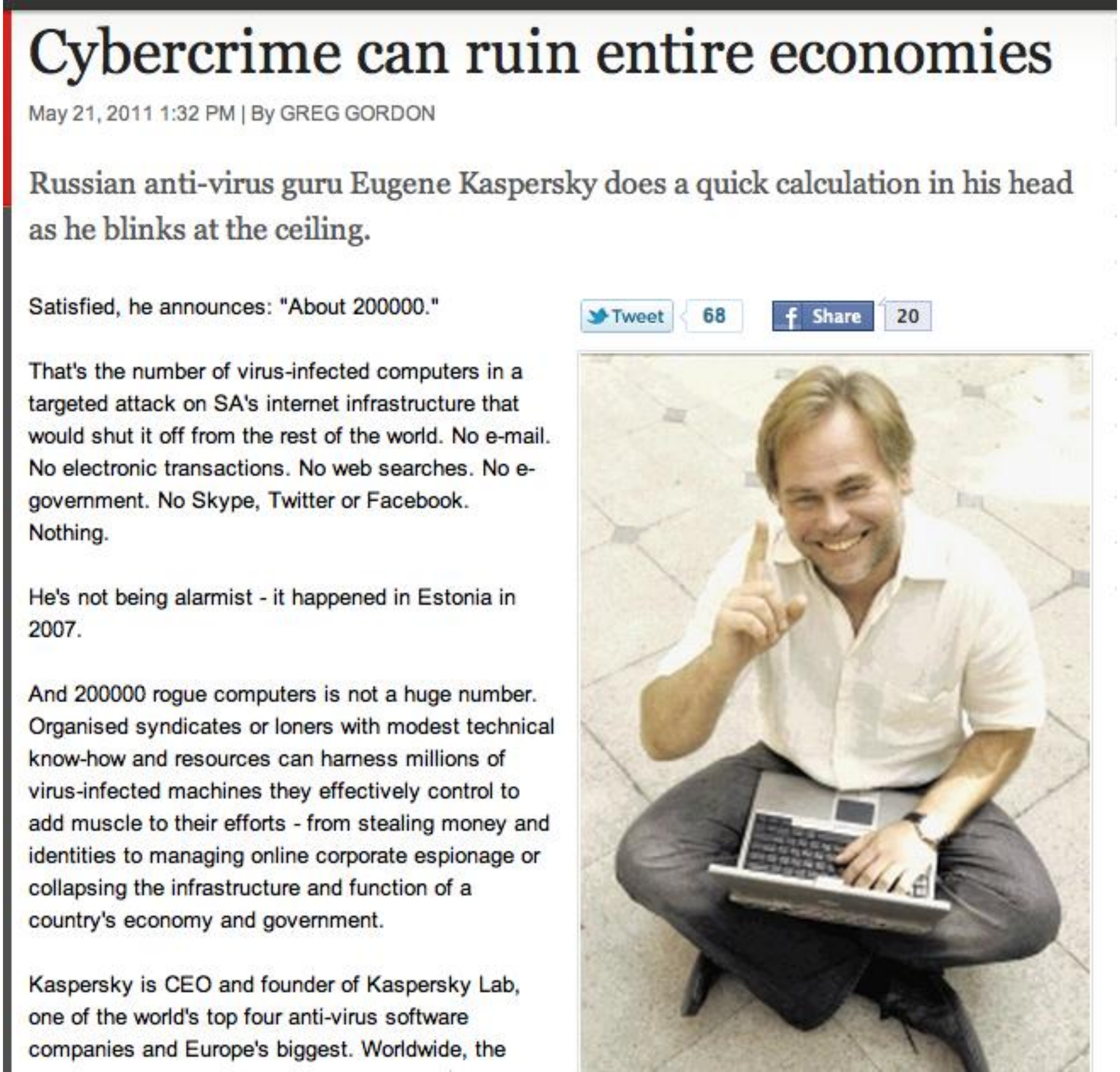
From 12/11/2010 12:27:27PM to
12/11/2010 1:27:27PM
the Uptime was 0.00%

Uptime
56.09%

Downtime
1d 13h 23m 24s
The average downtime length is 1h 29m 44s

Number of downtimes
25
The longest downtime was 1d 2h 11m on 12/08/2010 9:38:06AM and the shortest was 49s on 12/11/2010 12:12:17PM

3,000 to 30,000 attackers working together



Cybercrime can ruin entire economies

May 21, 2011 1:32 PM | By GREG GORDON

Russian anti-virus guru Eugene Kaspersky does a quick calculation in his head as he blinks at the ceiling.

Satisfied, he announces: "About 200000."

That's the number of virus-infected computers in a targeted attack on SA's internet infrastructure that would shut it off from the rest of the world. No e-mail. No electronic transactions. No web searches. No e-government. No Skype, Twitter or Facebook. Nothing.

He's not being alarmist - it happened in Estonia in 2007.

And 200000 rogue computers is not a huge number. Organised syndicates or loners with modest technical know-how and resources can harness millions of virus-infected machines they effectively control to add muscle to their efforts - from stealing money and identities to managing online corporate espionage or collapsing the infrastructure and function of a country's economy and government.

Kaspersky is CEO and founder of Kaspersky Lab, one of the world's top four anti-virus software companies and Europe's biggest. Worldwide, the

Layer 7 DoS

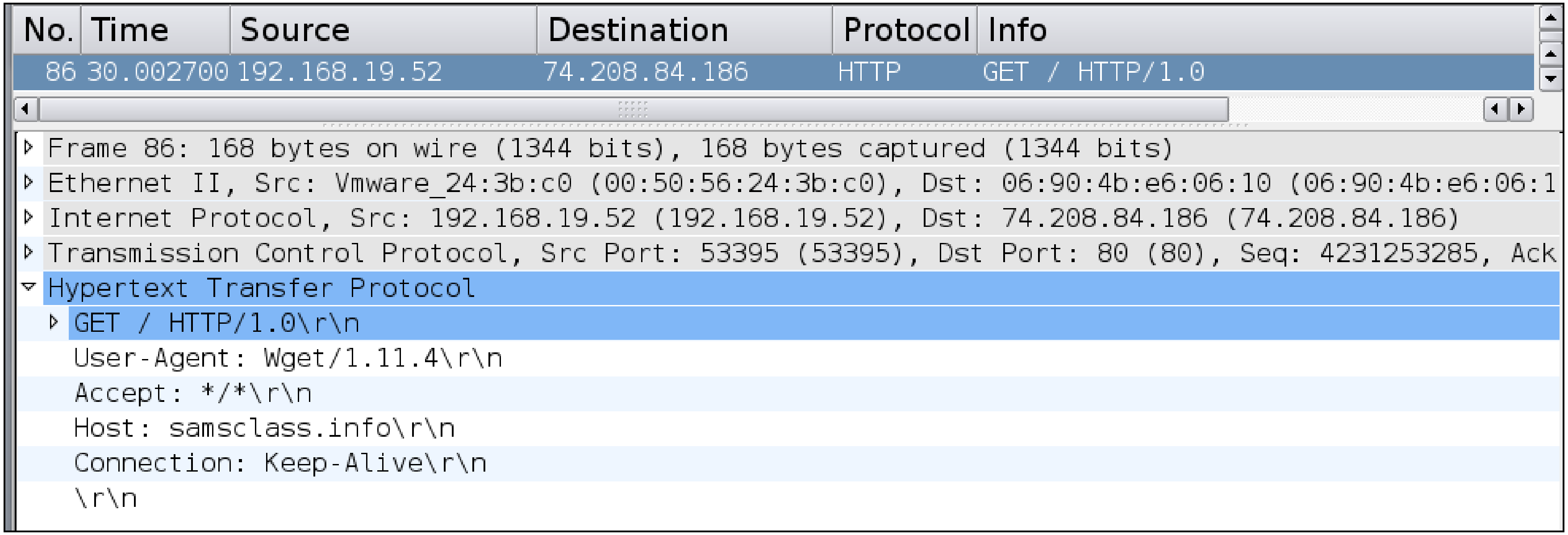
One Attacker – One Target

Exhausts Server Resources

Layer 7 DoS

- Subtle, concealable attack
- Can be routed through proxies
- Low bandwidth
- Can be very difficult to distinguish from normal traffic

HTTP GET

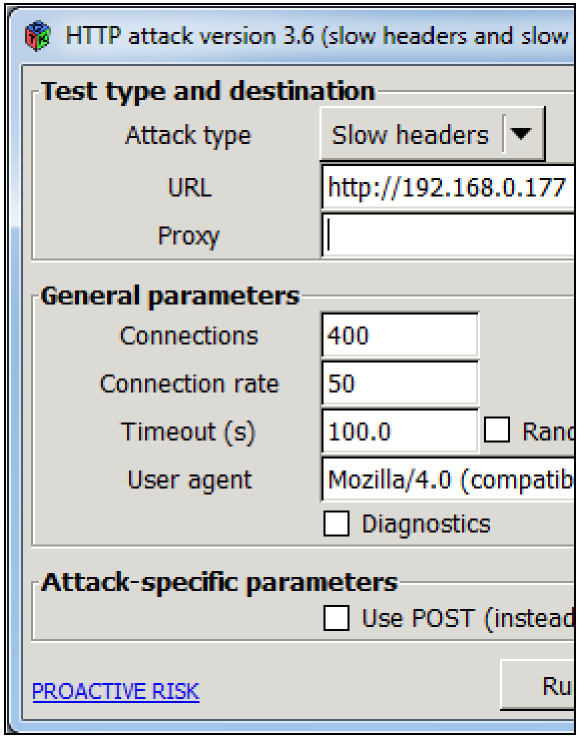


No.	Time	Source	Destination	Protocol	Info
86	30.002700	192.168.19.52	74.208.84.186	HTTP	GET / HTTP/1.0

```
Frame 86: 168 bytes on wire (1344 bits), 168 bytes captured (1344 bits)
Ethernet II, Src: Vmware_24:3b:c0 (00:50:56:24:3b:c0), Dst: 06:90:4b:e6:06:10 (06:90:4b:e6:06:1
Internet Protocol, Src: 192.168.19.52 (192.168.19.52), Dst: 74.208.84.186 (74.208.84.186)
Transmission Control Protocol, Src Port: 53395 (53395), Dst Port: 80 (80), Seq: 4231253285, Ack
Hypertext Transfer Protocol
  GET / HTTP/1.0\r\n
  User-Agent: Wget/1.11.4\r\n
  Accept: */*\r\n
  Host: samsclass.info\r\n
  Connection: Keep-Alive\r\n
  \r\n
```

SlowLoris

- Send incomplete GET requests
- Freezes Apache with one packet per second


HTTP attack version 3.6 (slow headers and slow
Test type and destination
General parameters
Attack-specific parameters
PROACTIVE RISK
Ru

Attack type: Slow headers

URL: http://192.168.0.177

Proxy:

Connections: 400

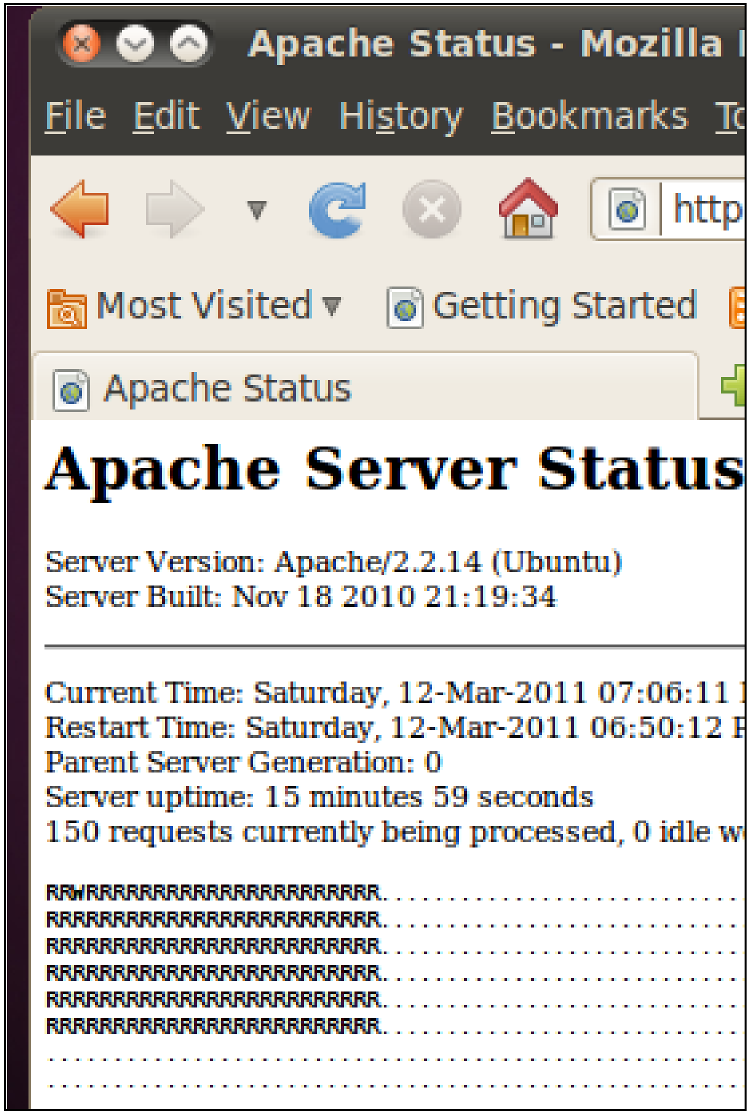
Connection rate: 50

Timeout (s): 100.0 □ Rand

User agent: Mozilla/4.0 (compatib

□ Diagnostics

□ Use POST (instead



Apache Server Status

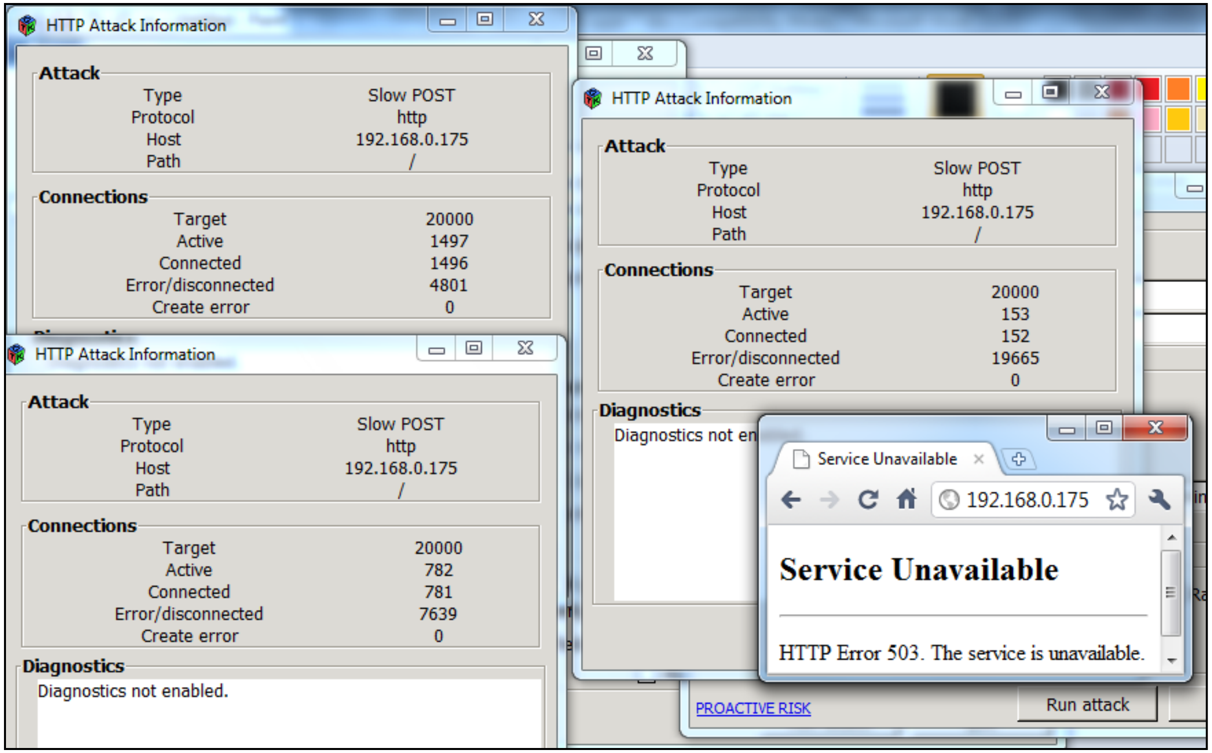
Server Version: Apache/2.2.14 (Ubuntu)
Server Built: Nov 18 2010 21:19:34

Current Time: Saturday, 12-Mar-2011 07:06:11
Restart Time: Saturday, 12-Mar-2011 06:50:12
Parent Server Generation: 0
Server uptime: 15 minutes 59 seconds
150 requests currently being processed, 0 idle w

```
RRWRRRRRRRRRRRRRRRRRRRRRR............................
RRRRRRRRRRRRRRRRRRRRRRRRR............................
RRRRRRRRRRRRRRRRRRRRRRRRR............................
RRRRRRRRRRRRRRRRRRRRRRRRR............................
RRRRRRRRRRRRRRRRRRRRRRRRR............................
RRRRRRRRRRRRRRRRRRRRRRRRR............................
.....................................................
.....................................................
```

R-U-Dead-Yet

- Incomplete HTTP POSTs
- Stops IIS, but requires thousands of packets per second



HTTP Attack Information

Attack

Type Slow POST
Protocol http
Host 192.168.0.175
Path /

Connections

Target 20000
Active 1497
Connected 1496
Error/disconnected 4801
Create error 0

HTTP Attack Information

Attack

Type Slow POST
Protocol http
Host 192.168.0.175
Path /

Connections

Target 20000
Active 782
Connected 781
Error/disconnected 7639
Create error 0

Diagnostics

Diagnostics not enabled.

HTTP Attack Information

Attack

Type Slow POST
Protocol http
Host 192.168.0.175
Path /

Connections

Target 20000
Active 153
Connected 152
Error/disconnected 19665
Create error 0

Diagnostics

Diagnostics not en

Service Unavailable

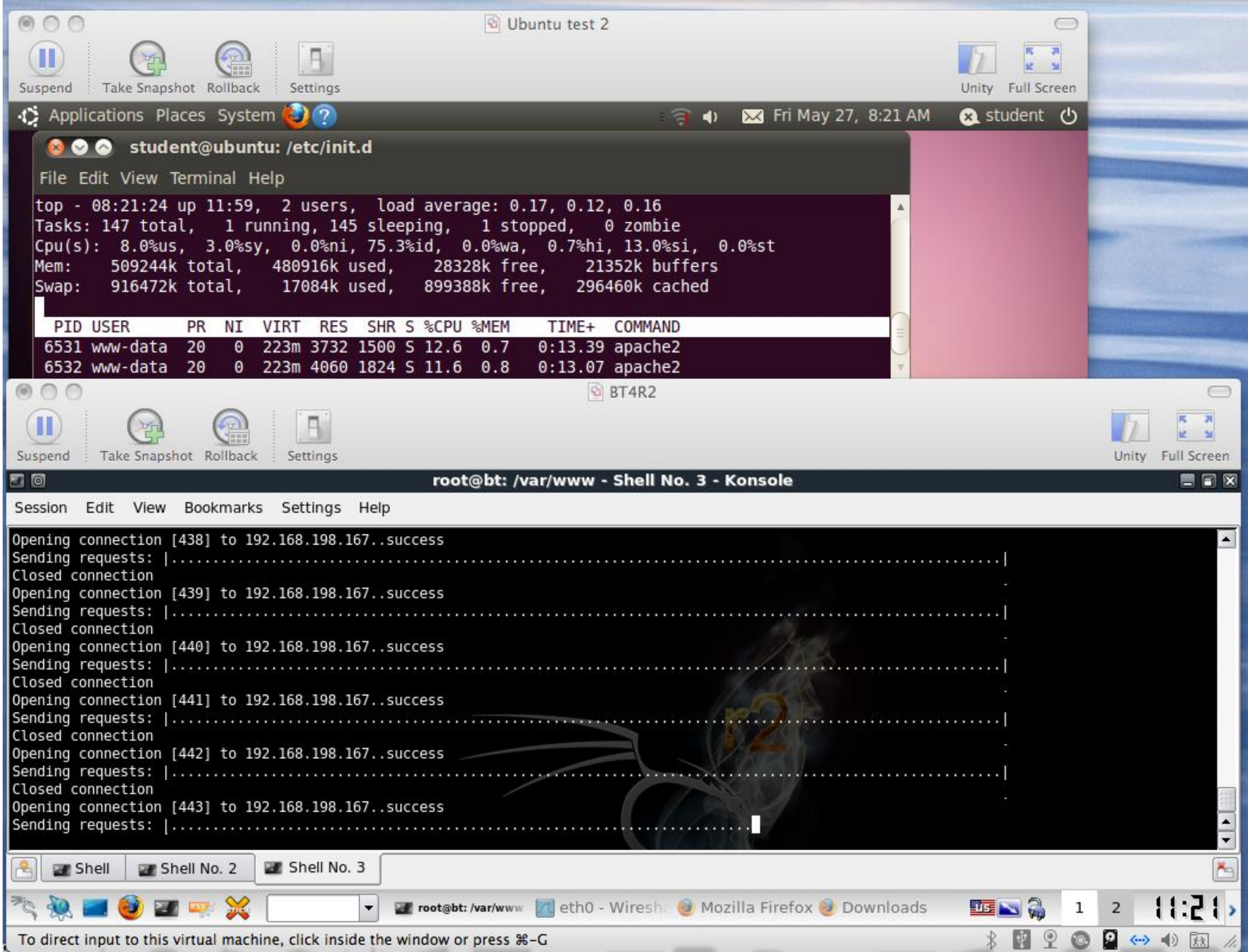
192.168.0.175

Service Unavailable

HTTP Error 503. The service is unavailable.

Keep-Alive DoS

- HTTP Keep-Alive allows 100 requests in a single connection
- HEAD method saves resources on the attacker
- Target a page that is expensive for the server to create, like a search
  - http://www.esrun.co.uk/blog/keep-alive-dos-script/
- A php script
  - pkp keep-dead.php



```
top - 08:21:24 up 11:59,  2 users,  load average: 0.17, 0.12, 0.16
Tasks: 147 total,   1 running, 145 sleeping,   1 stopped,   0 zombie
Cpu(s):  8.0%us,  3.0%sy,  0.0%ni, 75.3%id,  0.0%wa,  0.7%hi, 13.0%si,  0.0%st
Mem:    509244k total,   480916k used,    28328k free,    21352k buffers
Swap:   916472k total,    17084k used,   899388k free,   296460k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
 6531 www-data  20   0  223m 3732 1500 S 12.6  0.7   0:13.39 apache2
 6532 www-data  20   0  223m 4060 1824 S 11.6  0.8   0:13.07 apache2
```

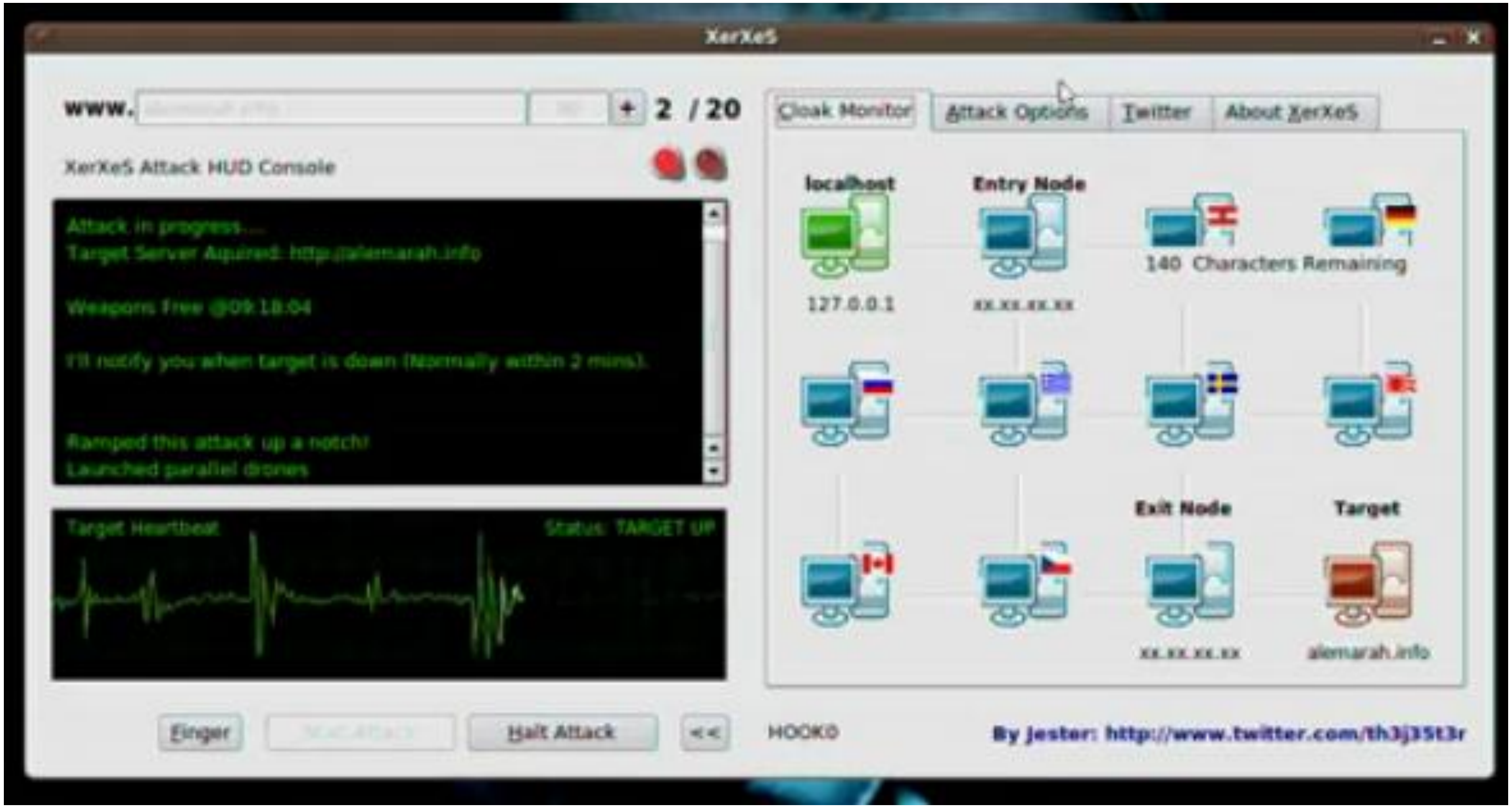
BT4R2
Suspend
Take Snapshot
Rollback
Settings
Unity
Full Screen
root@bt: /var/www - Shell No. 3 - Konsole
Session Edit View Bookmarks Settings Help

```
Opening connection [438] to 192.168.198.167..success
Sending requests: |...................................................................................................|
Closed connection
Opening connection [439] to 192.168.198.167..success
Sending requests: |...................................................................................................|
Closed connection
Opening connection [440] to 192.168.198.167..success
Sending requests: |...................................................................................................|
Closed connection
Opening connection [441] to 192.168.198.167..success
Sending requests: |...................................................................................................|
Closed connection
Opening connection [442] to 192.168.198.167..success
Sending requests: |...................................................................................................|
Closed connection
Opening connection [443] to 192.168.198.167..success
Sending requests: |.....................................................................
```

XerXes

- Th3j35t3r's DoS Tool
  - Routed through proxies like Tor to hide the attacker's origin
  - No one knows exactly what it does
  - Layer 7 DoS?

XerXes



```
Attack in progress....
Target Server Aquired: http://alemarah.info

Weapons Free @09:18:04

I'll notify you when target is down (Normally within 2 mins).


Ramped this attack up a notch!
Launched parallel drones
```

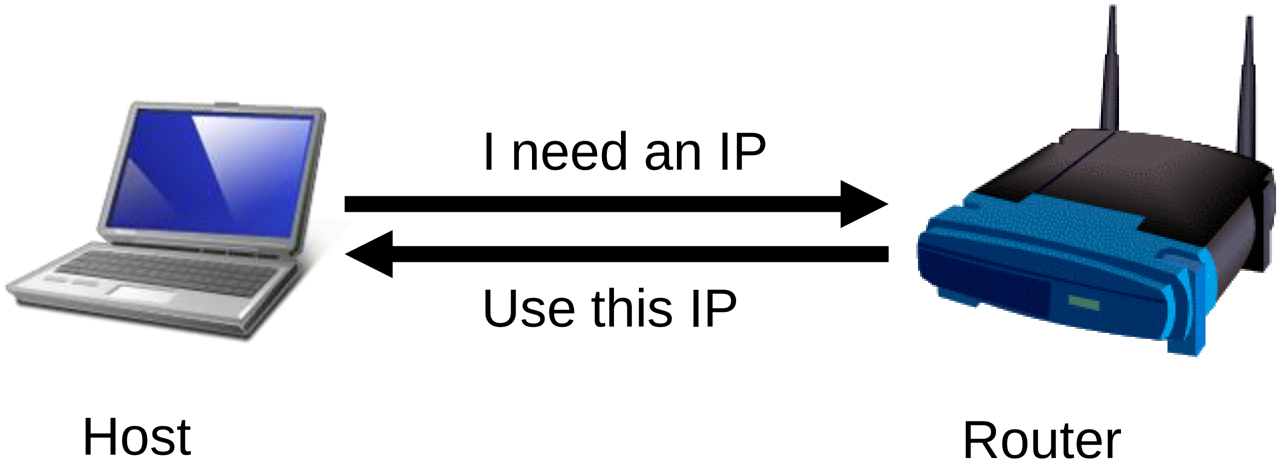
Link-Local DoS

IPv6 Router Advertisements

IPv4: DHCP

PULL process

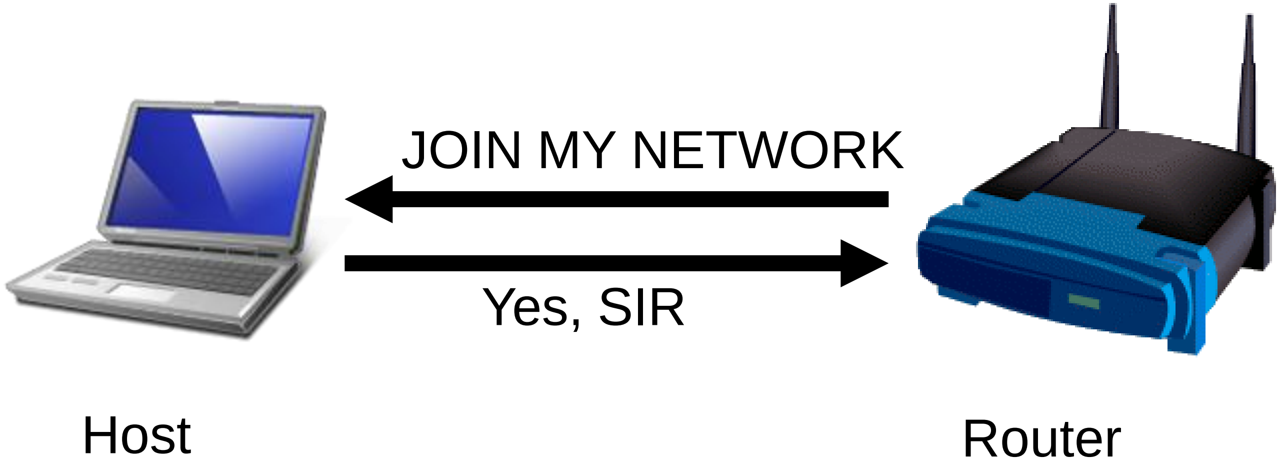
- Client requests an IP
- Router provides one



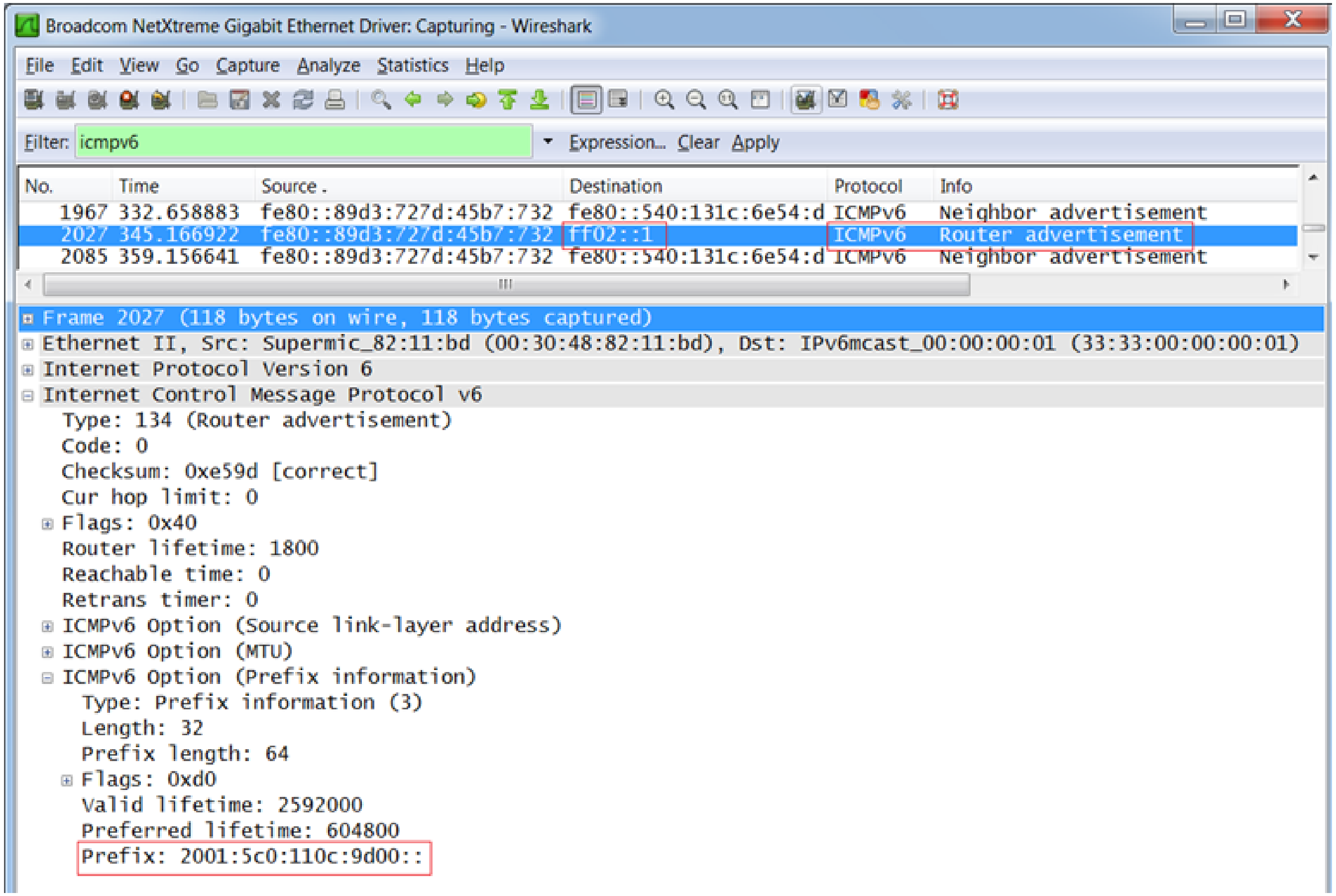
IPv6: Router Advertisements

PUSH process

- Router announces its presence
- Every client on the LAN creates an address and joins the network



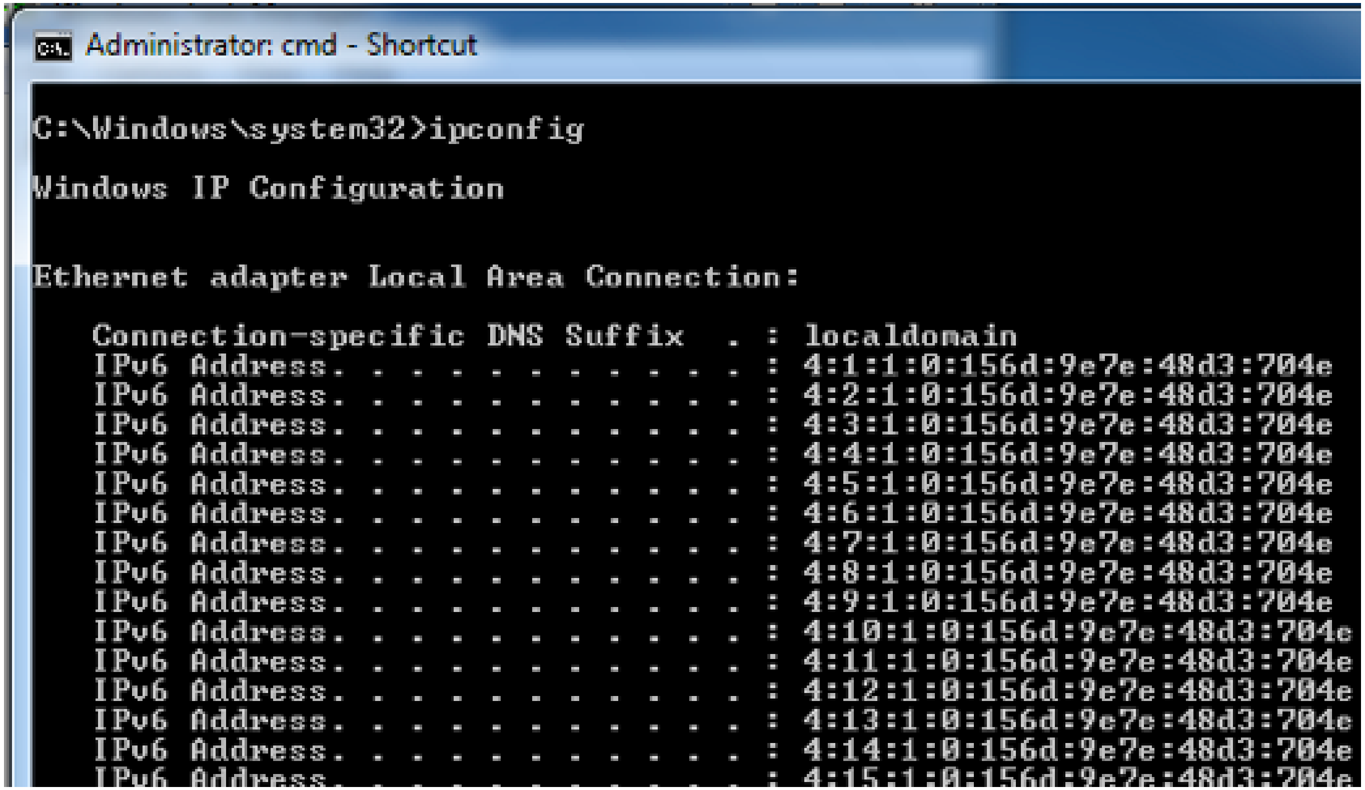
Router Advertisement Packet


Broadcom NetXtreme Gigabit Ethernet Driver: Capturing - Wireshark
File Edit View Go Capture Analyze Statistics Help
Filter: icmpv6
Expression... Clear Apply

```
No.   Time        Source .                  Destination               Protocol  Info
 1967 332.658883  fe80::89d3:727d:45b7:732  fe80::540:131c:6e54:d     ICMPv6    Neighbor advertisement
 2027 345.166922  fe80::89d3:727d:45b7:732  ff02::1                   ICMPv6    Router advertisement
 2085 359.156641  fe80::89d3:727d:45b7:732  fe80::540:131c:6e54:d     ICMPv6    Neighbor advertisement
```

```
⊞ Frame 2027 (118 bytes on wire, 118 bytes captured)
⊞ Ethernet II, Src: Supermic_82:11:bd (00:30:48:82:11:bd), Dst: IPv6mcast_00:00:00:01 (33:33:00:00:00:01)
⊞ Internet Protocol Version 6
⊟ Internet Control Message Protocol v6
    Type: 134 (Router advertisement)
    Code: 0
    Checksum: 0xe59d [correct]
    Cur hop limit: 0
  ⊞ Flags: 0x40
    Router lifetime: 1800
    Reachable time: 0
    Retrans timer: 0
  ⊞ ICMPv6 Option (Source link-layer address)
  ⊞ ICMPv6 Option (MTU)
  ⊟ ICMPv6 Option (Prefix information)
      Type: Prefix information (3)
      Length: 32
      Prefix length: 64
    ⊞ Flags: 0xd0
      Valid lifetime: 2592000
      Preferred lifetime: 604800
      Prefix: 2001:5c0:110c:9d00::
```

RA Flood



```
C:\Windows\system32>ipconfig

Windows IP Configuration


Ethernet adapter Local Area Connection:

   Connection-specific DNS Suffix  . : localdomain
   IPv6 Address. . . . . . . . . . . : 4:1:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:2:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:3:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:4:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:5:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:6:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:7:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:8:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:9:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:10:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:11:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:12:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:13:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:14:1:0:156d:9e7e:48d3:704e
   IPv6 Address. . . . . . . . . . . : 4:15:1:0:156d:9e7e:48d3:704e
```

Windows Vulnerability

- It takes a LOT of CPU for Windows to process those Router Advertisements
- 5 packets per second drives the CPU to 100%
- And they are sent to every machine in the LAN (ff02::1 is Link-Local All Nodes Multicast)
- One attacker kills all the Windows machines on a LAN

Responsible Disclosure

- Microsoft was alerted by Marc Heuse on July 10, 2010
- Microsoft does not plan to patch this
- Juniper and Cisco devices are also vulnerable
- Cisco has released a patch, Juniper has not

Defenses from RA Floods

- Disable IPv6
- Turn off Router Discovery
- Block rogue RAs with a firewall
- Get a switch with RA Guard

RA Guard Evasion

- Add "Fragmentation Headers" to the RA Packets
  - http://samsclass.info/ipv6/proj/RA-evasion.html

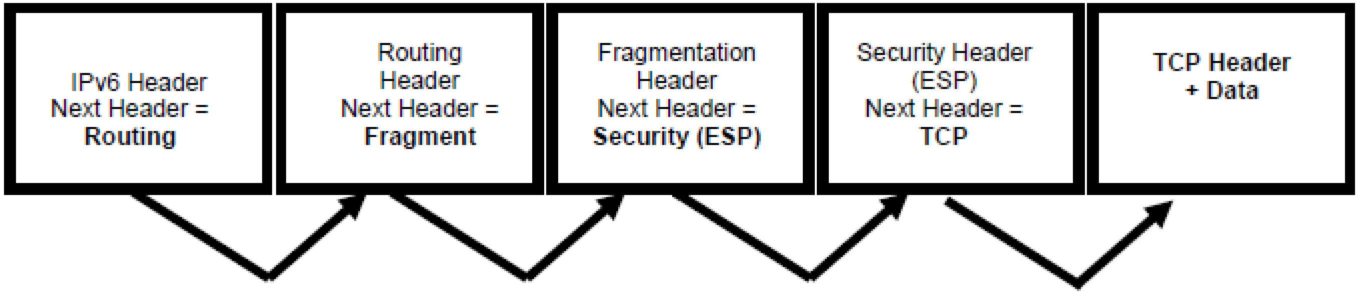
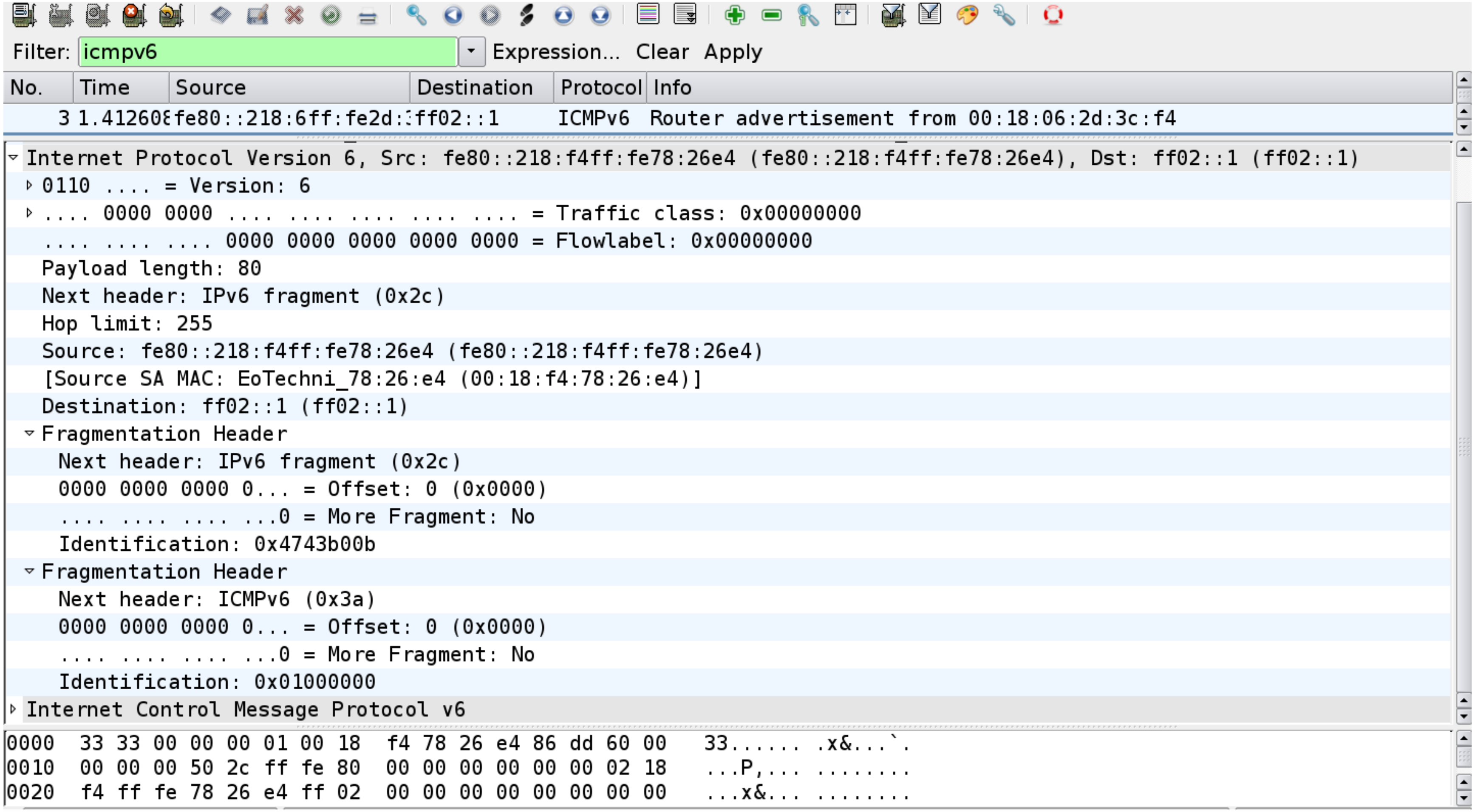


Figure 3-8. Next Header Fields in IPv6 and Extension Headers

Fragmentation Headers



```
No.  Time      Source                Destination  Protocol  Info
  3 1.41260€fe80::218:6ff:fe2d:ff02::1      ICMPv6   Router advertisement from 00:18:06:2d:3c:f4
```

```
▽ Internet Protocol Version 6, Src: fe80::218:f4ff:fe78:26e4 (fe80::218:f4ff:fe78:26e4), Dst: ff02::1 (ff02::1)
  ▷ 0110 .... = Version: 6
  ▷ .... 0000 0000 .... .... .... .... .... = Traffic class: 0x00000000
    .... .... .... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
    Payload length: 80
    Next header: IPv6 fragment (0x2c)
    Hop limit: 255
    Source: fe80::218:f4ff:fe78:26e4 (fe80::218:f4ff:fe78:26e4)
    [Source SA MAC: EoTechni_78:26:e4 (00:18:f4:78:26:e4)]
    Destination: ff02::1 (ff02::1)
  ▽ Fragmentation Header
      Next header: IPv6 fragment (0x2c)
      0000 0000 0000 0... = Offset: 0 (0x0000)
      .... .... .... ...0 = More Fragment: No
      Identification: 0x4743b00b
  ▽ Fragmentation Header
      Next header: ICMPv6 (0x3a)
      0000 0000 0000 0... = Offset: 0 (0x0000)
      .... .... .... ...0 = More Fragment: No
      Identification: 0x01000000
▷ Internet Control Message Protocol v6
```

```
0000  33 33 00 00 00 01 00 18  f4 78 26 e4 86 dd 60 00   33...... .x&...`.
0010  00 00 00 50 2c ff fe 80  00 00 00 00 00 00 02 18   ...P,... ........
0020  f4 ff fe 78 26 e4 ff 02  00 00 00 00 00 00 00 00   ...x&... ........
```

Defending Websites

Attack > Defense

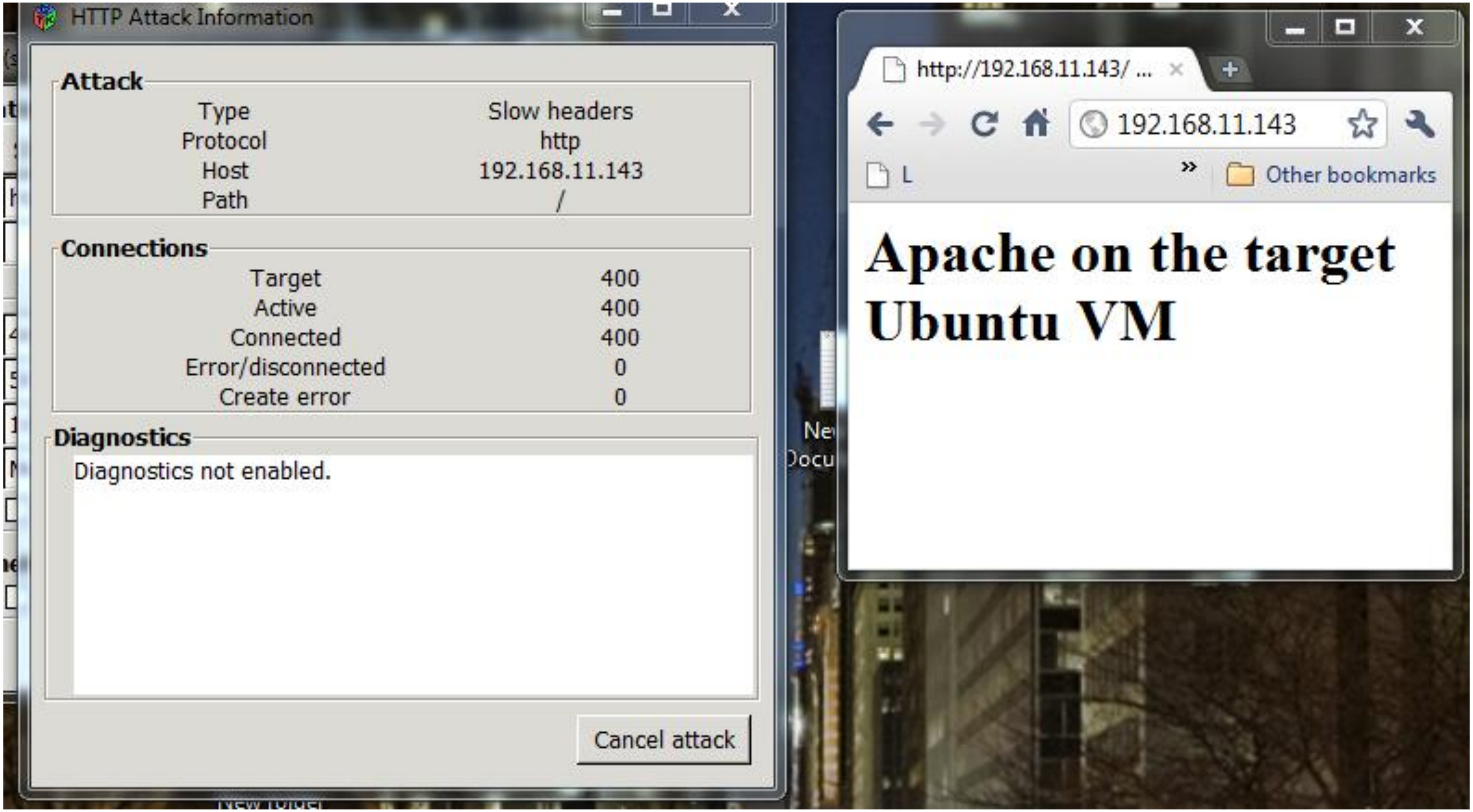
- Right now, your website is only up because
  - Not even one person hates you, or
  - All the people that hate you are ignorant about network security

Defense

- Mod Security--free open-source defense tool
  - Latest version has some protections against Layer 7 DoS

- Akamai has good defense solutions
  - Caching
  - DNS Redirection
  - Javascript second-request trick

Load Balancer



Attack

```
Type        Slow headers
Protocol    http
Host        192.168.11.143
Path        /
```

Connections

```
Target               400
Active               400
Connected            400
Error/disconnected   0
Create error         0
```

Diagnostics

Diagnostics not enabled.

Apache on the target Ubuntu VM

Counterattacks

- Reflecting attacks back to the command & control server
- Effective against dumb attackers like Anonymous' LOIC
  - Will lose effect if they ever learn about Layer 7 DoS, which is happening now

References

References

Anonymous Takes Down U.S. Chamber Of Commerce And Supporter Websites
http://goo.gl/Mue9k

Slowloris HTTP DoS
http://ha.ckers.org/slowloris/

OWASP HTTP DoS Tool
http://code.google.com/p/owasp-dos-http-post/

Mitigating Slow HTTP DoS Attacks
http://blog.spiderlabs.com/2010/11/advanced-topic-of-the-week-mitigating-slow-http-dos-attacks.html

‘Tis the Season of DDoS – WikiLeaks Edition (Outage charts)
http://goo.gl/V5jZc

References

ModSecurity
http://goo.gl/56hbl

Akamai DDoS Report
http://baythreat.org/MichaelSmith_DDoS.pdf

How Secure Is Julian Assange's "Thermonuclear" Insurance File?
http://goo.gl/sY6Nn

Overview of Anonymous and their attack on MasterCard:
http://goo.gl/lVsCD

Operation Payback Toolkit: LOIC and HiveMind
http://pastehtml.com/view/1c8i33u.html

References

r-u-dead-yet
http://code.google.com/p/r-u-dead-yet/

Keep-Alive DoS Script
http://www.esrun.co.uk/blog/keep-alive-dos-script/

Router Advertisement DoS in Windows
http://samsclass.info/ipv6/proj/flood-router6a.htm

RA Guard Evasion
http://samsclass.info/ipv6/proj/RA-evasion.html

XerXes Attack Video
http://goo.gl/j8NQE