

CSE 490K Lecture 14

Botnets and Spam

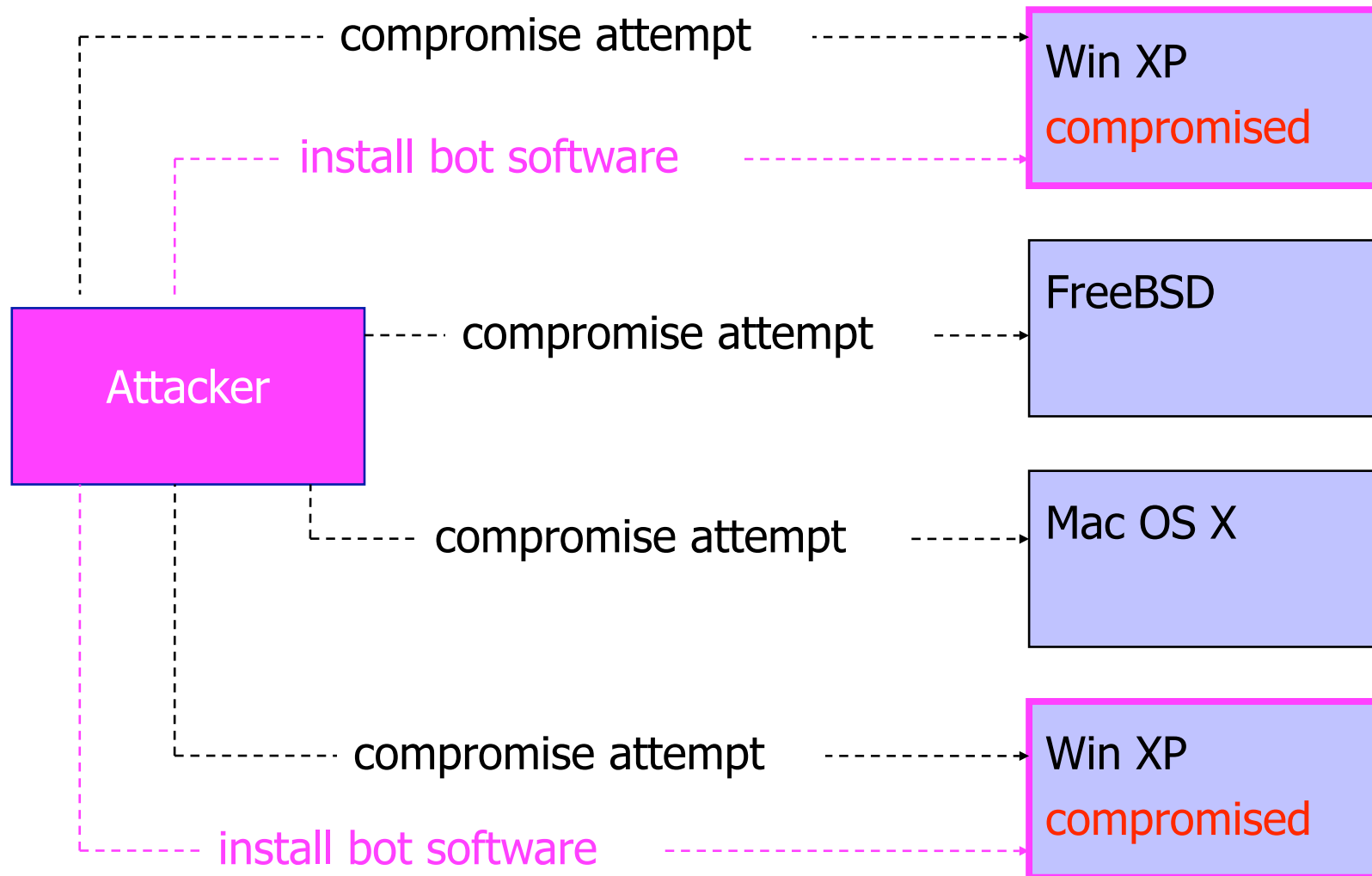
Tadayoshi Kohno

Some slides based on Vitaly Shmatikov's

Botnets

- ◆ Botnet = network of autonomous programs capable of acting on instructions
 - Typically a large (up to several hundred thousand) group of remotely controlled “zombie” systems
 - Machine owners are not aware they have been compromised
 - Controlled and upgraded via IRC or P2P
- ◆ Used as the platform for various attacks
 - Distributed denial of service
 - Spam and click fraud
 - Launching pad for new exploits/worms

Building a Botnet



Typical Infection Path

- ◆ Exploit a vulnerability to execute a short program (**shellcode**) on victim's machine
 - Buffer overflows, email viruses, etc.
- ◆ Shellcode downloads and installs actual bot
- ◆ Bot disables firewall and antivirus software
- ◆ Bot locates IRC server, connects, joins channel
 - Typically need DNS to find out server's IP address
 - Especially if server's original IP address has been blacklisted
 - Authentication password often stored in bot binary
- ◆ Botmaster issues authenticated commands

Joining the IRC Channel

Win XP

```
. . .  
/connect  
jade.va.us.dal.net  
/join #hacker  
. . .
```

Win XP

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. . .
```

jade.va.dal.net

Command and Control

```
(12:59:27pm) -- A9-pcgbdv (A9-pcgbdv@140.134.36.124)
has joined (#owned) Users : 1646
```

```
(12:59:27pm) (@Attacker) .ddos.synflood 216.209.82.62
```

```
(12:59:27pm) -- A6-bpxufrd (A6-
bpxufrd@wp95-81.introweb.nl) has joined (#owned)
Users : 1647
```

```
(12:59:27pm) -- A9-nzmpah (A9-nzmpah@140.122.200.221)
has left IRC (Connection reset by peer)
```

```
(12:59:28pm) (@Attacker) .scan.enable DCOM
```

```
(12:59:28pm) -- A9-tzrkeasv (A9-tzrkeas@220.89.66.93)
has joined (#owned) Users : 1650
```

Botnet Propagation

[Abu Rajab et al.]

- ◆ Each bot can scan IP space for new victims
 - Automatically
 - Each bot contains hard-coded list of IRC servers' DNS names
 - As infection is spreading, IRC servers and channels that the new bots are looking for are often no longer reachable
 - On-command: target specific /8 or /16 prefixes
 - Botmasters share information about prefixes to avoid
- ◆ Evidence of botnet-on-botnet warfare
 - DoS server by multiple IRC connections ("cloning")
 - Patch victim against other bots
- ◆ Active botnet management
 - Detect non-responding bots, identify "superbots"

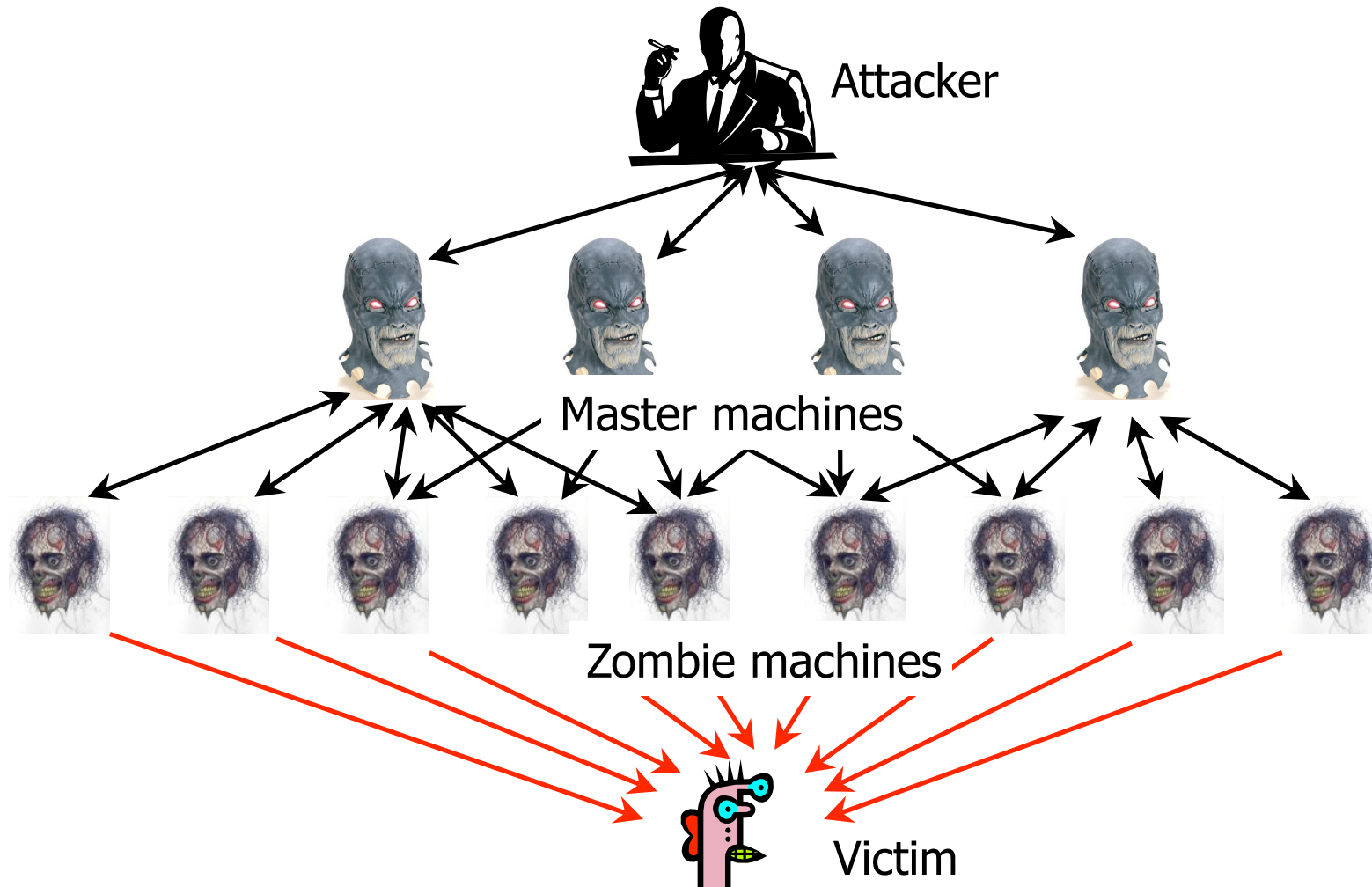
Denial of Service (DoS) Redux

- ◆ Goal: overwhelm victim machine and deny service to its legitimate clients
- ◆ DoS often exploits networking protocols
 - Smurf: ICMP echo request to broadcast address with spoofed victim's address as source
 - Ping of death: ICMP packets with payloads greater than 64K crash older versions of Windows
 - SYN flood: "open TCP connection" request from a spoofed address
 - UDP flood: exhaust bandwidth by sending thousands of bogus UDP packets

Distributed Denial of Service (DDoS)

- ◆ Build a botnet of zombies
 - Multi-layer architecture: use some of the zombies as “masters” to control other zombies
- ◆ Command zombies to stage a coordinated attack on the victim
 - Even in case of SYN flood, SYN cookies don't help (why?)
- ◆ Overwhelm victim with traffic arriving from thousands of different sources

DDoS Architecture



DDoS Tools: Trin00

- ◆ Scan for known buffer overflows in Linux & Solaris
 - Unpatched versions of wu-ftpd, statd, amd, ...
 - Root shell on compromised host returns confirmation
- ◆ Install attack daemon using remote shell access
- ◆ Send commands (victim IP, attack parameters), using plaintext passwords for authentication
 - Attacker to master: TCP, master to zombie: UDP
 - To avoid detection, daemon issues warning if someone connects when master is already authenticated
- ◆ August of 1999: a network of 227 Trin00 zombies took U. of Minnesota offline for 3 days

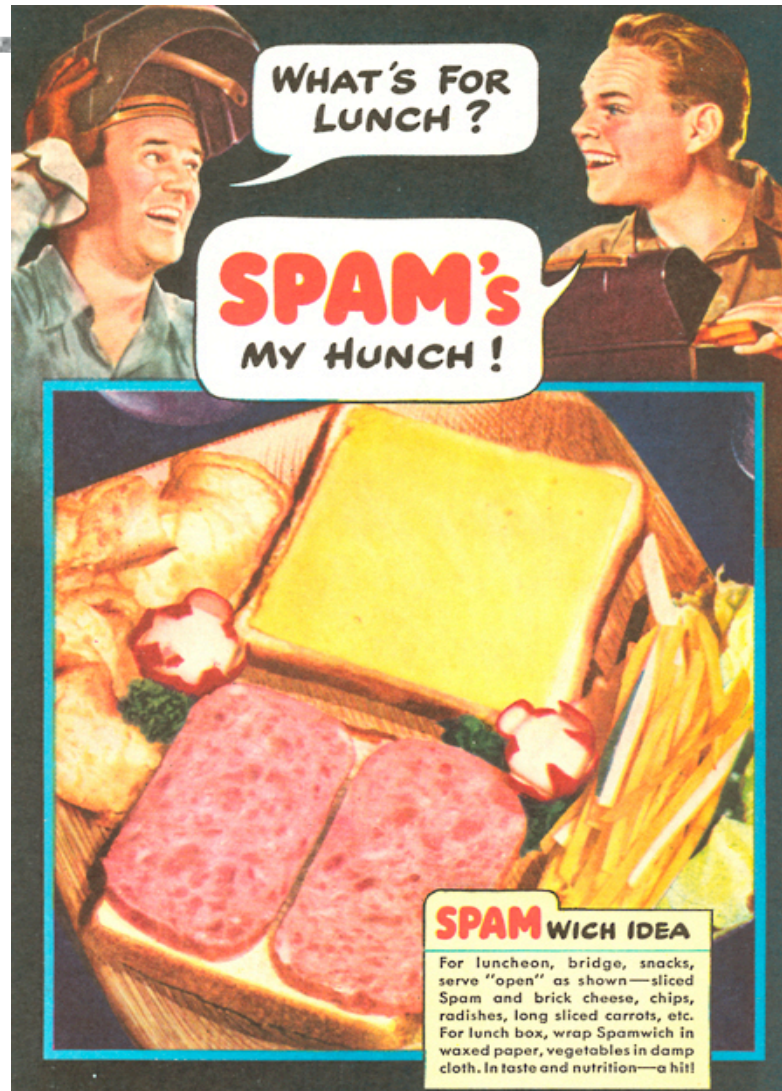
DDoS Tools: Tribal Flood Network

- ◆ Supports multiple DoS attack types
 - Smurf; ICMP, SYN, UDP floods
- ◆ Attacker runs masters directly via root backdoor; masters talk to zombies using ICMP echo reply
 - No authentication of master's commands, but commands are encoded as 16-bit binary numbers inside ICMP packets to prevent accidental triggering
 - Vulnerable to connection hijacking and RST sniping
- ◆ List of zombie daemons' IP addresses is encrypted in later versions of TFN master scripts
 - Protects identities of zombies if master is discovered

DDoS Tools: Stacheldraht

- ◆ Combines “best” features of Trin00 and TFN
 - Multiple attack types (like TFN)
- ◆ Symmetric encryption for attacker-master connections
- ◆ Master daemons can be upgraded on demand
- ◆ February 2000: crippled Yahoo, eBay, Amazon, Schwab, E*Trade, CNN, Buy.com, ZDNet
 - Smurf-like attack on Yahoo consumed more than a Gigabit/sec of bandwidth
 - Sources of attack still unknown

Spam



WHAT'S FOR LUNCH?

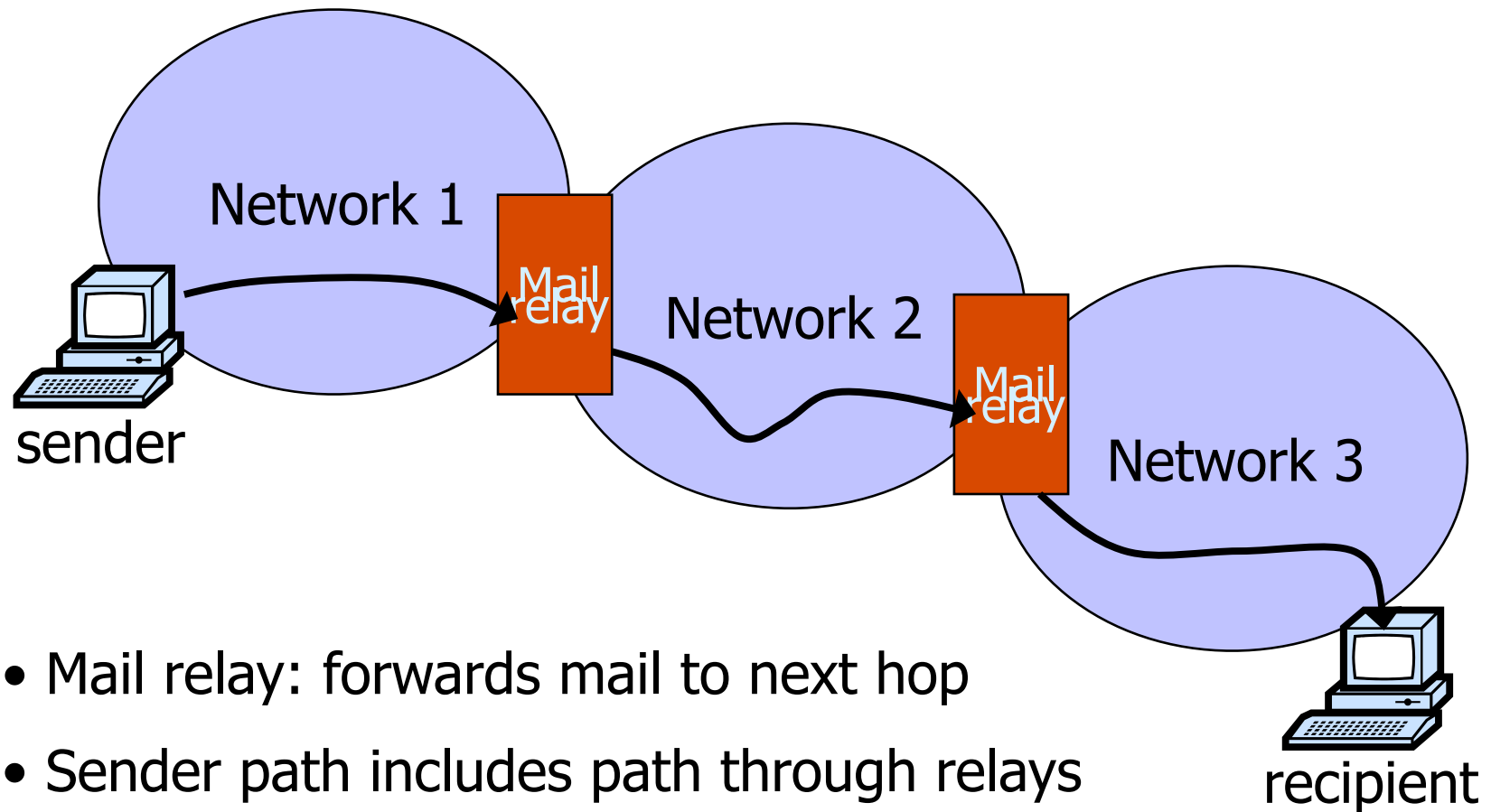
SPAM'S
MY HUNCH!

SPAM WICH IDEA

For luncheon, bridge, snacks, serve "open" as shown—sliced Spam and brick cheese, chips, radishes, long sliced carrots, etc. For lunch box, wrap Spamwich in waxed paper, vegetables in damp cloth. In taste and nutrition—a hit!

The advertisement features a vintage-style illustration. At the top, two men are shown in conversation. The man on the left is wearing a hat and a light-colored shirt, while the man on the right is wearing a dark apron over a light-colored shirt. A speech bubble from the man on the right asks, "WHAT'S FOR LUNCH?". Below this, a larger speech bubble from the man on the left says, "SPAM'S MY HUNCH!". The word "SPAM'S" is written in large, bold, red letters, with "MY HUNCH!" in smaller black letters below it. In the center of the advertisement is a wooden basket filled with various food items. The most prominent items are two slices of Spam, a slice of brick cheese, a slice of bread, a slice of radish, and a slice of carrot. There are also some french fries and other vegetables in the basket. At the bottom right of the basket, there is a small text box with the heading "SPAM WICH IDEA" and a paragraph of text describing how to serve the Spamwich.

Email in the Early 1980s



Email Spoofing

- ◆ Mail is sent via SMTP protocol
 - No built-in authentication
- ◆ MAIL FROM field is set by the sender
 - Classic example of improper input validation
- ◆ Recipient's mail server only sees IP address of the direct peer from whom it received the msg

Open Relays

- ◆ SMTP relay forwards mail to destination
 1. Bulk email tool connects via SMTP (port 25)
 2. Sends list of recipients via RCPT TO command
 3. Sends email body (once for all recipients!)
 4. Relay delivers message
- ◆ Honest relay adds correct Received: header revealing source IP
- ◆ Hacked relay does not

A Closer Look at Spam

Received: by 10.78.68.6 with SMTP id q6cs394373hua;

Mon, 12 Feb 2007 06:43:30 -0800 (PST)

Received: by 10.90.113.18 with SMTP id l18mr17307116agc.1171291410432;

Mon, 12 Feb 2007 06:43:30 -0800 (PST)

Return-Path: <wvnlwee@aviva.ro>

Received: from onelinkpr.net ([203.169.49.172])

by mx.google.com with ESMTP id 30si11317474agc.2007.02.12.06.43.18;

Mon, 12 Feb 2007 06:43:30 -0800 (PST)

Received-SPF: neutral (google.com: 203.169.49.172 is neither permitted nor denied by best guess record for domain of wvnlwee@aviva.ro)

Message-ID: <20050057765.stank.203.169.49.172@ASAFTU>

From: "Barclay Morales" <wvnlwee@aviva.ro>

To: <raykwatts@gmail.com>

Subject: You can order both Viagra and Cialis.

A Closer Look at Spam

Received: by 10.78.68.6 **Inserted by relays** hua;
Mon, 12 Feb 2007 06:43:30 -0800 (PST)
Received: by 10.90.113.18 with SMTP id l18mr17307116agc.1171291410432;
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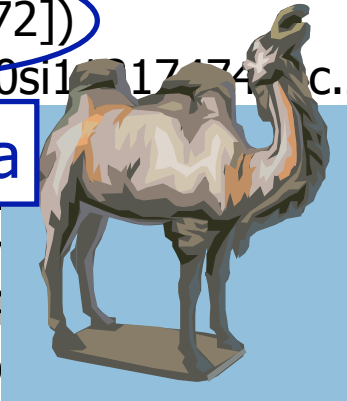
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by mx.google.com with ESMTP id 30si11317474agc.2007.02.12.06.43.18;
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Received: from onelinkpr.net (google.com: 203.169.49.172 is neither permitted nor
authorized to send mail from this host; you may best guess record for domain of wvnlwee@aviva.ro)
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Puerto Rico

A Closer Look at Spam

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Received: by 10.90.113.18 with SMTP id l18mr17307116agc.1171291410432;
Mon, 12 Feb 2007 06:43:30 -0800 (PST)
Return-Path: <wvnlwee@aviva.ro>
Received: from onelinkpr.net ([203.169.49.172])
by mx.google.com with ESMTP id 30si1171741c.2007.02.12.06.43.18;
:4. **Puerto Rico** **Mongolia**
Received: from onelinkpr.net ([203.169.49.172]) by mx.google.com with ESMTP id 30si1171741c.2007.02.12.06.43.18;
by best guess record for domain onelinkpr.net (google.com) (203.169.49.172) id 30si1171741c.2007.02.12.06.43.18;
Message-ID: <0050057765.stank.203.169.49.172@onelinkpr.net>
From: "Barclay Morales" <wvnlwee@aviva.ro>
To: <raykwatts@gmail.com>
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A Closer Look at Spam

Received: by 10.78.68.6 **Inserted by relays** hua;
Mon, 12 Feb 2007 06:43:30 -0800 (PST)

Received: by 10.101.10.10 MTP id l18mr17307116agc.1171291410432;
Mon, 12 Feb 2007 06:43:30 -0800 (PST)

Return-Path: <[redacted]>

Received: from onelinkpr.net ([203.169.49.172])
by mx.google.com with ESMTP id 30si117174...c.2007.02.12.06.43.18;

Puerto Rico :4 **Mongolia**

Received: from [redacted] (google.com) by best guess record for domain [redacted] (permitted nor
@aviva.ro)

Message-ID: <0050057765.stank.203.169.4...>

From: "Barclay Morales" <wvnlwee@aviva.ro>

To: <raykwatts@gmail.com>

Subject: You can order both Viagra and Cialis.

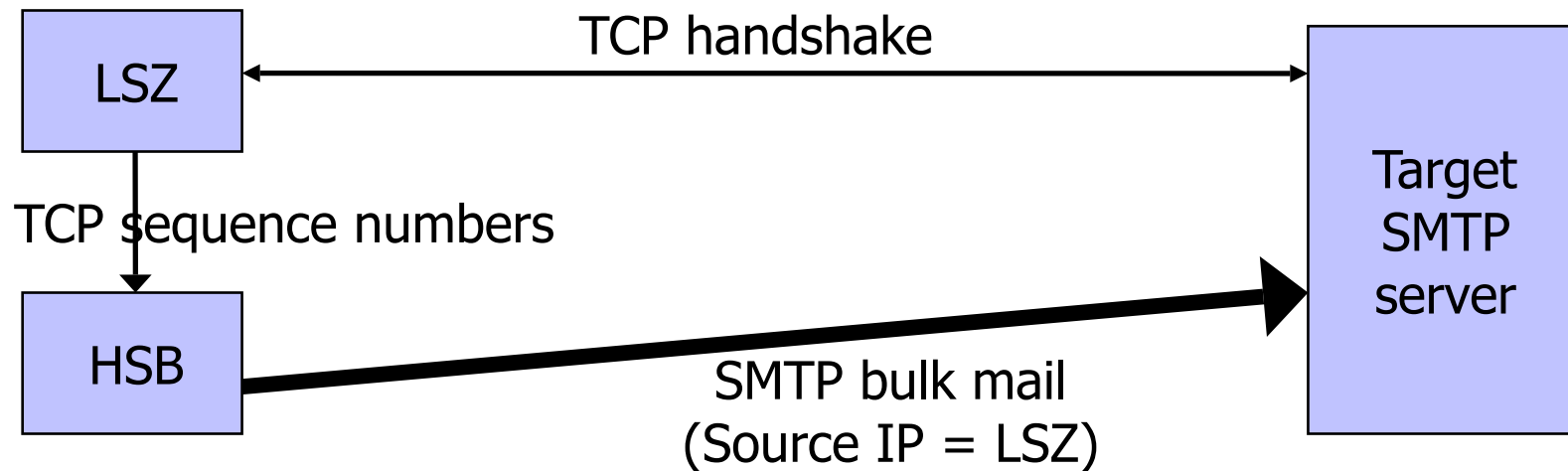


Why Hide Sources of Spam?

- ◆ Many email providers blacklist servers and ISPs that generate a lot of spam
 - Use info from spamhaus.org, spamcop.net
- ◆ Real-time blackhole lists stop 15-25% of spam at SMTP connection time
 - Over 90% after message body URI checks
- ◆ Spammers' objective: evade blacklists
 - Botnets come very handy!

Thin Pipe / Thick Pipe

- ◆ Spam source has high-speed broadband machine (HSB) and controls a low-speed zombie (LSZ)



- ◆ Hides IP address of HSB; LSZ is blacklisted

www.send-safe.com



Send-Safe Mailer

Send-Safe is a bulk email software that allows you to send email from your own computer, or a remote computer with or without the use of proxies. In those countries where it is legal to use proxies, the Send-Safe program can make it impossible for anyone to trace the email back to your ISP and thus keeps your connection to the internet safe. This gives you a safe haven in which to send your mail.

[Download demo](#) | [Purchase for Euro 50](#) | [Members Area](#)



Send-Safe Standalone

Send-Safe Standalone is a standalone version of one of the most successful and efficient bulk email software in the industry. It's designed specially for those top mailers who prefer to pay once for the software once and then don't spend extra money for the huge volume of their mailings. Purchasing Send-Safe Standalone, you get all the power of our famous Send-Safe mailer but pay only one time fee, with no troubles of credits overrun, account expiration, lost server connections and so on.

[Download demo](#) | [Purchase for Euro 599](#)



Send-Safe Enterprise

Send-Safe Spam Tool

Send-Safe v2.19b (build 544) - C:\Program Files\Send-Safe

File Run Mail Help

Elapsed: 05:18:03
Fails: 654 821
Deliverability: 87%
Avg speed: 950244 mails/hour

Messages Maillists Rotation Settings Proxies Advanced Test

SpecialOffer ID: ombt1115 New Save Delete

FROM Emails: FROM Aliases: TO Aliases: Attachments:

webmaster@indatate
testdirectv@yahoo.co
johntacker@hotmail.c

Webmaster
Postmaster
Administrator

Subjects:

Hi!
Hello!
How are you doing ?

Mail text: HTML content

{%ROT:Dear {%NAME%}!!Dear Colleague!!Hi,{%ACCOUNT%}}}

The RBT Catalog came into existence in 2001 and in short three years has become one of the most successful catalogs on the market. For this, we are pleased, proud and grateful.

We are pleased because our customers have confirmed our belief that if the products we offer are new, exciting, innovative and of excellent quality, they will be purchased.

01:57:15 gateway-s.comcast.net:25: 0 sent... Session time: 6.27 S
01:57:15 comcast.net, 2 MX(es) found: gateway-s.comcast.net. Processing 2 e-mails.
01:57:16 gateway-r.comcast.net:25: 4 sent... Session time: 7.56 S
01:57:16 comcast.net, 2 MX(es) found: gateway-s.comcast.net. Processing 2 e-mails.

Leased until: 2004-06-24 16:56:56
Credits Total: 10 000 000
Credits Left: 996 063
Message Size: 1377 bytes

Total good proxies: 527. Using 317 fastest proxies. Reply time: min=0.4534s, max=2.9521s

Open Relays vs. Open Proxies

◆ Open proxy

- Spammer must send message to each recipient through the proxy

◆ Open relay

- Takes a list of addresses and sends to all
- Can host an open relay on a **zombie**

◆ Listing services for open proxies and relays

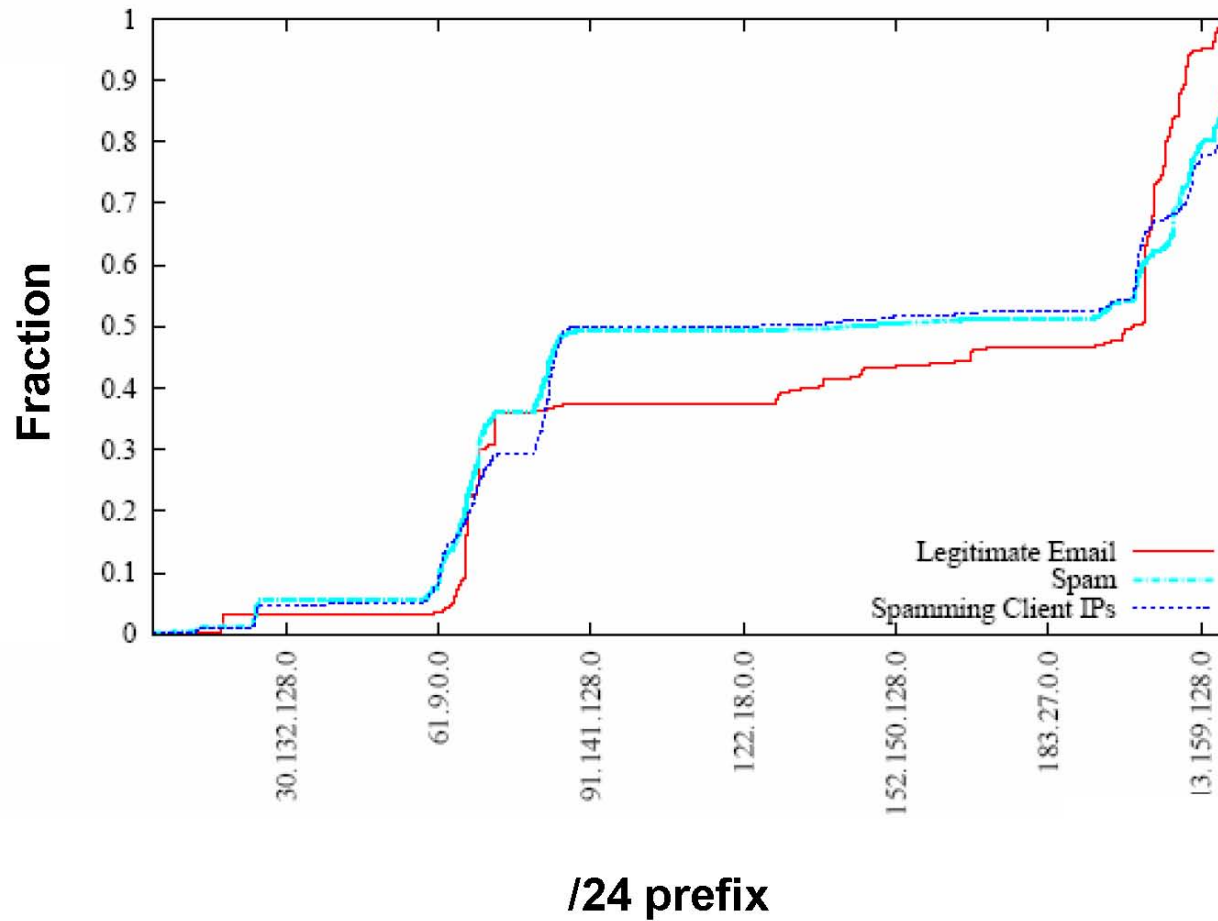
- <http://www.multiproxy.org/>
<http://www.stayinvisible.com/>
<http://www.openproxies.com/> (\$20/month)

Bobax Worm

- ◆ Infects machines with high bandwidth
 - Exploits MS LSASS.exe buffer overflow vulnerability
- ◆ Slow spreading (and thus hard to detect)
 - On manual command from operator, randomly scans for vulnerable machines
- ◆ Installs hacked open relay on infected zombie
 - Once spam zombie added to blacklist, spread to another machine
 - Interesting detection technique: look for botmaster's DNS queries (trying to determine who is blacklisted)

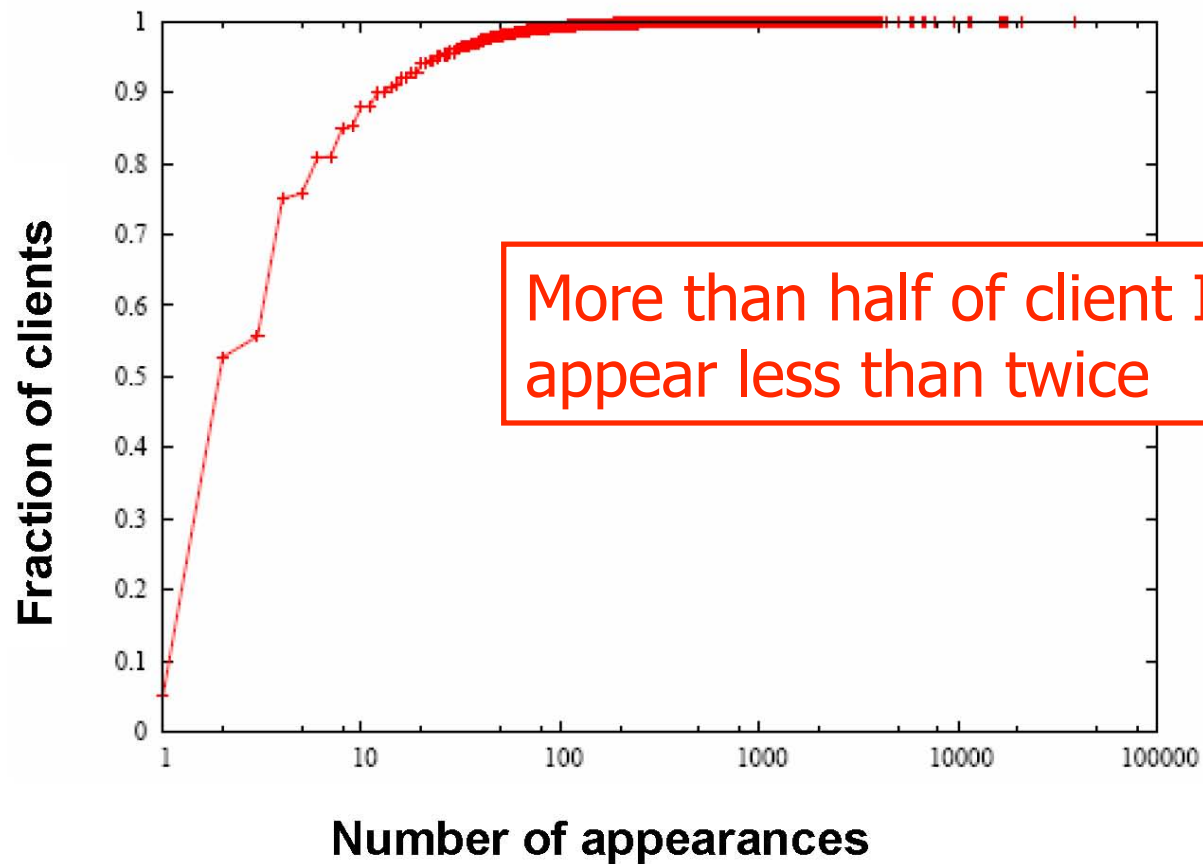
Distribution of Spam Sources

[Ramachandran, Feamster]



IP Blacklisting Not Enough

[Ramachandran, Feamster]



Distribution Across Domains

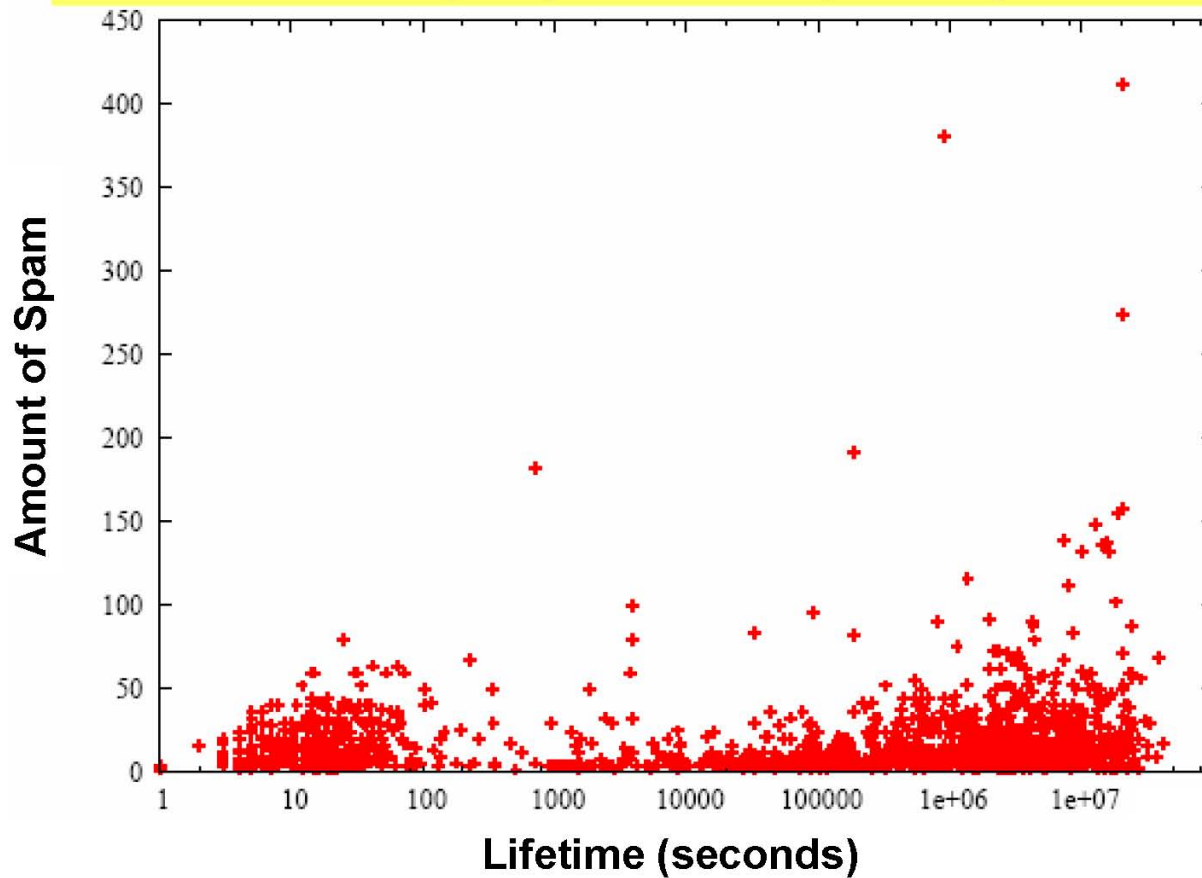
[Ramachandran, Feamster]

<i>AS Number</i>	<i># Spam</i>	<i>AS Name</i>	<i>Primary Country</i>
766	580559	Korean Internet Exchange	Korea
4134	560765	China Telecom	China
1239	437660	Sprint	United States
4837	236434	China Network Communications	China
9318	225830	Hanaro Telecom	Japan
32311	198185	JKS Media, LLC	United States
5617	181270	Polish Telecom	Poland
6478	152671	AT&T WorldNet Services	United States
19262	142237	Verizon Global Networks	United States
8075	107056	Microsoft	United States
7132	99585	SBC Internet Services	United States
6517	94600	Yipes Communications, Inc.	United States
31797	89698	GalaxyVisions	United States
12322	87340	PROXAD AS for Proxad ISP	France
3356	87042	Level 3 Communications, LLC	United States
22909	86150	Comcast Cable Corporation	United States
8151	81721	UniNet S.A. de C.V.	Mexico
3320	79987	Deutsche Telekom AG	Germany
7018	74320	AT&T WorldNet Services	United States
4814	74266	China Telecom	China

Most Bots Send Little Spam

[Ramachandran, Feamster]

Most bot IP addresses send very little spam, regardless of how long they have been spamming...



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 [Ramachandran, Feamster]

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- ◆ Spammers exploit routing infrastructure
 - Create short-lived connection to mail relay, then disappear
 - Hijack a large chunk of unallocated "dark" space

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 - Problem: false positives!
 - Problem: short-lived hijacks of dark address space

Detecting Botnets

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 - Look for hosts who ask many DNS queries, but receive few queries about themselves
- ◆ Easily evaded by using encryption and P2P ☹️