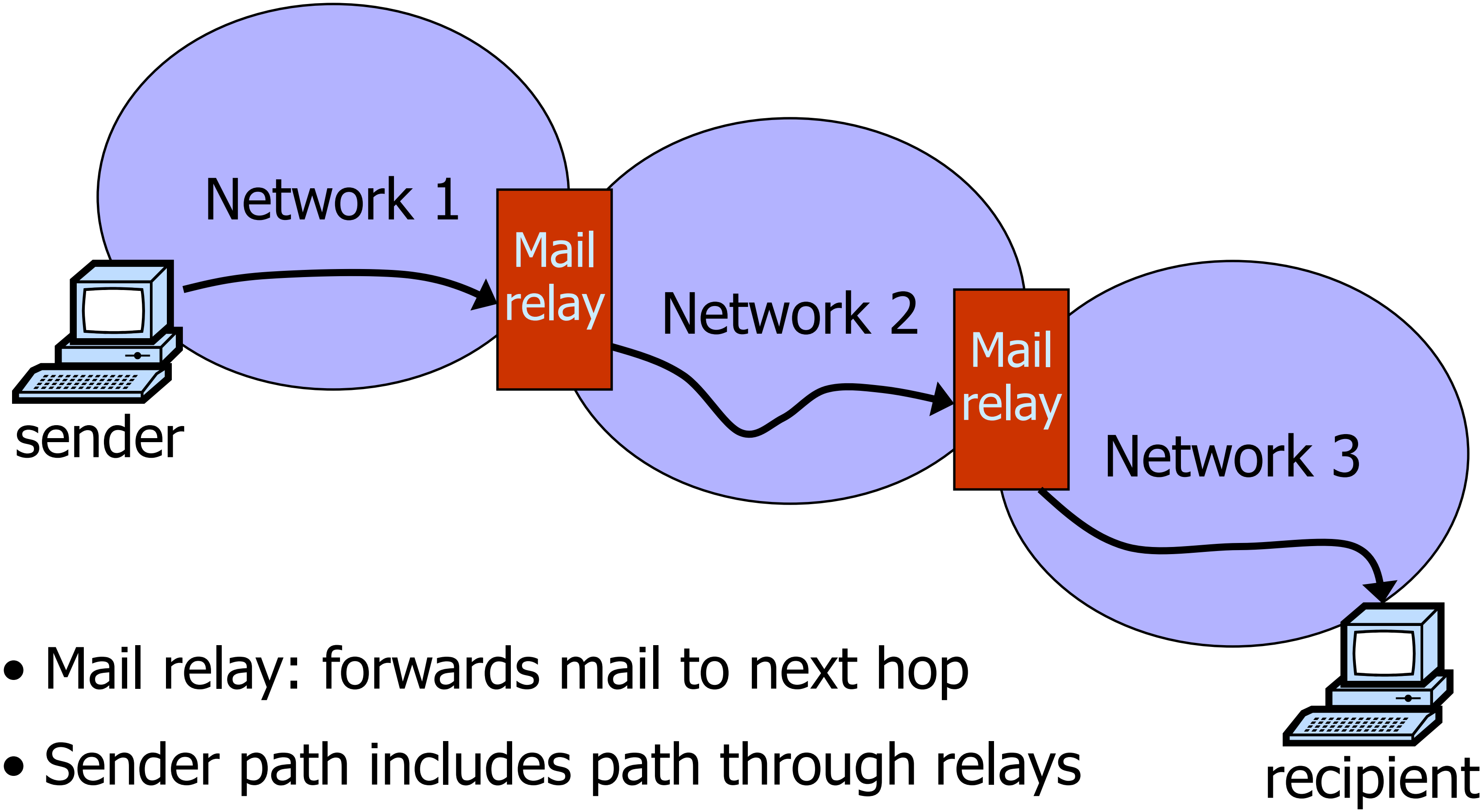
CS 361S

Vitaly Shmatikov

Email in the Early 1980s



- Mail relay: forwards mail to next hop
- Sender path includes path through relays

Email Spoofing

- Mail is sent via SMTP protocol
  - No built-in authentication
- MAIL FROM field is set by the sender
- Recipient’s mail server only sees the IP address of the direct peer from whom it received the message

Mail Relays

- An 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

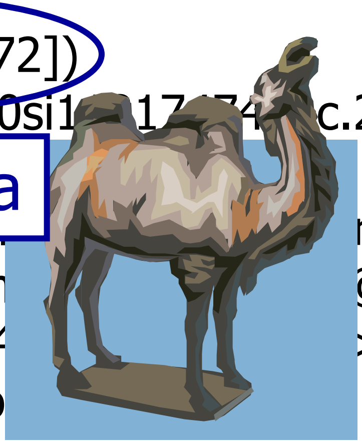
Inserted by relays

Received: by 10.78.68.6 hua;
Mon, 12 Feb 2007 06:43:30 -0800 (PST)
Received: by 10 MTP id l18mr17307116agc.1171291410432;
Mon 43:30 -0800 (PST)
Return-Path: < >
Received: from onelinkpr.net ([203.169.49.172])
by mx.google.com with ESMTP id 30si1 c.2007.02.12.06.43.18;
:4
Rec r permitted nor
by best guess record for don @aviva.ro)
Mes 050057765.stank.203.169.4 >
From: "Barclay Morales" <wvnlwee@aviva.ro
To: <raykwatts@gmail.com>
Subject: You can order both Viagra and Cialis.

Bogus!

Puerto Rico

Mongolia

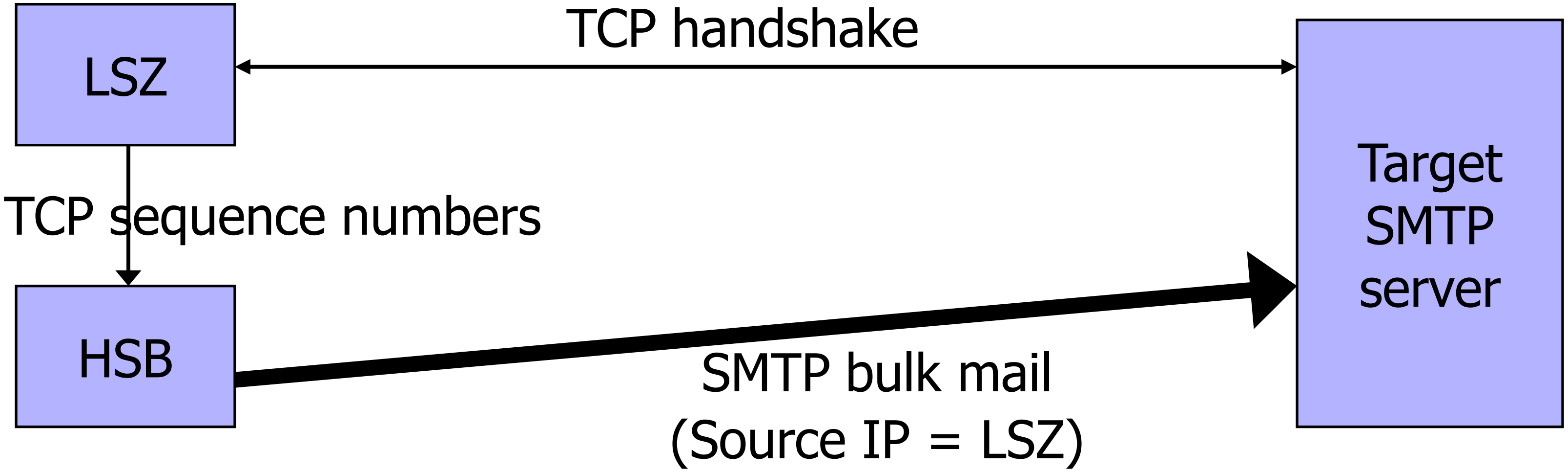


Why Hide Sources of Spam?

- 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 checks
- Spammers’ objective: evade blacklists
  - Botnets come very handy!

Thin Pipe / Thick Pipe

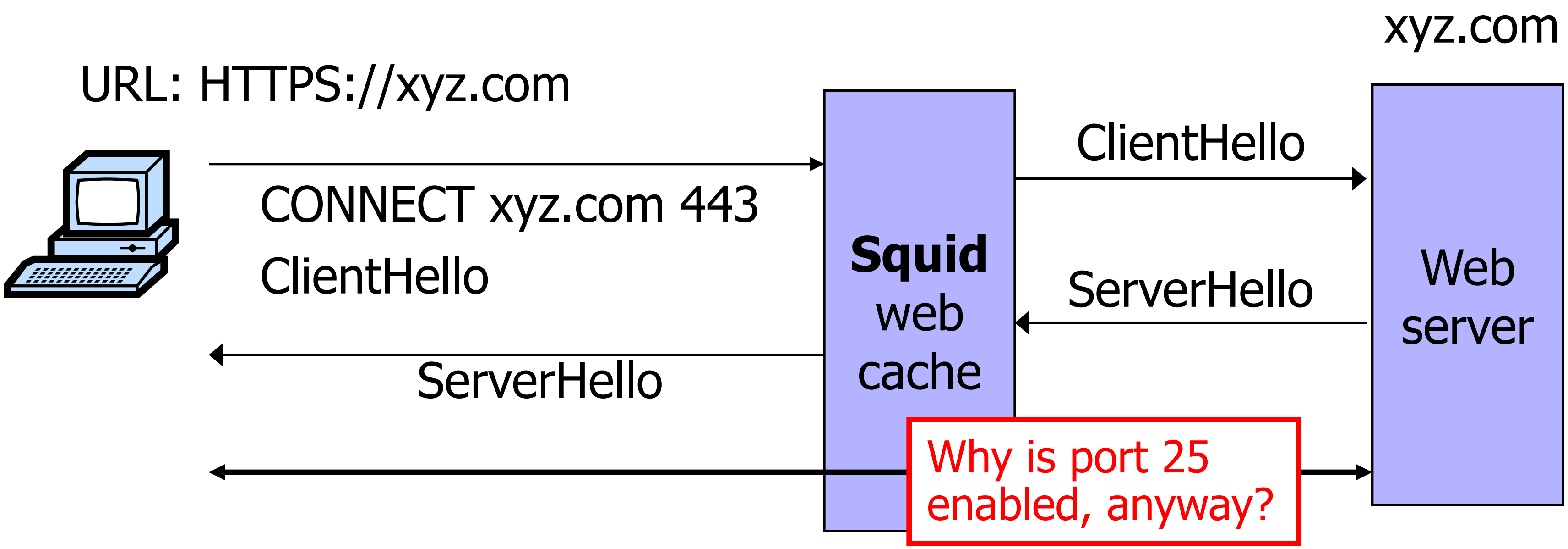
- Spam source has high-speed broadband machine (HSB) and controls a low-speed zombie (LSZ)



- Hides IP address of HSB; LSZ is blacklisted

Open HTTP Proxies

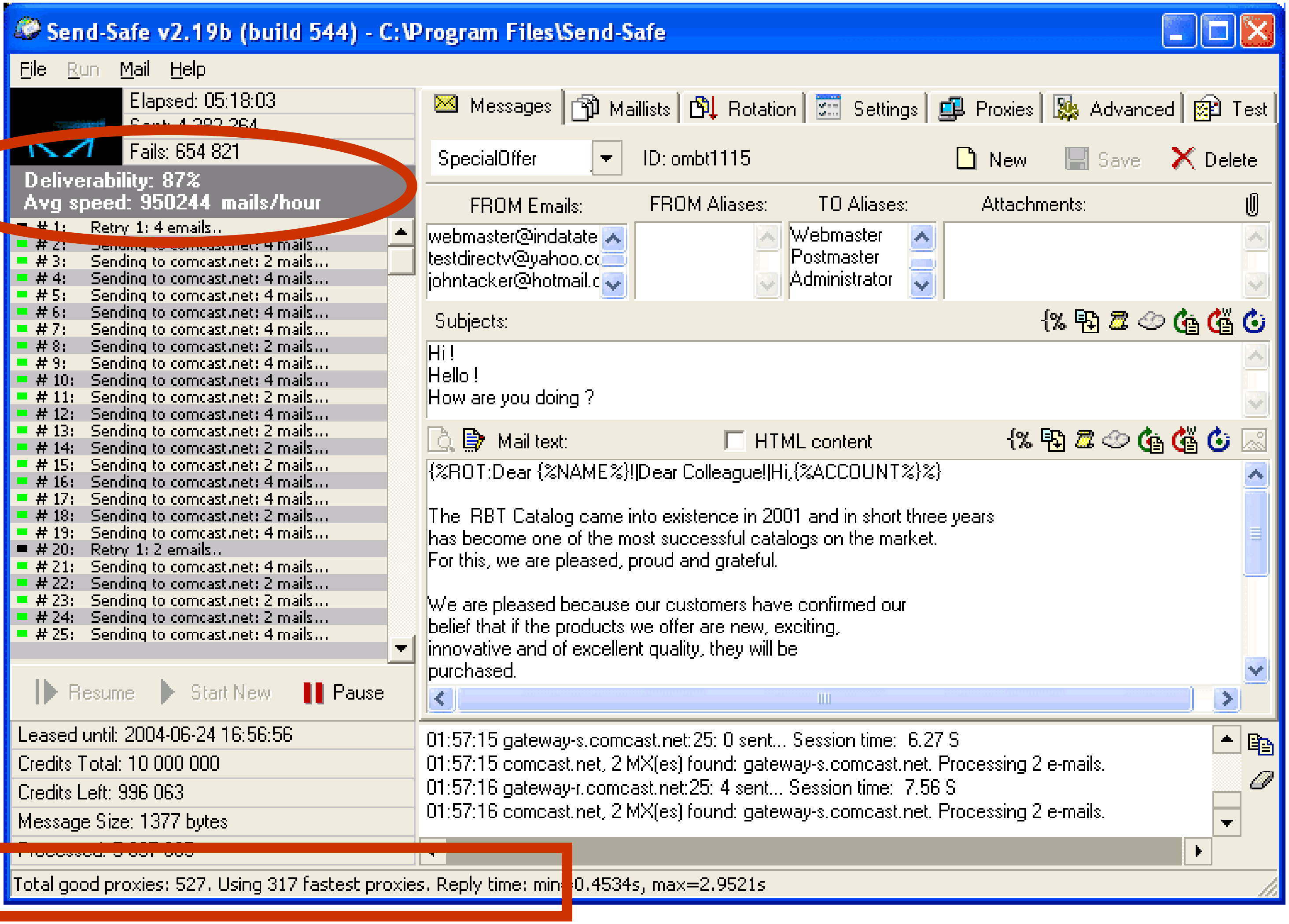
- Web cache (HTTP/HTTPS proxy), e.g., squid



Why is port 25 enabled, anyway?

- To spam: CONNECT <Victim's IP> 25, then issue SMTP Commands
  - Squid becomes a mail relay

Send-Safe Spam Tool



Elapsed: 05:18:03
Sent: 4 283 264
Fails: 654 821
Deliverability: 87%
Avg speed: 950244 mails/hour

```
# 1:  Retry 1: 4 emails..
# 2:  Sending to comcast.net: 4 mails...
# 3:  Sending to comcast.net: 2 mails...
# 4:  Sending to comcast.net: 4 mails...
# 5:  Sending to comcast.net: 4 mails...
# 6:  Sending to comcast.net: 4 mails...
# 7:  Sending to comcast.net: 4 mails...
# 8:  Sending to comcast.net: 2 mails...
# 9:  Sending to comcast.net: 4 mails...
# 10: Sending to comcast.net: 4 mails...
# 11: Sending to comcast.net: 2 mails...
# 12: Sending to comcast.net: 4 mails...
# 13: Sending to comcast.net: 2 mails...
# 14: Sending to comcast.net: 2 mails...
# 15: Sending to comcast.net: 2 mails...
# 16: Sending to comcast.net: 4 mails...
# 17: Sending to comcast.net: 4 mails...
# 18: Sending to comcast.net: 2 mails...
# 19: Sending to comcast.net: 4 mails...
# 20: Retry 1: 2 emails..
# 21: Sending to comcast.net: 4 mails...
# 22: Sending to comcast.net: 2 mails...
# 23: Sending to comcast.net: 2 mails...
# 24: Sending to comcast.net: 2 mails...
# 25: Sending to comcast.net: 4 mails...
```

Leased until: 2004-06-24 16:56:56
Credits Total: 10 000 000
Credits Left: 996 063
Message Size: 1377 bytes
Processed: 5 037 085

SpecialOffer ID: ombt1115

FROM Emails:
webmaster@indatate
testdirectv@yahoo.cc
johntacker@hotmail.c

FROM Aliases:

TO Aliases:
Webmaster
Postmaster
Administrator

Attachments:

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.

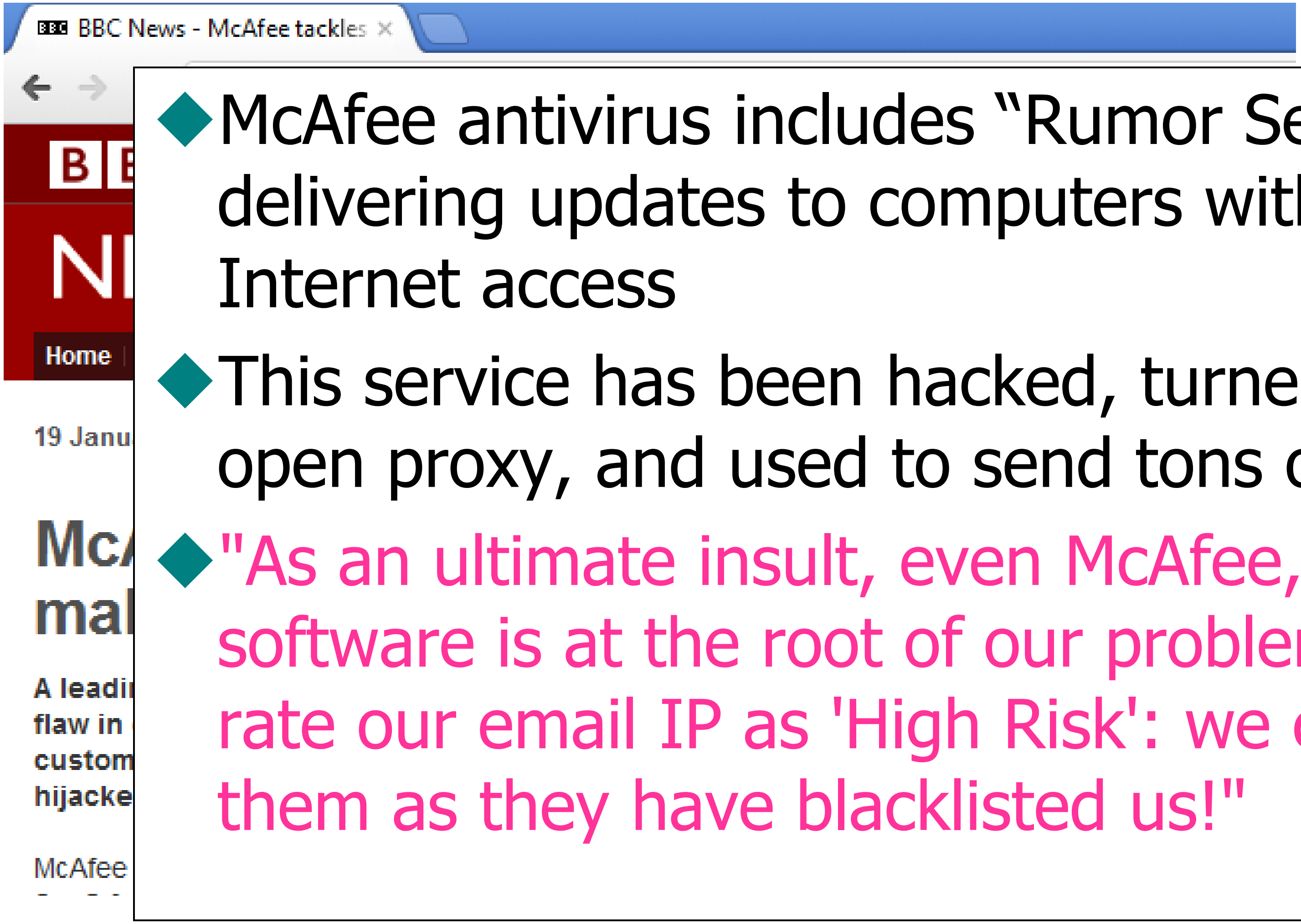
```
01:57:15 gateway-s.comcast.net:25: 0 sent... Session time:  6.27 S
01:57:15 comcast.net, 2 MX(es) found: gateway-s.comcast.net. Processing 2 e-mails.
01:57:16 gateway-r.comcast.net:25: 4 sent... Session time:  7.56 S
01:57:16 comcast.net, 2 MX(es) found: gateway-s.comcast.net. Processing 2 e-mails.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

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 (many appear to be defunct as of 2010)
  - http://www.multiproxy.org/
    http://www.stayinvisible.com/
    http://www.openproxies.com/ ($20/month)

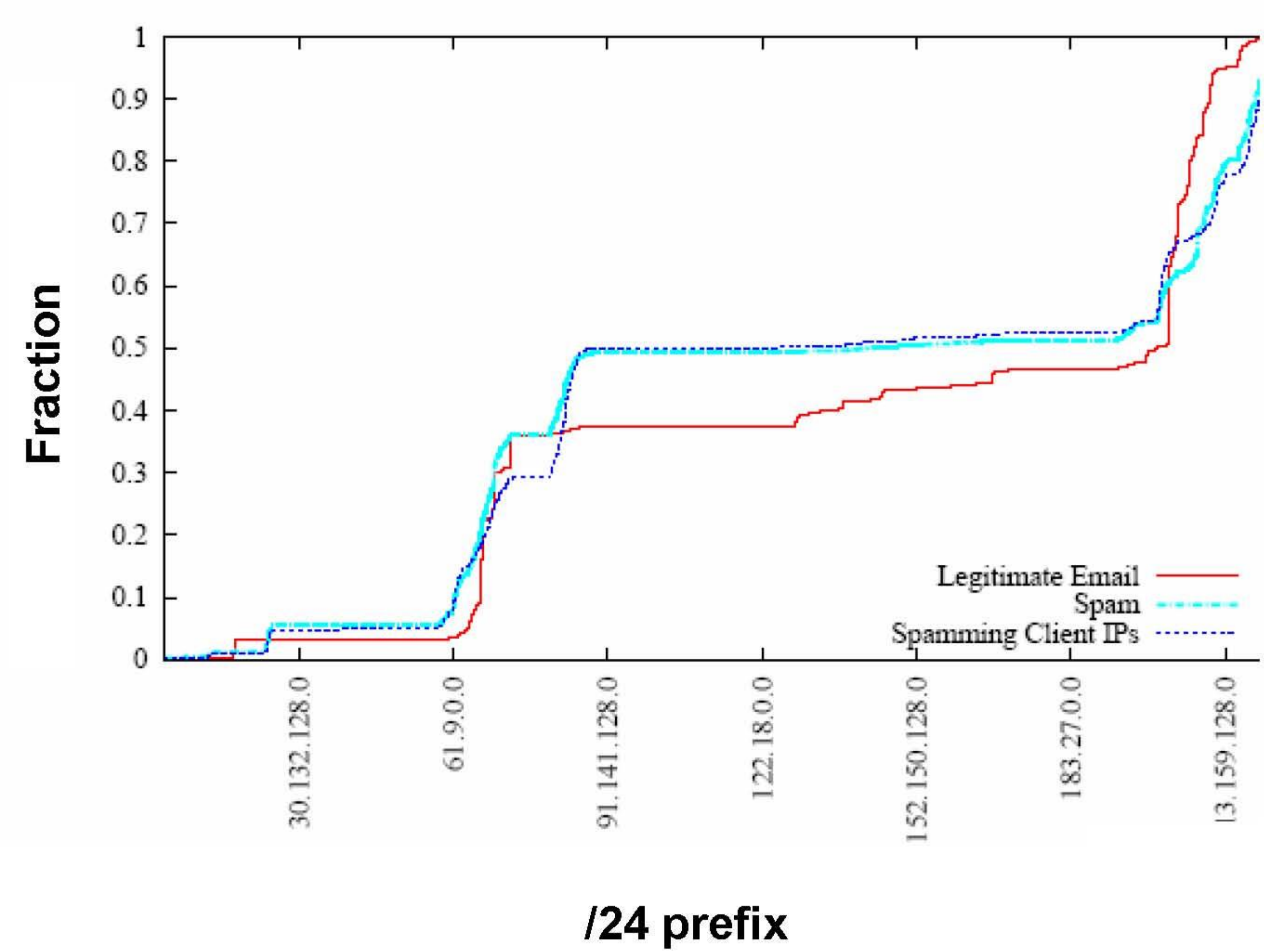
McAfee Spam Hijack (Jan 2012)



- McAfee antivirus includes “Rumor Service” for delivering updates to computers without direct Internet access
- This service has been hacked, turned into an open proxy, and used to send tons of spam
- "As an ultimate insult, even McAfee, whose software is at the root of our problems, now rate our email IP as 'High Risk': we can't email them as they have blacklisted us!"

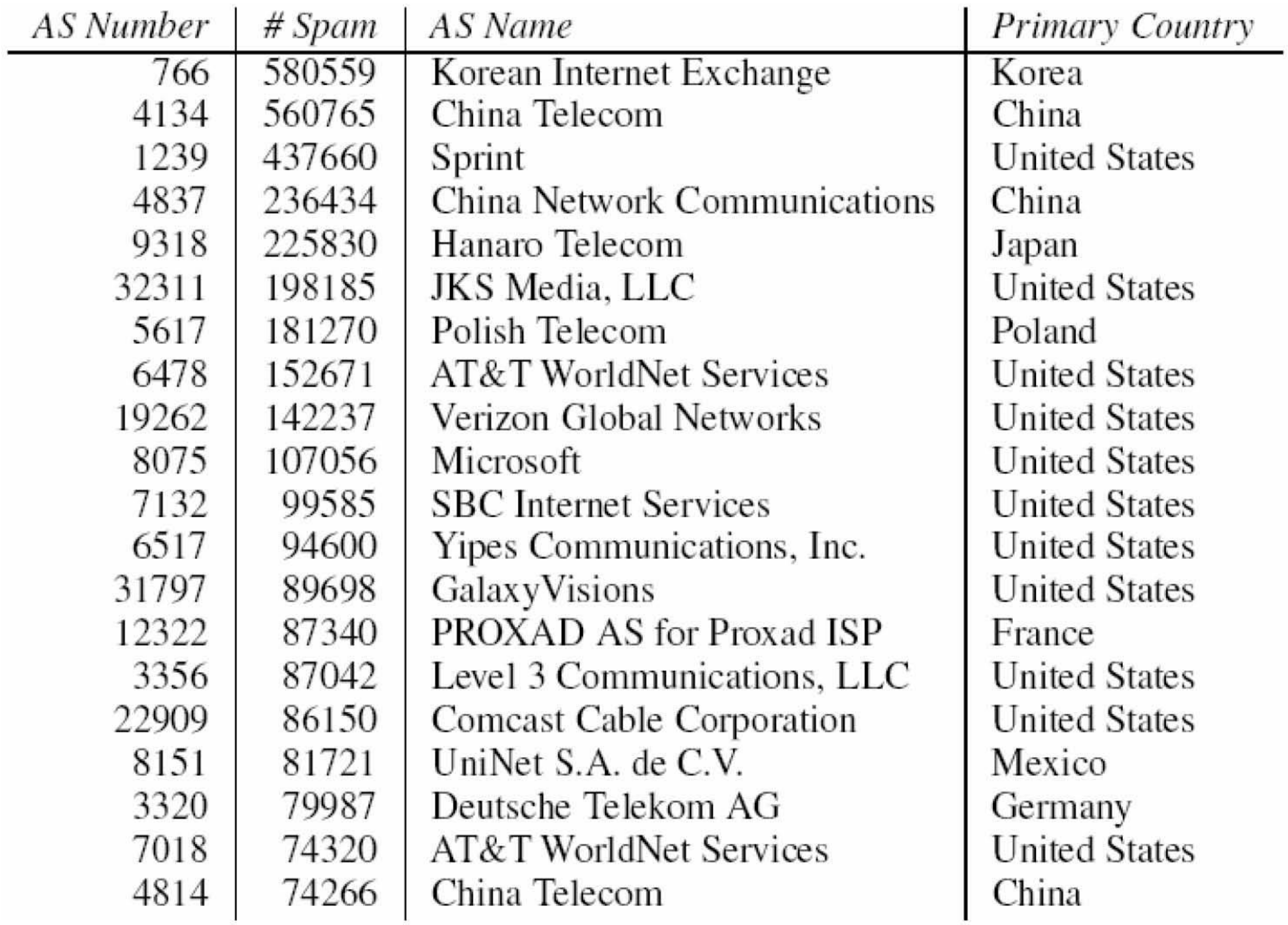
Distribution of Spam Sources

[Ramachandran, Feamster]



Distribution Across Domains

[Ramachandran, Feamster]



AS Number	*# Spam*	*AS Name*	*Primary Country*
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

Where Does Spam Come From?

[Ramachandran, Feamster]

- IP addresses of spam sources are widely distributed across the Internet
  - In tracking experiments, most IP addresses appear once or twice; 60-80% not reachable by traceroute
- Vast majority of spam originates from a small fraction of IP address space
  - Same fraction that most legitimate email comes from
- Spammers exploit routing infrastructure
  - Create short-lived connection to mail relay, then disappear
  - Hijack a large chunk of unallocated "dark" space

CAN-SPAM Act (passed in 2003)

http://www.ftc.gov/spam

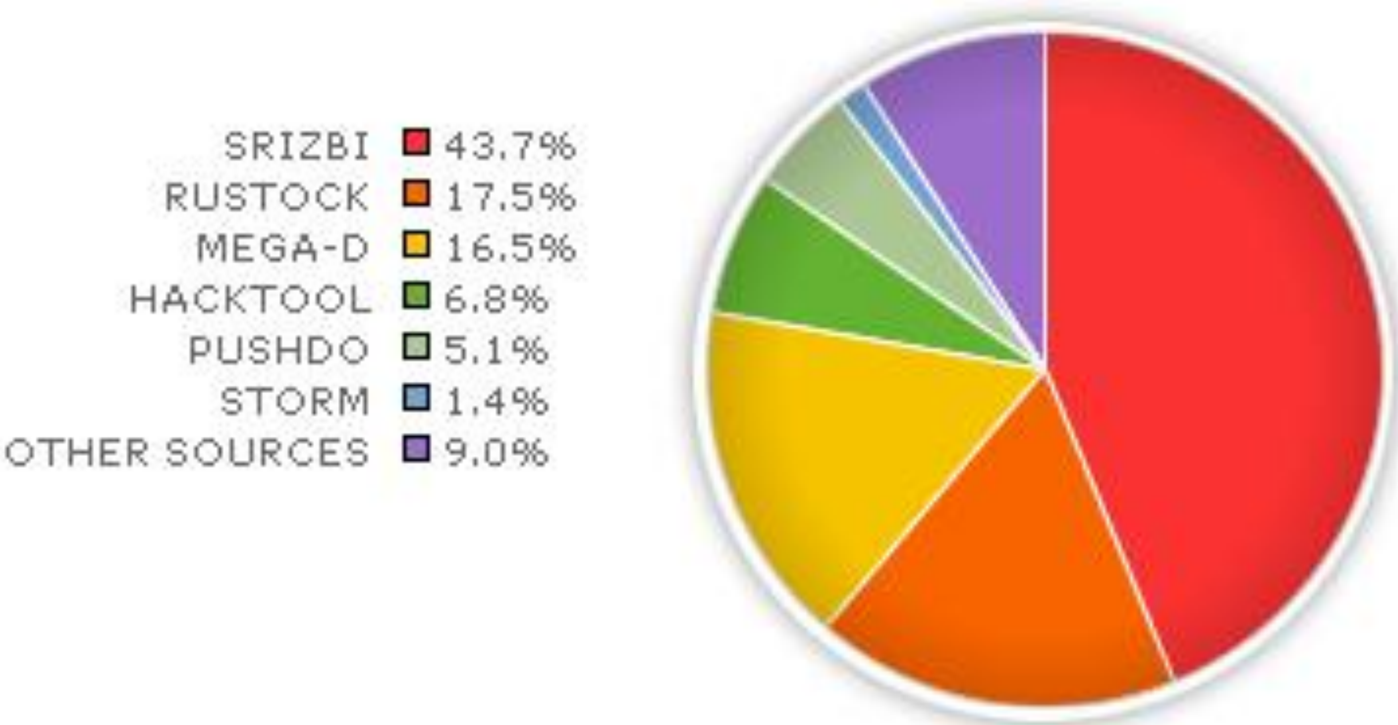
- Legal solution to the problem
  - Bans email harvesting, misleading header information, deceptive subject lines, use of proxies
  - Requires opt-out and identification of advertising
  - Imposes penalties (up to $11K per violation)
- FTC report on effectiveness (Dec 2005)
  - 50 cases pursued in the US
  - No impact on spam originating outside the US (60%)
  - Open relays hosted on botnets make it difficult to collect evidence

Bobax Worm

- Infects machines with high bandwidth
  - Exploits Windows LSASS 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 zombies
  - Once the spam zombie added to blacklist, spread to another machine
  - Interesting detection technique: look for botmaster’s DNS queries (trying to determine who is blacklisted)

Major Spambots in 2008

[redacted] http://www.marshal.com/trace/traceitem.asp?article=615



McColo

- McColo was a San Jose-based hosting provider
- Hosted command-and-control servers of the biggest spam botnets
  - Rustock, Srizbi, Mega-D, Pushdo/Cutwail, others
- Disconnected by upstream providers on Nov 11, 2008 ⇒ 75% reduction of spam worldwide
- Resurrected for 12 hours on Nov 20, 2008
  - Through a backup connection (soon terminated)
  - During this time, 15MB/sec of traffic to Russia – botmasters getting data to regain control of botnets

Srizbi

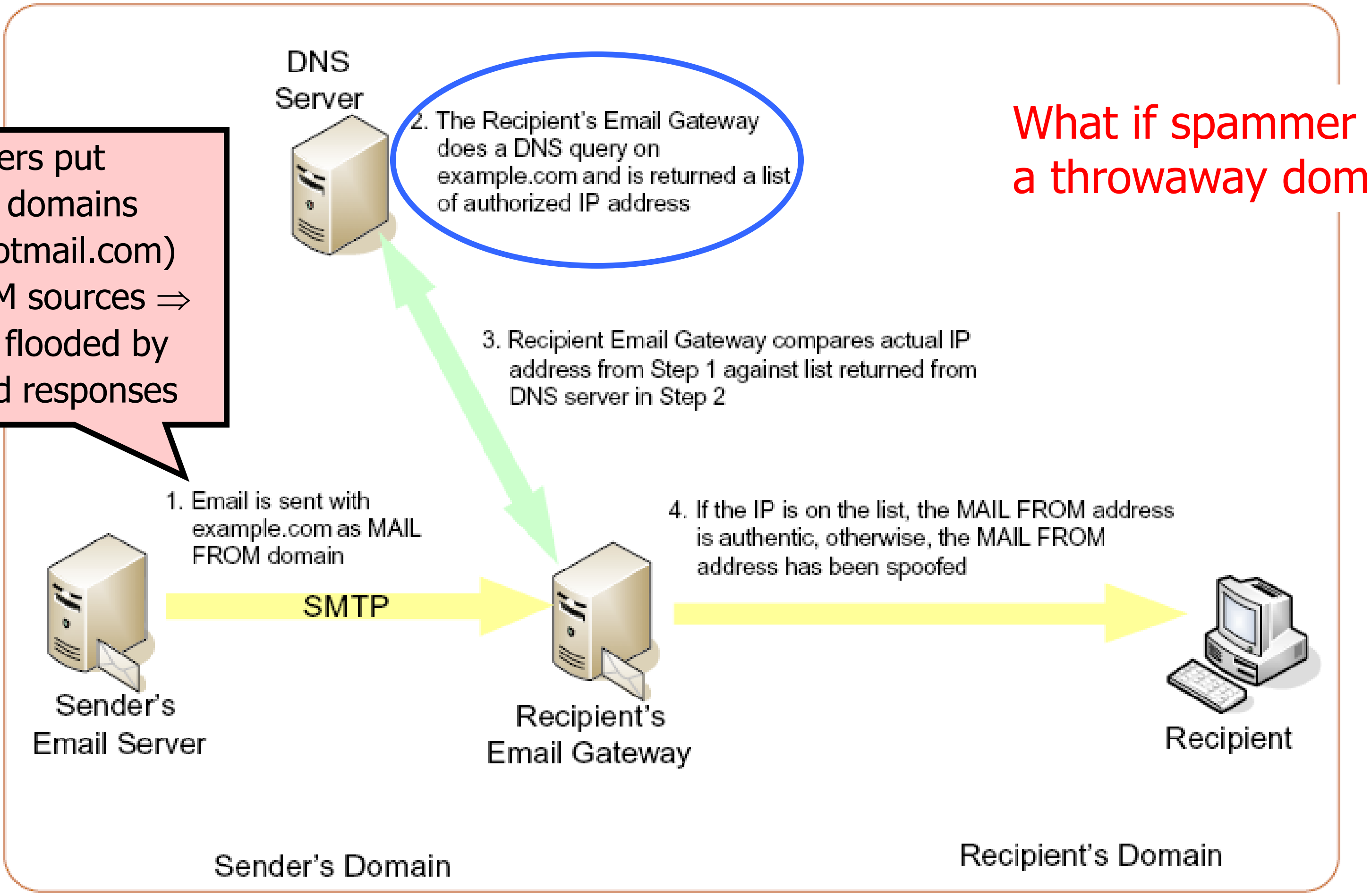
- Rootkit +
  sophisticated spam mailer
- 500K zombies, 60 billion spam messages daily
  - More than half of all spam worldwide
- After McColo takedown, fail-safe code inside bots started generating names of backup domains
  - ypouaypu.com, oryitugf.com, prpoqpsy.com …
  - Botmasters regained control by registering these domains (through a Russian registrar) and hosting new C&C servers in Estonia – shut down later

Rustock

- Responsible for 40% of all spam in 2010
- Between 1 and 2.5 million infected computers
  - Up to 240,000 messages daily from each host
- Based on a fairly elaborate rookit
- C&C servers taken down on March 16, 2011
  - Investigation by Microsoft, Pfizer, FireEye, and security researchers from the University of Washington
  - "John Doe" lawsuit against botnet operators
  - Coordinated seizure of C&C servers in the US
  - 33% decline in spam afterwards

SPF (Sender Policy Framework)

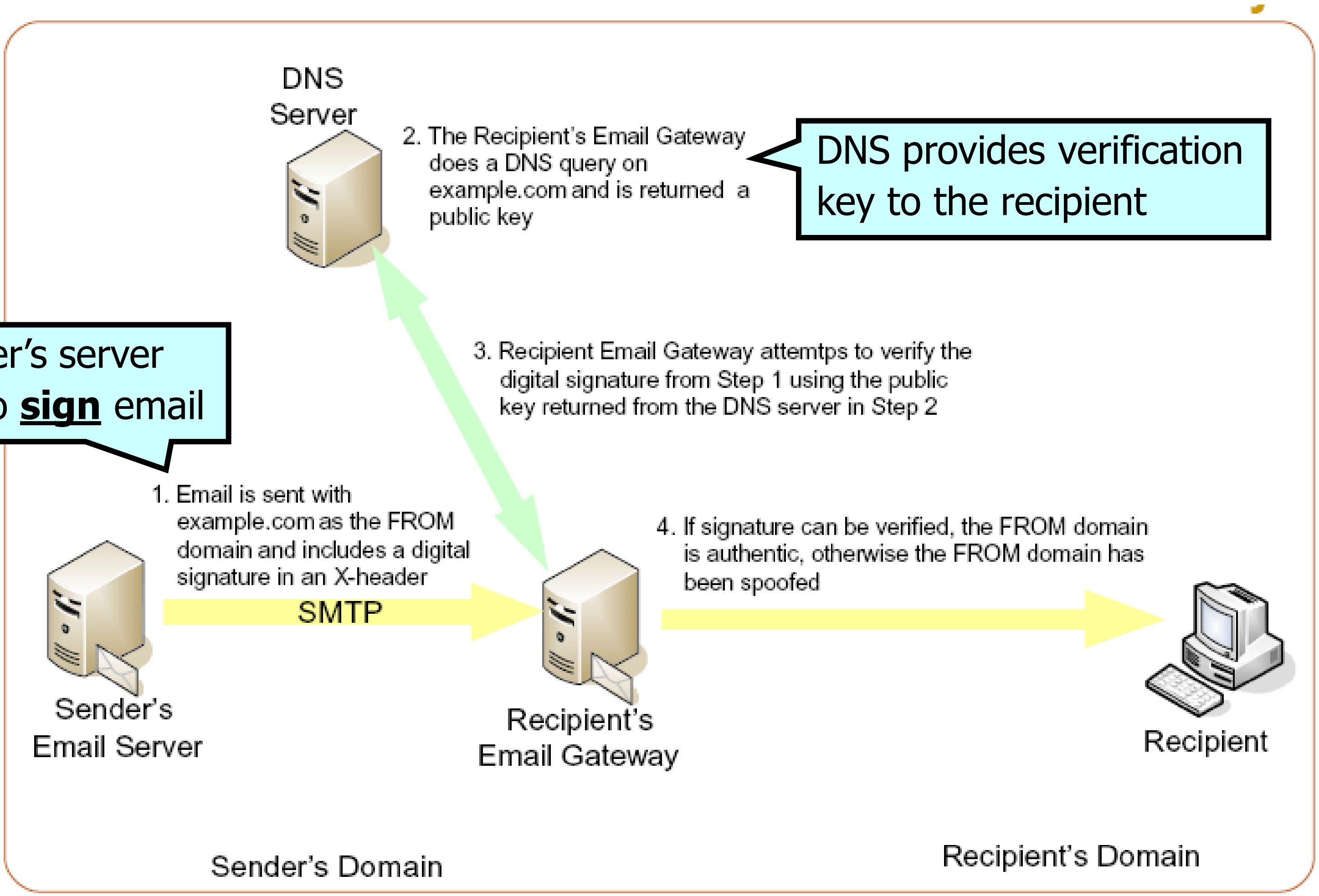
Spammers put popular domains (e.g., hotmail.com) as FROM sources ⇒ hotmail flooded by bounced responses


DNS Server
2. The Recipient's Email Gateway does a DNS query on example.com and is returned a list of authorized IP address
3. Recipient Email Gateway compares actual IP address from Step 1 against list returned from DNS server in Step 2
1. Email is sent with example.com as MAIL FROM domain
SMTP
4. If the IP is on the list, the MAIL FROM address is authentic, otherwise, the MAIL FROM address has been spoofed
Sender's Email Server
Recipient's Email Gateway
Recipient
Sender's Domain
Recipient's Domain

What if spammer gets a throwaway domain?

Used by AOL and others

Domain Keys (DKIM)



1. Email is sent with example.com as the FROM domain and includes a digital signature in an X-header

2. The Recipient's Email Gateway does a DNS query on example.com and is returned a public key

3. Recipient Email Gateway attemtps to verify the digital signature from Step 1 using the public key returned from the DNS server in Step 2

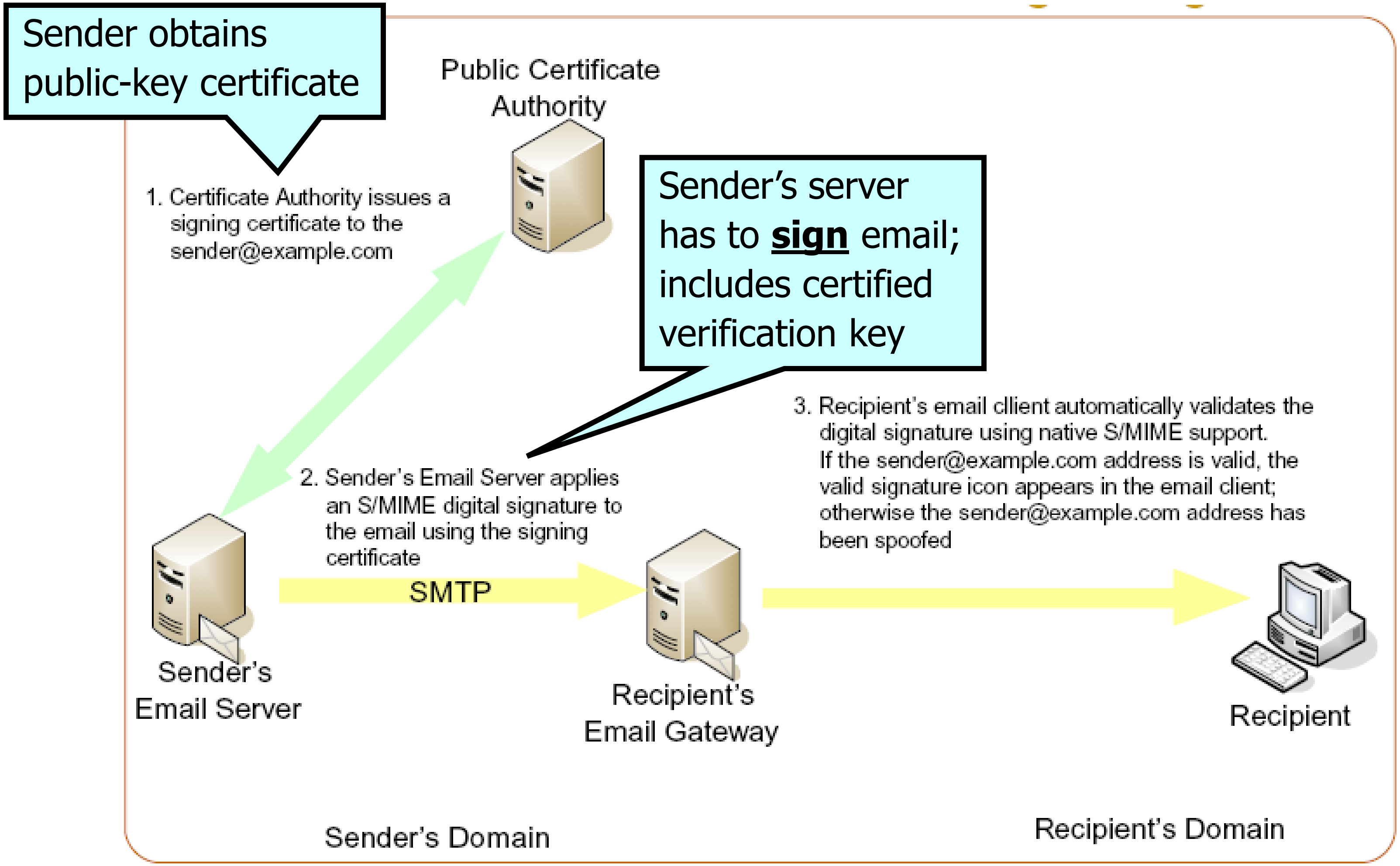
4. If signature can be verified, the FROM domain is authentic, otherwise the FROM domain has been spoofed

Sender's server has to **sign** email

DNS provides verification key to the recipient

From Yahoo

S/MIME



Sender obtains public-key certificate

Sender's server has to **sign** email; includes certified verification key

1. Certificate Authority issues a signing certificate to the sender@example.com

2. Sender's Email Server applies an S/MIME digital signature to the email using the signing certificate

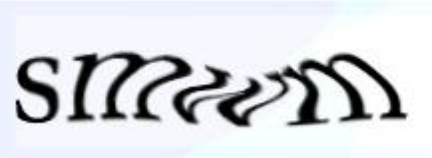
3. Recipient's email cllient automatically validates the digital signature using native S/MIME support. If the sender@example.com address is valid, the valid signature icon appears in the email client; otherwise the sender@example.com address has been spoofed

Graylists

- Recipient's mail server records (sender email, recipient email, peer IP) triple in its database
  - Each triple kept for 3 days (configuration parameter)
- First time (triple not in DB): 421 reply "Busy"
  - Records triple in the database
- Second time (after 5 minutes): let email pass
- What is this defense based on?
- Easily spoofable, but works against current spammers

Puzzles and CAPTCHAs

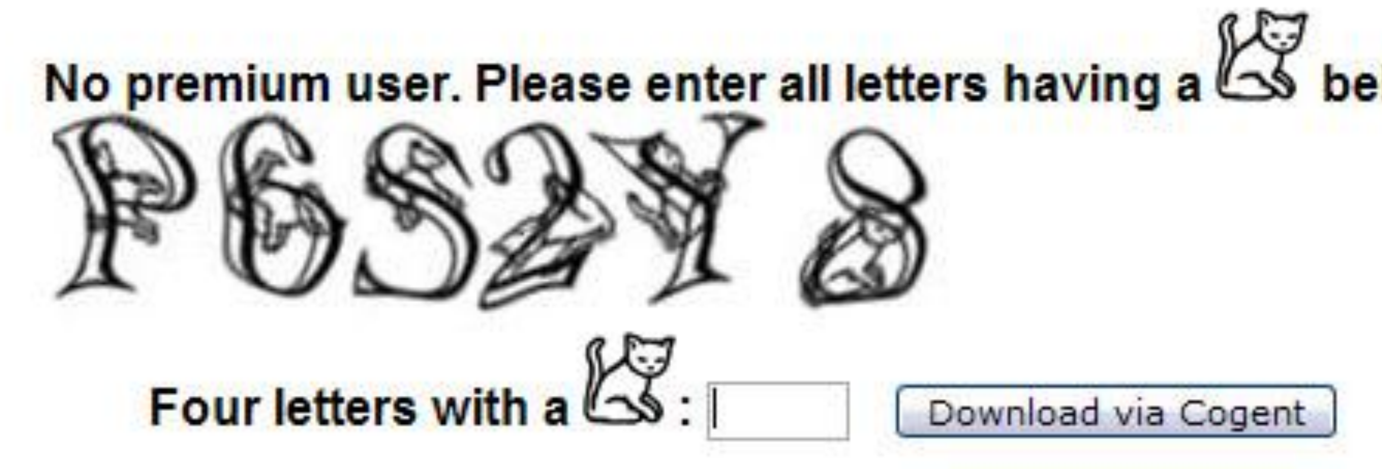
- Generic defenses against spam and DoS
- Basic idea: sender must solve a “puzzle” before his email or connection request is accepted
  - Takes effort to solve, but solution easy to check
  - Sender has to “pay” in computation time
    - Example (Hashcash): find collision in a short hash
- CAPTCHA: prove that the sender is human
  - Solve a “reverse Turing test”
  - Only in application layer (e.g., Web)



- Both are difficult to deploy (why?)

Worst CAPTCHA Ever?

[redacted] http://depressedprogrammer.wordpress.com/2008/04/20/worst-captcha-ever/



No premium user. Please enter all letters having a 🐈 below.

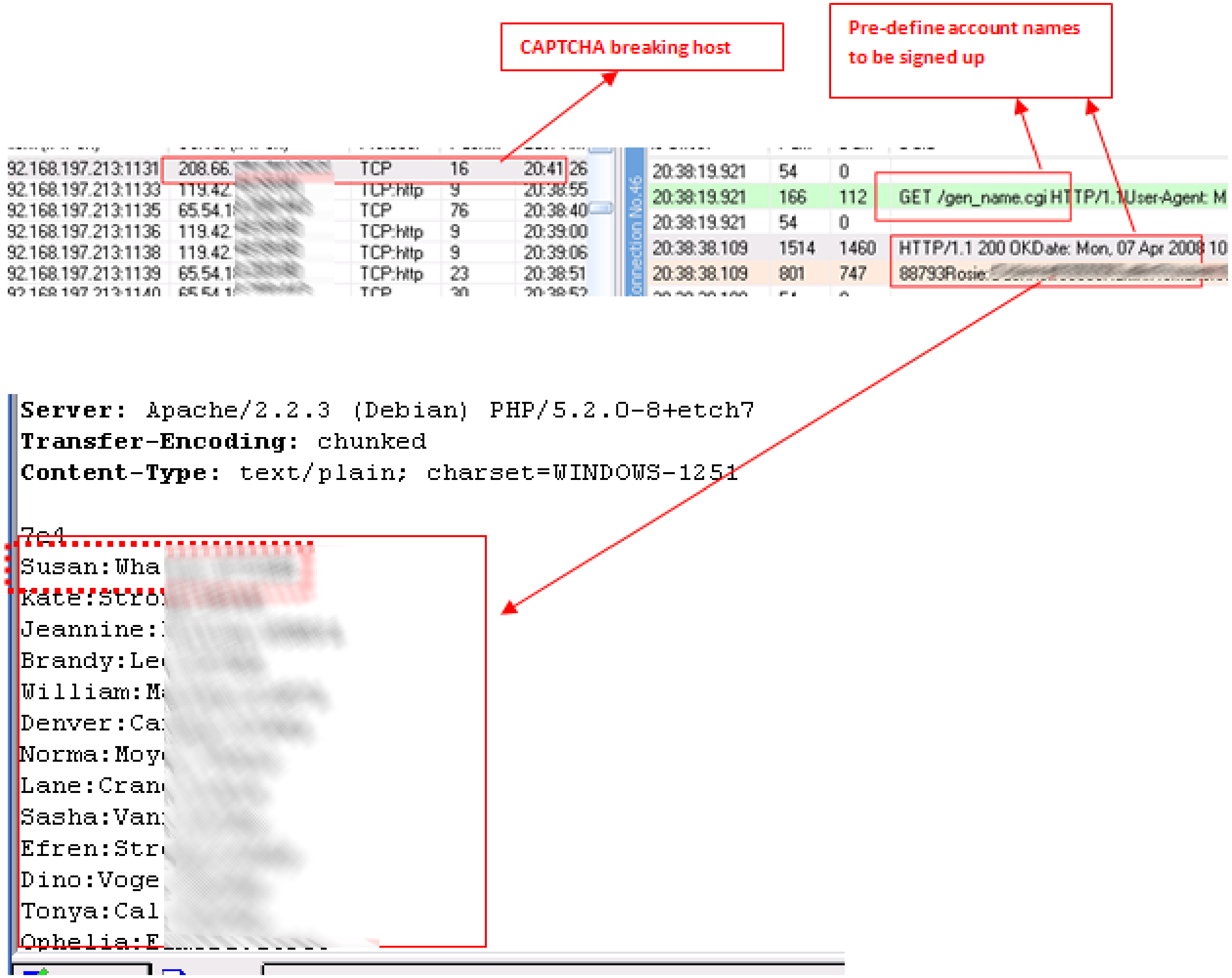
Four letters with a 🐈 :

Gone in Six Seconds

- Spammers like to create a large number of Gmail and Hotmail accounts, use them to send spam
  - DKIM and SPF don't help (why?)
  - But CAPTCHAs do (how?)
- Botnet = massive distributed computing platform, so spammers can use them to solve CAPTCHAs
  - 2008: 6 seconds per CAPTCHA, 10-15% success
  - After Microsoft upgraded their CAPTCHA system: 20 seconds per CAPTCHA, 12-20% success

CAPTCHA Cracking in Progress

[redacted] http://securitylabs.websense.com/content/Blogs/3063.aspx



CAPTCHA breaking host

Pre-define account names to be signed up

92.168.197.213:1131	208.66.[redacted]	TCP	16	20:41:26
92.168.197.213:1133	119.42.[redacted]	TCP:http	9	20:38:55
92.168.197.213:1135	65.54.1[redacted]	TCP	76	20:38:40
92.168.197.213:1136	119.42.[redacted]	TCP:http	9	20:39:00
92.168.197.213:1138	119.42.[redacted]	TCP:http	9	20:39:06
92.168.197.213:1139	65.54.1[redacted]	TCP:http	23	20:38:51
92.168.197.213:1140	65.54.1[redacted]	TCP	30	20:38:52

20:38:19.921	54	0	
20:38:19.921	166	112	GET /gen_name.cgi HTTP/1.1User-Agent: M
20:38:19.921	54	0	
20:38:38.109	1514	1460	HTTP/1.1 200 OKDate: Mon, 07 Apr 2008 10
20:38:38.109	801	747	88793Rosie:[redacted]

```
Server: Apache/2.2.3 (Debian) PHP/5.2.0-8+etch7
Transfer-Encoding: chunked
Content-Type: text/plain; charset=WINDOWS-1251

7c4
Susan:Wha[redacted]
Kate:Stro[redacted]
Jeannine:[redacted]
Brandy:Le[redacted]
William:M[redacted]
Denver:Ca[redacted]
Norma:Moy[redacted]
Lane:Cran[redacted]
Sasha:Van[redacted]
Efren:Str[redacted]
Dino:Voge[redacted]
Tonya:Cal[redacted]
Ophelia:F[redacted]
```

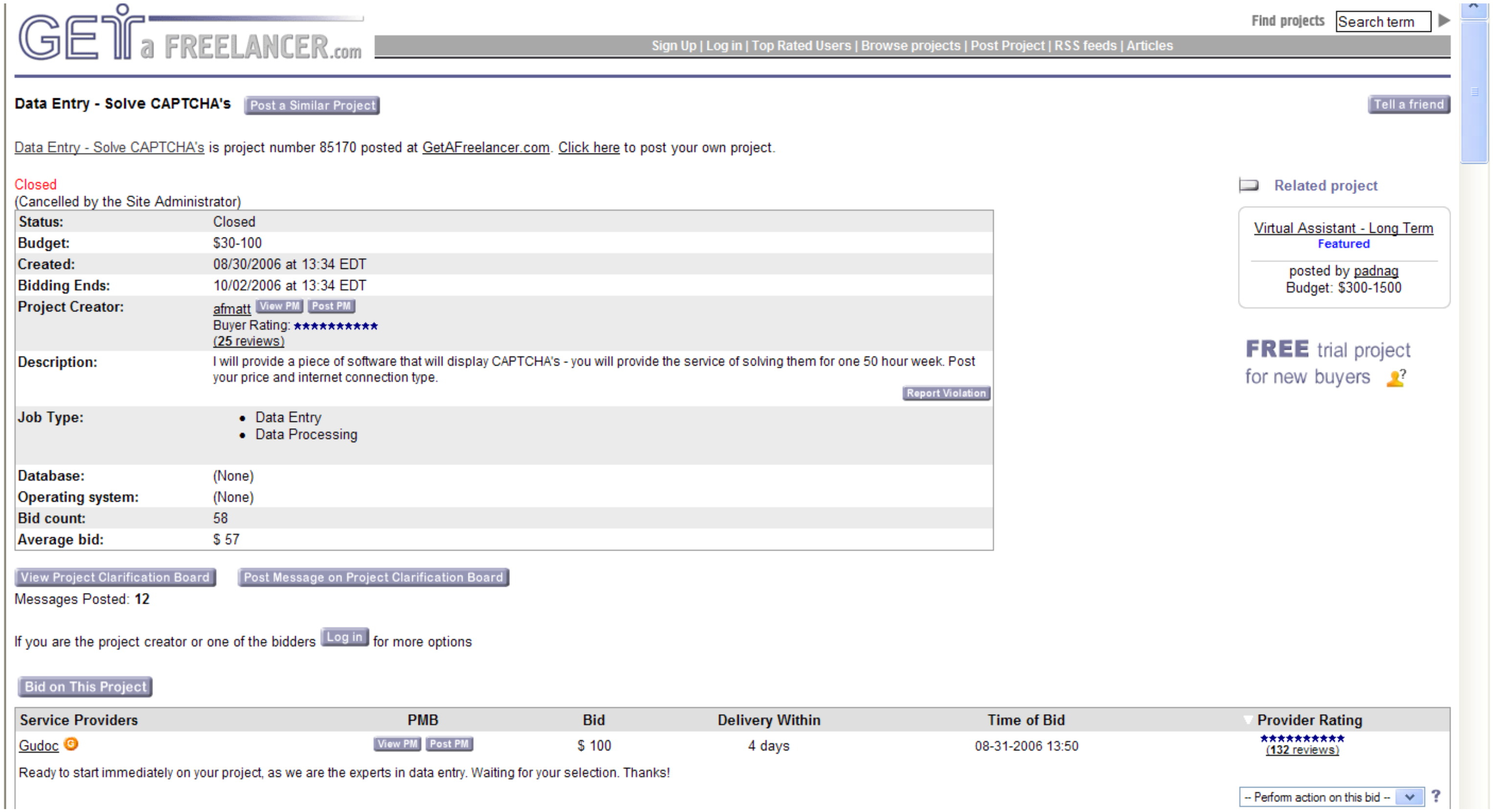
Using Humans to Solve CAPTCHAs

http://old.post-gazette.com/pg/03278/228349.stm

“But at least one potential spammer managed to crack the CAPTCHA test. Someone designed a software robot that would fill out a registration form and, when confronted with a CAPTCHA test, would post it on a free porn site. Visitors to the porn site would be asked to complete the test before they could view more pornography, and the software robot would use their answer to complete the e-mail registration.”

Solve CAPTCHAs for Fun and Profit

- Third-world "data entry specialists" will solve CAPTCHAs for 60 cents an hour



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Data Entry - Solve CAPTCHA's

Data Entry - Solve CAPTCHA's is project number 85170 posted at GetAFreelancer.com. Click here to post your own project.

Closed
(Cancelled by the Site Administrator)

Status:	Closed
Budget:	$30-100
Created:	08/30/2006 at 13:34 EDT
Bidding Ends:	10/02/2006 at 13:34 EDT
Project Creator:	afmatt View PM Post PM Buyer Rating: ★★★★★★★★★★ (25 reviews)
Description:	I will provide a piece of software that will display CAPTCHA's - you will provide the service of solving them for one 50 hour week. Post your price and internet connection type. Report Violation
Job Type:	• Data Entry • Data Processing
Database:	(None)
Operating system:	(None)
Bid count:	58
Average bid:	$ 57

View Project Clarification Board | Post Message on Project Clarification Board

Messages Posted: **12**

If you are the project creator or one of the bidders Log in for more options

Bid on This Project

Service Providers	PMB	Bid	Delivery Within	Time of Bid	Provider Rating
Gudoc	View PM Post PM	$ 100	4 days	08-31-2006 13:50	★★★★★★★★★★ (132 reviews)

Ready to start immediately on your project, as we are the experts in data entry. Waiting for your selection. Thanks!

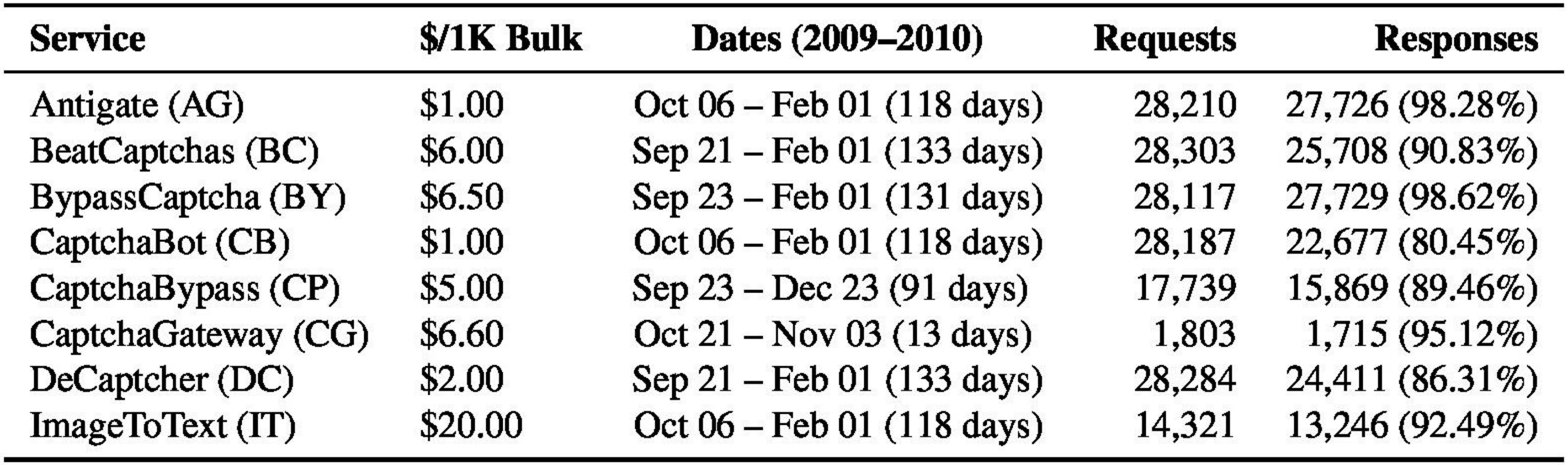
Related project

Virtual Assistant - Long Term
Featured
posted by padnag
Budget: $300-1500

FREE trial project for new buyers

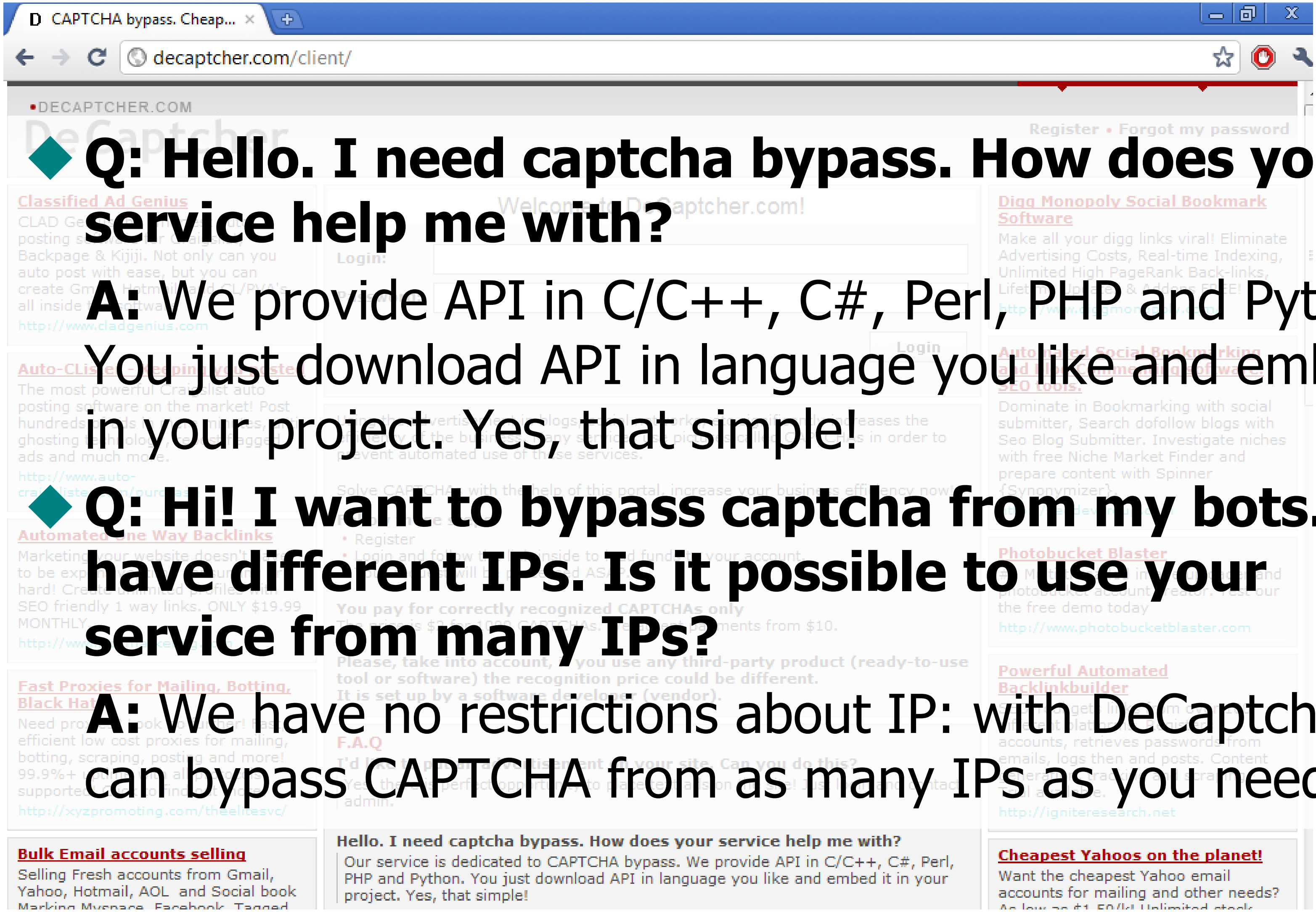
CAPTCHA-Solving Services

[Motoyama et al. “Understanding CAPTCHA-Solving Services in an Economic Context”]



Service	$/1K Bulk	Dates (2009–2010)	Requests	Responses
Antigate (AG)	$1.00	Oct 06 – Feb 01 (118 days)	28,210	27,726 (98.28%)
BeatCaptchas (BC)	$6.00	Sep 21 – Feb 01 (133 days)	28,303	25,708 (90.83%)
BypassCaptcha (BY)	$6.50	Sep 23 – Feb 01 (131 days)	28,117	27,729 (98.62%)
CaptchaBot (CB)	$1.00	Oct 06 – Feb 01 (118 days)	28,187	22,677 (80.45%)
CaptchaBypass (CP)	$5.00	Sep 23 – Dec 23 (91 days)	17,739	15,869 (89.46%)
CaptchaGateway (CG)	$6.60	Oct 21 – Nov 03 (13 days)	1,803	1,715 (95.12%)
DeCaptcher (DC)	$2.00	Sep 21 – Feb 01 (133 days)	28,284	24,411 (86.31%)
ImageToText (IT)	$20.00	Oct 06 – Feb 01 (118 days)	14,321	13,246 (92.49%)

DeCaptcher.com (Now Defunct)



CAPTCHA bypass. Cheap...

decaptcher.com/client/

DECAPTCHER.COM

Register • Forgot my password

Welcome to DeCaptcher.com!

Login:

Login

Classified Ad Genius

http://www.cladgenius.com

Digg Monopoly Social Bookmark Software

Make all your digg links viral! Eliminate Advertising Costs, Real-time Indexing, Unlimited High PageRank Back-links,

Dominate in Bookmarking with social submitter, Search dofollow blogs with Seo Blog Submitter. Investigate niches with free Niche Market Finder and prepare content with Spinner {Synonymizer}.

The most powerful Craigslist auto posting software on the market! Post

Automated One Way Backlinks

SEO friendly 1 way links. ONLY $19.99 MONTHLY

Photobucket Blaster

the free demo today

http://www.photobucketblaster.com

You pay for correctly recognized CAPTCHAs only

Please, take into account, if you use any third-party product (ready-to-use tool or software) the recognition price could be different. It is set up by a software developer (vendor).

Fast Proxies for Mailing, Botting, Black Hat

efficient low cost proxies for mailing, botting, scraping, posting and more!

http://xyzpromoting.com/theelitesvc/

F.A.Q

Powerful Automated Backlinkbuilder

accounts, retrieves passwords from emails, logs then and posts. Content

http://igniteresearch.net

Bulk Email accounts selling

Selling Fresh accounts from Gmail, Yahoo, Hotmail, AOL and Social book

Hello. I need captcha bypass. How does your service help me with?

Our service is dedicated to CAPTCHA bypass. We provide API in C/C++, C#, Perl, PHP and Python. You just download API in language you like and embed it in your project. Yes, that simple!

Cheapest Yahoos on the planet!

Want the cheapest Yahoo email accounts for mailing and other needs?

- **Q: Hello. I need captcha bypass. How does your service help me with?**

  A: We provide API in C/C++, C#, Perl, PHP and Python. You just download API in language you like and embed it in your project. Yes, that simple!

- **Q: Hi! I want to bypass captcha from my bots. Bots have different IPs. Is it possible to use your service from many IPs?**

  A: We have no restrictions about IP: with DeCaptcher you can bypass CAPTCHA from as many IPs as you need.

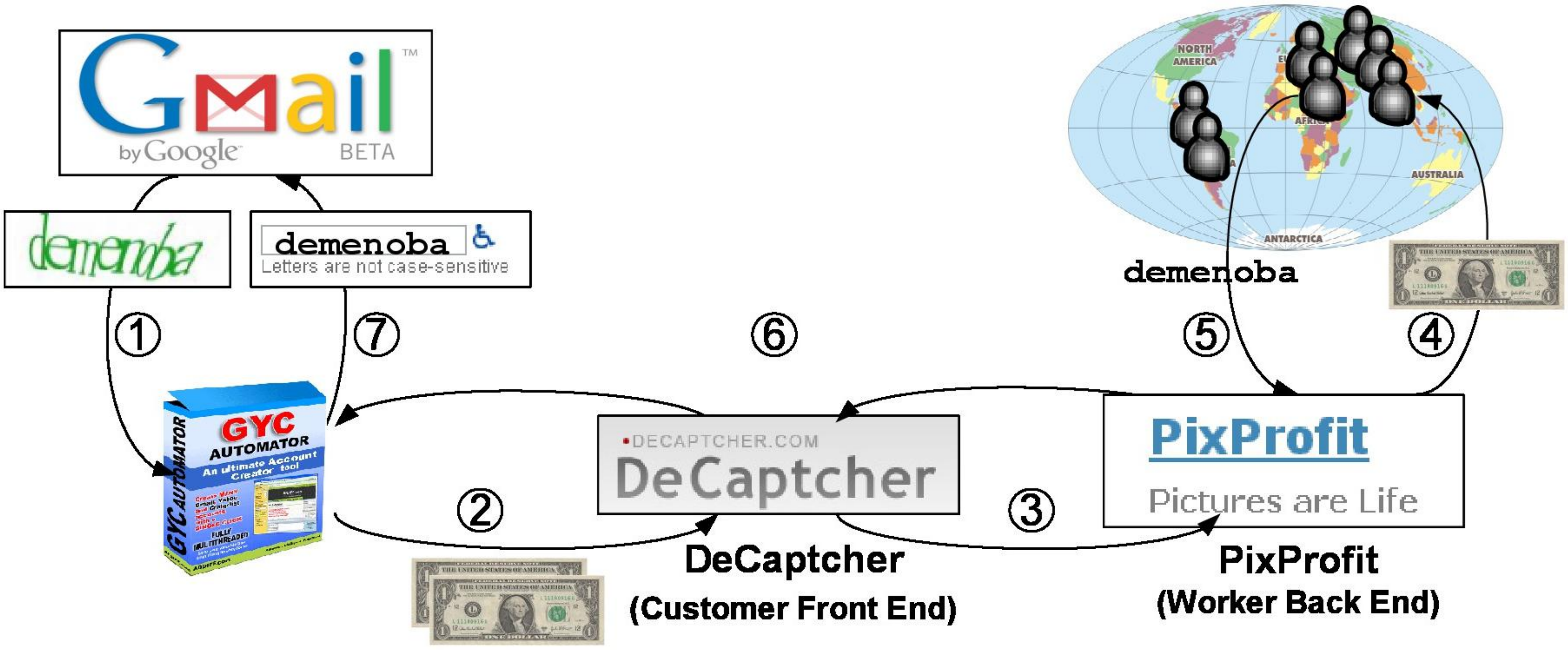
India’s CAPTCHA Solving Economy

[redacted] http://www.zdnet.com/blog/security/inside-indias-captcha-solving-economy/1835

- 24/7 support still like. We have 30 pc 90 worker & we have 300 captcha team. Your any captcha project we done quickly. We have high experience captcha worker
- Hello Sir, I will kindly introduce myself.. This is shivakumar.. we have a team to type capcthas 24/7 and we can type more than 200k captchas per day
- WE ARE PROFESSIONAL CAPCHA ENTRY OPEATORS AND WE CAN DO EVEN 25000 ENTRIES PER DAY AS MY COMPANY IS A 25 SEATER FIRM SPEALISED IN DATA ENTRY
- We having more then 10 teams,we are op ng 24/7 data entry works and delivering 700k/day captchas d !!
- My rate $4.00 per 1k My team can work 24/7. They are jobless now

CAPTCHA-Solving Economy

[Motoyama et al. “Understanding CAPTCHA-Solving Services in an Economic Context”]



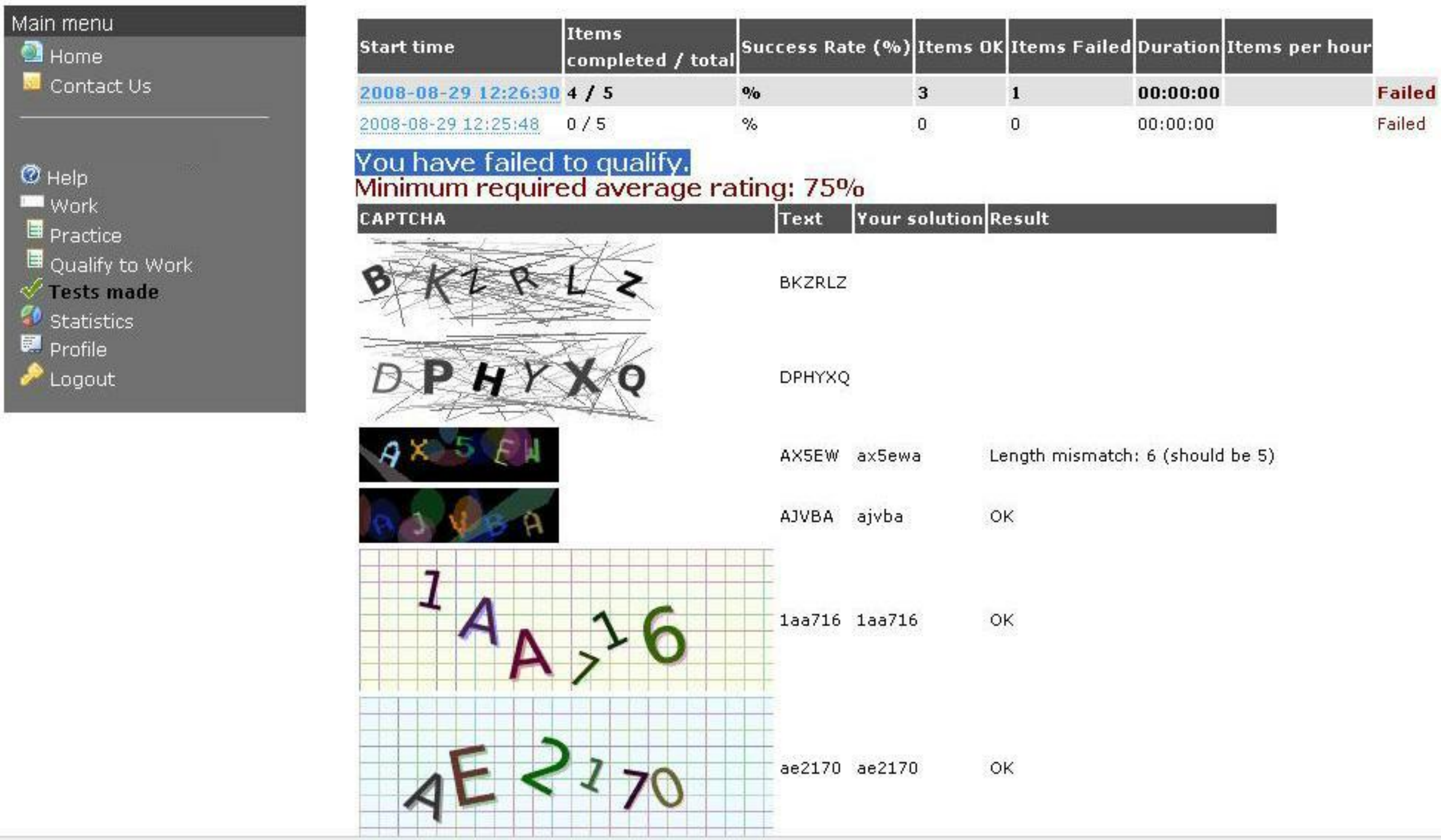
Gmail by Google BETA
demenoba
demenoba
Letters are not case-sensitive
①
⑦
⑥
⑤
④
②
③
GYC AUTOMATOR An ultimate Account Creator tool
DECAPTCHER.COM DeCaptcher
PixProfit Pictures are Life
NORTH AMERICA
AUSTRALIA
ANTARCTICA
demenoba

DeCaptcher
(Customer Front End)

PixProfit
(Worker Back End)

Support Tools

[redacted] http://www.zdnet.com/blog/security/inside-indias-captcha-solving-economy/1835



Start time	Items completed / total	Success Rate (%)	Items OK	Items Failed	Duration	Items per hour	
2008-08-29 12:26:30	**4 / 5**	**%**	**3**	**1**	**00:00:00**		**Failed**
2008-08-29 12:25:48	0 / 5	%	0	0	00:00:00		Failed

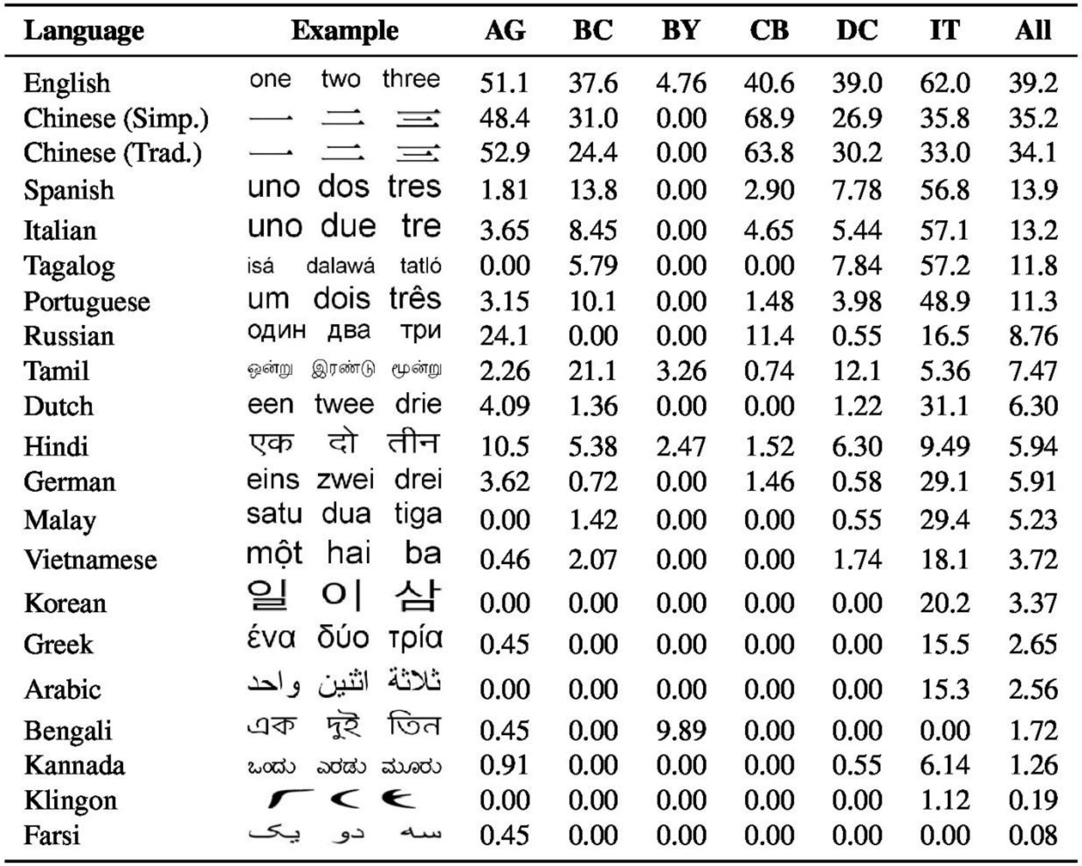
You have failed to qualify.

Minimum required average rating: 75%

CAPTCHA	Text	Your solution	Result
	BKZRLZ		
	DPHYXQ		
	AX5EW	ax5ewa	Length mismatch: 6 (should be 5)
	AJVBA	ajvba	OK
	1aa716	1aa716	OK
	ae2170	ae2170	OK

Where Do CAPTCHA Solvers Live?

[Motoyama et al. "Understanding CAPTCHA-Solving Services in an Economic Context"]



Language	Example	AG	BC	BY	CB	DC	IT	All
English	one two three	51.1	37.6	4.76	40.6	39.0	62.0	39.2
Chinese (Simp.)	一 二 三	48.4	31.0	0.00	68.9	26.9	35.8	35.2
Chinese (Trad.)	一 二 三	52.9	24.4	0.00	63.8	30.2	33.0	34.1
Spanish	uno dos tres	1.81	13.8	0.00	2.90	7.78	56.8	13.9
Italian	uno due tre	3.65	8.45	0.00	4.65	5.44	57.1	13.2
Tagalog	isá dalawá tatló	0.00	5.79	0.00	0.00	7.84	57.2	11.8
Portuguese	um dois três	3.15	10.1	0.00	1.48	3.98	48.9	11.3
Russian	один два три	24.1	0.00	0.00	11.4	0.55	16.5	8.76
Tamil	ஒன்று இரண்டு மூன்று	2.26	21.1	3.26	0.74	12.1	5.36	7.47
Dutch	een twee drie	4.09	1.36	0.00	0.00	1.22	31.1	6.30
Hindi	एक दो तीन	10.5	5.38	2.47	1.52	6.30	9.49	5.94
German	eins zwei drei	3.62	0.72	0.00	1.46	0.58	29.1	5.91
Malay	satu dua tiga	0.00	1.42	0.00	0.00	0.55	29.4	5.23
Vietnamese	một hai ba	0.46	2.07	0.00	0.00	1.74	18.1	3.72
Korean	일 이 삼	0.00	0.00	0.00	0.00	0.00	20.2	3.37
Greek	ένα δύο τρία	0.45	0.00	0.00	0.00	0.00	15.5	2.65
Arabic	واحد اثنين ثلاثة	0.00	0.00	0.00	0.00	0.00	15.3	2.56
Bengali	এক দুই তিন	0.45	0.00	9.89	0.00	0.00	0.00	1.72
Kannada	ಒಂದು ಎರಡು ಮೂರು	0.91	0.00	0.00	0.00	0.55	6.14	1.26
Klingon		0.00	0.00	0.00	0.00	0.00	1.12	0.19
Farsi	یک دو سه	0.45	0.00	0.00	0.00	0.00	0.00	0.08

Table 2: Percentage of responses from the services with correct answers for the language CAPTCHAS.