TLS trends at GCHQ

[redacted]

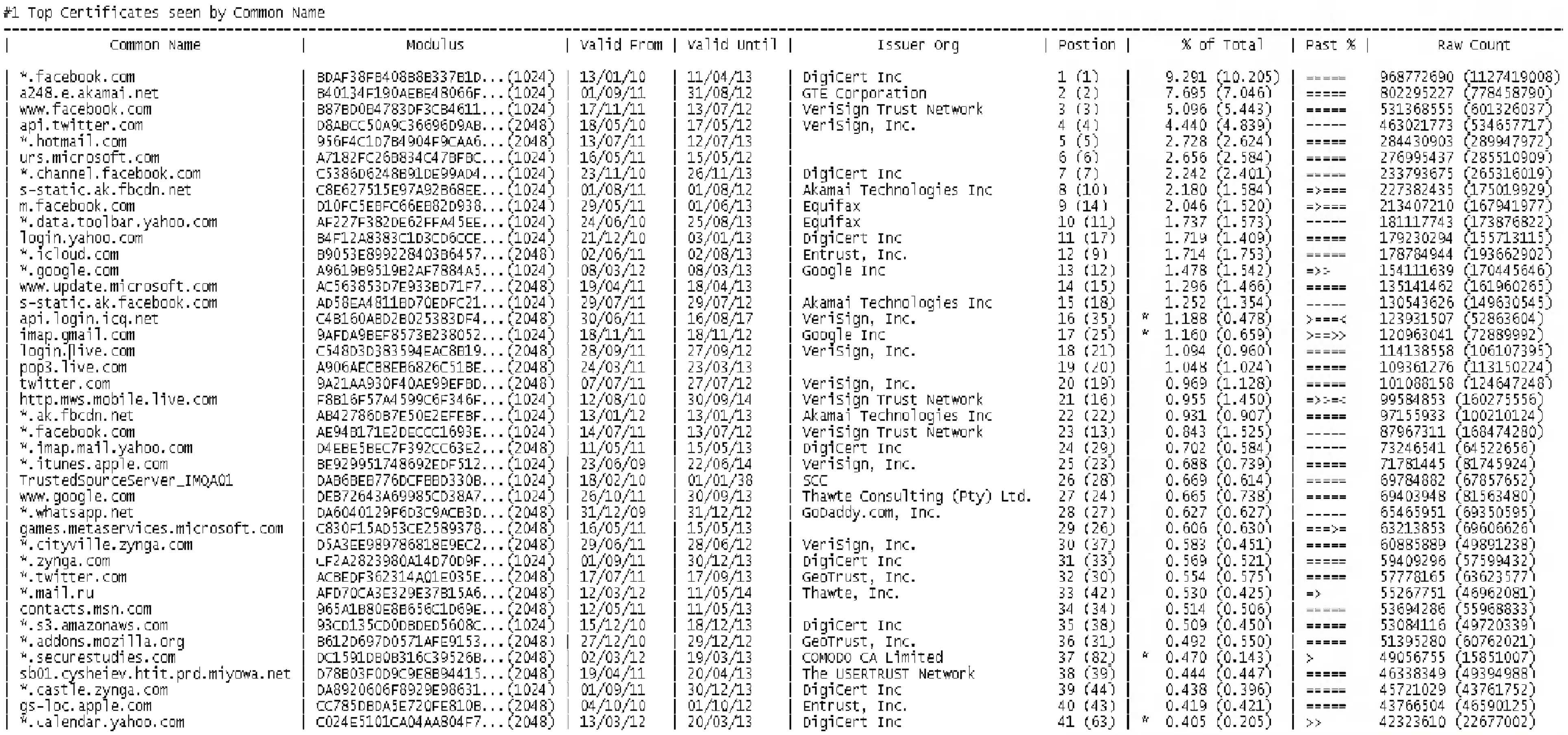
Source of data

- Our TLS events come from our TLS app
  - Runs on special source (approx. 200 x 10G) and Comsat data
  - Produces unselected events: about 10 billion Server Hellos per week
- Records details about the handshake: IPs, Hello messages, Certificate, Key Exchanges
- Events stored for 6 months in our clouds

Trends Reports

- We summarise these events to produce weekly trends reports, which record:
  - Types of key exchange (RSA/DH/EC)
  - “Top 40” TLS services in use, highlighting new services and changes in existing services
  - Details about the crypt (e.g. DH moduli)
  - “Watchlist” to keep an eye on widely-used services (Facebook, Gmail, Hotmail, etc)

Example: top 40 services



#1 Top Certificates seen by Common Name

Common Name	Modulus	Valid From	Valid Until	Issuer Org	Postion	% of Total	Past %	Raw Count
*.facebook.com	BDAF38FB408B8B337B1D...(1024)	13/01/10	11/04/13	DigiCert Inc	1 (1)	9.291 (10.205)	=====	968772690 (1127419008)
a248.e.akamai.net	B40134F190AEBE48066F...(1024)	01/09/11	31/08/12	GTE Corporation	2 (2)	7.695 (7.046)	=====	802295227 (778458790)
www.facebook.com	B87BD0B4783DF3CB4611...(1024)	17/11/11	13/07/12	VeriSign Trust Network	3 (3)	5.096 (5.443)	=====	531368555 (601326037)
api.twitter.com	D8ABCC50A9C36696D9AB...(2048)	18/05/10	17/05/12	VeriSign, Inc.	4 (4)	4.440 (4.839)	-----	463021773 (534657717)
*.hotmail.com	956F4C1D7B4904F9CAA6...(2048)	13/07/11	12/07/13		5 (5)	2.728 (2.624)	=====	284430903 (289947972)
urs.microsoft.com	A7182FC26B834C47BFBC...(1024)	16/05/11	15/05/12		6 (6)	2.656 (2.584)	=====	276995437 (285510909)
*.channel.facebook.com	C5386D6248B91DE99AD4...(1024)	23/11/10	26/11/13	DigiCert Inc	7 (7)	2.242 (2.401)	=====	233793675 (265316019)
s-static.ak.fbcdn.net	C8E627515E97A92B68EE...(1024)	01/08/11	01/08/12	Akamai Technologies Inc	8 (10)	2.180 (1.584)	=>===	227382435 (175019929)
m.facebook.com	D10FC5EBFC66EB82D938...(1024)	29/05/11	01/06/13	Equifax	9 (14)	2.046 (1.520)	=>===	213407210 (167941977)
*.data.toolbar.yahoo.com	AF227F382DE62FFA45EE...(1024)	24/06/10	25/08/13	Equifax	10 (11)	1.737 (1.573)	-----	181117743 (173876822)
login.yahoo.com	B4F12A8383C1D3CD6CCE...(1024)	21/12/10	03/01/13	DigiCert Inc	11 (17)	1.719 (1.409)	=====	179230294 (155713115)
*.icloud.com	B9053E899228403B6457...(2048)	02/06/11	02/08/13	Entrust, Inc.	12 (9)	1.714 (1.753)	=====	178784944 (193662902)
*.google.com	A9619B9519B2AF7884A5...(1024)	08/03/12	08/03/13	Google Inc	13 (12)	1.478 (1.542)	=>:-	154111639 (170445646)
www.update.microsoft.com	AC563853D7E933BD71F7...(2048)	19/04/11	18/04/13		14 (15)	1.296 (1.466)	=====	135141462 (161960265)
s-static.ak.facebook.com	AD58EA4811BD70EDFC21...(1024)	29/07/11	29/07/12	Akamai Technologies Inc	15 (18)	1.252 (1.354)	-----	130543626 (149630545)
api.login.icq.net	C4B160ABD2B025383DF4...(2048)	30/06/11	16/08/17	VeriSign, Inc.	16 (35)	* 1.188 (0.478)	>===<	123931507 (52863604)
imap.gmail.com	9AFDA9BEF8573B238052...(1024)	18/11/11	18/11/12	Google Inc	17 (25)	* 1.160 (0.659)	>==>>	120963041 (72889992)
login.[live.com	C548D3D383594EAC8B19...(2048)	28/09/11	27/09/12	VeriSign, Inc.	18 (21)	1.094 (0.960)	=====	114138558 (106107395)
pop3.live.com	A906AECB8EB6826C51BE...(2048)	24/03/11	23/03/13		19 (20)	1.048 (1.024)	=====	109361276 (113150224)
twitter.com	9A21AA930F40AE99EFBD...(2048)	07/07/11	27/07/12	VeriSign, Inc.	20 (19)	0.969 (1.128)	=====	101088158 (124647248)
http.mws.mobile.live.com	F8B16F57A4599C6F346F...(1024)	12/08/10	30/09/14	VeriSign Trust Network	21 (16)	0.955 (1.450)	=>:-=<	99584853 (160275556)
*.ak.fbcdn.net	AB42786DB7E50E2EFEBF...(1024)	13/01/12	13/01/13	Akamai Technologies Inc	22 (22)	0.931 (0.907)	=====	97155933 (100210124)
*.facebook.com	AE94B171E2DECCC1693E...(1024)	14/07/11	13/07/12	VeriSign Trust Network	23 (13)	0.843 (1.525)	-----	87967311 (168474280)
*.imap.mail.yahoo.com	D4EBE5BEC7F392CC63E2...(2048)	11/05/11	15/05/13	DigiCert Inc	24 (29)	0.702 (0.584)	-----	73246541 (64522656)
*.itunes.apple.com	BE929951748692EDF512...(1024)	23/06/09	22/06/14	VeriSign, Inc.	25 (23)	0.688 (0.739)	=====	71781445 (81745924)
TrustedSourceServer_IMQA01	DAB6BEB776DCFBBD330B...(1024)	18/02/10	01/01/38	SCC	26 (28)	0.669 (0.614)	=====	69784882 (67857652)
www.google.com	DEB72643A69985CD38A7...(1024)	26/10/11	30/09/13	Thawte Consulting (Pty) Ltd.	27 (24)	0.665 (0.738)	=====	69403948 (81563480)
*.whatsapp.net	DA6040129F6D3C9ACB3D...(2048)	31/12/09	31/12/12	GoDaddy.com, Inc.	28 (27)	0.627 (0.627)	-----	65465951 (69350595)
games.metaservices.microsoft.com	C830F15AD53CE2589378...(2048)	16/05/11	15/05/13		29 (26)	0.606 (0.630)	===>=	63213853 (69606626)
*.cityville.zynga.com	D5A3EE989786818E9EC2...(2048)	29/06/11	28/06/12	VeriSign, Inc.	30 (37)	0.583 (0.451)	=====	60885889 (49891238)
*.zynga.com	CF2A2823980A14D70D9F...(1024)	01/09/11	30/12/13	DigiCert Inc	31 (33)	0.569 (0.521)	=====	59409296 (57599432)
*.twitter.com	ACBEDF362314A01E035E...(2048)	17/07/11	17/09/13	GeoTrust, Inc.	32 (30)	0.554 (0.575)	=====	57778165 (63623577)
*.mail.ru	AFD70CA3E329E37B15A6...(2048)	12/03/12	11/05/14	Thawte, Inc.	33 (42)	0.530 (0.425)	=>	55267751 (46962081)
contacts.msn.com	965A1B80E8B656C1D69E...(2048)	12/05/11	11/05/13		34 (34)	0.514 (0.506)	=====	53694286 (55968833)
*.s3.amazonaws.com	93CD135CD0DBDED5608C...(1024)	15/12/10	18/12/13	DigiCert Inc	35 (38)	0.509 (0.450)	=====	53084116 (49720339)
*.addons.mozilla.org	B612D697D0571AFE9153...(2048)	27/12/10	29/12/12	GeoTrust, Inc.	36 (31)	0.492 (0.550)	=====	51395280 (60762021)
*.securestudies.com	DC1591DB0B316C39526B...(2048)	02/03/12	19/03/13	COMODO CA Limited	37 (82)	* 0.470 (0.143)	>	49056755 (15851007)
sb01.cysheiev.htit.prd.miyowa.net	D78B03F0D9C9E8B94415...(2048)	19/04/11	20/04/13	The USERTRUST Network	38 (39)	0.444 (0.447)	=====	46338349 (49394988)
*.castle.zynga.com	DA8920606F8929E98631...(1024)	01/09/11	30/12/13	DigiCert Inc	39 (44)	0.438 (0.396)	=====	45721029 (43761752)
gs-loc.apple.com	CC785DBDA5E720FE810B...(2048)	04/10/10	01/10/12	Entrust, Inc.	40 (43)	0.419 (0.421)	=====	43766504 (46590125)
*.calendar.yahoo.com	C024E5101CA04AA804F7...(2048)	13/03/12	20/03/13	DigiCert Inc	41 (63)	* 0.405 (0.205)	>>	42323610 (22677002)

Trends Reports: Findings

- RSA:DH:EC ratio roughly constant (90:5:5)
  - EC almost entirely Google (plus a bit of whatsapp)
- New certificates mostly use 2048-bit RSA keys
- We’ve seen new services jump up the list:
  - Summer 2011: Google’s switch to Elliptic Curves
  - Autumn 2011: Apple’s iCloud service
  - Spring 2012: Increase in mobile Facebook encryption

TLS and targets

- Trends reports not based on targeted data
- How do we judge interest in TLS services, and get analysts involved? Two ways we've tried:
  - Associate TLS events with targets, and inform the relevant analysts (TargeTLS)
  - Put TLS data out there for analysts to search (FLYING PIG)

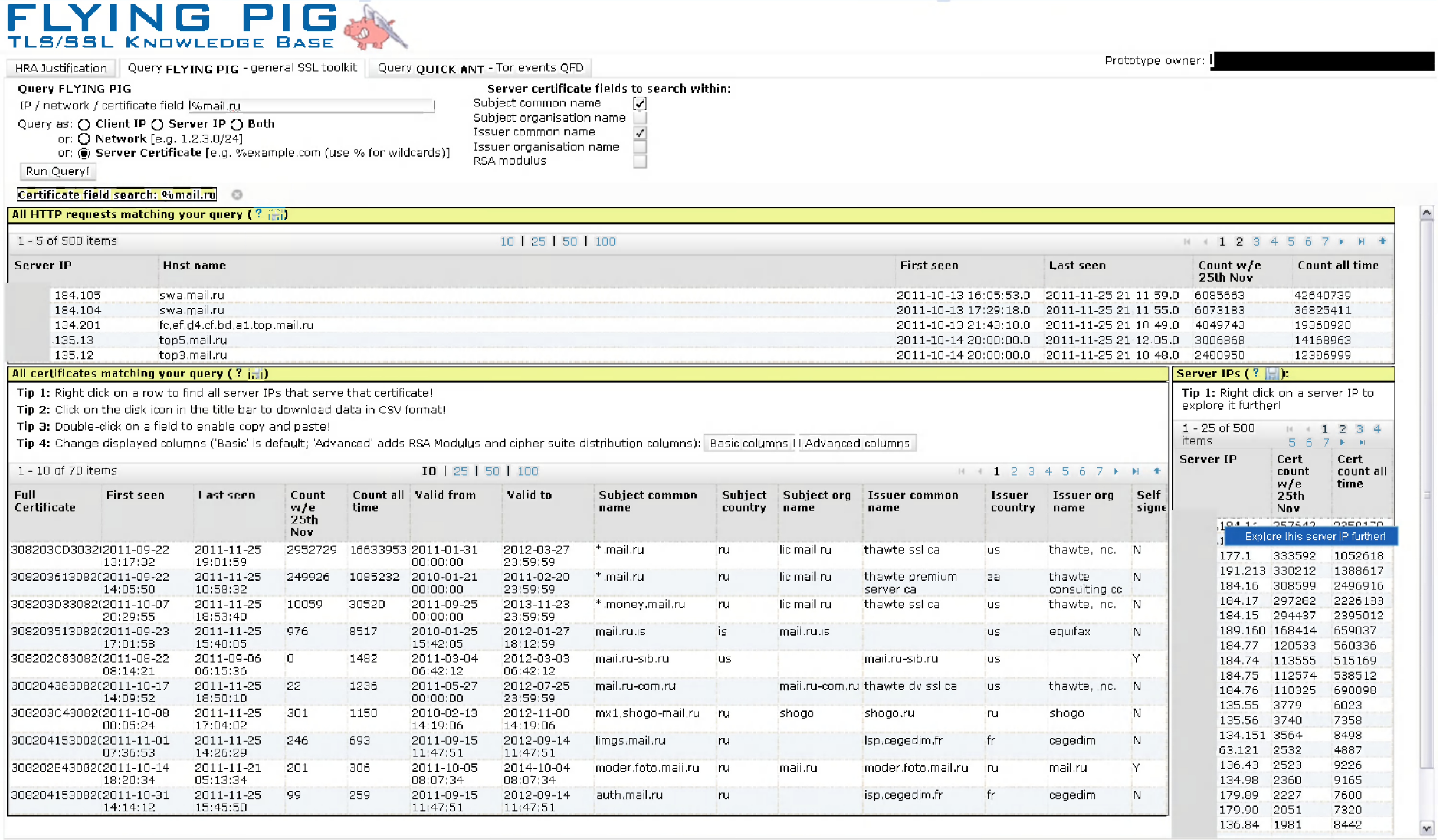
TargeTLS reports

- BROAD OAK: GCHQ’s repository of target info
- We match TLS events against this:
  - Is the server IP in BROAD OAK?
  - Does the certificate’s domain match a URL selector, or a number of email selectors?
- Email the relevant POC to ask if the traffic is of interest
- About 15% of the services we’ve identified in this way have been worth looking into further

FLYING PIG

- TLS knowledge base. Summarises all TLS events to answer multiple questions, e.g.:
  - What certificates are present on a given IP?
  - Which client IPs access a given service?
  - Which TDIs can be associated with a given service?

Example: search by domain



FLYING PIG
TLS/SSL KNOWLEDGE BASE

HRA Justification | Query FLYING PIG - general SSL toolkit | Query QUICK ANT - Tor events QFD

Prototype owner: [redacted]

Query FLYING PIG

IP / network / certificate field %mail.ru

Query as: ○ **Client IP** ○ **Server IP** ○ **Both**
or: ○ **Network** [e.g. 1.2.3.0/24]
or: ● **Server Certificate** [e.g. %example.com (use % for wildcards)]

Run Query!

Server certificate fields to search within:

Subject common name	☑
Subject organisation name	□
Issuer common name	☑
Issuer organisation name	□
RSA modulus	□

Certificate field search: %mail.ru

All HTTP requests matching your query (?)

1 - 5 of 500 items 10 | 25 | 50 | 100 1 2 3 4 5 6 7

Server IP	Host name	First seen	Last seen	Count w/e 25th Nov	Count all time
184.105	swa.mail.ru	2011-10-13 16:05:53.0	2011-11-25 21 11 59.0	6085663	42640739
184.104	swa.mail.ru	2011-10-13 17:29:18.0	2011-11-25 21 11 55.0	6073183	36825411
134.201	fc.ef.d4.cf.bd.a1.top.mail.ru	2011-10-13 21:43:10.0	2011-11-25 21 10 49.0	4049743	19360920
.135.13	top5.mail.ru	2011-10-14 20:00:00.0	2011-11-25 21 12.05.0	3006868	14168963
135.12	top3.mail.ru	2011-10-14 20:00:00.0	2011-11-25 21 10 48.0	2400950	12306999

All certificates matching your query (?)

Tip 1: Right click on a row to find all server IPs that serve that certificate!
Tip 2: Click on the disk icon in the title bar to download data in CSV format!
Tip 3: Double-click on a field to enable copy and paste!
Tip 4: Change displayed columns ('Basic' is default; 'Advanced' adds RSA Modulus and cipher suite distribution columns): Basic columns | Advanced columns

1 - 10 of 70 items 10 | 25 | 50 | 100 1 2 3 4 5 6 7

Full Certificate	First seen	Last seen	Count w/e 25th Nov	Count all time	Valid from	Valid to	Subject common name	Subject country	Subject org name	Issuer common name	Issuer country	Issuer org name	Self signe
308203CD3032(	2011-09-22 13:17:32	2011-11-25 19:01:59	2952729	16633953	2011-01-31 00:00:00	2012-03-27 23:59:59	*.mail.ru	ru	lic mail ru	thawte ssl ca	us	thawte, nc.	N
3082036130820(	2011-09-22 14:05:50	2011-11-25 10:58:32	249926	1085232	2010-01-21 00:00:00	2011-02-20 23:59:59	*.mail.ru	ru	lic mail ru	thawte premium server ca	za	thawte consulting cc	N
308203D33082(	2011-10-07 20:29:55	2011-11-25 18:53:40	10059	30520	2011-09-25 00:00:00	2013-11-23 23:59:59	*.money.mail.ru	ru	lic mail ru	thawte ssl ca	us	thawte, nc.	N
3082035130820(	2011-09-23 17:01:58	2011-11-25 15:40:05	976	8517	2010-01-25 15:42:05	2012-01-27 18:12:59	mail.ru.is	is	mail.ru.is		us	equifax	N
308202C83082(	2011-08-22 08:14:21	2011-09-06 06:15:36	0	1482	2011-03-04 06:42:12	2012-03-03 06:42:12	mail.ru-sib.ru	us		mail.ru-sib.ru	us		Y
3002043830820(	2011-10-17 14:09:52	2011-11-25 18:50:10	22	1236	2011-05-27 00:00:00	2012-07-25 23:59:59	mail.ru-com.ru		mail.ru-com.ru	thawte dv ssl ca	us	thawte, nc.	N
300203C43082(	2011-10-08 00:05:24	2011-11-25 17:04:02	301	1150	2010-02-13 14:19:06	2012-11-00 14:19:06	mx1.shogo-mail.ru	ru	shogo	shogo.ru	ru	shogo	N
3002041530020(	2011-11-01 07:36:53	2011-11-25 14:26:29	246	693	2011-09-15 11:47:51	2012-09-14 11:47:51	limgs.mail.ru	ru		lsp.cegedim.fr	fr	cegedim	N
300202E43002(	2011-10-14 18:20:34	2011-11-21 05:13:34	201	306	2011-10-05 08:07:34	2014-10-04 08:07:34	moder.foto.mail.ru	ru	mail.ru	moder.foto.mail.ru	ru	mail.ru	Y
3082041530820(	2011-10-31 14:14:12	2011-11-25 15:45:50	99	259	2011-09-15 11:47:51	2012-09-14 11:47:51	auth.mail.ru	ru		isp.cegedim.fr	fr	cegedim	N

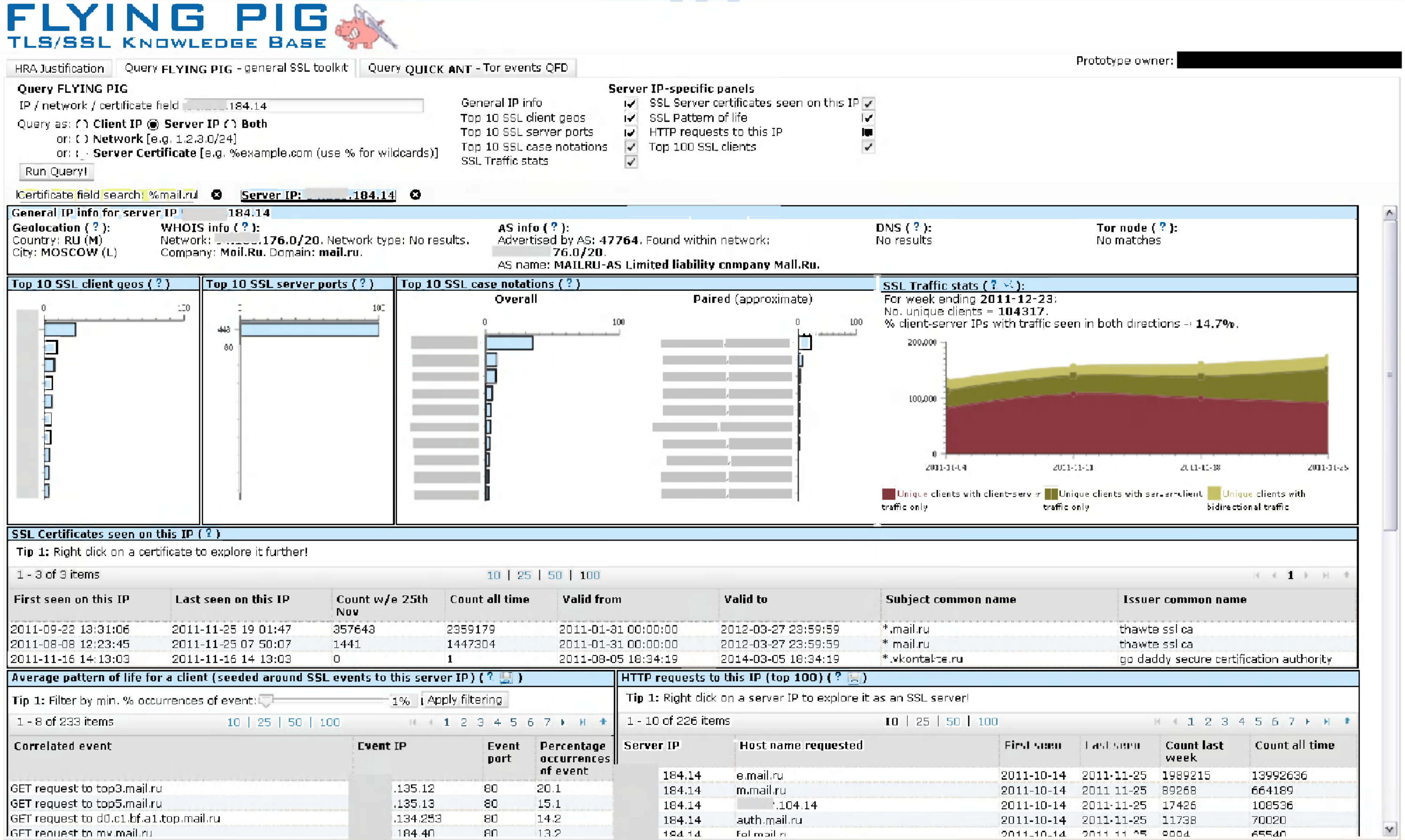
Server IPs (?):

Tip 1: Right click on a server IP to explore it further!

1 - 25 of 500 items 1 2 3 4 5 6 7

Server IP	Cert count w/e 25th Nov	Cert count all time
184.1[illegible]	[illegible]	[illegible]
.1[illegible]		
177.1	333592	1052618
191.213	330212	1388617
184.16	308599	2496916
184.17	297282	2226133
184.15	294437	2395012
189.160	168414	659037
184.77	120533	560336
184.74	113555	515169
184.75	112574	538512
184.76	110325	690098
135.55	3779	6023
135.56	3740	7358
134.151	3564	8498
63.121	2532	4887
136.43	2523	9226
134.98	2360	9165
179.89	2227	7600
179.90	2051	7320
136.84	1981	8442

Example: search by server IP



FLYING PIG
TLS/SSL KNOWLEDGE BASE
0
100
443
80
Overall
Paired (approximate)
200,000
100,000
2011-11-18
2011-11-25
Unique clients with client-server traffic only
Unique clients with server-client traffic only
Unique clients with bidirectional traffic

Prototype owner: [redacted]

HRA Justification | Query FLYING PIG - general SSL toolkit | Query QUICK ANT - Tor events QFD

Query FLYING PIG

IP / network / certificate field [redacted].184.14

Query as: ○ **Client IP** ● **Server IP** ○ **Both**
or: ○ **Network** [e.g. 1.2.3.0/24]
or: ○ **Server Certificate** [e.g. %example.com (use % for wildcards)]

Run Query!

Server IP-specific panels

General IP info	☑	SSL Server certificates seen on this IP	☑
Top 10 SSL client geos	☑	SSL Pattern of life	☑
Top 10 SSL server ports	☑	HTTP requests to this IP	☑
Top 10 SSL case notations	☑	Top 100 SSL clients	☑
SSL Traffic stats	☑		

Certificate field search: %mail.ru ⊗ **Server IP: [redacted].184.14** ⊗

General IP info for server IP [redacted]184.14

Geolocation (?):
Country: **RU** (M)
City: **MOSCOW** (L)

WHOIS info (?):
Network: [redacted].176.0/20. Network type: No results.
Company: **Moil.Ru.** Domain: **mail.ru**.

AS info (?):
Advertised by AS: **47764**. Found within network: [redacted]76.0/20.
AS name: **MAILRU-AS Limited liability cnmpany Mall.Ru.**

DNS (?):
No results

Tor node (?):
No matches

Top 10 SSL client geos (?)

Top 10 SSL server ports (?)

Top 10 SSL case notations (?)

SSL Traffic stats (?):
For week ending **2011-12-23**:
No. unique clients = **104317**.
% client-server IPs with traffic seen in both directions = **14.7%**.

SSL Certificates seen on this IP (?)

Tip 1: Right click on a certificate to explore it further!

1 - 3 of 3 items 10 | 25 | 50 | 100 1

First seen on this IP	Last seen on this IP	Count w/e 25th Nov	Count all time	Valid from	Valid to	Subject common name	Issuer common name
2011-09-22 13:31:06	2011-11-25 19 01:47	357643	2359179	2011-01-31 00:00:00	2012-03-27 23:59:59	*.mail.ru	thawte ssl ca
2011-08-08 12:23:45	2011-11-25 07 50:07	1441	1447304	2011-01-31 00:00:00	2012-03-27 23:59:59	* mail.ru	thawte ssl ca
2011-11-16 14:13:03	2011-11-16 14 13:03	0	1	2011-08-05 18:34:19	2014-03-05 18:34:19	*.vkontakte.ru	go daddy secure certification authority

Average pattern of life for a client (seeded around SSL events to this server IP) (?)

Tip 1: Filter by min. % occurrences of event: 1% Apply filtering

1 - 8 of 233 items 10 | 25 | 50 | 100 1 2 3 4 5 6 7

Correlated event	Event IP	Event port	Percentage occurrences of event
GET request to top3.mail.ru	[redacted].135.12	80	20.1
GET request to top5.mail.ru	[redacted].135.13	80	15.1
GET request to d0.c1.bf.a1.top.mail.ru	[redacted].134.253	80	14.2
GET request to my.mail.ru	[redacted].184.40	80	13.2

HTTP requests to this IP (top 100) (?)

Tip 1: Right click on a server IP to explore it as an SSL server!

1 - 10 of 226 items 10 | 25 | 50 | 100 1 2 3 4 5 6 7

Server IP	Host name requested	First seen	Last seen	Count last week	Count all time
[redacted]184.14	e.mail.ru	2011-10-14	2011-11-25	1989215	13992636
[redacted]184.14	m.mail.ru	2011-10-14	2011 11-25	89268	664189
[redacted]184.14	[redacted].104.14	2011-10-14	2011-11-25	17426	108536
[redacted]184.14	auth.mail.ru	2011-10-14	2011-11-25	11738	70020
[redacted]184.14	fel.mail.ru	2011-10-14	2011 11-25	9004	65540

Contacts

- TLS trends: Crypt Operations BULLRUN team
  - [redacted]@gchq)
  - [redacted]@gchq)
- FLYING PIG: ICTR Network Exploitation
  - [redacted]@gchq)