

NETWORK  
EXPLOITATION

# PROFILING SSL AND ATTRIBUTING PRIVATE NETWORKS

An introduction to FLYING PIG and HUSH PUPPY

[REDACTED]

ICTR - Network Exploitation  
GCHQ

# Outline

## NETWORK EXPLOITATION

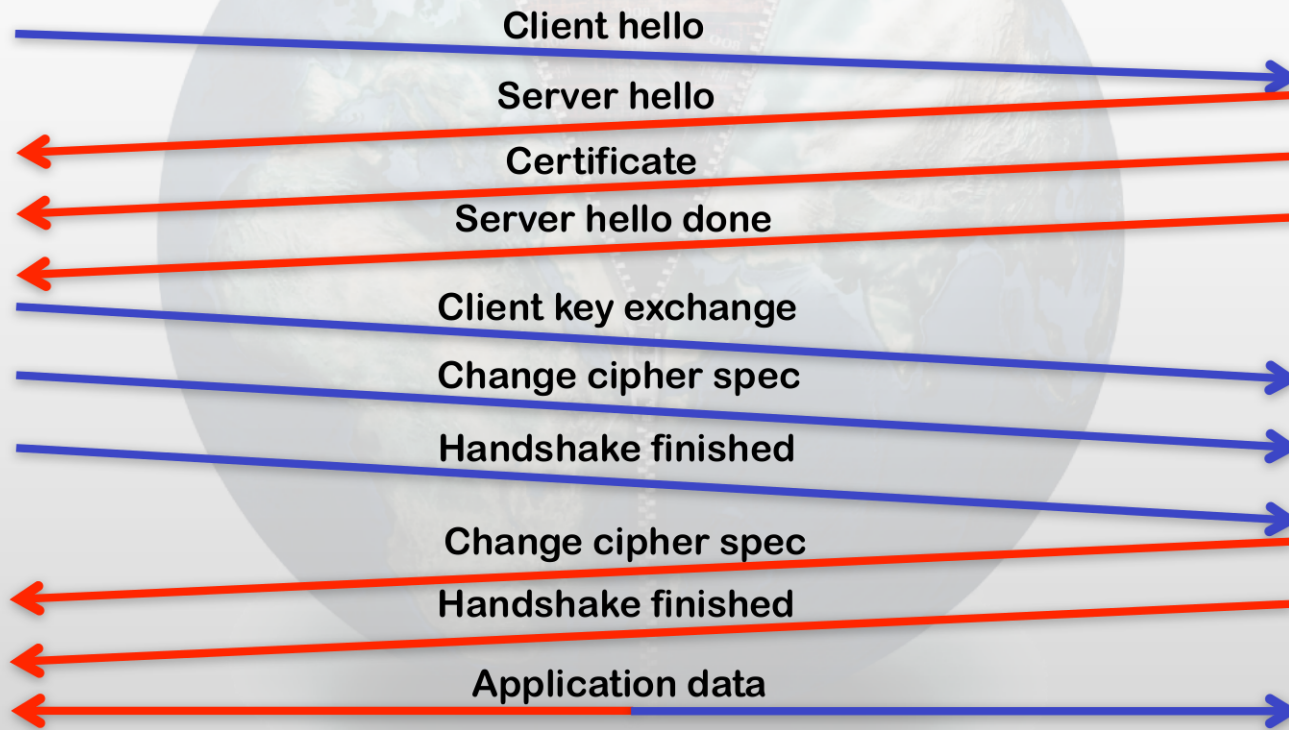
- Two separate prototypes – FLYING PIG and HUSH PUPPY
- Both are cloud analytics which work on bulk unselected data
- FLYING PIG is a knowledge base for investigating TLS/SSL traffic
- HUSH PUPPY is a tool for attributing private network traffic

# FLYING PIG - TLS/SSL Background

- TLS/SSL (Transport Layer Security / Secure Sockets Layer) provides encrypted communication over the internet
- Simple TLS/SSL handshake:

Client

Server



# Motivations for FLYING PIG

## NETWORK EXPLOITATION

- More and more services used by GCHQ targets are moving to TLS/SSL to increase user confidence, e.g. Hotmail, Yahoo, Gmail, etc.
- Terrorists and cyber criminals are common users of TLS/SSL to hide their comms (not necessarily using the big providers).
- A TLS/SSL knowledge base could provide a means to extract as much information from the unencrypted traffic as possible.



# FLYING PIG implementation

NETWORK  
EXPLOITATION

- **Federated QFD approach**
  - Multiple separate cloud analytics, each of which produce a QFD (Query Focussed Dataset).
  - Analytics are run once a week, on approximately 20 billion events.
  - A single query in the web interface results in calls to multiple QFDs, which are returned to the user in separate panels.
  - Results in:
    - (a) fast queries,
    - (b) easy-to-maintain modular code, and importantly
    - (c) easy to add future TLS/SSL QFDs.

# Query by certificate metadata



HRA Justification Query FLYING PIG - general SSL toolkit Query QUICK ANT - Tor events QFD Prototype owner: ██████████ ICTR-NE

**Query FLYING PIG**  
 IP / network / certificate field   
 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)]

**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**

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	2480950	12386999

**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):

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 signed
308203CD3082(2011-09-22 13:17:32	2011-11-25 19:01:59	2011-11-25 19:01:59	2952729	16638958	2011-01-31 00:00:00	2012-03-27 23:59:59	*.mail.ru	ru	llc mail.ru	thawte ssl ca	us	thawte, inc.	N
308203613082(2011-09-22 14:05:50	2011-11-25 18:58:32	2011-11-25 18:58:32	249926	1085232	2010-01-21 00:00:00	2011-02-20 23:59:59	*.mail.ru	ru	llc mail.ru	thawte premium server ca	za	thawte consulting cc	N
308203D33082(2011-10-07 20:29:55	2011-11-25 18:53:40	2011-11-25 18:53:40	10059	30520	2011-09-25 00:00:00	2013-11-23 23:59:59	*.money.mail.ru	ru	llc mail.ru	thawte ssl ca	us	thawte, inc.	N
308203513082(2011-09-23 17:01:58	2011-11-25 15:40:05	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	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
308204383082(2011-10-17 14:09:52	2011-11-25 18:50:10	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, inc.	N
308203C43082(2011-10-08 00:05:24	2011-11-25 17:04:02	2011-11-25 17:04:02	301	1150	2010-02-13 14:19:06	2012-11-08 14:19:06	mx1.shogo-mail.ru	ru	shogo	shogo.ru	ru	shogo	N
308204153082(2011-11-01 07:36:53	2011-11-25 14:26:29	2011-11-25 14:26:29	246	693	2011-09-15 11:47:51	2012-09-14 11:47:51	limgs.mail.ru	ru		isp.cegedim.fr	fr	cegedim	N
308202E43082(2011-10-14 18:20:34	2011-11-21 05:13:34	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
308204153082(2011-10-31 14:14:12	2011-11-25 15:45:50	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**

Server IP	Cert count w/e 25th Nov	Cert count all time
184.105	6085663	42640739
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



# Query by server IP



HRA Justification Query FLYING PIG - general SSL toolkit Query QUICK ANT - Tor events QFD Prototype owner [REDACTED] ICTR-NE

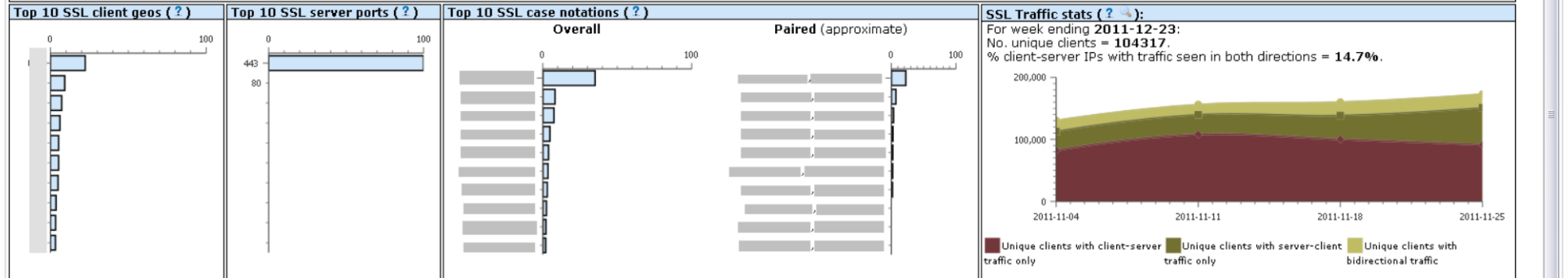
**Query FLYING PIG**  
 IP / network / certificate field:   
 Query as:  Client IP  Server IP  Both  
 or:  Network [e.g. 1.2.3.0/24]  
 or:  Server Certificate [e.g. %example.com (use % for wildcards)]

**Server IP-specific panels**

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

**General IP info for server IP 184.14**

**Geolocation (?):** Country: RU (M) City: MOSCOW (L)  
**WHOIS info (?):** Network: 76.0/20. Network type: No results. Company: Mail.Ru, Domain: mail.ru.  
**AS info (?):** Advertised by AS: 47764. Found within network: 76.0/20. AS name: MAILRU-AS Limited liability company Mail.Ru.  
**DNS (?):** No results  
**Tor node (?):** No matches



**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

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	2014-08-05 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) (?)** **HTTP requests to this IP (top 100) (?)**

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

1 - 8 of 233 items | 10 | 25 | 50 | 100

Correlated event	Event IP	Event port	Percentage occurrences of event
GET request to top3.mail.ru	135.12	80	28.1
GET request to top5.mail.ru	135.13	80	15.1
GET request to d0.c1.bf.a1.top.mail.ru	134.253	80	14.2
GFT request to mv.mail.ru	184.40	80	13.2

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

1 - 10 of 226 items | 10 | 25 | 50 | 100

Server IP	Host name requested	First seen	Last seen	Count last week	Count all time
184.14	e.mail.ru	2011-10-14	2011-11-25	1989215	13992636
184.14	m.mail.ru	2011-10-14	2011-11-25	89268	664189
184.14	184.14	2011-10-14	2011-11-25	17426	108536
184.14	auth.mail.ru	2011-10-14	2011-11-25	11738	70020
184.14	tel.mail.ru	2011-10-14	2011-11-25	8004	65540



# Query by server IP



HRA Justification Query FLYING PIG - general SSL toolkit Query QUICK ANT - Tor events QFD Prototype owner: [REDACTED] ICTR-NE

**Query FLYING PIG**  
 IP / network / certificate field: 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!

**Certificate field search:** %mail.ru **Server IP:** 184.14

Request	IP	Port	SSL	Server IP	Server Name	Start	End	Count	Count
GET request to top3.mail.ru	135.12	80	24.1	184.14	m.mail.ru	2011-10-14	2011-11-25	89268	664189
GET request to top5.mail.ru	135.13	80	15.1	184.14	94.100.184.14	2011-10-14	2011-11-25	17426	108536
GET request to d0.c1.bf.a1.top.mail.ru	134.253	80	14.2	184.14	auth.mail.ru	2011-10-14	2011-11-25	11738	70020
GET request to my.mail.ru	184.40	80	13.2	184.14	tel.mail.ru	2011-10-14	2011-11-25	8994	65540
GET request to my.mail.ru	184.41	80	12.9	184.14	e.	2011-10-15	2011-11-25	307	616
GET request to stat.my.mail.ru	184.40	80	10.8	184.14	e.mai	2011-10-14	2011-11-25	155	1101
GET request to stat.my.mail.ru	184.41	80	10.5	184.14	e.mail.	2011-10-14	2011-11-25	119	705
GET request to mirmaker1.mail.ru	189.183	80	10.4	184.14	mail.ru	2011-10-24	2011-11-23	110	367
				184.14	e.m	2011-10-15	2011-11-25	107	400

**Top 100 SSL clients of serve** 184.14 ( ? )

Tip 1: Filter by country of client IP (e.g. enter nothing to avoid filtering or PK,IR,IQ to filter by multiple countries): GB,US,CA,NZ,AU  
 Only show clients in these countries  Remove clients in these countries  
 Remove clients that also act as servers  
 Number of results returned: 100  
 Filter! RESET

Tip 2: Right click on a client or server IP to explore it further!

1 - 20 of 100 items 10 | 25 | 50 | 100

Client IP	Client country (conf)	Client company	First seen	Last seen	Count w/e 25th Nov	Count all time	Pairing status w/e 25th Nov	Pairing status all time
.212	ES(V)	Telefonica_de_Espana_SAU;rima-tde.net	2011-10-16	2011-11-19	1415	50136	Server -> Client only	Both directions
.139	ES(H)	R_Cable_y_Telecomunicaciones_Galicia_S.A.;mundo-r	2011-10-24	2011-11-25	424	726	Client -> Server only	Client -> Server only
.111	DE(V)	Bertelsmann_ZI_GmbH;mediaways.net	2011-11-23	2011-11-23	417	417	Server -> Client only	Server -> Client only
.56	NO(V)	Telenor_Nextel_AS;telenor.net	2011-11-21	2011-11-24	403	403	Server -> Client only	Server -> Client only
.38	IE(V)	Vodafone_ISP;UNKNOWN	2011-11-23	2011-11-23	330	330	Both directions	Both directions
.114	DE(V)	Bertelsmann_ZI_GmbH;mediaways.net	2011-11-23	2011-11-23	329	329	Server -> Client only	Server -> Client only
.127	KR(M)	Korea_Telecom	2011-09-04	2011-11-25	325	2266	Both directions	Both directions
.250	-(-)	-	2011-11-18	2011-11-18	296	296	Both directions	Both directions
.152	EC(H)	Ecuadortelecom_S.A.;ecutel.net.ec	2011-11-10	2011-11-25	290	291	Both directions	Both directions
.186	IE(V)	Vodafone_ISP;UNKNOWN	2011-11-20	2011-11-20	196	196	Both directions	Both directions
.9	MY(H)	TMNET;holcim.net	2011-09-03	2011-11-24	189	383	Both directions	Both directions
.153	KR(M)	QRINET;UNKNOWN	2011-10-20	2011-11-25	181	198	Both directions	Both directions
.53	MY(H)	CORE_IP_DEVELOPMENT ;dancom.com.my	2011-11-19	2011-11-25	179	179	Both directions	Both directions
.121	IR(V)	Static-Pool-TP3;pol.ir	2011-11-21	2011-11-21	177	177	Client -> Server only	Client -> Server only
.41	IE(V)	UTV_PLC;utvinternet.net	2011-11-19	2011-11-20	167	167	Both directions	Both directions
.237	KR(M)	KRNIC;ktcu.or.kr	2011-09-03	2011-11-25	150	1007	Both directions	Both directions
.38	BR(M)	Comite_Gestor_da_Internet_no_Brasil;ampernet.com	2011-11-23	2011-11-25	145	145	Server -> Client only	Server -> Client only
.87	KR(H)	Korea_Telecom;postman.co.kr	2011-10-16	2011-11-25	143	161	Both directions	Both directions
.155	KR(H)	Korea_Telecom;kornet.net	2011-10-24	2011-11-24	138	583	Both directions	Both directions
.1	IE(V)	Vodafone_ISP;UNKNOWN	2011-11-18	2011-11-18	137	158	Client -> Server only	Both directions





# Query by client IP



HRA Justification Query **FLYING PIG** - general SSL toolkit Query **QUICK ANT** - Tor events QFD Prototype owner: [REDACTED] ICTR-NE

**Query FLYING PIG**  
 IP / network / certificate field   
 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)]

**Client IP-specific panels**  
 General IP info   
 SSL Servers visited

Certificate field search: %mail.ru Server IP: 184.14 Client IP: .127

**General IP info for client IP .127**

**Geolocation ( ? ):** WHOIS info ( ? ): AS info ( ? ): DNS ( ? ): Tor node ( ? ):  
 Country: KR (M) Network: .0/20. Network type: No results. Advertised by AS: 4766. Found within network: .0.0/13. No results  
 City: SEOUL (L) Company: Korea Telecom. Domain: groupon.kr. AS name: KIXS-AS-KR Korea Telecom.

**Top 100 SSL servers visited by .127 ( ? ):**

Tip 1: Filter by country of server IP (e.g. enter PK to filter by Pakistan only or PK,IR,IQ to filter by multiple countries):  Only show servers in these countries Remove servers in these countries RESET

Tip 2: Right click on a client or server IP to explore it further!

1 - 8 of 8 items 10 | 25 | 50 | 100

Client IP	Server IP	Server country (conf)	Server company info (from GEOFUSSION export)	First seen	Last seen	Count w/e 25th Nov	Count all time	Pairing status w/e 25th Nov	Pairing status all time
.127	184.14	RU(M)	Mail.Ru;mail.ru	04-09-11 02:23:55	25-11-11 13:47:52	325	2266	Both directions	Both directions
.127	184.17	RU(M)	Mail.Ru;mail.ru	04-09-11 02:13:48	25-11-11 13:23:36	299	2207	Both directions	Both directions
.127	184.16	RU(M)	Mail.Ru;mail.ru	03-09-11 05:18:48	25-11-11 10:15:23	269	2240	Both directions	Both directions
.127	184.15	RU(M)	Mail.Ru;mail.ru	03-09-11 03:20:27	25-11-11 11:49:27	213	2354	Both directions	Both directions
.127	2131.207	DE(M)	BBBK91667;rapidshare.com	14-11-11 02:39:15	14-11-11 02:39:15	0	1	No traffic w/e 25th Nov	Client -> Server only
.127	213.87	NL(L)	Mozilla_Corporation	09-10-11 05:07:48	06-11-11 22:38:50	0	8	No traffic w/e 25th Nov	Server -> Client only
.127	181.127	RU(M)	Mail.Ru;mail.ru	16-10-11 19:05:16	13-11-11 21:31:31	0	13	No traffic w/e 25th Nov	Client -> Server only
.127	191.213	RU(M)	Mail.Ru;mail.ru	24-10-11 17:53:21	24-10-11 17:53:21	0	1	No traffic w/e 25th Nov	Client -> Server only



# Query by network range



HRA Justification Query FLYING PIG - general SSL toolkit Query QUICK ANT - Tor events QFD Prototype owner: [REDACTED] ICTR-NE

**Query FLYING PIG**  
 IP / network / certificate field [REDACTED].0/24  
 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)]

**Network-specific panels**  
 General network info  
 SSL Clients present in network  
 SSL Servers present in network  
 HTTP requests to IPs in network

Run Query!

Certificate field search: %mail.ru Server IP: 184.14 Client IP: .127 Network: .0/24

**General network info for .0/24**

**Geolocation (?):** Country: KR (M) City: SEOUL (L)  
**WHOIS info (?):** Network: No results. Network type: No results. Company: No results. Domain: No results.  
**AS info (?):** Advertised by AS: No results. Found within network: No results. AS name: No results.  
**DNS (?):** No results

**SSL clients in network .0/24: (?):**

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

1 - 20 of 57 items 10 | 25 | 50 | 100

Client IP	Client company info (from GEOFUSION export)	First seen	Last seen	Total SSL traffic w/e 25th Nov	Total SSL traffic all time	Num. unique servers contacted w/e 25th Nov	Num. unique servers contacted all time
.9	Korea_Telecom;mailplug.co.kr	2011-09-04	2011-09-04	0	1	0	1
.23	Korea_Telecom;mailplug.co.kr	2011-10-26	2011-11-23	1	7	1	3
.29	Korea_Telecom;mailplug.co.kr	2011-10-22	2011-10-22	0	1	0	1
.32	Korea_Telecom;mailplug.co.kr	2011-11-16	2011-11-18	1	2	1	2
.36	Korea_Telecom;mailplug.co.kr	2011-11-19	2011-11-22	7	7	1	1
.38	Korea_Telecom;mailplug.co.kr	2011-10-14	2011-11-16	0	21	0	5
.41	Korea_Telecom;mailplug.co.kr	2011-10-24	2011-10-26	0	2	0	2
.42	Korea_Telecom;mailplug.co.kr	2011-10-21	2011-10-21	0	1	0	1
.57	Korea_Telecom;mailplug.co.kr	2011-11-09	2011-11-11	0	3	0	2
.62	Korea_Telecom;mailplug.co.kr	2011-09-09	2011-09-09	0	1	0	1
.64	Korea_Telecom;mailplug.co.kr	2011-10-12	2011-10-12	0	1	0	1
.70	Korea_Telecom;mailplug.co.kr	2011-10-08	2011-10-31	0	18	0	5
.76	Korea_Telecom;mailplug.co.kr	2011-10-14	2011-11-07	0	14	0	1
.82	Korea_Telecom;mailplug.co.kr	2011-11-15	2011-11-15	0	2	0	1
.86	Korea_Telecom;mailplug.co.kr	2011-11-18	2011-11-18	1	1	1	1
.87	Korea_Telecom;mailplug.co.kr	2011-11-12	2011-11-12	0	1	0	1
.93	Korea_Telecom;mailplug.co.kr	2011-11-04	2011-11-04	0	2	0	1
.99	Korea_Telecom;mailplug.co.kr	2011-10-25	2011-11-21	3	12	2	5
.103	Korea_Telecom;mailplug.co.kr	2011-09-05	2011-09-05	0	1	0	1
.105	Korea_Telecom;mailplug.co.kr	2011-11-03	2011-11-03	0	1	0	1

**All SSL servers in network .0/24: (?):**

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

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

Server IP	Server company info (from GEOFUSION export)	Last week seen:	% Paired clients that week	Num. unique clients that week	Num. unique clients all time
.18	Korea_Telecom;mailplug.co.kr	2011-11-11	0.0	1	1
.205	test	2011-12-09	0.0	1	1
.202	test	2011-09-09	0.0	1	1

**HTTP requests to IPs in network .0/24 (top 100) (?):**

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

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

Server IP	Host name requested	First seen	Last seen	Count last week	Count all time
.40	.40	2011-10-30	2011-10-30	0	5



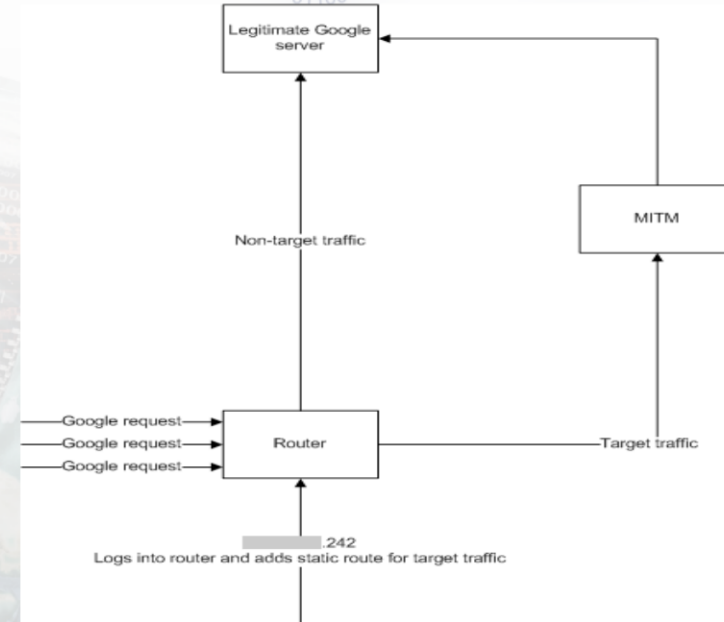
# Cyber applications

NETWORK EXPLOITATION

How the attack was done:

- **Diginotar certificate authority compromise :**

- Private keys of legitimate certificate authority, Diginotar, stolen by hacker.
- FLYING PIG was used to identify a FIS using them to launch a MITM against their own citizens.



**FLYING PIG screenshot showing fake certificate:**

308204303082039	2011-09-16 20:54:29	2011-10-20 17:14:05	0	3154	2011-09-05 06:05:49	2012-09-05 06:15:49	*.google.com	us	google inc	zscaler	us	www.zscaler.com	Y
3082052A3082049	2011-10-11 16:56:45	2011-11-25 15:41:29	5	1214	2011-09-20 06:07:12	2012-09-20 06:17:12	*.google.com			google internet authority			N
308204523082038	2011-11-11 02:30:27	2011-11-25 06:20:50	26	572	2011-11-02 21:08:36	2012-11-02 21:18:36	*.google.com	us	google inc	zscaler	us	www.zscaler.com	Y
308202DA3082024	2011-11-01 01:23:06	2011-11-25 17:48:58	71	547	2010-09-02 07:56:28	2011-09-02 08:06:28	*.google.com	us	google inc	sfbluecoat.sficorp.com	us	is	N
308204303082039	2011-08-25 13:03:12	2011-10-13 07:51:24	0	467	2011-08-12 03:49:02	2012-08-12 03:59:02	*.google.com	us	google inc	zscaler	us	www.zscaler.com	Y
308205283082041	2011-08-19 21:04:42	2011-08-26 19:51:50	0	441	2011-07-10 19:06:30	2013-07-09 19:06:30	*.google.com	us	google inc	diginotar public ca 2025	nl	diginotar	N
308204AA3082039	2011-11-08 09:35:22	2011-11-25 15:00:37	173	440	2011-09-20 06:07:12	2012-09-20 06:17:12	*.google.com	us	google inc	lorealinternetbrowsing	fr	loreal	N
30820464308203C	2011-11-17	2011-11-25	436	438	2011-11-10	2012-11-10	*.google.com	us	google inc	zscaler	us	www.zscaler.com	Y



# Cyber applications

NETWORK  
EXPLOITATION

- **Other Cyber applications:**

- Multiple examples of FIS data exfiltration using SSL have been found using **FLYING PIG**.
- In particular, certificates related to **LEGION JADE**, **LEGION RUBY**, and **MAKERSMARK** activity were found on **FLYING PIG** using known signatures
- These were then used to find previously unknown servers involved in exfiltration from US companies.
- **FLYING PIG** has also been used to identify events involving a mail server used by Russian Intelligence.



# Identification of malicious TLS/SSL

NETWORK  
EXPLOITATION

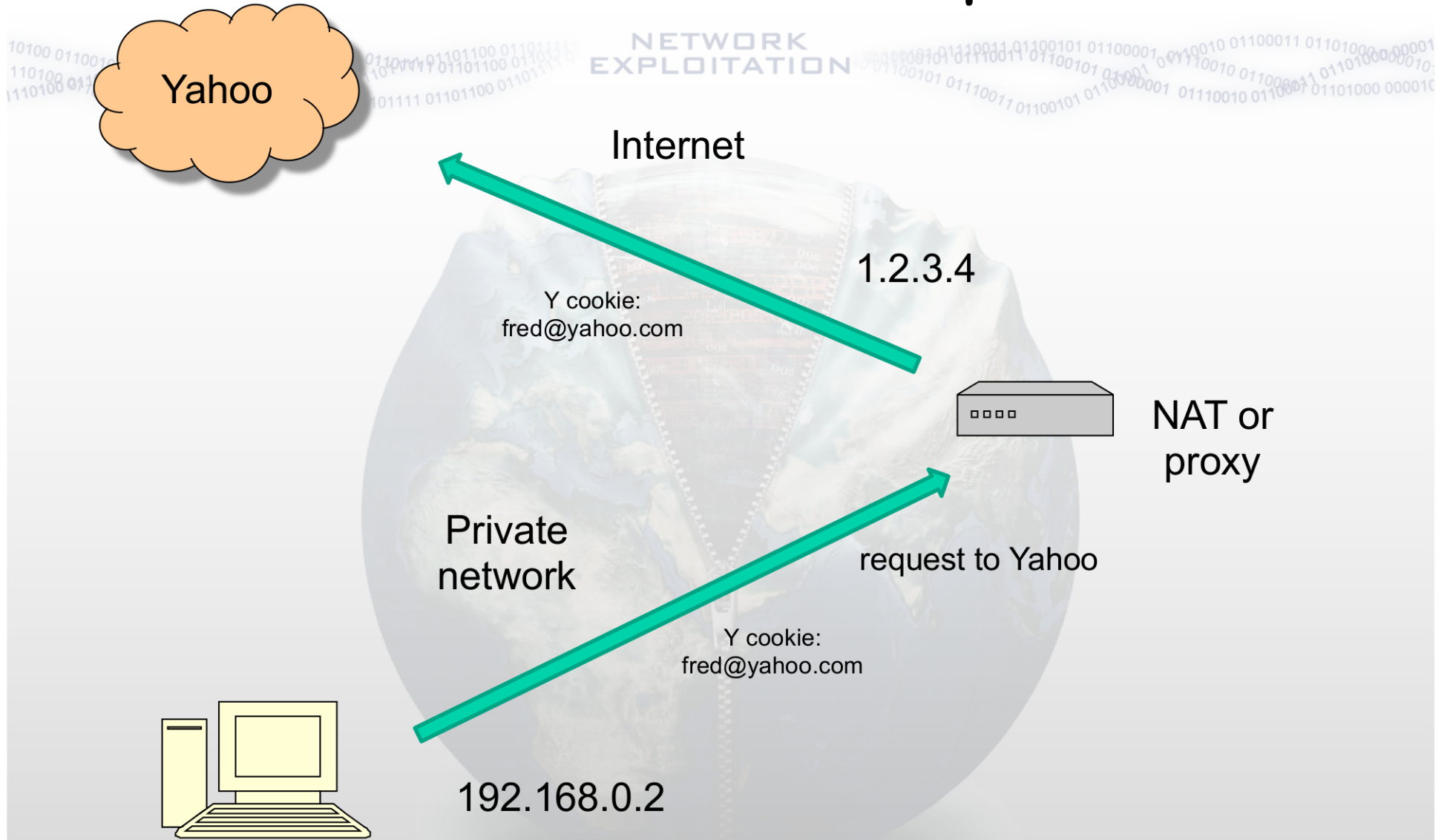
- Can identify malicious TLS/SSL using signatures if known
- However this approach generally does not allow discovery of new threats
- Alternative is to use “behavioural” features to automatically identify potentially malicious traffic
- Features currently being investigated include:
  - Certificates with same subject but different issuers – may be indicative of Diginotar-style attack
  - Beaconing in TLS/SSL (indicative of botnets/FIS implants)
  - Number of client cipher suites offered
  - Repeated identical random challenges

# HUSH PUPPY – motivation

NETWORK  
EXPLOITATION

- Much private network traffic seen but previously discarded
- If traffic could be attributed, potential high value – close access
- HUSH PUPPY is a bulk private network identification Cloud analytic
- Basic idea is to look for the same TDI being seen coming from a private address and then from a public address within a short time
- The private traffic can then be attributed to the owner of the public address
- Works for SSE & COMSAT

# HUSH PUPPY – example



# Other HUSH PUPPY datasets

- **HUSH PUPPY** also makes use of **Yahoo T-cookies** to do correlations
- A **T-cookie** contains the **IP address** of the client as **Yahoo** sees it
- Hence a **T cookie** coming from a **private IP** can give the **public IP** of the **NAT** or **proxy**
- In addition, **HUSH PUPPY** uses the following data to help verify results
  - **Kerberos & Lotus Notes**: Domains, organisations, departments, countries, machine names, user names
  - **HTTP**: Heuristic detection of **Intranet** web servers
  - **SSL**: Issuers, subjects, countries
  - **SMTP**: From & to domains



# Results – what do we find?

- Foreign government networks
- Airlines
- Energy companies
- Financial organisations
- In cases of good collection, 50-80% of collected private network traffic has been attributed
- Some false positives can arise if few events correlated, due to factors such as TDIs not being completely unique and public internet proxies giving misleading public IP results
- Results can frequently be verified using Kerberos etc data

# Examples of operational successes

## NETWORK EXPLOITATION

- A large private network related to the Afghan government was identified, with ~800,000 events correlated.
- Examination of the case notations suggested it belonged to the Afghan MOD
  - A Kerberos domain mod.local
  - HTTP servers \*.mod.local & mail
  - SSL certificates with the subject “Ministry of Defense” and the geo “AF”
- Results confirmed by analysis of content on XKEYSCORE
- A VSAT private network belonging to a Ministry of Foreign Affairs was identified
- NOSEY PARKER events were correlated with SSE

# Contacts

## NETWORK EXPLOITATION

- FLYING PIG – [REDACTED]
- HUSH PUPPY – [REDACTED]

