On Her Majesty's Secret Service - GRX & A spy agency

HITB Amsterdam 2014

Stephen Kho/ Rob Kuiters
29 May 2014

Agenda

- Who we are & why we are giving this talk
- The what, why & who - GRX
- GRX architecture & protocols
- GRX landscape – what we found & why it is interesting
- Vulnerabilities, attack vectors & techniques interesting to spy agencies
- Mitigation & best practises
- Conclusions
- Q&A

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Who we are & why this talk

- Stephen Kho & Rob Kuiters
- KPN CISO Team
- KPN-CERT & REDteam
- Penetration Testing & Incident Response
- Overview of GRX & why the interest (from spy agencies)
- Provide understanding of components, protocols, vulnerabilities & attack vectors

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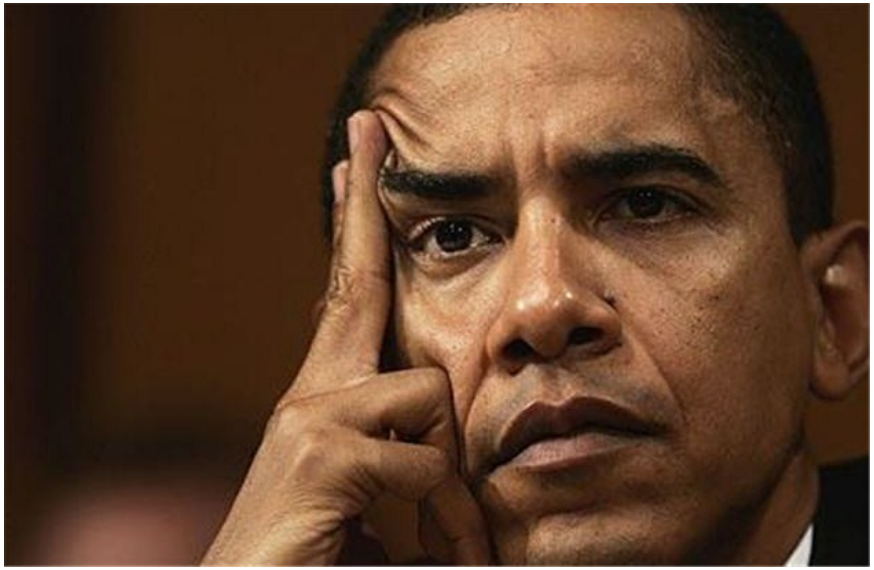
Why



This Talk?

Why this talk?

TOP SECRET STRAP 2

One Month Later – OP SOCIALIST

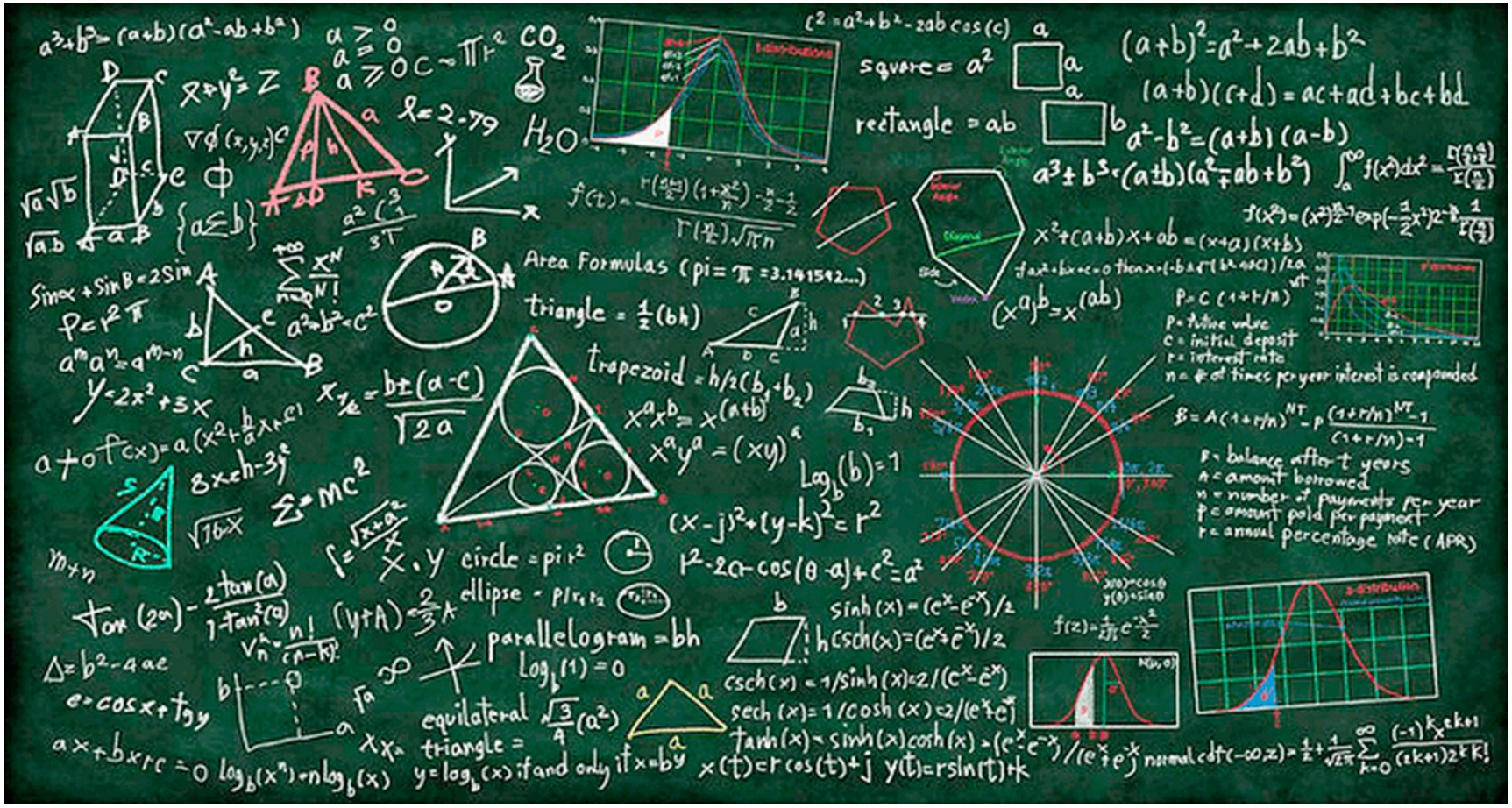
- Scoping session conducted – main focus to be on enabling CNE access to **BELGACOM GRX Operator**
- **Ultimate Goal – enable CNE access to BELGACOM Core GRX Routers from which we can undertake MiTM operations against targets roaming using Smart Phones.**
- Secondary focus – breadth of knowledge on GRX Operators
- Operations Manager assigned, team assembles

bics
a belgacom company

Why this talk?

Why this talk?

The Concept



On Her Majesty's Secret Service - GRX & A spy agency

The Concept
Death by abbreviations

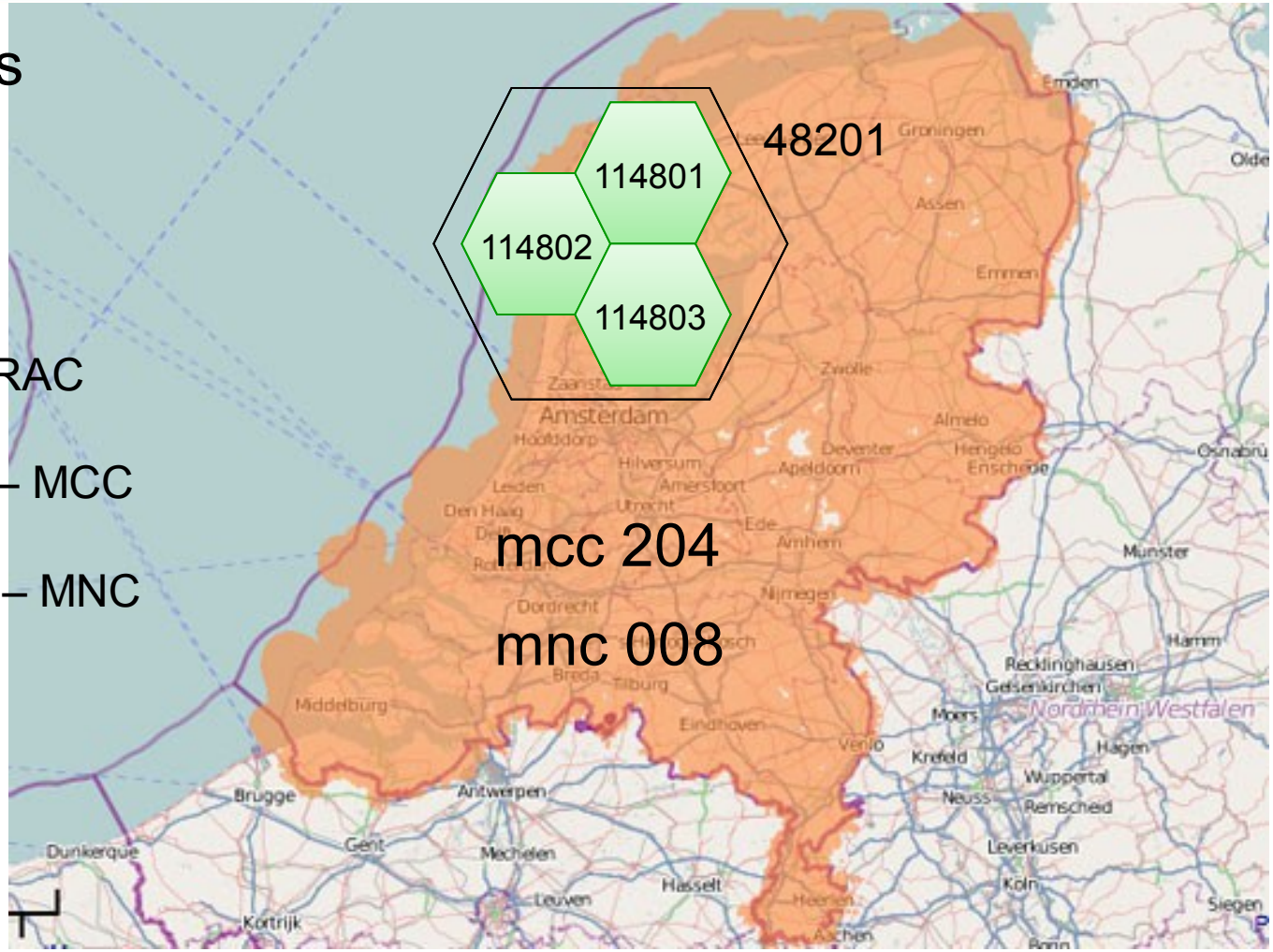
Mobility identifiers

Cell Identifier - CI

Routing Area Code – RAC

Mobile Country Code – MCC

Mobile Network Code – MNC



MCC	MNC	ISO	Country	Country Code	Network
204	14	nl	Netherlands	31	6GMOBILE BV
204	23	nl	Netherlands	31	Aspider Solutions
204	05	nl	Netherlands	31	Elephant Talk Communications Premium Rate Services Netherlands BV
204	17	nl	Netherlands	31	Intercity Mobile Communications BV
204	10	nl	Netherlands	31	KPN Telecom B.V.
204	08	nl	Netherlands	31	KPN Telecom B.V.
204	69	nl	Netherlands	31	KPN Telecom B.V.
204	12	nl	Netherlands	31	KPN/Telfort
204	28	nl	Netherlands	31	Lancelot BV
204	09	nl	Netherlands	31	Lycamobile Ltd
204	06	nl	Netherlands	31	Mundio/Vectone Mobile
204	21	nl	Netherlands	31	NS Railinfrabeheer B.V.
204	24	nl	Netherlands	31	Private Mobility Nederland BV
204	98	nl	Netherlands	31	T-Mobile B.V.
204	16	nl	Netherlands	31	T-Mobile B.V.
204	20	nl	Netherlands	31	Orange/T-mobile
204	02	nl	Netherlands	31	Tele2
204	07	nl	Netherlands	31	Teleena Holding BV
204	68	nl	Netherlands	31	Unify Mobile
204	18	nl	Netherlands	31	UPC Nederland BV
204	04	nl	Netherlands	31	Vodafone Libertel
204	03	nl	Netherlands	31	Voiceworks Mobile BV
204	15	nl	Netherlands	31	Ziggo BV

The Concept
Death by Abbreviations

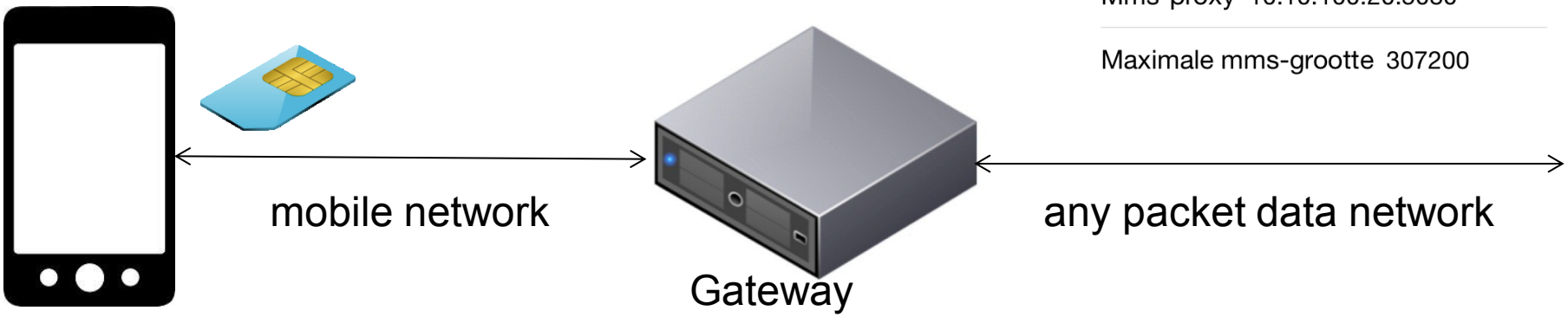
Access Point Name – APN

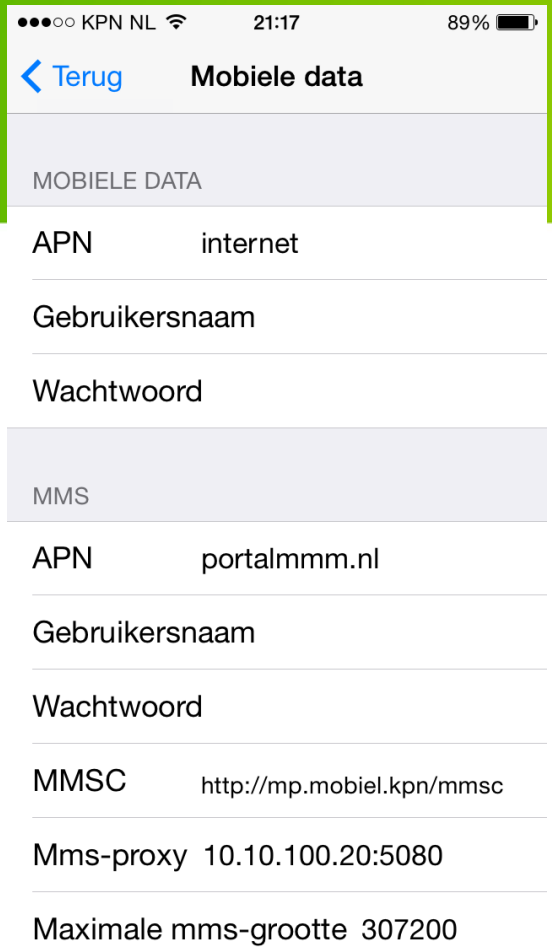
International Mobile Subscriber Identity – IMSI

Universal Integrated Circuit Card – UICC

Packet Data Protocol Context – PDP Context

internet.mnc008.mcc204.gprs
internet.mnc008.mcc204.3gppnetworks.org





The Concept
Elements

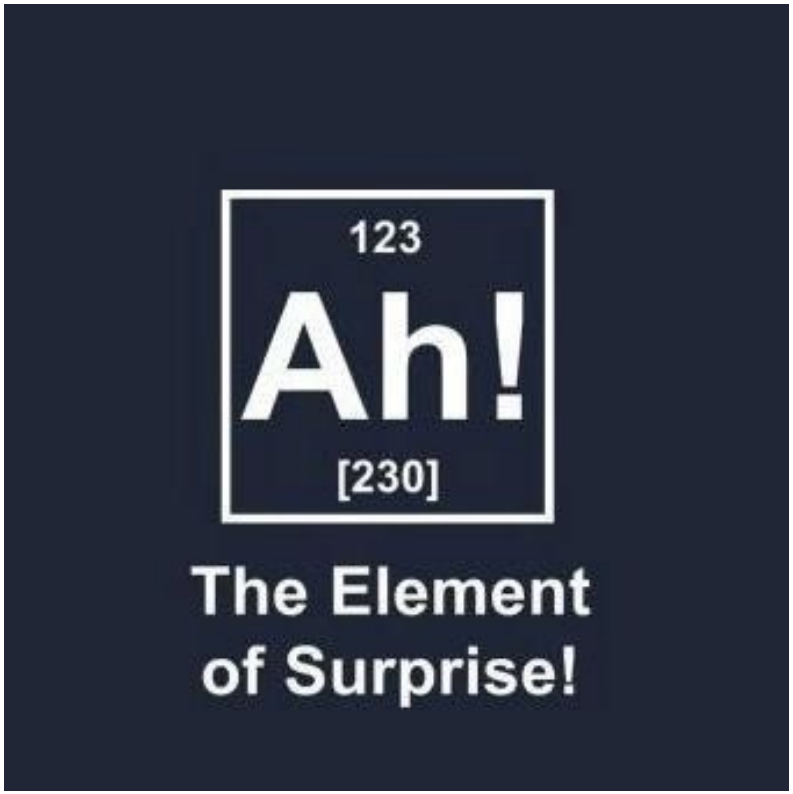
Radio (BTS / nodeB)

Home Location Register

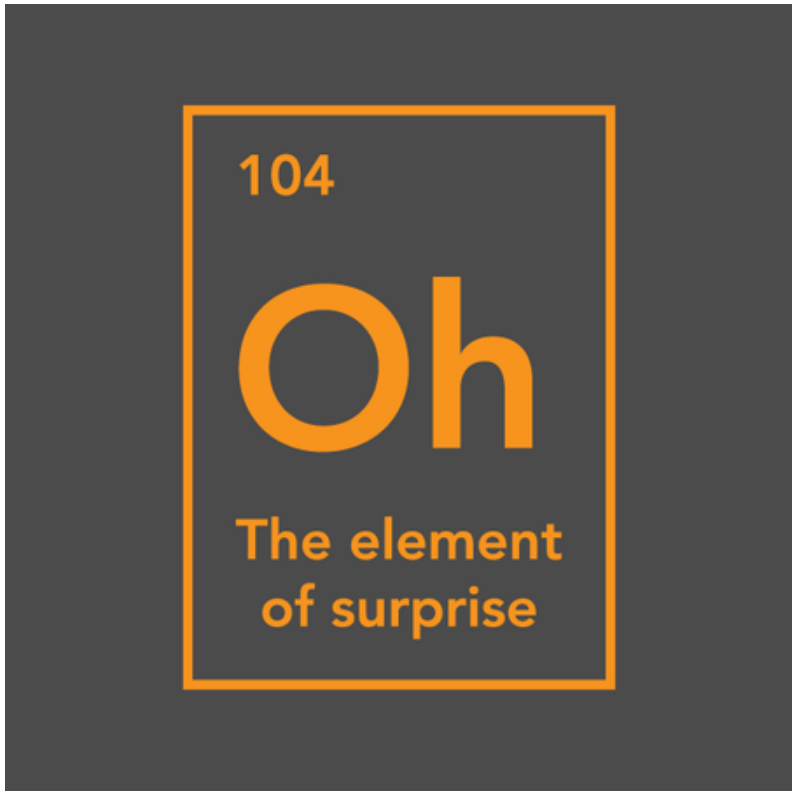
Serving GPRS support node

Gateway GPRS support node

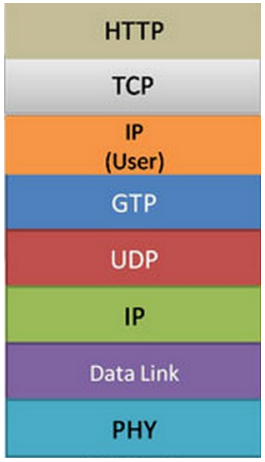
Domain Name Server



The Concept
Elements

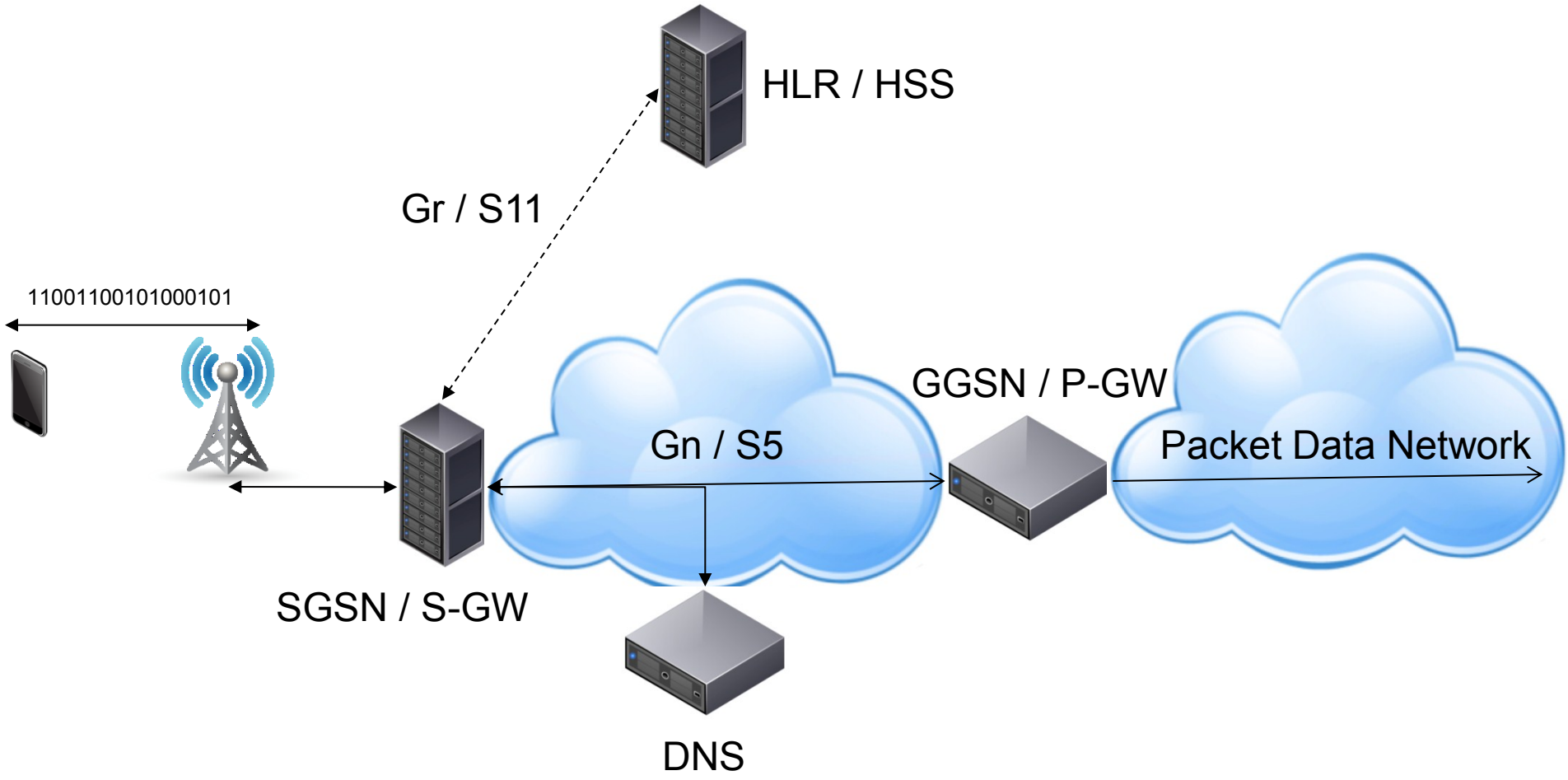


Networks

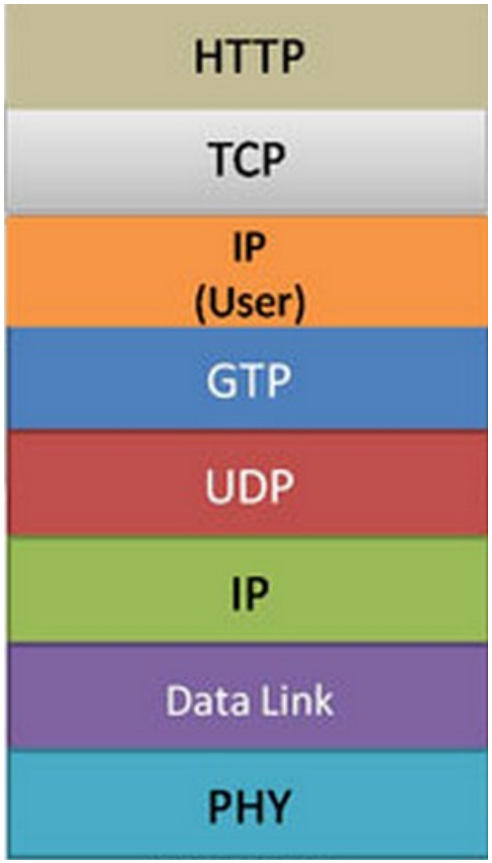


Protocols

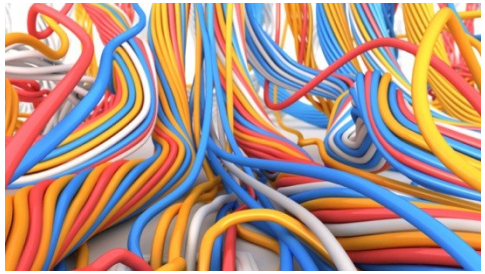
Connecting the Dots



GPRS Tunneling Protocol

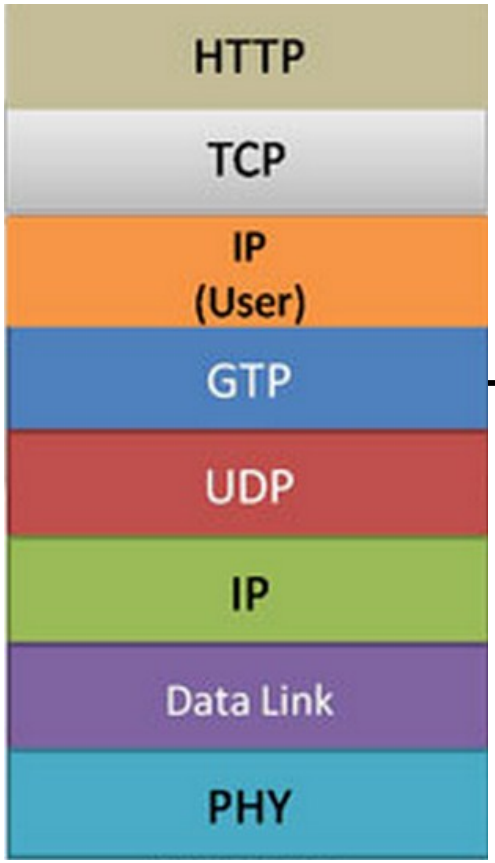


End User Data



Mobile Network Operator

GPRS Tunneling Protocol



GTPv0 GPRS

- UDP 3386

GTPv1 GPRS/UMTS

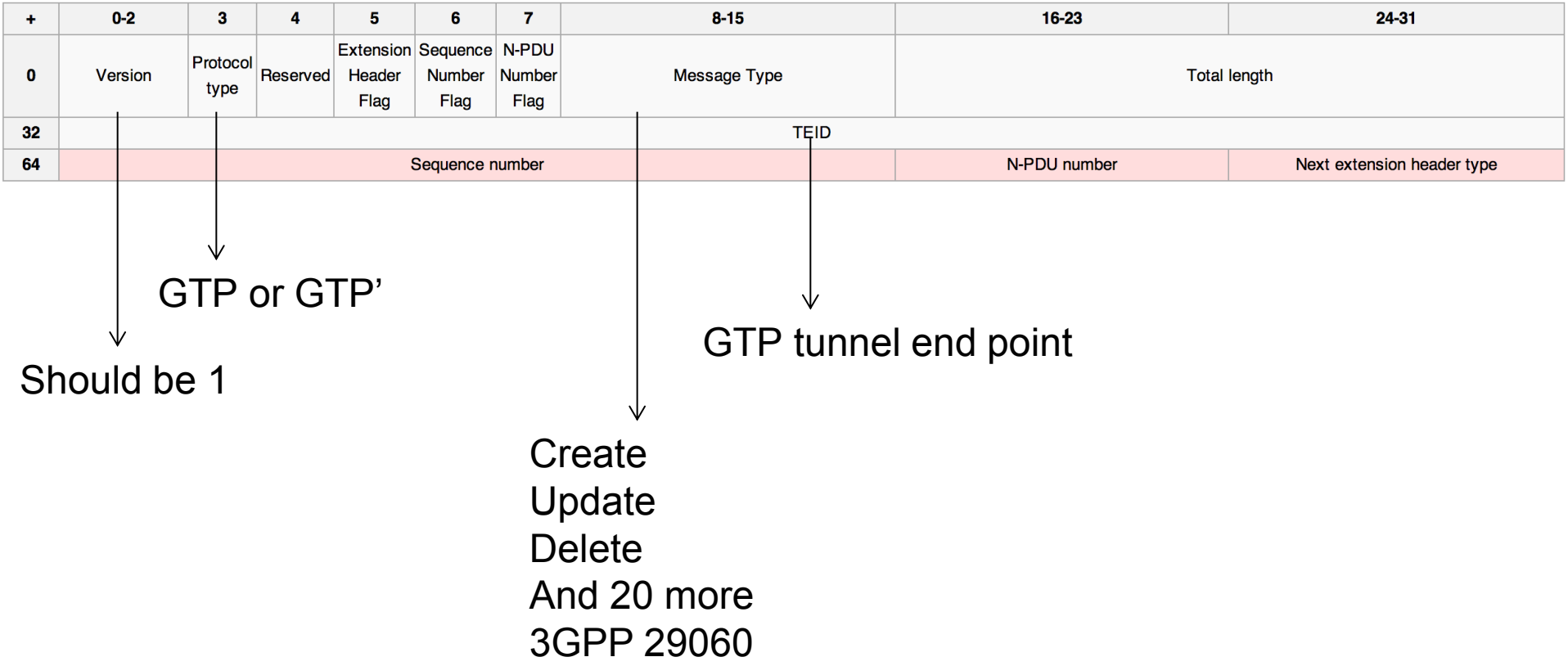
- UDP 2123 / 2152

GTPv2 LTE

- UDP 2123

GPRS Tunneling protocol Header

GTPv1



GPRS Tunneling protocol

Information Elements in a Create PDP Context

Information element	Presence requirement	Reference
IMSI	Conditional	7.7.2
Routeing Area Identity (RAI)	Optional	7.7.3
Recovery	Optional	7.7.11
Selection mode	Conditional	7.7.12
Tunnel Endpoint Identifier Data I	Mandatory	7.7.13
Tunnel Endpoint Identifier Control Plane	Conditional	7.7.14
NSAPI	Mandatory	7.7.17
Linked NSAPI	Conditional	7.7.17
Charging Characteristics	Conditional	7.7.23
Trace Reference	Optional	7.7.24
Trace Type	Optional	7.7.25
End User Address	Conditional	7.7.27
Access Point Name	Conditional	7.7.30
Protocol Configuration Options	Optional	7.7.31
SGSN Address for signalling	Mandatory	GSN Address 7.7.32
SGSN Address for user traffic	Mandatory	GSN Address 7.7.32
MSISDN	Conditional	7.7.33
Quality of Service Profile	Mandatory	7.7.34
TFT	Conditional	7.7.36
Trigger Id	Optional	7.7.41
OMC Identity	Optional	7.7.42
Common Flags	Optional	7.7.48
APN Restriction	Optional	7.7.49
RAT Type	Optional	7.7.50
User Location Information	Optional	7.7.51
MS Time Zone	Optional	7.7.52
IMEI(SV)	Conditional	7.7.53
CAMEL Charging Information Container	Optional	7.7.54
Additional Trace Info	Optional	7.7.62
Correlation-ID	Optional	7.7.82
Evolved Allocation/Retention Priority I	Optional	7.7.91
Extended Common Flags	Optional	7.7.93
User CSG Information	Optional	7.7.94
APN-AMBR	Optional	7.7.98
Signalling Priority Indication	Optional	7.7.103
Private Extension	Optional	7.7.46

- APN
- IMSI
- End User Address
- User Location Information
- IMEI

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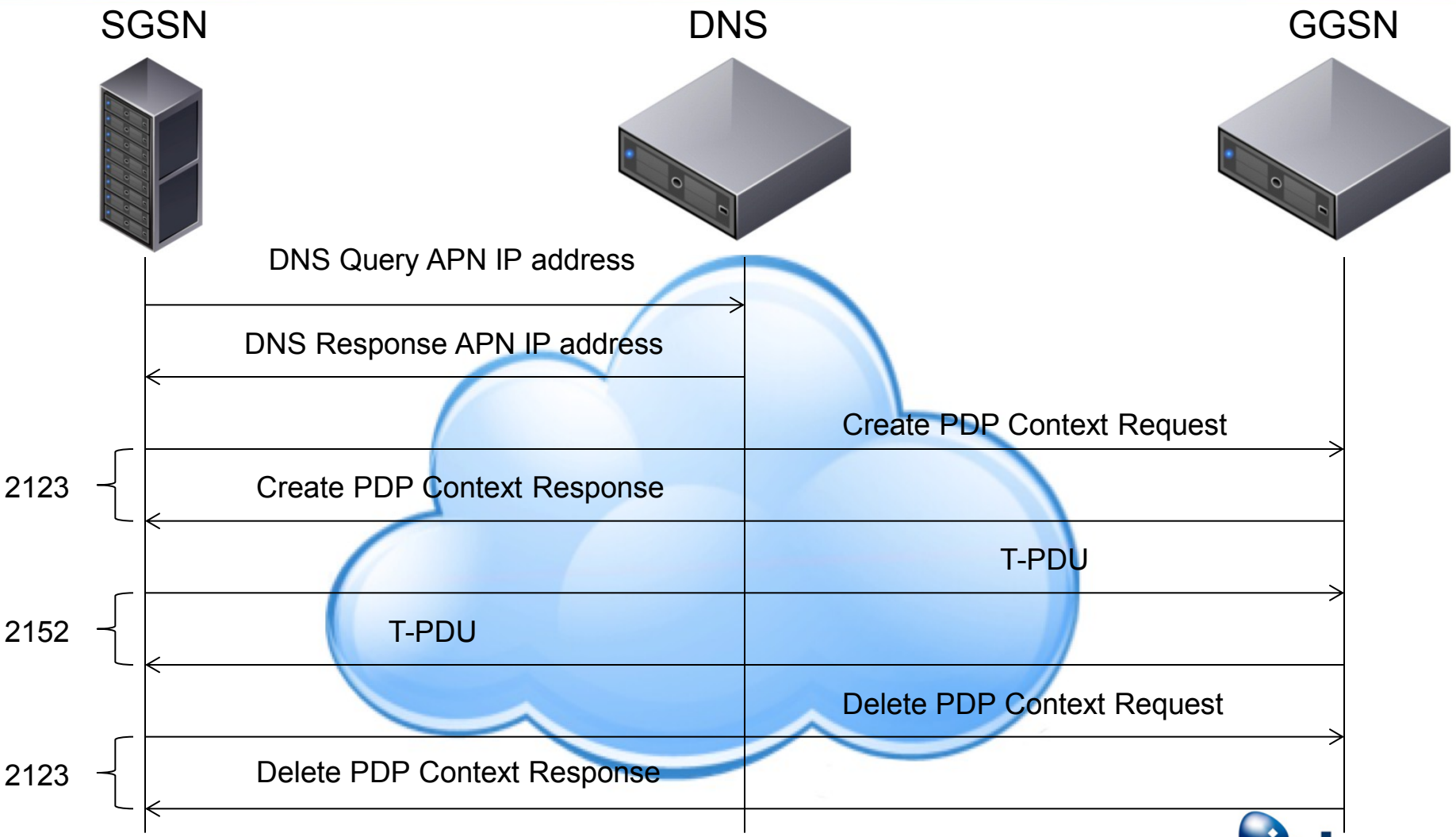
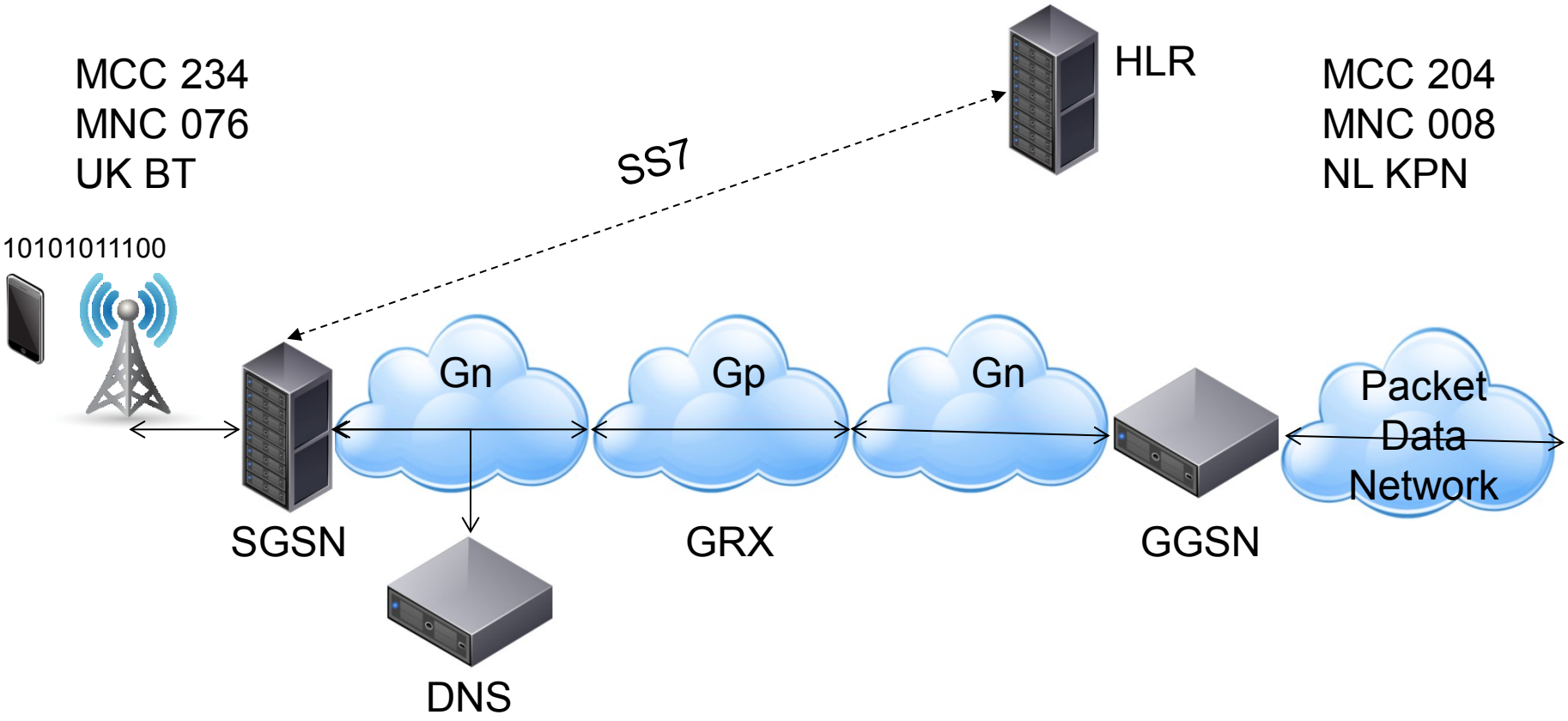
GPRS Tunneling protocol

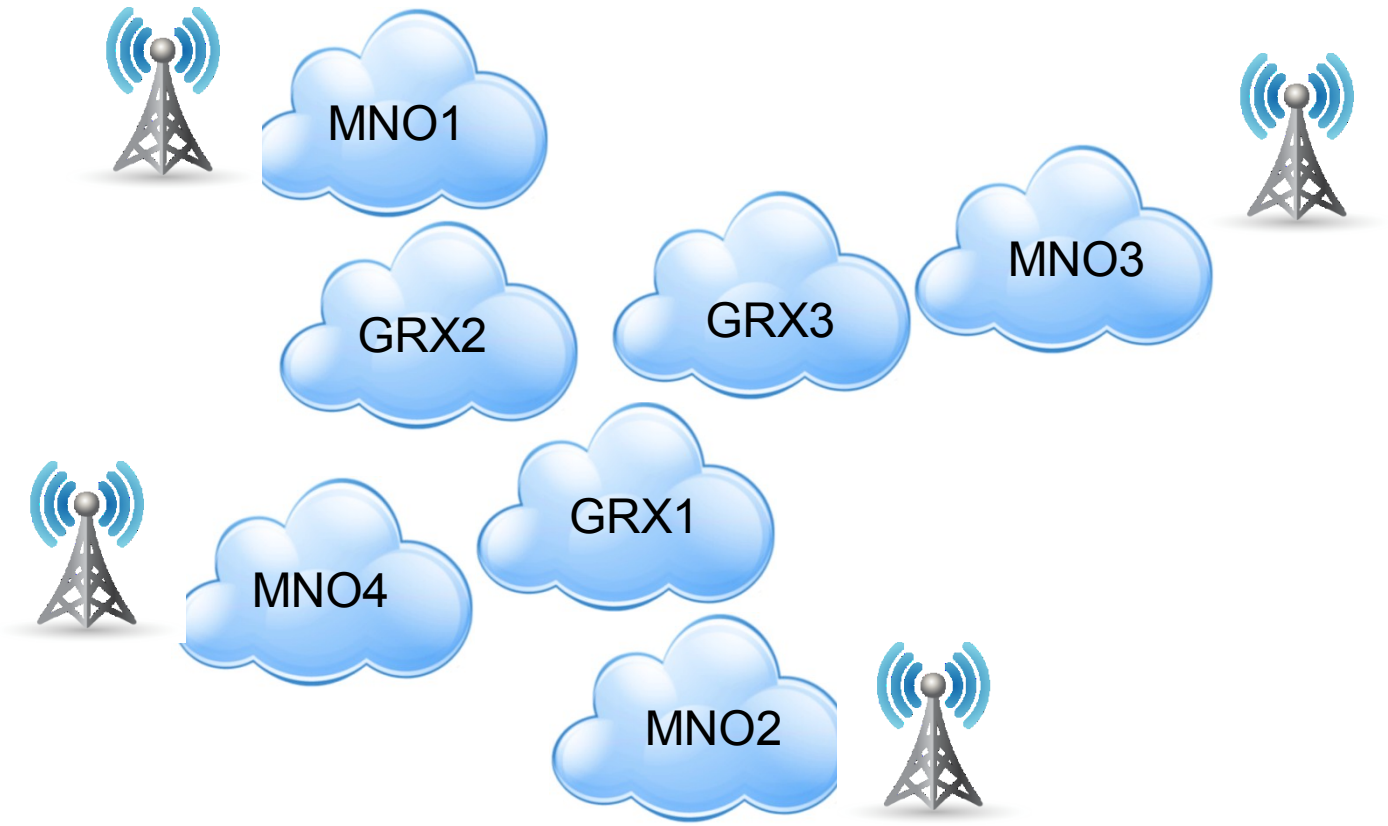


GPRS Roaming eXchange

GPRS Roaming eXchange

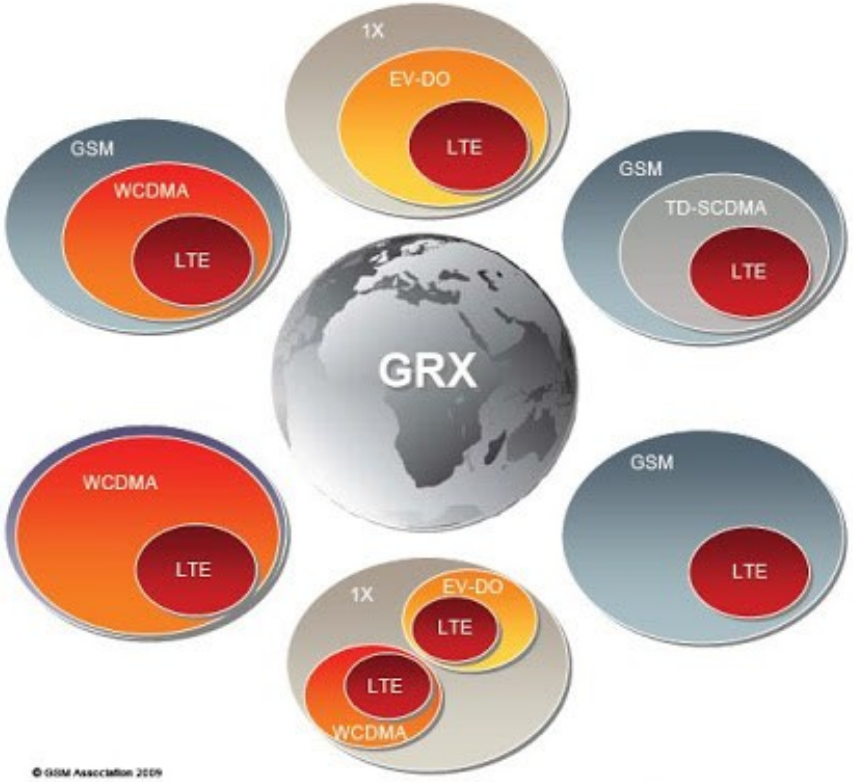


GRX architecture & protocols



GRX architecture & protocols

Linking the “islands” – backwards compatibility & roaming



- GRX will support LTE/EPC Roaming
- Including support for GTPv2, MIP, Diameter
- GSMA Project will deliver Next Gen. roaming capability on time for service launch
- Work carried out by existing GSMA expert working groups

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GRX providers

Name	City/Country
AMS-IX	Amsterdam/Netherlands
Astelnet	Prague, Czech Republic
Telefonica Spain	Madrid, Spain
NTT	Tokyo, Japan
Neustar	Sterling, VA, USA
TELE2	Stockholm, Sweden
Etisalat	Abu Dhabi, UAE
Telenor	Oslo, Norway
Telecom-Austria	Vienna, Austria
Comfone	Bern, Switzerland
Syniverse	Florida, USA
Citic	Beijing, China
Telecom Italia Sparkle	Rome, Italy
Aicent	California, USA
Portugal Telecom	Lisbon, Portugal
T-Systems	Frankfurt, Germany
TDC	Copenhagen, Denmark
Telstra/Reach	Melbourne, Australia
OTE Globe	Athens, Greece
TATA	Mumbai, India
MTT	Moscow, Russia
iBasis/KPN	Burlington, USA
BICS	Brussels, Belgium

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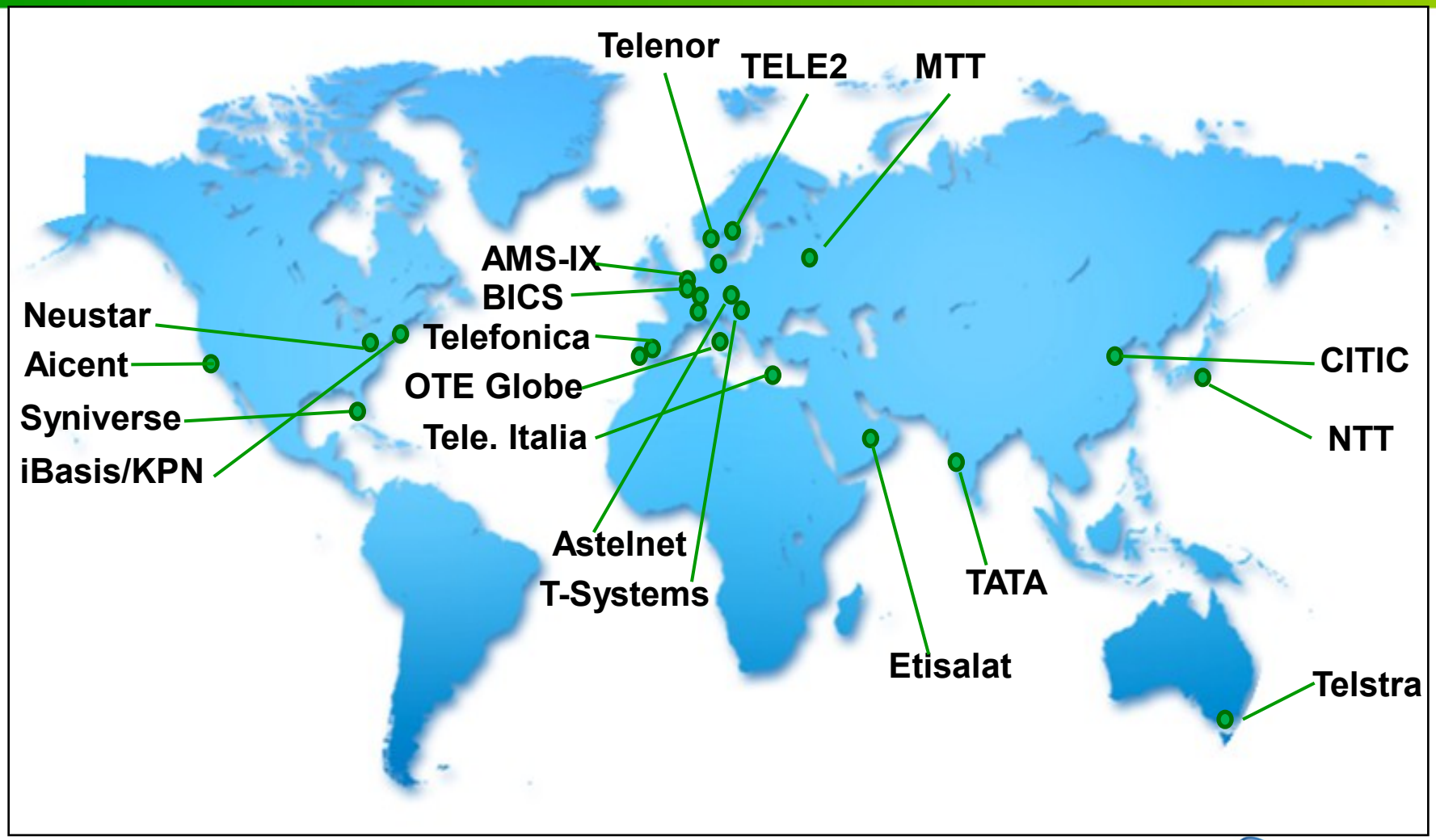
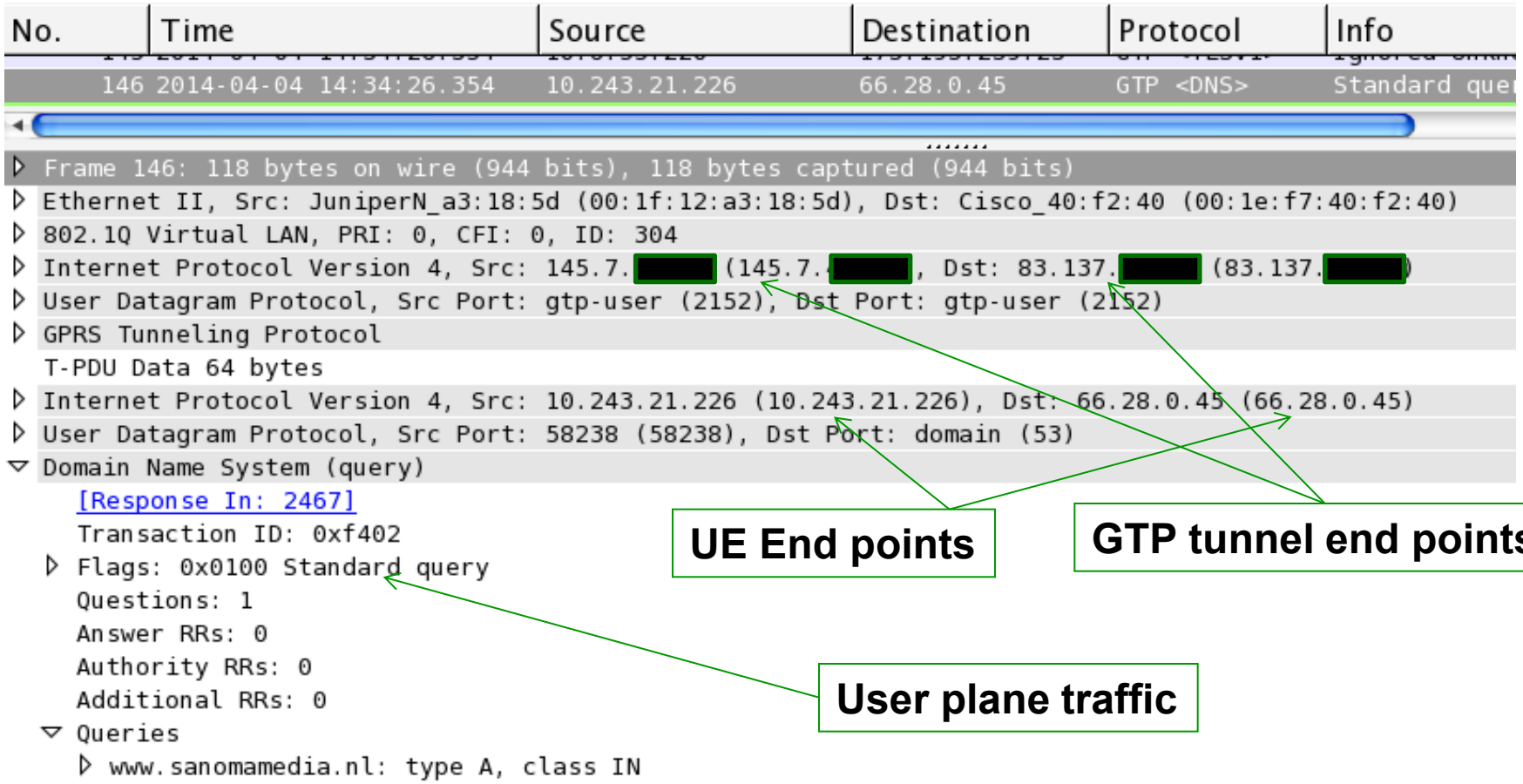
GRX providers - HQ

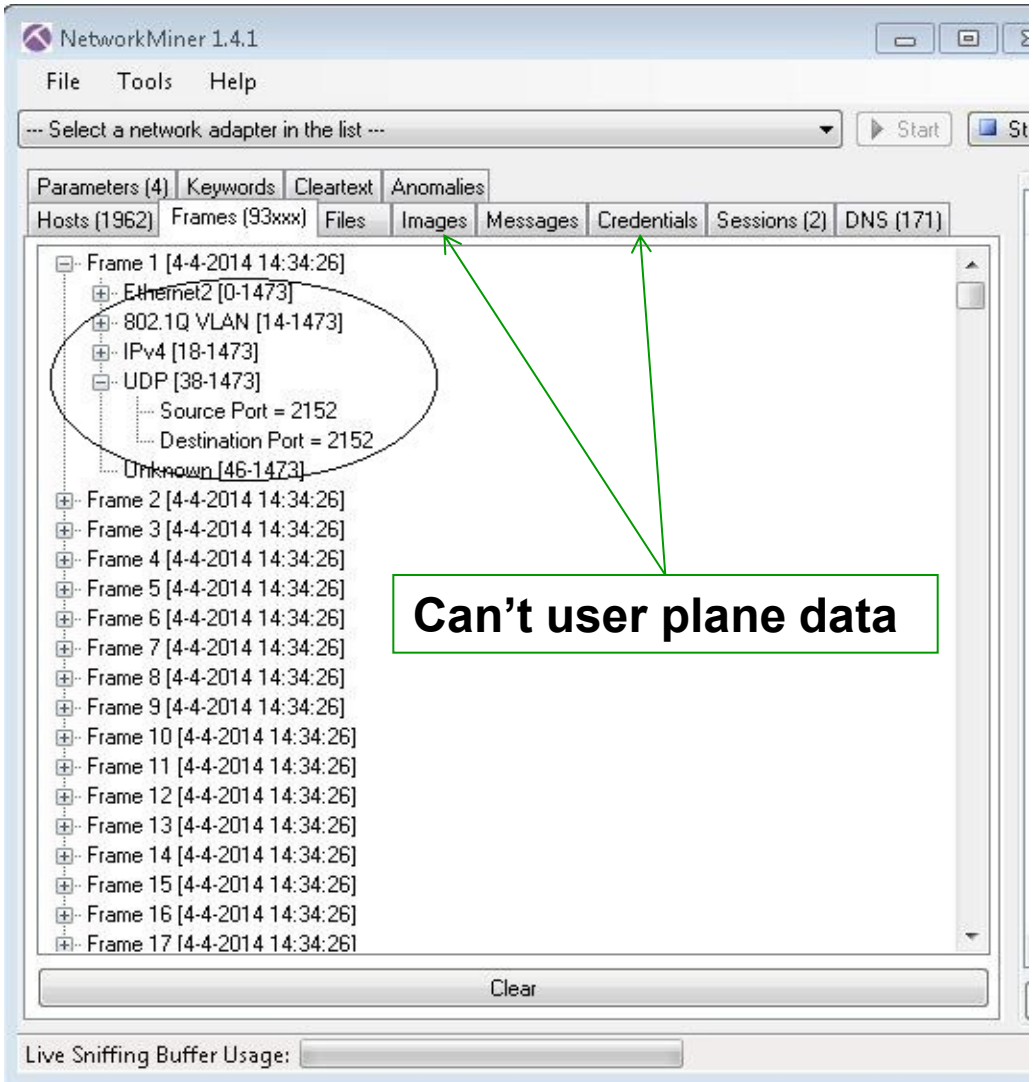


GTP Traffic – why the interest?

- GTP traffic captured from GRX router: looks like this in Wireshark:



GTP Traffic – why the interest?

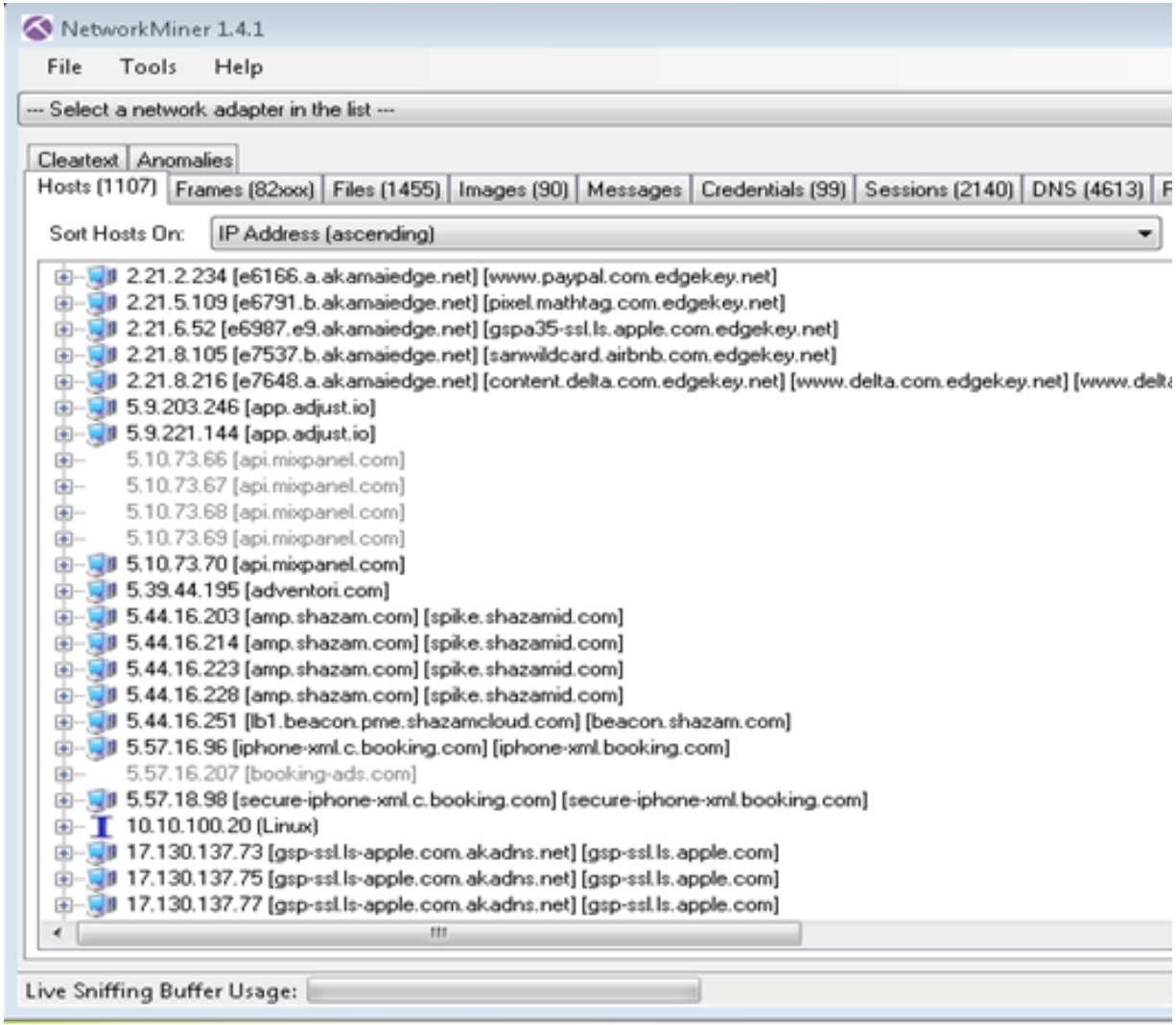


- Network forensics
- NetworkMiner, Explico
- Frames loaded but…

GTP Traffic – why the interest?

- Need to remove GTP headers
- Here's Wesley - CERT team
- Cool shirts (http://en.wikipedia.org/wiki/Brainfuck)
- gtpstrip.c
  - identifies link layer header
  - detects VLAN tag
  - checks for IP header
  - checks for UDP header
  - confirms GTP user plane traffic
  - removes IP, UDP & GTP headers
  - re-write frame

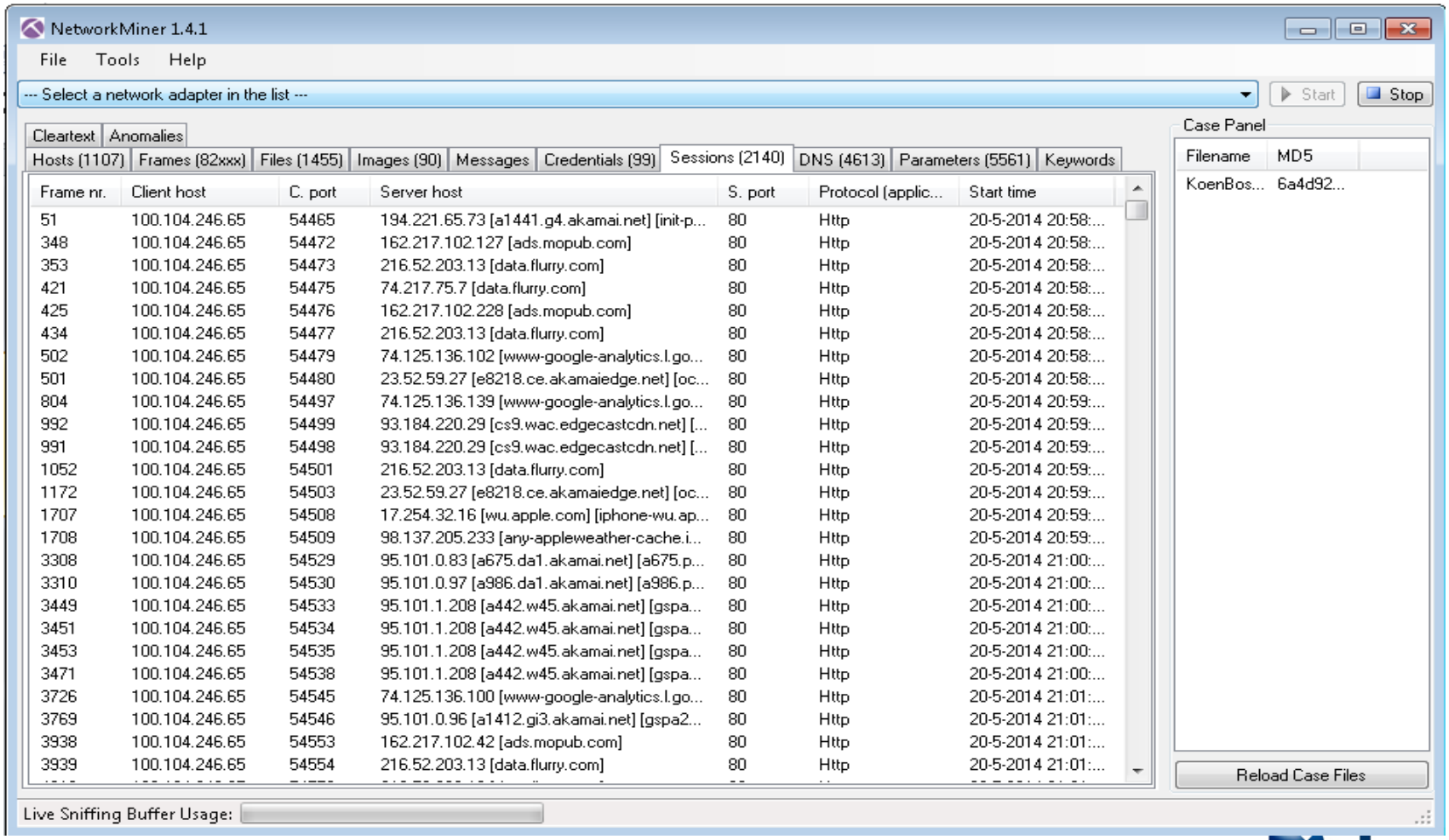
GTP Traffic – why the interest?



- Re-load stripped PCAP file
- Now can see info:
- **Hosts details**

GTP Traffic – why the interest?

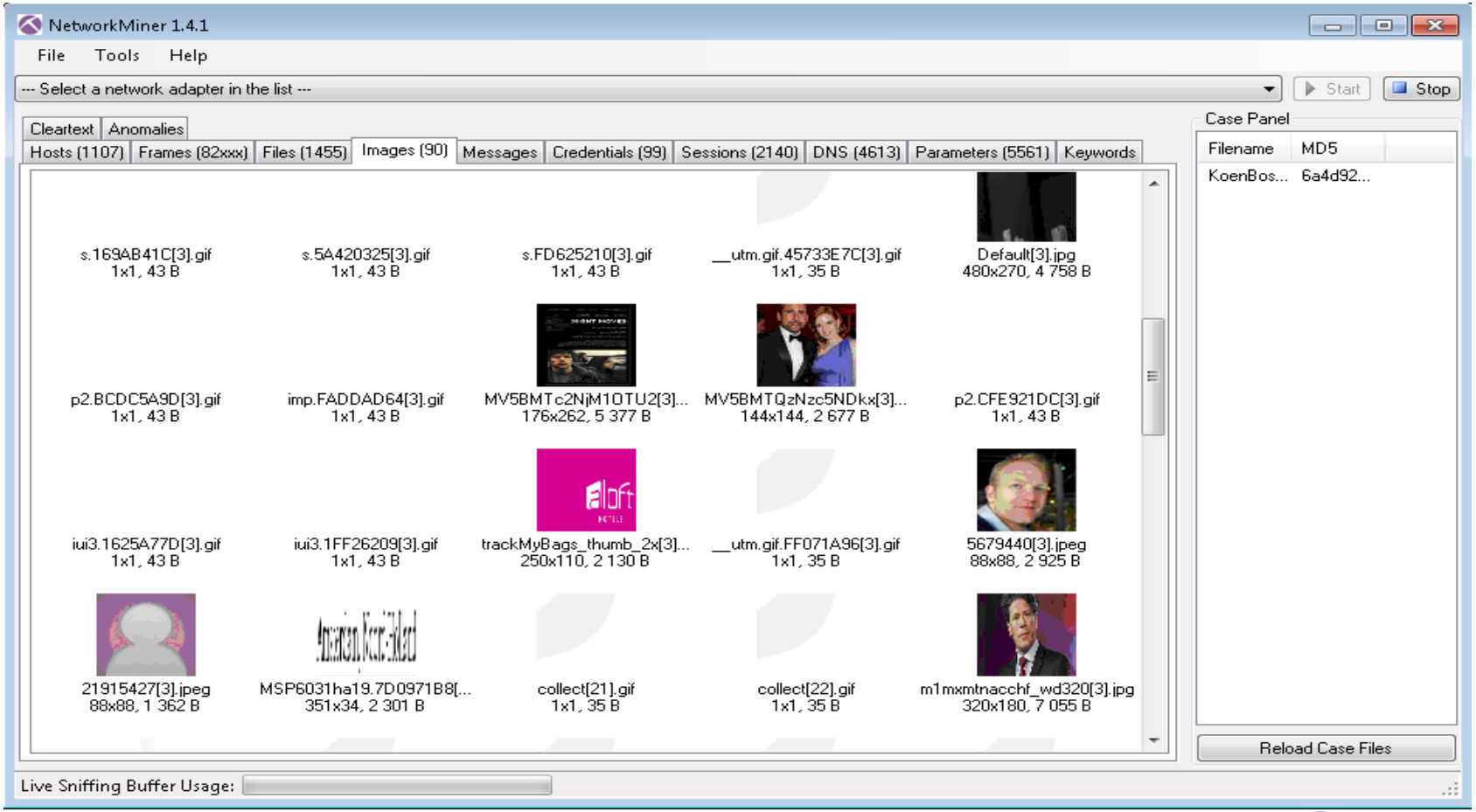
- Now can see info: **Sessions**



Frame nr.	Client host	C. port	Server host	S. port	Protocol (applic...	Start time
51	100.104.246.65	54465	194.221.65.73 [a1441.g4.akamai.net] [init-p...	80	Http	20-5-2014 20:58:...
348	100.104.246.65	54472	162.217.102.127 [ads.mopub.com]	80	Http	20-5-2014 20:58:...
353	100.104.246.65	54473	216.52.203.13 [data.flurry.com]	80	Http	20-5-2014 20:58:...
421	100.104.246.65	54475	74.217.75.7 [data.flurry.com]	80	Http	20-5-2014 20:58:...
425	100.104.246.65	54476	162.217.102.228 [ads.mopub.com]	80	Http	20-5-2014 20:58:...
434	100.104.246.65	54477	216.52.203.13 [data.flurry.com]	80	Http	20-5-2014 20:58:...
502	100.104.246.65	54479	74.125.136.102 [www-google-analytics.l.go...	80	Http	20-5-2014 20:58:...
501	100.104.246.65	54480	23.52.59.27 [e8218.ce.akamaiedge.net] [oc...	80	Http	20-5-2014 20:58:...
804	100.104.246.65	54497	74.125.136.139 [www-google-analytics.l.go...	80	Http	20-5-2014 20:59:...
992	100.104.246.65	54499	93.184.220.29 [cs9.wac.edgecastcdn.net] [...	80	Http	20-5-2014 20:59:...
991	100.104.246.65	54498	93.184.220.29 [cs9.wac.edgecastcdn.net] [...	80	Http	20-5-2014 20:59:...
1052	100.104.246.65	54501	216.52.203.13 [data.flurry.com]	80	Http	20-5-2014 20:59:...
1172	100.104.246.65	54503	23.52.59.27 [e8218.ce.akamaiedge.net] [oc...	80	Http	20-5-2014 20:59:...
1707	100.104.246.65	54508	17.254.32.16 [wu.apple.com] [iphone-wu.ap...	80	Http	20-5-2014 20:59:...
1708	100.104.246.65	54509	98.137.205.233 [any-appleweather-cache.i...	80	Http	20-5-2014 20:59:...
3308	100.104.246.65	54529	95.101.0.83 [a675.da1.akamai.net] [a675.p...	80	Http	20-5-2014 21:00:...
3310	100.104.246.65	54530	95.101.0.97 [a986.da1.akamai.net] [a986.p...	80	Http	20-5-2014 21:00:...
3449	100.104.246.65	54533	95.101.1.208 [a442.w45.akamai.net] [gspa...	80	Http	20-5-2014 21:00:...
3451	100.104.246.65	54534	95.101.1.208 [a442.w45.akamai.net] [gspa...	80	Http	20-5-2014 21:00:...
3453	100.104.246.65	54535	95.101.1.208 [a442.w45.akamai.net] [gspa...	80	Http	20-5-2014 21:00:...
3471	100.104.246.65	54538	95.101.1.208 [a442.w45.akamai.net] [gspa...	80	Http	20-5-2014 21:00:...
3726	100.104.246.65	54545	74.125.136.100 [www-google-analytics.l.go...	80	Http	20-5-2014 21:01:...
3769	100.104.246.65	54546	95.101.0.96 [a1412.gi3.akamai.net] [gspa2...	80	Http	20-5-2014 21:01:...
3938	100.104.246.65	54553	162.217.102.42 [ads.mopub.com]	80	Http	20-5-2014 21:01:...
3939	100.104.246.65	54554	216.52.203.13 [data.flurry.com]	80	Http	20-5-2014 21:01:...

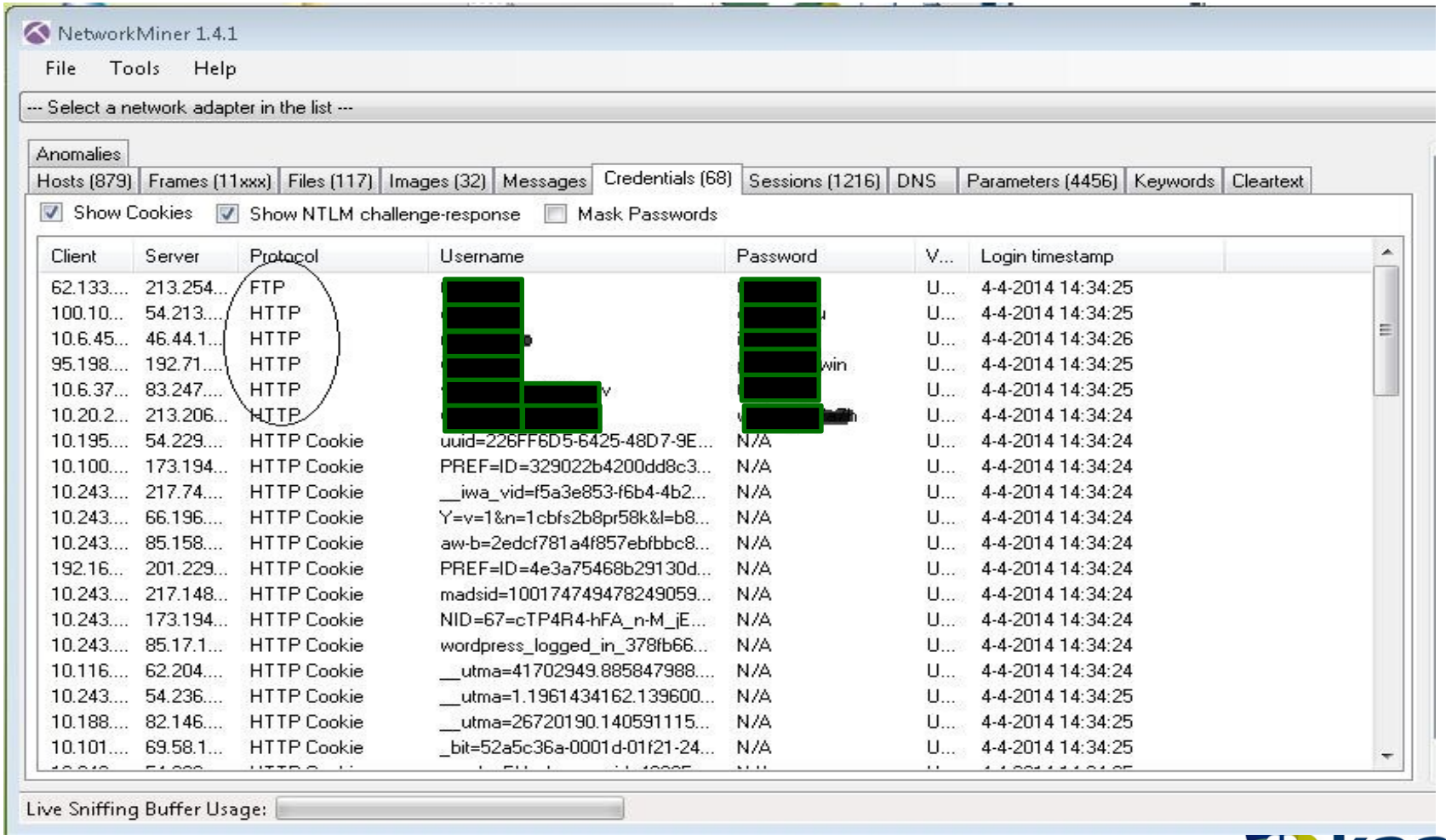
GTP Traffic – why the interest?

- Now can see info: **Images**



GTP Traffic – why the interest?

- Now can see info: **Credentials**



GTP Traffic – why the interest?

```
GPRS Tunneling Protocol
  Flags: 0x32
    Message Type: Create PDP context request (0x10)
    Length: 160
    TEID: 0x00000000
    Sequence number: 0x2519
    N-PDU Number: 0x00
    IMSI: 204091004[redacted]
    .... ..00 = Selection mode: MS or network provided APN, subscribed verified (0)
    TEID Data I: 0x384d6bfe
    TEID Control Plane: 0x9cf72016
  NSAPI: 5
  End user address (IETF/IPv4)
  Access Point Name: data.lycamobile.nl
  Protocol configuration options
  GSN address : 145.7.[redacted]
  GSN address : 145.7.[redacted]
  MS international PSTN/ISDN number
  Quality of Service
  Common Flags :
  RAT Type: GERAN
  User Location Information
      Length: 8
      Geographic Location Type: 0
      Mobile Country Code (MCC): Netherlands (Kingdom of the) (204)
      Mobile Network Code (MNC): KPN Mobile The Netherlands B.V. (08)
      Cell LAC: 0x0c62 (3170)
      Cell CI: 0xc09c (49308)
  MS Time Zone: GMT + 1 hours 0 minutes
  IMEI(SV): 0114720062758705
    [Response In: 41370]
```

IMSI

MCC
MNC
LAC
CI

IMEI

- What else?
- Location details
- Device detail

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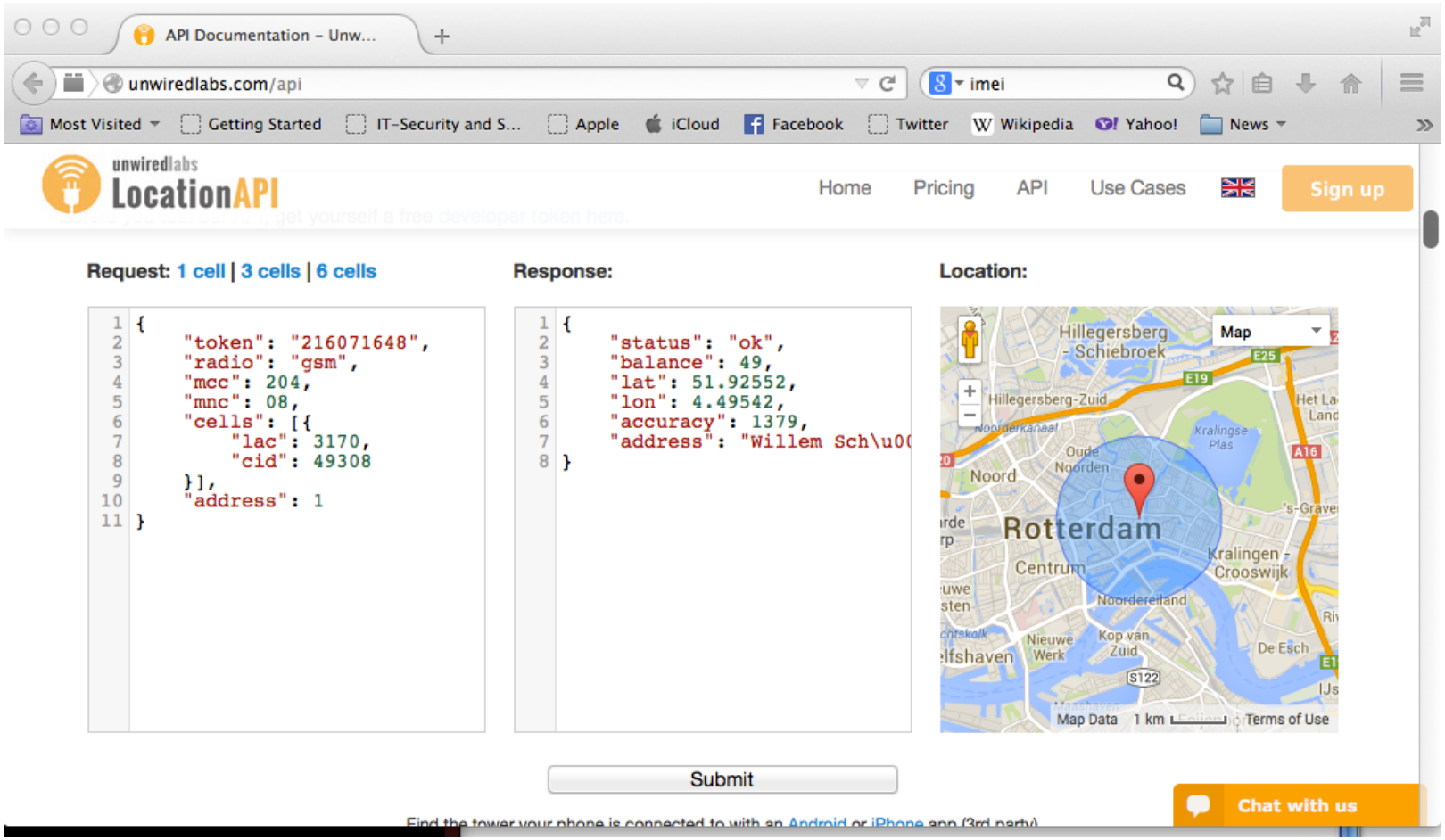
GTP Traffic – why the interest?
MCC, MNC, LAC, CI = your location

- http://unwiredlabs.com/api



GTP Traffic – why the interest?
MCC, MNC, LAC, CI = your location

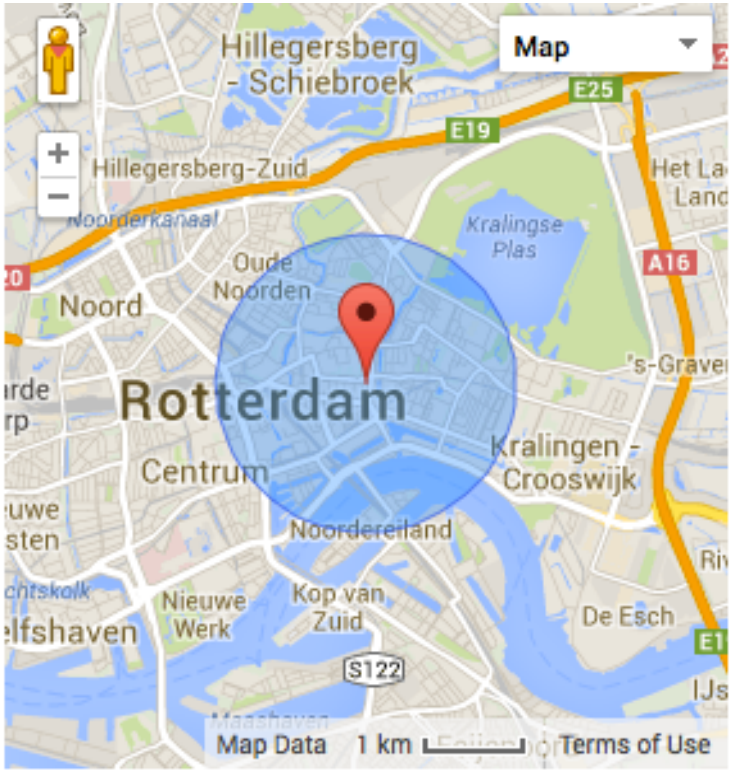
Request

```
{
    "token": "216071648",
    "radio": "gsm",
    "mcc": 204,
    "mnc": 08,
    "cells": [{
        "lac": 3170,
        "cid": 49308
              }],
    "address": 1
}
```

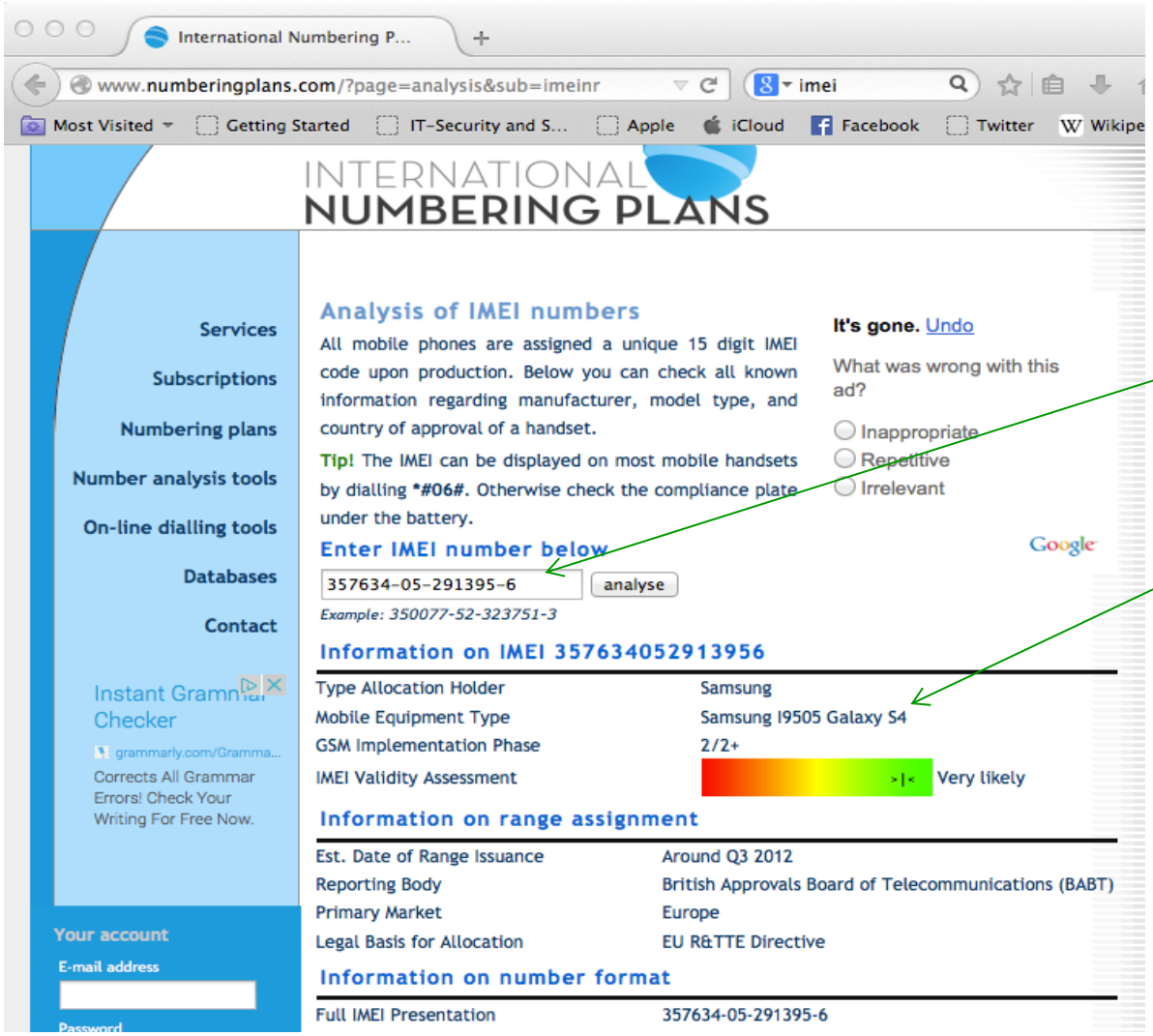
Response

```
{
    "status": "ok",
    "balance": 49,
    "lat": 51.92552,
    "lon": 4.49542,
    "accuracy": 1379,
    "address": "Willem Schurmannstraat, Rotterdam, Stadsregio Rotterdam, South Holland, Kingdom of the Netherlands, 3061CT, The Netherlands, European Union"
}
```

GPS coordinates



GTP Traffic – why the interest?
IMEI – International Mobile Equipment Identity



- http://www.numberingplans.com/

IMEI

Samsung I9505 Galaxy S4

Handset specific payload?

GRX landscape – overview

- Now we know the **what**, **who**, **why**
- Now need to find and work out **How** to get unauthorised access?

- Kill Chain (Reconnaissance → Weaponization)
  - Identify hosts, enumerate service ONLY

- GRX BGP routing table (MNOs)
  - Total number of subnets: 4.8K
  - Total IP address space: 320K

- Host discovery - limited port scan & GTP ping

```
./masscan <target> p21,22,23,25,80,139,443,445,3868,1433 -oB out-$b.bin –ping
```

- Approximate live hosts: 42K

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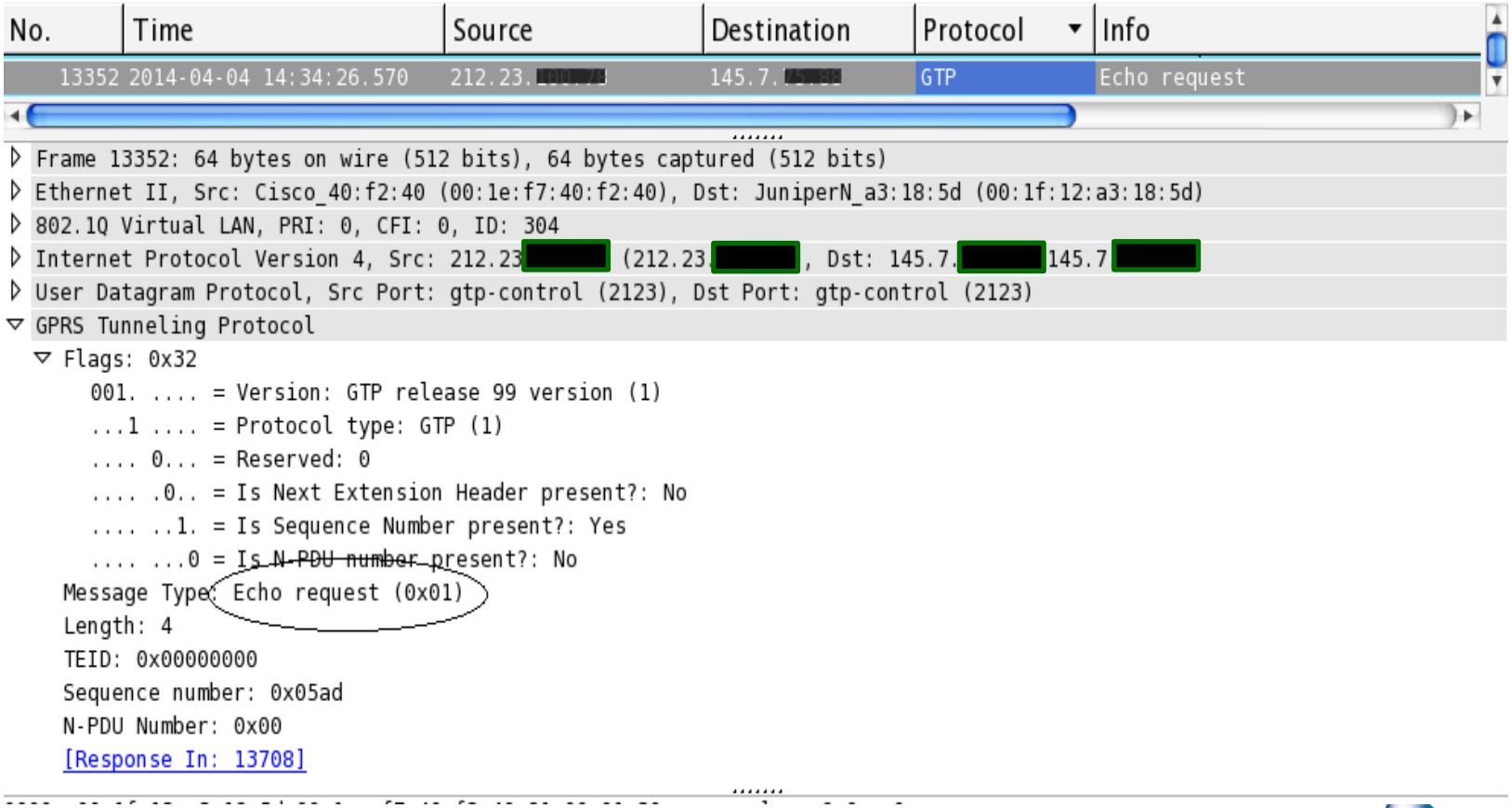
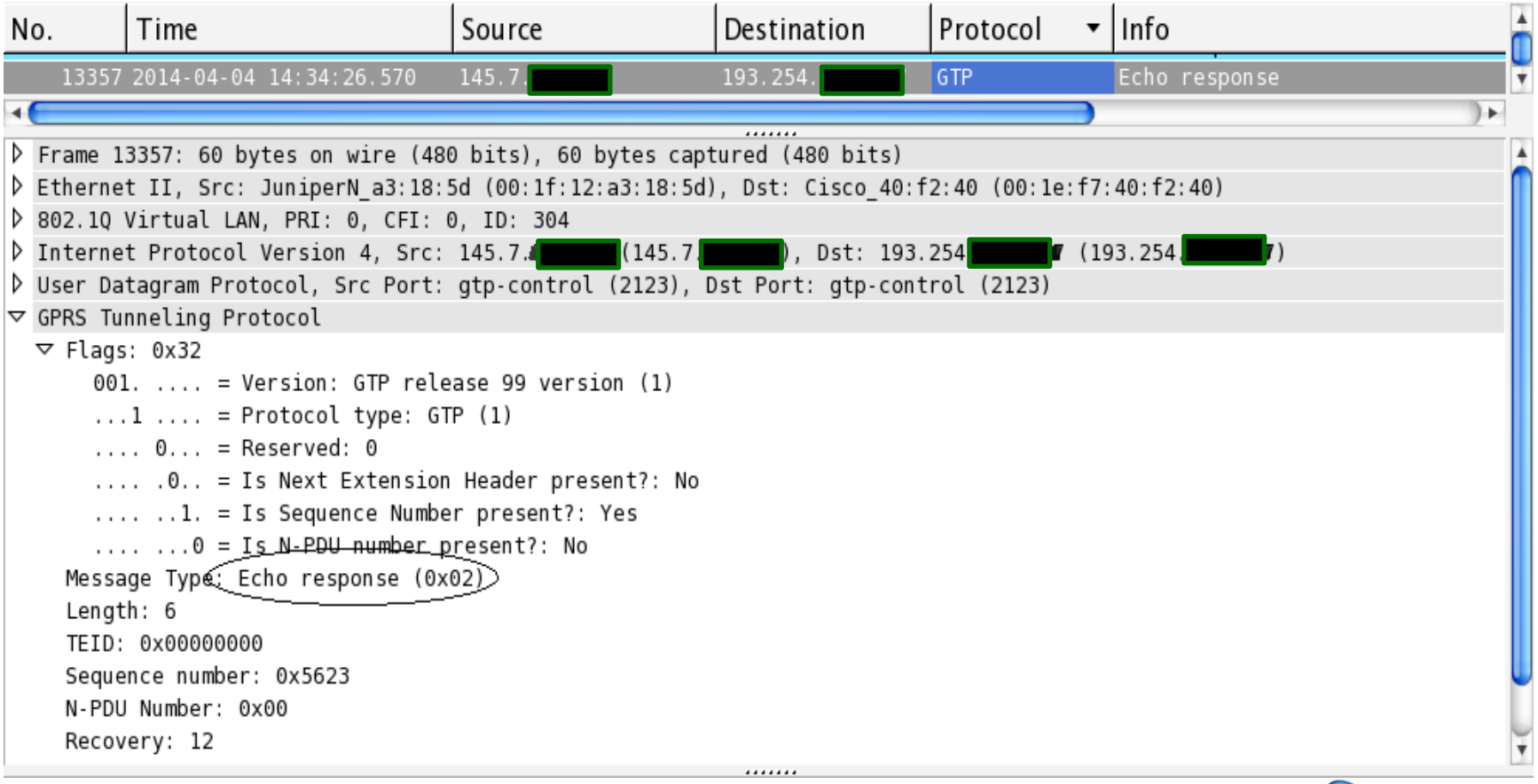
GRX landscape – Looking for GGSNs

- Search for GTP ports: UDP 2152 & UDP 2123
- GTP echo request looks like this:



GRX landscape – Looking for GGSNs

- GTP echo response looks like this:



GRX landscape – Looking for GGSNs

- Scan for GTP ports
  - zmap (https://zmap.io/)
  - Async & fast – ICMP, TCP, UDP
  - Can scale up to 1.4 million packets/sec, good idea to rate limit
- zmap -M udp -p 2123 <IP> --probe-args=file:GTP-2123-echo.pkt -o GTP-2123-<IP>.csv -B 1G
- Now you've found a GTP port, then what?
  - Send PDP context request to confirm active GGSN
- OpenGGSN project (http://sourceforge.net/projects/ggsn/)

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GRX landscape – Talking to GGSNs

- SGSNEMU (part of OpenGGSN)
  - connections to the GGSN
  - ping request, create PDP context
  - forward packets to connections on Gn/Gp interface.

```
# sgsnemu --listen 192.168.253.249 --remote xx.xx.xx.xx --timelimit 10 --contexts 1 1 --apn internet --imsi
240011234567890 --msisdn 46702123456 –create

<snip>
Initialising GTP library
openggsn[21672]: GTP: gtp_newgsn() started
Setting up interface
Done initialising GTP library

Sending off echo request
Setting up PDP context #0
Waiting for response from ggsn.....
Received echo response
Received create PDP context response.
```

GTP daemon ready to talk!

GRX landscape threat profile – DNS servers

- DNS on GRX used for resolving APNs to set up GTP tunnel
- Typical query for KPN looks like this:
  - dig **internet.mnc008.mcc204.gprs** @ <DNS IP>

globally agreed APN

DNS response:

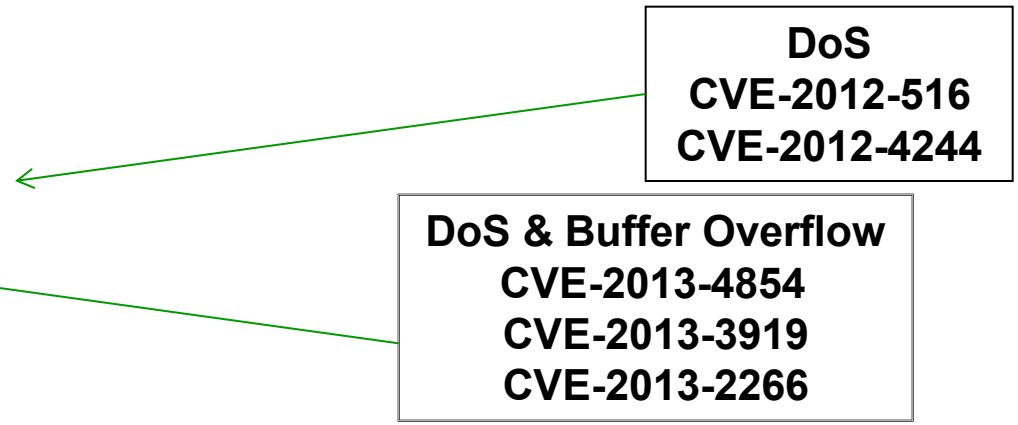
```
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 26251
;; flags: qr rd ra; QUERY: 1, ANSWER: 4, AUTHORITY: 4, ADDITIONAL: 8

;; QUESTION SECTION:
;internet.mnc008.mcc204.gprs.    IN      A

;; ANSWER SECTION:
internet.mnc008.mcc204.gprs. 300 IN     A       145.7.xx.xx
internet.mnc008.mcc204.gprs. 300 IN     A       145.7.xx.xx
internet.mnc008.mcc204.gprs. 300 IN     A       145.7.xx.xx
internet.mnc008.mcc204.gprs. 300 IN     A       145.7.xx.xx
```

GRX landscape threat profile– DNS servers

- Enumerate versions of DNS
- Command to get Bind version:
  - *dig chaos* txt *version.bind* @<DNS IP>
  - BIND versions 9.2.3 to 9.8.1-P1
  - Microsoft DNS 6.0.6002
  - Outdated versions with publicly known vulnerabilities



- Bind version 9.2.3
- Bind 9.8.1-P1
- **Aside from GTP & DNS – what else?**

GRX landscape threat profile – SMTP

- Cisco PIX sanitized smtpd
- Exim smtpd 4.63
- Microsoft ESMTP 5.0.2195.6713
- Postfix smtpd
- Sendmail 1.0, 2.5.3
- Sendmail 8.11.1, 8.11.6+Sun, 8.11.7p1+Sun/8.11.7
- Sendmail 8.12.9+Sun/8.12.9, 8.13.3 rev 1.001
- Sendmail 8.13.7+Sun, 8.13.8+Sun/8.13.8, 8.14.1/8.14.1, 8.14.5+Sun/8.13.4
- Sendmail 8.9.3
- netqmail smtpd 1.04
- qmail smtpd

Remote Root Exploit
CVE-2010-4344

Remote Code Execution
CVE-2006-0058

Remote Code Exec
CVE-2003-0694

Buffer Overflow
CVE-2002-1337

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GRX landscape threat profile – FTP servers

- BSD ftpd 6.00
- Cisco ftpd 5.3.1
- HP-UX ftpd 1.1.214.8
- Microsoft ftpd 5.0
- OpenBSD ftpd 6.4 (Linux port 6.4)
- Sun Solaris 8 ftpd
- TopLayer/Alcatel ftpd
- VxWorks ftpd 5.4
- WU-FTPD 2.6.1 (revision 4.0), wu-2.6.1-16
- vsftpd 2.0.4, 2.0.5, 2.0.7, 2.2.2

Buffer Overflow CVE 2001-0053

Buffer Overflow CVE-2003-0466

BoF/DoS CVE-2002-2300

DoS CVE-2011-0762

- 3Com 3CDaemon ftpd
- Axis 211M Network
- BulletProof FTPd
- FileZilla ftpd 0.9.33, 0.9.40
- ProFTPD 1.3.0, 1.3.1
- Pure-FTPd
- Serv-U ftpd 6.0

Remote Code Exec CVE-2006-5815

Banner based only!

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GRX landscape threat profile – Web servers

- Apache Tomcat/Coyote JSP engine 1.0, 1.1
- Apache httpd 2.0.59, 2.2.14 (Ubuntu)
- Apache httpd 2.2.14 (Win32)
- Apache httpd 2.2.15 (Red Hat)
- Apache httpd 2.2.21 (Unix)
- Apache httpd 2.2.22 (FreeBSD)
- Apache httpd 2.2.26 (Unix)
- Apache httpd 2.2.3 (CentOS)
- Apache httpd 2.2.9 (Debian)
- Cisco ASA firewall http,Cisco IOS administrative httpd
- Microsoft IIS webserver 5.0, 6.0, 7.5
- MiniServ (Webmin httpd)
- Netscreen administrative web server (Virata-EmWeb/R6_0_1)
- Oracle HTTP Server Powered by Apache 1.3.22
- lighttpd 1.4.13

Remote Code Exec CVE-2010-0425

Remote Code Exec CVE-2013-1862

Remote Code Exec CVE-2008-1446

DoS/Code Exec CVE-2002-0392

Why are these servers even here??

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GRX landscape threat profile – Telnet daemons

- Alcatel 7750 SR router telnetd
- BSD-derived telnetd
- Cisco IOS telnetd
- Cisco PIX 500 series telnetd
- Cisco or Edge-core switch telnetd
- Cisco router
- HP-UX telnetd
- Huawei Quidway Eudemon firewall telnetd
- Linux telnetd
- Microsoft Windows 2000 telnetd
- Microsoft Windows XP telnetd
- Netscreen ScreenOS telnetd
- Nortel Extranet Contivity Secure IP Services telnetd
- Openwall GNU/*/Linux telnetd
- Sun Solaris telnetd

DoS
CVE-2001-0348

Remote Code Exec
MS01-031

Login Bypass
CVE-2007-0882

Seriously?!

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GRX landscape threat profile – SMB (Server Message Block)

- Mainly used for providing shared access to files
  - directly over TCP/445
  - via the NetBIOS API (TCP/139)

- SMB null sessions = blank username & password
  - ./smbclient –N –L //<IP>

Remote Code Exec
CVE-2012-1182

Remote Code Exec
CVE-2008-4835
CVE-2012-1182

Some OS seen:

- Domain=[WORKGROUP] OS=[Unix] Server=[**Samba 3.6.3**]
- Domain=[XX] OS=[Windows 5.0] Server=[**Windows 2000** LAN Manager]
- Domain=[WORKGROUP] OS=[**Windows Server 2008** R2 Standard 7601 Service Pack 1] Server=[Windows Server 2008 R2 Standard 6.1]
- Domain=[WORKGROUP] OS=[**Windows Server 2003** 3790 Service Pack 2] Server=[Windows Server 2003 5.2]

Looks like people are mixing GRX and office network!

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GRX landscape threat profile – SMB

- Information disclosure via null session

#winfo XX.XX.XX.XX -n
winfo 1.6 - copyright (c) 1999-2002, Arne Vidstrom
  - http://www.ntsecurity.nu/toolbox/winfo/

Trying to establish null session...
Null session established.

USER ACCOUNTS:

** udadmin*
(This account is the built-in guest account)
** udadmin*
** root*
** ftpuser1*

PASSWORD POLICY:

min pw length: 5
min pw age: 0 (in days)
max pw age: forever.
pw hist len: 0

No account lockout.

SHARES:

** IPC$*
** DataDisk2*
** DataDisk1*

GRX landscape – SNMP (UDP/161)

- Default community strings: PUBLIC & **PRIVATE**
  - Possibly execute arbitrary commands
  - Shutdown machines
  - Stop & start tasks, change settings
  - Gain valuable information

Cisco IOS C2600
Cisco IOS C2900
Cisco IOS C3560
Cisco IOS C3900

Cisco IOS 1841
Cisco IOS 2800
Cisco IOS 3800
Cisco IOS 7200

Cisco IOS C7600
Cisco IOS-XE
Cisco CSP VPN Gate 3.1
DrayTek Corp
Ericsson IPOS-12.1

sysDescr.0 = STRING: AGENT++v3.5.27 ATM Simulation Agent
- sysDes…are, 1841 Software (C1841-IPBASE-M), Vers…
- sysDes…are, 2800 Software (C2800NM-ADVIPSERVI…
- sysDes…are, 3800 Software (C3825-IPBASE-M), Vers…
- sysDes…are, 7200 Software (C7200-ADVENTERPRISEK9-M), Version 12.4(4)T1
- sysDes…are, C1900 Software (C1900-UNIVERSALK9-M), Version 15.1(4)M4
- sysDes…are, C2600 Software (C2600-IPVOICE_IVS-M), Version 12.4(9)T
- sysDes…are, C2900 Software (C2900-UNIVERSALK9_NPE-M), Version 15.1(4)M3
- sysDescr.0 = STRING: Cisco IOS Software, C3560E Software (C3560E-UNIVERSALK9-M), Version 12.2(50)SE2
- sysDescr.0 = STRING: Cisco IOS Software, C3900e Software (C3900e-UNIV…
- sysDescr.0 = STRING: Cisco IOS Software, c7600rsp72043_rp Software (c7…n 15.1(3)S5
- sysDescr.0 = STRING: Cisco IOS Software, C880 Software (C880DATA-UNI…
- sysDescr.0 = STRING: Cisco IOS Software, IOS-XE Software (PPC_LINUX_…
- sysDescr.0 = STRING: Cisco IOS Software, MWAM Software (MWAM-G8IS-…
- sysDescr.0 = STRING: CSP CSP VPN Gate 3.1.10330
- sysDescr.0 = STRING: DrayTek Corporation
- sysDescr.0 = STRING: DT 815
- sysDescr.0 = STRING: Ericsson IPOS-12.1.109.8p1-Release

GRX landscape – SNMP

- **SNMP UDP/161**
- **Default community strings: PUBLIC & PRIVATE**

Windows 2000
Windows 2003
Hexabyte ADSL
Huawei VRP router
Linux ADSL2PlusRouter

Huawei Quidway E300 FW/VRP Router
Redback Networks SmartEdge OS
SUN NETRA X4250
SunOS 5.10
Sun Netra-240

TANDBERG Codec
RedHat eCOs
ZTE ZXR10 ROS V4.8.11.01
ZTE ZXR10 GGSN V4.10.10
ZyXEL MAX-207HW2

- sysDescr.0 = STRING: Linux iTOP-01 2.6.32.59-0.7-defaul
- sysDescr.0 = STRING: Product: MG 2K;SW Version: 5.60.0
- sysDescr.0 = STRING: Quidway E300 Firewall, Huawei Ver
- sysDescr.0 = STRING: Redback Networks SmartEdge OS Version SEOS-11.1.2.9-Release
- sysDescr.0 = STRING: RouterOS CCR1036-12G-4S
- sysDescr.0 = STRING: SUN NETRA X4250, ILOM v3.0.3.30, r47608
- sysDescr.0 = STRING: SunOS dpireport 5.10 Generic_127128-11 i86pc
- sysDescr.0 = STRING: Sun SNMP Age
- sysDescr.0 = STRING: TANDBERG C
- sysDescr.0 = STRING: ucd-snmp-4.1.2
- sysDescr.0 = STRING: ZXR10 ROS Ve … n ZXR10 G-Series&8900&6900 V2.8.01.C.27.P06 Copyright (c) 2001-2 … 17:15:50
- sysDescr.0 = STRING: ZXR10 xGW-1 … GSN)V4.10.10(1.0.0)
- sysDescr.0 = STRING: ZyXEL MAX-20

GRX landscape – the numbers

- **Summary of open ports on GRX hosts found during this "light" survey**

Service	Open port	Number
DNS	UDP/53	413
	UDP/2152	1042
Diameter	TCP/3868	177
SMB	TCP/139	208
	TCP/445	115
SNMP	UDP/161	219

These were found from the Internet!

Out of the 42K GRX live hosts
5.5K hosts from 15 operators were reachable from the Internet!

May not need to be in GRX to access GRX

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On Her Majesty's Secret Service - GRX & A spy agency - Conclusion

- GRX traffic is interesting (and definitely for spy agencies!)
- GRX is not a closed off network as was agreed
- 15 operators distribute BGP route prefixes to both GRX & Internet
- 5.5K GRX hosts reachable from the Internet
- Misconfigurations, vulnerable & unnecessary services running
- Security best practices such as ingress filtering not commonly adopted
- Mobile operators need more security awareness & testing

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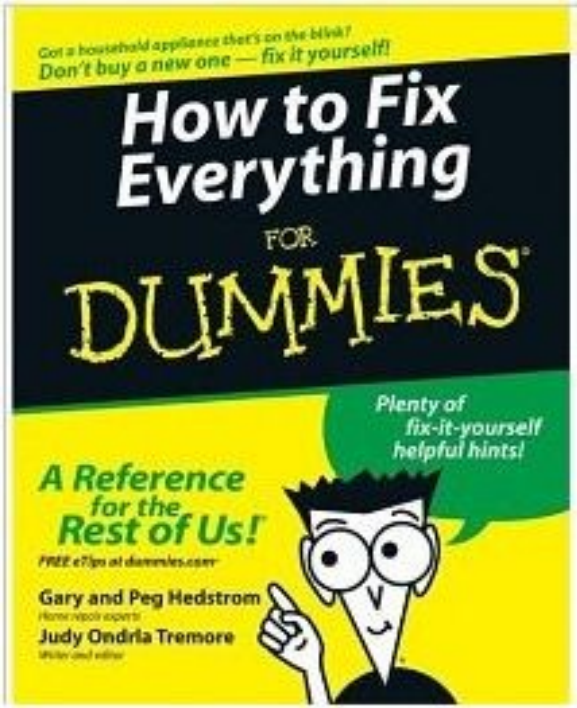
Mitigation & best practises

All systems

- Update & apply security patch
- Harden and remove all unnecessary services

BGP

- Remove GRX prefixes from Internet routers
- Use BGP authentication
- Routers import only specific prefixes from specific AS numbers with roaming agreements
- Ingress filtering
  - permit BGP sessions
  - block spoofed IP addresses (RFC1918,3330 & own IPs)
  - permit GTP (v1&2) towards GGSNs
  - permit DNS traffic to DNS systems
  - permit ICMP echo-reply & request from upstream interface
  - **block all others**



Thank you!

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stephen.kho@kpn.com

Resource list

OpenGGSN project
http://sourceforge.net/projects/ggsn/

Location API
http://unwiredlabs.com/api

Network Miner
http://www.netresec.com/?page=NetworkMiner

ZMAP
https://zmap.io

Masscan
https://github.com/robertdavidgraham/masscan

GTP specification
http://www.3gpp.org/DynaReport/29060.htm