Through the Looking-Glass, and what Eve found there

http://www.s3.eurecom.fr/lg/

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About us

- S3 group at Eurecom (FR) - System security
  - Embedded systems
  - Networking devices
  - Critical infrastructures
  - Memory forensics
  - Malware research

Outline

- Motivations
- Intro to looking glasses
- Threats
- Vulns & incidents
- Countermeasures

Motivations – how this started

- Picture yourself as a newbie cyber-criminal looking for the next target
  - Aim: critical infrastructure
  - Impact: worldwide
  - Skill level: low
  - Goal: break havoc

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  - Traffic routing across ASes
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  - Traffic routing across ASes
  - Basic web skills, google dorks, etc…
  - Goal: break havoc

Motivations – how this started

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  - The Internet
  - Traffic routing across ASes
  - Basic web skills, google dorks, etc…
  - Gaining access to BGP routers

Motivations – how this started

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A good candidate:

LOOKING-GLASS

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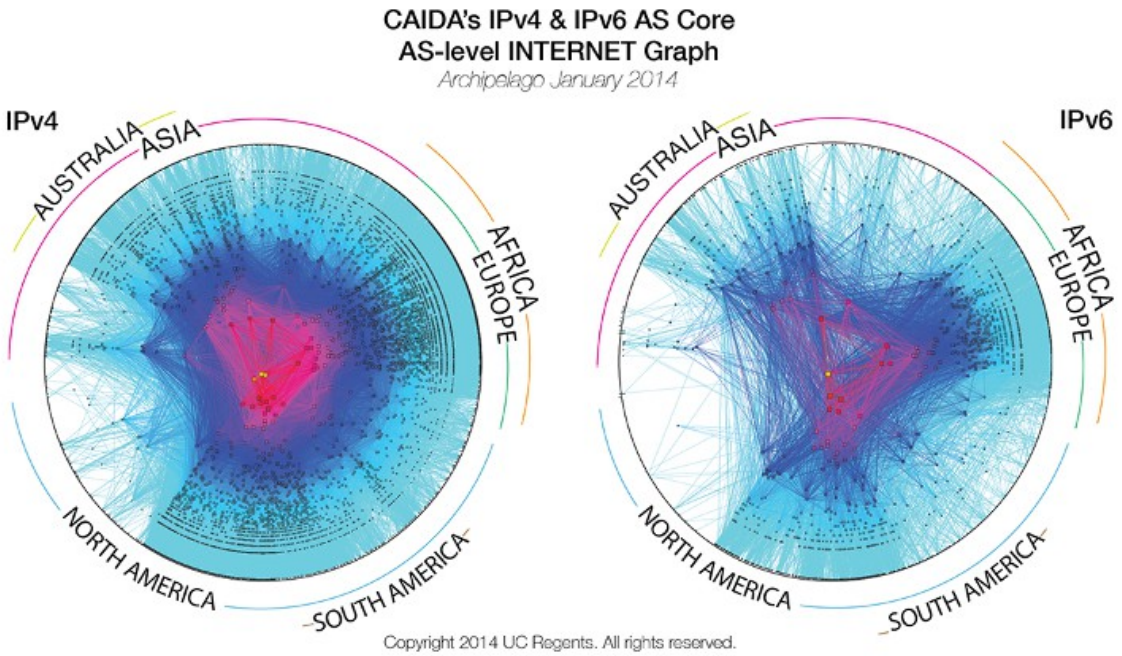
The Internet

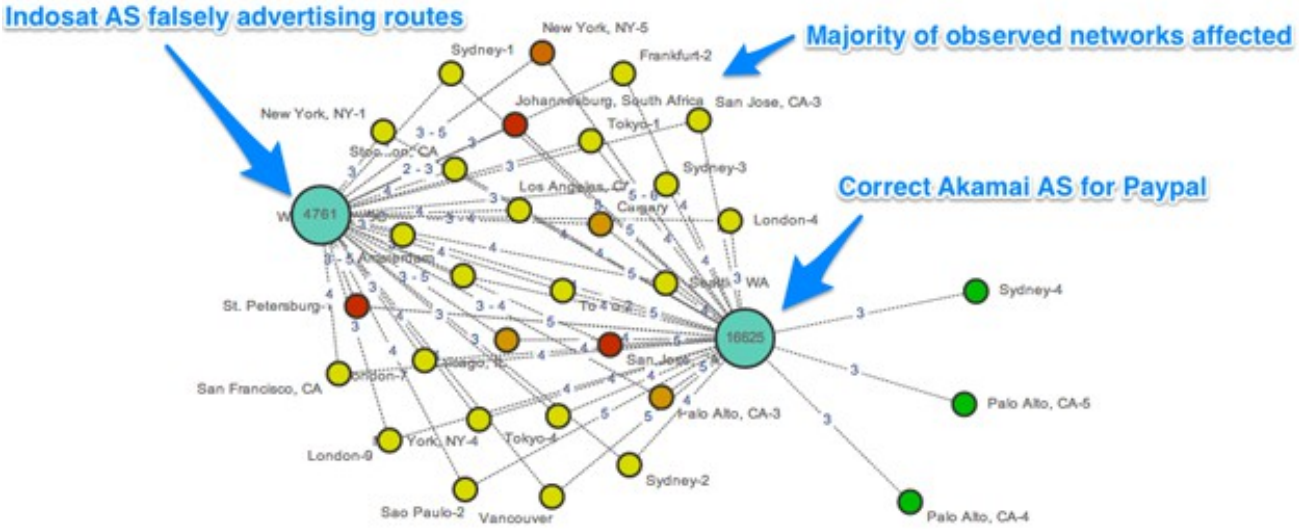
- A network of networks, glued by BGP



http://www.caida.org/research/topology/as_core_network/2014/

One routing-table, many routing-tables

- BGP is worldwide, each AS routing table is a (partial) local view
- What you see depends on where you are



http://blog.thousandeyes.com/4-real-bgp-troubleshooting-scenarios/

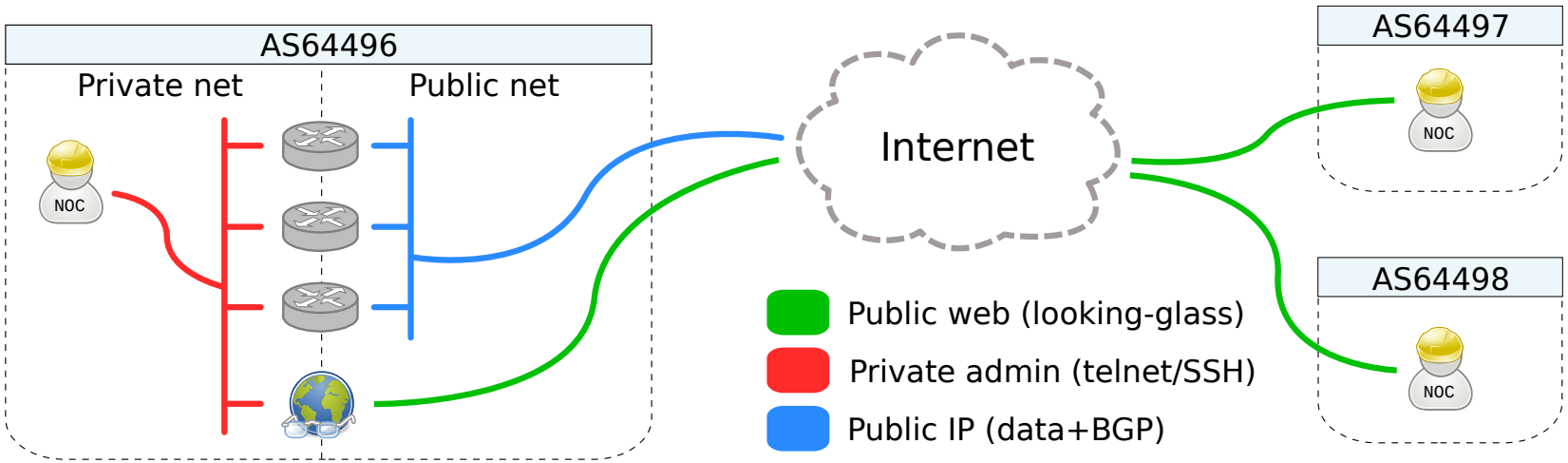
Connectivity troubleshooting

- NOC tools for troubleshooting:
  - Distributed BGP probes, eg. RIPE Labs
  - Private shells exchange, eg. NLNOG
  - Limited web-access to routers, ie. via looking-glasses

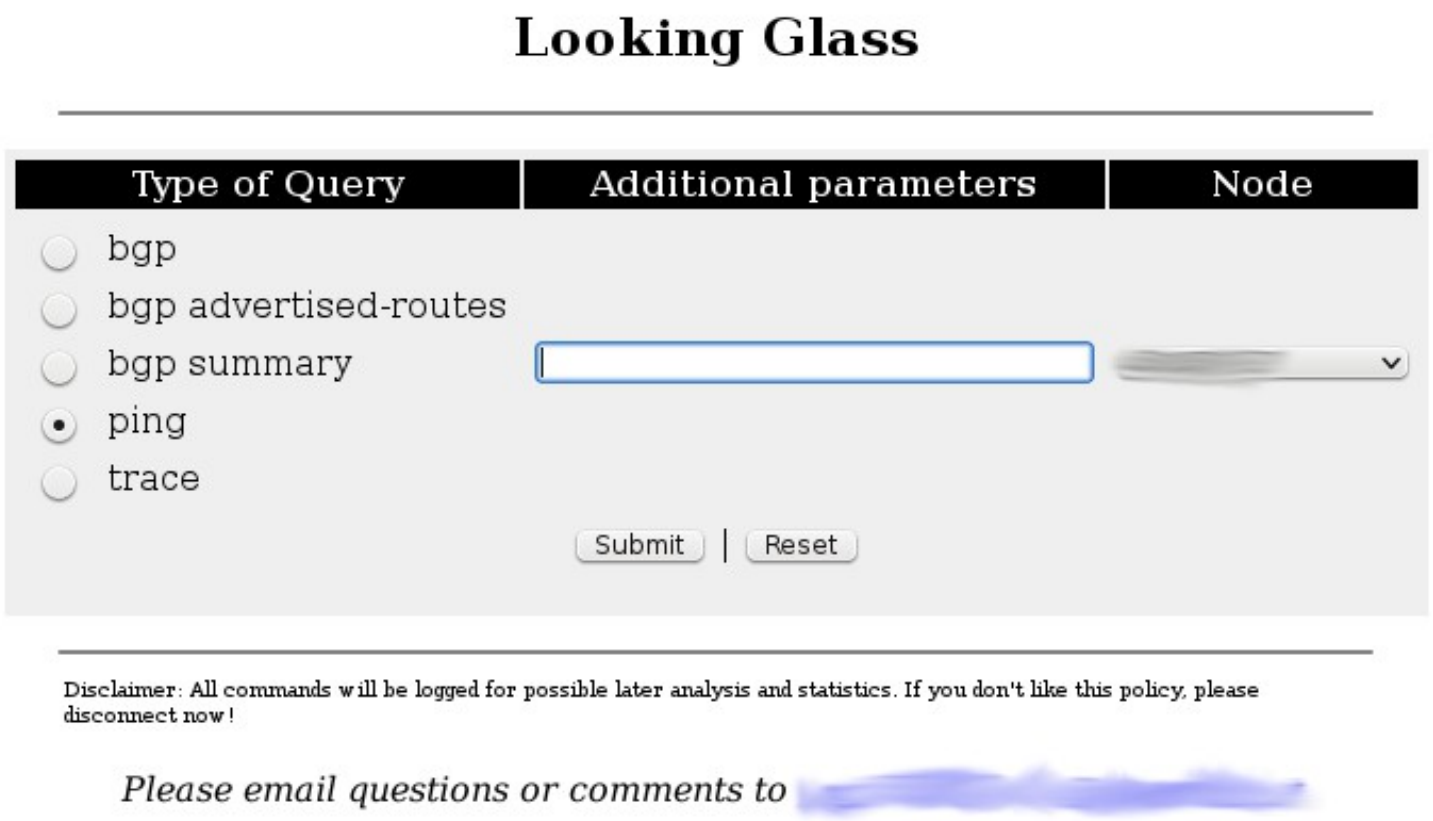
What's in a looking glass

- A simple '90s style web-script:
  - Usually PHP or Perl
  - Single file, can be dropped in webroot
  - Direct connection to SSH/telnet router console
  - Cleartext config file (ie. credentials)

How does it work



How does it look like



Where to get it

- Focus on open-source most common ones:
  - Cougar LG (Perl)
  - Cistron LG (Perl)
  - MRLG (Perl)
  - MRLG4PHP (PHP)

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Targeting humans

- Assume bug-proof software
- Humans can still mis-deploy it, and forget to:
  - Enable CGI/mod_php/mod_perl
  - Protect config files
  - Protect private SSH keys

Exposed routers credentials

Targeting the web-app

- Assume some minor bugs may exist in the web frontend
- Pwn the LG web interface:
  - Improper escaping
  - XSS/CSRF/etc.

Cookie stealing for other web services

Targeting the server

- Assume some medium severity bugs may exist in the whole package
- Pwn the host through LG:
  - Embedded third-party tools
  - Forked/modified modules

Escalate to the hosting server

Targeting the router

- Assume important bugs may exist in the backend
- Pwn the router through LG:
  - Missing input escaping
  - Command injection to router
  - Known bugs in router CLI

Escalate to router administration

Targeting the Internet

- Assume you control multiple routers in multiple ASes
- Pwn the Internet:
  - Reroute/blackhole local traffic
  - Announce bogus BGP prefixes

Chaos ensues :)

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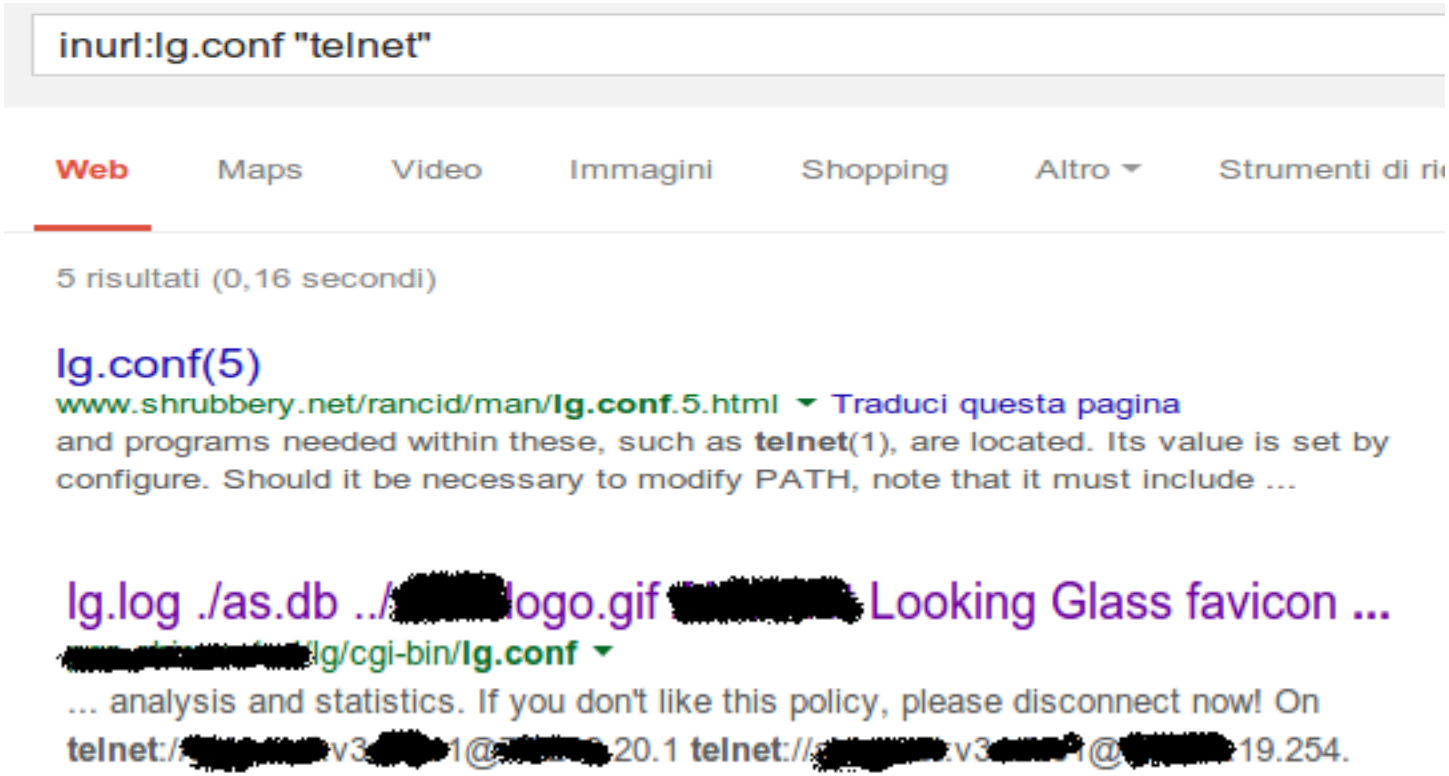
Web issues

- Exposed Credentials:
  - Stored in cleartext: IPs, usernames and passwords
  - Configuration files at known URLs
- Cookie Stealing:
  - XSS vulnerabilities in LG, to target other web-apps

Web Misconfigurations

- Google Dorks for login credentials:
  - Find LG configuration files
  - Examples:
    - *"login" "telnet" inurl:lg.conf*
    - *"login" "pass" inurl:lg.cfg*

Google Dorks – Exposing conf files



Google Dorks – Exposing conf files

[redacted]lg/cgi-bin/lg.conf

```
<?xml version="1.0" encoding="ISO-8859-1" ?>

<!-- $Id: lg.conf,v 1.9 2004/01/25 20:19:45 cougar Exp $ -->

<LG_Conf_File>

      <LGURL></LGURL>
      <LogFile>lg.log</LogFile>
      <ASList>./as.db</ASList>
      <LogoImage Align="center" Link="http://www.[redacted]/">../[redacted]
      <HTMLTitle>[redacted] Looking Glass</HTMLTitle>
      <Favicon>favicon.ico</Favicon>
      <ContactMail>backbone@[redacted]</ContactMail>
      <RSHCmd>/usr/bin/rsh -l lg</RSHCmd>
      <HTTPMethod>POST</HTTPMethod>  <!-- use "GET" if you like to
      <TimeOut>25</TimeOut>
      <Disclaimer>All commands will be logged for possible later analys
      <SecureMode>On</SecureMode>

      <Router_List>


<!-- [redacted] (AS[redacted]) Looking Glass -->


            <Router Name="[redacted]">
                  <URL>telnet://[redacted]:v3[redacted]1@[redacted]20.1</URL>
            </Router>
            <Router Name="[redacted]">
                  <URL>telnet://[redacted]:v3[redacted]1@[redacted]19.254</URL>
            </Router>

      </Router_List>
</LG_Conf_File>
```

Index of /lg/cgi-bin

[redacted]/lg/cgi-bin/

Index of /lg/cgi-bin

- Parent Directory
- favicon.ico
- lg.cgi
- lg.conf
- lg.log

Default config paths

- Example from Cougar LG root directory:

```
as.txt  CHANGELOG  communities.txt  COPYING  favicon.ico
 lg.cgi  lg.conf  makeaslist.pl  makedb.pl  README
```

- So just crawl for it:

  $BASE_LG_URL/lg.conf

Best Practices :)

README sometime mentions them:

```
21   Then copy the lg.pl, lg.cfg and lg.html.inc files to a subdirectory on
22   your webserver.  Make sure that those files are readable by your webserver,
23   and that lg.pl is also executable. Make sure there is NO WORLD READ ACCESS
24   on the lg.cfg file since it contains YOUR CISCO PASSWORD (hope you get it)..
25
26   Because your Cisco password is in the configuration file, it is preferable
27   to run this script on a web server where noone else has access to - not
28   the virtualhosting server for all your customers...
```

...still, we've found about 35 exposed cases!

Exposed Source Code

lg.cern.ch/lgform.cgi

```
    $rtrdb = $LG_ROUTERDB;
} else {
    $rtrdb = "$SYSCONFDIR/router.db";
}

if (! -f $rtrdb) {
    my(@dirs, $dir);
    # if the router.db file does not exist, try to compile the list from
    # the rancid group router.db files.
    local(*DIR);
    if (! opendir(DIR, $LOCALSTATEDIR)) {
        dolog(LOG_ERR, "ERROR: couldn\'t read $LOCALSTATEDIR: $!\n");
    } else {
        while ($dir = readdir(DIR)) {
            next if ($dir =~ /^(\.|\.\.|\.ssh|CVS|bin|etc|logs|util)$/);
```

In use LG

www.noc.garr.it/lg.phps

```
else:
$command = "sh ".$query." ".$para;
endif;

if (getenv("REQUEST_METHOD") != "POST"):
$command = "";
endif;
$command = str_replace("\n", "Not Valid", $command);
$command = substr($command, 0, 60);
$command = $command."\n";
```

(Hopefully) non-working LG

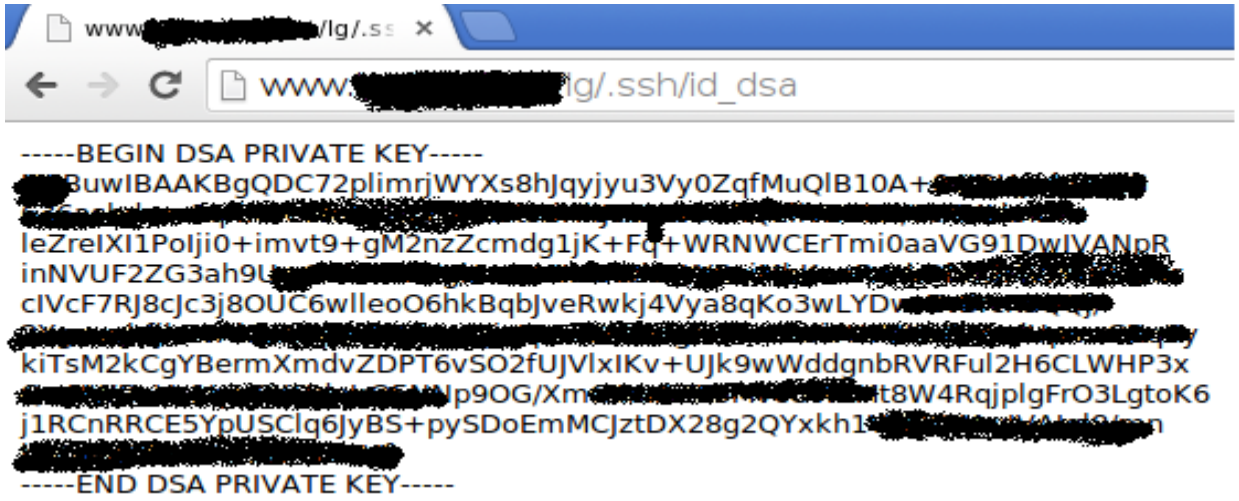
Exposed Private SSH Keys

- Default path for SSH keys (CVE-2014-3929) in Cougar LG

- Where are SSH private keys stored?

  lg.conf:18 → `/var/www/.ssh/private_key`

Exposed Private SSH Keys



First steps into the web

- No CAPTCHA anywhere!
- This eases attacker's work:
  - Automated resource mapping (ping-back and conf dumping)
  - Automated command injection
  - Automated attacks from multiple AS (if bugs are found)

XSS

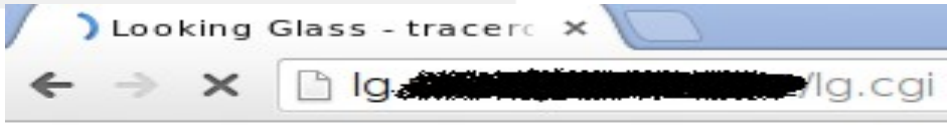
- XSS in <title> via "addr" parameter (CVE-2014-3926)
- LG maybe are not worthy web targets…
  - But other NOC services often are under the same-origin domain!

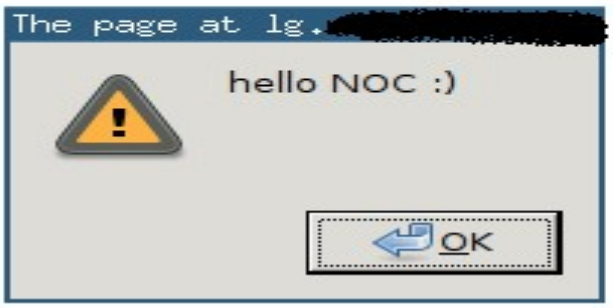
XSS – for the lulz!

Looking Glass

Type of Query	Additional parameters	Node
○ bgp		
○ bgp advertised-routes		
○ bgp summary	8.8.8.8</TITLE></head><body><sc	EDGE1-TC1 ▾
○ ping		
◉ trace		

Submit | Reset





Router Command Injection

- What if you can run whatever CLI command you want?
  - CVE-2014-3927 in MRLG4PHP
- 'argument' parameter issue
  - HTML escape != sanitization
- Let's look at the code (mrlg-lib.php:120)

Router Command Injection

```
106         else $argument = trim ($_REQUEST["argument"]);
```

```
120     $command = $request[$requestid]["command"] . (!empty ($argument) ? (" " . safeOutput ($argument)) : "");
121     global $socket_timeout;
122     $link = fsockopen ($address, $port, $errno, $errstr, $socket_timeout);
123     if (!$link)
124     {
125         printError ("Error connecting to router");
126         return;
127     }
128     socket_set_timeout ($link, $socket_timeout);
129     $username = $router[$routerid]["username"];
130     if (!empty ($username)) fputs ($link, "{$username}\n");
131     fputs ($link, "{$password}\nterminal length 0\n{$command}\r");
132     // let daemon print bulk of records uninterrupted
133     if (empty ($argument) && $request[$requestid]["argc"] > 0) sleep (2);
134     fputs ($link, "quit\n");
```

```
28 function safeOutput ($string)
29 {
30     return htmlentities (substr ($string, 0, 50));
31 }
```

Router Command Injection - PoC

- From HTTP to router CLI,
  just adding newlines :)

```
curl --data \
'routerid=10
&requestid=50
&argument=8.8.8.8%0Adate%0Aexit%OA'
```

Remote Memory Corruption

- Sometime LG ships with embedded third-party binaries
  - CVE-2014-3931 in MRLG (fastping SUID bin)
- ICMP echo reply is used without proper validation
  - fastping.c:546
    ```
    Riempie_Ritardi( *((long *)&(icp->icmp_data[8])) , triptime );
    ```
- Let's have a look at the code

Remote Memory Corruption

```
// #### Stampa il ritardo del pacchetto ricevuto
Riempie_Ritardi( *((long *)&(icp->icmp_data[8])) , triptime );
```

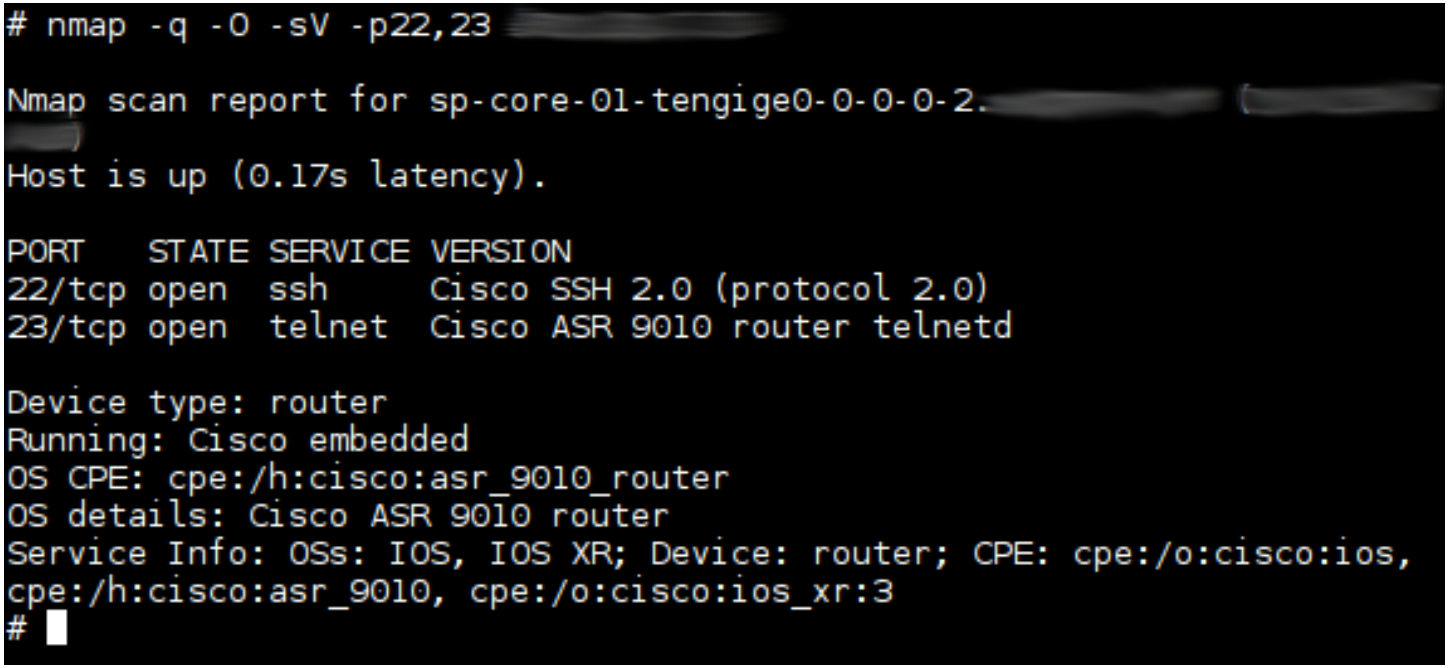
```
870 /*  Inserisce nel vettore ritardi il RTD di ogni pacchetto*/
871
872 void Riempie_Ritardi ( long indice, long ritardo )
873 {
874   /* controllo se e' presente un fuori sequenza */
875   if ( indice < prec)
876   {
877   fuoriseq++;
878   //printf("%ld\n",fuoriseq);
879
880   }
881
882   prec=indice;
883
884   //printf("%ld\n",indice);
885   ritardi[indice]=ritardo;
886
887
888 }
```

Exploitation notes

- 3rd-party, probably not commonly deployed
  - WONTFIX by upstream
- Time-dependent…
  - But you get host time in ICMP echo request!
- Every ICMP reply can overwrite one long word in memory…
  - And you have 100 probes on every try

Talking about network design

- Routers admin consoles needlessly exposed over globally routable interfaces



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Code-wise

- Understand that exposing router consoles to the web with hardcoded credentials can be dangerous!
- Review all critical web-services written during the ~~wild-west~~ '90s

Deployment-wise

- Prefer a dedicated read-only route-server as LG endpoint
- Check if your private files are reachable over the web (LG config, SSH keys)
- Double check your web server config! (vhost vs. default docroot)

Administration-wise

- Setup proper ACL on your routers
- Use strong, unique passwords
- Put admin and out-of-band services in private VLANs and subnets!

Recap

- Best-practices are often disregarded
- Unaudited, old, forgotten code often sits in critical places
- Attackers go for the weak links…
  - and escalate quickly!

Internet core is fragile

Fin

Thank you for listening!

Thanks to all the members of NOPS team, who helped in bug-finding

Backup – router CLI escalation

- Cracking Cisco weak hashes
  - Type-0, Type-5, Type-4 (cisco-sr-20130318-type4)
- Exploiting CLI bugs
  - Cisco, AAA Command Authorization by-pass (cisco-sr-20060125-aaatcl)
  - Juniper, Unauthorized user can obtain root access using CLI (JSA10420)
  - Juniper, Multiple privilege escalation vulnerabilities in Junos CLI (JSA10608)

Backup – reported incidents

Vulnerabilities	*Affected ASes*
Exposed configuration files	28
Remote command injection	12
Misconfigured CGI	4
Exposed SSH private keys	2