PERISCOPE: Standardizing and Orchestrating Looking Glass Querying

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Purpose of this talk

• Inform the operational community about Periscope.

• Solicit feedback:
  o Details that we may have missed
  o Ways to make Periscope more useful
  o Technical insights, usage statistics, historical data …

• Encourage engagement and contributions
High-level goals and principles of Periscope

Periscope unifies the discovery and querying of Looking Glasses under a uniform API

• Respect resource limitations and preserve conservative query rates

• Provide transparency and accountability in Looking Glass querying.

• Be responsive and compliant to operators’ requests.
Advantages of LG measurements

• LGs are among the few public measurement tools that provide direct interfaces to routers:
  o Access to non-transitive BGP attributes (e.g. LocPref).
  o Co-located BGP and traceroute/ping monitors.
  o Vantage Points at colocation facilities, IXPs, datacenters.
  o Vantage Points in ASes not covered by other platforms
Problems with LGs

• Lack of standardization and consistency:
  o Disparate interfaces and output formats

• Hard to discover and track:
  o No centralized index of LGs, their locations and their capabilities

• High attrition rates:
  o Hard to maintain an up-to-date list of LGs

Problems with LGs

• Lack of standardization and consistency:
  o Disparate interfaces and output formats

  Periscope implements a common querying scheme, indexing and data persistence features

• High attrition rates:
  o Hard to maintain an up-to-date list of LGs

Periscope Workflow

1. API Request
   USER

2. HTTP Request
   PERISCOPE
   LG

3. HTTP Response

4. API Response

```json
{
  "command": "bgp",
  "destination": "103.22.203.0/24",
  "sources": [
    {
      "asn": 680, "host": "Stuttgart_DE"
    },
    {
      "asn": 766, "host": "Madrid_ES"
    }
  ]
}
```

```json
{
  "source": "AS680_XR-STU1_Stuttgart_DE",
  "destination": "103.22.203.0/24",
  "AS_path": ["3356", "3356", "6453", "13335"],
  "best": true,
  "communities": ["680:66", "3356:66", "6453:3000"],
  "localpref": "100",
  "next_hop": "188.1.200.77",
  "datetime": "2016-03-23 05:41:05"
}
```

```plaintext
BGP routing table entry for "103.22.203.0/24"
version 126601054
BGP Bestpath: deterministic-med
Paths: (2 available, "best #2")
  table default
  Advertised to update-groups: 8
  Refresh Epoch 1
  3356 3356 6453 13335
  188.1.200.77 (metric 1141) from "b"
```

```
Request URL: https://www.noc.dfn.de/lg/
Request Method: POST
Status Code: 200 OK
Remote Address: 194.95.237.14:443
Form Data
  query: bgp
  protocol: IPv4
  addr: 103.22.203.0/24
  router: Stuttgart%3A4XR-STU1
```

```
View source
```
For each Periscope User the controller allocates a different cloud-hosted **VM instance** to execute the user queries.

Each VM instance takes an IP address from the cloud operator’s address space.

The controller implements throttling of query rates.
Periscope enforces per-user and per-LG query rate limits

• Two limits control the rate of issued LG queries:
  o **User-specific**: Each user can issue only 1 query per 5 minutes to the same LG.
  o **LG-specific**: Each LG will execute up to 3 queries per minute from all the users.
• A query is allocated if neither limit is exceeded.
• Exponential back off when LGs respond with errors
Periscope sets three custom HTTP headers in every request:
  - "X-Request-Origin: periscope"
  - "X-Request-For:<user-ip>"
  - "X-Request-Client:<gcloud OR aws OR ark>"

- Periscope IPs configured with reverse DNS records.
- Periscope assigns an LG client with a static IP address to each Periscope user to allow persistence identification.
Coverage of Periscope LGs

- 572 ASNs with 2,951 VPs.
- 77 countries, 492 cities.

- > 75% of VPs provide both traceroute and BGP.
- > 60% of LGs support IPv6.
The topology observed by LGs is largely complementary to other platforms

- Queried 2,000 randomly selected IPs from each LG and from each VP available in RIPE Atlas and CAIDA’s Ark
Benefits

• Easier to discover and query new VPs for reverse paths

• Easier policing of Looking Glass usage through an access-control layer

• Improved utilization and load distribution

• Avoid redundant measurements by archiving and making public historical measurement data.
Request for contributions

• Please contribute feedback regarding:
  1. Per user query limits
  2. Global query limits
  3. Opt-in or opt-out requests

• Utilization statistics and archived queries.

• Funding, infrastructure support (VM instances, cloud computing credit).
Conclusion

• Periscope goals:
  o Unify LGs under a uniform API.
  o Enforce per-user and global query limits.
  o Provide Transparency and accountability
• Access request: periscope-info@caida.org
• Documentation: http://www.caida.org/tools/utilities/looking-glass-api/
BACKUP SLIDES
Support for multiple concurrent users requires multiple LG clients

Native LG querying

LGs use the users’ IP address to impose per-user querying quotas

Single-client Periscope

Putting multiple Periscope users behind the same IP causes all the users to share the quotas of a single user

Multi-client Periscope

Using different client per user allows Periscope to provide the same querying quotas as native querying
LG Ingestion Workflow

- PeeringDB
- Traceroute.org

LG URLs → Web Crawler → HTML forms → Automatic configuration extraction → Successful mapping

- No → Manual inspection needed
- Yes → LG attributers

- LG URLs
- LG templates
- http://www.phplg.com/
- https://github.com/Cha0sgr/BGP-Looking-Glass-NG
- http://sourceforge.net/projects/klg
- http://mrlg.op-sec.us/
- https://www.gw.com/sw/stripes/

Health checker
LG Ingestion Workflow

Filters-out dead URLs & extracts HTML forms

PeeringDB

LG URLs

Traceroute.org

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PeeringDB

LG URLs

Filters-out dead URLs & extracts HTML forms

PeeringDB

LG URLs

1. Successful mapping
2. Health checker
3. Filters-out dead URLs & extracts HTML forms
4. LG attributers
5. No LG templates
6. Manual inspection needed
7. Automatic configuration extraction

Fraction of LGs

LG Status

Healthy
Unreachable
URL not LG
Error 404
Error 403
Error 401
Error 500
Error 502
LG Ingestion Workflow

PeeringDB
Traceroute.org

LG URLs

Web Crawler

HTML forms

Automatic configuration extraction

Manual inspection needed

No

Successful mapping

Yes

LG attributers

Automatically extracted LG specifications used to interpret API calls to LG queries

http://www.phplg.com/
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Load Distribution among LGs

AS3356 (High query load)

AS680 (Low query load)
Load Distribution among Platforms

Traceroute to caida.org (192.172.226.78), 48 byte p

<table>
<thead>
<tr>
<th>Source</th>
<th>Destination</th>
<th>AS</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 193.174.247.1</td>
<td>krgslv1-vel1000-ase.dfn.de</td>
<td>AS680</td>
<td>1.82ms</td>
</tr>
<tr>
<td>2 188.1.230.45</td>
<td>cr-fra2-pwethe1-x-win.dfn.de</td>
<td>AS680</td>
<td>7.665ms</td>
</tr>
<tr>
<td>3 62.40.124.217</td>
<td>dfn-mxl.fra.de.geant.net</td>
<td>AS21320</td>
<td>7.173ms</td>
</tr>
<tr>
<td>4 62.40.125.18</td>
<td>internet2-gw.mx1.fra.de.geant.net</td>
<td>AS21320</td>
<td>104ms</td>
</tr>
<tr>
<td>5 198.71.45.6</td>
<td>ei-7-3-0.4072.rosa.atlas.net.intern2.edu</td>
<td>AS11537</td>
<td>174.1ms</td>
</tr>
<tr>
<td>6 198.71.45.13</td>
<td>ei-10-2-0.105.rtr.hous.net.intern2.edu</td>
<td>AS11537</td>
<td>176.3ms</td>
</tr>
<tr>
<td>7 198.71.45.21</td>
<td>ei-7-1-0.4070.rosa.losa.net.intern2.edu</td>
<td>AS11537</td>
<td>176.49ms</td>
</tr>
<tr>
<td>8 137.164.26.200</td>
<td>hpr-lax-hpr2-12-r&amp;e.cenic.net</td>
<td>AS2153</td>
<td>176.606ms</td>
</tr>
<tr>
<td>9 137.164.26.34</td>
<td>hpr-sdsc-10ge--lax-hpr.cenic.net</td>
<td>AS2153</td>
<td>176.606ms</td>
</tr>
<tr>
<td>10 192.12.207.10</td>
<td>medusa-mx960.sdsc.edu</td>
<td>AS195</td>
<td>176.606ms</td>
</tr>
<tr>
<td>11 192.172.226.78</td>
<td>ns1.caida.org</td>
<td>AS1909</td>
<td>176.606ms</td>
</tr>
</tbody>
</table>

Type escape sequence to abort.
Tracing the route to ns1.caida.org (192.172.226.78)
VRF info: (vrf in name/id, vrf out name/id)
1 xr-fzk1-pc2.x-win.dfn.de (188.1.145.81) [MPLS: Label 1274]
2 cr-fra2-he9.x-win.dfn.de (188.1.144.121) 4 msec 8 msec 4 msec
3 dfn-mxl.fra.de.geant.net (62.40.124.217) [AS 20965] 4 msec
4 internet2-gw.mx1.fra.de.geant.net (62.40.125.18) [AS 20965] 4 msec
5 et-7-3-0.4072.rosa.atlas.net.intern2.edu (198.71.45.6) [AS 2153] 4 msec
6 et-10-2-0.105.rtr.hous.net.intern2.edu (198.71.45.13) [AS 2153] 4 msec
7 et-7-1-0.4070.rosa.losa.net.intern2.edu (198.71.45.21) [AS 2153] 4 msec
8 hpr-lax-hpr2-12-r&e.cenic.net (137.164.26.200) [AS 2153] 4 msec
9 hpr-sdsc-10ge--lax-hpr.cenic.net (137.164.26.34) [AS 2153] 4 msec
10 medusa-mx960.sdsc.edu (192.12.207.10) [AS 195] 180 msec 176 msec
11 ns1.caida.org (192.172.226.78) [AS 1909] 188 msec 176 msec
Case study: ARTEMIS