Platforms for network experimentation

The value of platforms
RIPE Atlas
Options and open challenges

Based on Emile’s slides emile.aben@ripe.net
The value of experimental platforms

- To measure and understand the network
- To design and test Internet-scale systems
RIPE Atlas

- A global, open, distributed Internet measurement platform
- Established in 2010 by RIPE NCC (Network Coordination Centre)
- Goal: Improve Internet through measurements
- Probes hosted by volunteers
- Data publicly available

As of June 2017: >9,800 probes and 266 anchors
Most popular features

- Six types of measurements: ping, traceroute, DNS, SSL/TLS, NTP and HTTP (to anchors)
- APIs and CLI tools to start measurements and get results
- Streaming data for real-time results
- "Time Travel", LatencyMON, DomainMON
- Status checks (Icinga and Nagios)
RIPE Atlas – The platform

- **Probes** – 3 versions
  - V1, V2 – Lantronix XPort Pro with 167MHz CPU, 8-16MB of RAM, 16MB flash
    - Before 2013; by 2015 ~28%
  - V3 – TP-Link TL-MR3020 router with 400MHz CPU, 32MB of RAM, 4MB NAND

- **Anchors**
  - 1U servers (Soekris nets6501-70)

- **Software**
  - Based on BusyBox [https://www.busybox.net](https://www.busybox.net)
  - ATLAS probe – source code available
But let’s get you access now

- You need a RIPE NCC Access account:
  - access.ripe.net

- Measurement credits voucher: Argentina17
  - https://atlas.ripe.net/user/credits/#!redeem
  - https://atlas.ripe.net/user/credits/
Users can create and lookup measurement using several different tools

User interact with the RIPE Atlas controller, not directly the probes
Interfaces

- **Web UI**
  - [https://atlas.ripe.net/](https://atlas.ripe.net/)
    - [https://atlas.ripe.net/docs/](https://atlas.ripe.net/docs/)

- **API**
  - [https://atlas.ripe.net/api/v2/root/](https://atlas.ripe.net/api/v2/root/)
  - [https://atlas.ripe.net/docs/api/v2/reference/](https://atlas.ripe.net/docs/api/v2/reference/)
  - [https://atlas.ripe.net/docs/api/v2/manual/](https://atlas.ripe.net/docs/api/v2/manual/)

- **Command Line Interface**
  - [https://github.com/RIPE-NCC/ripe-atlas-tools](https://github.com/RIPE-NCC/ripe-atlas-tools)
Interface: https://atlas.ripe.net/
Programming interfaces

- **Python**
  - ripe.atlas.cousteau: Interfacing with RIPE Atlas APIs
  - ripe.atlas.sagan: Interfacing with RIPE Atlas results

- **Community contributions:**
  - [https://github.com/RIPE-Atlas-Community/](https://github.com/RIPE-Atlas-Community/)
Outline

- Overview
- Interfaces
- **Probes**
- Measurements
- Creating measurements
- Getting the results
### Searching for probes

This is a list of all current RIPE Atlas probes, including information specific to each probe. More probes are continually online.

- Learn more about probes
- See the probes map
- Apply for your own probe

#### Probes

<table>
<thead>
<tr>
<th>Id</th>
<th>ASN v4</th>
<th>ASN v6</th>
<th>Country</th>
<th>Description</th>
<th>Connection Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>6175</td>
<td>1103</td>
<td>1103</td>
<td>NL</td>
<td>SURFnet nv</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6146</td>
<td>60781</td>
<td>60781</td>
<td>NL</td>
<td>Leaseweb Network B.V.</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6152</td>
<td>28753</td>
<td>28753</td>
<td>DE</td>
<td>Leaseweb Network B.V.</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6137</td>
<td>3333</td>
<td>3333</td>
<td>NL</td>
<td>nl-ams-as3333-preprod</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6147</td>
<td>33280</td>
<td>33280</td>
<td>NL</td>
<td>Afilias</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6112</td>
<td>197216</td>
<td>197216</td>
<td>RO</td>
<td>Delta Softmedia Ltd</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6161</td>
<td>27843</td>
<td>27843</td>
<td>CA</td>
<td>Optical Technologies</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6142</td>
<td>63403</td>
<td>63403</td>
<td>CA</td>
<td>Afilias</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6008</td>
<td>2607</td>
<td>2607</td>
<td>RO</td>
<td>AA sk-bts-as2607</td>
<td>4 weeks</td>
</tr>
<tr>
<td>6001</td>
<td>3333</td>
<td>3333</td>
<td>NL</td>
<td>AA nl-ams-as3333</td>
<td>4 weeks</td>
</tr>
</tbody>
</table>

Filter based on ASN, country, location...
Searching for probes (API)

- [https://atlas.ripe.net/docs/api/v2/reference/#/probes](https://atlas.ripe.net/docs/api/v2/reference/#/probes)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
<th>Parameter Type</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>optional_fields</td>
<td>📌</td>
<td>Include additional fields named in comma-separated values in response.</td>
<td>form</td>
<td>enum</td>
</tr>
<tr>
<td>country_code</td>
<td>🇪🇪</td>
<td>filter on id being less than value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>id__lt</td>
<td>🌋</td>
<td>filter on id being less than value.</td>
<td>query</td>
<td>integer</td>
</tr>
<tr>
<td>id__lte</td>
<td>🌋</td>
<td>filter on id being less than or equal to value.</td>
<td>query</td>
<td>integer</td>
</tr>
<tr>
<td>id__gte</td>
<td>🌋</td>
<td>filter on id being greater than or equal to value.</td>
<td>query</td>
<td>integer</td>
</tr>
<tr>
<td>id__gt</td>
<td>🌋</td>
<td>filter on id being greater than value.</td>
<td>query</td>
<td>integer</td>
</tr>
<tr>
<td>id__in</td>
<td>🌋</td>
<td>filter on id being one of comma-separated values.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>latitude</td>
<td>🌋</td>
<td>filter on the latitude equaling the exact supplied float value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>latitude__lt</td>
<td>🌋</td>
<td>filter on the latitude being less than value (south to).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>latitude__lte</td>
<td>🌋</td>
<td>filter on the latitude being less than or equal to value (south of).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>latitude__gte</td>
<td>🌋</td>
<td>filter on the latitude being greater than or equal to value (north of).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>latitude__gt</td>
<td>🌋</td>
<td>filter on the latitude being greater than value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>longitude</td>
<td>🌋</td>
<td>filter on the longitude equaling the exact supplied float value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>longitude__lt</td>
<td>🌋</td>
<td>filter on the longitude being less than the value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>longitude__lte</td>
<td>🌋</td>
<td>filter on the longitude being less than or equal to value (to the west of).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>longitude__gte</td>
<td>🌋</td>
<td>filter on the longitude being greater than or equal to value (to the east of).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>longitude__gt</td>
<td>🌋</td>
<td>filter on the longitude being greater than value (to the east of).</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>asn</td>
<td>🌋</td>
<td>filter on probes announced by the autonomous system with the name of value.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>asn_v4</td>
<td>🌋</td>
<td>filter on probes with an IPv4 address announced by an autonomous system with a particular number.</td>
<td>query</td>
<td>string</td>
</tr>
<tr>
<td>asn_v4__in</td>
<td>🌋</td>
<td>filter on probes with an IPv4 address announced by one of the autonomous systems in a comma-separated list.</td>
<td>query</td>
<td>string</td>
</tr>
</tbody>
</table>
Example for probeID 4
- UI: https://atlas.ripe.net/probes/4
- API: https://atlas.ripe.net/api/v2/probes/4
- CLI: ripe-atlas probe-info 4

Probe type embedded in ID:
- < 6000 : Probe v1,v2
- 6000-10000 : Anchors
- > 10000 : Probes v3
Probes - Where users are?

http://sg-pub.ripe.net/petros/population_coverage/
Outline

- Overview
- Interfaces
- Probes
- **Measurements**
- Creating measurements
- Getting the results
RIPE Atlas measurements

- Built-in global measurements towards root nameservers
  - Visualised as Internet traffic maps
- Built-in regional measurements towards “anchors”
- Users can run customised measurements
  - ping, traceroute, DNS, SSL/TLS, NTP and HTTP
A RIPE Atlas “measurement specification” is:
- A number of sources (1-all probes)
- A single destination (by hostname or IP)
- For a given IP protocol (IPv4/IPv6)
- For a given measurement type (ping, traceroute, DNS…)
- At a given interval (or as a one-off)
RIPE Atlas measurement IDs

- **UI**
  - [https://atlas.ripe.net/measurements/](https://atlas.ripe.net/measurements/)
  - [https://atlas.ripe.net/measurements/<msm_id>](https://atlas.ripe.net/measurements/<msm_id>)

- **API**
  - [https://atlas.ripe.net/api/v2/measurements/](https://atlas.ripe.net/api/v2/measurements/)
    - [https://atlas.ripe.net/api/v2/measurements/<msm_id>](https://atlas.ripe.net/api/v2/measurements/<msm_id>)/
  - [https://atlas.ripe.net/api/v2/measurements/<msm_id>/results](https://atlas.ripe.net/api/v2/measurements/<msm_id>/results)

- **CLI**
  - ripe-atlas measurement-info <msm_id>
  - ripe-atlas report <msm_id>
<table>
<thead>
<tr>
<th><strong>General Information</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>#8754060</td>
</tr>
<tr>
<td>Group ID</td>
<td>#8754060</td>
</tr>
<tr>
<td>Type</td>
<td>🌴 Traceroute</td>
</tr>
<tr>
<td>Owner</td>
<td>Emile Aben</td>
</tr>
<tr>
<td>Charge credits to</td>
<td>Emile Aben</td>
</tr>
<tr>
<td>Public measurement?</td>
<td>Yes</td>
</tr>
<tr>
<td>Target</td>
<td>hu-bud-as12303.anchors.atlasripe.net</td>
</tr>
<tr>
<td>Resolve on Probe</td>
<td>No</td>
</tr>
<tr>
<td>This is a one-off measurement</td>
<td></td>
</tr>
<tr>
<td>Timing</td>
<td>2017-05-17 12:52 - 2017-05-17 13:00</td>
</tr>
<tr>
<td>Costs</td>
<td>60 per result, 60 per day</td>
</tr>
<tr>
<td>Response timeout</td>
<td>4000</td>
</tr>
<tr>
<td>Protocol</td>
<td>TCP</td>
</tr>
<tr>
<td>Paris</td>
<td>16</td>
</tr>
<tr>
<td>Packets</td>
<td>3</td>
</tr>
<tr>
<td>Firsthop</td>
<td>255</td>
</tr>
<tr>
<td>Maxhops</td>
<td>255</td>
</tr>
<tr>
<td>Port</td>
<td>80</td>
</tr>
<tr>
<td>Size</td>
<td>0</td>
</tr>
<tr>
<td>Probe Fulfilment</td>
<td>Responsive</td>
</tr>
<tr>
<td>Total responsive:</td>
<td>1 Total allocated:</td>
</tr>
<tr>
<td>Costs</td>
<td>Others</td>
</tr>
</tbody>
</table>
Anchoring measurements

- Both
  - Enhanced RIPE Atlas probes with more measurement capacity
  - Regional measurement targets within the RIPE Atlas network
- From-To:
  - 100s of probes towards each RIPE Atlas anchor
  - All anchors in a mesh
- Types: ping, traceroute, HTTP
Anchoring measurements

- **UI**
  - [https://atlas.ripe.net/anchors/list/](https://atlas.ripe.net/anchors/list/)
  - [https://atlas.ripe.net/anchors/map/](https://atlas.ripe.net/anchors/map/)

- **API**
  - [https://atlas.ripe.net/api/v2/anchor-measurements/](https://atlas.ripe.net/api/v2/anchor-measurements/)
  - [https://atlas.ripe.net/api/v2/anchors/](https://atlas.ripe.net/api/v2/anchors/)
Use existing measurements

- Many measurements already running!
- Search for existing public measurements first…
- Only then schedule your own measurement
Outline

- Overview
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- Creating measurements
- Getting the results
Measurements cost credits

- Running measurements costs credits
  - ping = 3 credits, traceroute = 30, etc.
  - Why? Fairness and to avoid overload
  - Daily spending limit & max measurements user can create
  - Hosting a RIPE Atlas probe earns credits

- Get extra credits by:
  - Being a RIPE NCC member
  - Hosting an anchor
  - Sponsoring probes

- Credit transfers (ask me!)
How to create a measurement?

- UI or API
- Many options per measurement type!!
- Upon creation you’ll get an ID back by which you can track the status and download the data

https://atlas.ripe.net/measurements/form/
UI (Probe selection and timing)

**Step 2** Probe Selection

- Worldwide 10

- New Set - wizard
- New Set - manual
- IDs List
- Reuse a set from a measurement

**Step 3** Timing

- **This is a One-off:** [ ]
- Start time (UTC):
  - As soon as possible
- Stop time (UTC):
  - Never
Measurement API Compatible Specification

curl --dump-header -H "Content-Type: application/json" -H "Accept: application/json" -X POST -d '{
    "definitions": [
    {
        "af": 4,
        "packets": 3,
        "size": 48,
        "description": "Ping measurement",
        "interval": 240,
        "resolve_on_probe": false,
        "skip_dns_check": false,
        "type": "ping"
    }
}'}
API

- You’ll need an API key
  - https://atlas.ripe.net/keys/
- POST a JSON measurement specification to
  - https://atlas.ripe.net/api/v2/measurements/?key=YOUR_KEY_HERE
- Probably easier: via Python library ripe.atlas.cousteau
from datetime import datetime
from ripe.atlas.cousteau import (Ping,
    Traceroute,
    AtlasSource,
    AtlasCreateRequest
)

ATLAS_API_KEY = ""

ping = Ping(af=4, target="www.google.gr", description="testing new wrapper")

traceroute = Traceroute(
    af=4,
    target="www.ripe.net",
    description="testing",
    protocol="ICMP",
)

source = AtlasSource(
    _type="area",
    value="WW",
    requested=5,
    tags={"include": ["system-ipv4-works"]}
)

source1 = AtlasSource(
    _type="country",
    value="NL",
    requested=50,
    tags={"excluded": ["system-anchor"]}
)

atlas_request = AtlasCreateRequest(
    start_time=datetime.utcnow(),
    key=ATLAS_API_KEY,
    measurements=[ping, traceroute],
    sources=[source, source1],
    is_oneoff=True
)

(is_success, response) = atlas_request.create()}
Outline

- Overview
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Retrieving measurement results

- By Measurement ID
- Streaming
- Daily dumps (bulk downloads) new!
By Measurement ID

- **UI**
  - https://atlas.ripe.net/measurements/<msm_id>/#!
    - download
  - other tabs have visualisation of results

- **API**
  - https://atlas.ripe.net/api/v2/measurements/<msm_id>/results

- **CLI**
  - ripe-atlas report <msm_id>
RIPE Atlas streaming

- To receive the measurement results as soon as they are sent by probes
  - Publish/subscribe through web sockets (RFC 6455)

- Two types of data
  - Measurement results
  - Probe connection status events

- Advanced filtering examples
  - All data between 2017-01-01 and 2017-01-03
  - All measurements of a single type
  - All measurements towards an IP prefix

https://atlas.ripe.net/docs/result-streaming/
Daily dumps

- Public datasets daily dumps
  - https://labs.ripe.net/Members/petros_gigis/daily-atlas-results-dumps

- Other bulk downloads
  - Probe archive
    ftp://ftp.ripe.net/ripe/atlas/probes/archive/
  - Measurement archive (specifications!)
Summary and caveats

- Most platforms today don’t capture the diversity of the growing Internet
  - The heterogeneity of links
  - And its current bottlenecks

- RIPE Atlas is a good hardware-based attempt
  - Still, high-rate of placement of probes on commercial and academic networks
  - As with most other platforms, experimenters != people hosting the nodes
    (you != your aunt)
Today and the next few days

• Today
  – The course and the instructor
  – Networking in 30’
  – Measurement platforms for all
  ➡️ How to read research papers

• ... and the next few days
  – Approaches to experimentation
  – Examples on network infrastructure
  – … applications and their users
  – … and a short walk on risky grounds