



# RIPE Internet Measurements

Presentation of RIPE's tools,  
methodologies and datasets

Vesna Manojlovic and Emile Aben | 17 June 2020 | IMV 2020

# To Inform and Inspire



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# RIPE and the RIPE NCC



# RIPE Community



- Started in 1989 by researchers in Europe
- Technical coordination of IP network
- Volunteers, no legal structure
- Open to everybody
  - Meetings
  - Working Groups
  - Mailing lists
- Collaboration and coordination



# RIPE Working Groups



- Anyone can join the discussion
  - On mailing lists
  - At RIPE meetings (in-person and online)
  - Remote participation
- Read and/or subscribe
  - [ripe.net/participate/ripe/wg](https://ripe.net/participate/ripe/wg)
- Learning opportunities
- Please contribute!

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[Address Policy Working Group](#)

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[Anti-Abuse Working Group](#)

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[Connect Working Group](#)

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[Cooperation Working Group](#)

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[Database Working Group](#)

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[DNS Working Group](#)

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[Internet of Things Working Group](#)

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[IPv6 Working Group](#)

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[MAT Working Group](#)

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[Open Source Working Group](#)

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[RIPE NCC Services Working Group](#)

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[Routing Working Group](#)

# The RIPE NCC



- Independent, not-for-profit, membership organisation
  - Funded by membership fees
- Distributing Internet resources as a Regional Internet Registry (RIR)
  - Policies decided by regional community
  - Through a neutral, impartial, open and transparent process
- Supporting the Internet through technical coordination

# RIPE Database



- The RIPE Database contains registration information for networks in the RIPE NCC service region and related contact details.
- Some uses of the RIPE Database and its contents:
  - Providing accurate registration information of Internet number resources
  - Publishing routing policies by network operators
  - Facilitating coordination between network operators
- Uses the “whois” protocol, data is open

# Regional Internet Registries (RIRs)



# Get Involved



- RIPE meetings attendance support:
  - RACI programme, RIPE Fellowship, Diversity Task Force
- Other events organised by the RIPE NCC
  - Regional meetings, training courses, hackathons
- RIPE NCC's Community support
  - NOG support, Community Projects Fund
- RIPE Labs



**But What About  
Data?**

# We Collect a lot of Interesting Data!



- For the community, by the community
- For network operators
- Data collections:
  - RIPE Atlas : latencies and paths (how do packets experience the network)
  - RIPE RIS : control plane (BGP)
    - “where should packets be routed”

# Why Do We Collect Data?



- It's in our mission: "As a neutral source of information and knowledge, we actively contribute to a stable and innovative Internet."
- To measure is to improve





# RIPE Atlas

# Seeing your Network from the Outside



- RIPE Atlas is a global, open, distributed Internet measurement platform, operated by the RIPE NCC
  - Consisting of thousands of devices (probes, anchors, VM, software probes)
  - Actively measuring Internet connectivity in real time
  - Open data available to the operators and research community
  - Ping, traceroute, DNS, TLS, NTP
  - Supports IPv4 and IPv6
  - February 2020: we launched software probes

# RIPE Atlas Data Interfaces



- Data files, APIs, CLI
- Widgets, tools, code
- [atlas.ripe.net/docs](https://atlas.ripe.net/docs)

## APIs Manuals and References

- [APIs Manual ↗](#)
- [API keys Manual](#)
- [API Resources Reference](#)
- [Streaming API Reference](#)
- [Built-in Measurements Reference](#)
- [RIPE Atlas Daily Data Dumps](#)

# Contact RIPE Atlas



- Website
  - [atlas.ripe.net](https://atlas.ripe.net)
- Articles and updates
  - [labs.ripe.net/atlas](https://labs.ripe.net/atlas)
- Mailing list for active users
  - [ripe-atlas@ripe.net](mailto:ripe-atlas@ripe.net)
- Questions
  - [atlas@ripe.net](mailto:atlas@ripe.net)
- Twitter
  - @RIPE\_NCC and #RIPEAtlas

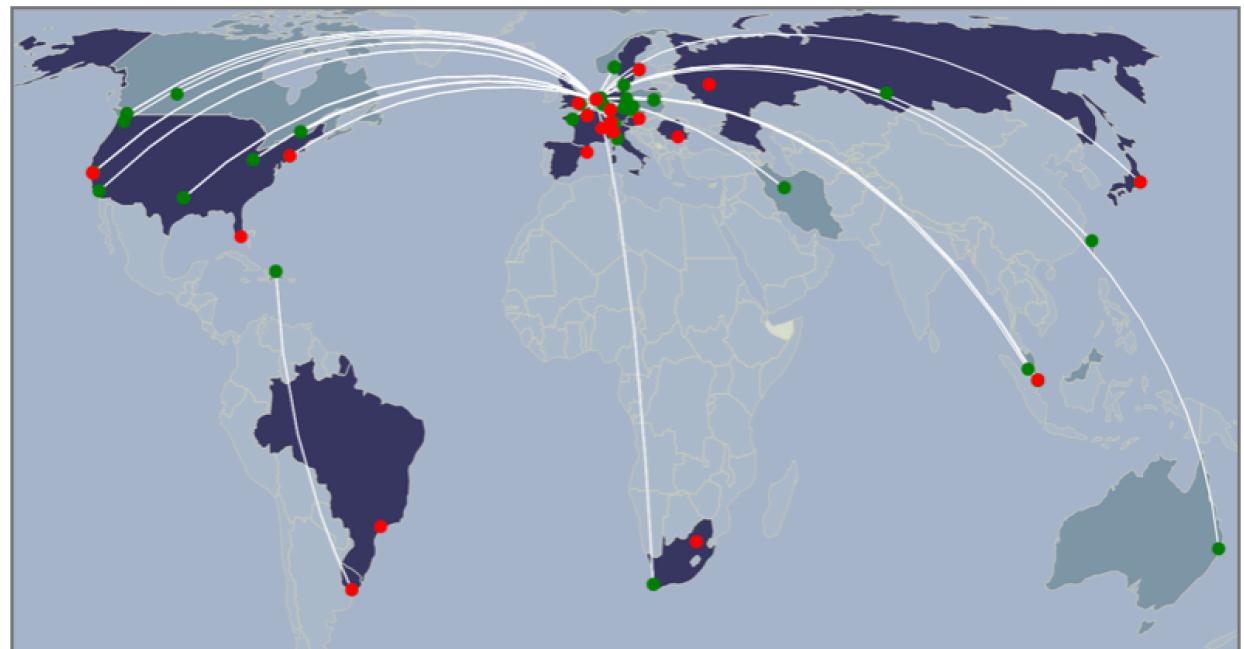


**RIPE RIS**

# RIPE Routing Information Service



- RIS collects BGP routing data
  - Since 1999
  - From multiple viewpoints
- [ris.ripe.net](http://ris.ripe.net)
- [ris-users@ripe.net](mailto:ris-users@ripe.net)



# BGP: Internet Traffic Control



- BGP makes Interdomain routing work
- Border routers: routers that receive explicit routing information for all of the Internet
- How do we monitor this traffic control?
- Listen in on this chatter at interesting places in the Internet

# RIPE RIS Data Interfaces



- Data Files
- Streaming
- Widgets / APIs in RIPEstat

# RIPEstat: Multi-perspective on IPs



- RIPEstat is a web-based interface that provides everything you ever wanted to know about IPs, AS Numbers and related information for hostnames and countries in one place.
- [stat.ripe.net](https://stat.ripe.net)

## Web-based interface

Using the web-based interface, you can see query results displayed in widgets (organised in tabs), compare results for different resources across different widgets, access the mobile site, and take advantage of personalised features for logged-in users.

## Individual widgets

Widgets are interactive graphical and visual representations of data that can be embedded on other websites.

## Data API

The RIPEstat Data API (Application Programming Interface) can be used to directly access RIPEstat data via your own scripts and programs.

## Text service

The RIPEstat Text Service offers the CLI (Command Line Interface) access to RIPEstat data, either via standard CLI tools or our own program, available as open source code.

## Mobile app (iOS)



# 3rd Party Tools

- **CAIDA IODA**

- [ioda.caida.org](http://ioda.caida.org)

- **Internet Health Report**

- [ihr.ijl.net/ihr](http://ihr.ijl.net/ihr)

- **Artemis**

- [bgpartemis.org](http://bgpartemis.org)

- **BGP Alerter**

- [github.com/nttgin/BGPalerter](https://github.com/nttgin/BGPalerter)



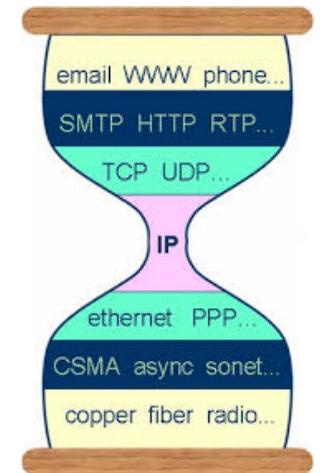
# Measuring Websites

with RIPE Atlas



# The Most Wanted Feature...

- By design, RIPE Atlas does not measure “application layer”
  - Operators are happy with transport/network layer
  - Ping, traceroute, DNS, TLS/SSL, NTP
- Users have been asking for HTTP measurements
- Due to ethical reasons, we decided:
  - to not target arbitrary websites with probes
  - that “standard” HTTP measurements are ONLY possible towards RIPE Atlas anchors



# Ethical Reason: Protecting Hosts



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# Ethics in Tech



- Ethics in Network Measurements ([RIPE Labs](#))
- Ethics in Technology ([RIoT Summit](#), [SHA2017](#))





# Workaround: Using a TCP Ping

- Traceroute (TCP) to the targeted web server
  - Towards IP address: port 80
  - 3 packets; a packet size of zero
  - “maximum hops” = 64, initial time-to-live (TTL) = 64
  - Long enough for the first traceroute attempt to immediately reach the destination address
- Mimics the behaviour of the TCP handshake
  - That takes place when setting up an HTTP connection
- This measures the same network delays!
  - RTT turns out to be equivalent to HTTP connect times

# How to: Web UI



- Go to Measurements
- Click on New msm
- Advanced options
- Add up to 1000 probes
- Choose one off
  - Or continuous / repeated
- Done!
  - You need to have credits

## Create a New Measurement

Step 1 Definitions

Traceroute measurement to dk-blip-as39839.anchors.atlas.ripe.net

Target\*: dk-blip-as39839.anchors.atlas.ripe.net  
Description: Traceroute measurement to dk-blip-as39839.  
An IP address or hostname

Protocol\*: TCP (highlighted with a red circle)

Address Family\*: IPv4

Timeout (ms): 4000

Interval: 600  
How often this should be done (seconds between samples). Note that this value is ignored for one-off measurements.

Resolve on Probe:  Force the probe to do DNS resolution

Advanced Options (highlighted with a red rectangle)

Packets: 3

Size: 0  
Size of the packet

First Hop: 64  
Start measuring the traceroute at this hop.

Maximum Hops: 64  
Stop measuring the traceroute at this hop.

Port: 80

Paris: 16  
Number of different variations for paris traceroute. Set 0 for standard traceroute.

Destination Extension Header Size: 0  
The size of the destination extension header to include in the IPv6 packet.

Hop-by-Hop Extension Header Size: 0  
The size of the hop-by-hop extension header to include in the IPv6 packet.

Don't Fragment:

Skip DNS check:  Disables target DNS check on measurement creation

Spread:  Spread of uniformly distributed random probe start time phase



# Credit System

- Running your own measurements cost credits
  - Ping = 10 credits, traceroute = 20, etc.
- Why? Fairness and to avoid overload
- Limits: daily spending and # of measurement results
- How to get credits?
  - Generated by hosting a probe / anchor
  - Transferred from another user
  - Reclaiming a gift voucher

# How to: Command Line (CLI)



```
# ripe-atlas measure traceroute --target 82.94.235.165 --protocol  
TCP --size 1 --first-hop 64 --max-hops 64 --port 80
```

- "—size" should actually be 0 (will be fixed soon)
  - Please help us by fixing it yourself, make a pull request!
- CLI tools:
  - Source: [github.com/RIPE-NCC/ripe-atlas-tools/](https://github.com/RIPE-NCC/ripe-atlas-tools/)
  - Documentation: [ripe-atlas-tools.readthedocs.org](https://ripe-atlas-tools.readthedocs.org)
  - Included in many Linux/BSD distributions



# Results

- Reachability Map
- Colour-coded for latency
- List of probes and latencies
- Download as JSON

⚡ 3rd TCP Ping measurement to 82.94.235.165 (unciv.nl)

Probe	ASN (IPv4)	ASN (IPv6)	Time (UTC)	RTT	Hop
10150	6830	6830	2017-10-03 11:51	23.829	1
10782	3265	3265	2017-10-03 11:51	18.605	1
24605	3265	3265	2017-10-03 11:51	18.090	1
13538	6830		2017-10-03 11:51	17.560	1
31178	6830		2017-10-03 11:51	16.069	1
16274	28685		2017-10-03 11:51	14.752	1



# Detailed Technical Information



- For 68% of the probe/destination pairs, median values differ by less than 1ms
- Interdecile ranges differ by less than 6ms
- When compared to RTT of 100 milliseconds, a difference in spread of 5-15ms may still be acceptable to assess network performance
- <https://labs.ripe.net/Members/wilhelm/measuring-your-web-server-reachability-with-tcp-ping>

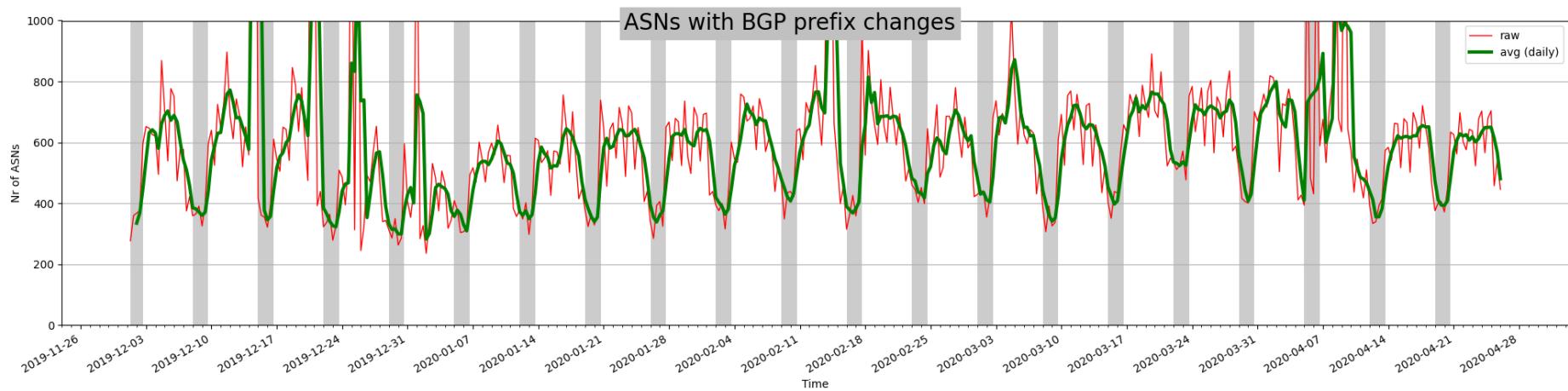


# Internet Health



# Routing and COVID-19

- Number of ASes with any type of origin change in BGP
  - No visible decrease in the number of changes



# Routing and COVID-19

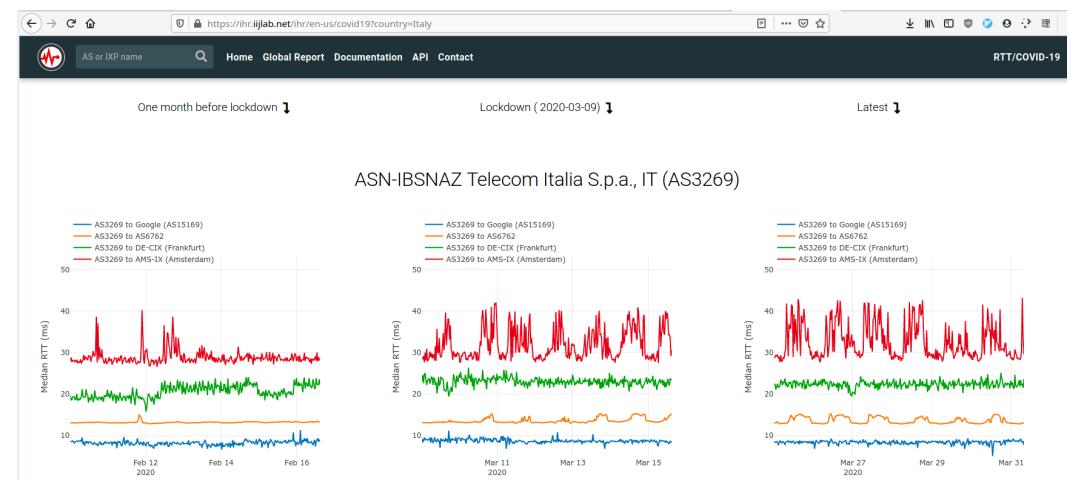


- Normal change pattern
- Periodic dips on Saturday and Sundays
- Stable BGP activity
- Operators take their responsibility and maintain their networks
- More on [RIPE Labs](#)

# RIPE Atlas and COVID-19



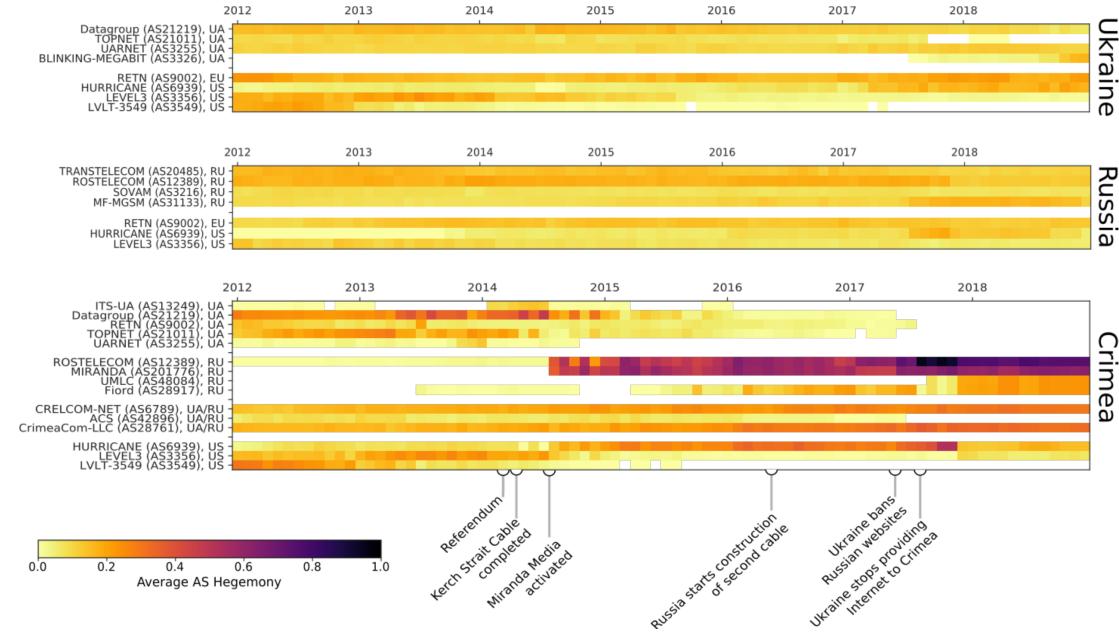
- Internet Health Report during COVID-19
  - Network Delays in Times of Corona (RIPE Labs)
  - Network Delays During National Lockdowns (IHR)
- Internet is keeping up!
- Delays in some locations





# Internet in Crimea (Study)

- Sociological fieldwork and Internet measurement
- Read the full study



# Country Reports



- SEE Region Country Report, April 2020
- Germany Country Report, November 201
- Dutch Routing, August 2019



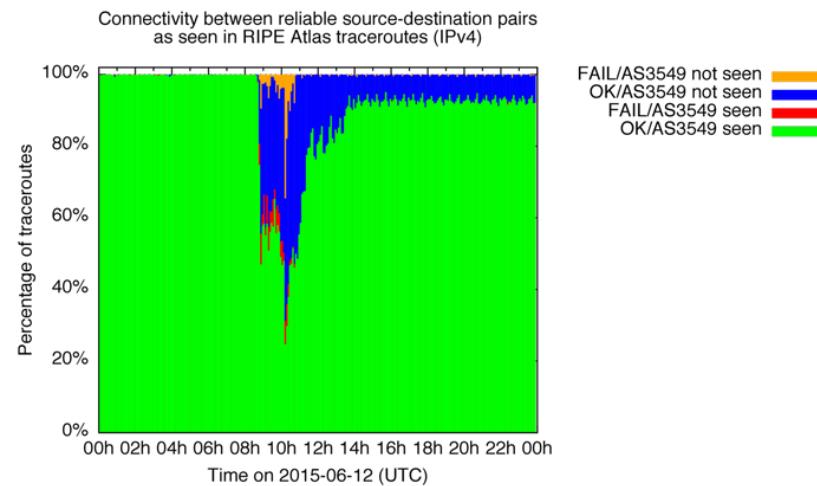
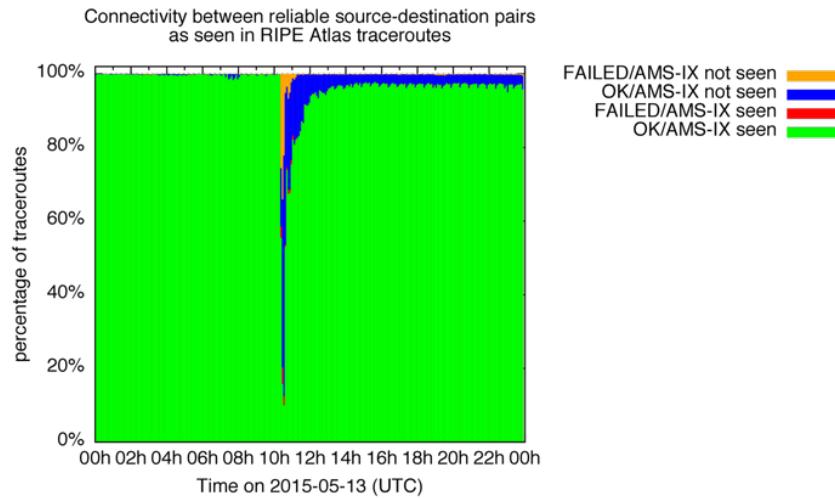


# Outages Visualisations

# Outages at the Core: AMS-IX, Level 3



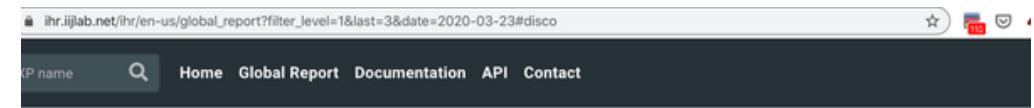
- Does the Internet Route Around Damage? A Case Study Using RIPE Atlas



# Croatian Earthquake, March 2020



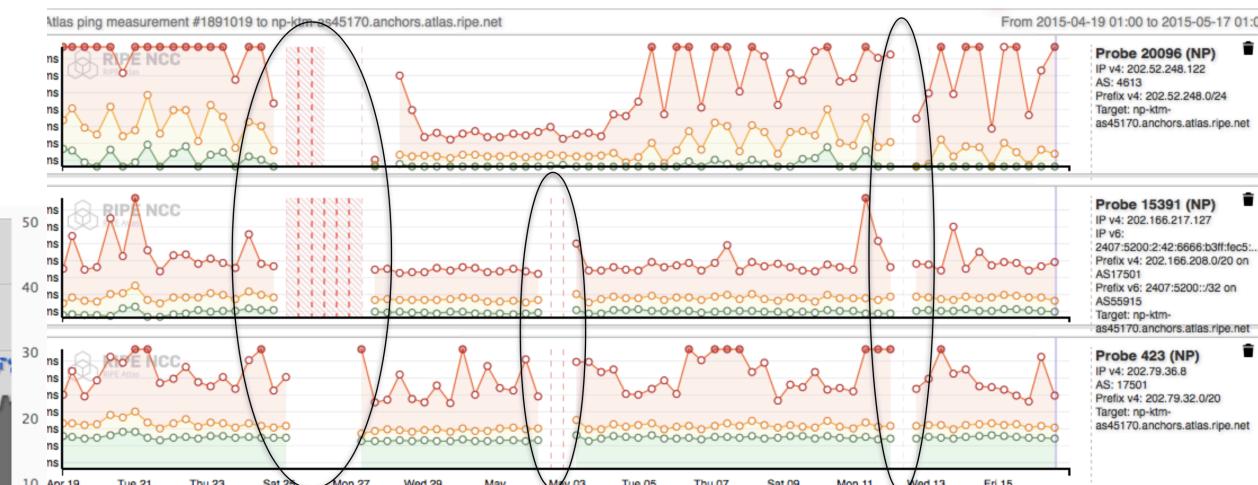
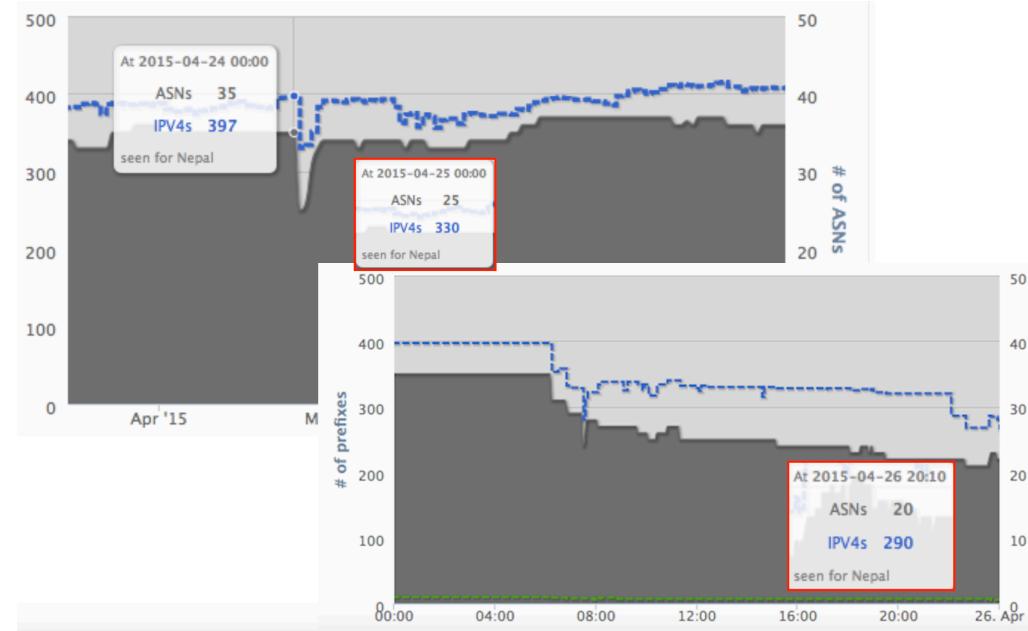
- After the Quake in Croatia



# Earthquake in Nepal, April 2016



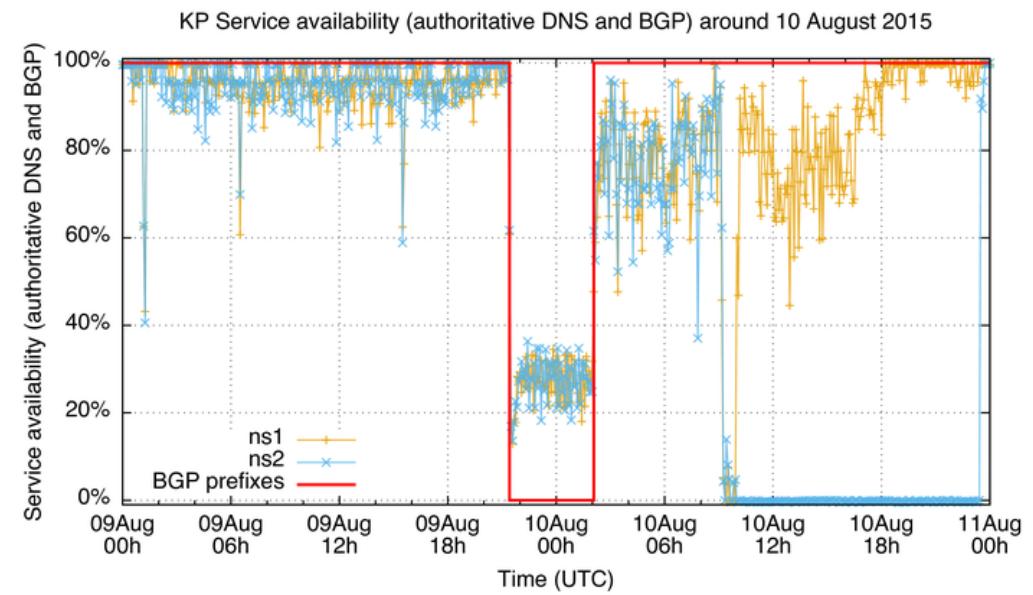
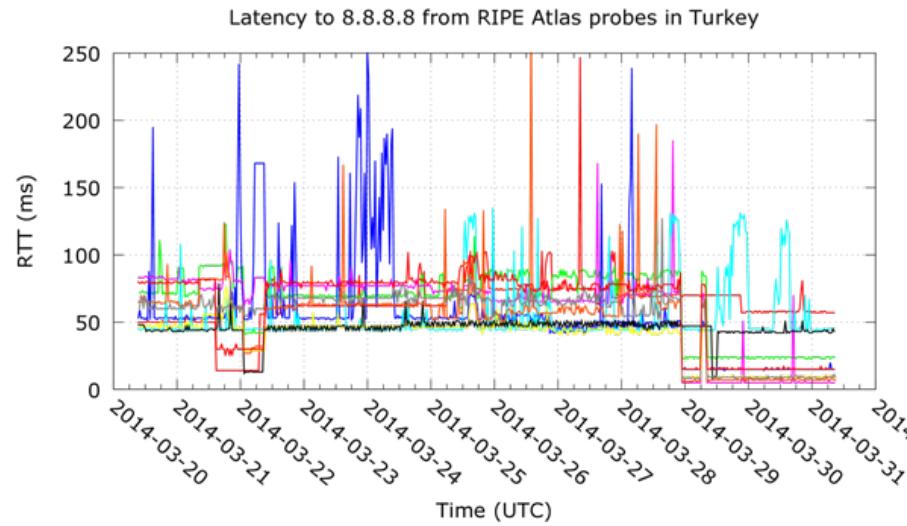
- Using RIPE Atlas and RIPEstat to detect network outage events





# Country Events: .TR, .KP, .IR

- The Internet in North Korea - Hanging by a Single Thread?
- Iran and K-root: The Rest of the Story
- A RIPE Atlas View of Internet Meddling in Turkey



# Power Outage in Amsterdam



- Amsterdam Power Outage as Seen by RIPE Atlas
- RIPE Atlas Hackathon 2015 Discomo Team Visualises Netherlands Power Outage

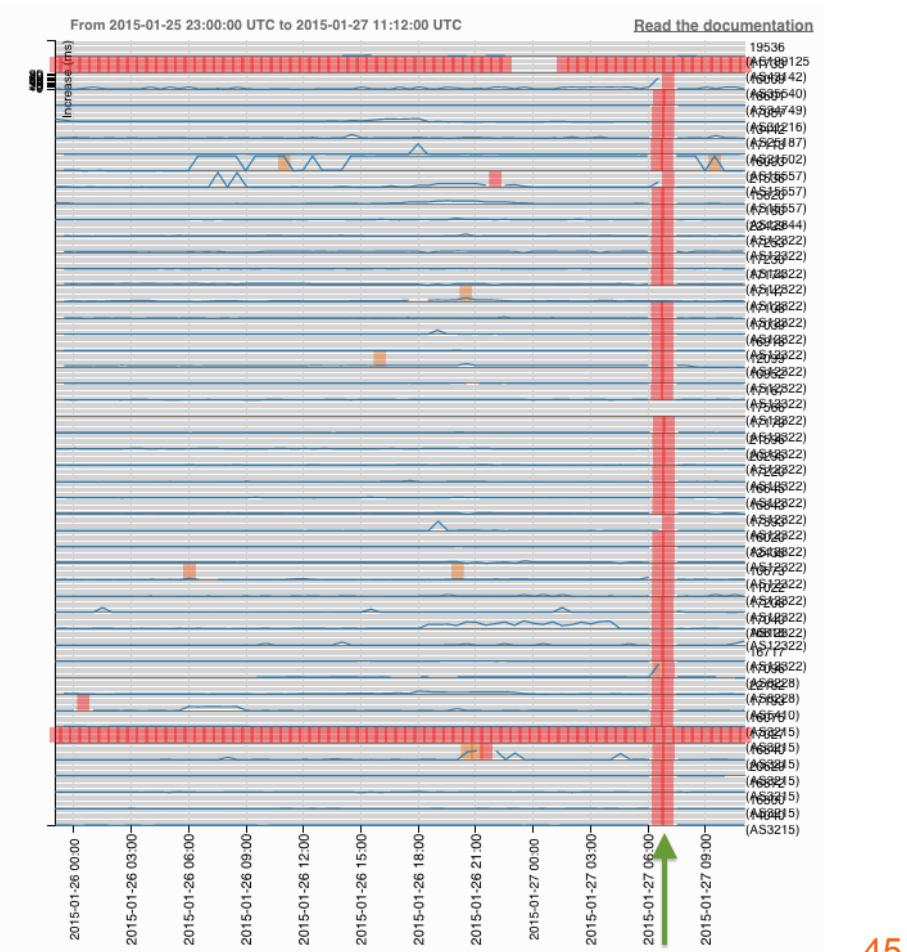


Map created by astrikos

# TWC, ASM-IX and Facebook Outages



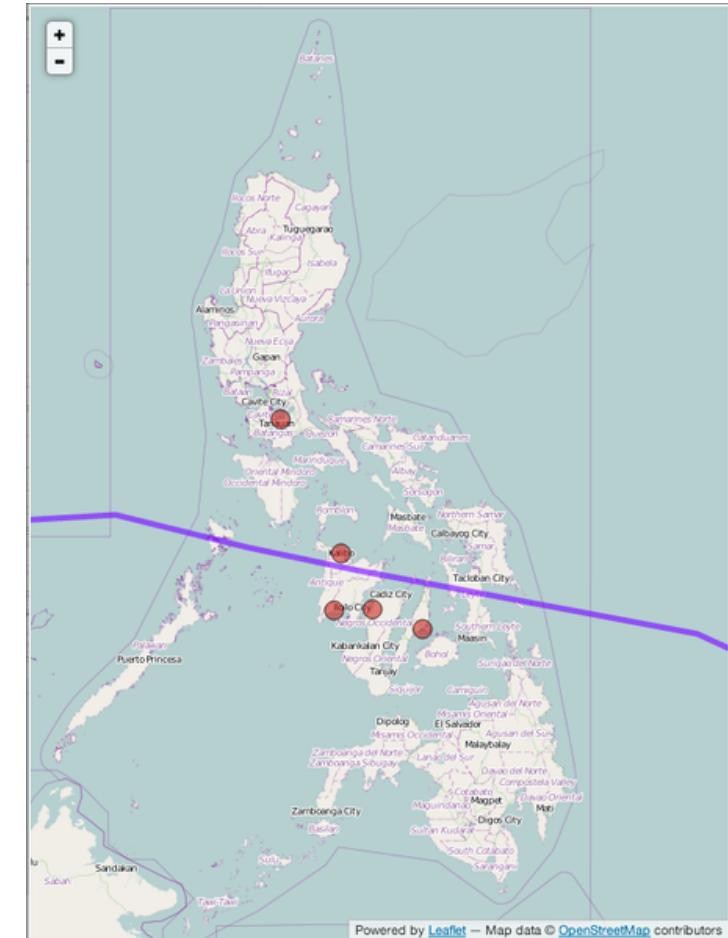
- The AMS-IX Outage as Seen with RIPE Atlas
  - #facebookdown? What Internet Measurement Data Shows
  - Time Warner Cable Outage



# Natural Disasters: Haiyan, Sandy, Pam



- RIPE Atlas: Hurricane Sandy and How the Internet Routes Around Damage
- Typhoon Haiyan - What we see in RIPEstat and RIPE Atlas
- Cyclone Pam and the Internet in Vanuatu





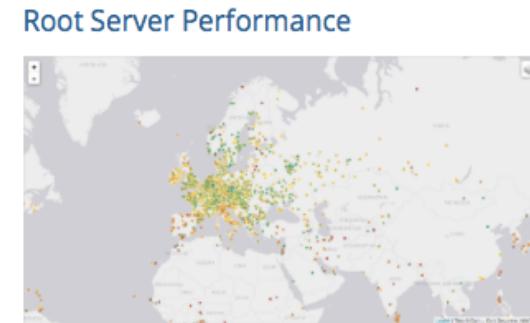
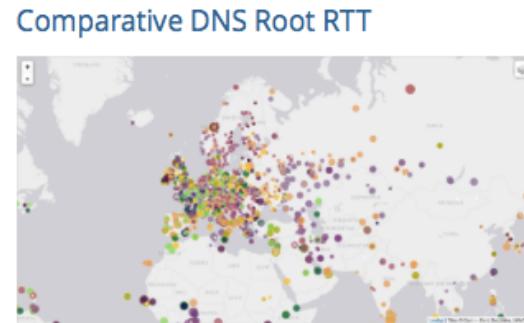
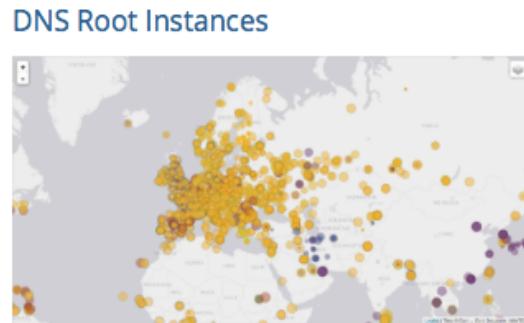
## DNS Related

RIPE Atlas Measurements

# Maps Based on DNS Measurements



- DNS Root Instances
- Comparative DNS Root RTT
- Root Server Performance



# DNSMON



- From anchors to ccTLDs
- An Updated DNS Monitoring Service



# DomainMon



- Like “DNSMON”, but
  - From probes
  - To second-level domains
- RIPE Atlas: DomainMON is Here

Monitor a new domain: ripe.net.

## Servers 12

•	pri.authdns.ripe.net.	193.0.9.5	2001:67c0:0:5
•	sec1.apnic.net.	202.12.29.59	2001:dc0:2001:a:4608:59
•	tinlle.arin.net.	199.212.0.53	2001:500:13::784:35
•	sns-ph-lsc.org.	192.5.4.1	2001:500:2e:1
•	ns3.nic.fr.	192.134.0.49	2001:660:3006:1::1
•	sec3.apnic.net.	202.12.28.140	2001:dc0:1:0:4777:140

## Probes 10

10 probes from Worldwide +



## Measurements 1

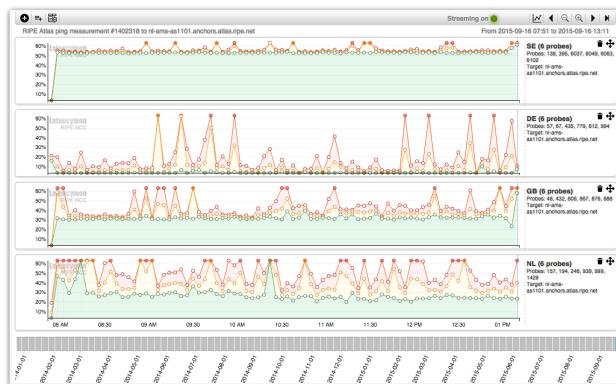
Type	Interval (seconds)	Include?
UDP SOA	3600	<input checked="" type="checkbox"/>
TCP SOA	3600	<input type="checkbox"/>
ICMP Traceroute	3600	<input type="checkbox"/>

Back Monitor

# User Measurements Visualisations



- List of probes: sortable by RTT
- Map: colour-coded by RTT
- LatencyMON: compare multiple latency trends



4 DNS measurement to 195.253.65.6 (c.flexireg)

Probe	ASN (IPv4)	ASN (IPv6)	Time (UTC)	Answer	Response Time
2458	49272	49272	2017-04-05 09:27	NOERROR	42.68
15171	8473	8473	2017-04-05 09:26	NOERROR	30.317
21733	44746	44746	2017-04-05 09:27	NOERROR	44.629
24854	62094	62094	2017-04-05 09:25	NOERROR	29.595



# Additional System and Global DNS Measurements



- Measuring random domains
- Measuring popular domains
  - New RIPE Atlas Root Zone DNS Measurements
- Instead of setting-up your own measurements, use the existing data!

# DNS Measurements Analysis



- DNS Censorship (DNS Lies) As Seen By RIPE Atlas (Stéphane Bortzmeyer)
- Orange Blacklisting: A Case for Measuring Censorship (Stéphane Bortzmeyer, Oct 2016)
- Operator Level DNS Hijacking (Babak Farrokhi, Jul 2016)
- Dissecting DNS Defenses During DDoS Attacks (Giovane Moura, May 2018)

# DNS Measurements Hackathon, April 2017



- Results of the DNS Measurements Hackathon
- DNS resolver hijack tester
  - Out of 6,700 probes, 113 were “suspicious” or “being weird”,
- DNS Fingerprinting to identify hijacked resolvers
  - Top-5 countries were: VN, MG, IQ, ID and KR
- Data sets for researchers, Dec 2018



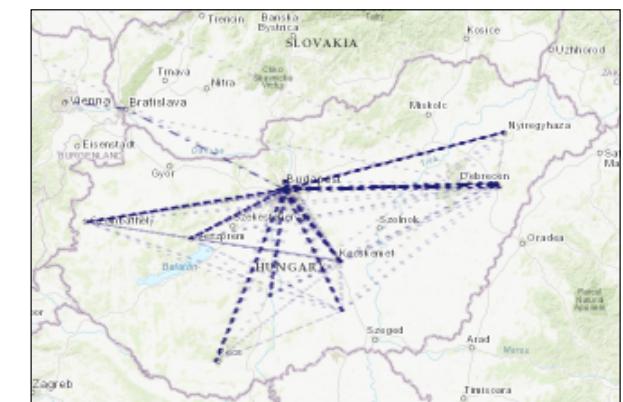
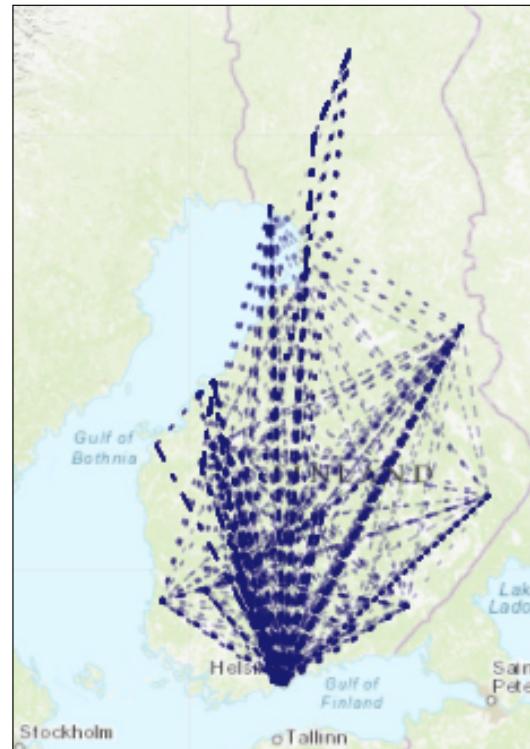
# IXP Country Jedi

# Does Internet Traffic Stay in a Country?

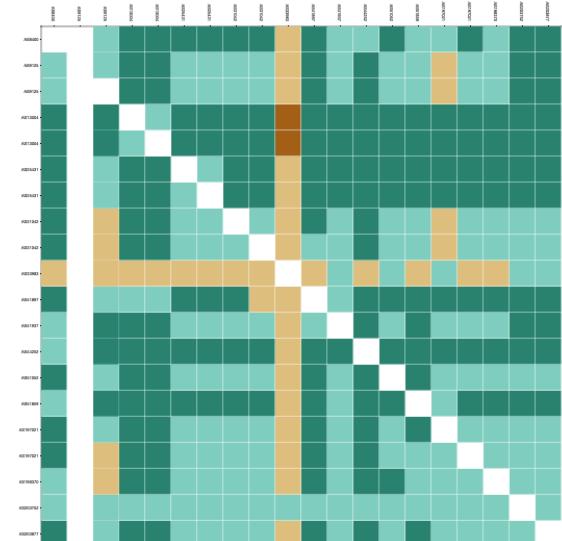
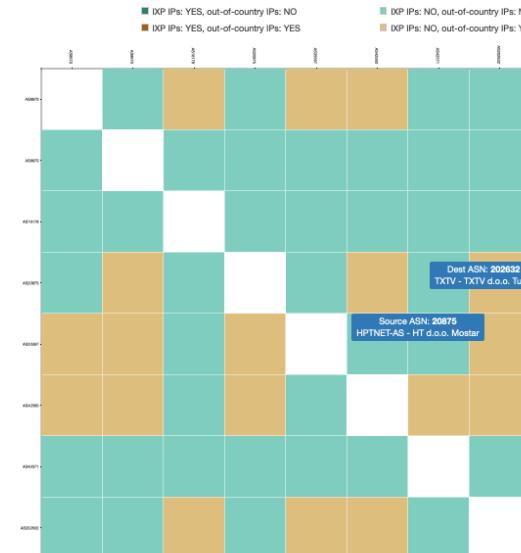
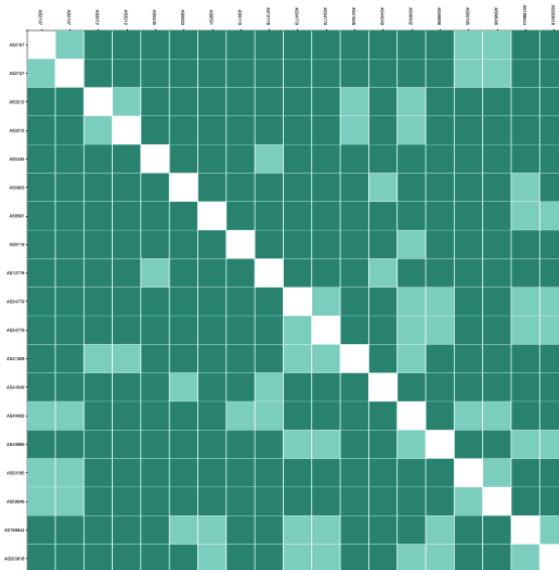


- Internet traffic paths (traceroutes) between RIPE Atlas probes in the same country to answer the following questions:
  - Do the paths take out-of-country detours?
  - Do we see Internet Exchange Points in the paths?
- Probe to probe
- User to user

# IPv4 paths: Hungary, Bosnia, Finland



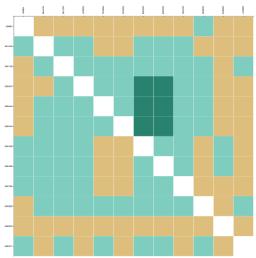
# Slovenia, Bosnia, Serbia



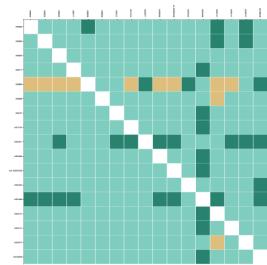
<span style="background-color: darkgreen; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	IXP IPs: YES, out-of-country IPs: NO	<span style="background-color: lightgreen; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	IXP IPs: NO, out-of-country IPs: NO
<span style="background-color: brown; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	IXP IPs: YES, out-of-country IPs: YES	<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 15px; height: 15px;"></span>	IXP IPs: NO, out-of-country IPs: YES



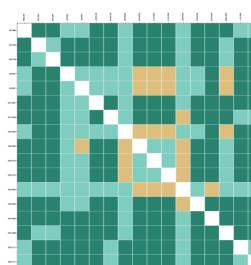
Albania



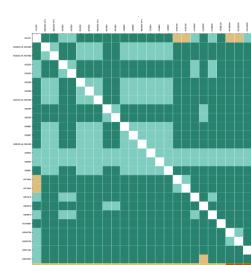
Bulgaria



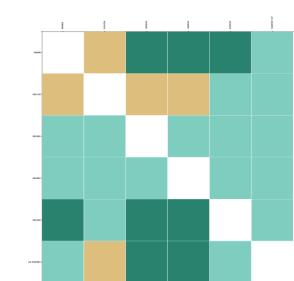
Croatia



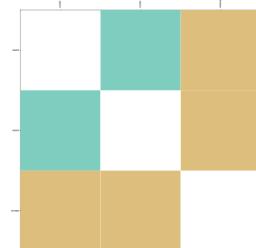
Greece



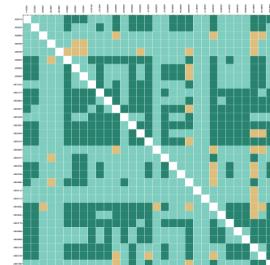
Montenegro



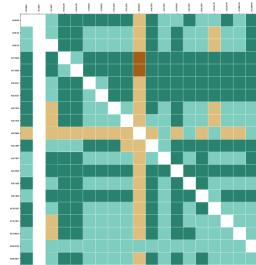
Macedonia



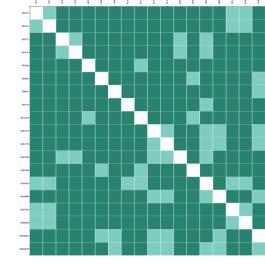
Romania



Serbia

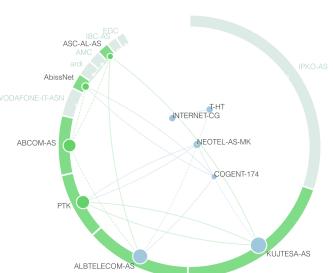


Slovenia

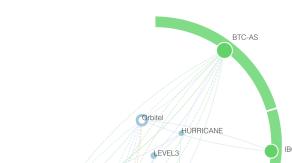




## Albania



# Bulgaria



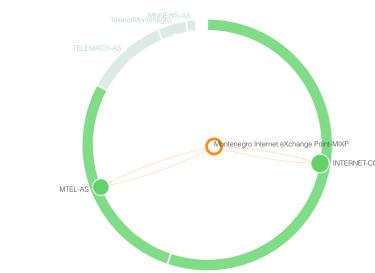
# Croatia



# Greece



# Montenegro

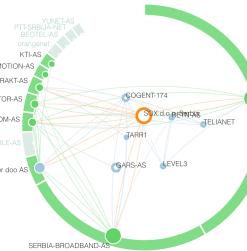


# Macedonia

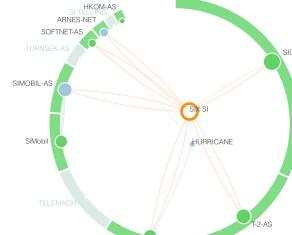
# Romania



# Serbia



# Slovenia





# Questions

[BECHA@ripe.net](mailto:BECHA@ripe.net)  
[emile.aben@ripe.net](mailto:emile.aben@ripe.net)



# Feedback



- What would you want to do with this data?
- What is missing?
- What could be easier?

# Get Involved



- Use RIPE Atlas and RIS for your purposes: data analysis, network troubleshooting, investigative journalism
- Do scientific research and add your paper to the Wikipedia page
- Contribute to the code and community tools
- Add multi-lingual content / documentation on GitHub
- Sponsor a hackathon!
- Host a RIPE Atlas anchor or a (SW) probe
- Write a RIPE Labs article



**With Great Power  
Comes  
Great Responsibility**