



**RIPE NCC**  
RIPE NETWORK COORDINATION CENTER

# **RIPE Atlas in Action**

## **The Connectivity of Moldova**

Alex Semenyaka | June 2025 | RIPE NCC Days Chisinau

# RIPE Atlas



## What is RIPE Atlas?

RIPE Atlas is the RIPE NCC's main Internet data collection system. It is a global network of devices, called probes and anchors, that actively measure Internet connectivity. Anyone can access this data via Internet traffic maps, streaming data visualisations, and an API. RIPE Atlas users can also perform customised measurements to gain valuable data about their own networks.

# What is RIPE Atlas?

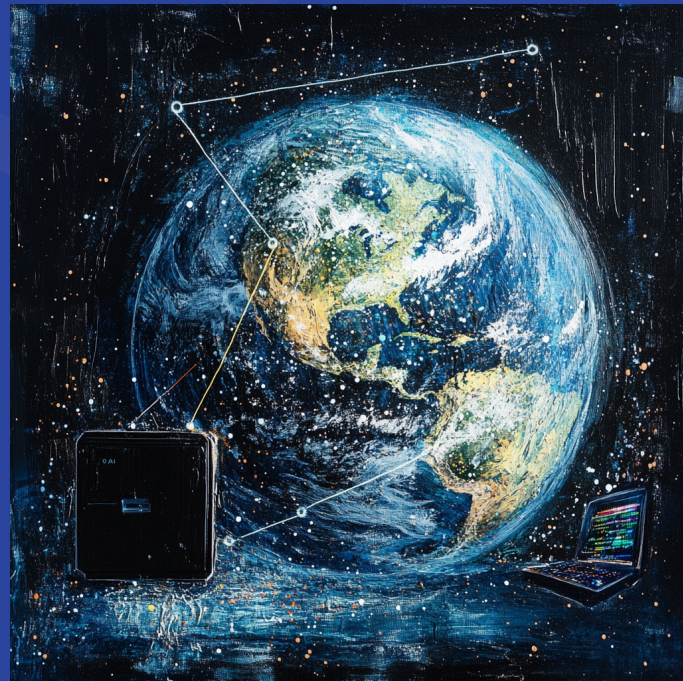


## A technology...

- Can be embedded into the different products
- Including your internal ones

## ...measuring some parameters

- from any probe/anchor
- to any point of the Internet



Check <https://atlas.ripe.net/>



# Equipment



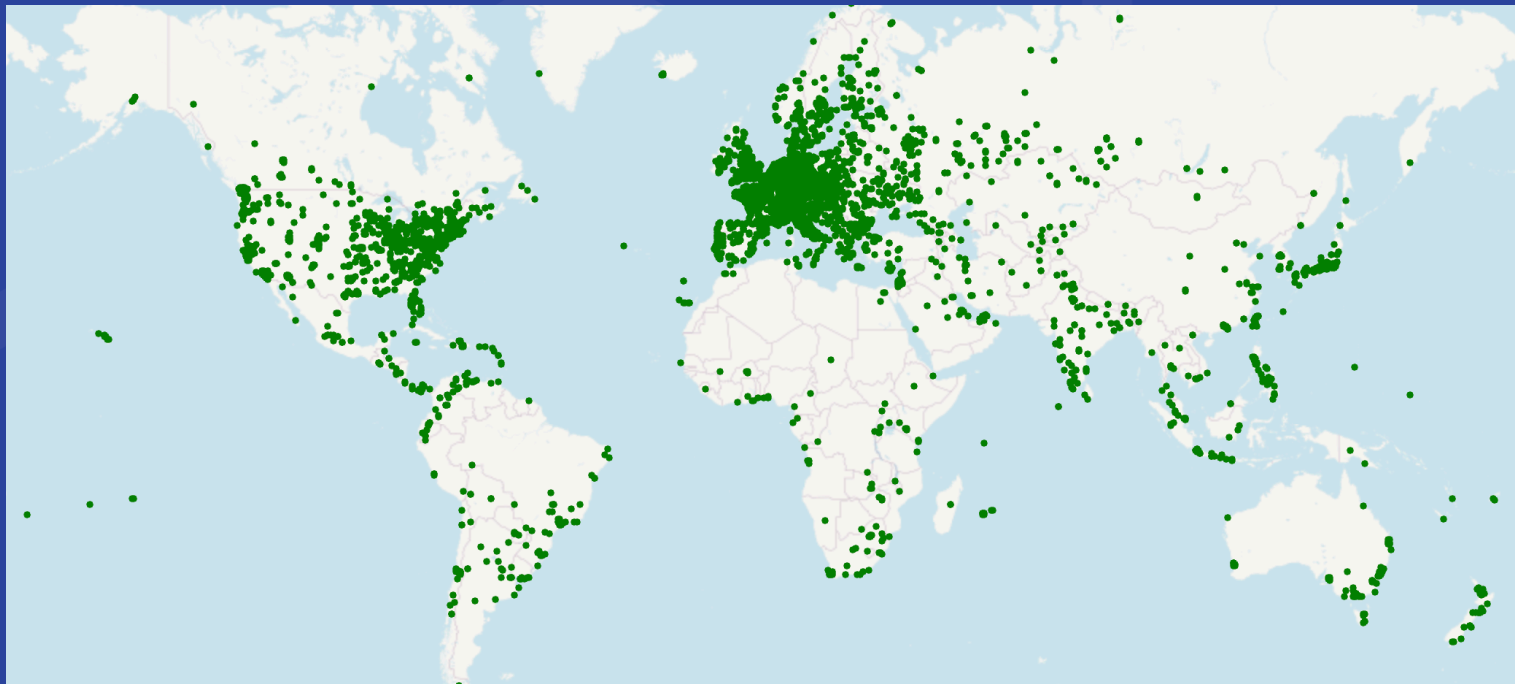
**RIPE Atlas  
Probe**



**RIPE Atlas  
Anchor**

**“Virtual”  
(software)  
versions also  
exist!**

# RIPE Atlas Probes distribution

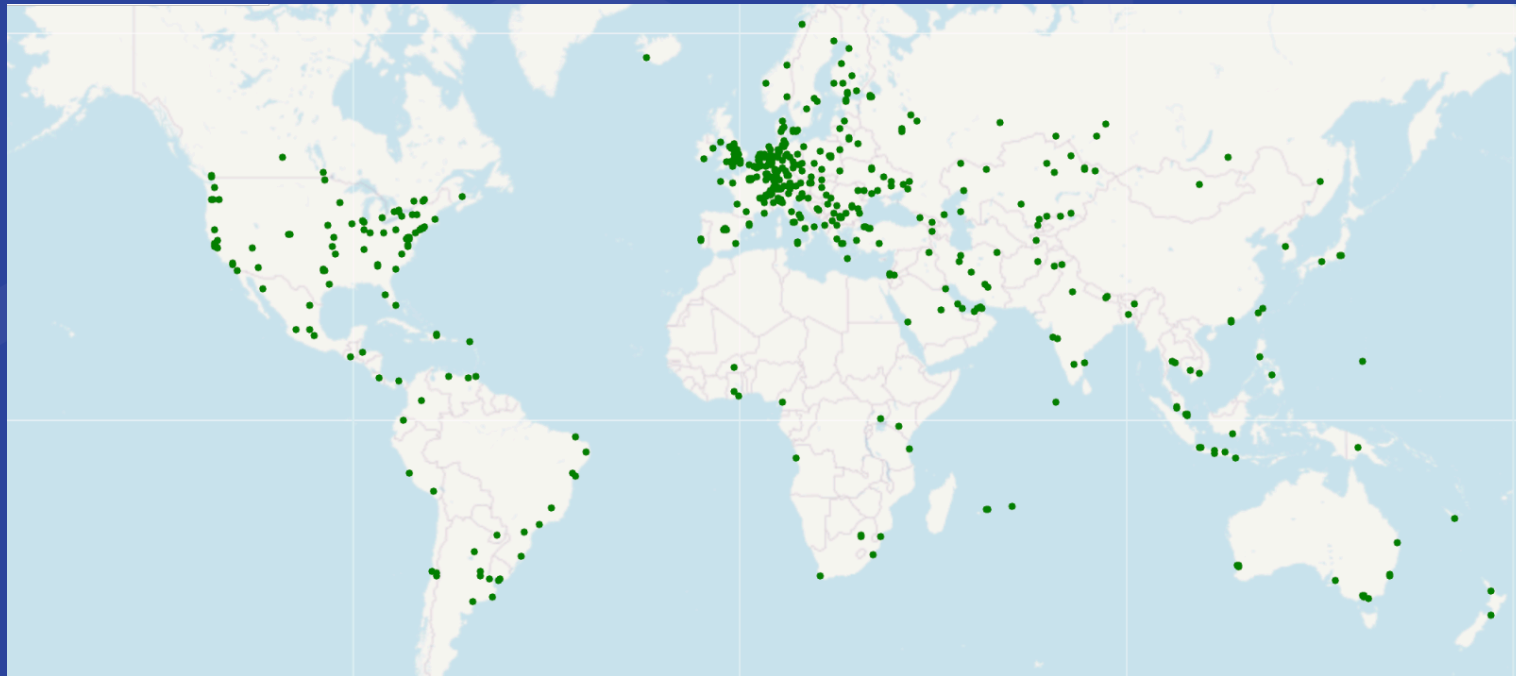


**All over the globe**

**13000+ probes**

**177 countries**

# RIPE Atlas Anchors distribution



**All over the globe**

**1000+ anchors**

**103 countries**

# Types of measurements



Probe	ASN (IPv4)	ASN (IPv6)		Time (UTC)	RTT	Packet Loss
6101	53824	53824		2021-02-12 04:51	0.777	0.0%
10394	22773			2021-02-12 04:51	81.322	0.0%
19270	22773			2021-02-12 04:51	33.879	0.0%
1000732	14315			2021-02-12 04:51	12.170	0.0%

Probe	ASN (IPv4)	ASN (IPv6)		Time (UTC)	RTT	Hops	Success
162	24638			2021-02-12 04:53	2.680	7	✓
165	42548			2021-02-12 04:53			No recent report available
224	8331	8331		2021-02-12 04:53	2.276	6	✓
241	8359	8359		2021-02-12 04:53	3.104	10	✓
401	8359	8359		2021-02-12 04:53	3.049	10	✓
567	2609	5438		2021-02-12 04:53	82.171	11	✓

Probe	ASN (IPv4)	ASN (IPv6)		Time (UTC)	Answer	Response Time
10122	35567			2021-02-12 02:25	NOERROR	40.16
10146	7922			2021-02-12 02:25	NOERROR	22.669
12851	25229			2021-02-12 02:25	NOERROR	45.347
13299	15399			2021-02-12 02:25	NOERROR	3.402
16063	6830			2021-02-12 02:25	NOERROR	84.098

Probe	ASN (IPv4)	ASN (IPv6)		Time (UTC)	Majority	Validity	Self Signed
1119	7922			2021-02-10 13:49	✗ Error: handshake_failure		
4155	20115			2021-02-10 13:49	✗ Error: handshake_failure		
4706	14051			2021-02-10 13:49	✗ Error: handshake_failure		
10597		7922		2021-02-10 13:49	Yes	Time SAN *	
11500	7922	7922		2021-02-10 13:49	Yes	Time SAN *	
12334	11351	11351		2021-02-10 13:49	Yes	Time SAN *	

## What you can measure

- ICMP echo (ping)
- Traceroute (TCP, UDP, ICMP)
- DNS
- HTTP
- SSL/TLS
- NTP

**+a lot of precautions and measures against converting it to a botnet**

# Methods to create measurements



## On the website

- <https://atlas.ripe.net>

## REST API

- <https://beta-docs.atlas.ripe.net/apis/>

## Command-line interface

- <https://github.com/RIPE-NCC/ripe-atlas-tools>
- <https://framagit.org/bortzmeyer/blaueu>

## Python frameworks

- <https://github.com/RIPE-NCC/ripe-atlas-cousteau>
- <https://github.com/RIPE-NCC/ripe-atlas-sagan>

# Where results to be found?



## Most of the results are public

### RIPE Atlas Website

- <https://atlas.ripe.net>

### RIPE Atlas API

- <https://beta-docs.atlas.ripe.net/apis/>

### RIPE Atlas storage

- <https://data-store.ripe.net/datasets/atlas-daily-dumps/>

### Google BigQuery

- <https://github.com/RIPE-NCC/ripe-atlas-bigquery/blob/main/docs/gettingstarted.md>

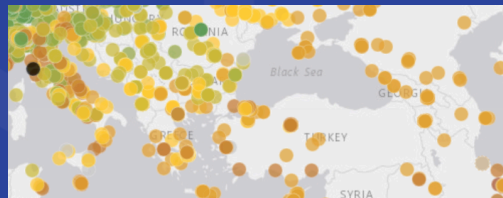
# Built-in “Internet Maps”



## Ready-to-use products

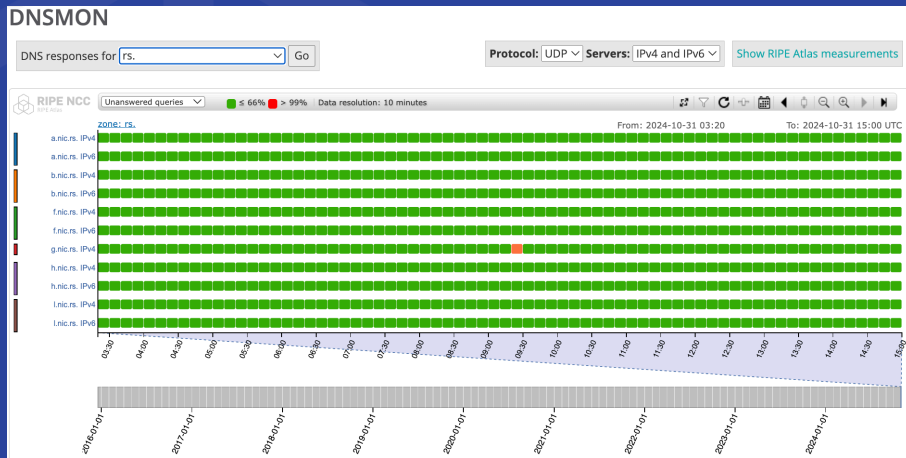
### RTT Measurements

- To some fixed destinations



### Root DNS Monitoring

- DNS Root Instances
  - which one is using?
- Comparative DNS Root RTT
  - which one is closer?
- DNS Root Server Performance
  - how fast they are?
- DNSMON
  - quality of the tld DNS servers answers
- DomainMON
  - monitors your own domains



# Connectivity research





## We have geography

- Each probe have it's geographic coordinates

## We have sources

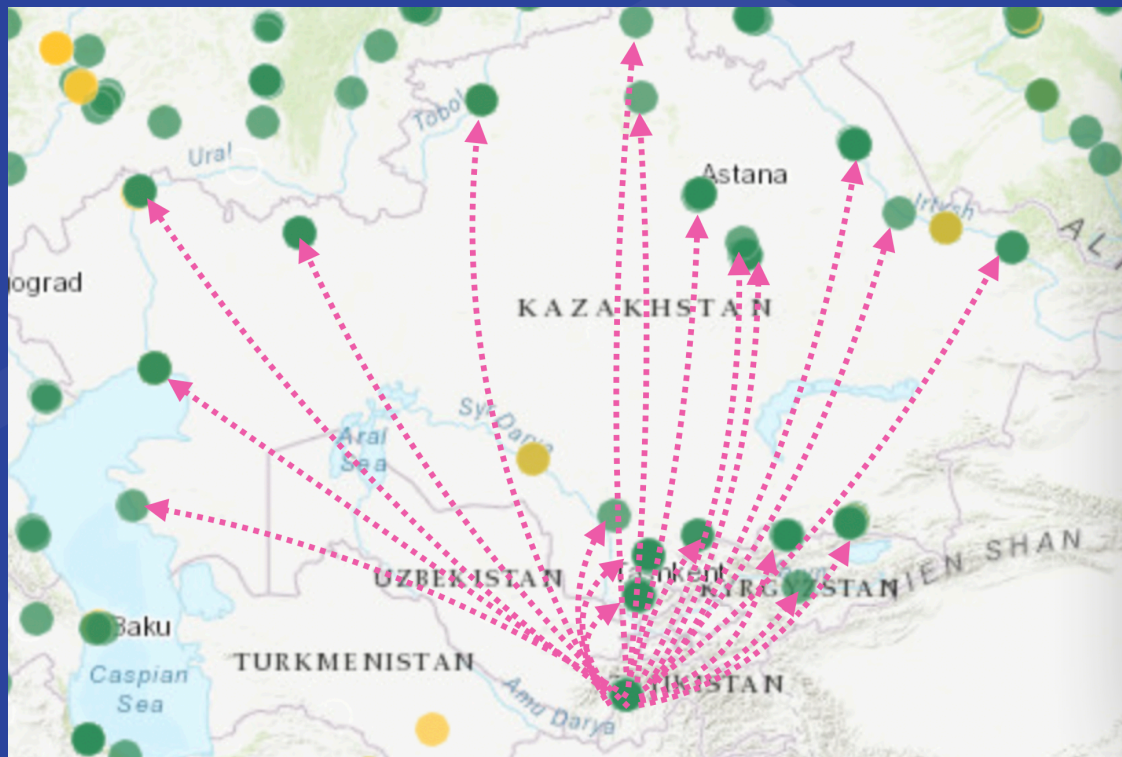
## We have destinations

- Our Atlas probes and Anchors in both cases

## We can gather mutual traceroutes

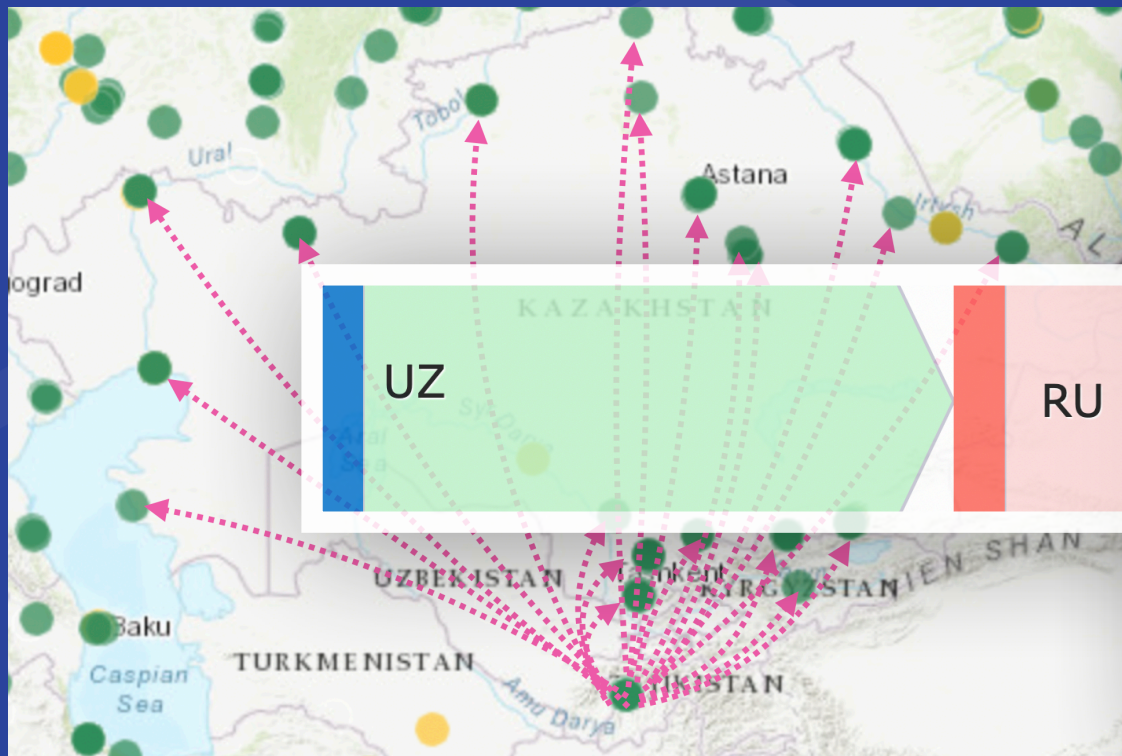
- And the geolocate all intermediate routers
- Then we can reveal the geopaths of packets

# Central Asia case: methodology



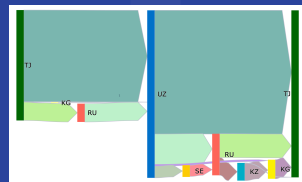
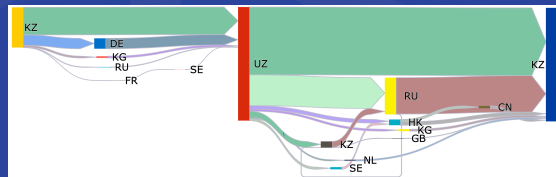
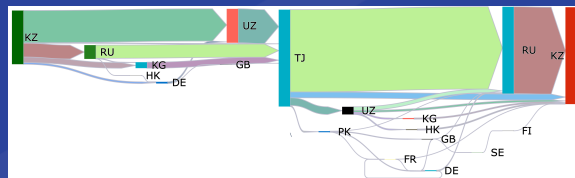
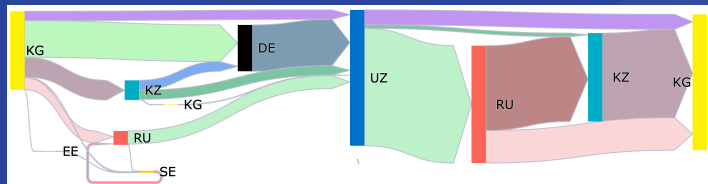
- 1: 172.18.0.1
- 2: 10.10.10.1
- 3: 62.122.137.35
- 4: 62.122.137.1
- 5: 62.122.136.66
- 6: 62.122.136.82
- 7: 91.218.162.141
- 8: 212.46.238.57
- 9: 79.104.235.207
- 10: 81.211.81.125
- 11: 95.59.172.18
- 12: 95.59.172.12
- 13: 95.59.170.57
- 14: 92.47.144.142
- 15: 95.59.172.12 81.211.193.45

# Central Asia case: methodology



1: 172.18.0.1  
2: 10.10.10.1  
3: 62.122.137.35  
4: 62.122.137.1  
5: 62.122.136.66  
6: 62.122.136.82  
7: 91.218.162.141  
8: 212.46.237.7  
9: 79.104.235.207  
10: 81.211.81.125  
11: 95.59.172.18  
12: 95.59.172.12  
13: 95.59.170.57  
14: 92.47.144.142  
15: 95.59.172.12 81.211.193.45

# Central Asia case: results



## Basic trends

- Traffic is becoming regionalised
- Connectivity continues to diversify
- New players are emerging

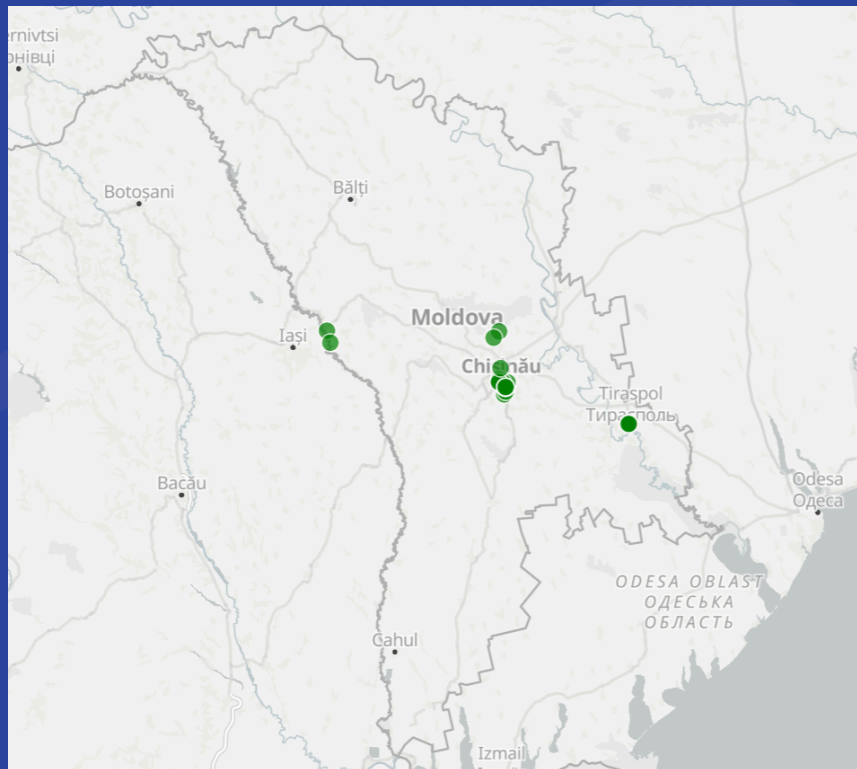
## Some oddities found

- KZ-RU-HK-DE-GB-TJ
- TJ-PT-GB-SE-FI-KZ
- UZ-SE-RU-KZ-KG-TJ
- UZ-SE-HK-CN-KZ



# Case of Moldova

# RIPE Atlas probes in Moldova



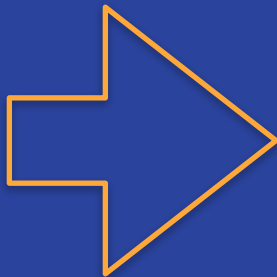
- Probes exist beyond Chisinau — which is good
  - ▶ However, geographic diversity is still limited
- Total number of probes remains low
- Clear room for growth and outreach

# RIPE Atlas probes: neighbours



## Probes and opportunities

- Romania: 96 probes
- Ukraine: 195 probes



- 14550 combinations “src-dst”
- Digging up data on hundreds of thousands of intermediate nodes

**Repeating the methodology for Central Asia would be TOO labour-intensive**

# Science behind ping



## Some math...

$$RTT = d_1 + d_2 + d_3$$

$$d_1 = \sum_i (\text{propagation delay})_i$$

Channels

$$d_2 = \sum_i (\text{equipment delay})_i$$

Hardware

$$d_3 = \sum_i (\text{queue delay})_i$$

Load

$$\min(d_3) = 0 \quad (!)$$

• In 2025:

$$d_2 \approx 0$$



$$RTT = \min(\{RTT_i\}) = d_1 + d_2$$

$$d_1 = \sum_i \frac{\text{distance}_i}{c_{\text{fibre } i}}$$

Length of the fiber sector

Velocity of speed in this fibre

The speed of light in different fibers differs insignificantly ( $\pm 10\%$  max), so:

$$d_1 \approx \frac{\text{total distance}}{c_{\text{fibre}}}$$

$$RTT \approx \frac{\text{total distance}}{c_{\text{fibre}}}$$





## Some physics...

- The speed of light in fiber is 60-70% of the speed of light in vacuum, i.e.

$$c_{\text{fibre}} \approx 200 \frac{\text{km}}{\text{ms}}$$

- Therefore, in the case of perfectly straight fiber the ratio

$$S = 100 \frac{RTT, \text{ms}}{\text{distance}, \text{km}} \quad \text{is equal to 1}$$



## Simplified approach

- Let's measure RTT!
  - Moldova ↔ Moldova
  - Ukraine ↔ Moldova
  - Romania ↔ Moldova
- Filter out bizarre probes and probes in disputable locations
- Find a minimal RTT between each two points
- Analyze the RTT and S-factor matrix
- Try to find oddities and analyse them

# Internal connectivity: S-factor

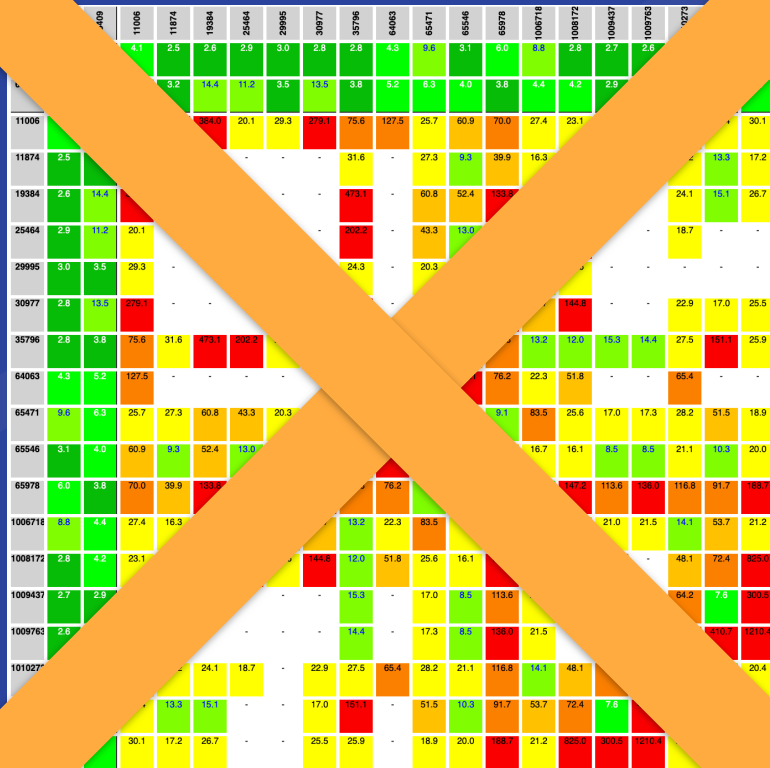


	64417	65409	11006	11874	19384	25464	29995	30977	35796	64063	65471	65546	65978	1006718	1008172	1009437	1009703	1010273	1010750	1010753
64417	-	92.5	4.1	2.5	2.6	2.9	3.0	2.8	2.8	4.3	1.6	3.1	6.0	8.8	2.8	2.7	2.6	2.9	3.1	3.1
65409	92.5	-	5.5	3.2	14.4	11.2	3.5	13.5	9.8	5.2	6.3	4.0	3.8	4.4	4.2	2.9	3.2	4.1	18.8	4.1
11006	4.1	5.5	-	133.0	384.0	20.1	29.3	27.9	75.8	127.5	25.7	60.9	70.0	27.4	23.1	19.1	21.0	39.6	23.4	30.1
11874	2.5	3.2	133.0	-	-	-	-	-	31.6	-	27.3	9.3	38.9	16.3	10.9	-	-	17.2	13.3	17.2
19384	2.6	14.4	384.0	-	-	-	-	-	473.1	-	60.8	52.4	133.8	47.9	182.2	-	-	24.1	15.1	26.7
25464	2.9	11.2	20.1	-	-	-	-	-	202.2	-	43.3	13.0	794.5	35.6	296.4	-	-	18.7	-	-
29995	3.0	3.5	29.3	-	-	-	-	-	24.3	-	20.3	17.1	70.5	16.4	25.6	-	-	-	-	-
30977	2.8	13.8	279.1	-	-	-	-	-	493.3	-	56.4	47.4	136.8	59.7	144.8	-	-	22.9	17.0	25.5
35796	2.8	9.8	75.6	31.6	473.1	202.2	24.3	493.3	-	116.3	17.5	38.0	65.8	13.2	12.0	15.9	14.4	27.5	151.1	25.9
64063	4.3	5.2	127.5	-	-	-	-	-	116.3	-	25.2	70.1	76.2	22.3	51.8	-	-	65.4	-	-
65471	9.6	6.3	25.7	27.3	60.8	43.3	20.3	56.4	17.5	25.2	-	31.3	9.1	83.5	25.6	17.0	17.3	28.2	51.5	18.9
65546	3.1	4.0	60.9	9.3	52.4	13.0	17.1	47.4	38.0	700.1	31.3	-	57.0	16.7	16.1	8.0	8.6	21.1	10.0	20.0
65978	6.0	9.8	70.0	39.9	133.8	794.5	70.5	136.8	65.8	76.2	9.1	57.0	-	5.8	147.2	113.6	136.0	116.8	31.7	186.7
1006718	8.8	4.4	27.4	16.3	47.9	35.6	16.4	59.7	13.2	22.3	63.5	16.7	5.9	-	13.1	21.0	21.5	14.1	53.7	21.2
1008172	2.8	4.2	23.1	10.9	182.2	296.4	25.6	144.8	12.0	51.8	25.6	16.1	147.2	13.1	-	117.0	-	48.1	72.4	825.0
1009437	2.7	2.9	19.1	-	-	-	-	-	15.3	-	17.0	8.5	113.6	21.0	117.0	-	-	64.2	7.6	300.5
1009703	2.8	3.2	21.0	-	-	-	-	-	14.4	-	17.3	8.5	136.0	21.5	-	-	-	68.1	410.7	1210.4
1010273	2.9	4.1	39.6	17.2	24.1	18.7	-	22.9	27.5	65.4	28.2	21.1	116.8	14.1	48.1	64.2	69.1	-	10.7	20.4
1010750	3.1	18.8	23.4	13.3	15.1	-	-	17.0	151.1	-	51.5	10.3	91.7	53.7	72.4	7.6	410.7	10.7	-	10.1
1010753	3.1	4.1	30.1	17.2	26.7	-	-	25.5	25.9	-	18.9	20.0	186.7	21.2	825.0	300.5	1310.4	20.4	15.1	-

## S-factor does not work

- Distances too small, error too large
- Best results: two distant probes on the Romanian border

# Internal connectivity: S-factor



## S-factor does not work

- Distances too small, error too large
- Best results: two distant probes on the Romanian border

# Internal connectivity: RTT



	11006	11874	19384	25464	29995	30977	35796	64063	64417	65409	65471	65546	65978	1006718	1008172	1009437	1009763	1010273	1010750	1010753
11006	0.3	1.0	4.9	1.6	1.1	3.9	1.0	2.6	3.6	4.6	5.9	1.3	4.3	1.4	0.9	1.0	1.1	1.2	1.4	1.2
11874	1.0	-	-	-	-	-	0.6	-	2.5	3.1	6.6	0.5	3.1	3.3	0.5	-	-	0.6	0.8	0.8
19384	4.9	-	-	-	-	-	8.8	-	2.6	11.8	14.0	0.9	8.9	9.4	8.3	-	-	0.9	0.9	1.2
25464	1.6	-	-	-	-	-	11.7	-	2.9	9.7	13.1	1.2	12.9	9.4	9.8	-	-	0.9	-	-
29995	1.1	-	-	-	0.3	-	0.7	-	2.9	3.2	5.1	1.0	3.4	3.4	0.7	-	-	-	-	-
30977	3.9	-	-	-	-	-	9.7	-	2.7	11.1	13.0	0.9	9.3	11.6	6.8	-	-	0.9	1.0	1.2
35796	1.0	0.6	8.8	11.7	0.7	9.7	0.2	2.0	2.5	3.2	4.2	0.8	3.2	2.8	0.4	0.6	0.6	0.6	9.8	0.8
64063	2.6	-	-	-	-	-	2.0	-	3.9	4.6	6.5	2.1	4.6	4.7	2.0	-	-	2.1	-	-
64417	3.6	2.6	2.6	2.9	2.9	2.7	2.5	3.9	0.5	5.7	8.0	3.0	5.8	8.8	2.4	2.8	2.7	2.5	2.7	2.7
65409	4.6	3.1	11.8	9.7	3.2	11.1	3.2	4.6	5.7	0.5	5.3	9.6	3.6	3.4	3.5	2.9	3.1	3.4	14.8	3.4
65471	5.8	6.8	14.0	13.1	5.1	13.0	4.2	6.5	8.0	5.3	0.6	7.6	3.1	3.3	5.6	4.9	5.0	5.9	8.7	4.9
65546	1.3	0.5	0.9	1.2	1.0	0.9	0.8	2.1	3.0	3.6	7.6	0.4	3.5	3.5	0.7	0.7	0.8	0.7	0.8	0.8
65978	4.3	3.1	8.9	12.9	3.4	9.3	3.2	4.6	5.6	3.6	3.1	3.5	0.7	1.6	2.8	3.1	3.3	3.5	10.2	3.6
1006718	8.4	3.3	9.4	9.4	3.4	11.6	2.8	4.7	8.8	3.4	3.3	3.5	1.6	0.1	3.1	4.9	5.1	3.2	7.7	5.9
1008172	0.9	0.5	8.3	9.8	0.7	6.8	0.4	2.0	2.4	3.5	6.6	0.7	2.8	3.1	0.0	0.3	0.6	0.6	6.6	0.7
1009437	1.0	-	-	-	-	-	0.6	-	2.8	2.9	4.9	0.7	3.1	1.9	0.3	-	-	0.6	0.8	0.8
1009763	1.1	-	-	-	-	-	0.6	-	2.7	3.1	5.0	0.8	3.3	4.3	0.6	-	-	0.8	3.5	1.0
1010273	1.2	0.6	0.9	0.9	-	0.9	0.6	2.1	2.5	3.4	6.9	0.7	3.5	3.2	0.6	0.6	0.8	0.0	0.9	0.3
1010750	1.4	0.8	0.9	-	-	1.0	9.8	-	2.7	14.8	8.7	0.8	10.2	7.7	6.6	0.8	3.5	0.9	0.1	1.0
1010753	1.2	0.8	1.2	-	-	1.2	0.8	-	2.7	3.4	4.9	0.8	3.6	5.0	0.7	0.8	1.0	0.3	1.0	0.0

## Evaluation: not bad

- Most of RTT inside the country are below 10 ms
- Only one value greater than 25 ms was detected
  - ▶ Between probes #1009763 and #1010750
  - ▶ AS Sequence from traceroute:
    - AS31252 (Starnet)
    - InterLAN
    - AS6939 (HE)
    - AS28917 (Fiord), Frankfurt
    - AS8926 (Moldtelecom)
    - AS200019 (AlexHost)
- Oversight in routing policies

# Connectivity between Moldova and Ukraine (S-factor)



← Probes from UA →

← Probes from MD →

	3775	6930	7371	10972	11003	11060	12357	13429	13443	23718	25432	26622	27527	29683	32723	50011	53329	53657	54687	1000356	1000360	1000413	1002506	1006834	1007156	1009365	1010182
11006	12.8	25.4	13.5	43.7	12.2	13.5	21.9	13.8	17.4	22.3	2.5	-	8.5	11.5	-	13.1	14.4	9.9	30.2	10.4	17.8	17.7	12.0	11.7	41.7	19.9	10.8
11874	-	40.2	10.2	-	11.2	9.5	-	-	11.8	-	19.6	-	-	12.2	-	11.5	-	8.6	23.5	24.2	-	-	12.8	11.3	42.9	18.6	19.3
19384	-	1.2	5.8	-	5.4	7.0	-	-	7.7	-	2.2	-	-	12.3	-	5.4	-	8.0	2.5	8.1	-	-	11.7	5.6	12.1	8.7	8.6
25464	-	41.5	11.1	-	11.3	10.8	-	-	11.1	-	13.7	-	-	8.3	-	11.5	-	6.9	25.3	7.5	-	-	12.9	11.3	43.2	17.2	8.3
29995	-	32.9	5.3	-	5.3	5.6	-	-	7.4	-	2.3	-	-	5.9	-	4.8	-	4.8	3.5	7.7	-	-	6.7	5.5	12.5	8.9	7.4
30977	-	7.1	5.8	-	5.4	7.0	-	-	7.7	-	2.2	-	-	12.3	-	5.4	-	8.0	2.5	7.4	-	-	11.1	5.6	12.1	8.7	8.2
35796	7.4	13.3	5.4	40.1	5.3	6.4	28.1	5.5	8.4	10.7	14.0	-	5.7	5.9	-	5.3	7.0	7.5	14.5	7.4	8.1	11.3	6.8	5.3	12.2	9.2	9.0
64063	-	22.5	6.0	-	5.6	7.4	-	-	8.1	-	2.8	-	-	13.7	-	5.6	-	10.4	3.7	8.6	-	-	15.1	5.8	13.4	9.2	7.9
64417	16.8	6.0	7.5	33.1	7.0	8.3	2.7	1.5	11.8	5.0	2.2	-	7.4	19.0	-	7.0	7.3	13.0	2.9	11.7	14.9	3.4	20.2	7.2	9.8	10.3	12.0
65409	8.6	10.2	9.6	33.0	1.8	9.0	9.7	12.9	13.1	8.9	9.3	-	6.4	11.8	-	9.3	7.4	18.0	6.2	12.4	15.0	13.7	11.5	8.1	10.6	19.8	12.1
65471	7.5	13.9	5.7	43.2	6.4	7.0	28.9	7.1	8.7	11.2	13.8	-	5.9	6.1	-	6.0	7.5	5.0	14.0	9.8	8.9	13.0	7.1	6.0	15.2	12.1	9.5
65546	14.4	24.9	12.5	42.5	12.4	10.0	25.0	13.5	14.9	24.0	2.2	-	8.2	11.3	-	13.0	13.9	9.8	29.4	15.2	17.1	21.6	11.9	11.1	40.8	19.6	15.1
65978	7.8	14.4	5.6	39.5	5.6	8.1	15.6	7.7	8.1	11.6	14.5	-	5.4	6.5	-	5.8	7.1	8.7	15.2	7.9	8.6	11.9	6.6	5.5	12.4	9.8	8.1
1006716	7.0	14.2	4.8	41.9	5.5	6.8	12.3	6.9	8.1	10.6	12.6	-	5.8	5.8	-	5.2	7.0	10.2	8.1	8.1	8.5	12.2	7.0	5.5	13.3	20.0	9.7
1008172	6.8	14.5	4.6	39.1	5.2	5.2	28.6	6.2	7.3	11.4	11.9	-	5.3	4.8	-	5.0	6.5	4.6	8.8	8.4	7.0	12.1	5.8	4.8	27.4	10.2	7.4
1009437	-	41.6	11.8	-	11.4	19.5	-	-	18.0	-	13.3	-	-	11.7	-	11.3	-	8.8	26.5	19.8	-	-	12.0	11.9	43.6	16.9	19.9
1009763	-	12.6	5.2	-	4.9	5.6	-	-	7.6	-	7.8	-	-	5.1	-	4.9	-	8.5	6.8	7.4	-	-	6.1	4.8	11.7	9.6	7.8
1010273	18.2	41.1	9.6	19.4	9.8	9.4	36.9	9.6	11.4	29.6	18.9	-	7.1	11.3	-	9.8	14.7	8.0	25.4	13.4	15.0	21.0	12.3	8.9	43.9	17.7	6.0
1010756	-	7.0	5.8	-	5.4	7.2	-	-	8.0	-	2.2	-	-	14.8	-	5.4	-	9.7	2.0	8.1	-	-	14.2	-	13.2	8.9	8.3
1010753	-	41.8	9.9	-	10.0	8.4	-	-	11.3	-	19.8	-	-	11.9	-	10.0	-	8.6	25.0	10.5	-	-	12.2	9.9	43.5	17.3	8.4

Evaluation:  
mediocre

- S-factor values are mostly not pathological, but far from ideal
  - Most in the range of 8-15
- Single-colour 'columns' prevail over 'rows'
- Most probably: routing policies are managed by a foreign partner

# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6493	13053	18664	23494	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	3.8	3.8	4.2	336.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	15.3	3.3	4.0	465.8	30.4	411.2	250.4	23.9	15.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	66.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	20.1	27.7	12.8	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.6	16.8	9.4
1006718	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	9.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	9.0

Evaluation: bad

- Many really bad values of S-factor
- Single-colour 'columns' also prevail over 'rows'

# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6493	13053	18664	23204	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	3.8	3.8	4.2	399.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	15.3	3.3	4.0	408.8	30.4	411.2	250.4	23.9	15.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	66.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	20.1	27.7	12.8	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.6	16.8	9.4
1006718	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	9.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	9.0

Evaluation: bad

- Many really bad values of S-factor
- LET'S ANALYSE ONE OF THEM



# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6403	13053	18664	23404	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	3.8	3.8	4.2	399.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	15.3	3.3	4.0	408.8	30.4	411.2	250.4	23.9	15.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	66.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	29.1	27.7	12.8	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.8	16.8	9.4
1006718	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	9.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	9.0

Evaluation: bad

- Many really bad values of S-factor
- LET'S ANALYSE ONE OF THEM
- Between probes #64417 and #34679

# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6493	13053	18664	23494	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	9.8	3.8	4.2	299.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	19.3	3.3	4.0	408.8	30.4	411.2	450.4	23.9	18.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	66.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	20.1	27.7	12.8	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.8	16.8	9.4
1006718	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	8.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	8.0

Evaluation: bad

- Many really bad values of S-factor
- LET'S ANALYSE ONE OF THEM
- Between probes #64417 and #34679
- Distance between them: 16 km

# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6493	13053	18664	23494	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	9.8	3.8	4.2	399.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	19.3	3.3	4.0	408.8	30.4	411.2	250.4	23.9	18.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	86.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	20.1	27.7	12.3	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.6	16.8	9.4
1006716	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	9.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	8.0

Evaluation: bad

- Many really bad values of S-factor
- LET'S ANALYSE ONE OF THEM
- Between probes #64417 and #34679
- Distance between them: 16 km
- Located near the Romanian border, from the different sides

# Connectivity between Moldova and Romania (S-factor)



← Probes from RO →

← Probes from MD →

	1211	2905	2982	6403	13053	18664	23404	29662	33727	34411	34679	50207	50687	52301	54371	65994
11006	6.5	8.1	5.4	20.2	-	16.3	6.5	4.1	4.0	4.5	21.5	16.8	23.6	27.3	14.5	10.2
11874	-	8.3	-	17.9	-	-	5.6	-	3.5	3.9	-	14.8	-	-	-	8.7
19384	-	8.2	-	19.0	-	-	8.1	-	4.1	3.7	-	16.9	-	-	-	10.1
25464	-	20.3	-	34.1	-	-	11.1	-	9.5	12.2	-	17.3	-	-	-	10.2
29995	-	12.7	-	18.9	-	-	7.4	-	3.5	3.9	-	12.3	-	-	-	8.3
30977	-	8.8	-	20.7	-	-	8.0	-	3.1	3.8	-	16.3	-	-	-	9.5
35796	10.9	30.0	9.4	87.4	-	13.4	17.1	18.7	9.9	3.5	62.3	16.5	78.0	71.5	17.3	8.1
64063	-	24.8	-	19.2	-	-	14.7	-	4.9	4.0	-	14.5	-	-	-	10.8
64417	69.0	22.2	10.8	193.4	-	106.1	9.5	3.8	3.8	4.2	296.3	27.7	187.2	290.7	51.9	18.9
65409	26.2	51.0	7.4	176.5	-	108.8	23.1	15.3	3.3	4.0	408.8	30.4	411.2	250.4	23.9	15.3
65471	12.7	30.5	6.2	42.3	-	15.8	18.3	18.1	4.2	3.9	71.4	14.6	75.8	86.2	18.6	10.7
65546	5.9	11.2	5.3	19.0	-	15.8	5.9	3.9	3.8	4.4	21.5	16.6	20.1	27.7	12.3	10.1
65978	11.7	28.0	3.4	28.2	-	13.4	17.9	20.6	3.4	3.7	62.1	12.8	71.7	64.6	16.8	9.4
1006716	10.6	32.8	6.1	30.7	-	17.2	17.3	19.6	3.4	12.2	89.6	16.0	72.9	70.3	19.3	8.1
1008172	11.7	35.6	5.1	40.5	-	13.6	19.4	20.3	3.9	20.8	73.1	42.4	74.5	75.8	16.6	9.7
1009437	-	16.1	-	38.1	-	-	10.9	-	3.7	11.8	-	15.3	-	-	-	8.9
1009763	-	27.8	-	41.8	-	-	17.7	-	3.8	13.1	-	13.8	-	-	-	8.0
1010273	12.2	8.8	4.7	19.4	28.4	30.7	6.2	4.1	3.6	4.3	25.6	16.0	22.3	20.8	14.8	9.7
1010750	-	9.4	-	20.1	17.4	-	8.1	-	4.1	3.6	-	16.2	-	70.4	-	8.2
1010753	-	11.1	-	19.8	28.4	-	6.2	-	3.9	4.0	-	16.2	-	23.1	-	8.0

Evaluation: bad

- Many really bad values of S-factor
- LET'S ANALYSE ONE OF THEM
- Between probes #64417 and #34679
- Distance between them: 16 km
- Located near the Romanian border, from the different sides
- NOW, let's perform the traceroute measurement

# Long way from #34679 to #64417



1	10.1.0.1	3.11	ms	3.489	ms	3.49	ms
2	10.0.34.125	1.342	ms	1.248	ms	1.266	ms
3	10.65.137.33	1.57	ms	1.926	ms	1.621	ms
4	10.220.211.144		ms	11.77	ms	11.776	ms
5	10.221.100.112	11.872	ms	11.464	ms	11.994	ms
6	10.221.96.54	52.545	ms	42.458	ms	42.273	ms
7	149.11.160.1	42.875	ms	42.453	ms	42.61	ms
8	154.54.61.161	42.502	ms	42.505	ms	42.463	ms
9	130.117.51.42	46.165	ms	46.387	ms	46.082	ms
10	154.54.38.210	64.558	ms	64.072	ms	67.583	ms
11	154.54.59.62	64.683	ms	64.636	ms	64.613	ms
12	154.54.59.106	64.259	ms	64.541	ms	64.557	ms
13	154.54.59.178	65.528	ms	66.091	ms	65.566	ms
14	154.54.38.246	65.973	ms	65.669	ms	65.867	ms
15	154.54.61.177	64.149	ms	64.713	ms	65.176	ms
16	154.54.58.249	64.285	ms	64.656	ms	64.127	ms
17	154.54.72.134	65.796	ms	65.695	ms	65.449	ms
18	149.14.58.99	64.942	ms	64.951	ms	65.223	ms
19	37.233.0.21	72.259	ms	65.307	ms	65.306	ms
20	37.233.0.20	64.252	ms	68.922	ms	64.438	ms
21	89.28.33.1	67.1	ms	67.174	ms	67.845	ms
22	89.28.33.213	68.245	ms	68.27	ms	68.261	ms

# Long way from #34679 to #64417



Moldovan-Romanian border

London 🤝🤝🤝 !!!

Amsterdam

Hamburg

Prague

Bratislava

Budapest

Bucharest

Ukrainian border

Odesa 🤝🤝🤝 !!!

Chisinau

Other side of Moldovan-Romanian border

**Why?!**



## Large operators

- They perform traffic engineering to ensure the effective utilisation of their channels.
- They do not care of the traffic localisation
  - And often they do opposite



# Summary



# Long story short



- There is huge room for optimising the external connectivity of Moldovan operators
- This process can be monitored using RIPE Atlas:
  - RIPE Atlas is a powerful tool
  - It provides insights even in the simplest usage scenarios
- You could carry out the described research yourself...
  - ...or even conduct it on a regular basis

# Questions? Comments?

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**RIPE NCC**  
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**THANK YOU!**