



**RIPE NCC**  
RIPE NETWORK COORDINATION CENTRE

# The Internet in Ukraine

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NLUUG | 2022-05-10



# Russo-Ukrainian War

2022



# More Info: in Original Articles

- **“The Resilience of the Internet in Ukraine” (2022-03-10)**

- <https://labs.ripe.net/author/emileaben/the-resilience-of-the-internet-in-ukraine/>

- **“The Ukrainian Internet” (2022-02-28)**

- <https://labs.ripe.net/author/emileaben/the-ukrainian-internet/>

- **2019, Kyiv: “State of the Internet in Ukraine”**

- [https://www.ripe.net/participate/forms/uploads/fobi\\_plugins/file/ripe-ncc-days-kyiv/2019-09-26%20NCC%20Days,%20State%20of%20Internet\\_v3\\_b0e1fc0b-eed7-417b-813c-0dbc83f3e82c.pdf](https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/ripe-ncc-days-kyiv/2019-09-26%20NCC%20Days,%20State%20of%20Internet_v3_b0e1fc0b-eed7-417b-813c-0dbc83f3e82c.pdf)

- **“You are Not Alone: RIPE Community Resilience” (2021)**

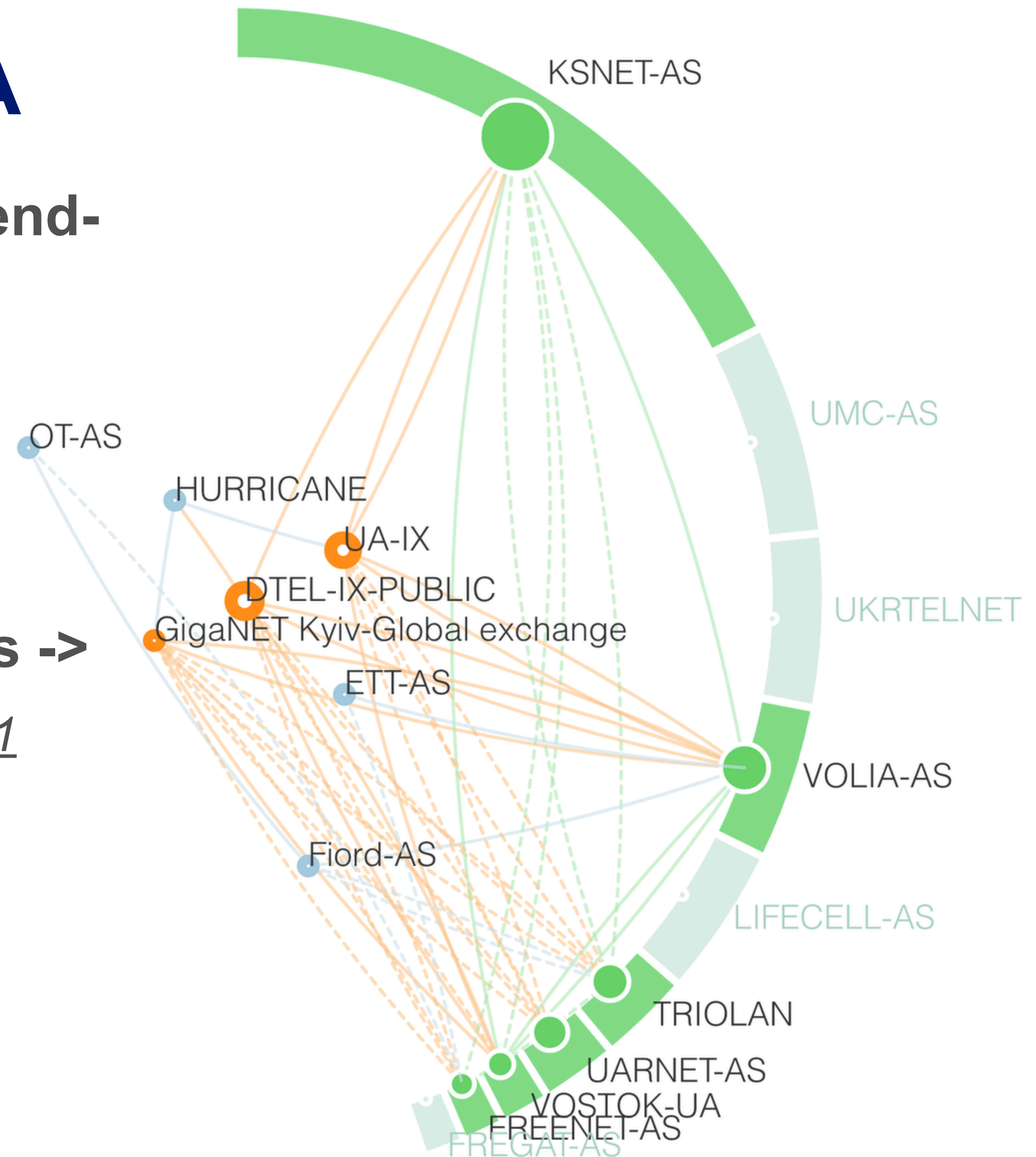
- <https://labs.ripe.net/author/becha/you-are-not-alone-ripe-community-resilience/>

# Elements of Resiliency

- **Human Connections, Dedication, Courage, Perseverance**
- **ISP Decentralisation (absence of market consolidation)**
- **Diverse interconnections (abundance of IXPs)**
- **High independence, at transit networks level, according to IHR**
  - <https://ihr.ijilab.net/ihr/hegemony/countries/UA>
- **Diverse fibre paths, from multiple organisations**
  - <https://blog.telegeography.com/what-to-know-about-fibers-role-in-ukraines-information-war>

# ISP Decentralisation in UA

- **Absence of market concentration at end-user networks level**
  - UA: 4th in the world! HH Index of 0.052
  - an economic indicator for market concentration (on the scale 0-1)
- **How Ukrainian end-user networks interconnect, as seen from RIPE Atlas ->**
  - <https://jedi.ripe.net/peer-to-peer/ua/2022/03/01>
  - <https://atlas.ripe.net>
- **55% ISPs serve <1% of the market!**
  - not visualised (left half of the circle)



# IXP Abundance

- **19 IXPs!** (Internet eXchange Point)
  - as seen in PeeringDB
- **13 visible by RIPE Atlas**
  - visualising the paths between probes
  - <https://jedi.ripe.net/latest/UA/>
- **Not one single dominant IXP!**





# How Did We Measure This?

- **RIPE Atlas**

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



- **IXP-country-jedi**

- Open Source: <https://github.com/emileaben/ixp-country-jedi> . Does:
  - Atlas probes Mesh-traceroutes, typically within a country
  - Analyse/visualise results



# February Outage



Connected RIPE Atlas probes

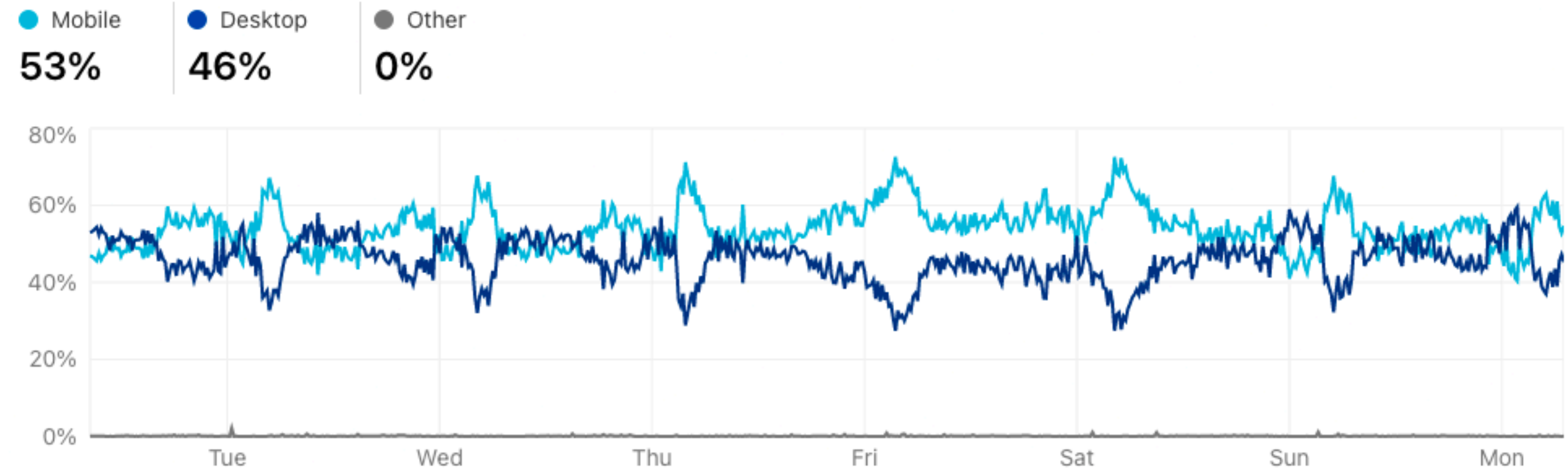


- **The number of RIPE Atlas probes online in Triolan (AS13188). Top graph is the number of connected probes, the lower graph shows for each individual probe when it was online or offline.**
- <https://labs.ripe.net/author/emileaben/the-ukrainian-internet/>

# More Outages

- [ioda.live](#) / [@gatech\\_ioda](#)
- Moved away from fixed, towards mobile connectivity
  - CloudFlare data ->
- Decreasing number of connected RIPE Atlas probes, over time

## Mobile vs. Desktop — Ukraine (Excluding Bots / Last 7 days)



Data shown from Feb 21, 2022 8:30 AM (UTC) to Feb 28, 2022 7:00 AM (UTC)  
Source: <https://radar.cloudflare.com>



# Simple Outage Detector Prototype



- Live demo (!)

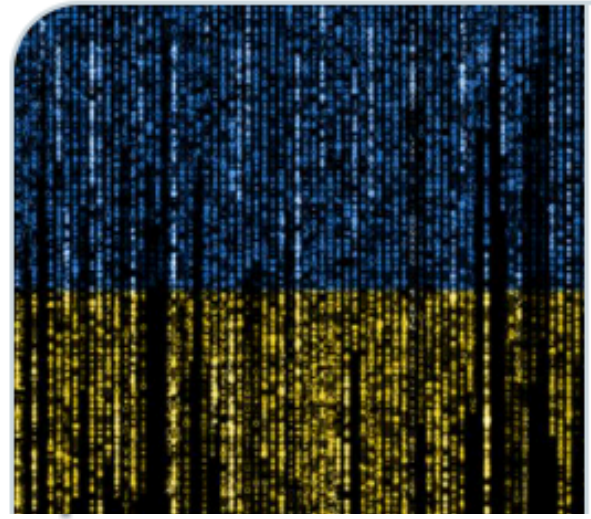
**Select probes through one of the following:**  
The latest input you "focus" on is the one that gets submitted.

Location and radius around	<input type="text" value="Utrecht, NL"/> <input type="range" value="50 km"/>
ASN	<input type="text" value="3333"/>
Country code(s)	<input type="text" value="UA"/>

<https://observablehq.com/@ripencc/internet-outages-as-seen-by-ripe-atlas>

 **Julian Oliver**  
@julianOliver

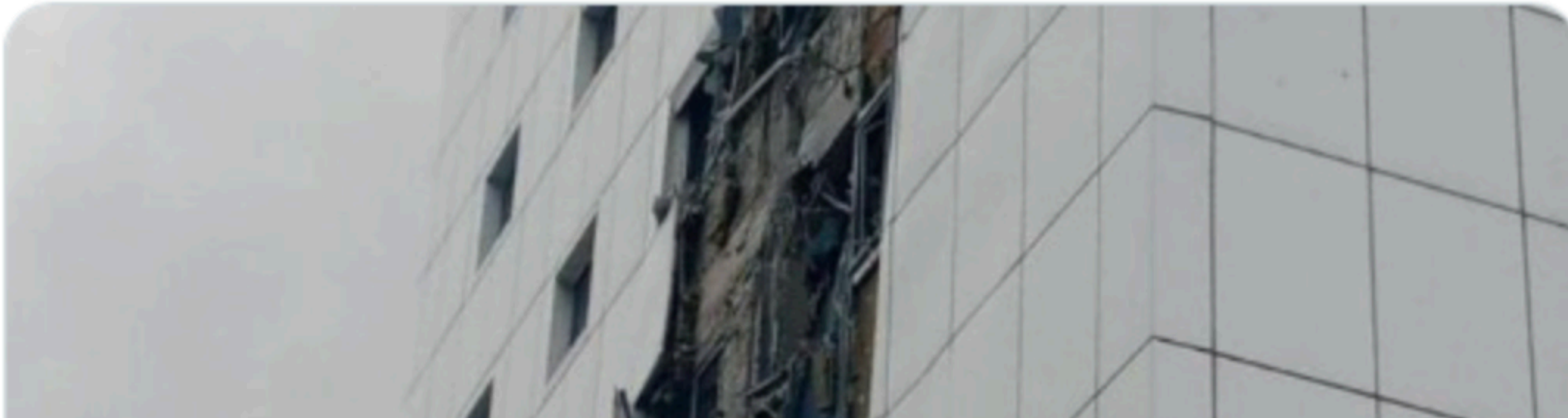
Very interesting piece on how factors like lack of market concentration, large number of exchanges (IXPs), diverse underground cable/fibre paths, and the raw determination of operators has helped keep the Ukranian Internet up



labs.ripe.net  
The Resilience of the Internet in Ukraine  
We look at the structure of the Internet in Ukraine and how it may be helping the country stay connected.

 **Thomas Brewster** ✓ @iblametom · Mar 15  
NEW - They're fixing internet in bombed out buildings, finding rogue operators providing Russians with mobile connections and thwarting hackers...

The telecom companies of Ukraine and their employees are being hailed as heroes in the war with Russia.



 **SSSCIP Ukraine** ✓  
@dsszzi

The #War unites #Ukrainian competitors

Thus, two small local providers [Gigabit.net](https://gigabit.net) and [brd.net.ua](https://brd.net.ua) restored the main cable (was damaged by the occupiers), so #Chernihiv oblast is connected again!

More: [bit.ly/3MYTdTO](https://bit.ly/3MYTdTO)

#WARINUKRAINE #StopRussia



# Effect Of Starlink?



- **Lots of buzz!**
- **Hard to measure the effect this has on general connectivity in UA**
  - Best guess: limited bandwidth available, so won't replace current fibre capacity
- **Works very well for disaster/emergency situations**
  - Mariupol (no electricity, fibre infra damaged)
  - Bucha: The only 2 GSM base stations just after Russian army left, via Starlink



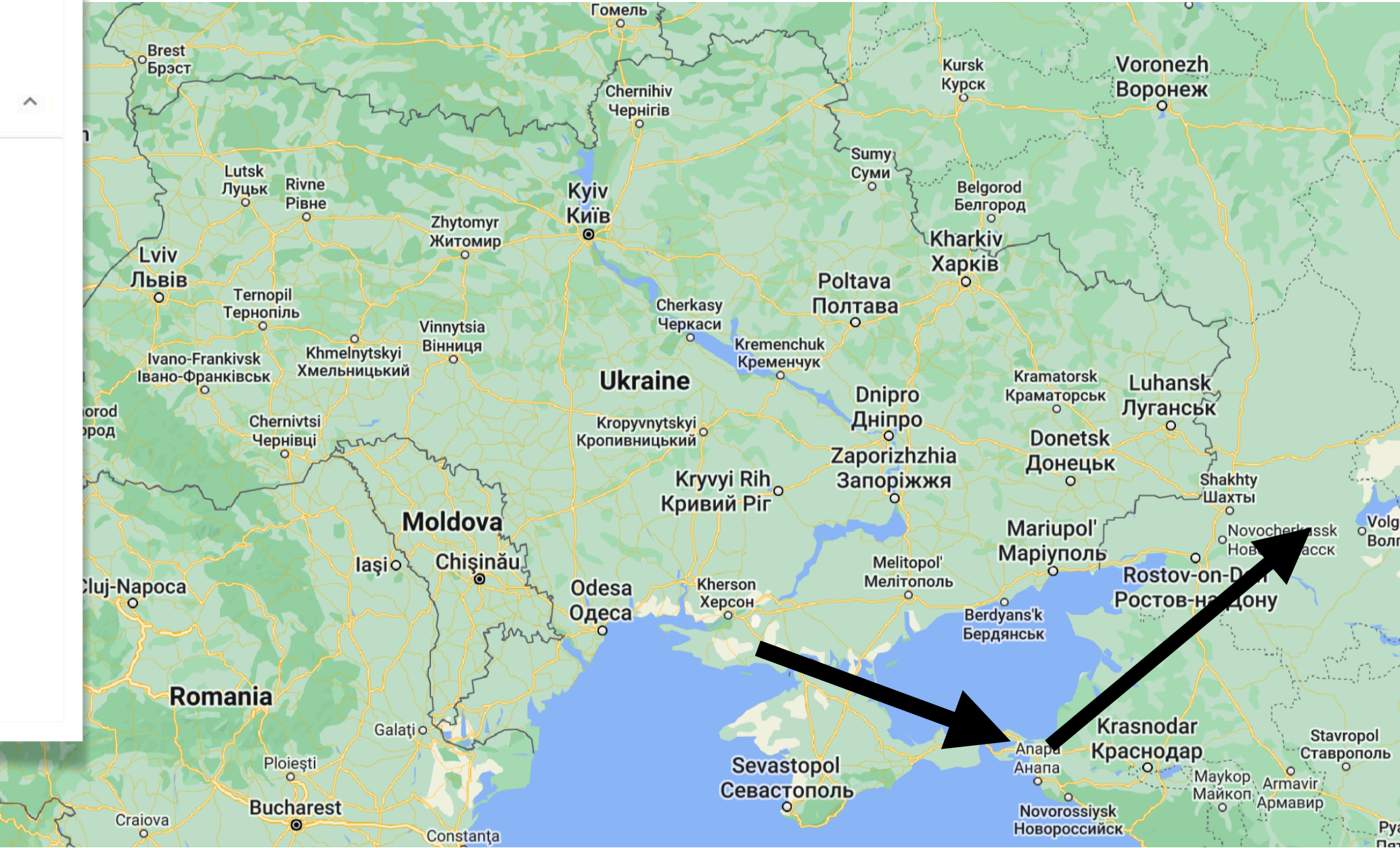
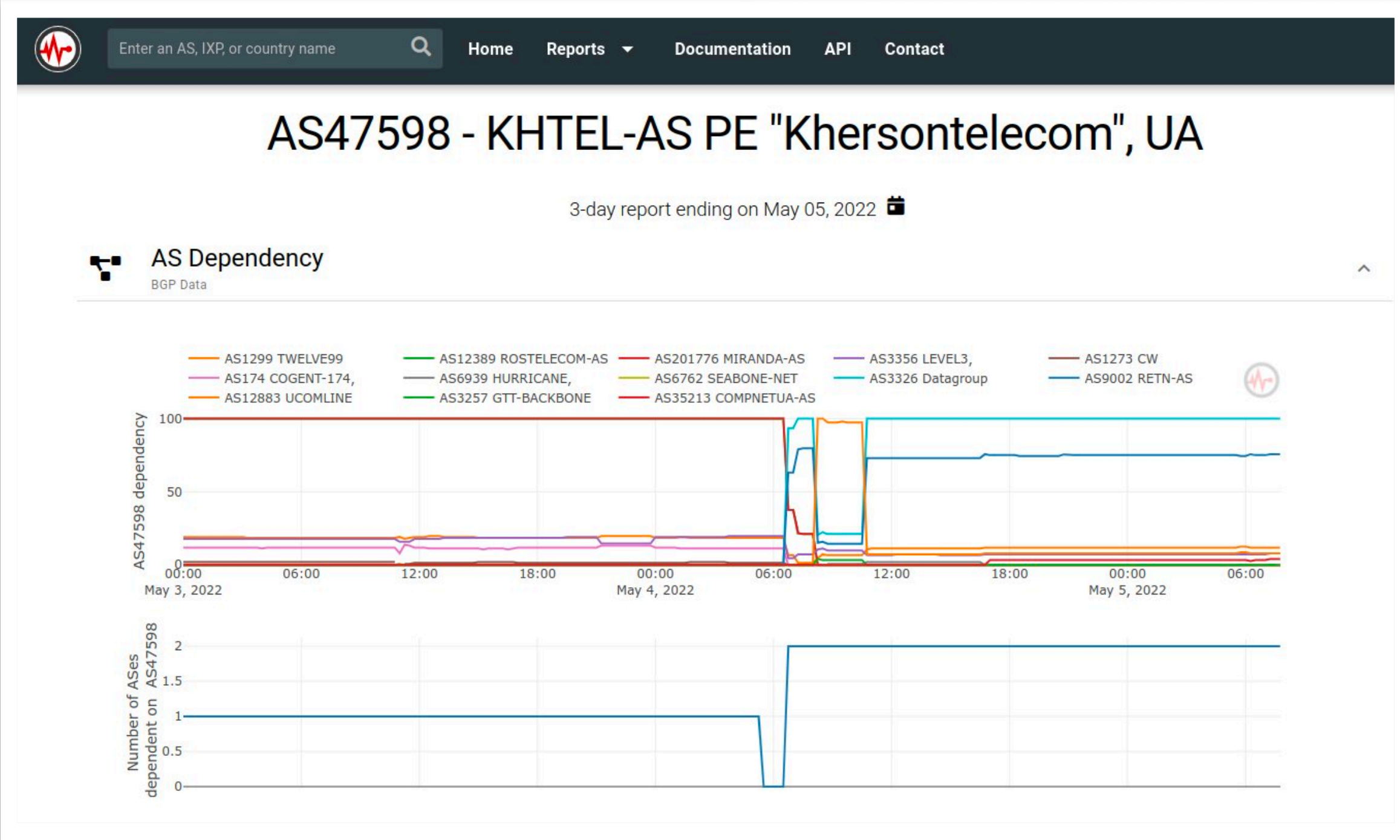
# Crimea & South

What happens in occupied  
territories

# Kherson - Some Routes via Crimea now



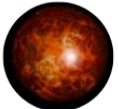
- [https://twitter.com/romain\\_fontugne/status/1522198122885132291/photo/1](https://twitter.com/romain_fontugne/status/1522198122885132291/photo/1)





# Filters?



- <https://twitter.com/KillSudo/status/1521164263078998017>

 **KillSudo**  
@KillSudo

@US\_CYBERCOM @ripencc @TeliaCompany Why is Rostelecom being allowed to propagate stolen number assets helping fascist? AS1299 needs to be installing AS Filters to drop UA space learned thru RU providers.

 **NetBlocks**  @netblocks · May 1

See also, traceroute metrics showing that Ukraine's internet provider Skynet (Khersontelecom) is now routing via Russia's Miranda and Rostelecom rather than Ukrainian telecom infrastructure following the region's occupation by Russia:  
[Show this thread](#)

```
Traceroute - Start: 2022-05-01T20:49:29+0000
```

				Loss%	Snt	Last	Avg	Best	Wrst	StDev
...										
11.	DE	AS1299	62.115.124.xxx	90.0%	10	29.1	29.1	29.1	29.1	0.0
12.	DE	AS1299	62.115.151.xxx	0.0%	10	36.2	29.9	27.7	36.2	2.5
13.	RU	AS12389	87.226.183.xxx	0.0%	10	69.6	68.9	67.0	70.7	1.2
15.	RU	AS201776	185.64.45.xxx	0.0%	10	96.6	94.7	93.6	96.6	0.9
16.	RU	AS201776	2.63.191.xxx	0.0%	10	102.3	102.2	99.6	106.9	2.2
17.	UA	AS47598	91.206.110.xxx	0.0%	10	98.1	98.8	96.6	104.9	2.4

6:26 PM · May 2, 2022 · Twitter Web App

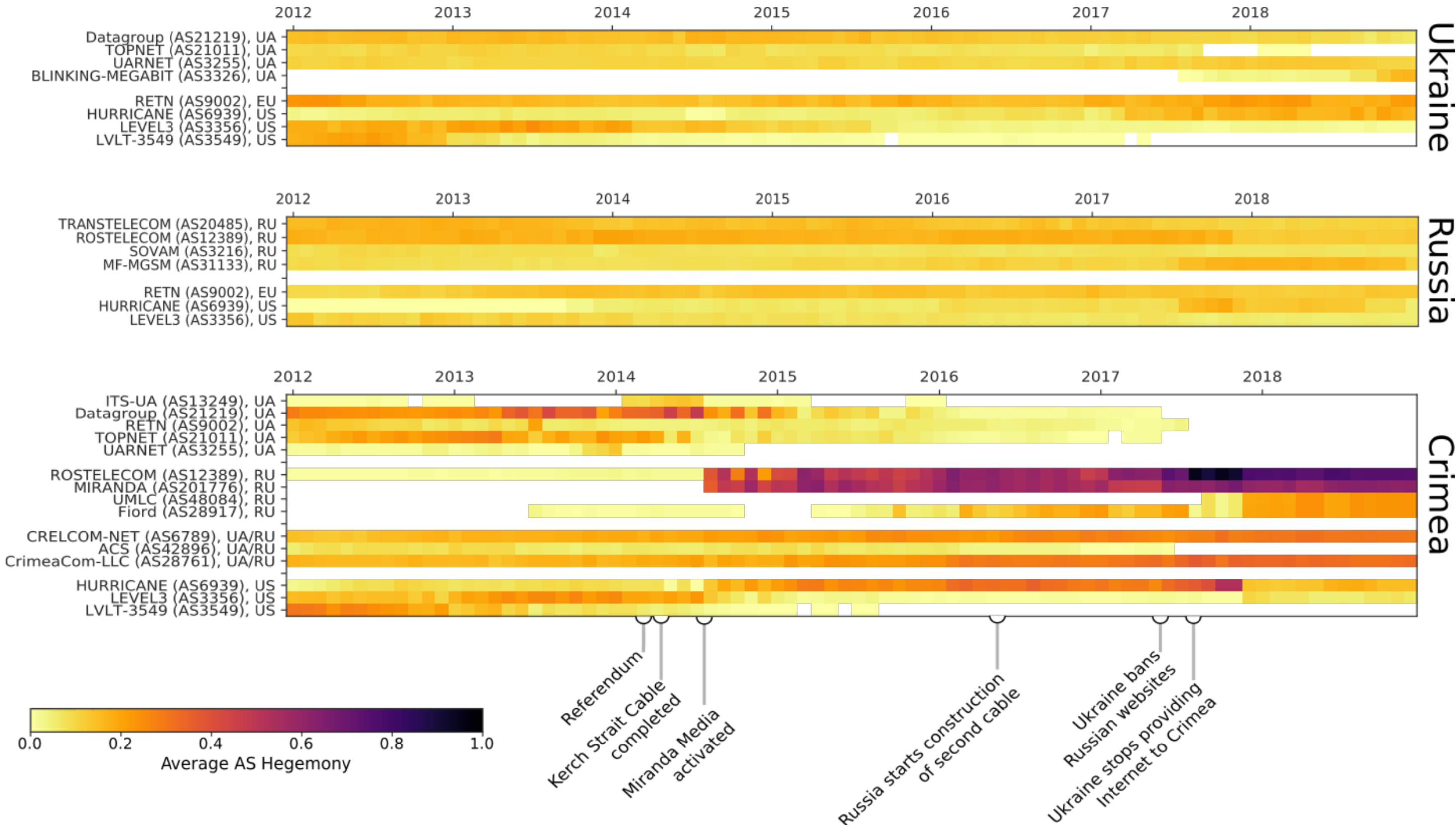




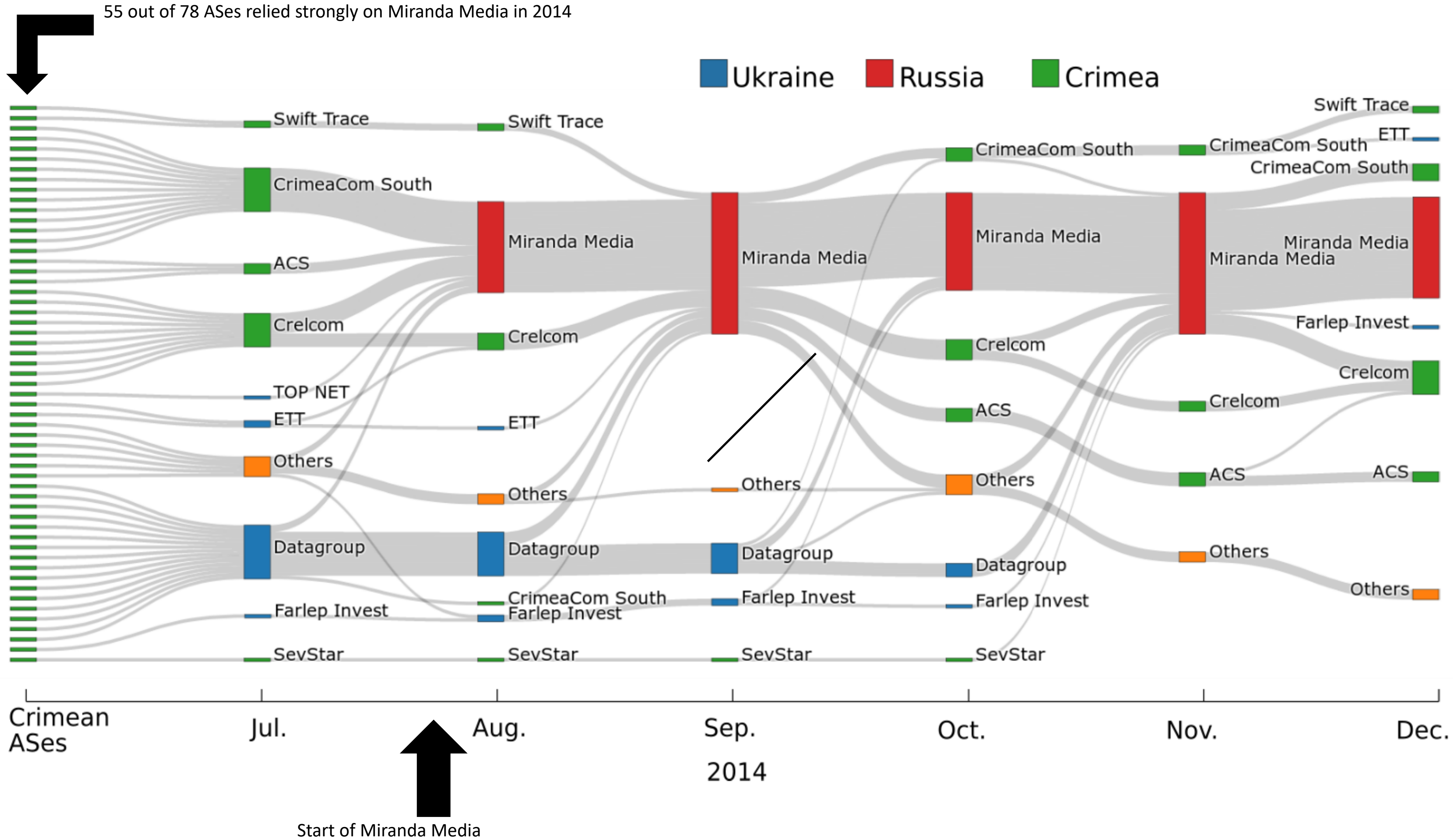
# Internet in Crimea

- **Case study of an Internet “Interregnum” (2014-2017)**
- **Sociological fieldwork combined with Internet measurements:**
  - <https://hal.archives-ouvertes.fr/hal-03100247>
  - Collaboration with Romain Fontugne (IIJ) and Ksenia Ermoshina (CIS)
  - Uses “AS-Hegemony”
    - To what extent does an AS depend on another AS?
    - Per AS data at IHR: Ex. <https://ihr.ijlab.net/ihr/en-us/networks/AS3333/>
    - Depends on BGP data in RIPE RIS

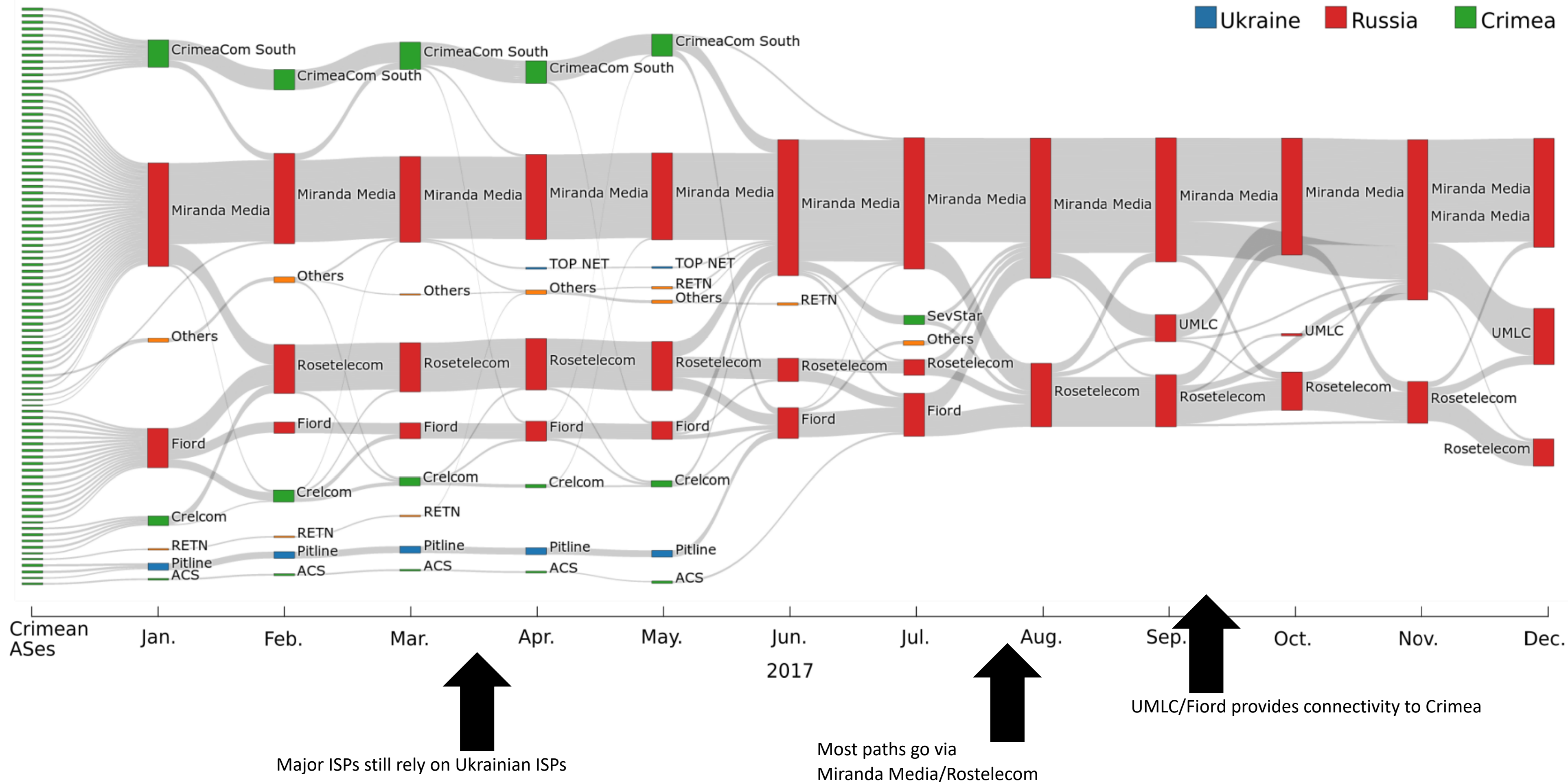
# Crimea Interregnum (2014-2017)



# Start of Transition in Crimea



# End of Transition in Crimea





# Interregnum conclusion

- **Significant changes to Crimea's Internet connectivity**
- **Long transition (3+ years)**
- **Good match with compiled timeline**
- **Paths are going through Miranda Media/Rostelecom or UMLC/Fjord**
- **Topological chokepoint reflecting geo-politics in the region**



# Sanctions

## And the Internet

# Sanctions on All Russian Networks?



- **RIPE NCC was asked by UA govt to revoke Internet number resources for Russian members**
- **RIPE NCC can't comply, not in our mandate (community developed policy, nor Dutch law)**
- **Leniency towards Ukrainian members (non-payment etc.)**

<https://www.ripe.net/publications/news/announcements/ripe-ncc-response-to-request-from-ukrainian-government>

# Sanctions?



- **Some transit providers made public statements about sanctioning Russian networks**
- **We didn't see much evidence of this:**
  - <https://labs.ripe.net/author/emileaben/how-is-russia-connected-to-the-wider-internet/>

Changes in network adjacencies between selected tier1 networks from 1 Feb - 19 March

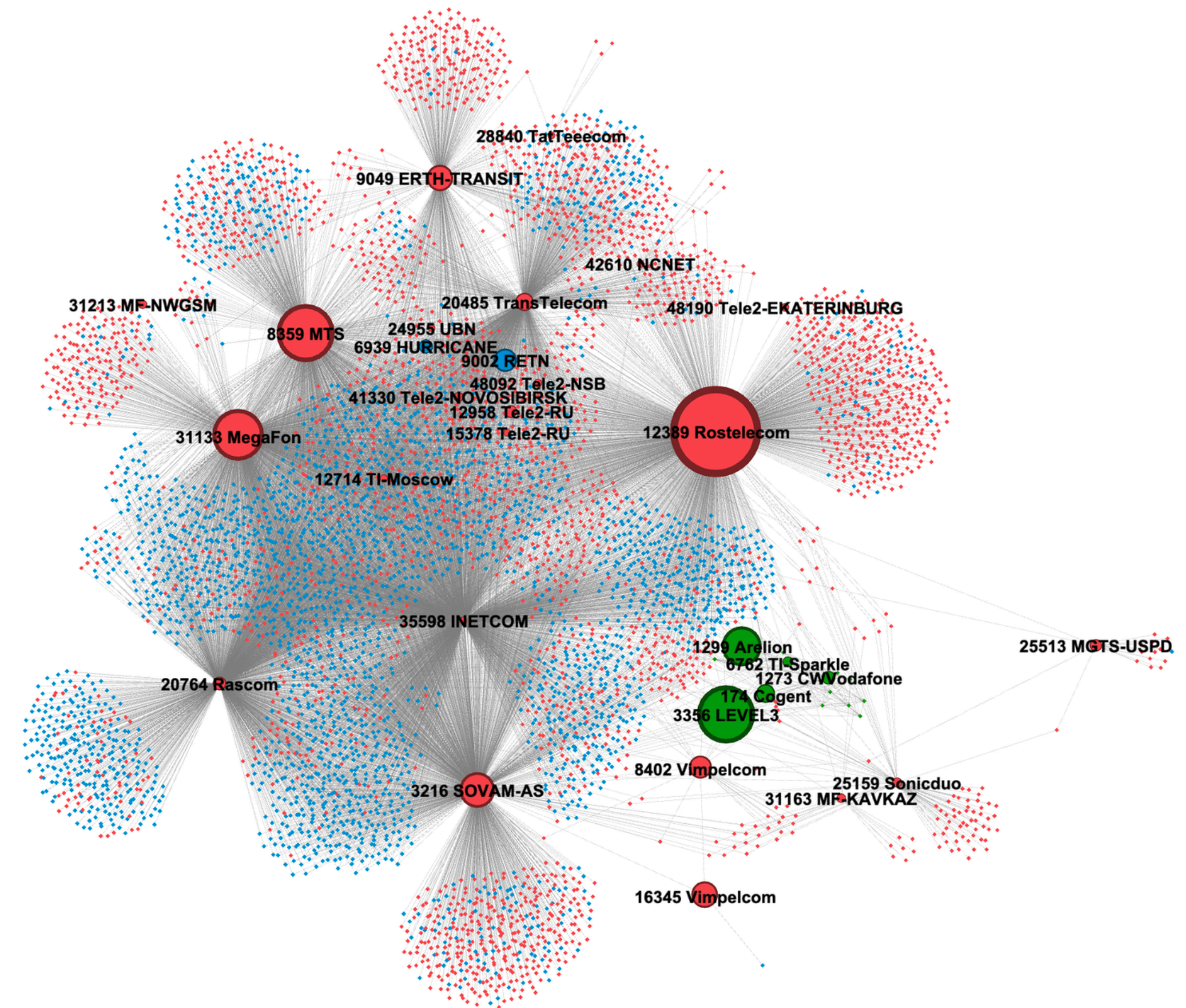
Network	ASN	Added	Removed
Arelion	AS1299	6	13
Lumen	AS3356	2	7
Cogent	AS174	0	8



# Who Connects Russian Internet Users?



- Green: tier1
- Red: RU networks
- Blue: other networks
- Size of bubble: importance for connecting RU users (directly or indirectly), ie. “AS-Hegemony for users”
- All RU-non-RU interconnects in RIS

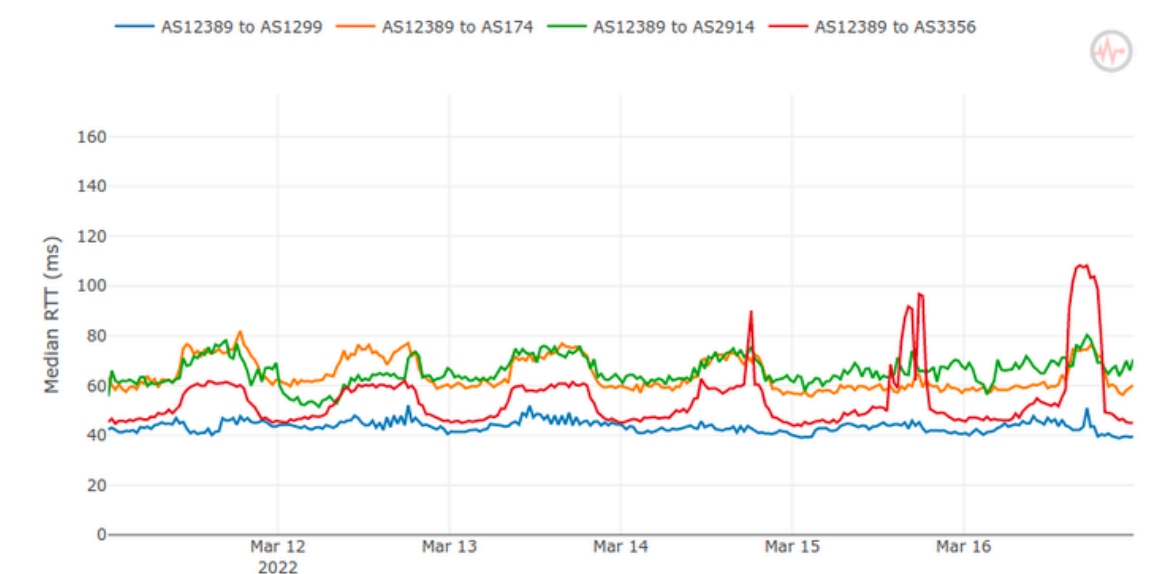
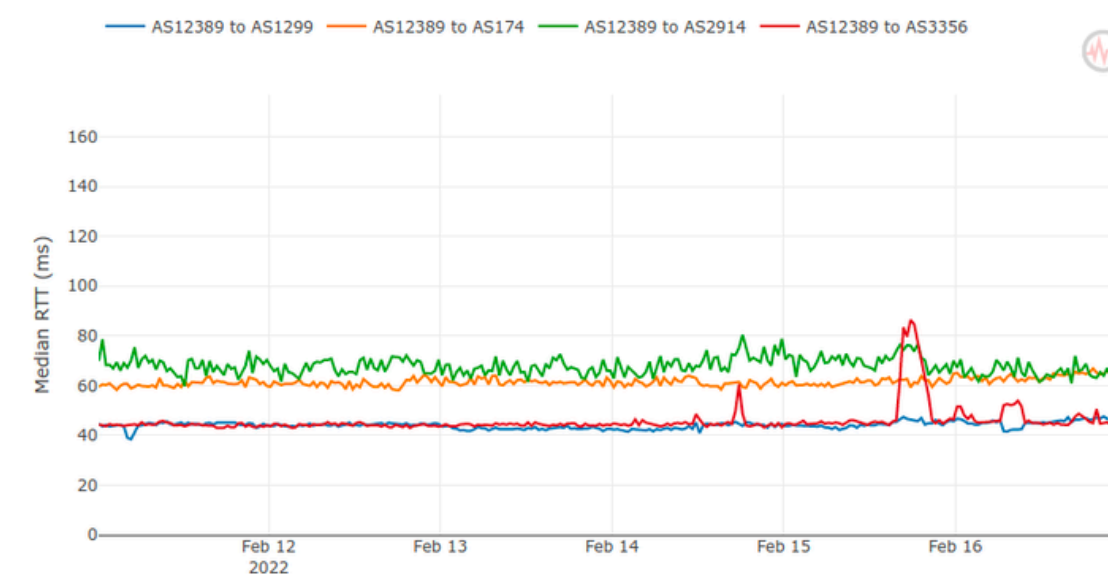


# Latency Changes for RU Networks

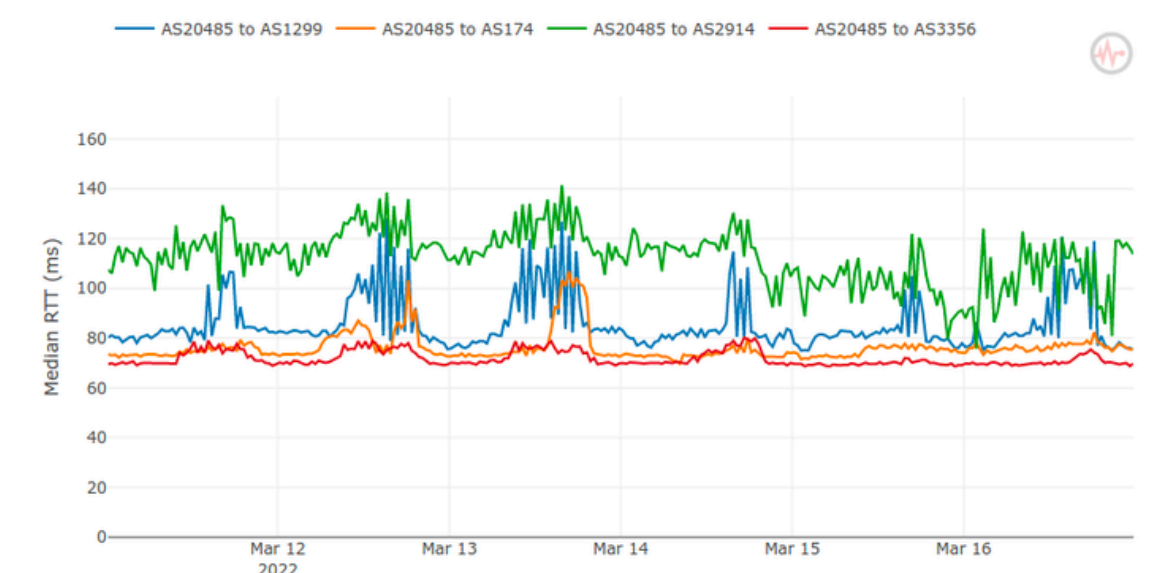
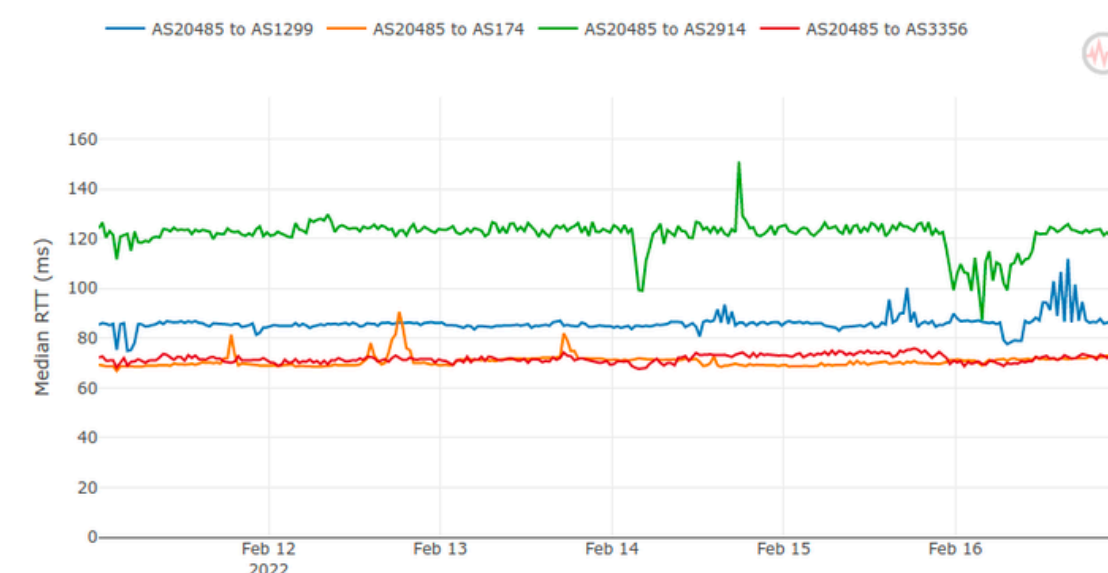


- Internet Health Report
- Based on RIPE Atlas latency measurements
- More patterns post-invasion

Rosetelecom (AS12389)



TransTeleCom (AS20485)



# LINX And Sanctions to Russian Networks



**Bill Woodcock**  
@woodyatpch

Looks like [@LINX\\_Network](#) has just decided what they're doing about sanctions:


The Board of Directors of LINX has considered the situation in Ukraine and taken legal advice concerning the legal sanctions imposed against designated persons, and entities under the beneficial ownership or ultimate control of those designated persons.

Following this, the Board has decided cease the provision of all services to, and to suspend membership of LINX for, the following members:

- Megafon (AS 31133)
- Rostelecom (AS 12389)

with immediate effect.

The company continues to investigate whether any other members may be connected to designated persons. We are contacting selected members seeking information concerning their ultimate control and ownership, where we believe there may be such a relationship with a designated person. If LINX staff contact you with such an enquiry, I would be grateful if you would provide your full cooperation.

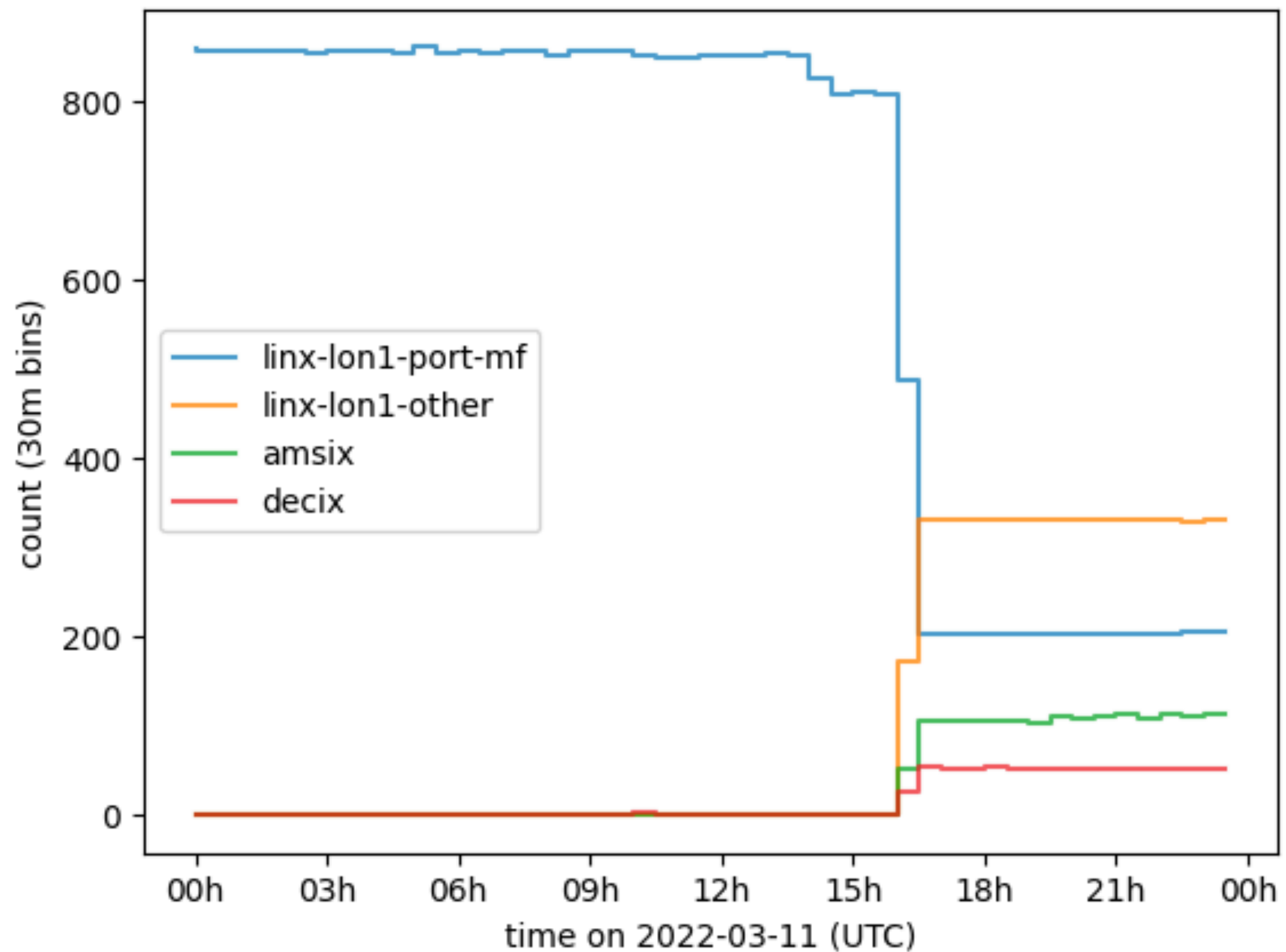
  
Pieter Knook  
Chairman, LINX

1:16 PM · Mar 11, 2022

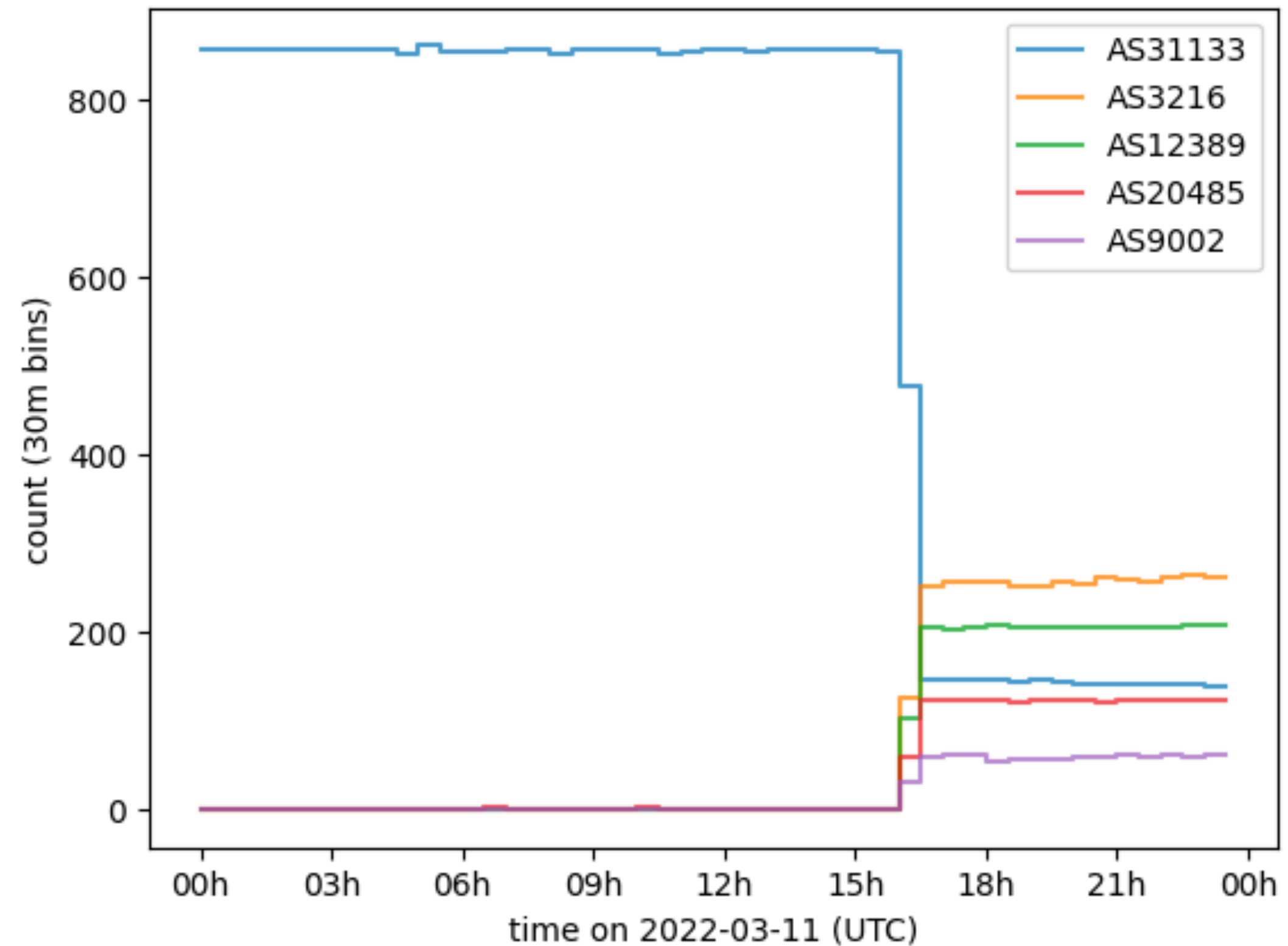
# How RIPE Atlas Saw This



IXPs in RIPE Atlas traceroutes (top 5 diff)  
(only traceroutes that went via Megafon@LINX on 2022-03-10)



Networks in RIPE Atlas traceroutes (top 5 diff)  
(only traceroutes that went via Megafon@LINX on 2022-03-10)



# Other Countries Depending on Russia

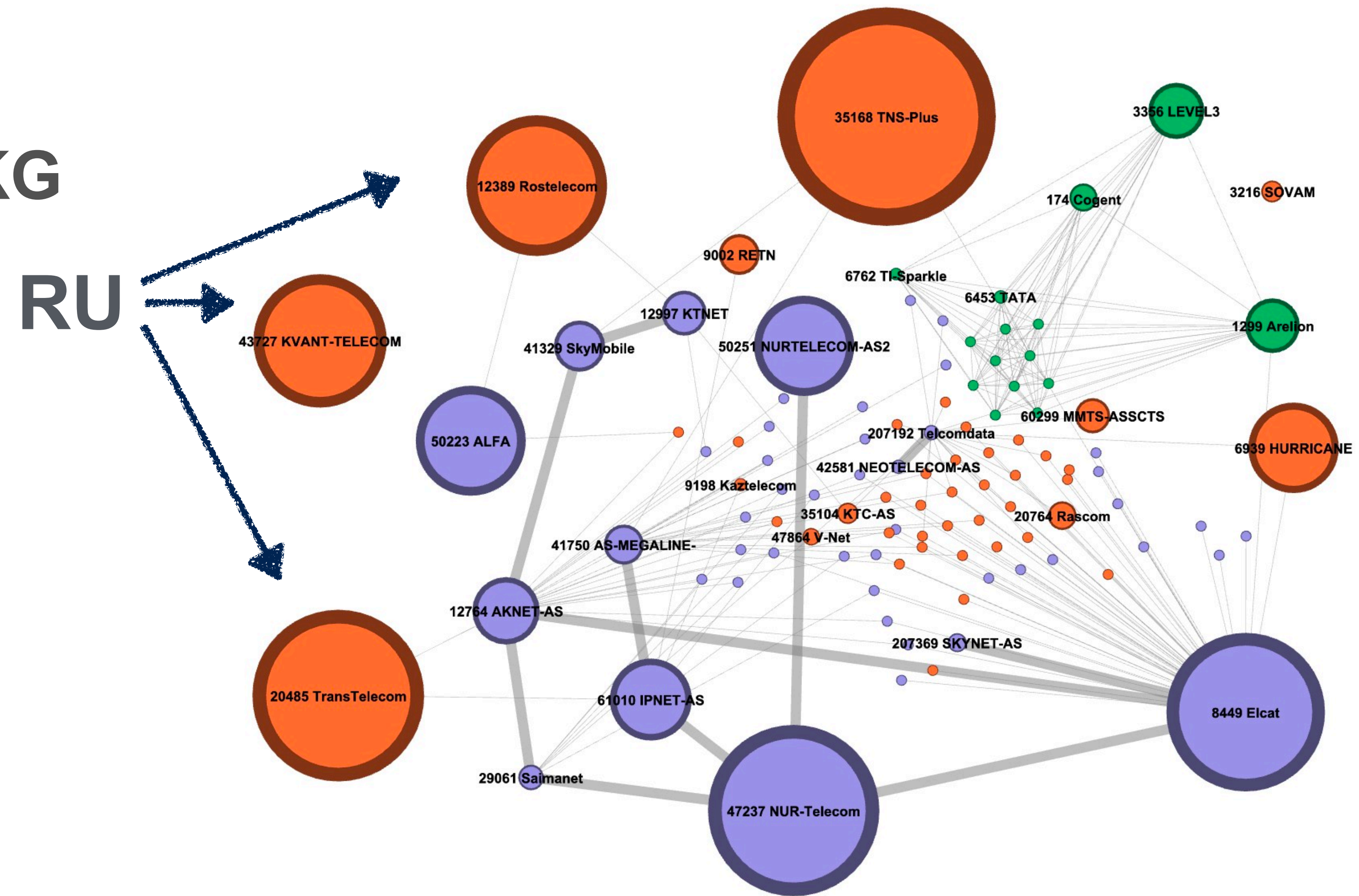


- **Central Asian (ex-USSR) countries depend on Russian networks**
- **They will be (are?) affected by sanctions to Russian networks**

# Example: Kyrgyzstan



- Purple = KG
- Red = non-KG





# Conclusion



# But first - An Aside

- **Language matters!**
  - “The Ukraine” vs “Ukraine”
  - City names: Kiev vs. Kyiv, Kharkov vs. Kharkiv
- [https://en.wikipedia.org/wiki/Name\\_of\\_Ukraine](https://en.wikipedia.org/wiki/Name_of_Ukraine)

## English definite article [\[edit\]](#)

Ukraine is one of a few English country names traditionally used with the **definite article** *the*.<sup>[1]</sup> Use of the article was standard before Ukrainian independence, but has decreased since the 1990s.<sup>[2][3][30]</sup> For example, the **Associated Press** dropped the article "the" on 3 December 1991.<sup>[3]</sup> Use of the definite article was criticised as suggesting a non-sovereign territory, much like "**the Lebanon**" referred to the region before its independence, or as one might refer to "**the Midwest**", a region of the United States.<sup>[31][32][33]</sup>

In 1993, the Ukrainian government explicitly requested that, in linguistic agreement with countries and not regions,<sup>[34]</sup> the Russian **preposition** *в* be used instead of *на*,<sup>[35]</sup> and in 2012, the Ukrainian embassy in London further stated that it is politically and grammatically incorrect to use a definite article with *Ukraine*.<sup>[1]</sup> Use of *Ukraine* without the definite article has since become commonplace in journalism and diplomacy (examples are the style guides of *The Guardian*<sup>[36]</sup> and *The Times*<sup>[37]</sup>).





# Take Aways

- **The Ukrainian Internet is a very resilient Internet**
  - Many redundancies in many layers
- **.. but any human-made system has a breaking point**
  
- **Observable with data we collect**
  - RIPE Atlas: data plane (ping, traceroute, ...)
  - RIPE RIS: control plane (BGP)



# Take Aways (2)

- **Interfaces/data built on top of RIS/Atlas**
  - IHR
  - AS Hegemony
  - IXP-country-jedi
  - Observable notebooks
- **Open source: Open to tinker with and improve!**

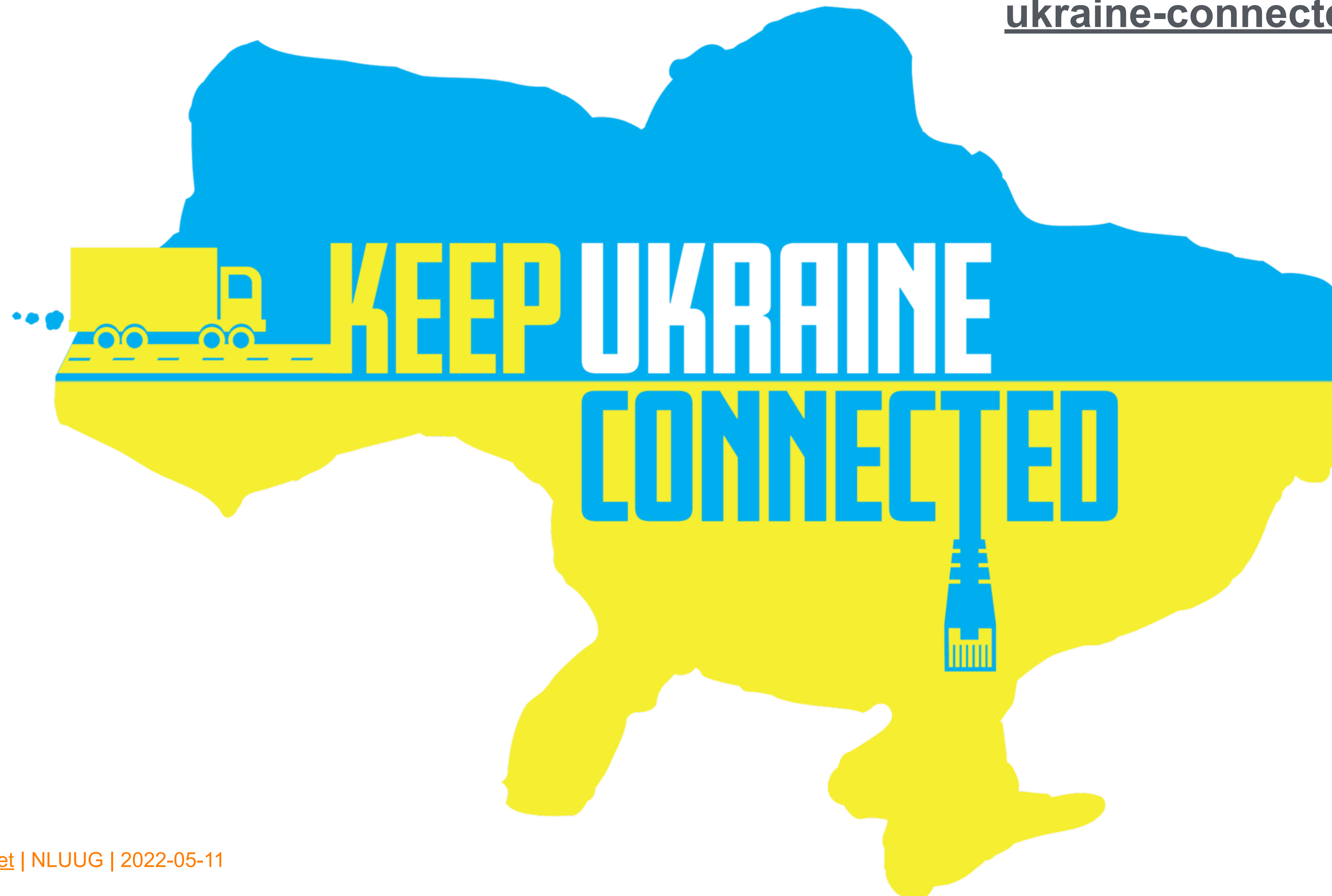


# Support

The Internet in Ukraine

# NOGs for Networkers

[https://nogalliance.org/  
our-task-forces/keep-  
ukraine-connected/](https://nogalliance.org/our-task-forces/keep-ukraine-connected/)





# Questions



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

# More Measurements

- [https://labs.ripe.net/author/stephane\\_bortzmeyer/internet-network-shutdowns-in-russia/](https://labs.ripe.net/author/stephane_bortzmeyer/internet-network-shutdowns-in-russia/)
- <https://blog.mozilla.org/data/2022/03/09/mozilla-opens-access-to-dataset-on-network-outages>
- <https://ooni.org/post/2022-russia-blocks-amid-ru-ua-conflict/>

# More Articles

- <https://www.forbes.com/sites/thomasbrewster/2022/03/15/internet-technicians-are-the-hidden-heroes-of-the-russia-ukraine-war/?sh=1a709c9c2884>
- <https://9to5mac.com/2022/03/16/ukraine-mobile-carriers-work-together/>
- <https://www.platformer.news/p/the-internet-is-a-force-multiplier>
- <https://techcrunch.com/2022/02/28/ukrainians-turn-to-encrypted-messengers-offline-maps-and-twitter-amid-russian-invasion/>
- <https://labs.ripe.net/author/waehlich/secure-personal-communication-in-the-event-of-crisis/>

# More Refs

- [Internet Health Report \(IHR\)](#)
- [AS Hegemony](#)
- [IXP-country-jedi](#)
- [ObservableHQ](#)
- <https://observablehq.com/@emileaben>
- <https://observablehq.com/@aguformoso>
- <https://observablehq.com/@ripencc>