How Russia's Invasion of Ukraine Impacted the Internet Peering of the Conflicted Countries

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Related Work

- Douzet et al. [1] reported rerouting of traffic from Ukraine to Russian based ISPs when the invasion in Crimea (2014) happened.
- Luconi et al, [2] studied the impact of the first three months of the war (2/2022 -5/2022) on routing and latency.
- Cloudflare [3] detected traffic patterns and high number of DDoS attacks. (2/2022 -3/2022)
- MANRS [4] also reported DDoS attacks and potential BGP hijacking events in the region. (1/2022 - 3/2022)

[1] "Measuring the fragmentation of the Internet: the case of the Border Gateway Protocol (BGP) during the Ukrainian crisis" IEEE 2020'

[2] "Impact of the First Months of War on Routing and Latency in Ukraine" Computer Networks 2023'

[3] "Internet traffic patterns in Ukraine since February 21, 2022" 4/2022'

[4] "Did Ukraine suffer a BGP hijack and how can networks protect themselves?" 3/2022'

Focus of the paper

We study the impact of the Russia-Ukraine conflict on Internet peering for the period of April 2021 - January 2025* in 3 month intervals.

- AS organization country changes (Ukrainian to Russian and vise versa)
- AS churn of foreign ASes in IXPs and facilities of the two countries
- Actual status of Ukrainian IXPs
- Validation of our data sources
- AS relationship between the countries

Datasets

AS to organization data



- AS members in IXPs and facilities
- Traceroutes (IXPs status)
- AS relationship data



Methodology



Surge in number of ASes that change country

- The number of Ukrainian ASes stood at around 1,840 in April 2021 and decreased to 1,641 by January 2025.
- Russian ASes numbered 5,199 in April 2021 and decreased to 5,025 by January 2025.

# of ASes	2021/04 - 2021/10	2021/10 - 2022/04	2022/04 - 2022/10	2022/10 - 2023/04	2023/04 - 2023/10	2023/10 - 2024/04	2024/04 - 2025/01
RU to UA	4	3	8	21	0	0	0
UA to RU	2	8	4	36	6	11	8

The departure of Ukrainian ASes from Russia

Joins and disconnections of non-Russian ASes in Russian infrastructure.



The departure of Russian ASes from Ukraine

Joins and disconnections of non-Ukrainian ASes in Ukrainian infrastructure.



Concentration of IXPs in Ukraine and Russia



- We emailed to every Ukrainian IXP in order to find out if it was offline, and for how long.
- We also asked to get a list of the AS members that are hosted inside.
- Only the MESH-IX responded, informing us that the building was destroyed at March 2022!

• We had to validate our sources!

- We retrieved all available Traceroutes from RIPE Atlas, for the first 15 days of each timestamp.
- For every traceroute, If we found an IXP's IP in the path, we save the source destination IP of it.





Src-Dst pair list: (67.32.14.2, 105.48.32.9) (10.12.1.9, 177.42.63.2)

- Collect all traceroutes that have source destination IP from that list.
- If no IXP's IP found on those traceroutes for other timestamps, then we consider the IXP is **maybe** inactive for that timestamp.

- IXPs IP detected
- IXPs IP not detected for the same route that in previous or next timestamp did.
- The IXP does not exist in the specific timestamp
- IXP existed in our dataset but with no matched traceroute



Validation of Ukrainian IXPs' members

PTR record: Tenet-ix.giganet.ua

- signifies that a router is registered in Giganet in Ukraine and
- is connected to a network named Tenet.

Validation of Ukrainian IXPs' members

For each Ukrainian IXP:

• We retrieved all the available PTR records(~1500) from their IPs

• We manually matched the organization name or AS name, to the PTR

Validation of Ukrainian IXPs' members

Internet Exchange Point	Validated members		
GigaNET IXN	248/317 (78.23%)		
Digital Telecom Internet Exchange	201/274 (73.36%)		
Ukrainian Internet Exchange	184/210 (87.62%)		
1-IX Internet Exchange	64/81 (79.01%)		
IF-IX	13/30 (43.33%)		

75 % accuracy

AS Relationship data

We retrieved the AS-relationship data from CAIDA for the timestamps we study.

- Extracted peer to peer information for Ukraine and Russia
- Extracted provider to client information for Ukraine and Russia

Decline of Russia-Ukraine for (peer to peer)



AS Relationship for Ukrainian peers



AS Relationship for Russian peers

Decline of Russia-Ukraine (for provider-client)



AS Relationship for Ukrainian providers



AS Relationship for Russian providers

Conclusion

- De-peering activity took place months before invasion and continued during the first months after the invasion.
- Parts of peering infrastructure in eastern Ukraine were destroyed or lost connection until today
- Peering between Russian and Ukrainian networks were significantly impacted
- Increased number of country changes for the conflicted countries

Questions?



Backup slides

82.51.1.185.in-addr.arpa. 5	IN	PTR	gigabitonline2-10g-gw.ix.net.ua.	["Gigabit-Online LLC"]	[49620]	q2
217.50.1.185.in-addr.arpa. 5	IN	PTR	euroline2-gw.ix.net.ua.	["EUROLINE-UKRAINE, LLC"]	[60159, 60812]	q1
245.180.25.193.in-addr.arpa. 5	IN	PTR	dtel-ix.akamai.com.	["Akamai International B.V."]	[20940]	q1
72.39.1.185.in-addr.arpa. 5	IN	PTR	ip-72.ix.ks.ua.			
232.180.25.193.in-addr.arpa. 5	IN	PTR	dtel-ix.studnet.net.ua.			
103.180.25.193.in-addr.arpa. 5	IN	PTR	dtel-ix.volia.net.	["Volia"]	[25229]	q1
63.39.1.185.in-addr.arpa. 5	IN	PTR	ip-63.ix.ks.ua.			
181.181.25.193.in-addr.arpa. 5	IN	PTR	dtel-ix-1.ip-connect.info.	[" IP-Connect LLC"]	[57944]	q1