The Internet in Crimea

a Case Study on Routing Interregnum

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Introduction

- Crimea used to be administrated by Ukraine
- From March 2014 it is administrated by Russia

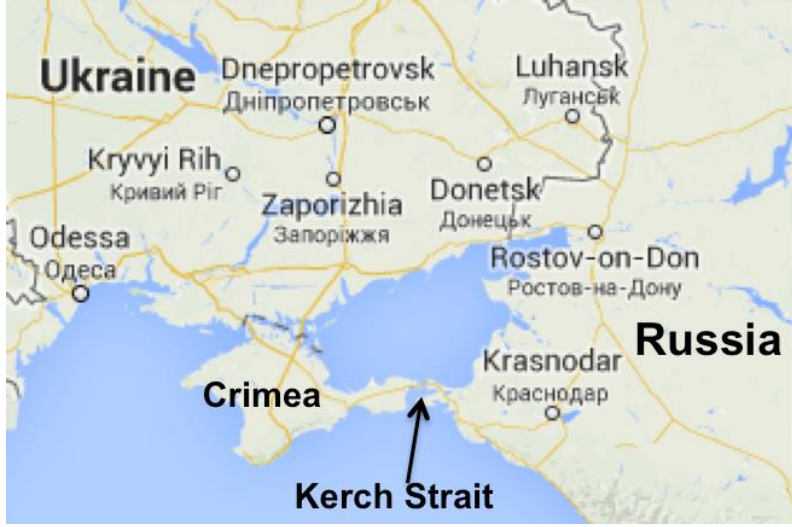
- Goal: How this change impacts Internet connectivity?

- Approach:
  - Sociological fieldwork: interviews with local ISPs
  - Internet measurements: analysis of BGP data

Sociological fieldwork

- 45 semi-structured interviews of 1 to 2 hours with:
  - ISPs from Crimea and Ukraine
  - journalists and human rights defenders
  - members of the Ministry of Communications of Ukraine
  - digital security trainers
- Focusing on infrastructure transitions between March 2014 and July 2017

Internet in Crimea (2014-2015)



- 2014 March: Referendum
- 2014 April: Completion of submarine link from Russia to Crimea (Kerch Strait cable)
- **2014 July**: Start of cable operation by **Miranda Media** (Rostelcom's local agent)
- 2014 December: Most Ukranian ISPs left Crimea
- 2015: Price for Internet raised

Internet in Crimea (2016-2017)

- 2016 May: Russia started the construction of a second Internet cable (in service from July)
- 2017 May: Ukrainian president orders to block access to popular Russian platforms
- 2017 May: Crimean users complain about Ukrainian blockpages when accessing these websites
- **2017 July: Ukraine stop providing Internet connectivity**

Internet measurements

- **Finding Crimean ASes**
  - Who is operating in Crimea?
- **Network dependencies**
  - Who provides connectivity to Crimean networks?
  - How does it change over time?
  - How does it correlate with our timeline?

Locating ASes

- Geolocation of IP space is hard (even more for disputed area)
- A lot of different manual inspections:
  - RIPE Atlas / OONI probes
  - Manually checked upstream networks
  - IXP information (Crimea IX)
  - Manual validation with whois/forums/interviews
  - BGP data: downstream of Miranda-Media

- **Found 111 ASNs** that were active between 2012-2019

Network dependency

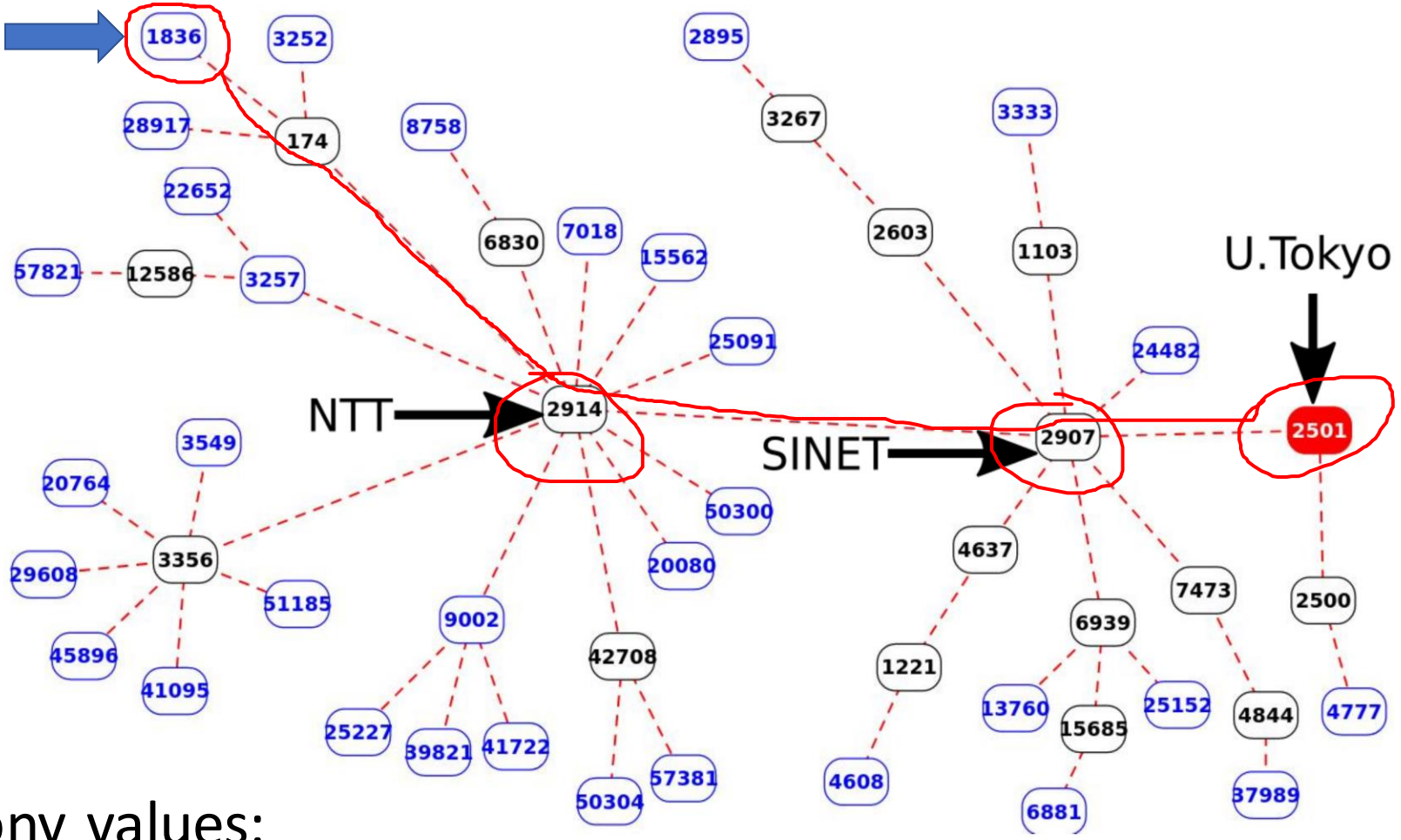
- How network depend on each other? How are the main transits?

- **AS Hegemony** [PAM18]
  - Take AS paths from BGP data
  - Make graph with all paths to a selected AS
  - Compute node centrality (values range in [0,1])
  - Account for sampling bias
  - Weight paths by prefix size

[PAM18] R.Fontugne, A.Shah, E.Aben. "The (thin) Bridges of AS Connectivity: Measuring Dependency using AS Hegemony", Proceedings of PAM'18

Example: U. Tokyo dependencies

blue nodes are vantage points

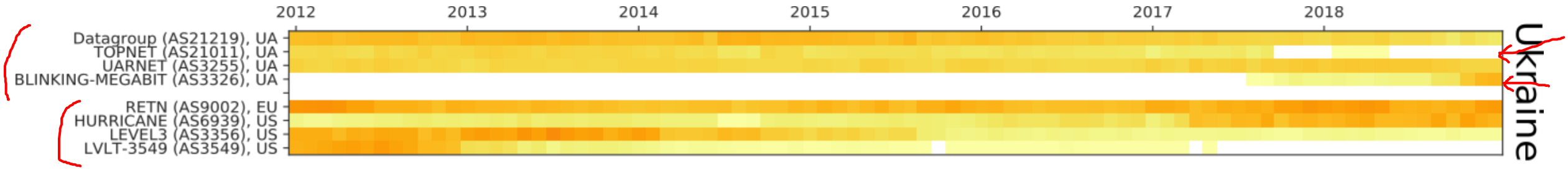


- AS Hegemony values:
  - SINET= 1.0
  - NTT = 0.8

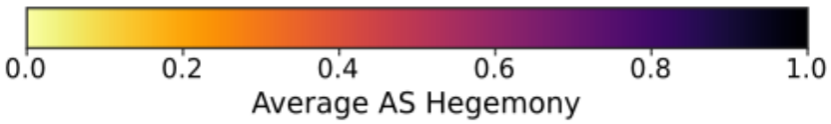
Network dependency of multiple ASes

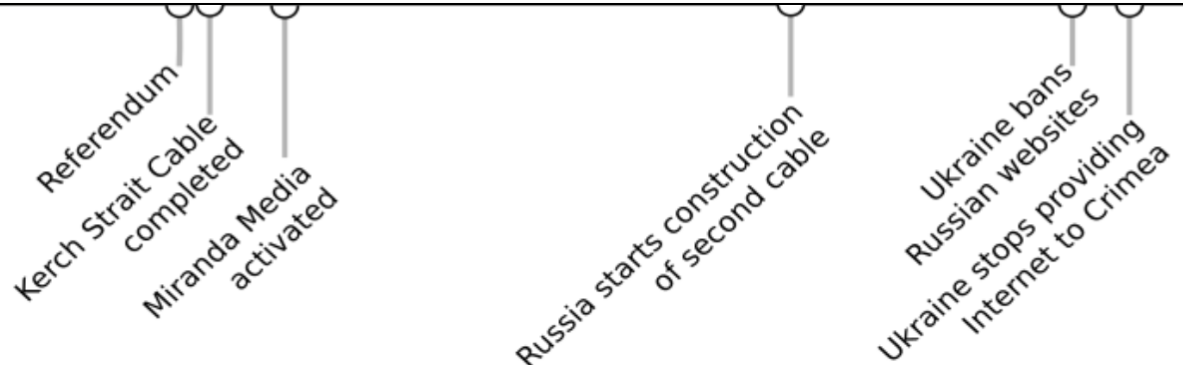
- Compute AS Hegemony for each AS (weight by IP space)
- Mean AS Hegemony accross all ASes (weight by AS)
- Obtain typical network dependency for selected ASes

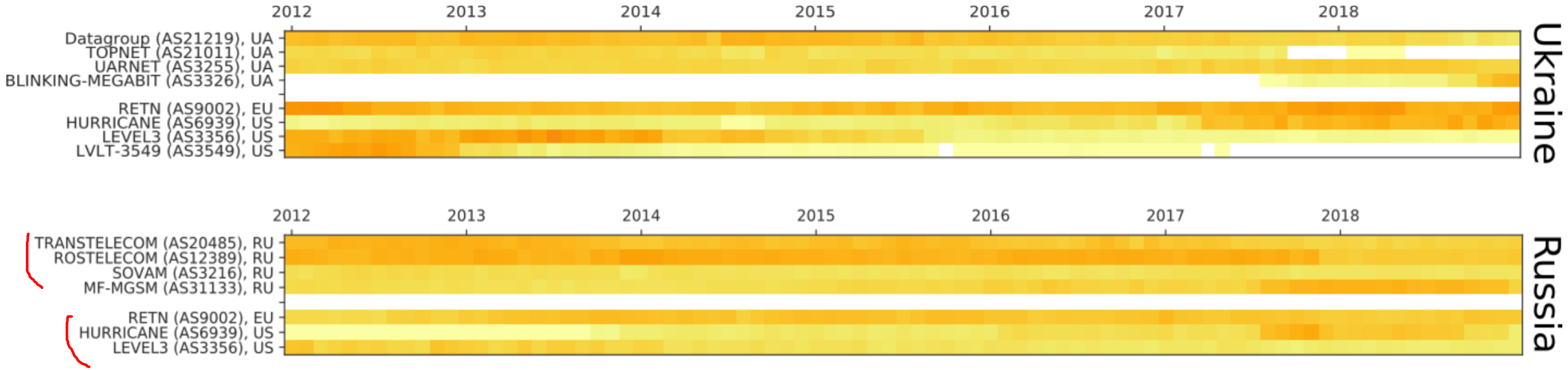
- Pros/Cons:
  + Recycle AS Hegemony results from PAM18
  + Small ASes are equally important
  - Not accounting for AS sizes



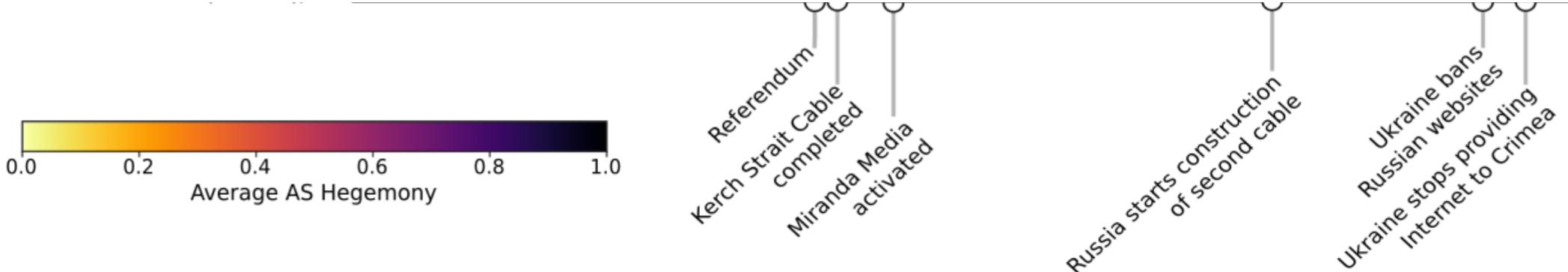
- **AS Hegemony values for Ukraine are stable**
- **Dependencies are mainly Ukrainian**

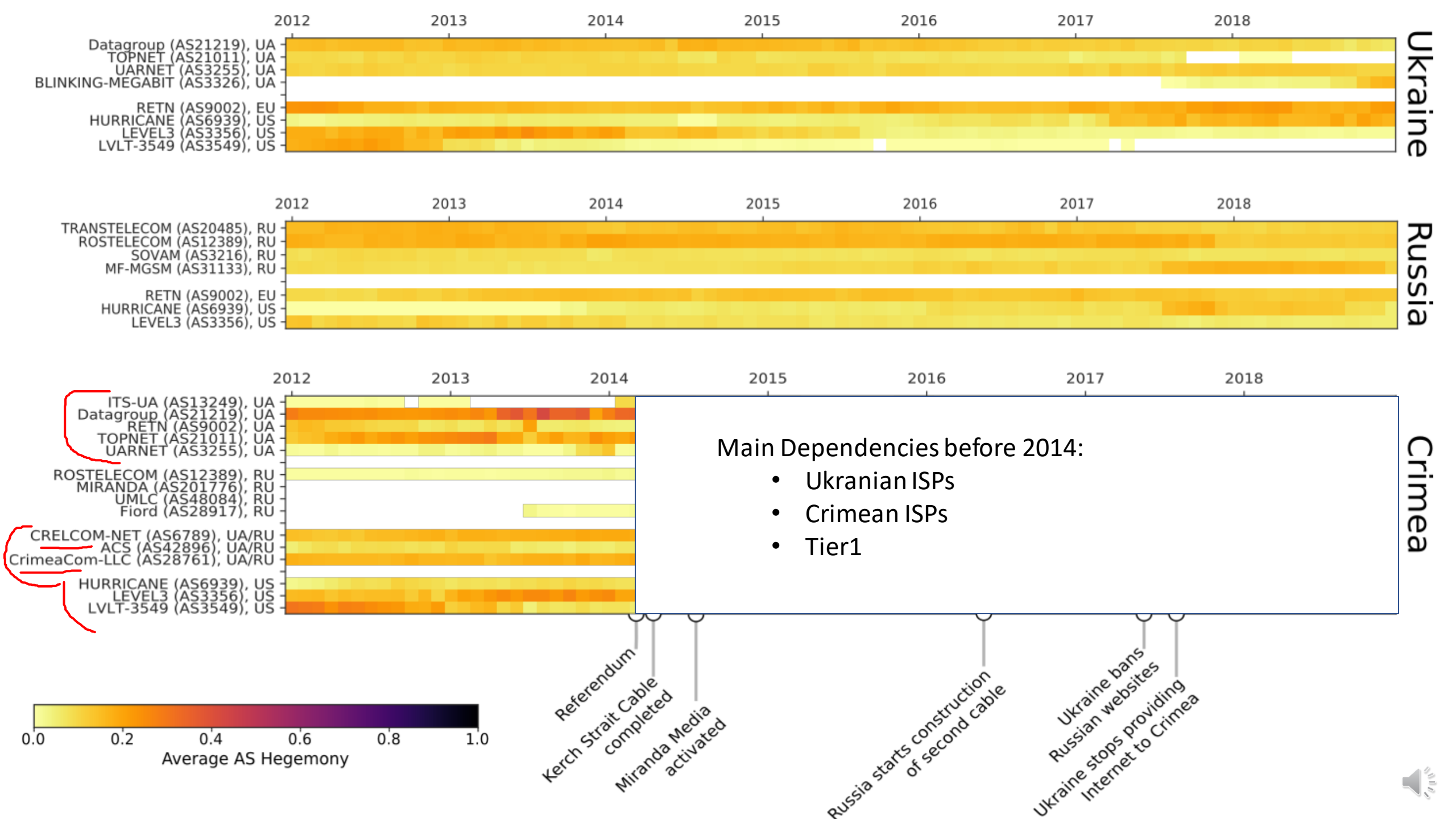






- **AS Hegemony values for Russia are very stable**
- **Dependencies are mainly Russian**




2012
2013
2014
2015
2016
2017
2018
Datagroup (AS21219), UA
TOPNET (AS21011), UA
UARNET (AS3255), UA
BLINKING-MEGABIT (AS3326), UA
RETN (AS9002), EU
HURRICANE (AS6939), US
LEVEL3 (AS3356), US
LVLT-3549 (AS3549), US
Ukraine
TRANSTELECOM (AS20485), RU
ROSTELECOM (AS12389), RU
SOVAM (AS3216), RU
MF-MGSM (AS31133), RU
RETN (AS9002), EU
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Russia
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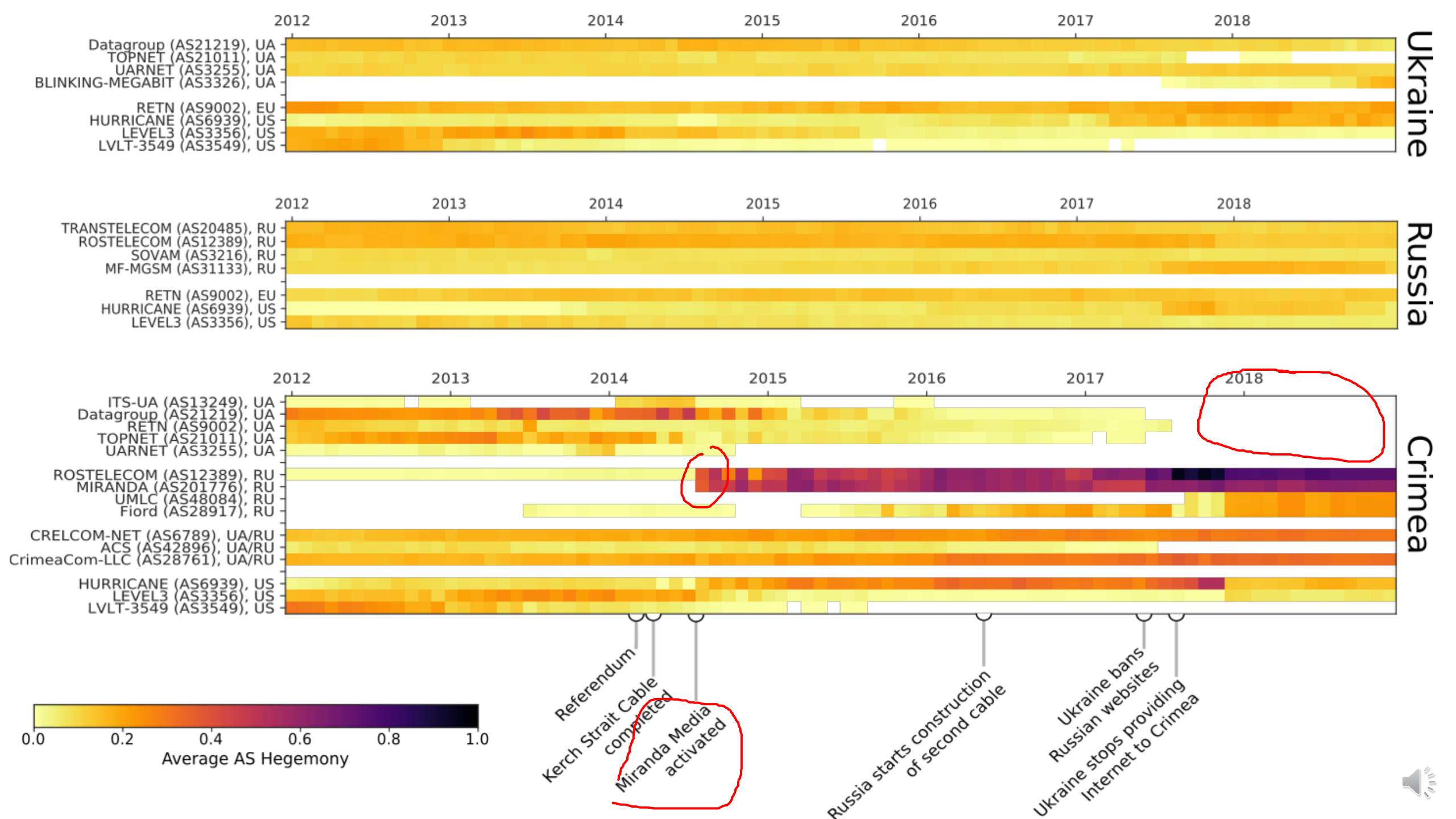
Datagroup (AS21219), UA
RETN (AS9002), UA
TOPNET (AS21011), UA
UARNET (AS3255), UA
ROSTELECOM (AS12389), RU
MIRANDA (AS201776), RU
UMLC (AS48084), RU
Fiord (AS28917), RU
CRELCOM-NET (AS6789), UA/RU
ACS (AS42896), UA/RU
CrimeaCom-LLC (AS28761), UA/RU
HURRICANE (AS6939), US
LEVEL3 (AS3356), US
LVLT-3549 (AS3549), US
Crimea
Main Dependencies before 2014:
• Ukranian ISPs
• Crimean ISPs
• Tier1
Referendum
Kerch Strait Cable completed
Miranda Media activated
Russia starts construction of second cable
Ukraine bans Russian websites
Ukraine stops providing Internet to Crimea
0.0
0.2
0.4
0.6
0.8
1.0
Average AS Hegemony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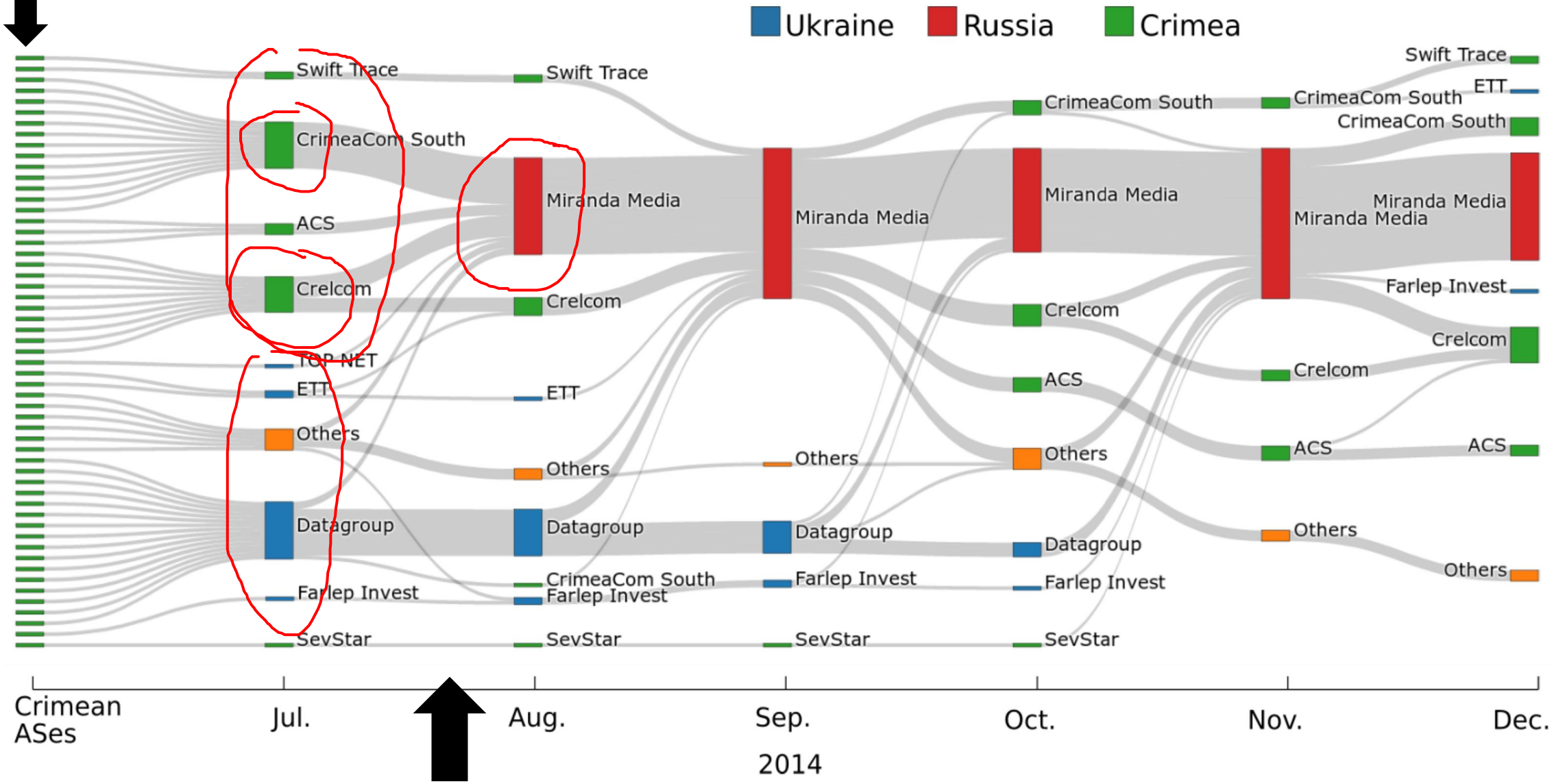
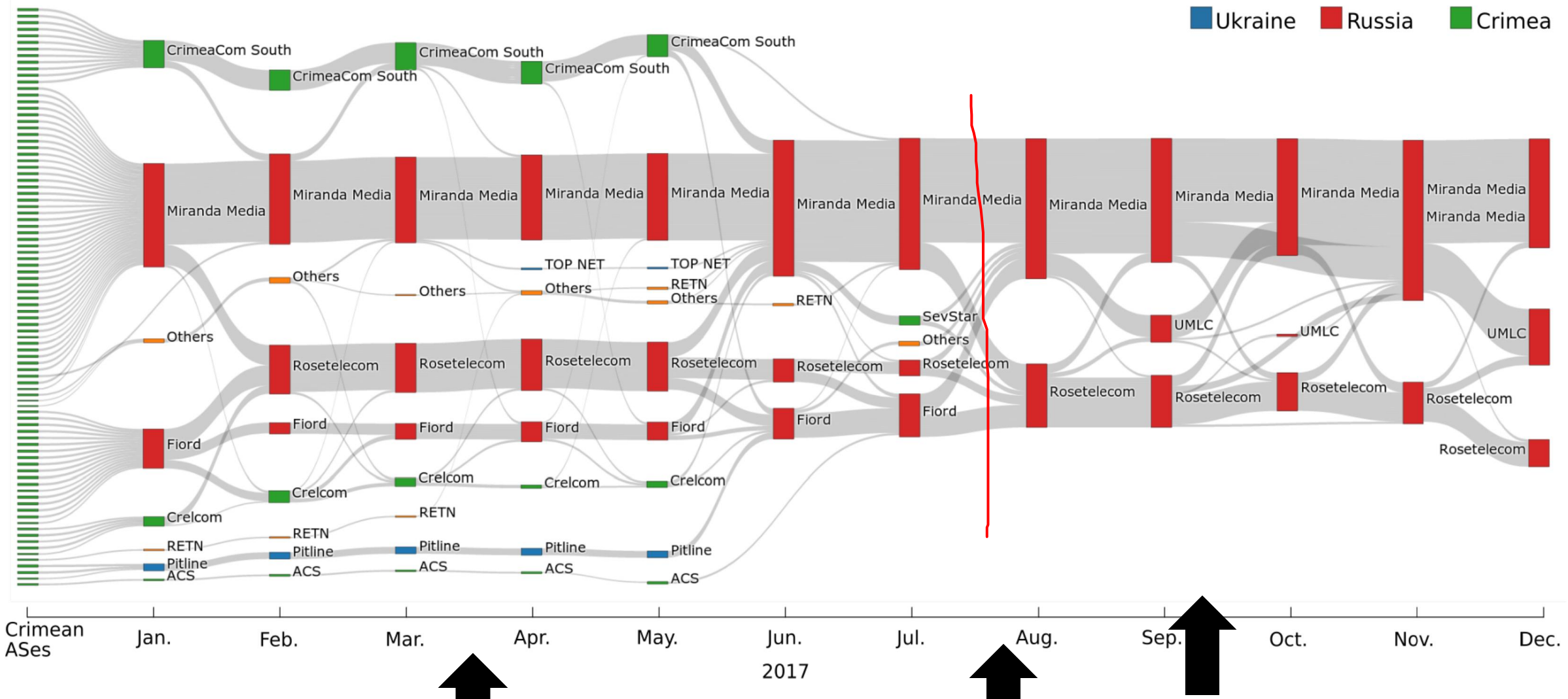
Adoption of Miranda Media

55 out of 78 ASes relied strongly on Miranda Media in 2014



End of transition



Major ISPs still rely on Ukrainian ISPs

Most paths go via Miranda Media/Rostelecom

UMLC/Fiord provides connectivity to Crimea

Discussions

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

Community contributions

- Data: AS Hegemony values available on Internet Health Report
  - REST API: https://ihr.iijlab.net/ihr/en-us/api
  - Python library: https://pypi.org/project/abondance/

- Tool: Country AS Hegemony
  - https://github.com/InternetHealthReport/country-as-hegemony
  - Fetch AS Hegemony values per country
  - Merge values weighted by IP space or eyeballs

Conclusions

- Investigated Crimea's topological changes during interregnum
- Cross referenced BGP measurements and survey data
- Significant changes to Crimea's Internet connectivity
- Long transition (3+ years)
- Data and tool available:
  - https://ihr.iijlab.net/
  - https://github.com/InternetHealthReport/country-as-hegemony

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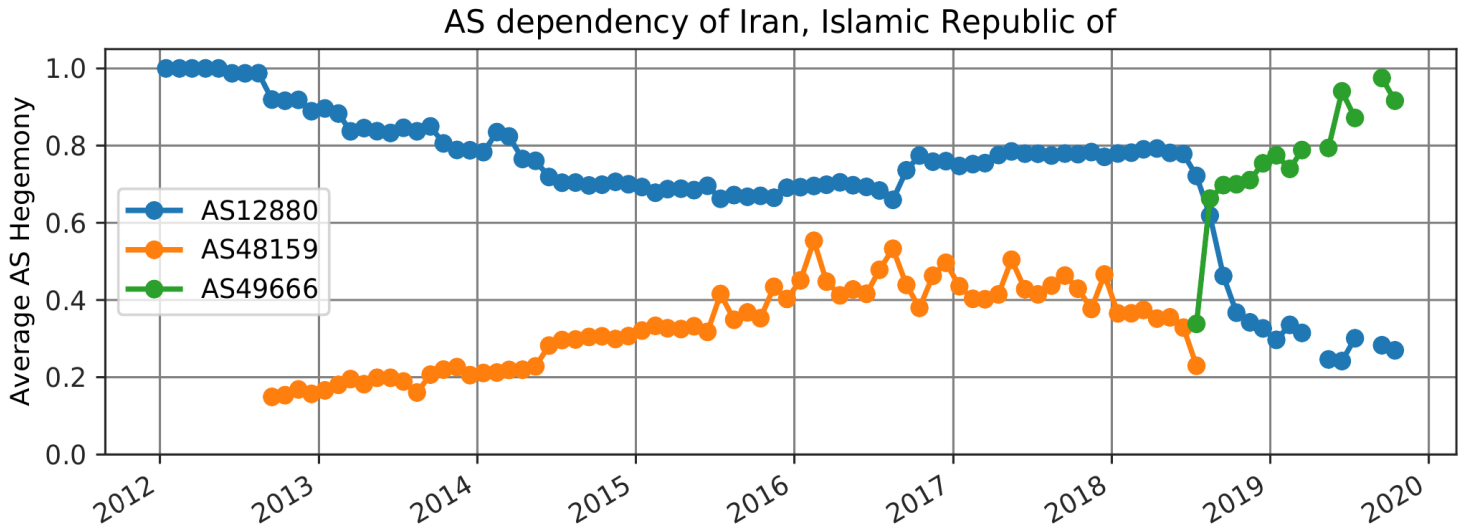
Backup

Examples

- Iranian networks depend on 3 ASes from the state-owned ISP (TCI)



- Second upstream for North Korea