

November 2023

Indexing Europe's Internet Resilience



Robbie Mitchell
mitchell@isoc.org

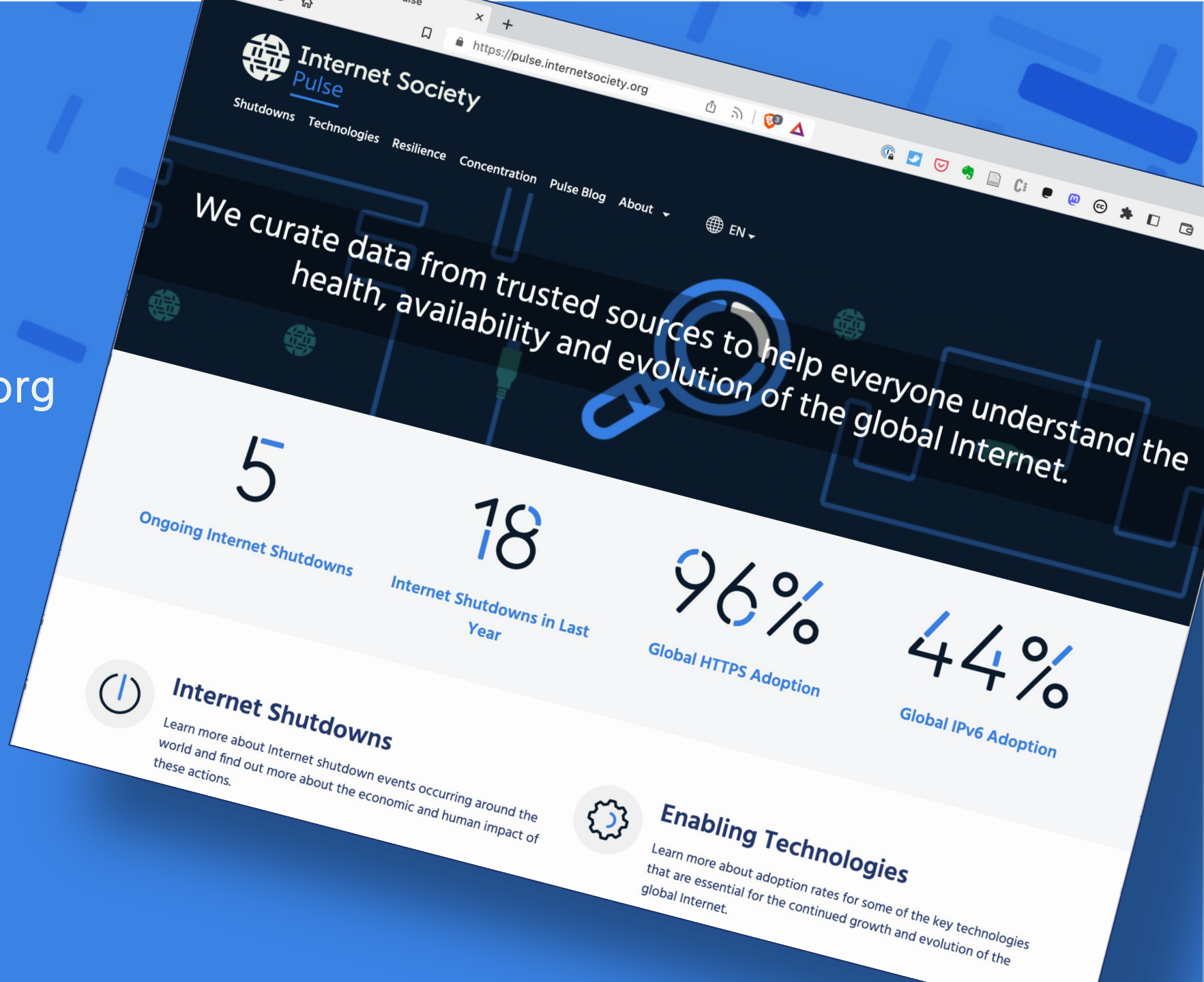
What we'll cover

- Why we are seeking to better inform decision-makers.
- What can we learn from recent incidents?
- Strengths and weaknesses within Europe
- The industry and Internet community have a role to play in improving the Internet's resilience.



pulse.internetsociety.org

Your Data Dashboard



Pulse tracks

Shutdowns: Where do Internet Shutdowns take place?

Technologies: What is the state of deployment of technologies critical for the evolution of the Internet?

Concentration: How much are services concentrated in the hands of a few?

Resilience: How robust is the Internet ecosystem?



Internet Society Pulse Internet Resilience Index (IRI)



The Internet Resiliency Index (IRI)

pulse.internetsociety.org/resilience

The framework collates around 30 sets of public metric data that relate to **four pillars** of a resilient Internet:

Infrastructure

The existence and availability of physical infrastructure that provides Internet connectivity.

Performance

The ability of the network to provide end-users with seamless and reliable access to Internet services.

Security

The ability of the network to resist intentional or unintentional disruptions through the adoption of security technologies and best practices.

Market Readiness

The ability of the market to self-regulate and provide affordable prices to end-users by maintaining a diverse and competitive market.



Methodology: <https://pulse.internetsociety.org/wp-content/uploads/2023/07/Internet-Society-Pulse-IRI-Methodology-July-2023-v2.0-Final-EN.pdf>

What can we learn from recent incidents?



AS4804 outage

- The outage lasted 10 hours
- It affected the fixed broadband and mobile communications of over 10 million individuals and 400,000 businesses and services.
- Issue believed to be related to BGP Maximum-Prefix filter.
- Signs of lack of resilience were clear to see



15 November 2023

Optus Outage Exposes Australia's Internet Resilience



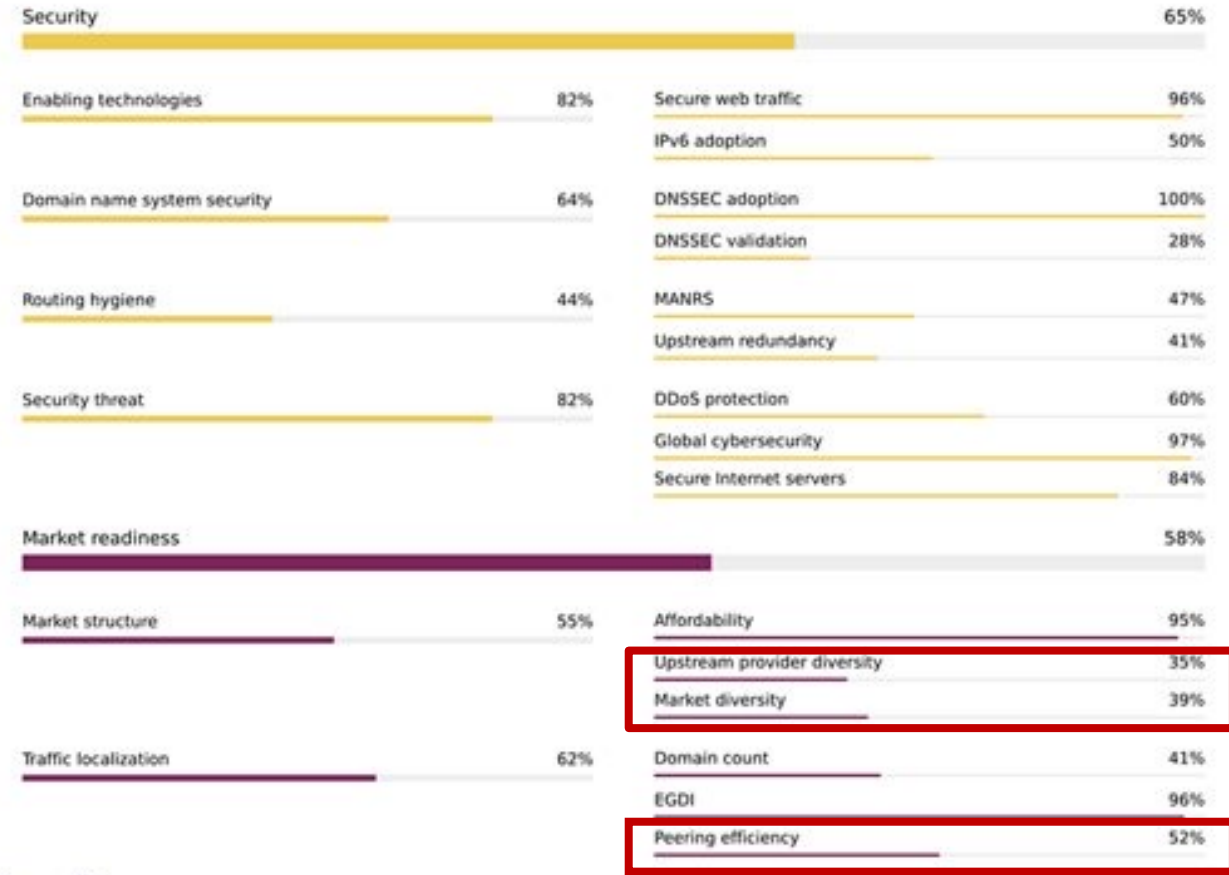
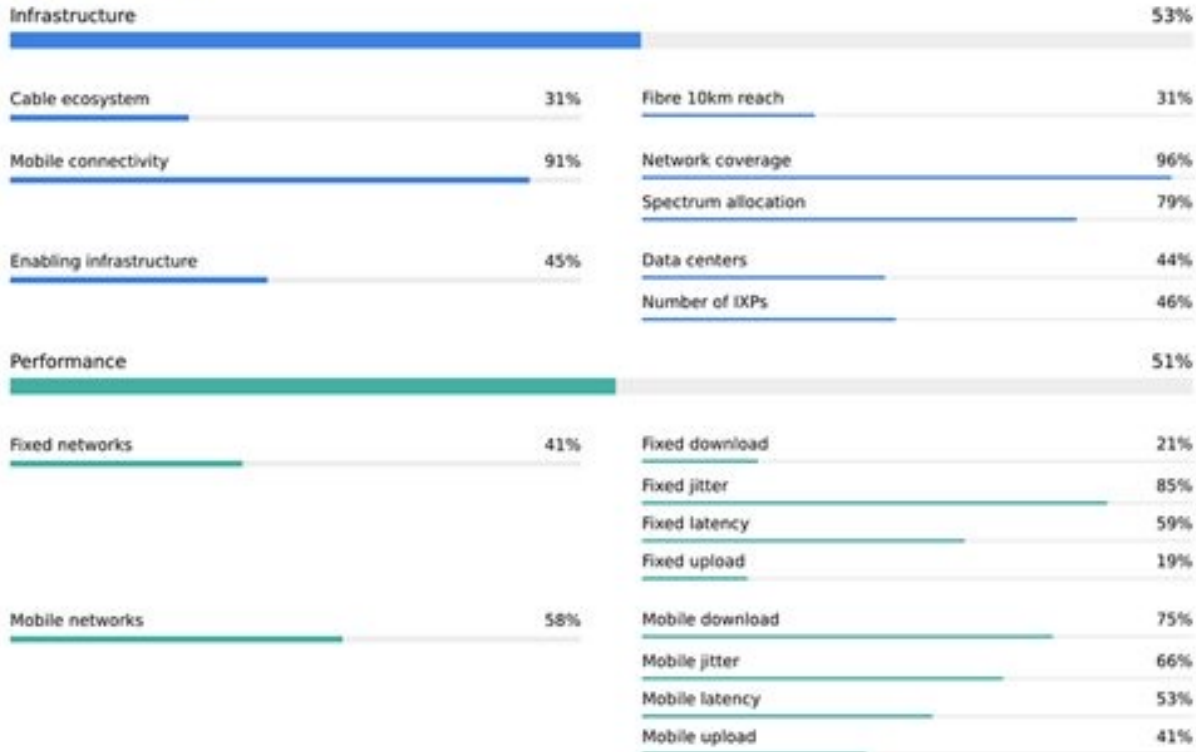
Aftab Siddiqui

Senior Manager, Internet
Technology - Asia-Pacific,
Internet Society

Categories:
Resilience

A minor technical slip-up by Australia's second-largest operator causes one-third of Australians to lose Internet and mobile connectivity.

Australia – Internet Resilience Index



Internet Resilience
pulse.internetsociety.org

data source: Pulse Internet Resilience Index

AS812 outage

- The outage lasted 19 hours.
- It affected 12 million subscribers and indirectly affected millions of others.
- Cost the economy nearly 142 million USD and Rogers 150M USD in customer credits.
- Rogers has also never provided a Root Cause Analysis



9 September 2022

Rogers Outage: What do we Know After Two Months?



Jim Cowie

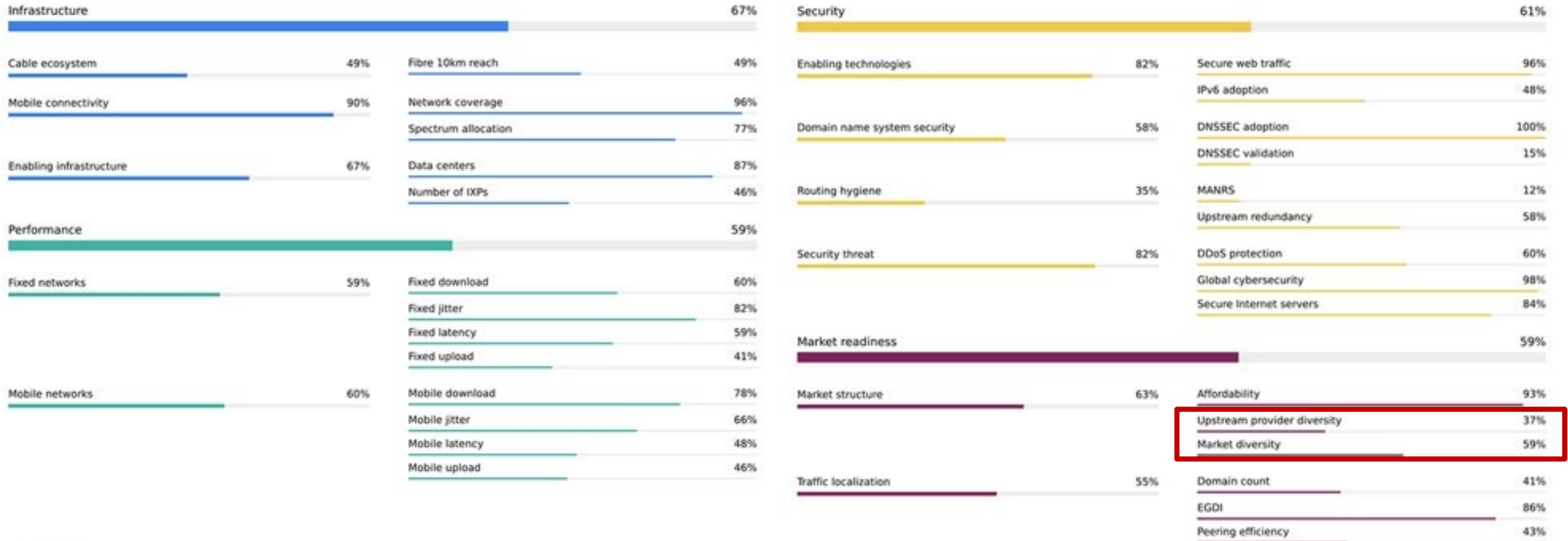
Former Resident
Advisor, Internet
Society

Categories:
Concentration,
Resilience

Hiding operational failures in darkness helps nobody.

Canada – Internet Resilience Index

🇨🇦 Canada



AS3269 and AS16232 outage

- Outage lasted 5 hours
- It affected one-third of Italy's Internet users.
- Cost the economy nearly 142 million USD and Rogers 150M USD in customer credits.
- Rogers has also never provided a Root Cause Analysis



8 February 2023

Italy's Internet Outage a Perfect Storm



Massimiliano Stucchi

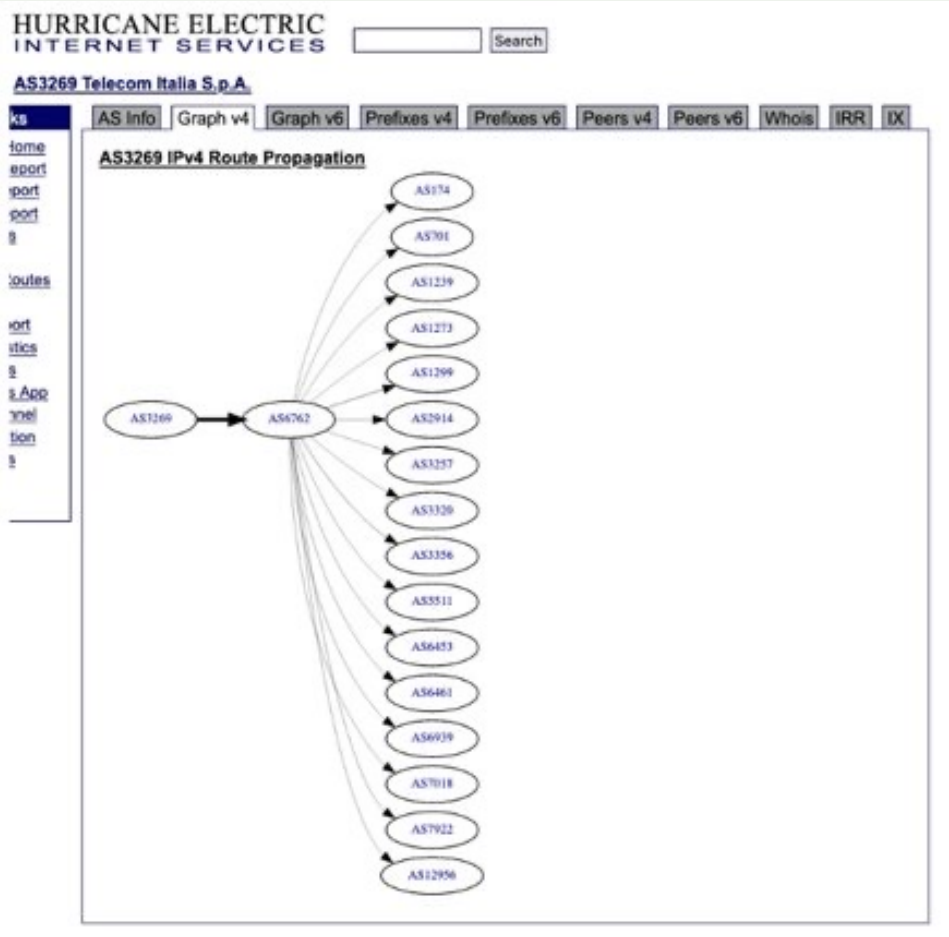
Regional Technical Advisor -
Europe, Internet Society

Categories:
Resilience

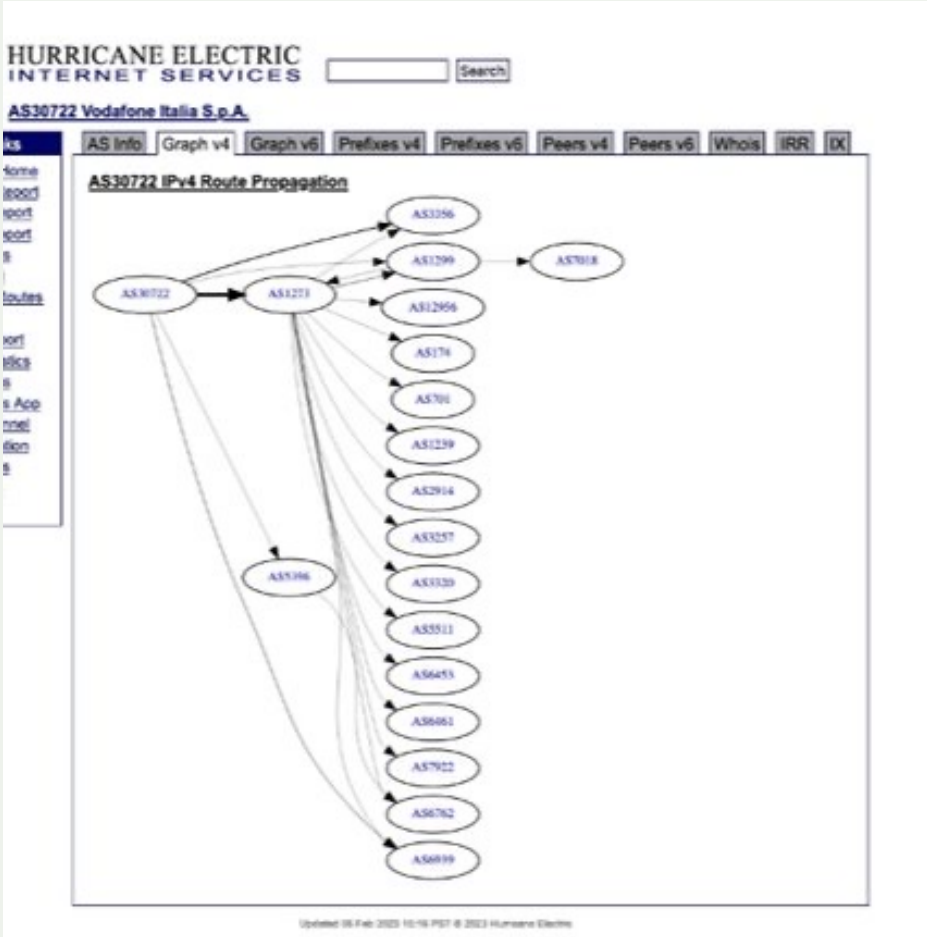
Italy's recent Internet outage was a failure that was years in the making and could have been negated through greater interconnectivity.

Italy – Compare the Pair

AS3269 TIM



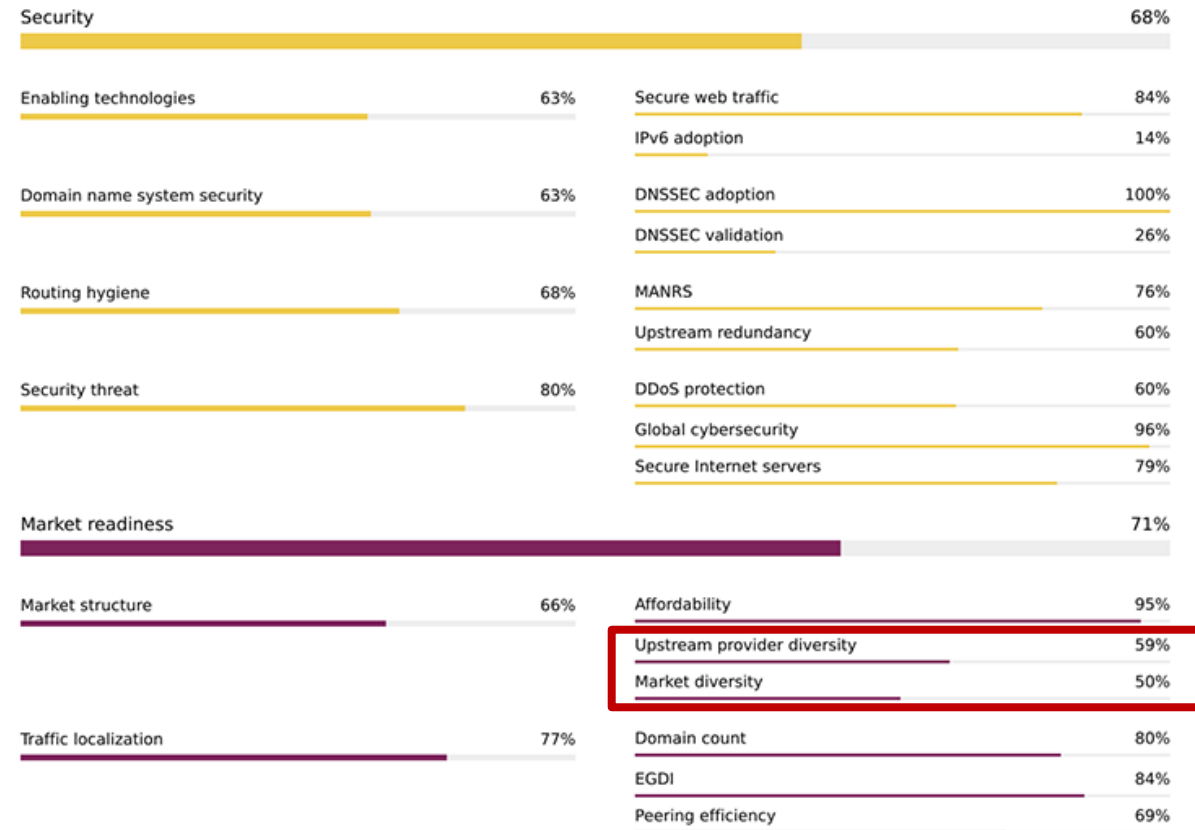
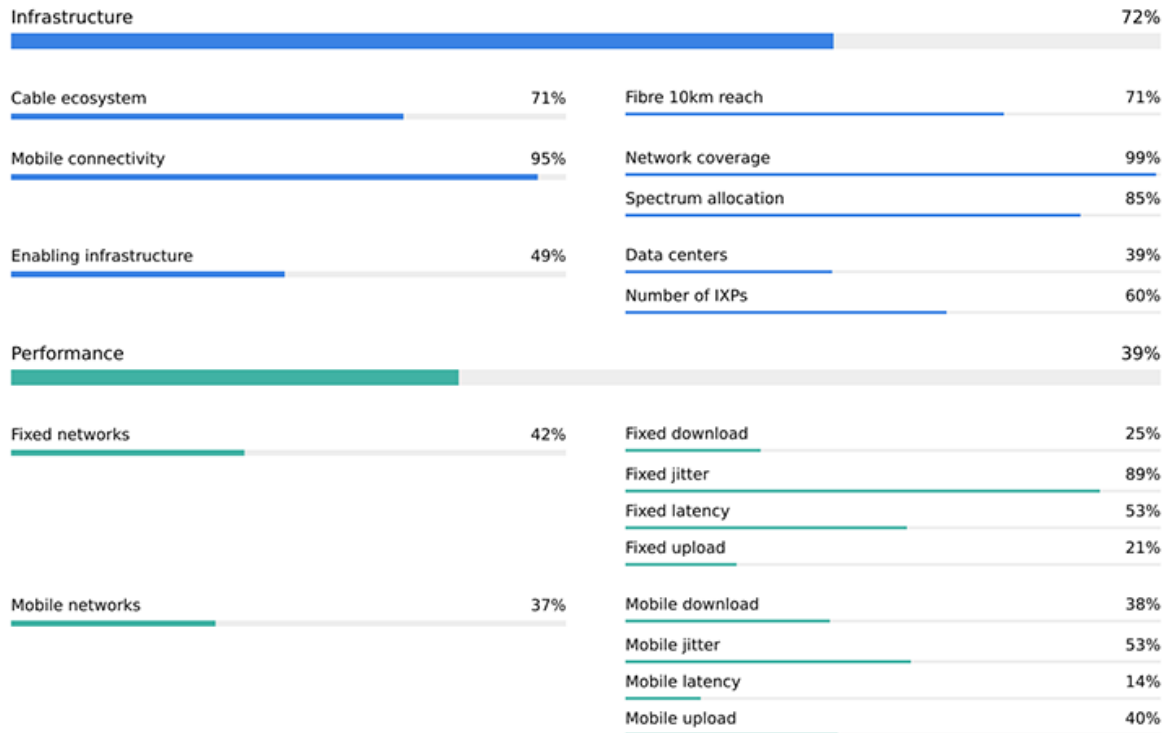
AS30722 Vodafone Italia



Italy – Internet Resilience Index



Italy



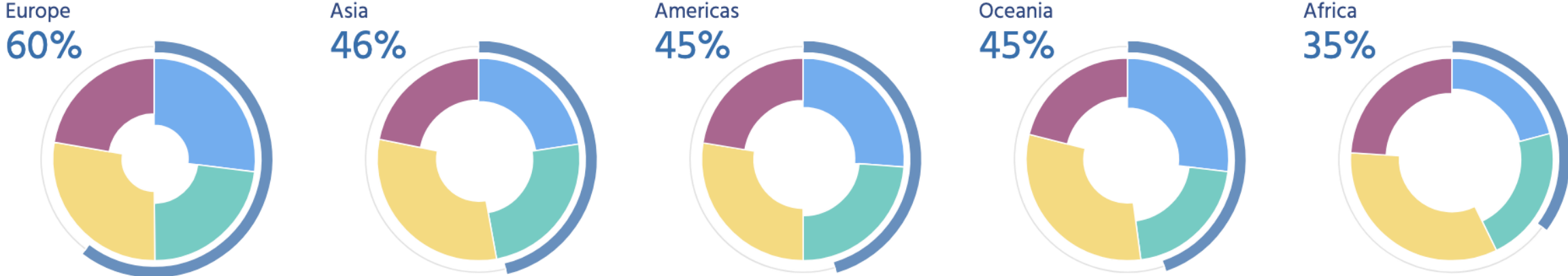
Internet Resilience in Europe: Strengths and Weaknesses



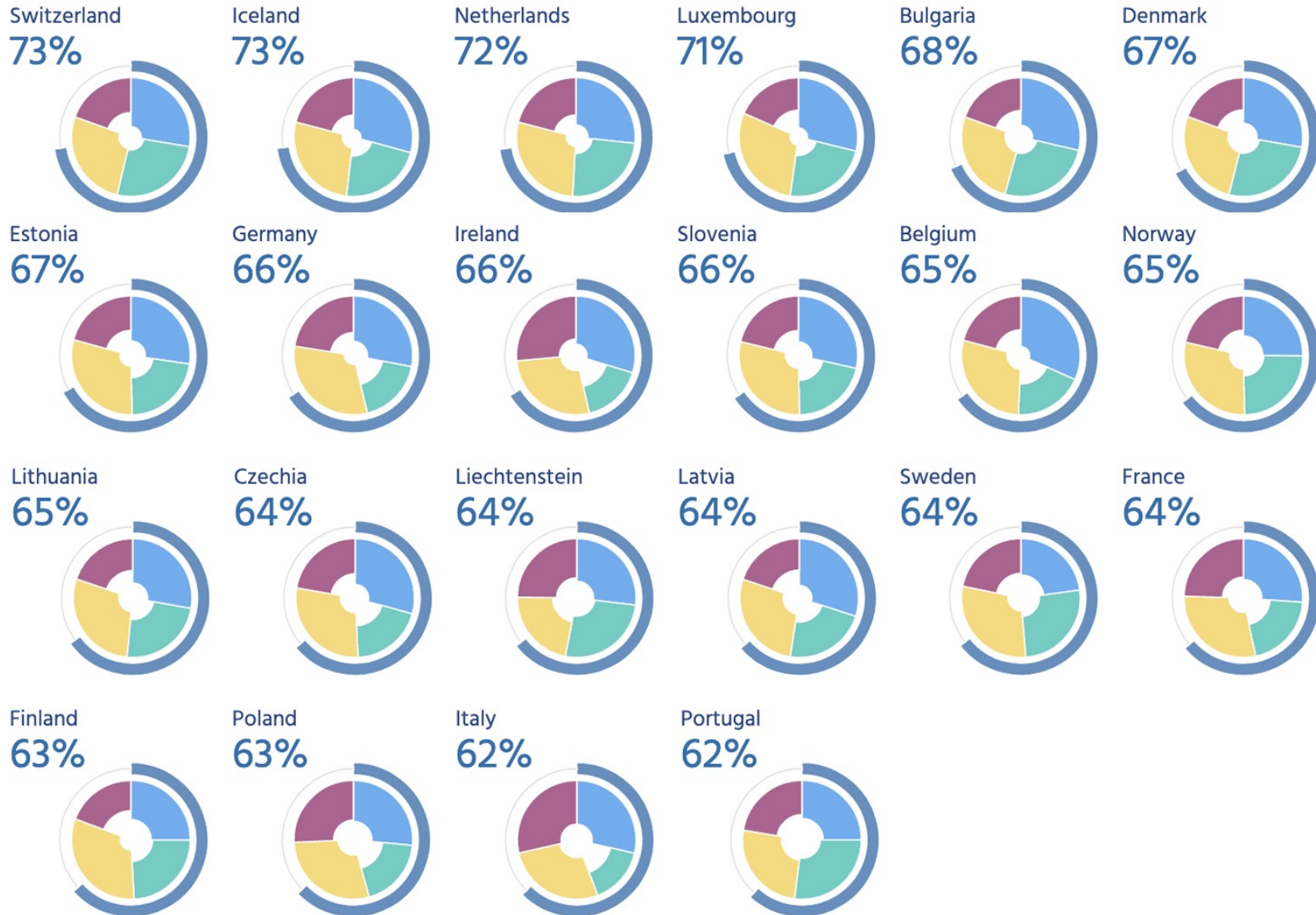
Overall Internet Resilience — By Region

● Overall Resilience ● Infrastructure ● Performance ● Security ● Market Readiness

Overall Resilience

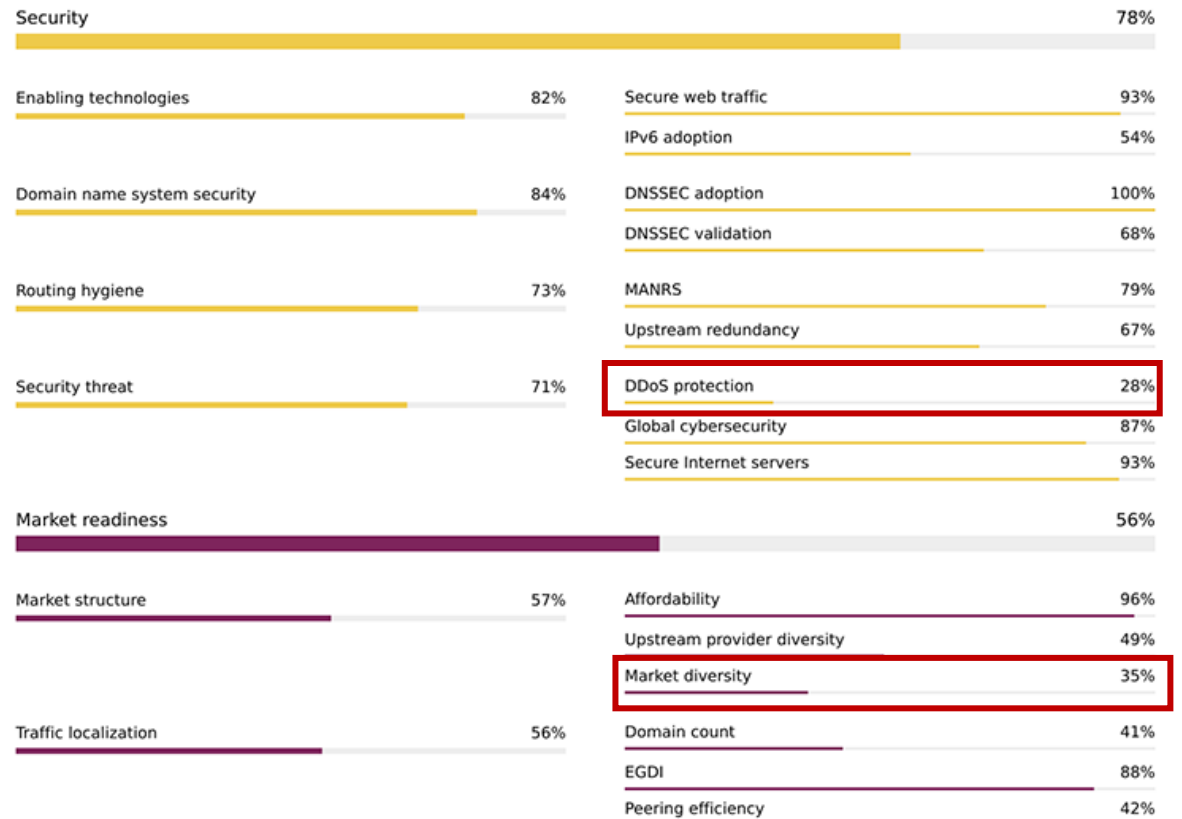
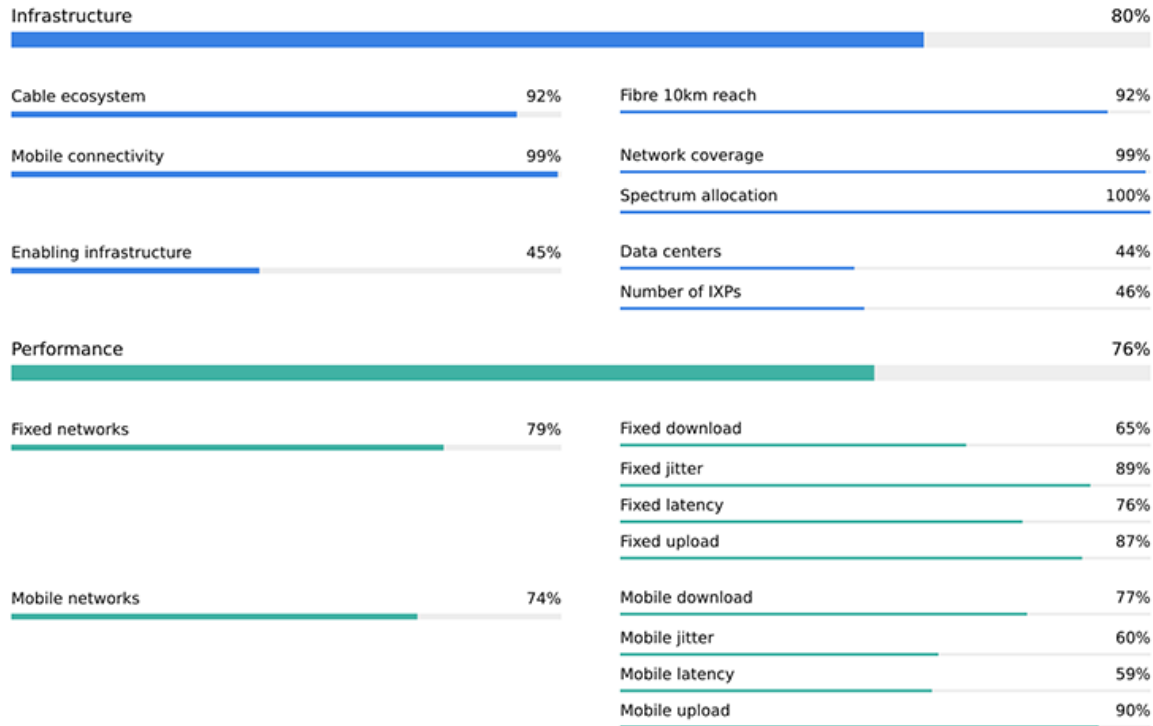


Overall Resilience - Countries in Europe

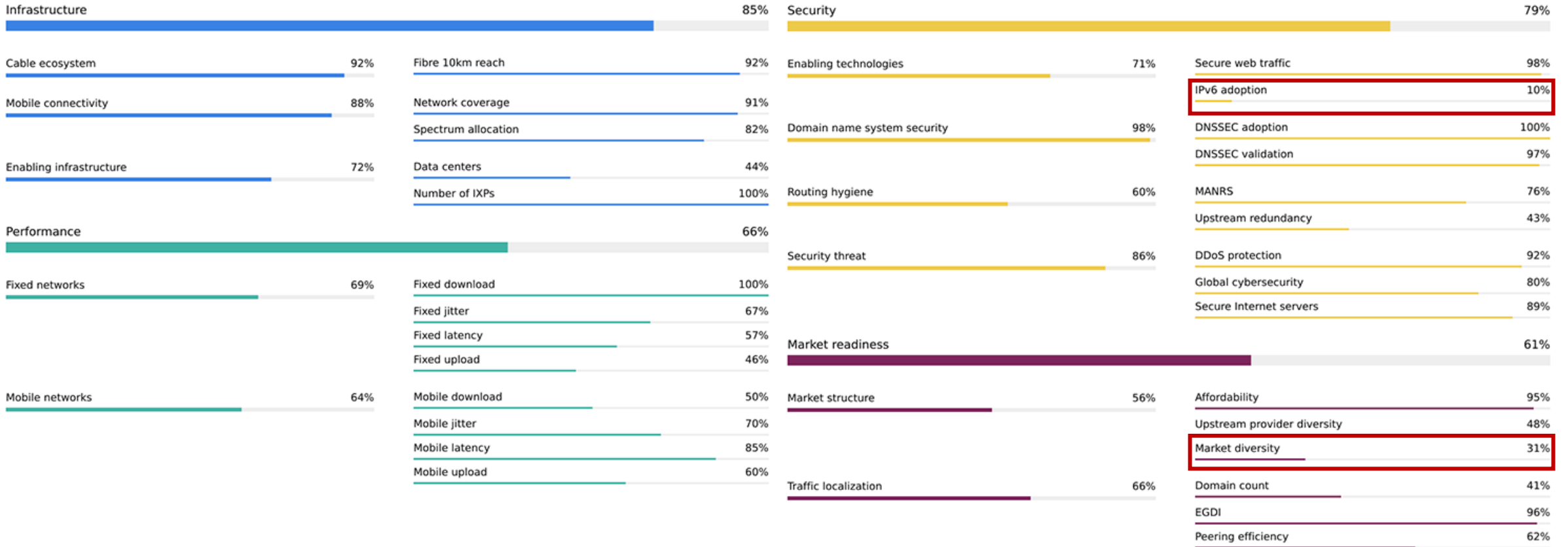


Switzerland- Internet Resilience Index

Switzerland



Iceland– Internet Resilience Index



Overall Resilience - Countries in Europe

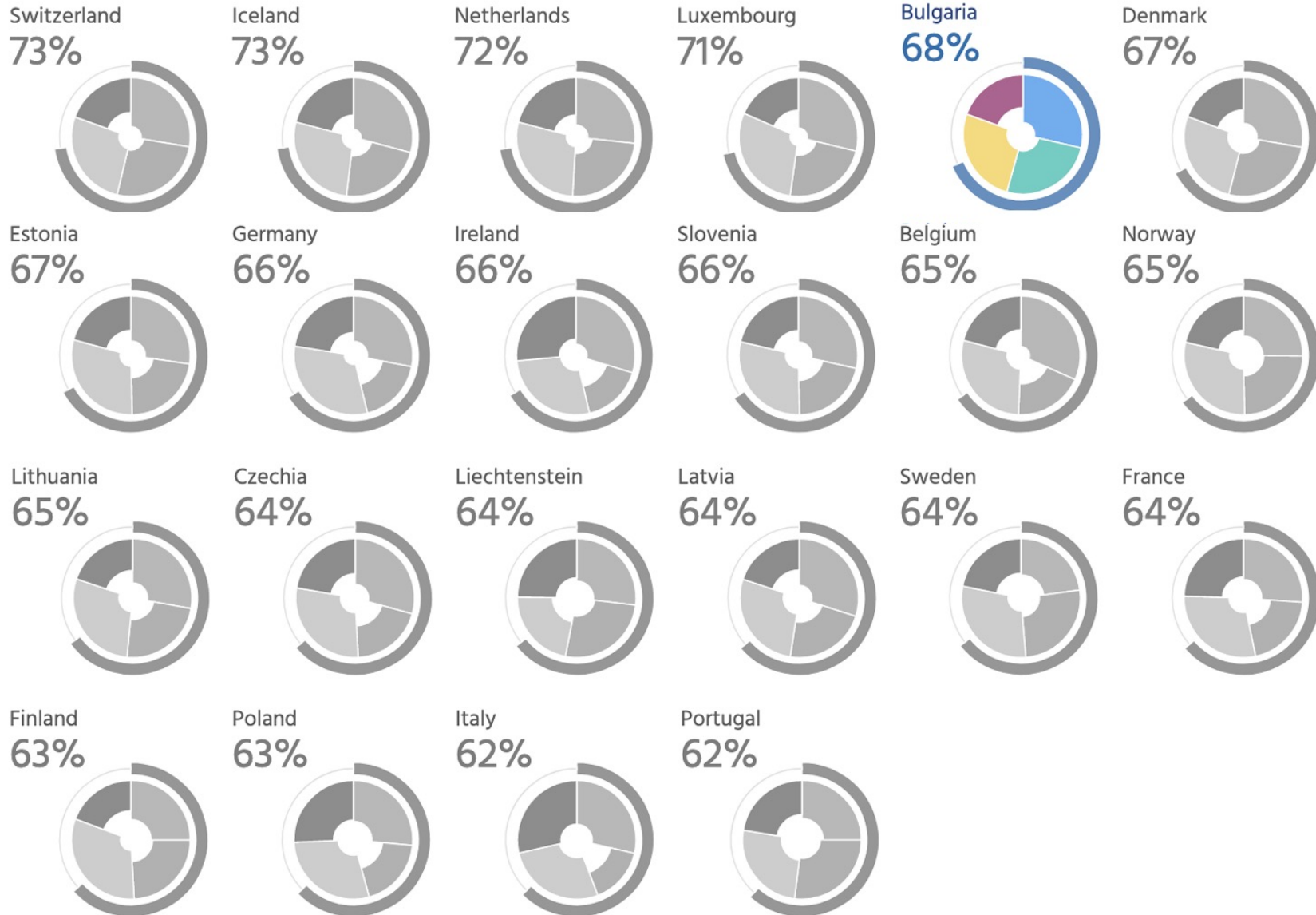
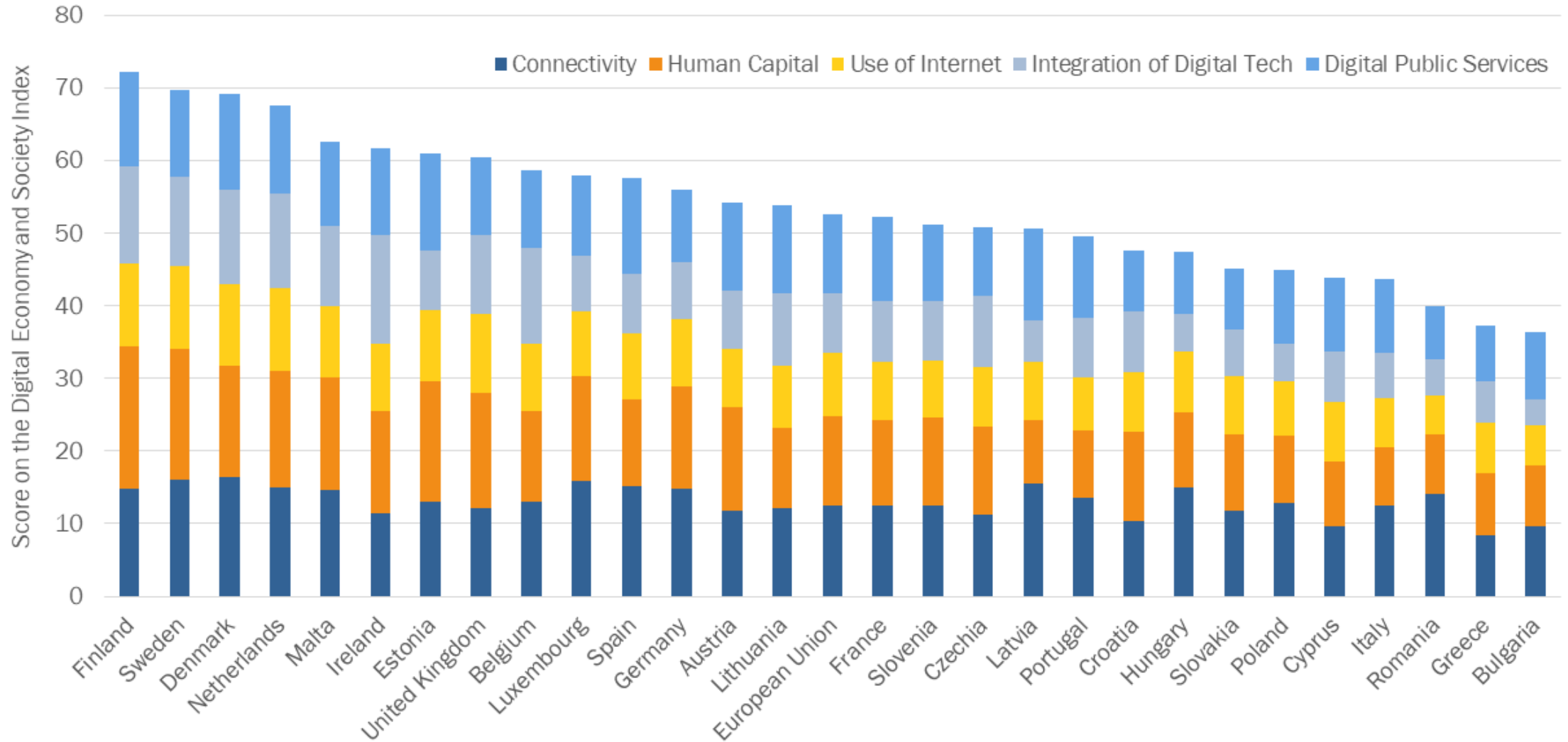


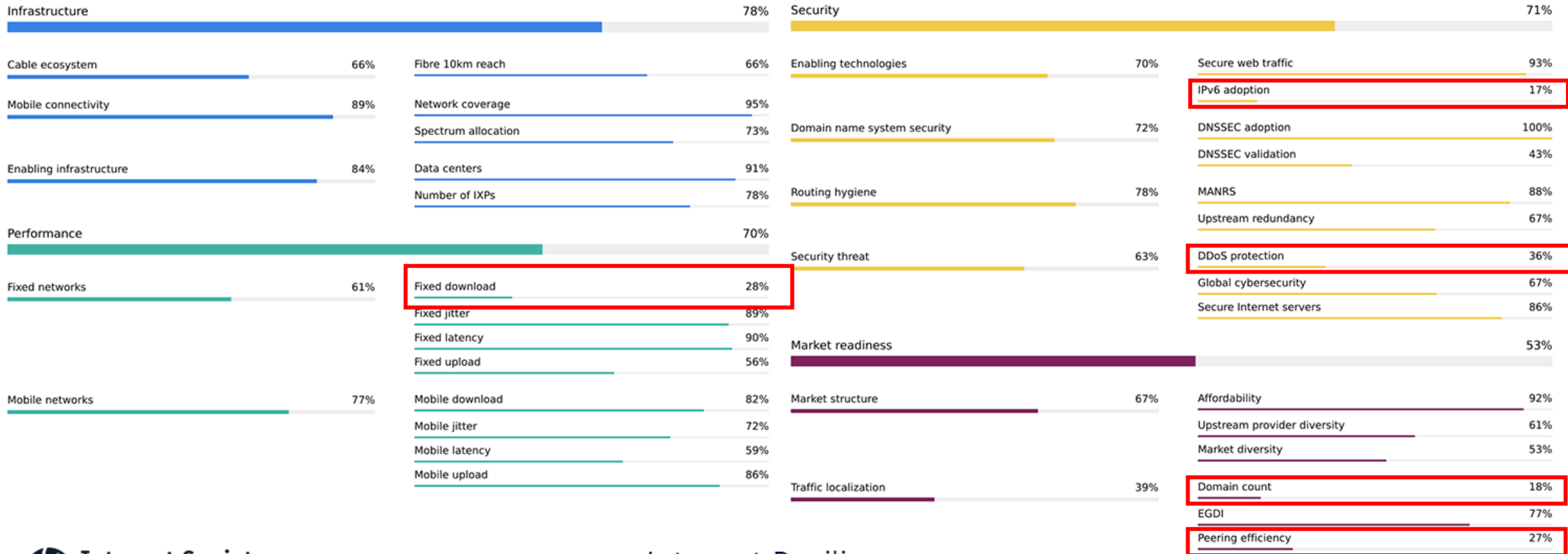
Figure 1. Bulgaria lags the rest of Europe in digitization



Source: European Commission, Digital Economy and Society Index (DESI), 2020.

<https://www.brookings.edu/articles/can-bulgaria-catch-the-digital-wave-defining-the-policy-priorities/>

Bulgaria– Internet Resilience Index



Overall Resilience - Countries in Europe

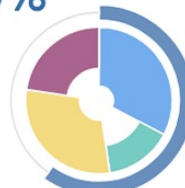
Romania
61%



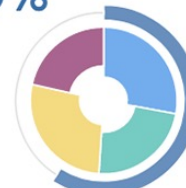
Austria
61%



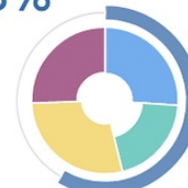
United Kingdom
60%



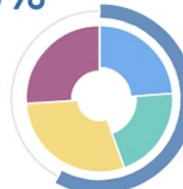
Croatia
59%



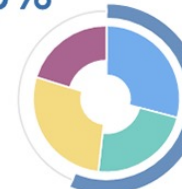
Spain
58%



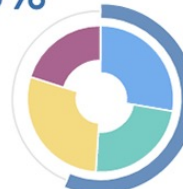
Greece
58%



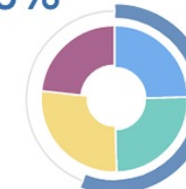
Slovakia
56%



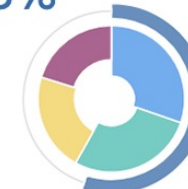
Moldova
56%



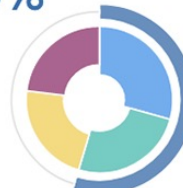
Hungary
56%



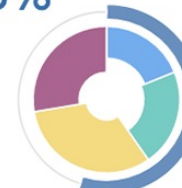
North Macedonia
55%



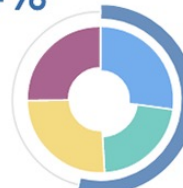
Malta
55%



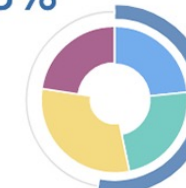
Russian Federation
55%



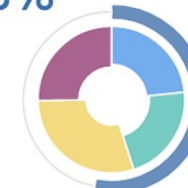
Albania
54%



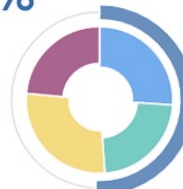
Serbia
53%



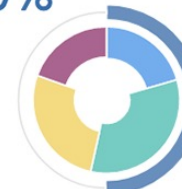
Ukraine
53%



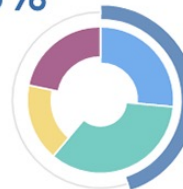
Montenegro
51%



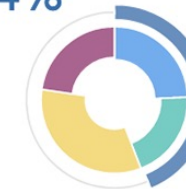
Andorra
50%



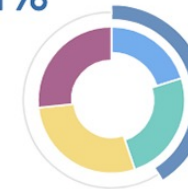
San Marino
45%



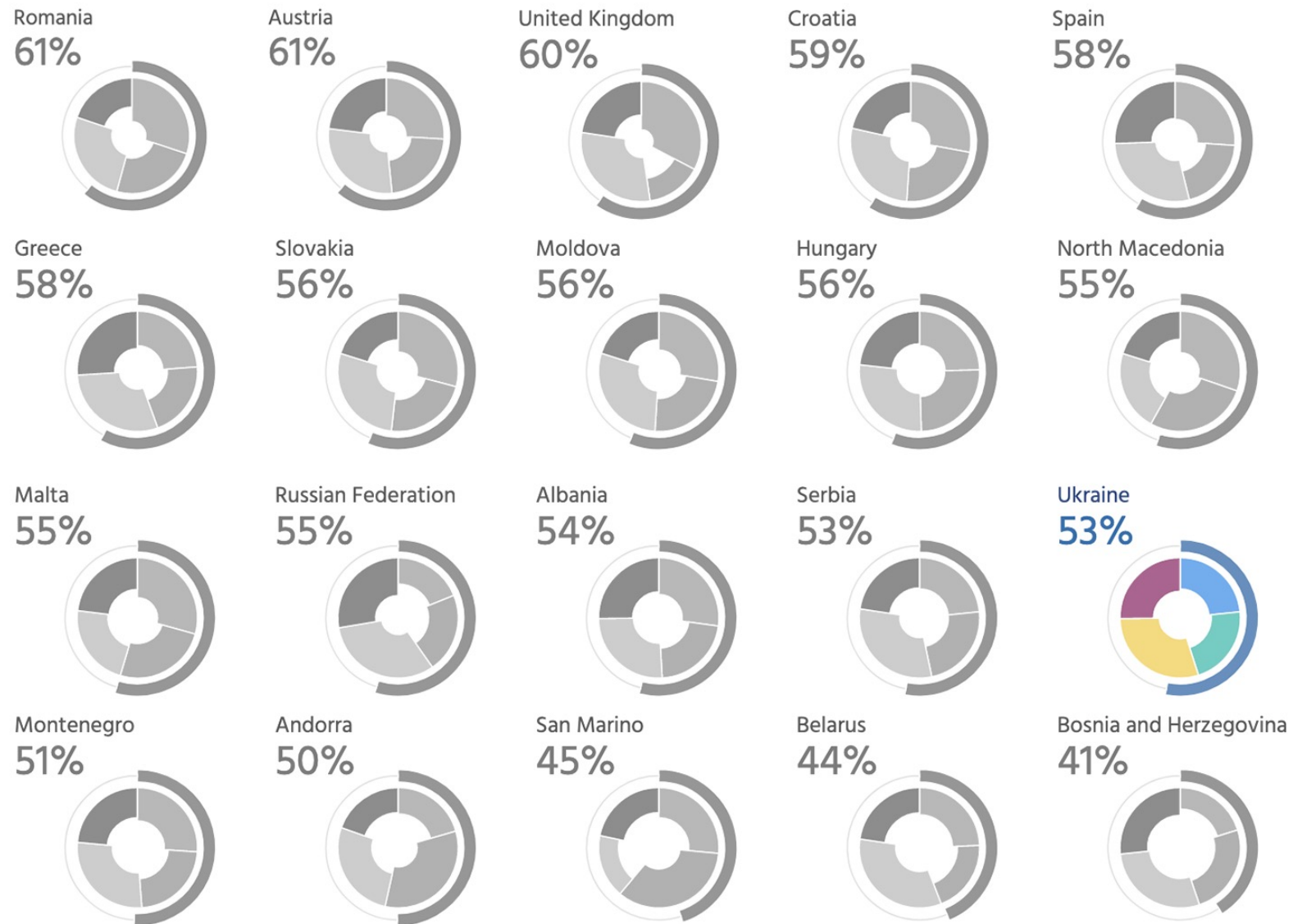
Belarus
44%



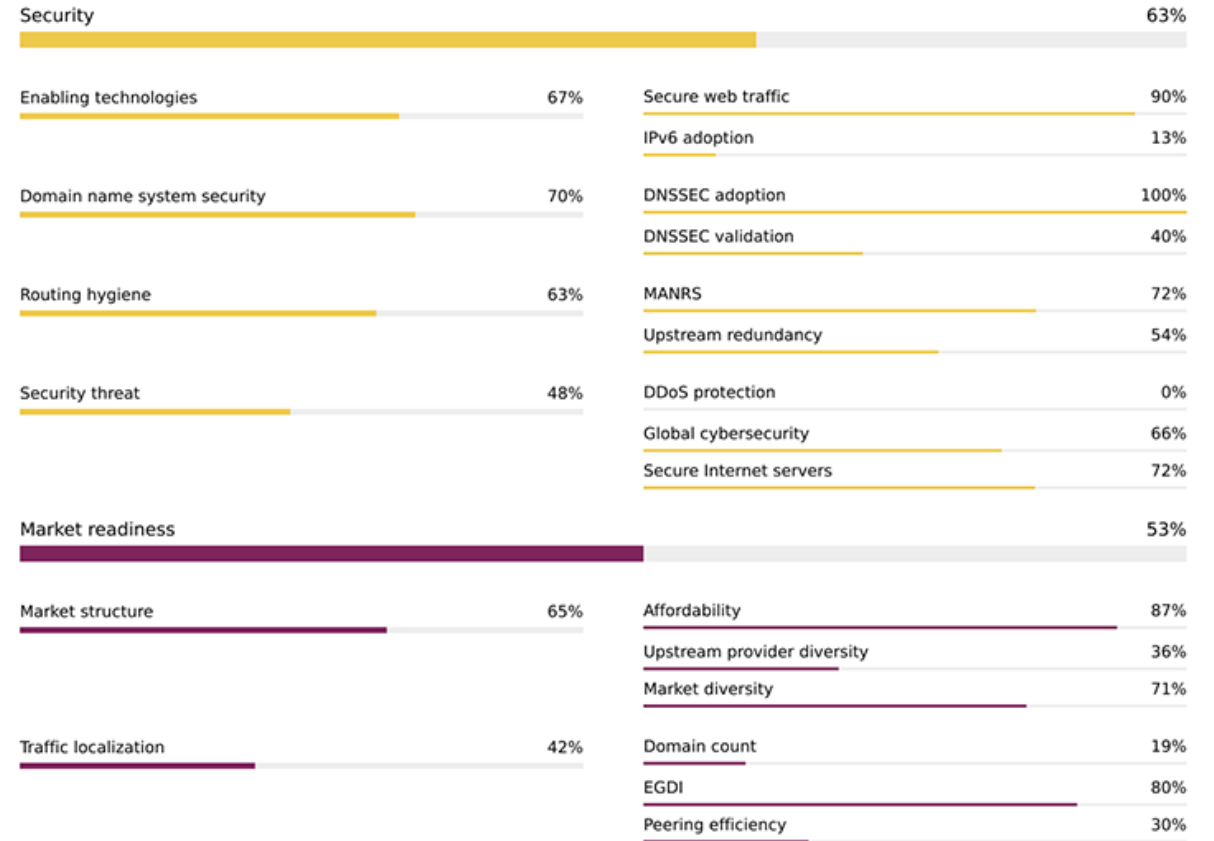
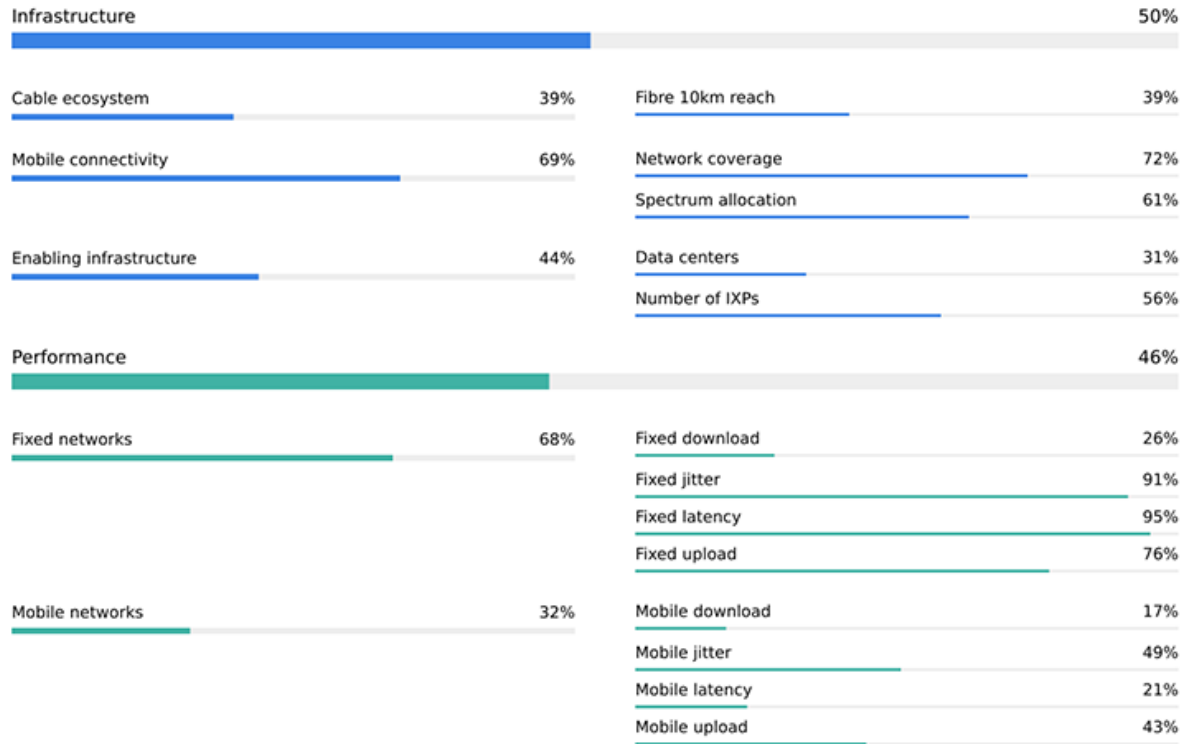
Bosnia and Herzegovina
41%



Overall Resilience - Countries in Europe



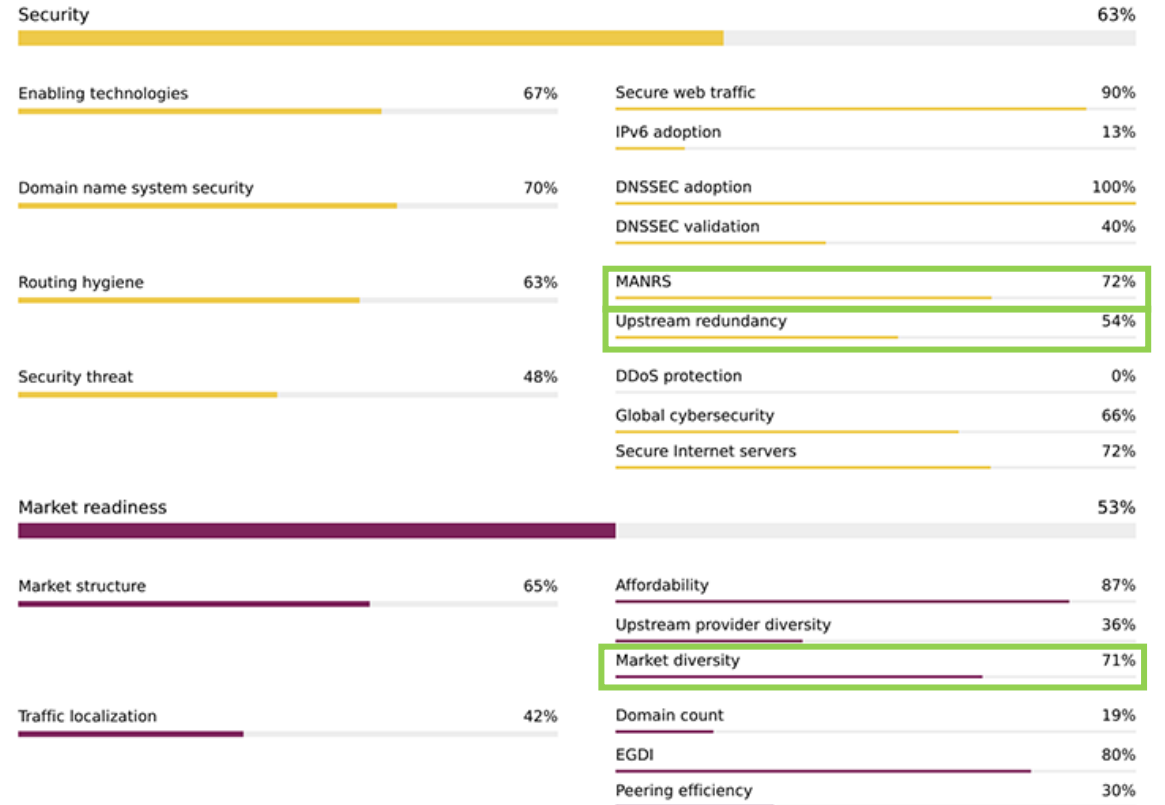
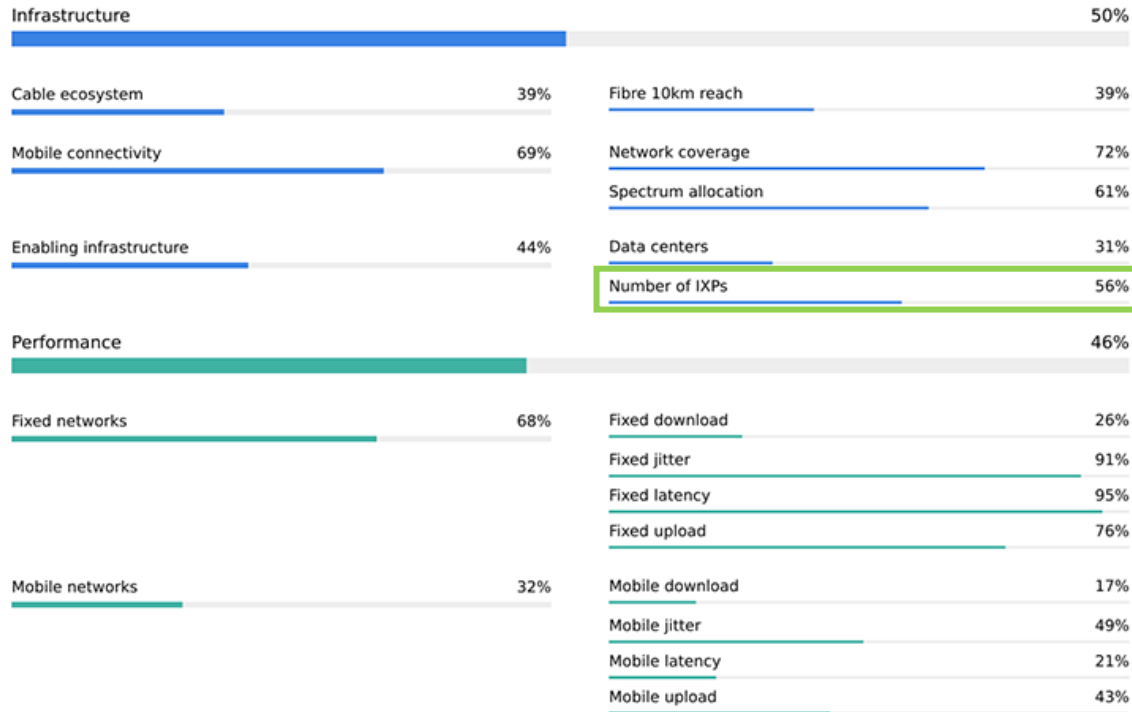
Ukraine– Internet Resilience Index



Internet Resilience
pulse.internetsociety.org

data source: Pulse Internet Resilience Index

Ukraine– Internet Resilience Index



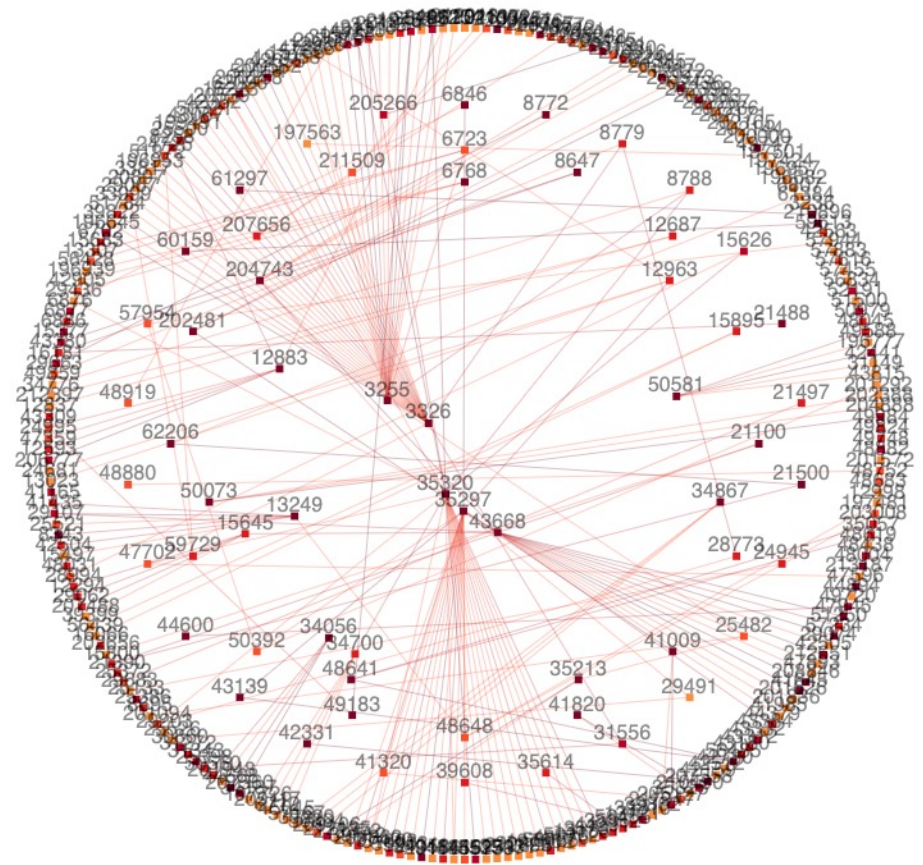
Internet Resilience
pulse.internetsociety.org

data source: Pulse Internet Resilience Index

Ukraine – IPv4 and v6 Interconnection (APNIC REX)

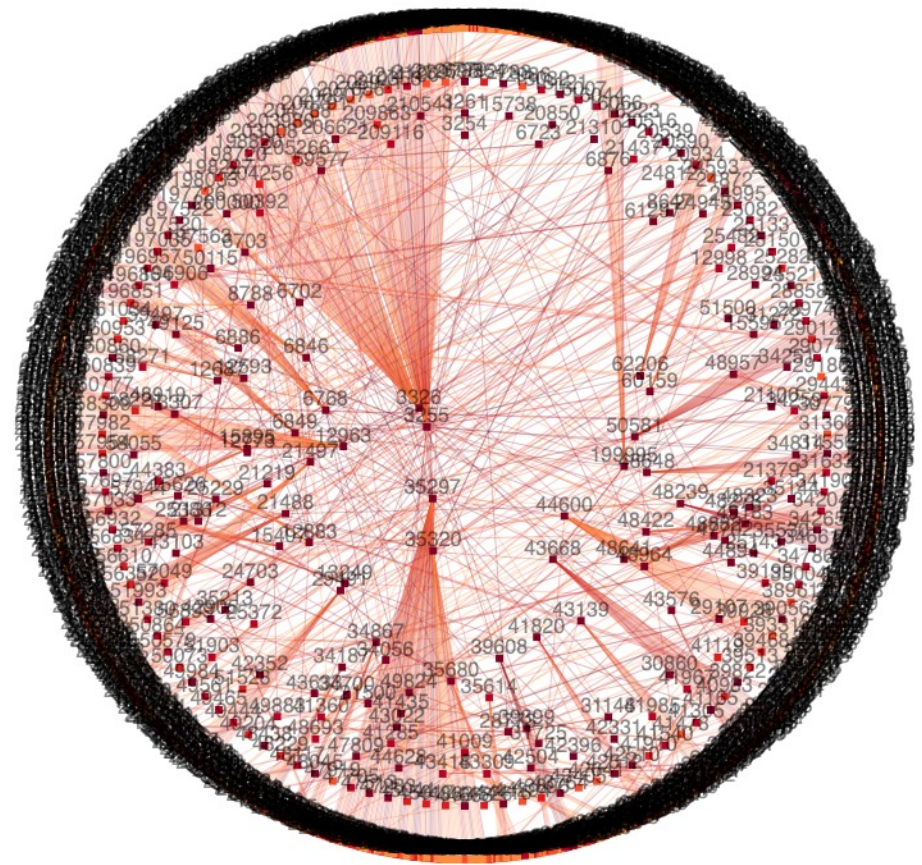
302 Autonomous Systems

Search ASN here



1668 Autonomous Systems

Search ASN here



<https://rex.apnic.net/as-interconnections?allocationType=ipv4,ipv6&economy=UA>

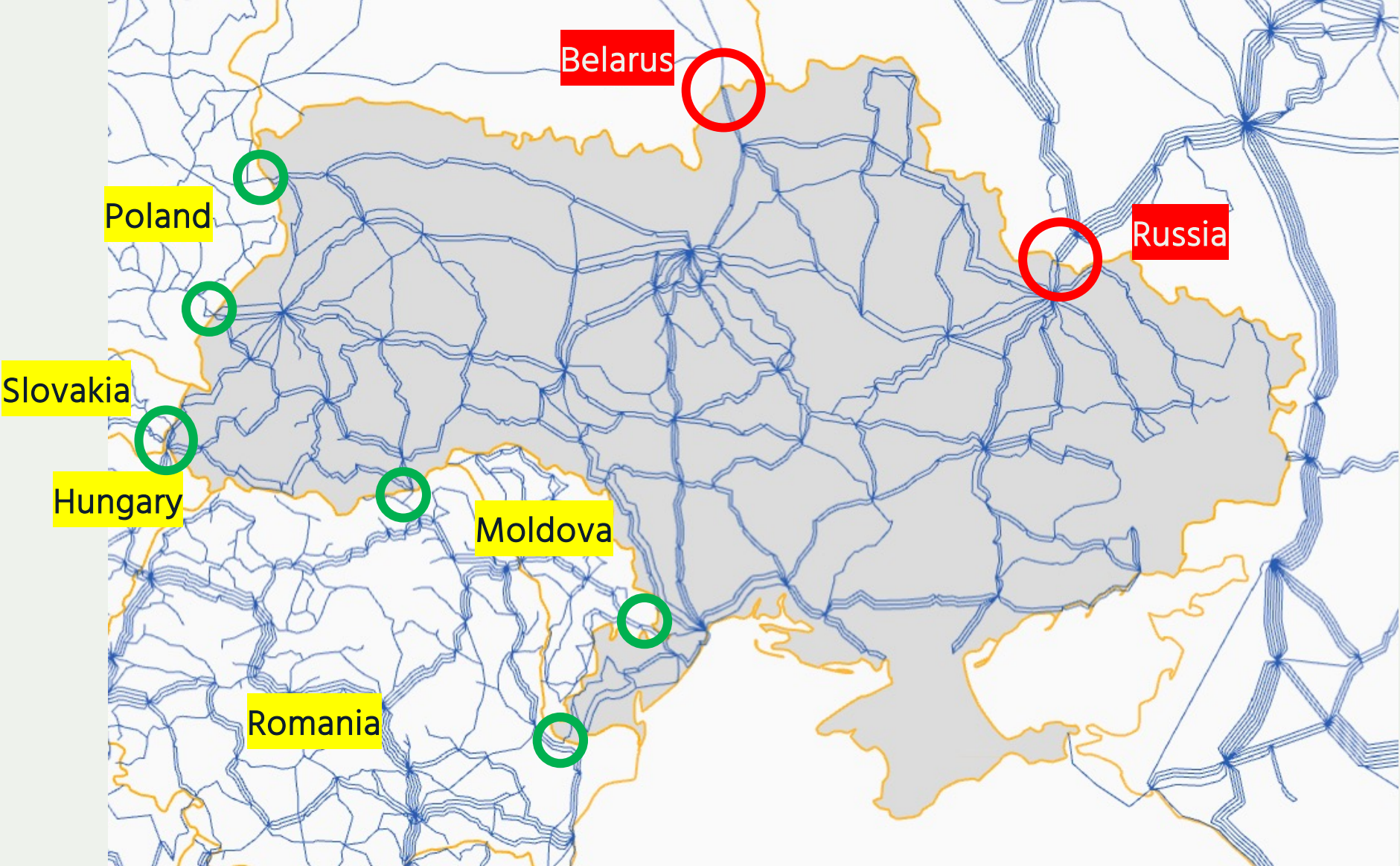
Ukraine – ASN Dependency (IiJ Internet Health Report)

Autonomous System		Population coverage [?]			AS coverage [?]
<input type="text" value="Search"/>		Total	Direct ↓	Indirect	Total
AS15895	KSNET-AS "Kyivstar" PJSC, UA	23.5%	22.5%	0.7%	1.5%
AS21497	UMC-AS PrJSC "VF UKRAINE", UA	10.0%	9.7%	0.2%	1.5%
AS34058	LIFECCELL-AS Limited Liability Company "lifecell", UA	5.7%	5.6%	0.0%	0.1%
AS6849	UKRTELNET JSC "Ukrtelecom", UA	3.5%	3.3%	0.2%	1.5%
AS25229	VOLIA-AS Kyivski Telekomunikatsiyi Merezhi LLC, UA	3.2%	3.1%	0.1%	1.0%
AS13188	TRIOLAN CONTENT DELIVERY NETWORK LTD, UA	2.5%	2.5%	0.0%	0.1%
AS3255	UARNET-AS State Enterprise Scientific and Telecommunication Centre "Ukrainian Academic and Research Network" of the Institute for Condensed Matter Physics of the National Academy of Science of Ukraine (UARNet), UA	9.9%	2.1%	7.8%	11.6%
AS15377	FREGAT "Fregat TV" Ltd., UA	1.2%	1.2%	0.0%	0.1%
AS3326	Datagroup PRIVATE JOINT STOCK COMPANY "DATAGROUP", UA	6.9%	1.1%	5.8%	11.4%
AS31148	FREENET_LLC Freenet LTD, UA	1.2%	1.1%	0.1%	0.3%

https://ihr.iijlab.net/ihr/en-us/countries/UA?af=4&last=3&date=2023-08-24&rov_tb=routes



Ukraine – Exit Points



Limitations



Limitations

- The data is pulled from external public sources, not always up-to-date.
 - An indicator is not included if data is missing on more than 25% of countries in the Index.
- Without in-country measurements, it's difficult to validate the data.
 - RIPE Atlas and OONI are doing great work in this area, but more is needed.
- Some of the data undergoes processing, normalization, and weighing, we use a methodology that is reproducible.
 - You can see raw numbers via API. Email us for access pulse@isoc.org
- Ultimately, the Index benchmarks countries with one another and helps decision makers recognize gaps and weaknesses to conduct further study into validating these and work towards addressing them.



We all have a role to play

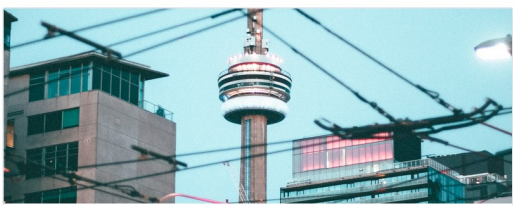


Take aways

- Understanding what's happening upstream and beyond your shores is equally important as knowing your network's health.
- Having an insightful national measurement system in place improves the resolution of the health of the edge.
- Your network's health and the health of the whole of Europe's Internet are interconnected. We all have a role to play to make sure it is robust and secure.



Not if, but when



9 September 2022

Rogers Outage: What do we Know After Two Months?

Jim Cowie
Former Resident
Advisor, Internet
Society

Categories:
Concentration,
Resilience

Hiding operational failures in darkness helps nobody.

Canada, July 2022



8 February 2023

Italy's Internet Outage a Perfect Storm

Massimiliano Stucchi
Regional Technical Advisor -
Europe, Internet Society

Categories:
Resilience

Italy's recent Internet outage was a failure that was years in the making and could have been negated through greater interconnectivity.

Italy, February 2023



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Australia, November 2023



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methodology



Thank you



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mitchell@isoc.org