RIPE NCC
RIPE NETWORK COORDINATION CENTER

# How the Internet routed around Cable Damage in the Baltic Sea

Internet event analysis with **RIPE Atlas**

**Robert Kisteleki** | nog.fi **2025.06, Tampere, FI** | 17 June 2025

# RIPE Labs


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Tiago Heinrich • 3 Apr 2025 • 8 min read

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routing training competition +1

28 0

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ripestat operational

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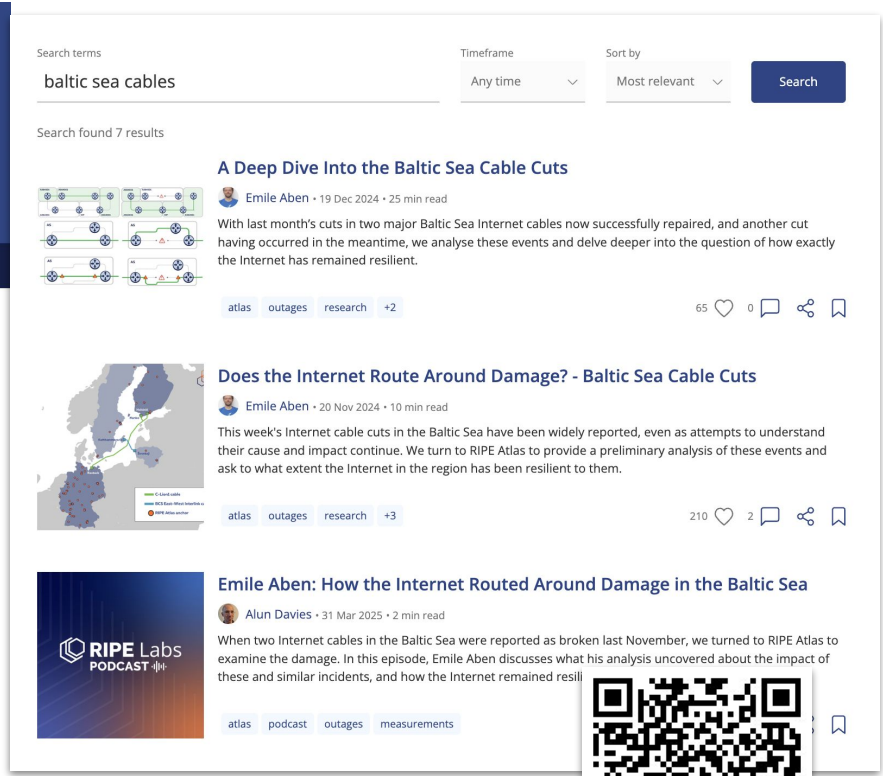


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## Emile Aben

105 Articles

886 Likes on articles

### About the author

Manage Profile

Based in Amsterdam, NL

I'm a data scientist at the RIPE NCC. I'm a chemist by training, but have been working since 1998 on Internet related things, as a sysadmin, security consultant, web developer and researcher. I am interested in technology changes (like IPv6 deployment), Internet measurement, data analysis, data visualisation, sustainability and security. I'd like to bring research and operations closer together, ie. do research that is operationally relevant. When I'm not working I like to make music (electric guitar, bass and drums), do sports (swimming, (inline) skating, bouldering, soccer), and try to be a good parent.

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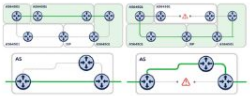


#### A Deep Dive Into the Baltic Sea Cable Cuts

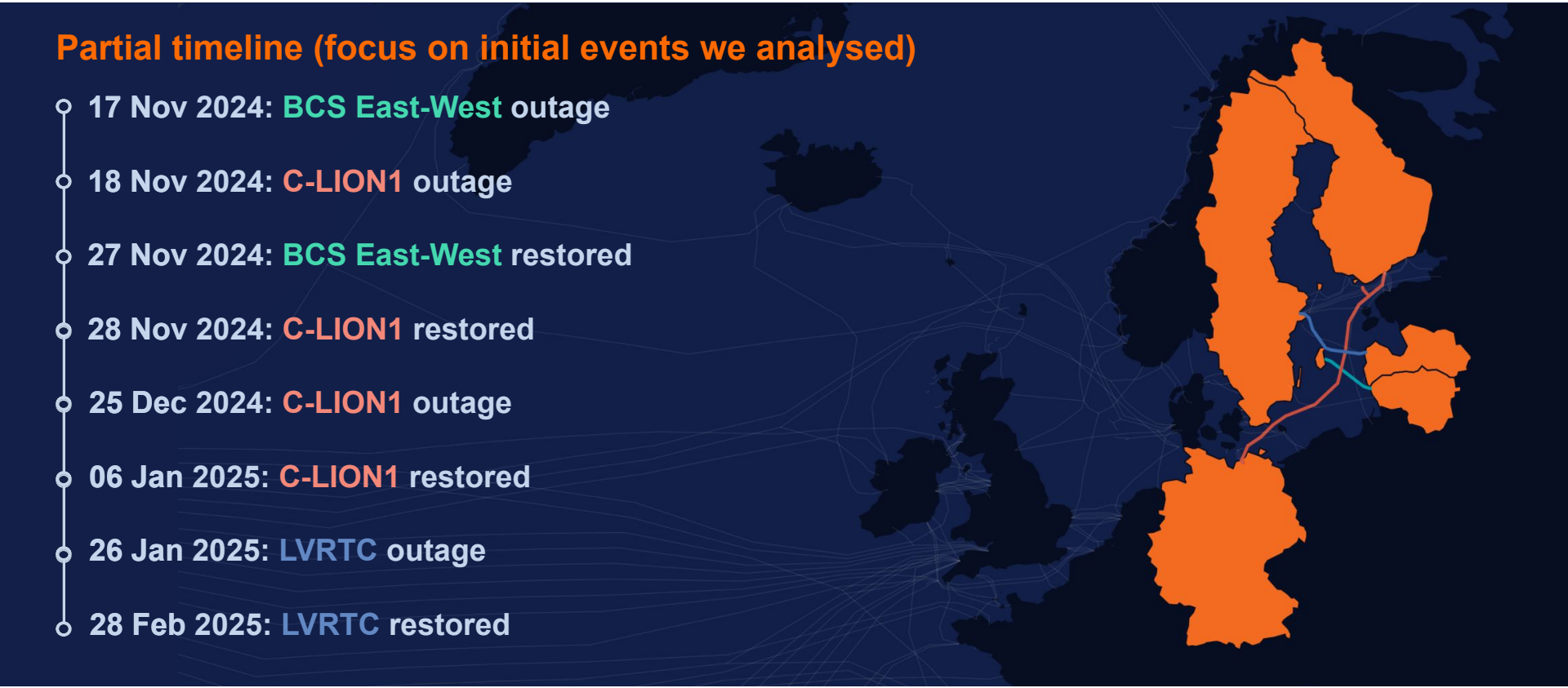
Emile Aben • 19 Dec 2024 • 25 min read

With last month's cuts in two major Baltic Sea Internet cables now successfully repaired, and another cut having occurred in the meantime, we analyse these events and delve deeper into the question of how

# Baltic Sea cable damage

## Partial timeline (focus on initial events we analysed)

- 17 Nov 2024: BCS East-West outage
- 18 Nov 2024: C-LION1 outage
- 27 Nov 2024: BCS East-West restored
- 28 Nov 2024: C-LION1 restored
- 25 Dec 2024: C-LION1 outage
- 06 Jan 2025: C-LION1 restored
- 26 Jan 2025: LVRTC outage
- 28 Feb 2025: LVRTC restored



# Baltic Sea cable damage

## Media coverage

**Two Baltic Sea cables disrupted – is this 'hybrid warfare'?**

By **Annie Turner** - 19 November 2024

**European governments point finger at Russia over Baltic cable cuts**

Investigations are underway into two subsea cable breaches in the Balt
and European governments are starting to suggest that Russia is behin

Mary Lennighan
November 20, 2024

3 Min Read

**Sweden opens inquiry into damaged undersea cable as Nato deploys ships**

A vessel has been seized al
optic line, probably due to

**Damaged cables appear to be accident, Finland says**

3 December 2024

Share Save

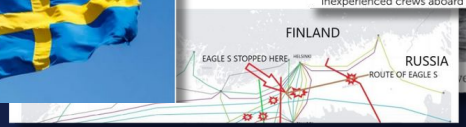
George Wright
BBC News

December 31, 2024

**Christmas Day Cable Cuts in the Baltic Sea**

*Written by Alexander Lott*

bmarine telecommunic
Lithuania, Russia, an
In addition, an underv
ut by a ship anchor. Th
ll involving a foreign c
or over a hundred kilom
cident occurred in Oct
nber 2024, and the Ea
ndicated on the map b
e infrastructure locate
ged in the NewNew F
electricity cable and
's decisive interventior
*ical offshore infrastruct*
*and the Eagle S incid*




***Sweden Investigates New Cable Break Under Baltic Sea***

e authorities are looking into possible damage to an undersea
east of Gotland island. NATO has stepped up its surveillance
he region.

**Baltic subsea cable damage was accidental, not sabotage - US and European officials**

Refutes all claims of Russian sabotage

January 20, 2025 By: Niva Yadav Have your say

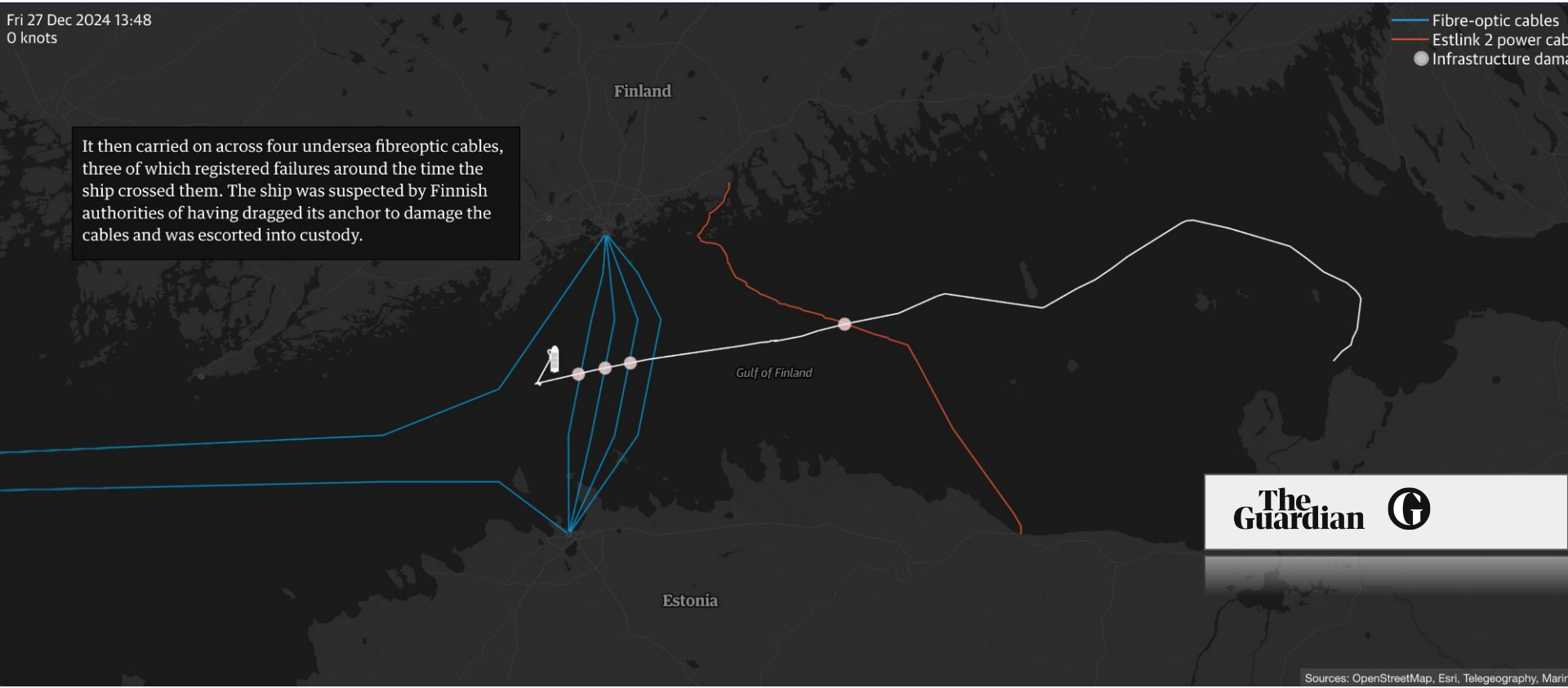
Subsea cable damage in the Baltic Sea in recent months was likely the result of maritime accidents, not Russian sabotage, according to several US and European intelligence officials.

As reported by The Washington Post, US and European officials have gathered evidence - including intercepted communications - which have concluded that anchors were dragged across the seabed accidentally because of inexperienced crews aboard poorly maintained



edish Coast Guard vessel in the Baltic Sea. Sweden also investigated the severing

# Baltic Sea cable damage



# Measuring damage with RIPE Atlas

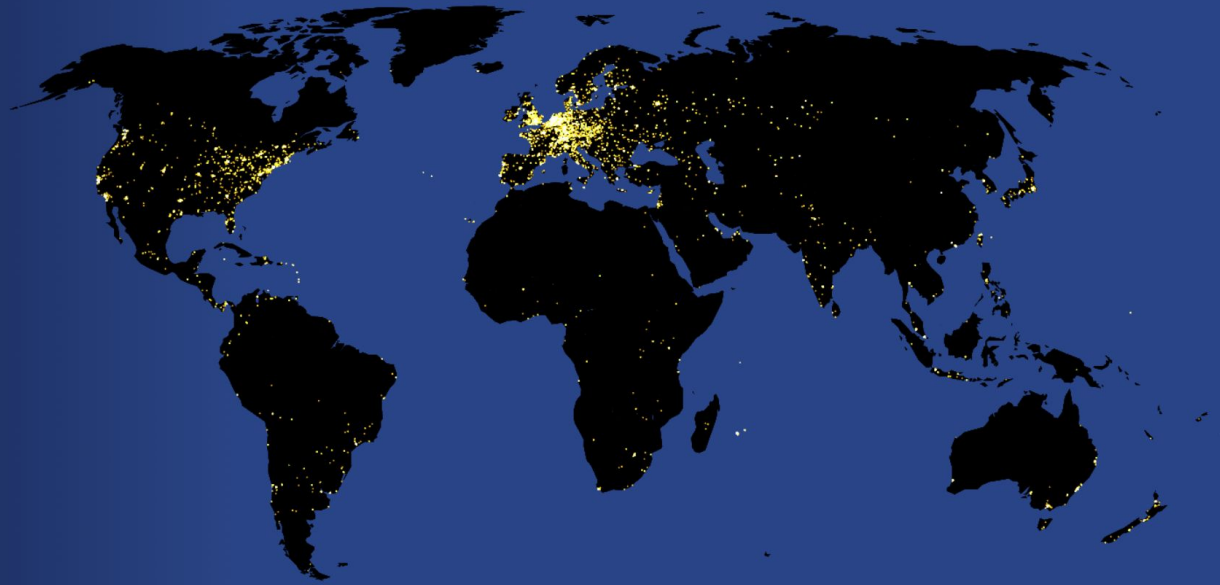
## RIPE Atlas

**A global network of probes measuring the Internet in real time**

**13,400+** probes connected

**850+** anchors deployed

**35,000+** daily measurements on average (both user-defined and built-in)



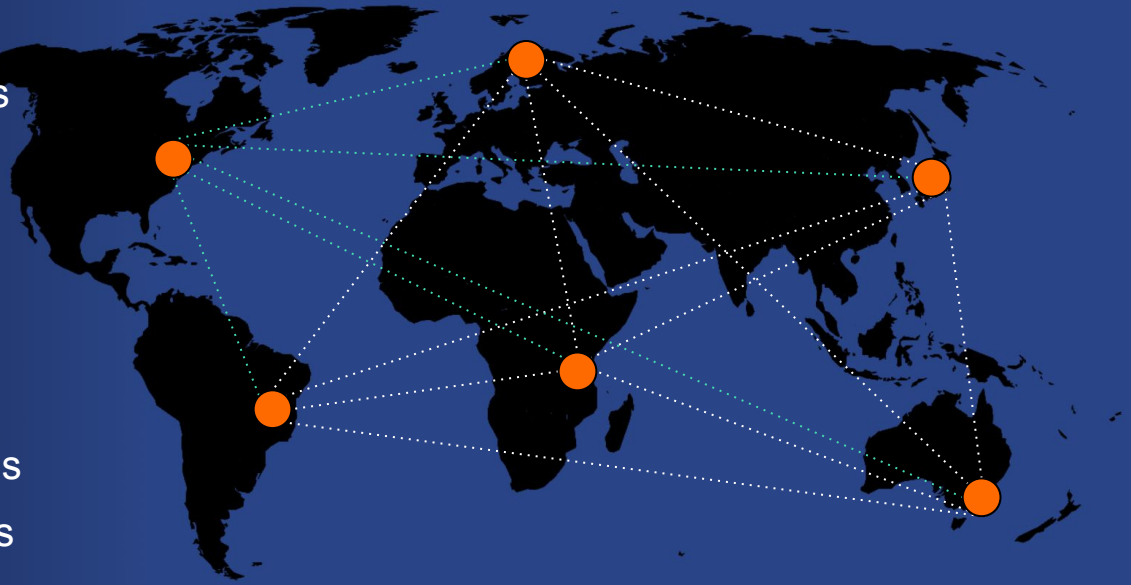
# Measuring damage with RIPE Atlas

## Anchor mesh

RIPE Atlas anchors support ping, traceroute, DNS, HTTP/S measurements

Each anchor performs ongoing ping and traceroute measurements to all other anchors at four-minute intervals

Resulting ‘mesh’ of measurements lets us observe latency changes and packet loss between anchors



# First look

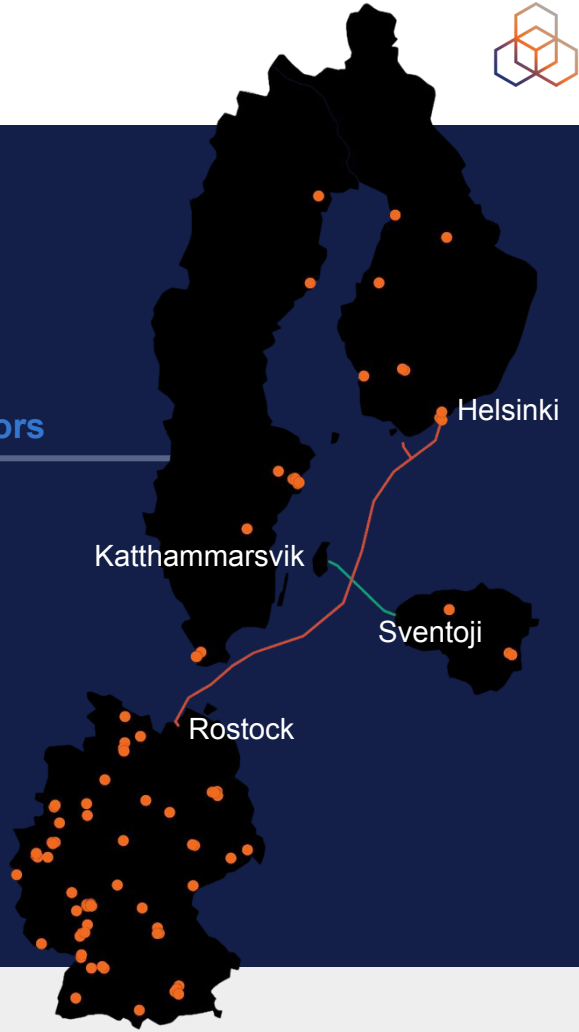
## 17-18 November

BCS East-West: Sweden-Lithuania

C-LION1: Germany-Finland

We looked at results in the RIPE Atlas anchor mesh between these countries around reported time of the event

| Country | # anchors |
|---|---|
| Germany: | 100 |
| Sweden: | 15 |
| Finland: | 12 |
| Lithuania: | 5 |



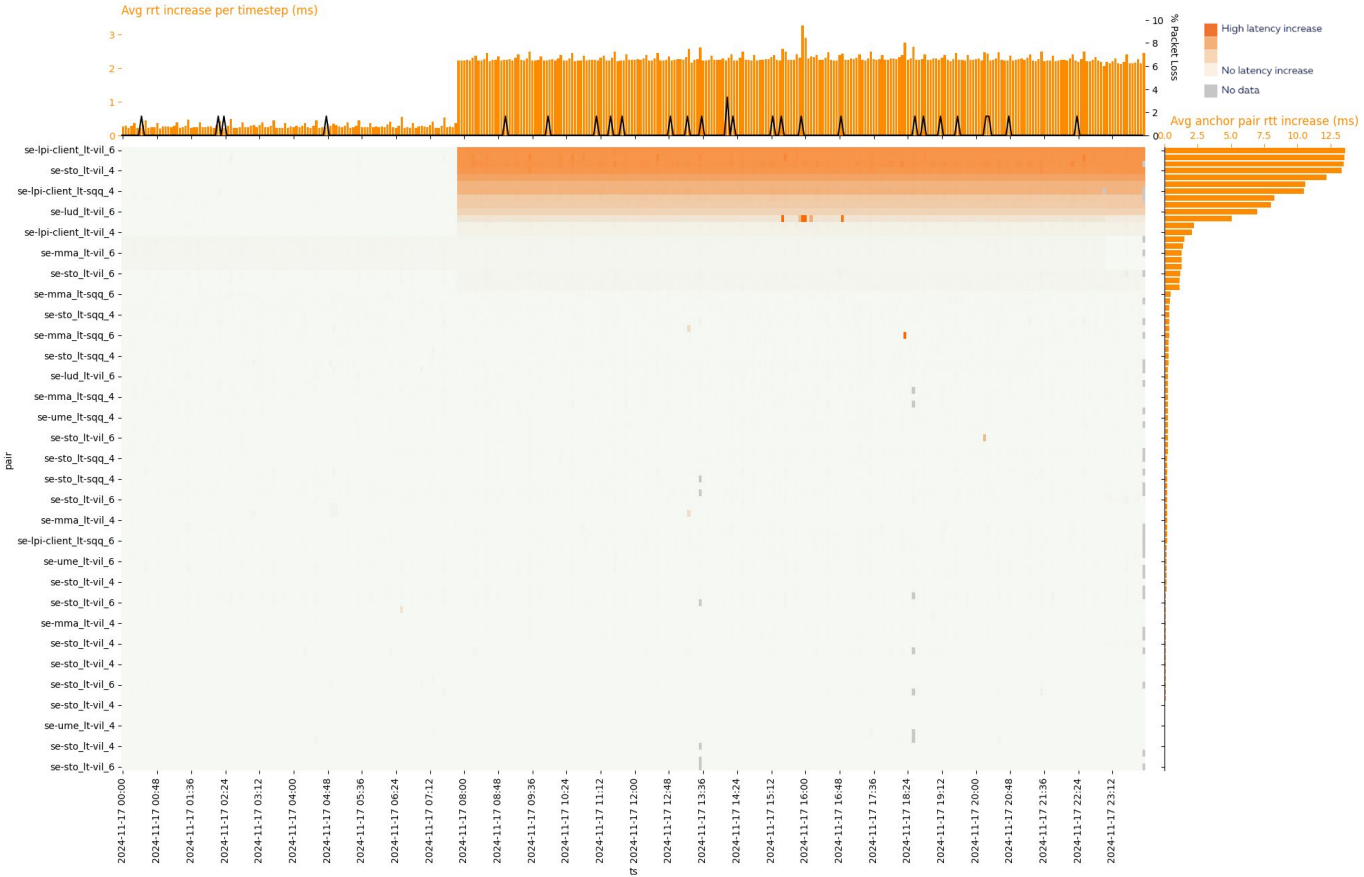
# BCS East West

## Latency shift

12 hour before/after time of event

Latency increase of approx 10-20 ms shortly before 08:00 UTC on 17 November

*We subtract the minimum latency for a path during our observation period to make the latency jumps comparable*



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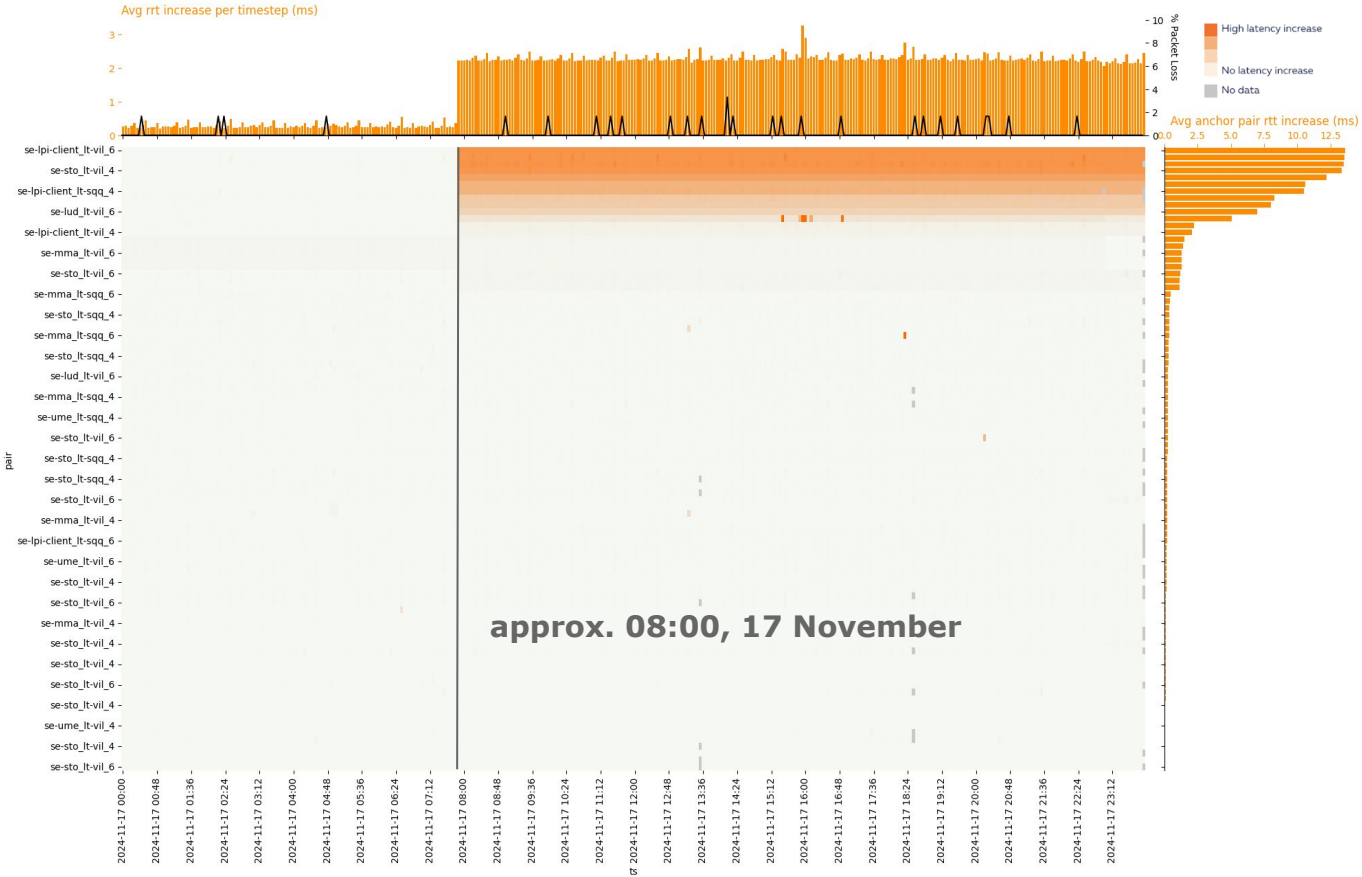
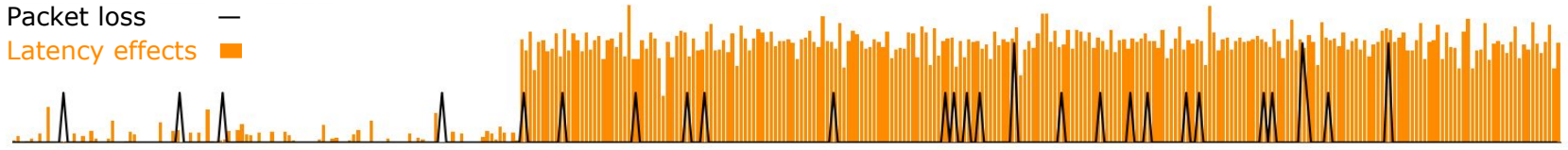


# BCS East West

## Packet loss

Baseline of 0% packet loss

(with occasional spikes)




No significant increase in packet loss at time of the cable outage (shortly before 08:00 UTC)

# C-LION1

## Latency shift

Latency increase of approx 5ms a little after 02:00 UTC on 18 November

## Packet loss

Again, no significant increase in packet loss at time of outage

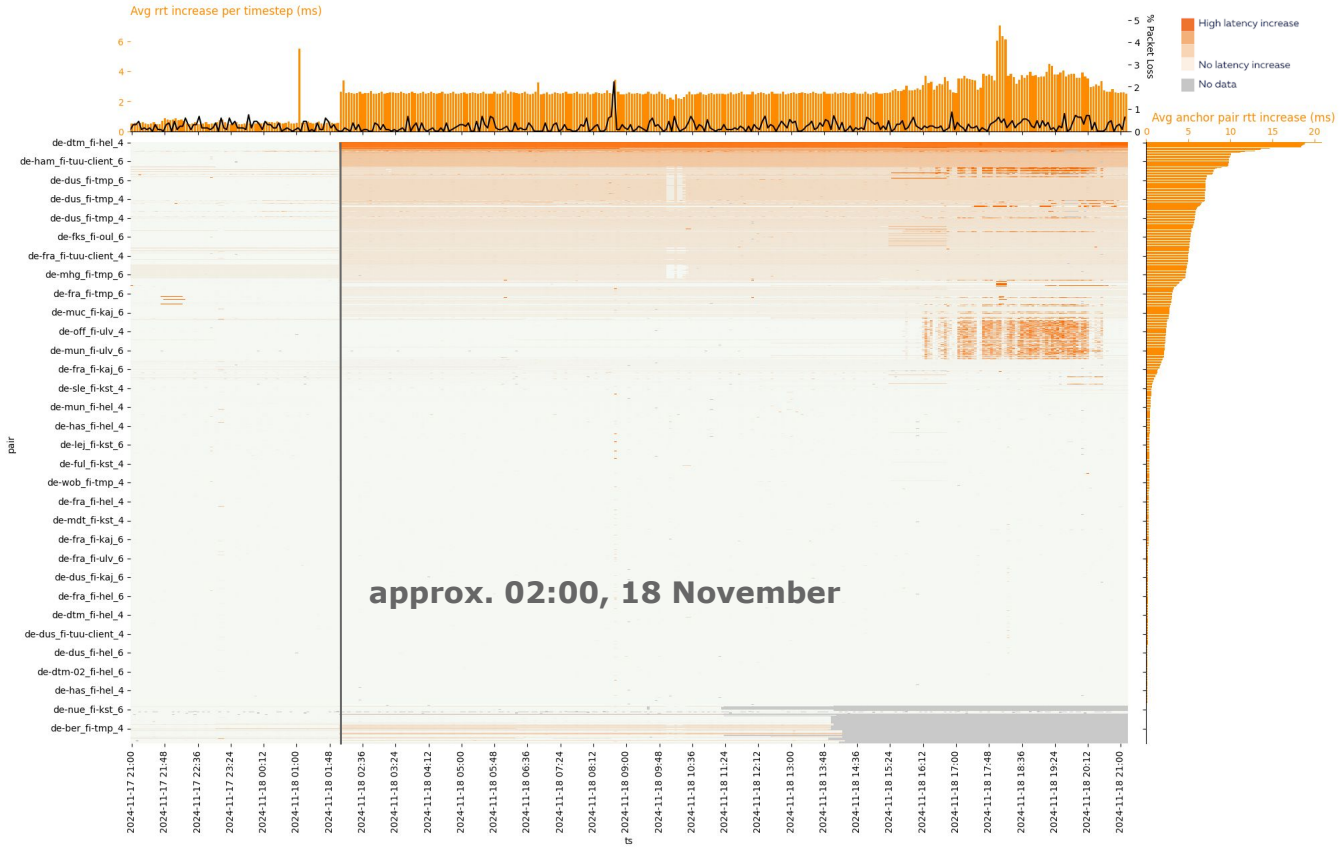
# C-LION1

## Latency shift

Latency increase of approx 5ms a little after 02:00 UTC on 18 November

## Packet loss

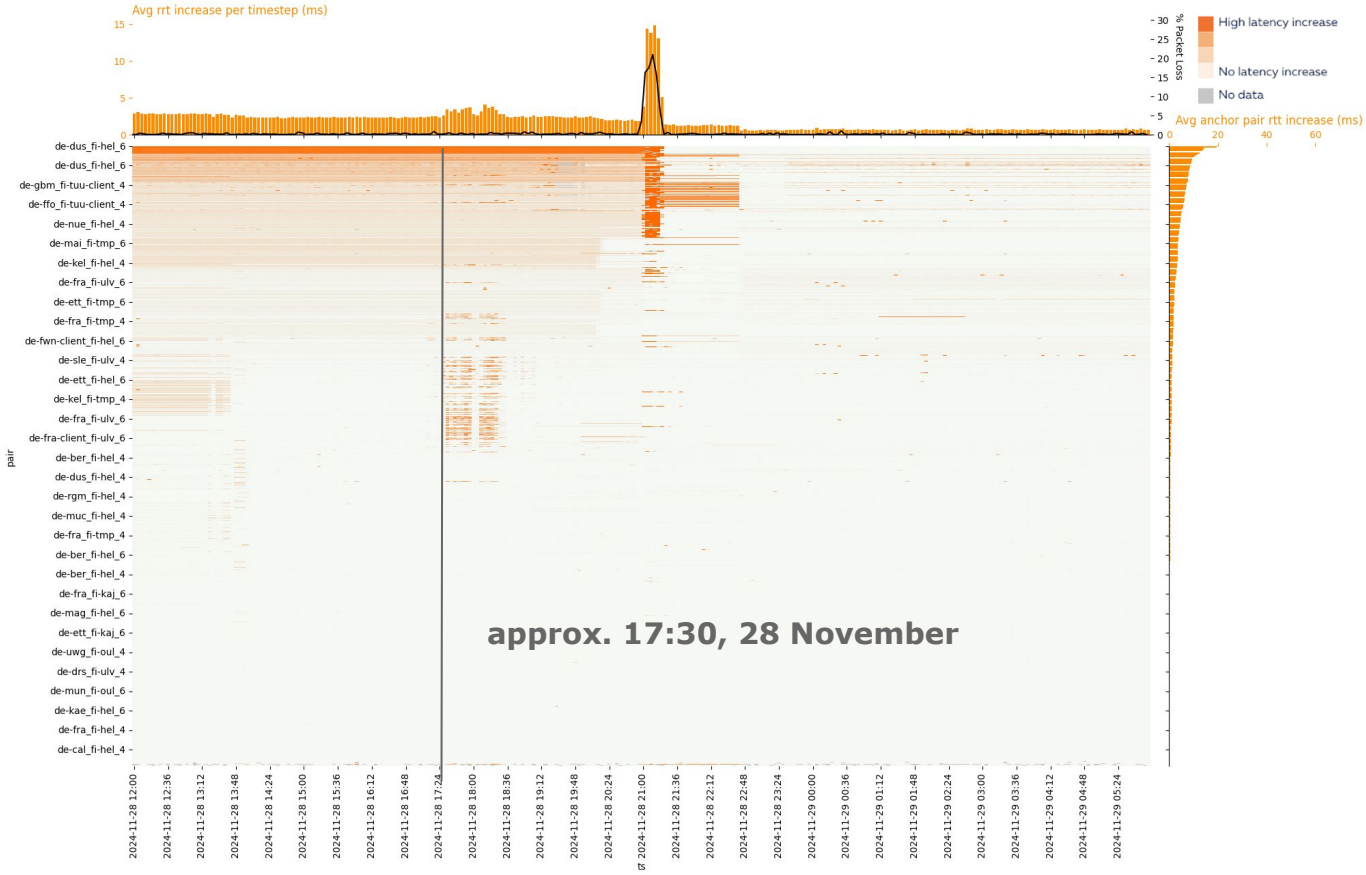
Again, no significant increase in packet loss at time of outage



# C-LION1 repair

28 November (17:30 UTC): C-Lion1 cable repair ship reported leaving the area after successful repair

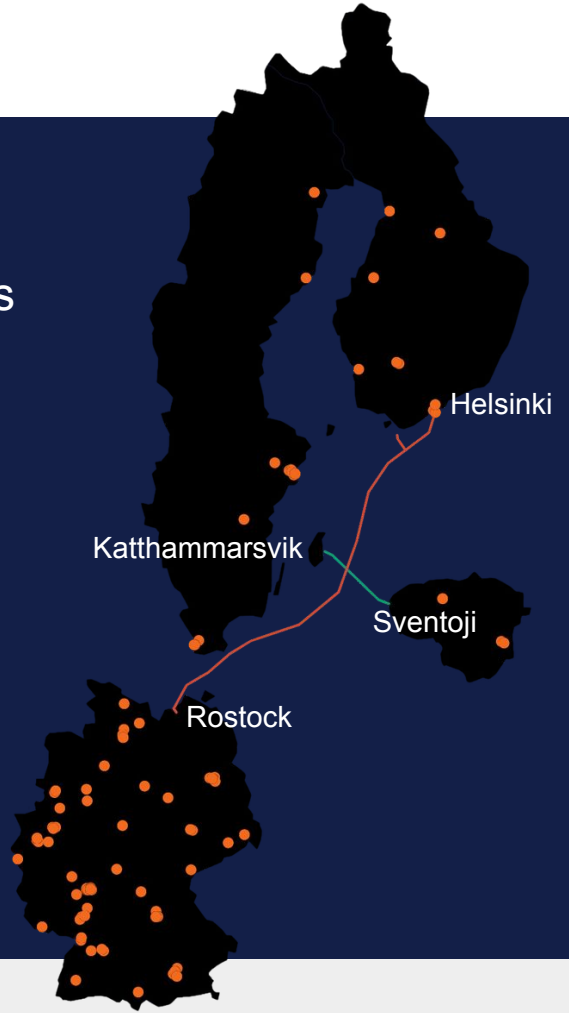
*Unclear what exactly causes these latency effects and the temporary increase in packet loss…*



# Summing up

There was a relatively minor but visible shift in latency for around 20-30% of paths between observed anchors

But there was no concurrent increase in packet loss



# Summing up

There was a relatively minor but visible shift in latency for around 20-30% of paths between observed anchors

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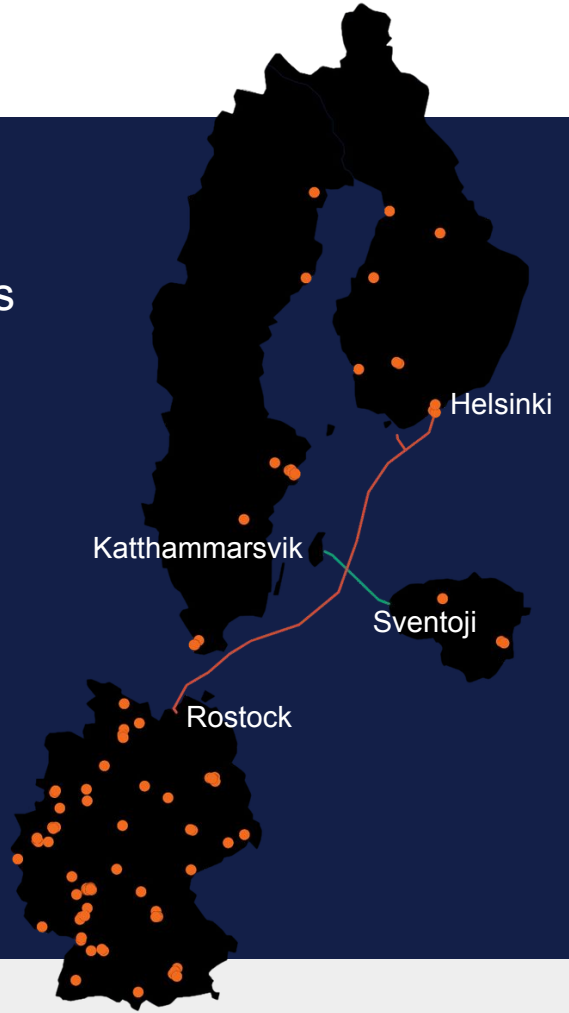
**The Internet routed around damage!**



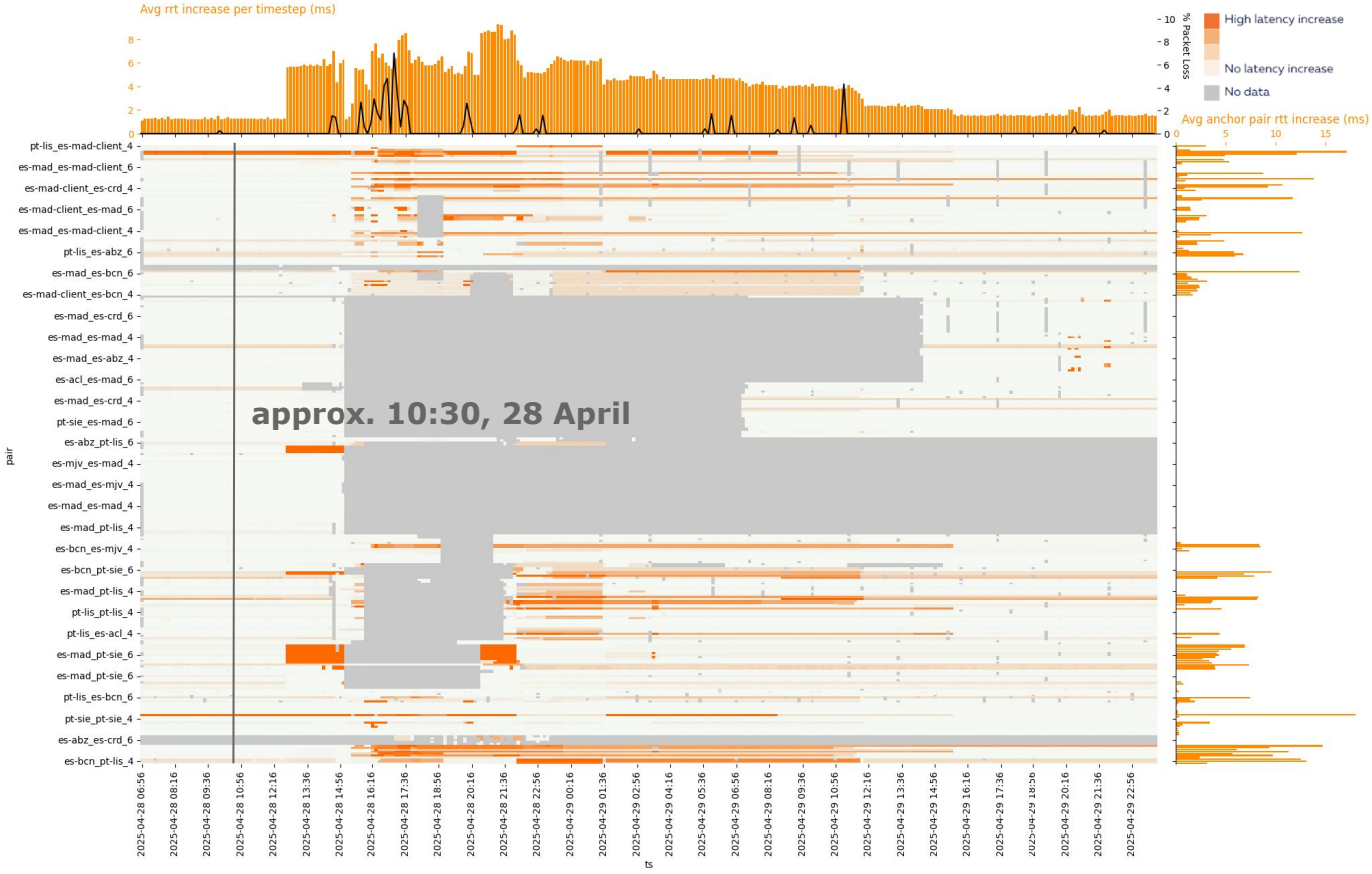
# Beyond the Baltic Sea: ES-PT Power Outage April 2025

Anchor mesh measurements have broad potential for getting insights into outages

In this case: “Iberian mesh”

However, power outage events are much harder to measure compared to cable outage events

Due to the infrastructure being brought offline by the event itself

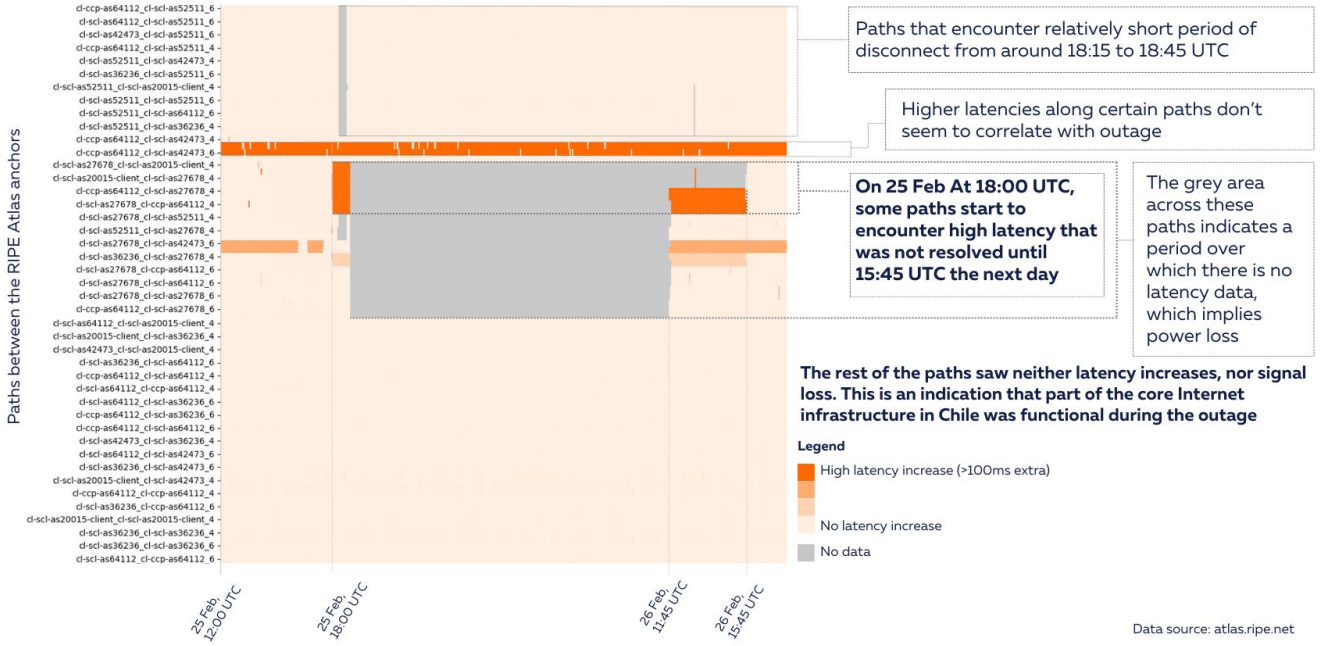


# Beyond the Baltic Sea

Anchor mesh measurements have broad potential for getting insights into outages

## Chile Power Outage

**On 25 February, at around 18:00 UTC, a nationwide power outage affected Chile. The RIPE Atlas anchors (Internet measurement devices) in Chile give us a glimpse of how the Internet infrastructure coped with the power outage. Here's a breakdown of the effects we saw on the paths between the anchors.**

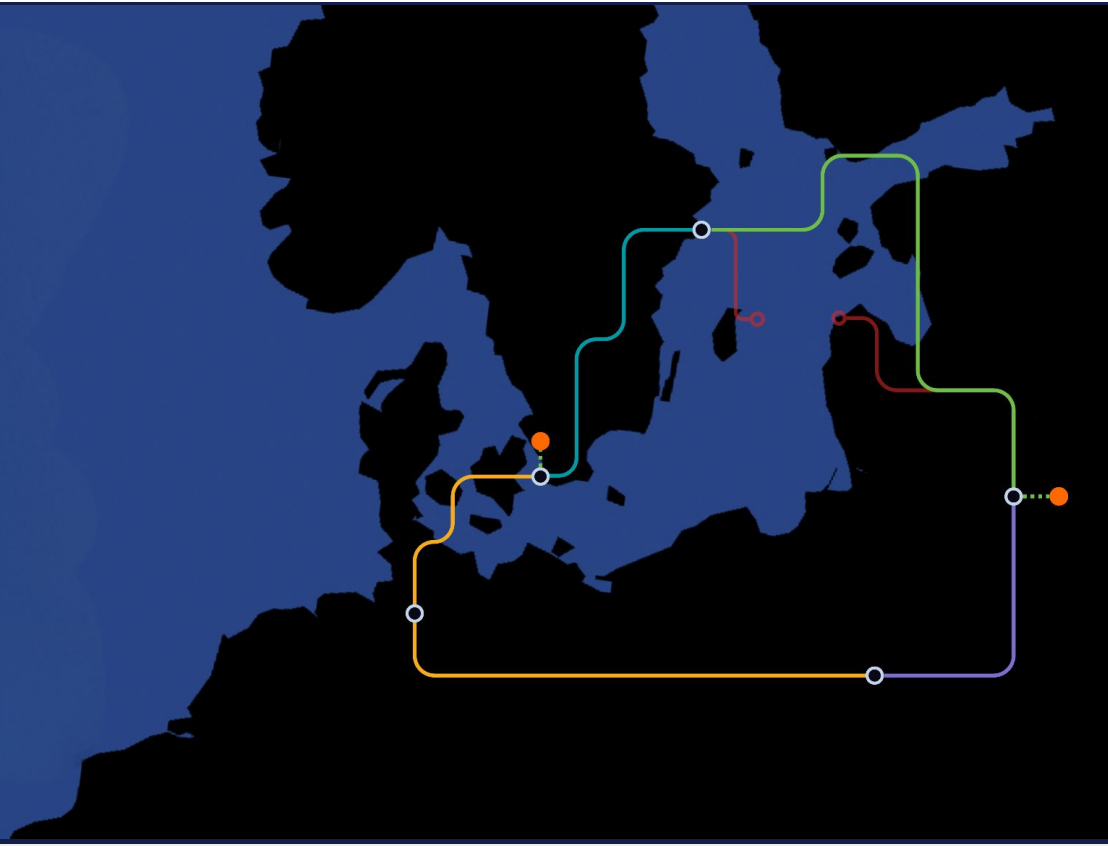


# Deeper dive

Initial analysis was based on ping (end-to-end latency) data

We followed this up with in depth analysis using traceroute data

Aim: to examine how the paths actually changed while end-to-end connectivity was maintained



# Levels of resilience

## Inter-domain rerouting:

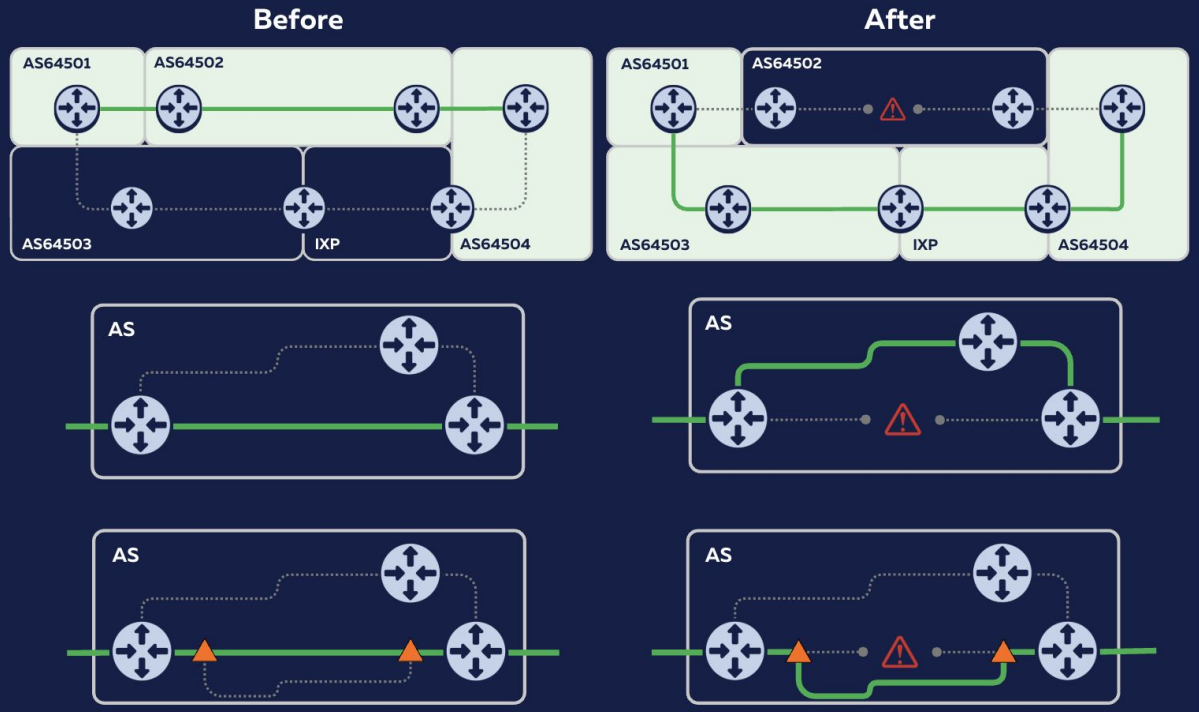
Traffic rerouted through alternative ASes/IXPs (eBGP routing protocol)

## Intra-domain rerouting:

Rerouting *within* networks over alternative paths (IGP: OSPF, IS-IS)

## Circuit-level rerouting:

Rerouting along alternative circuit-level connections between routers (same IP address!)

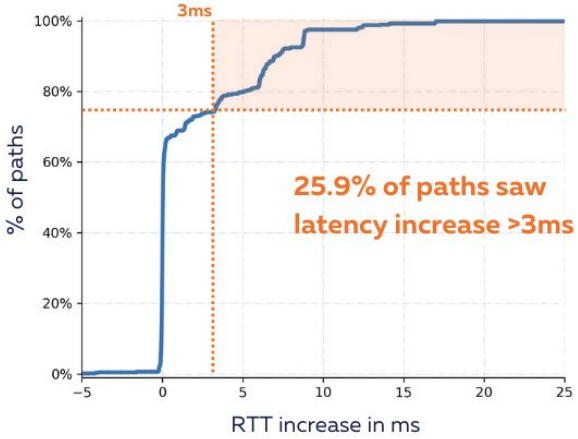


# Levels of resilience

Of the 2,141 paths between anchors in Germany and Finland used for this analysis:

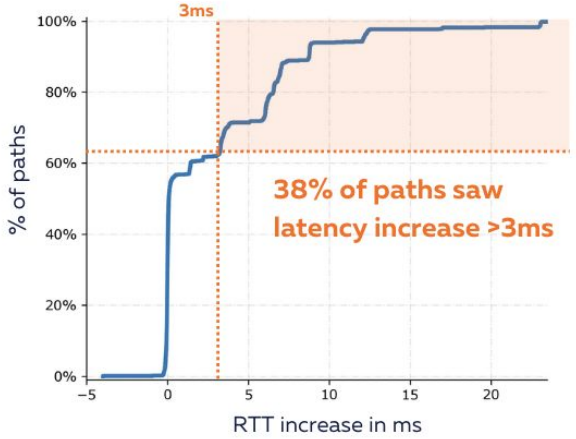
### Inter-domain rerouting

RTT profile for **637** paths where inter-domain routing changed.



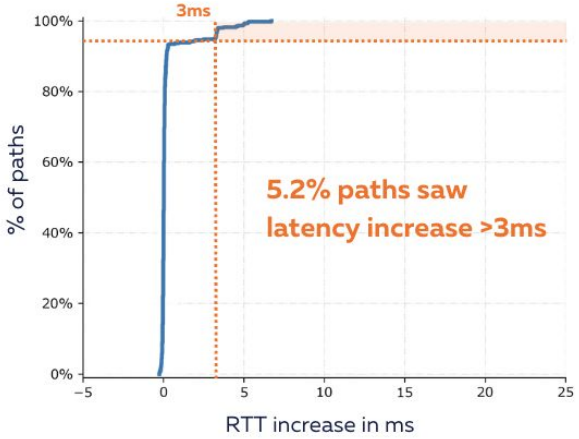

### Intra-domain rerouting

RTT profile for **1,044** paths with IP-level changes, but no inter-domain changes.




### Circuit-level rerouting

RTT profile for **460** paths with no inter-domain or intra-domain changes.



# Resilience is not guaranteed

## Cable damage in Africa

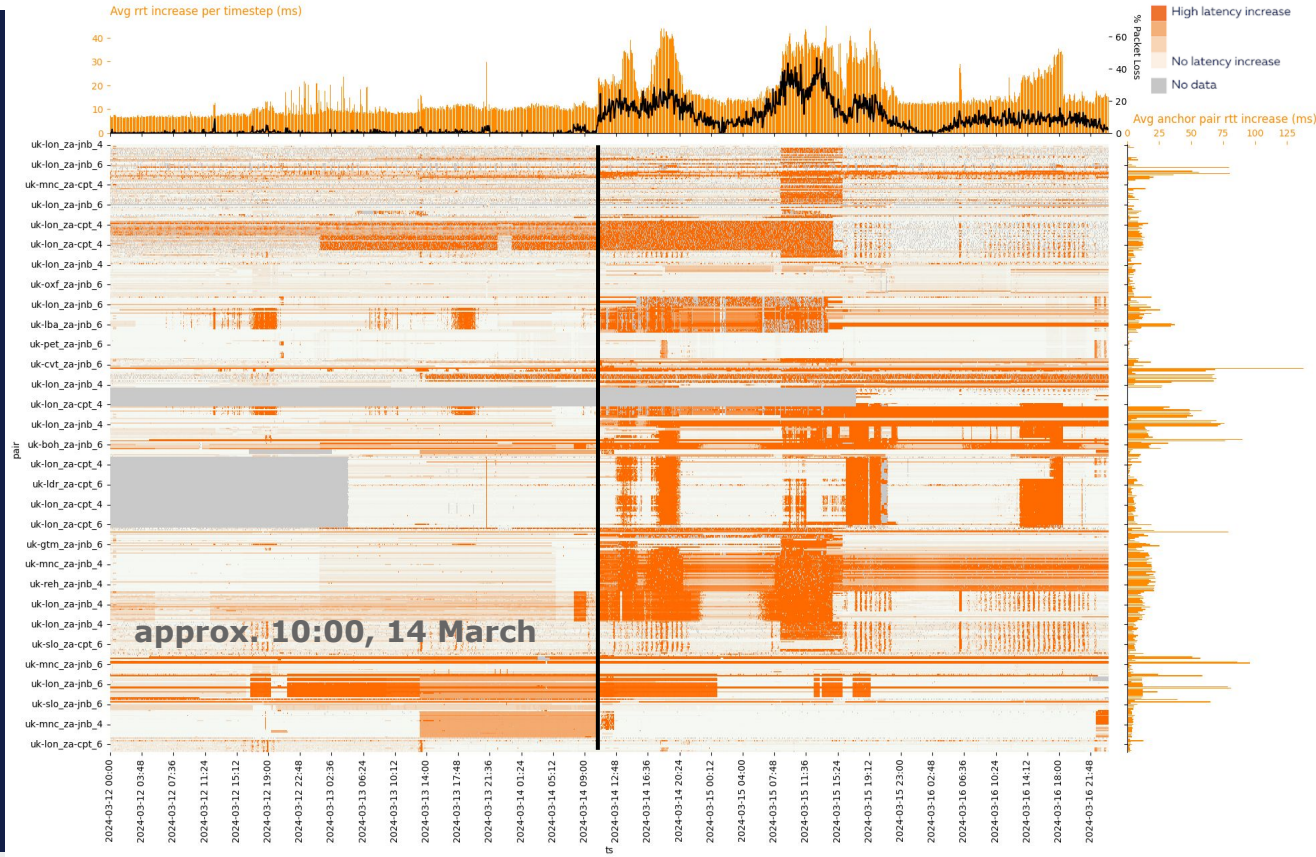
14 March 2024: Submarine landslide off coast of Cote d'Ivoire resulted in damage across multiple cables:

- ACE: Africa Coast to Europe
- MainOne
- SAT-3: Submarine Atlantic 3/West Africa Submarine Cable
- WACS: West Africa Cable System

# Resilience is not guaranteed

## Latency shift *with* packet loss

Latency increases of approx 20-30 ms accompanied by concurrent increase in packet loss



# Conclusions

In the Baltic Sea:

- “The Internet routed around damage”
- Internet resilience depends on multiple levels of redundancy
    - Redundancy between networks
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# Conclusions

In the Baltic Sea:

- “The Internet routed around damage”
- Internet resilience depends on multiple levels of redundancy
    - Redundancy between networks
    - Redundancy within networks (circuit and routing)

**But resilience is not guaranteed**

**We have to keep monitoring, measuring, understanding**

# RIPE Atlas coverage - how far can we see?

RIPE NCC is a neutral source of Internet measurement data

To gain visibility into Internet events, we need vantage points

**Coverage is key!**

***We are actively seeking hosts who can help us get RIPE Atlas probes and anchors set up in locations where they can shed light on the state of the Internet. Learn more:***

# RIPE Atlas coverage - how far can we see?

| Country code | Nr of anchor | Nr of cities ... | Nr of ASNs ... | landings | Cables wit... | Cable Count | List of citie... | List of AS... |
|---|---|---|---|---|---|---|---|---|
| AR | 4 | 4 | 4 | 3 | firmina malb... | 7 | bhi bue ttd v... | 28109 42... |
| AW | 0 | 0 | 0 | 2 | celia alonso... | 3 | | |
| BZ | 0 | 0 | 0 | 3 | arcos | 1 | | |
| BO | 0 | 0 | 0 | 0 | | 0 | | |
| BR | 14 | 9 | 14 | 63 | norte-cone... | 18 | bhz cci cpv ... | 10417 61... |
| CL | 7 | 2 | 6 | 19 | halaihai sou... | 6 | ccp scl | 64112 20... |
| CO | 2 | 1 | 2 | 10 | tam-1 mant... | 12 | bog | 12008 27... |
| CR | 1 | 1 | 1 | 2 | tam-1 arco... | 5 | fil | 273147 |
| CU | 0 | 0 | 0 | 7 | arimao gtm... | 4 | | |
| DO | 4 | 4 | 4 | 5 | antillas-1 ar... | 6 | lav mca ssu ... | 273867 2... |
| EC | 1 | 1 | 1 | 7 | carnival-su... | 4 | uio | 61468 |
| SV | 0 | 0 | 0 | 0 | | 0 | | |
| FK | 0 | 0 | 0 | 0 | | 0 | | |
| GF | 0 | 0 | 0 | 2 | deep-blue-... | 4 | | |
| GT | 1 | 1 | 1 | 2 | tam-1 tikal... | 6 | gua | 273149 |
| GY | 0 | 0 | 0 | 1 | deep-blue-... | 3 | | |
| HT | 0 | 0 | 0 | 2 | bahamas-d... | 2 | | |
| HN | 1 | 1 | 1 | 3 | tam-1 arco... | 3 | sap | 64150 |
| MX | 5 | 4 | 4 | 13 | carnival-su... | 11 | hmo mex qr... | 4493 424... |
| AN | 0 | 0 | 0 | 0 | | 0 | | |
| NI | 0 | 0 | 0 | 2 | arcos | 1 | | |
| PA | 1 | 1 | 1 | 7 | tam-1 mant... | 9 | pty | 272037 |
| PY | 1 | 1 | 1 | 0 | | 0 | vlr | 266858 |
| PE | 2 | 2 | 2 | 3 | south-pacif... | 3 | aqp lim | 263189 6... |
| GS | 0 | 0 | 0 | 0 | | 0 | | |
| SR | 0 | 0 | 0 | 2 | deep-blue-... | 2 | | |
| TT | 1 | 1 | 1 | 4 | deep-blue-... | 6 | ptw | 264811 |
| UY | 2 | 1 | 2 | 2 | firmina tann... | 4 | mvd | 28000 6057 |
| VE | 0 | 0 | 0 | 0 | | 0 | | |

# RIPE Atlas coverage - how far can we see?

| Country code | Nr of anchor | Nr of cities ... | Nr of ASNs ... | landings | Cables wit... |
|---|---|---|---|---|---|
| MY | 2 | 1 | 2 | 20 | vietnam-sin... |
| SG | 24 | 1 | 24 | 8 | ice-iv asia-... |
| TH | 2 | 2 | 2 | 7 | cat-submar... |
| ID | 12 | 8 | 10 | 139 | padang-tua... |
| BN | 0 | 0 | 0 | 2 | asia-link-c... |
| PH | 2 | 2 | 2 | 71 | asia-conne... |
| VN | 3 | 1 | 3 | 3 | vietnam-sin... |
| KH | 0 | 0 | 0 | 1 | cambodia-... |
| MM | 0 | 0 | 0 | 2 | umo asia-af... |
| LA | 0 | 0 | 0 | 1 | |
| CN | 4 | 2 | 4 | 25 | cambodia-... |
| BD | 1 | 1 | 1 | 2 | seamewe-6... |
| IN | 8 | 8 | 7 | 26 | ice-iv seam... |
| NP | 1 | 1 | 1 | 0 | |
| PK | 0 | 0 | 0 | 1 | seamewe-6... |
| TW | 9 | 2 | 9 | 20 | orca tpu tai... |
| HK | 2 | 1 | 2 | 0 | |
| MV | 1 | 1 | 1 | 16 | seamewe-6... |
| KR | 3 | 1 | 3 | 10 | ulleung-mai... |
| JP | 10 | 2 | 10 | 67 | okinawa-mi... |

# RIPE Atlas coverage - how far can we see?

| Country code | Nr of anchor | Nr of cities ... | Nr of ASNs ... | landings | Cables wit... |
|---|---|---|---|---|---|
| NP | 1 | 1 | 1 | 0 | |
| IN | 8 | 8 | 7 | 26 | ice-iv seam... |
| CN | 4 | 2 | 4 | 25 | cambodia-... |
| BD | 1 | 1 | 1 | 2 | seamewe-6... |
| BT | 0 | 0 | 0 | 0 | |
| PK | 0 | 0 | 0 | 1 | seamewe-6... |
| MM | 0 | 0 | 0 | 2 | umo asia-af... |
| TH | 2 | 2 | 2 | 7 | cat-submar... |
| LA | 0 | 0 | 0 | 1 | |
| VN | 3 | 1 | 3 | 3 | vietnam-sin... |
| AF | 1 | 1 | 1 | 0 | |
| KG | 1 | 1 | 1 | 0 | |
| TJ | 1 | 1 | 1 | 0 | |
| KZ | 15 | 12 | 4 | 1 | caspian-cr... |
| UZ | 1 | 1 | 2 | 0 | |
| IR | 4 | 3 | 4 | 7 | gulf-bridge... |
| MN | 1 | 1 | 1 | 0 | |
| MY | 2 | 1 | 2 | 20 | vietnam-sin... |
| KH | 0 | 0 | 0 | 1 | cambodia-... |
| SG | 24 | 1 | 24 | 8 | ice-iv asia-... |

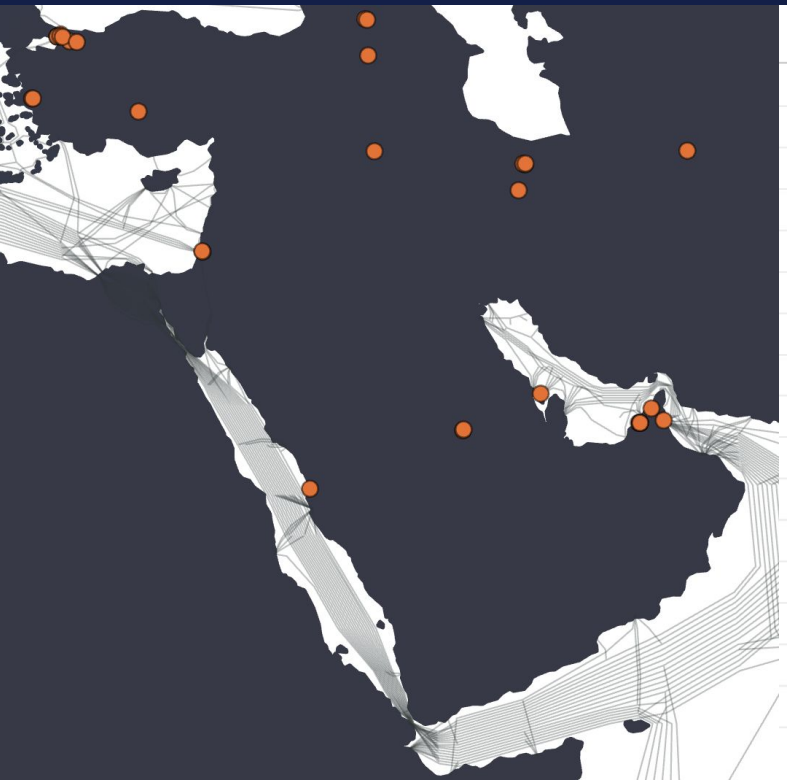
# RIPE Atlas coverage - how far can we see?

| Country code | Nr of anchor | Nr of cities w a... | Nr of ASNs w a... | landings |
|---|---|---|---|---|
| ZA | 14 | 3 | 13 | 6 |
| KE | 2 | 1 | 2 | 3 |
| MU | 2 | 2 | 2 | 4 |
| AO | 1 | 1 | 1 | 7 |
| BF | 1 | 1 | 1 | 0 |
| CM | 1 | 1 | 1 | 3 |
| GH | 1 | 1 | 1 | 1 |
| MZ | 1 | 1 | 1 | 2 |
| TZ | 1 | 1 | 1 | 1 |
| UG | 1 | 1 | 1 | 2 |
| DZ | 0 | 0 | 0 | 6 |
| BJ | 0 | 0 | 0 | 1 |
| BW | 0 | 0 | 0 | 0 |
| BI | 0 | 0 | 0 | 0 |
| CV | 0 | 0 | 0 | 10 |
| CF | 0 | 0 | 0 | 0 |
| TD | 0 | 0 | 0 | 0 |
| KM | 0 | 0 | 0 | 4 |

# RIPE Atlas coverage - how far can we see?

| Country code | Nr of anchor | Nr of cities w a... | Nr of ASNs w a... | landings |
|---|---|---|---|---|
| DE | 101 | 48 | 90 | 8 |
| NL | 49 | 21 | 47 | 8 |
| FR | 41 | 24 | 39 | 28 |
| GB | 32 | 18 | 30 | 119 |
| CH | 30 | 14 | 27 | 0 |
| AT | 22 | 8 | 21 | 0 |
| IT | 21 | 15 | 20 | 54 |
| RU | 20 | 11 | 19 | 28 |
| SE | 16 | 7 | 14 | 27 |
| CZ | 15 | 3 | 14 | 0 |
| KZ | 15 | 12 | 4 | 1 |
| FI | 12 | 7 | 12 | 11 |
| PL | 12 | 9 | 12 | 1 |
| UA | 10 | 8 | 9 | 2 |
| LU | 9 | 4 | 8 | 0 |
| ES | 9 | 5 | 9 | 49 |
| TR | 9 | 5 | 8 | 5 |
| BG | 7 | 3 | 6 | 2 |
| DK | 7 | 7 | 7 | 33 |
| RO | 7 | 4 | 6 | 1 |
| BE | 6 | 5 | 4 | 2 |
| GR | 5 | 4 | 5 | 37 |
| LT | 4 | 2 | 4 | 2 |
| NO | 4 | 2 | 4 | 47 |
| EE | 3 | 1 | 3 | 3 |
| PT | 3 | 2 | 3 | 19 |
| RS | 3 | 2 | 4 | 0 |

# RIPE Atlas coverage - how far can we see?

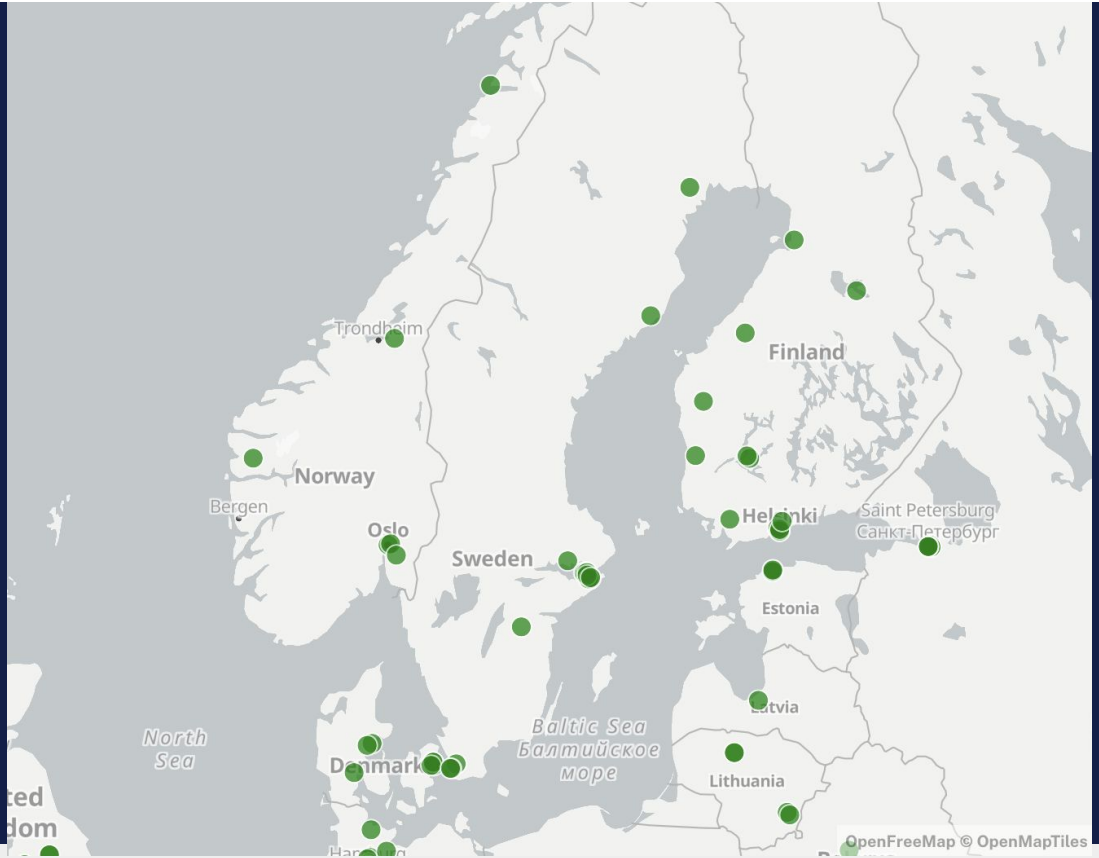


| Country code | Nr of anchor | Nr of cities w a... | Nr of ASNs w a... | landings |
|---|---|---|---|---|
| AE | 9 | 2 | 9 | 7 |
| TR | 9 | 5 | 8 | 5 |
| IR | 4 | 3 | 4 | 7 |
| SA | 3 | 2 | 3 | 5 |
| BH | 1 | 1 | 1 | 3 |
| IQ | 1 | 1 | 1 | 1 |
| IL | 1 | 1 | 1 | 8 |
| CY | 0 | 0 | 0 | 4 |
| EG | 0 | 0 | 0 | 8 |
| JO | 0 | 0 | 0 | 1 |
| KW | 0 | 0 | 0 | 2 |
| LB | 0 | 0 | 0 | 4 |
| OM | 0 | 0 | 0 | 14 |
| PS | 0 | 0 | 0 | 0 |
| QA | 0 | 0 | 0 | 4 |
| SY | 0 | 0 | 0 | 1 |
| YE | 0 | 0 | 0 | 3 |

# RIPE Atlas coverage - how far can we see?

## Anchors in the region

FI: 14
SE: 16
DK: 8
NO: 6
LT: 4
EE: 3
LV: 1



# Questions & Comments

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RIPE NCC
RIPE NETWORK COORDINATION CENTER

# THANK YOU!