

How the Internet routed around Cable Damage in the Baltic Sea

Internet event analysis with **RIPE** Atlas

Alun Davies | SEE 13, Sofia Bulgaria | 7 April 2025

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#### Does the Internet Route Around Damage? - Baltic Sea Cable Cuts

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This week's Internet cable cuts in the Baltic Sea have been widely reported, even as attempts to understand their cause and impact continue. We turn to RIPE Atlas to provide a preliminary analysis of these events and ask to what extent the Internet in the region has been resilient to them.

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Alun Davies • 31 Mar 2025 • 2 min read

When two Internet cables in the Baltic Sea were reported as broken last November, we turned to RIPE Atlas to examine the damage. In this episode, Emile Aben discusses what his analysis uncovered about the impact of these and similar incidents, and how the Internet remained resil

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# Emile Aben

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#### About the author

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#### 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

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### **Baltic Sea cable damage**



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

- 4 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**



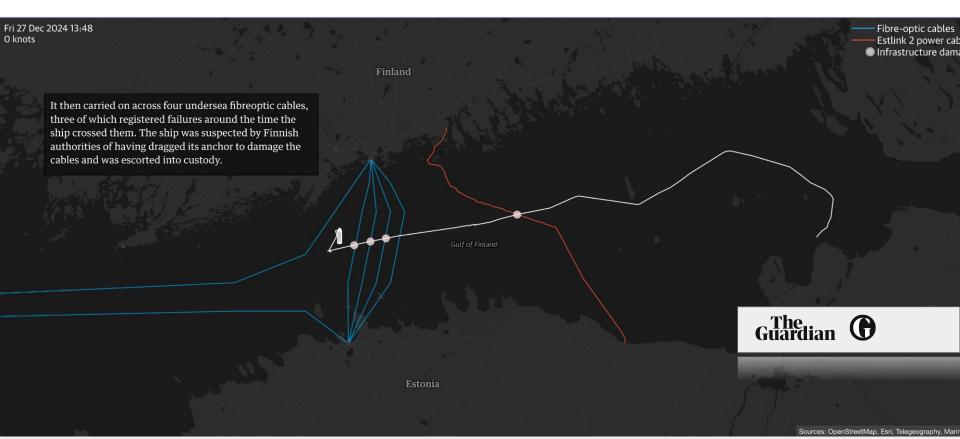
#### Media coverage

#### Sweden opens inquiry into damaged Two Baltic Sea cables disrupted – is Sweden Investigates New undersea cable as Nato deploys ships this 'hybrid warfare'? Cable Break Under Baltic Sea A vessel has been seized al December 31, 2024 authorities are looking into possible damage to an undersea optic line, probably due to By Annie Turner - 19 November 2024 east of Gotland island. NATO has stepped up its surveillance Christmas Day Cable Cuts in the Baltic Sea European governments point finger at Russia he region. Written by Alexander Lott over Baltic cable cuts bmarine telecommunic Baltic subsea cable damage was Damaged cables appear to be accident, Lithuania, Russia, an AD accidental, not sabotage - US and rticle Investigations are underway into two subsea cable breaches in the Balt In addition, an underv **Finland** says and European governments are starting to suggest that Russia is behin It by a ship anchor. Th European officials 3 December 2024 l involving a foreign c Share < Save [] or over a hundred kilon Mary Lennighan George Wright Refutes all claims of Russian sabotage November 20, 2024 dent occurred in Oct January 20, 2025 By: Niva Yadav O Have your say ③ 3 Min Read ber 2024, and the Ea ndicated on the map be 0 💓 in 🤕 🔤 infrastructure locate d in the NewNew electricity cable and 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. I's decisive intervention As reported by The Washington Post, US and ical offshore infrastruct European officials have gathered evidence and the Eagle S incide including intercepted communications - which have concluded that anchors were dragged across the seabed accidentally because of inexperienced crews aboard p FINLAND EAGLE S STOPPED HERE RUSSIA ROUTE OF EAGLE S dish Coast Guard vessel in the Baltic Sea. Sweden also investigated the severing

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### **Baltic Sea cable damage**





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# **Measuring damage with RIPE Atlas**



#### **RIPE Atlas**

A global network of probes measuring the Internet in real time

13,400+ probes connected800+ anchors deployed

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

#### **Anchor mesh**

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

Each anchor performs ongoing ping 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	Helsinki
Germany:	100	
Sweden:	15	Katthammarsvik
Finland:	12	Sventoji
Lithuania:	5	Sventoji
		Rostock

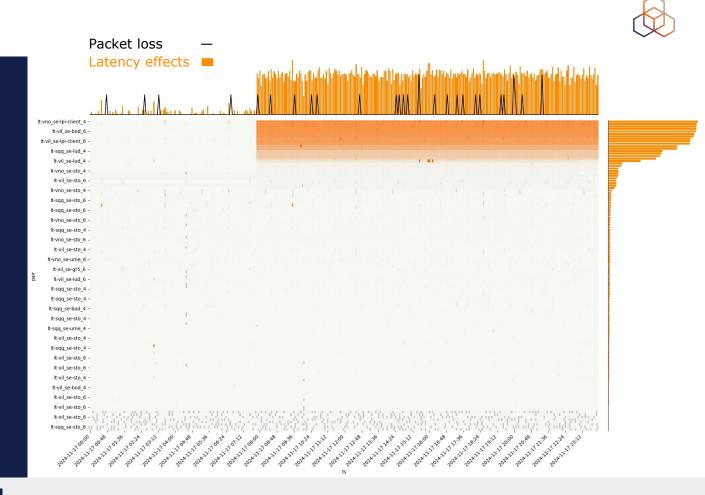
### **BCS East West**

### 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



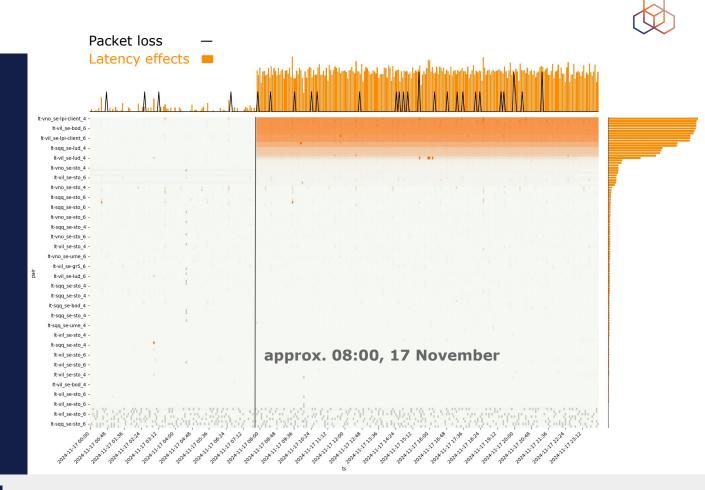
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#### **Packet loss**

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

#### Packet loss Latency effects de-dus\_fi-kaj\_6 de-rgm\_fi-tuu-client\_6 de-abm fi-tmp 4 de-ber fi-tmp 6 de-fwn-client fi-hel 6 de-rgm\_fi-tmp\_6 · de-ber fi-tuu-client 4 de-erl-client fi-tuu-client 4 de-ber fi-oul 6 de-fra fi-tmp 4 de-fra fi-kaj 6 de-muc fi-ulv 6 de-mdt fi-hel 4 de-gbm fi-hel 6 de-ber fi-ulv 4 de-bre fi-kst 4 · de-has\_fi-hel\_4 de-dus fi-kst 4 de-erl-client\_fi-tmp\_4 de-fra fi-hel 4 de-fra\_fi-kst\_4 de-ful fi-hel 4 de-ber-client fi-hel 4 de-fra fi-hel 4 approx. 02:00, 18 November de-has\_fi-kaj\_4 de-dtm-02 fi-oul 6 de-dus fi-tmp 6 de-str fi-hel 4 de-fra fi-hel 4 de-fra fi-ulv 4 de-goe fi-hel 4 de-ImI fi-hel 4 024.11.11 21.32 A-12-17 23:40 A-12-18 00:12 2A-11-28-00:AA A-11-28-01-16 A-12-18 01:48 A-12-18 02:20 A-12-18 02:52 4-11-28 03:24 A-12-18 03:56 024-12-1805 11:18 05:32 111808:12 1222820:20 11.18 10:52 024.11.18 11:56 224-22-37 22:00 24.71.77 22:04 24.11.17 22:36 A-11-1723:08 ×12-18 04:28 111-18 06:04 3A-11-18 06:36 24-11-18-07:08 A-12-18-07:40 x:12:18 08:44 \*11-18-09:16 11-1809:48 24.2.1.28.11.24

# **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...

de-fra\_fi-kaj\_6 de-mag fi-hel 6 de-ett fi-kaj 6 de-uwg\_fi-oul\_4 de-drs fi-ulv 4 de-mun fi-oul 6 de-kae\_fi-hel\_6 de-fra fi-hel 4 de-cal fi-hel 4

2024-12-28-22:00 2014-11-28 22:36

2014-11-28 13:12

524-12-28 13:48 1024-11-28 14:24 1024-11-28 15:00 024-11-28 15:36

2024-11-28-16:12

024.11.28 16.48 -02A-11-28 17:2A 024.11.28 18:00 024-11-28 18:36

#### Packet loss Latency effects de-dus fi-hel 6 de-dus fi-hel 6 de-gbm\_fi-tuu-client\_4 de-ffo fi-tuu-client 4 de-nue\_fi-hel\_4 de-mai\_fi-tmp\_6 de-kel fi-hel 4 de-fra fi-ulv 6 de-ett\_fi-tmp\_6 de-fra fi-tmp 4 de-fwn-client fi-hel 6 de-sle fi-ulv 4 de-ett fi-hel 6 de-kel fi-tmp 4 de-fra fi-ulv 6 13 14 de-fra-client\_fi-ulv\_6 de-ber fi-hel 4 de-dus fi-hel 4 de-rgm fi-hel 4 de-muc fi-hel 4 de-fra fi-tmp 4 de-ber\_fi-hel\_6 de-ber\_fi-hel\_4 -

-024-11-28 19:12

1024-11-28 19:48 2024-21-28-20:24 2024-11-28-21:00

2024-12-28-22:12

202A-12-28-21:36

2014-11-28 22:48 -D24-12-28-23:24 2024-11-29 00:00 2024-21-29-00:36 2024-31-29 01:32 2024-12-29 01:48 2024-1229 02:24 -02A-11-29-03:00

-024-71-29-03-36 2014-11-29 04:12 2024-12-304.48 2024-12-29.05:24

# 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



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But there was no concurrent increase in packet loss

The Internet routed around damage!



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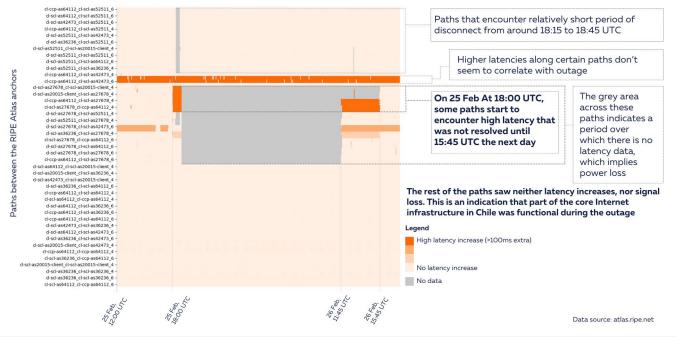
### **Beyond the Baltic Sea**



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.



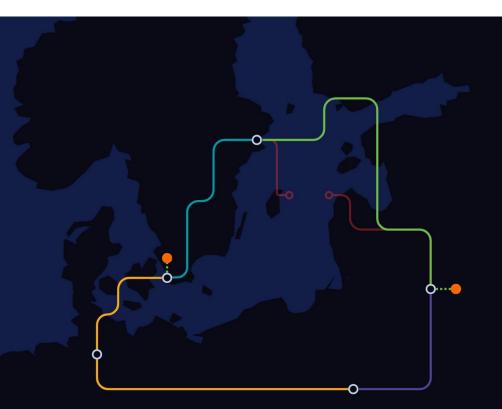
### **Deeper dive**



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:**

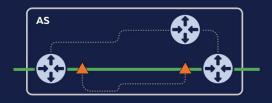
Rerouting along alternative circuit-level connections between routers (same IP address!)













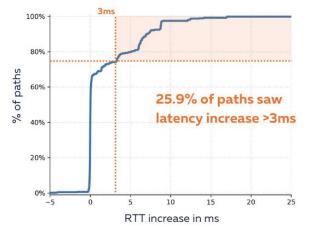
# Levels of resilience



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

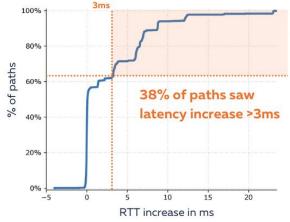
#### Inter-domain rerouting

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



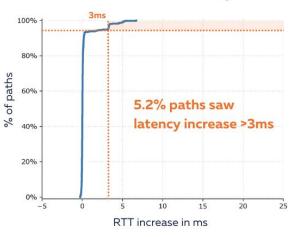
#### Intra-domain rerouting

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 interdomain or intra-domain changes.



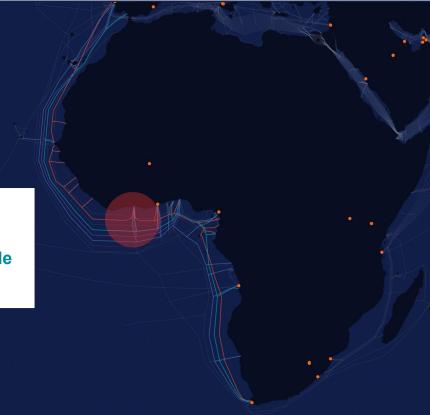
# **Resilience is not guaranteed**



### 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



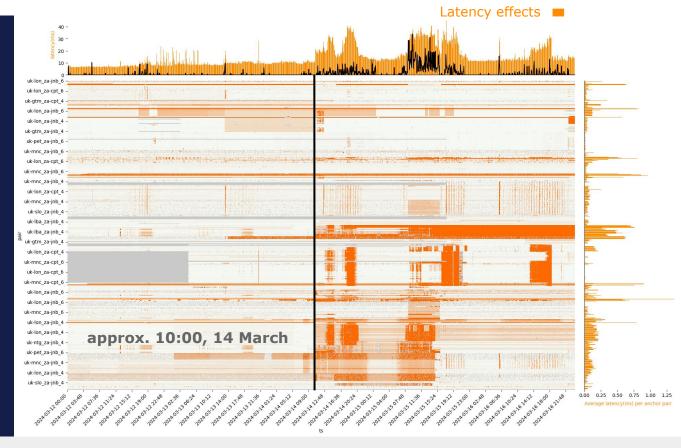
# **Resilience is not guaranteed**



Packet loss

Latency shift *with* packet loss

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







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)





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### But resilience is not guaranteed





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 NCC is a neutral source of Internet measurement data

To gain visibility into Internet events, we need vantage points

Coverage is key!

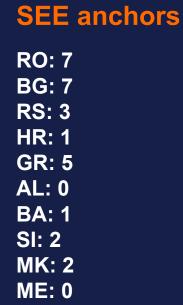
We are actively seeking hosts who can help us get RIPE Atlas probes and anchors set up in locations where they can shed light on the state of the Internet. Learn more:

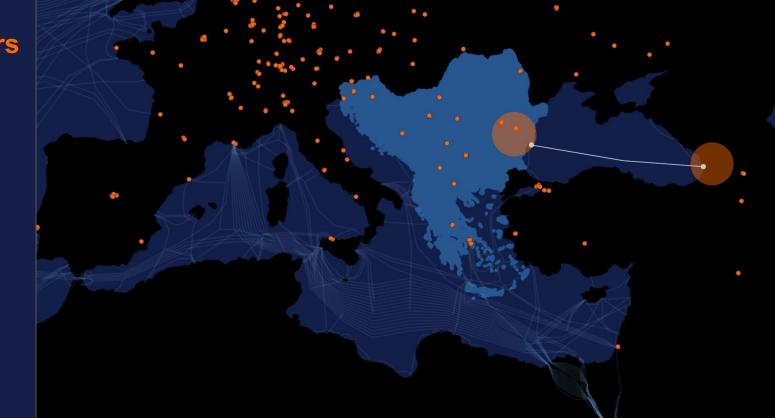














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#### Public By Joaquin Vaquero Ortiz D Edited Apr 3

### Anchors by country

jvaquero

The table below is a live view of RIPE Atlas anchor diversity per country

Country Codes (comma separated, \_\_\_\_\_\_\_\_no spaces)

viewof cc\_list = Inputs.text({label: "Country Codes (comma separated, no spaces)"})

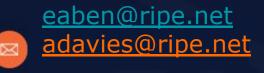
Country code	Nr of anchor	Nr of cities w a	Nr of ASNs w a	landings	Cables with lan	Cable Count	List of cities w	List of ASNs
AF	1	1	1	0		0	kbl	138322
AG	0	0	0	3	celia eastern-c	3		
AI	0	0	0	1	eastern-caribb	1		
AL	0	0	0	2	eagle trans-adri	4		
AM	1	1	1	0		0	evn	51225
AN	0	0	0	0		0		
AO	1	1	1	7	nzadi-cable-sy	5	lad	37468
AR	4	4	4	3	firmina malbec t	7	bhi bue ttd vgg	28109 4270 2
AS	0	0	0	1	hawaiki samoa	2		
Alun Davies   SEE 13	7 April 2025	8	22	0		0	fkt hit inn klu lei	48362 34347
ALL	0.0	5		0.0		0.0	have set as all as a	4000 4000 40







# Questions & Comments







# **THANK YOU!**