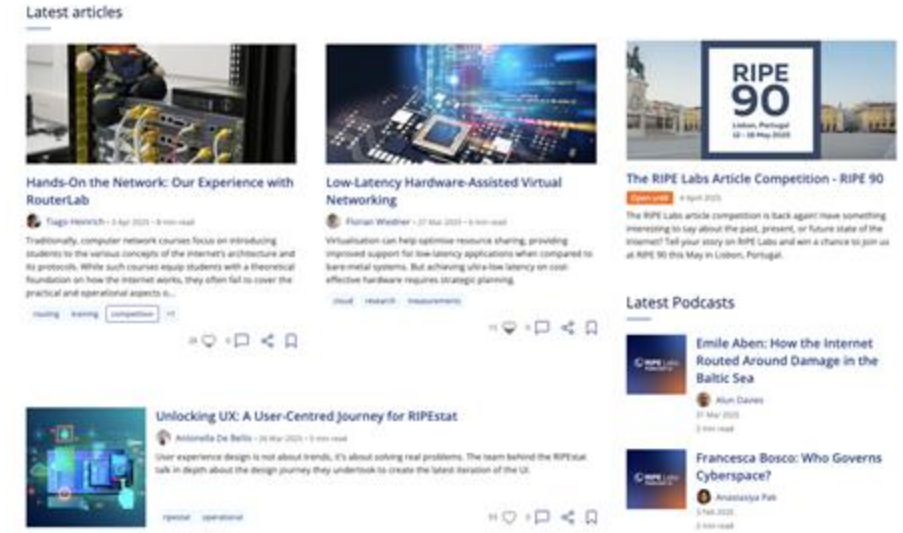
RIPE NCC
RIPE NETWORK COORDINATION CENTER

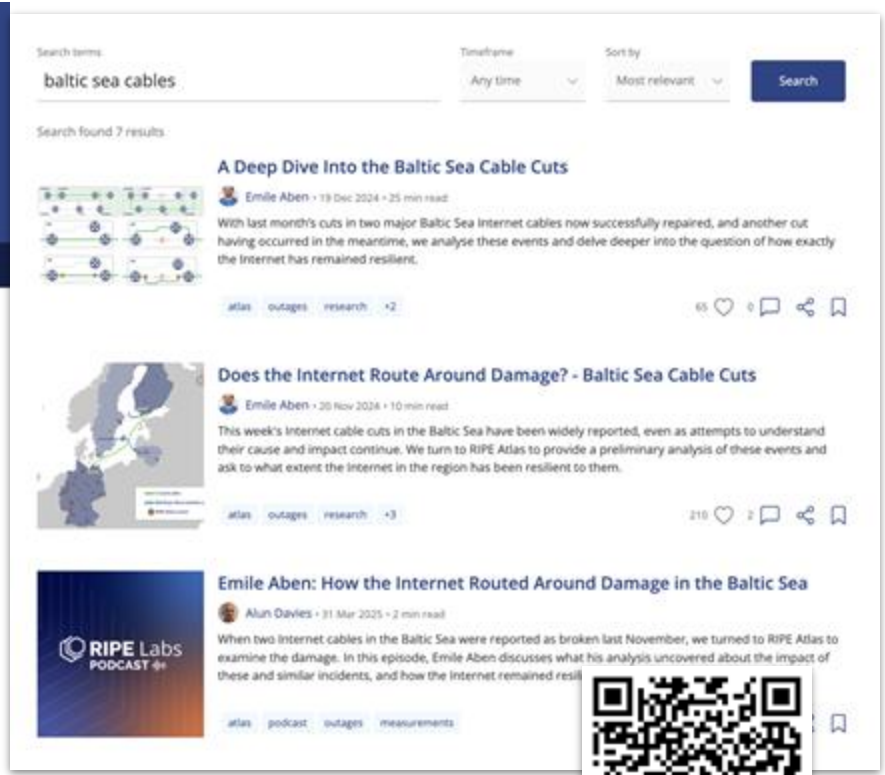
How the Internet routed around Cable Damage in the Baltic Sea

Internet event analysis with **RIPE Atlas**

Alastair Strachan - LINX 125 - 20 November 2025

RIPE Labs





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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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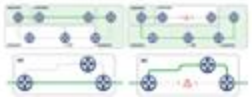


A Deep Dive Into the Baltic Sea Cable Cuts

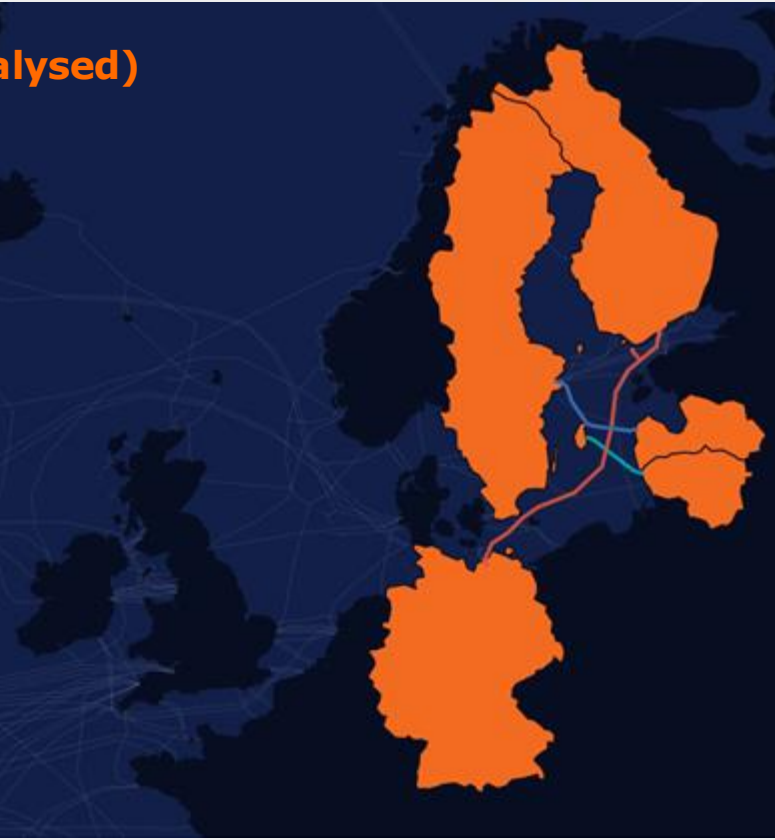
Emile Aben • 19 Dec 2024 • 25 min read

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

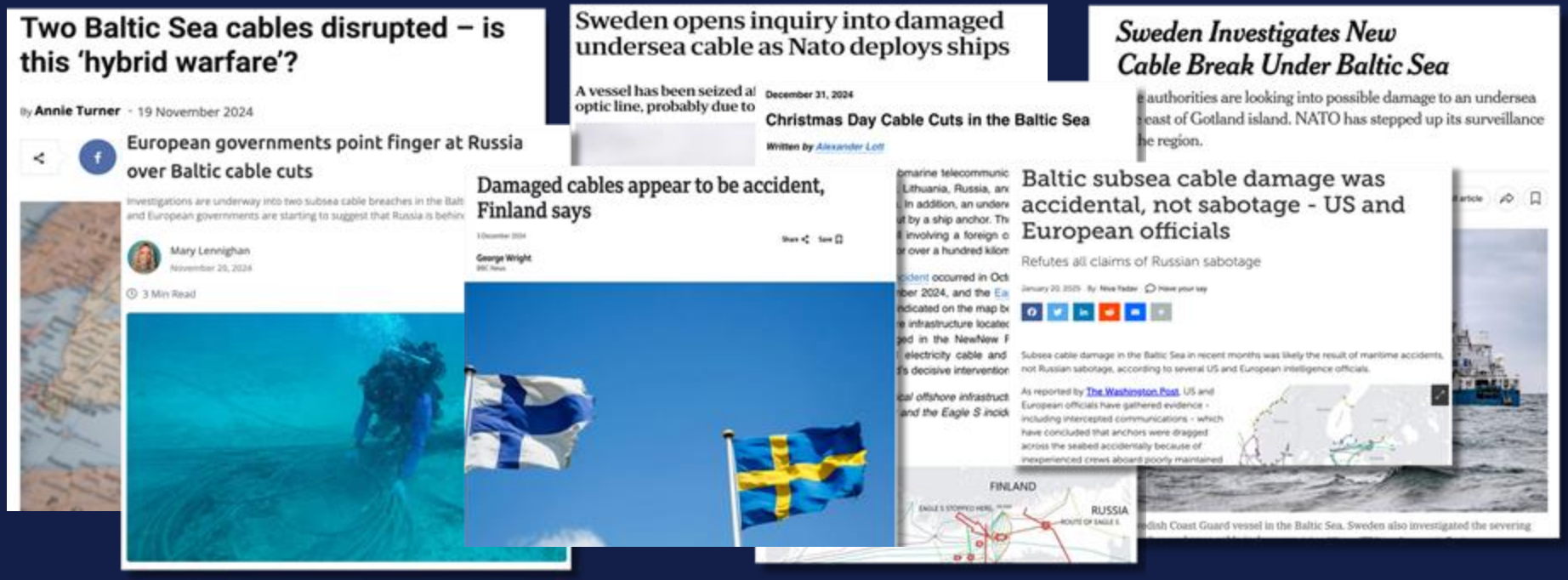
Partial timeline (focus on initial events we analysed)

- 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

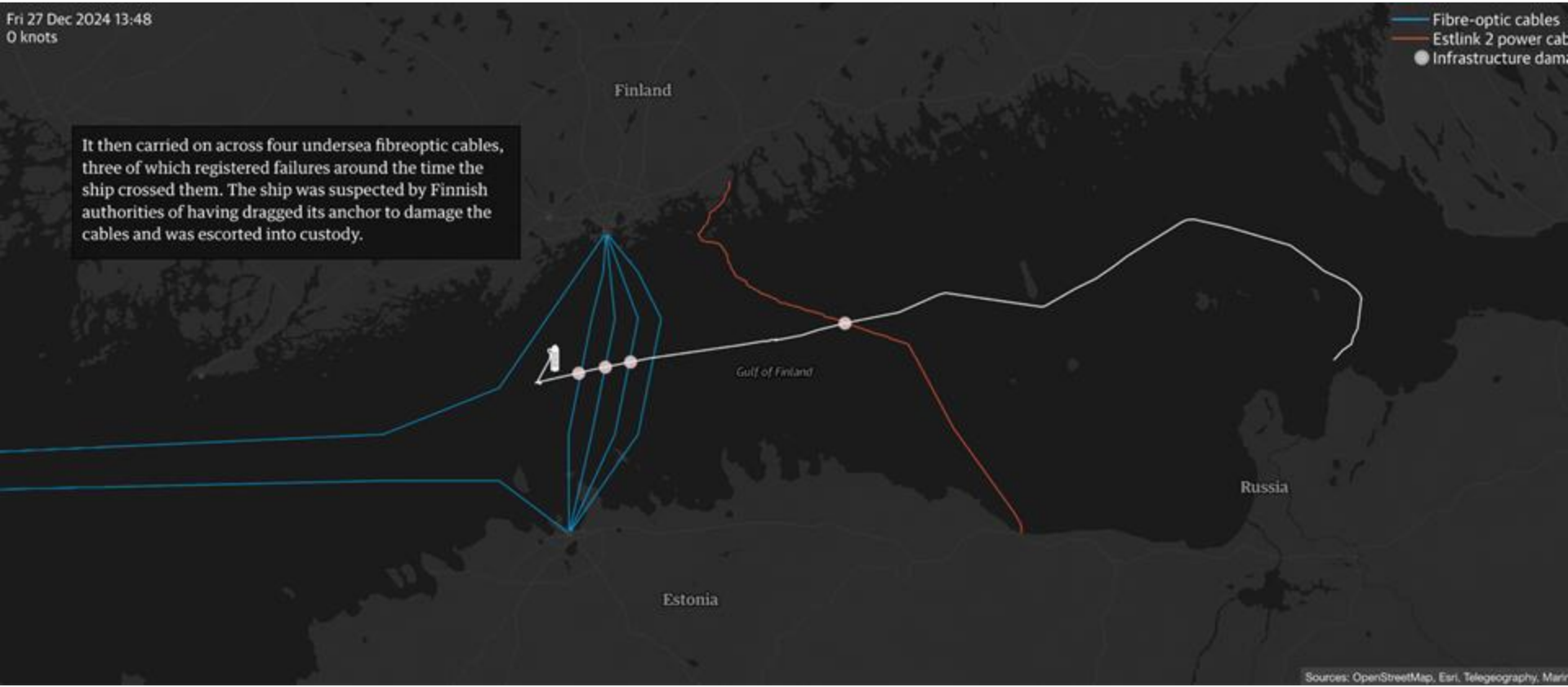


Baltic Sea cable damage

Media coverage



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

800+ anchors deployed

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

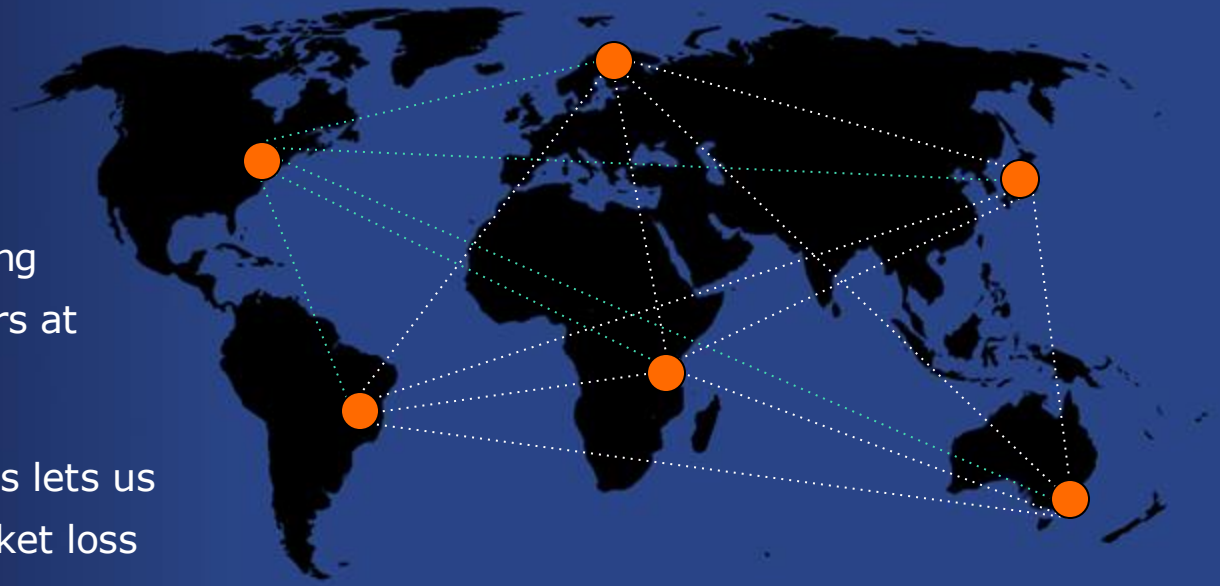
Measuring damage with RIPE Atlas

Anchor mesh

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

Each anchor performs ongoing ping 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

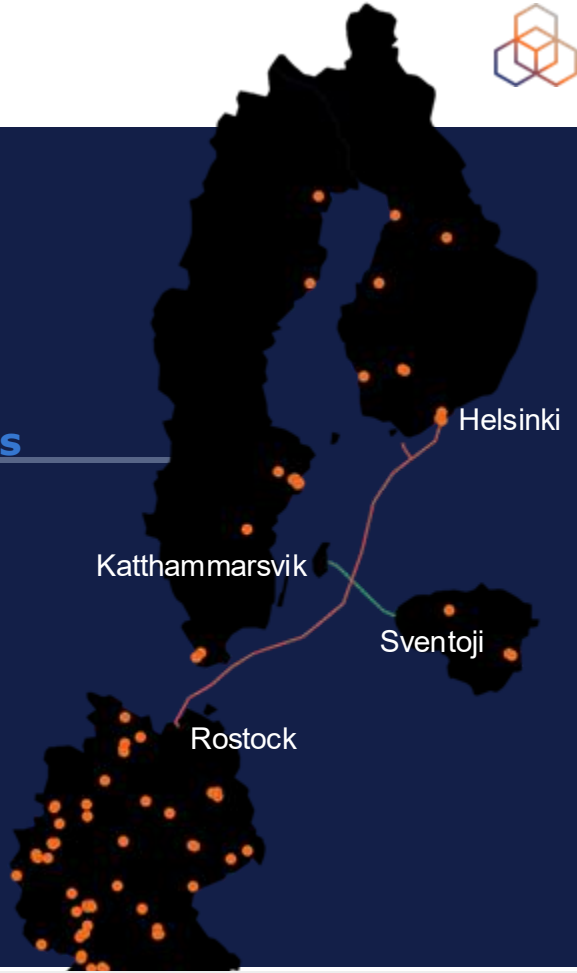
17-18 November

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



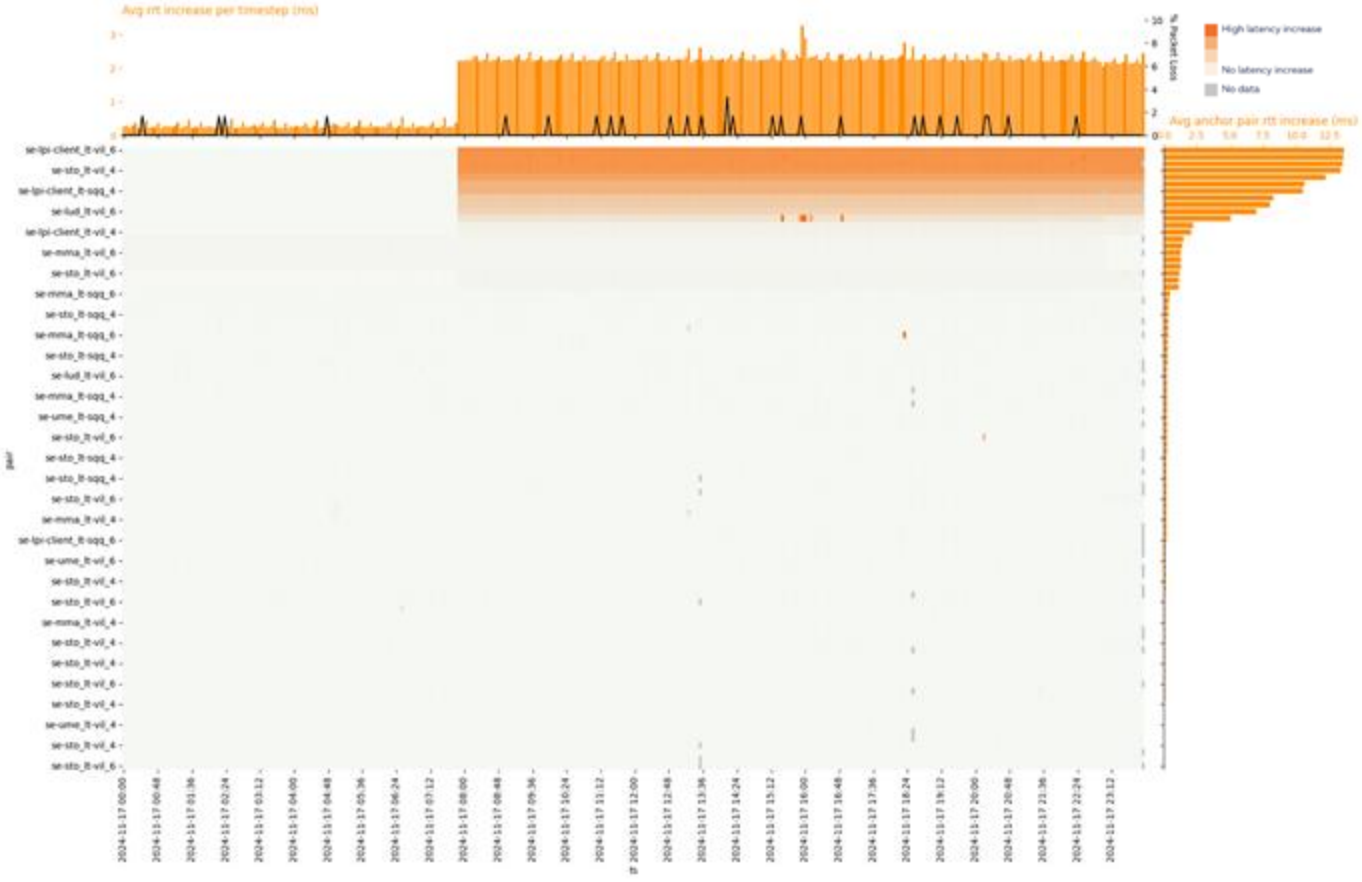
BCS East West

Latency shift

View of paths between anchors in Sweden and Lithuania, 12 hours 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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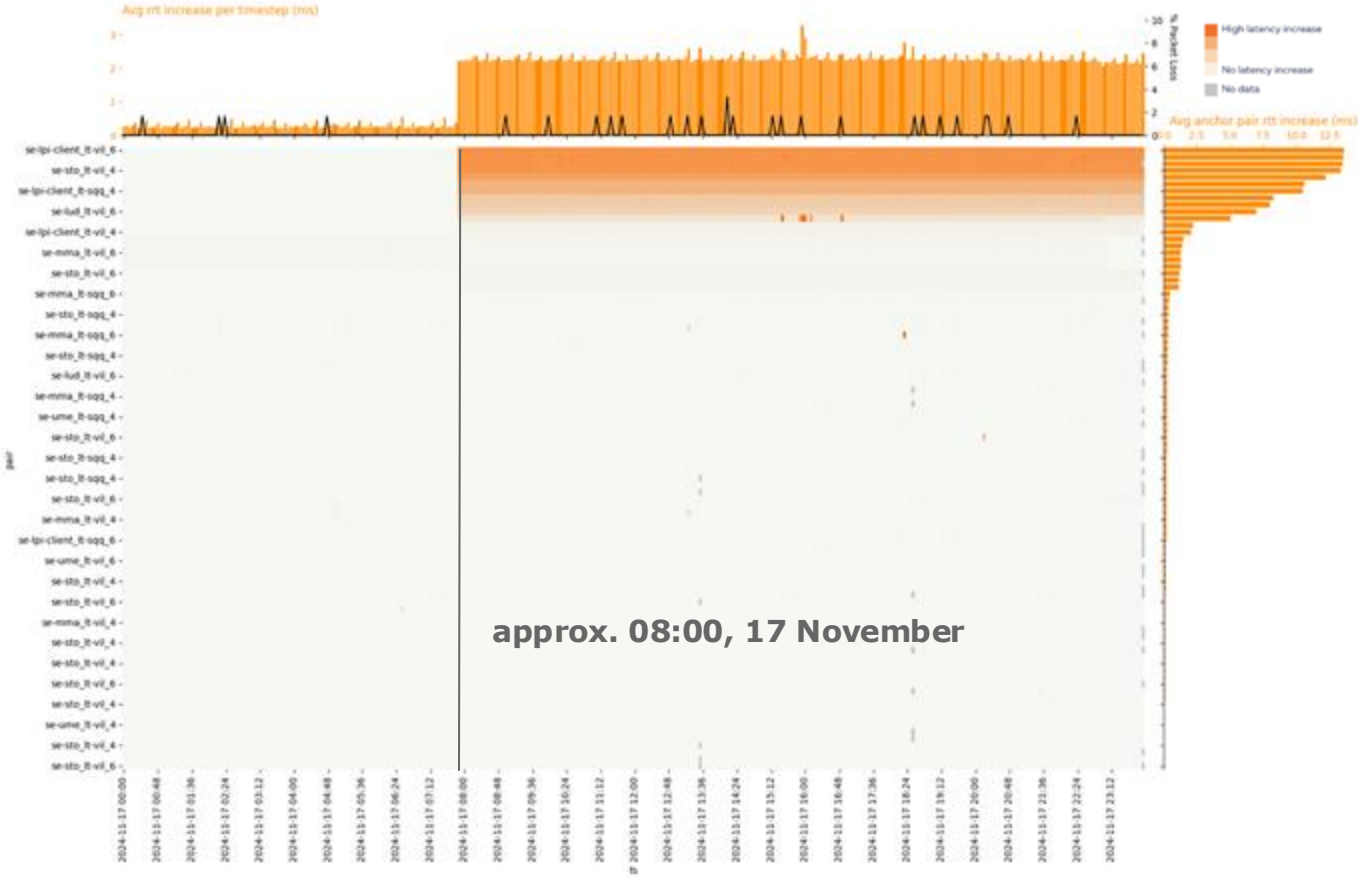


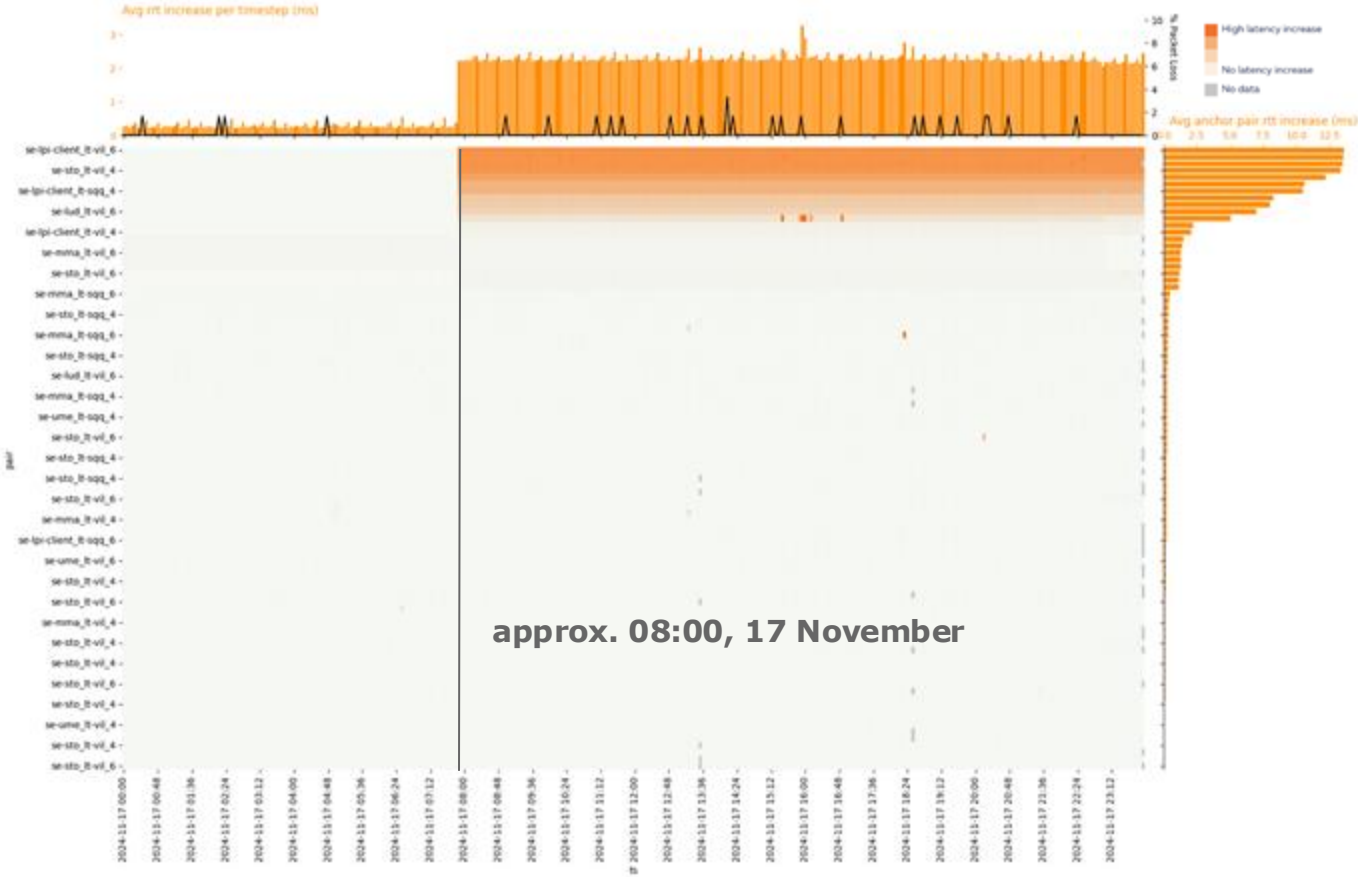
BCS East West

Latency shift

View of paths between anchors in Germany and Finland, 12 hours before/after time of event

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

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



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)

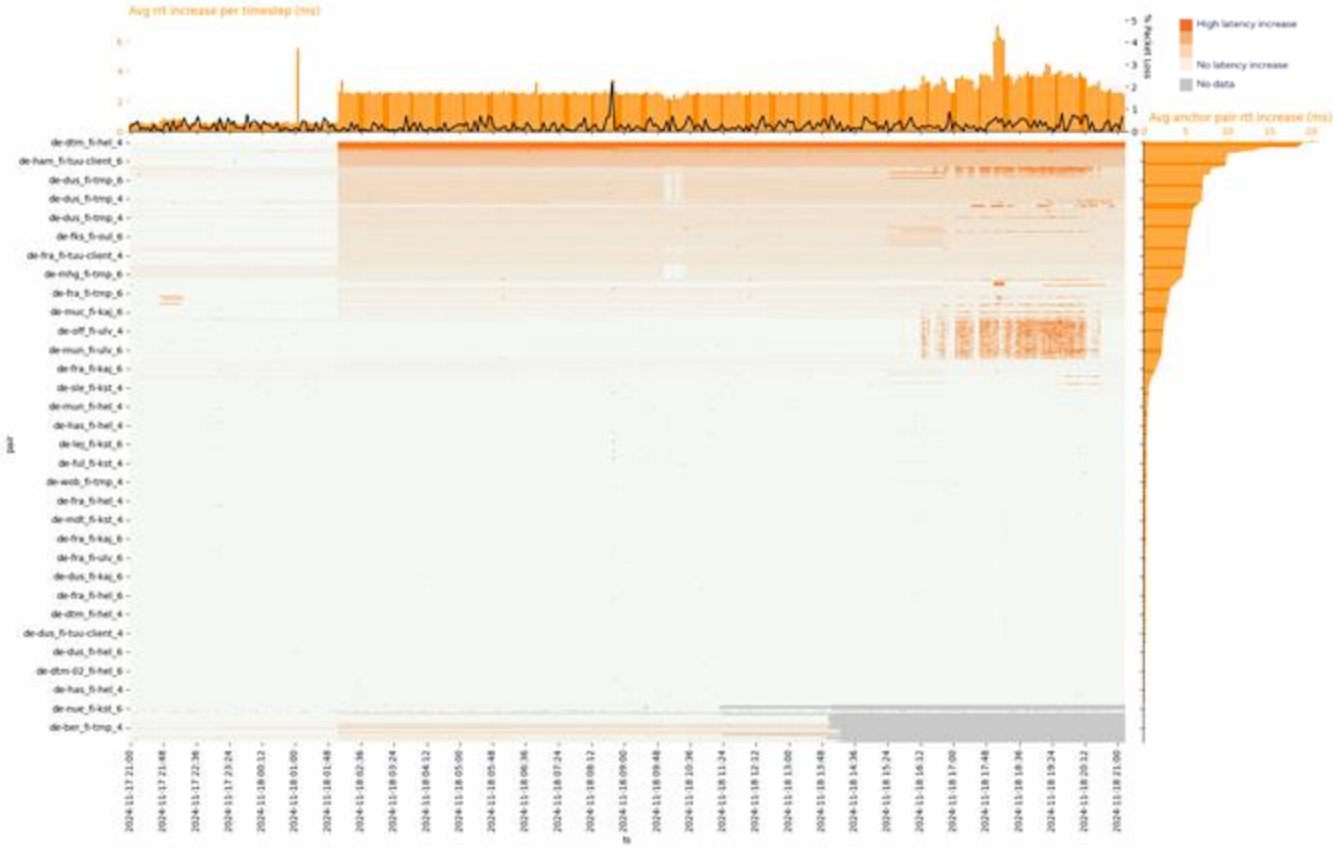
C-LION1

Latency shift

View of paths between anchors in Germany and Finland, 12 hours before/after time of event

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

Again: **no significant increase in packet loss**



C-LION1

Latency shift

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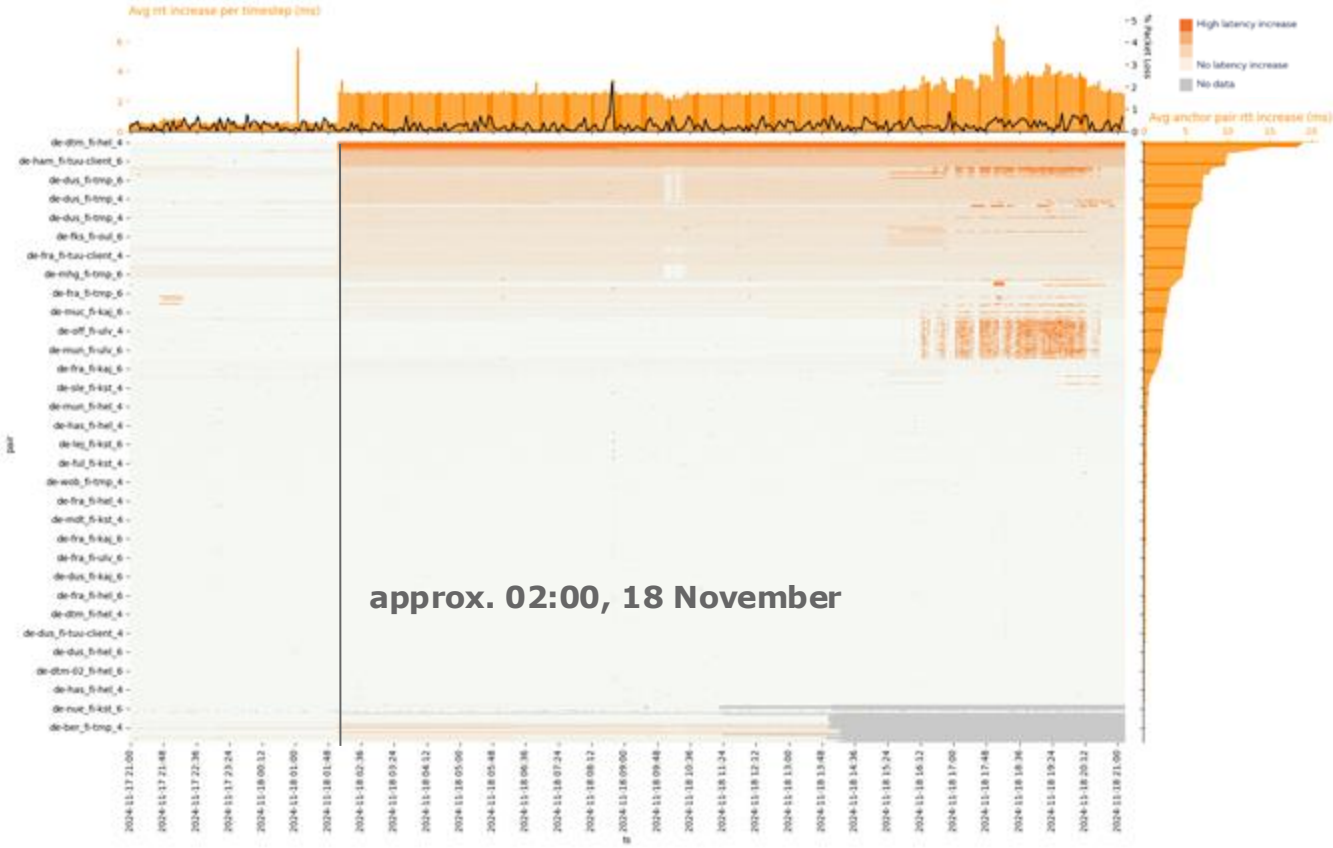
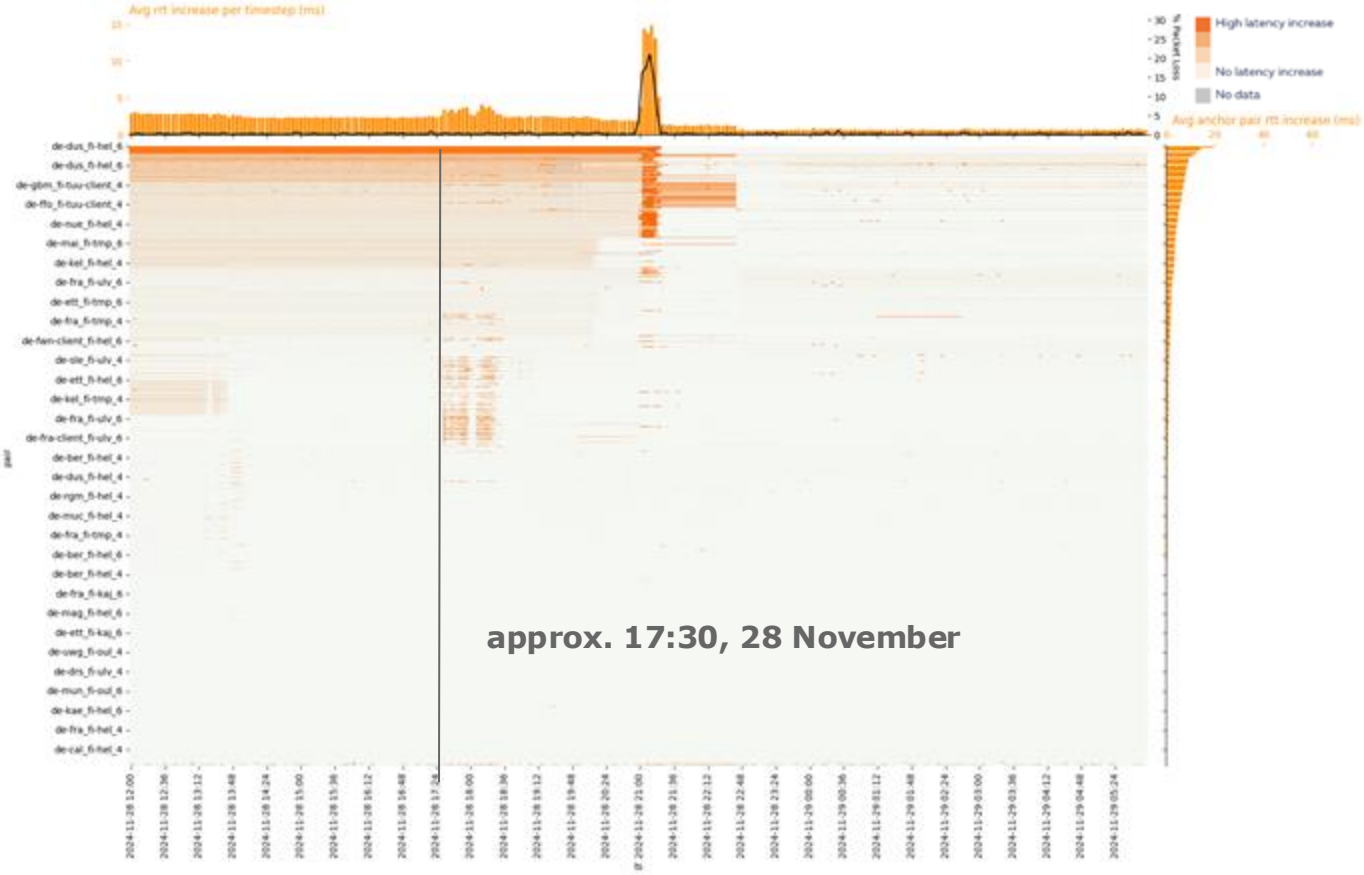


C-LION1 repair

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

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

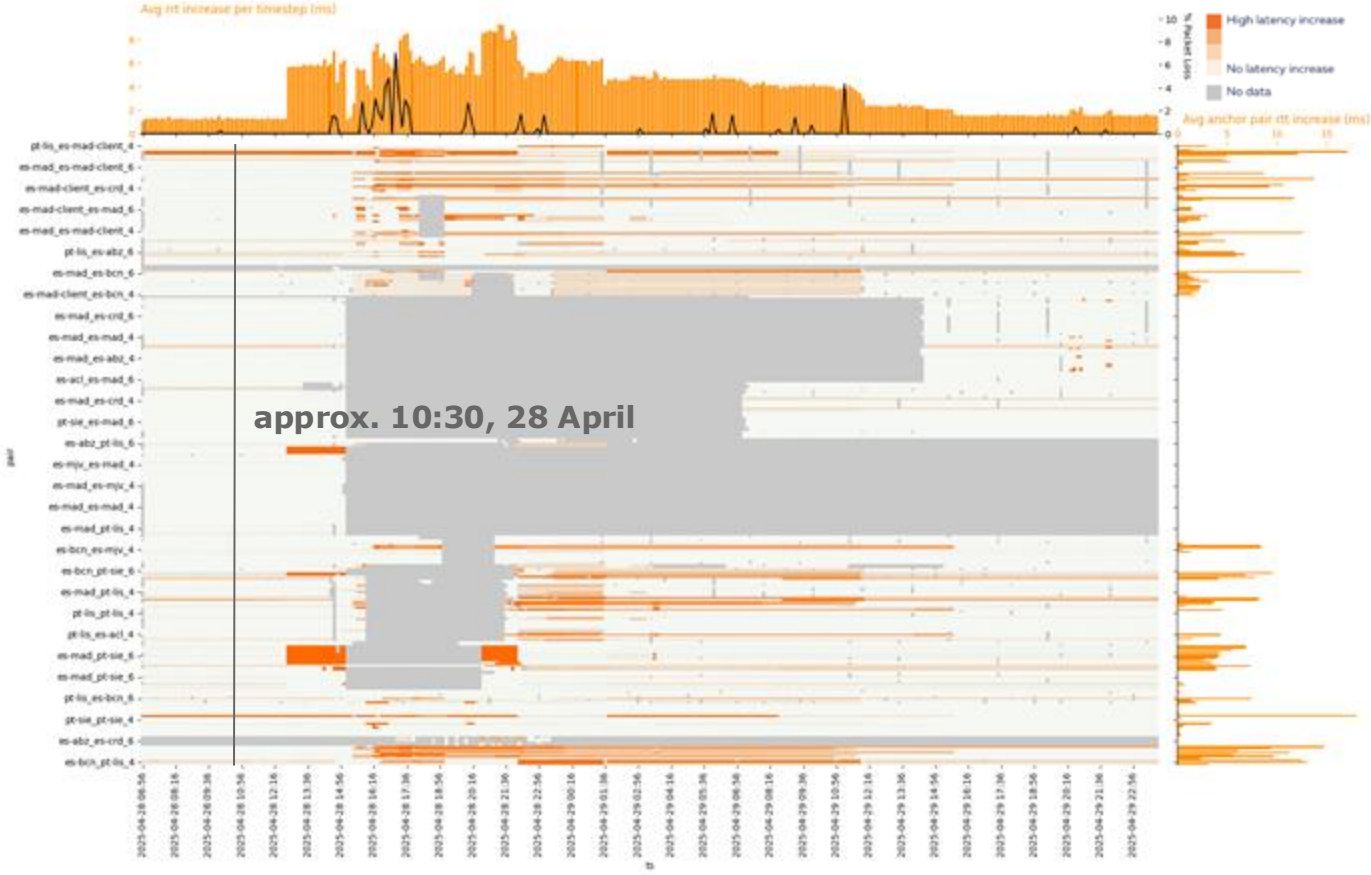


Beyond the Baltic: ES-PT Power Outage April 2025

Anchor mesh measurements - potential for getting insights into outages

Power outage events much harder to measure compared to cable outage events

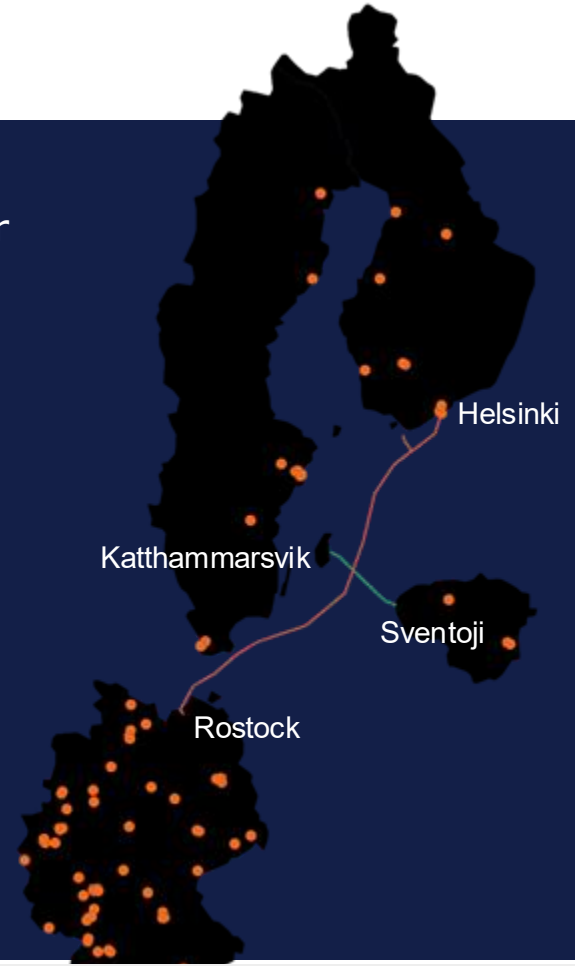
Due to the infrastructure being brought offline by the event itself



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

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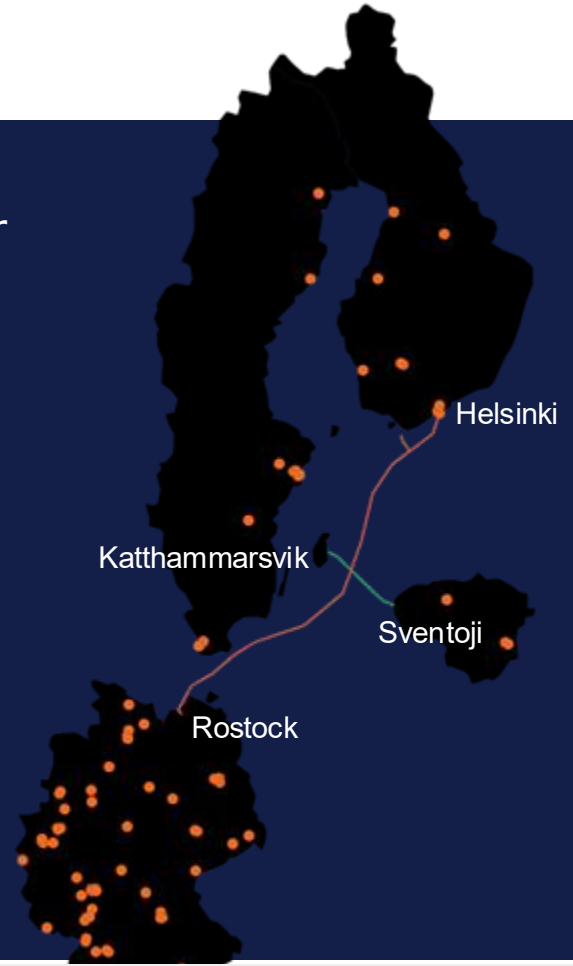
But there was no concurrent increase in packet loss

The Internet routed around damage!

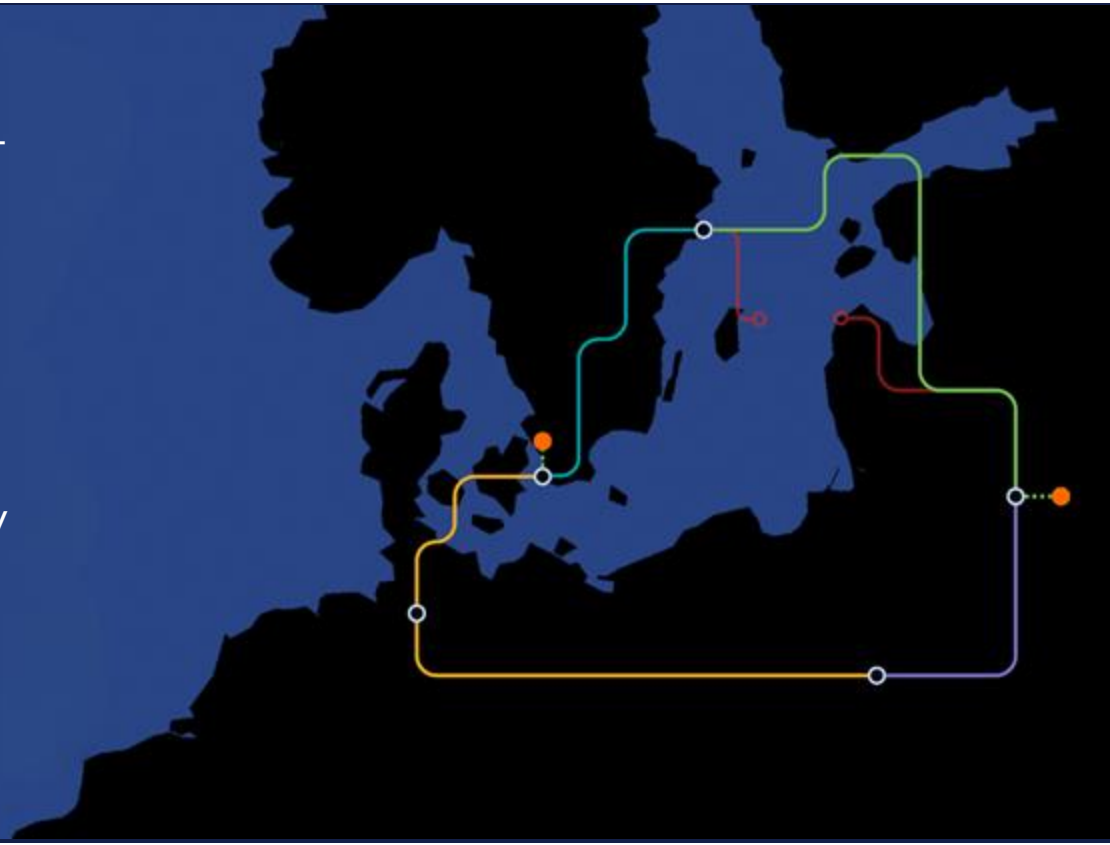


Deeper dive

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:

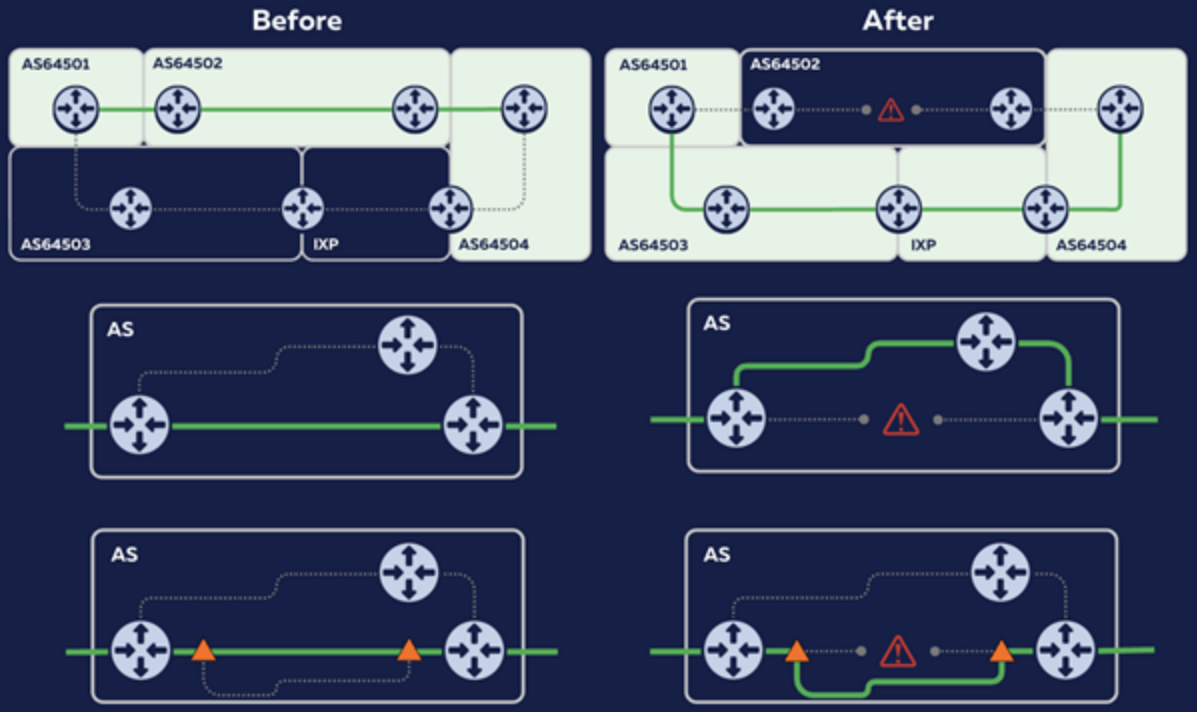
Traffic rerouted through alternative ASes/IXPs (eBGP routing protocol)

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!)

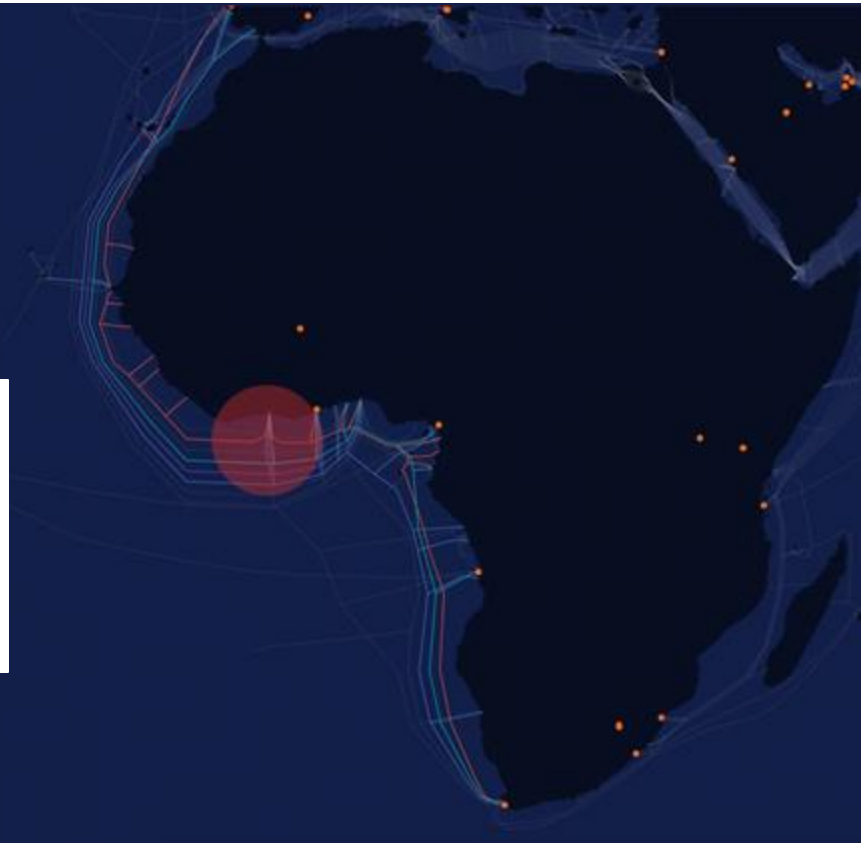


Resilience is not guaranteed: Côte d'Ivoire, 2024

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**

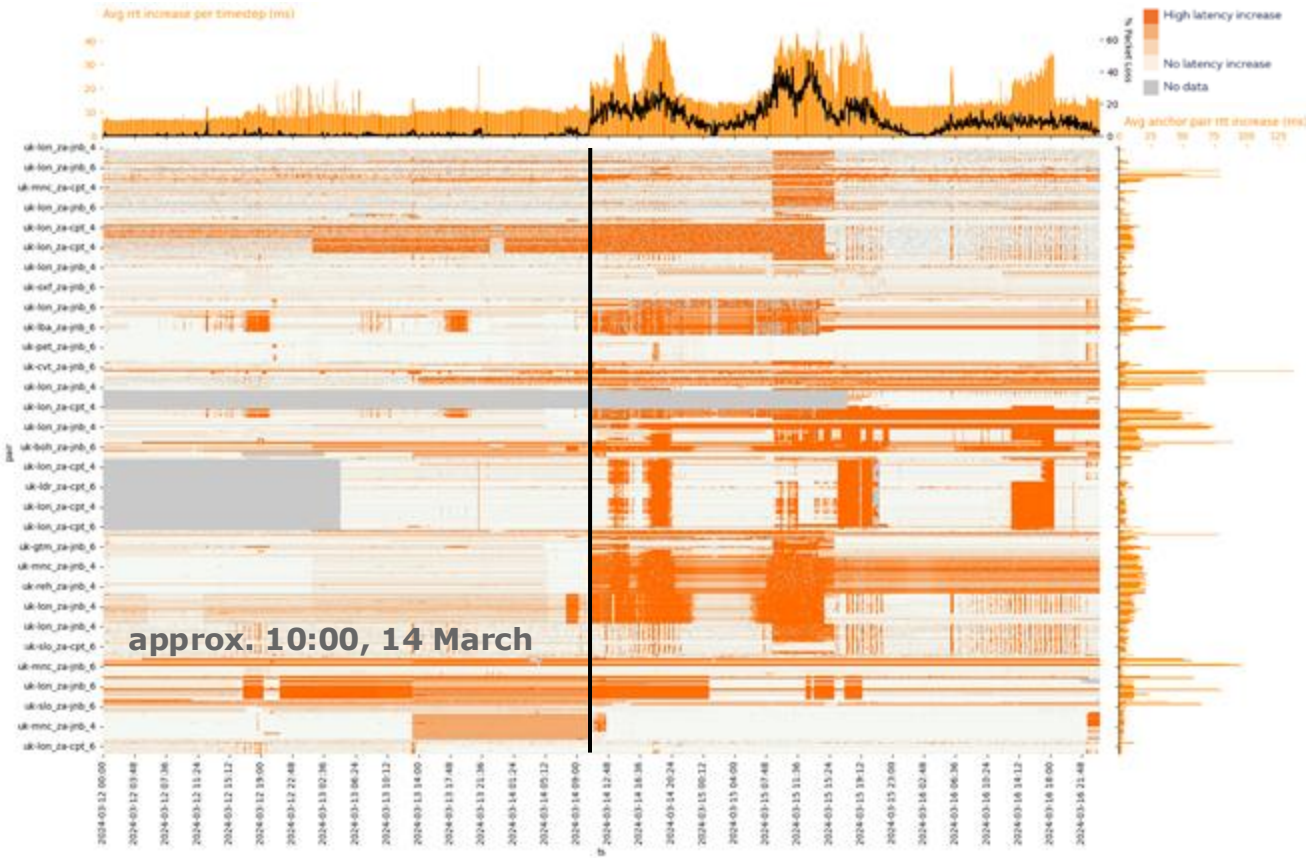


Resilience is not guaranteed: Côte d'Ivoire, 2024

Latency shift *with* packet loss

View of paths between anchors in UK and South Africa.

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



Resilience is not guaranteed: Red Sea, 2025

Cable damage in the Red Sea

5 September 2025: Reports emerge of cable outages in the Red Sea affecting:

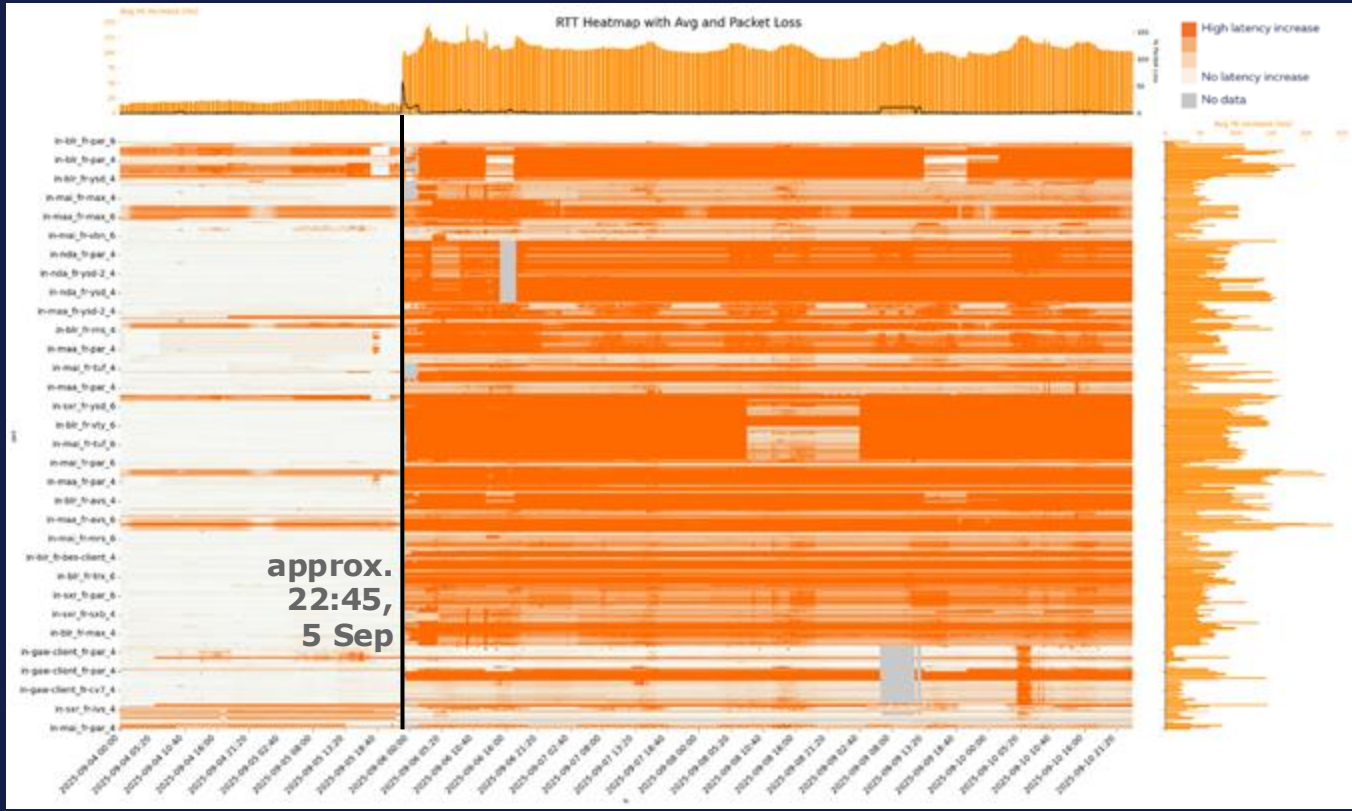
- **FALCON**
- **SeaMeWe-4**
- **IMEWE**
- **Europe India Gateway (EIG)**

Resilience is not guaranteed: Red Sea, 2025

Latency shift *with* packet loss

View of paths between anchors in France and India.

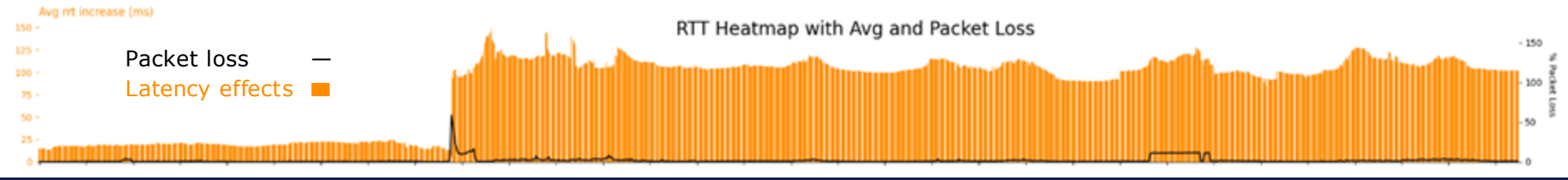
Latency increases of approx 100 ms accompanied by concurrent increase in packet loss



Resilience is not guaranteed: Red Sea, 2025

Packet loss

Up to 50% increase in packet loss



Significant increase (up to 50%) in packet loss at time of the initial cable outage followed by ongoing loss over next 24 hours.

Note: the right hand y-axis (associated with the black line indicating packet loss) is of a higher scale here compared to previous plots: 0-150 ms

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)

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In the Baltic Sea:

- "The Internet routed around damage"
- Internet resilience depends on multiple levels of redundancy
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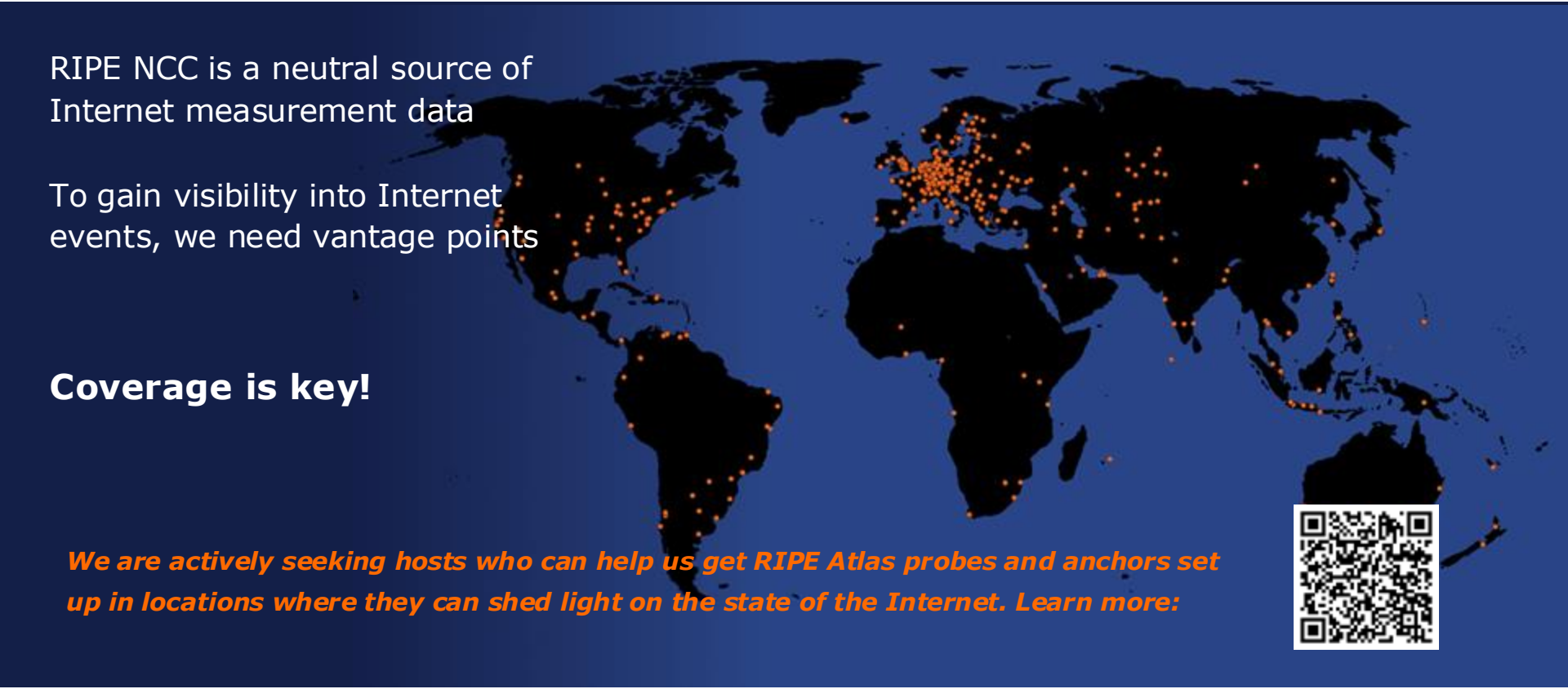
But resilience is not guaranteed

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

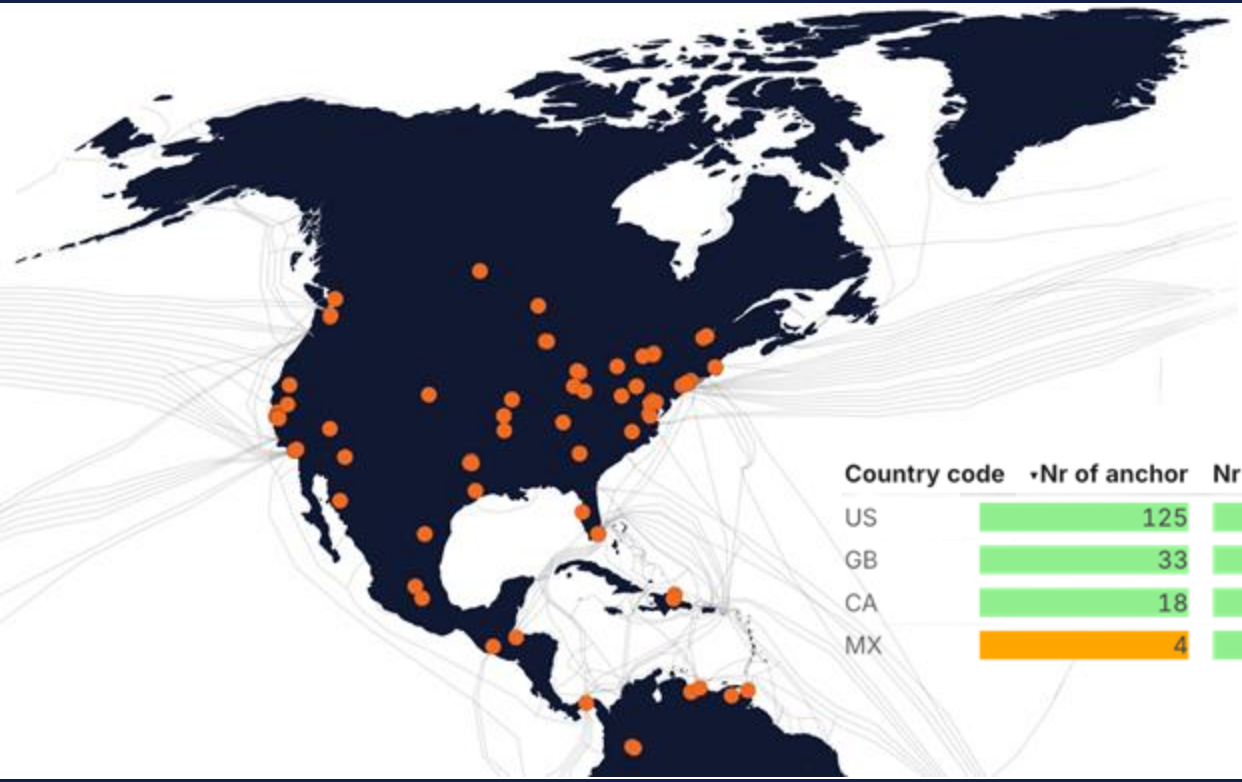
To gain visibility into Internet events, we need vantage points



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 w a...	Nr of ASNs w a...	landings
US	125	59	87	158
GB	33	18	30	119
CA	18	9	17	152
MX	4	3	3	13

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	fll	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 w a...	Nr of ASNs w a...	landings
DE	100	47	91	8
NL	48	21	46	8
FR	41	24	39	28
GB	31	17	29	119
CH	30	14	27	0
AT	22	8	21	0
IT	20	14	19	54
CZ	16	4	14	0
FI	14	9	14	11
SE	14	7	12	27
PL	13	10	13	1
ES	9	5	9	49
LU	9	4	8	0
BE	6	5	4	2
LT	4	2	4	2
NO	4	2	4	47
EE	3	1	3	3
IE	2	2	2	13
SK	1	1	1	0
LV	1	1	1	2

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?

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 ...	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...
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 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

Questions & Comments

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THANK YOU!