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AI-ARC

ARTIFICIAL INTELLIGENCE-BASED VIRTUAL CONTROL ROOM FOR THE ARCTIC

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The AI-ARC VISION

- **Change Raw Data into High-Value Insights**
- **Increase Safety & Security at Sea**
- **Enhance the situational awareness at Sea**
- **For both civilians, merchant mariners and Law Enforcement authorities (LEA's)**
- **Enable powerful collaboration in Real Time**



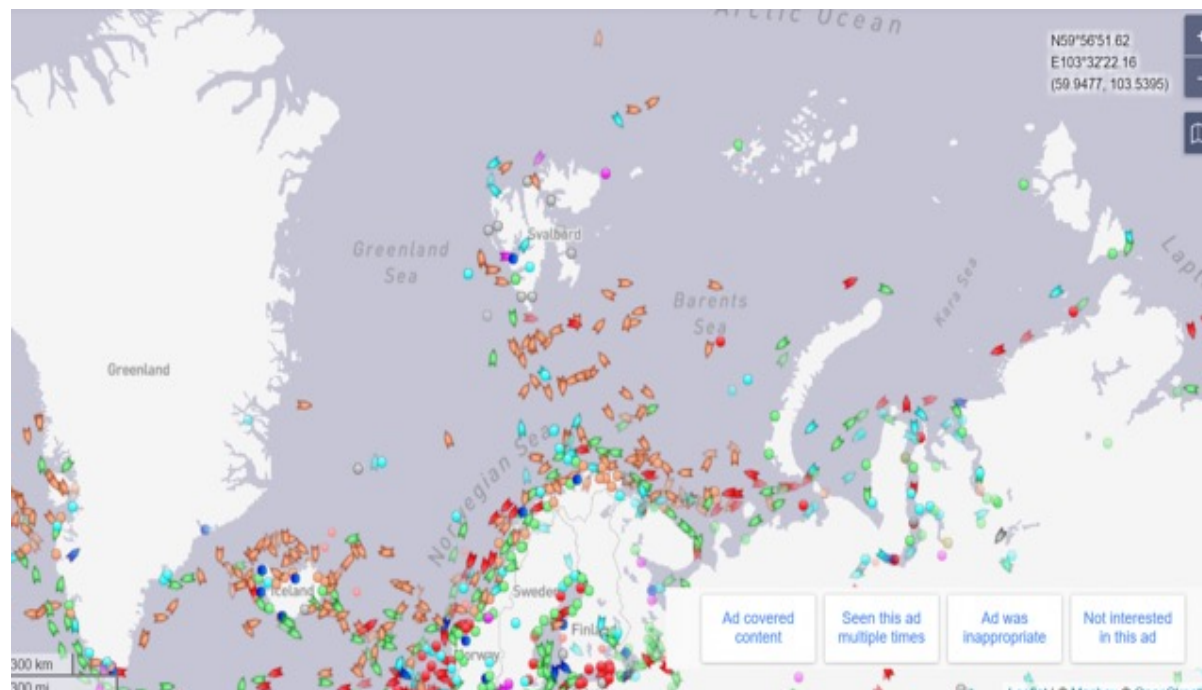


Overview of AI-ARC - Challenge

Challenge

- **Climate change** brings increasing maritime traffic to the Arctic
- **Increasing traffic** brings higher risks to people, infrastructure and the environment
- **International cooperation** between SAR and other authorities increasingly important

More than 200 vessels operating in Arctic waters every minute



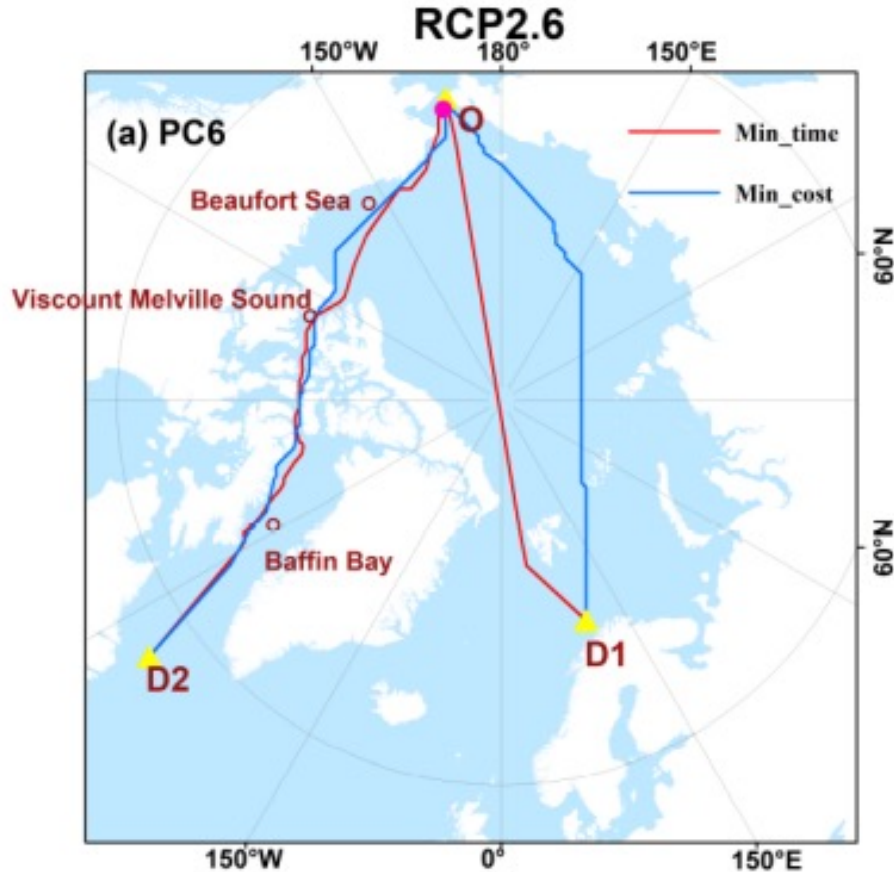
Opportunity

- Full broadband **satellite communications coverage** (US, CAN) enables valuable safety services e.g., for commercial traffic, **from 2023 onwards**
- **Real-time alerts** for dangerous or suspicious behaviour by vessels
- Interactive **multinational collaboration** using VR technology





Overview of AI-ARC - Challenge



- Ships passing through the Arctic lead to shorter shipping times and cheaper shipping costs. N
 - No existing safety infrastructure – need for AI-ARC
- By analyzing the trade among China, EU, and North America when Arctic Sea Routes (ASR) open, we found that up to 17-36% of the trade via ports in China could be shipped via ASRs, up to 10-21% of trade via ports in EU could be shipped via ASRs, and up to 26-52% of trade via ports in NA could be shipped via ASR*.

(Trade value between China and the EU was €586bn in 2021)

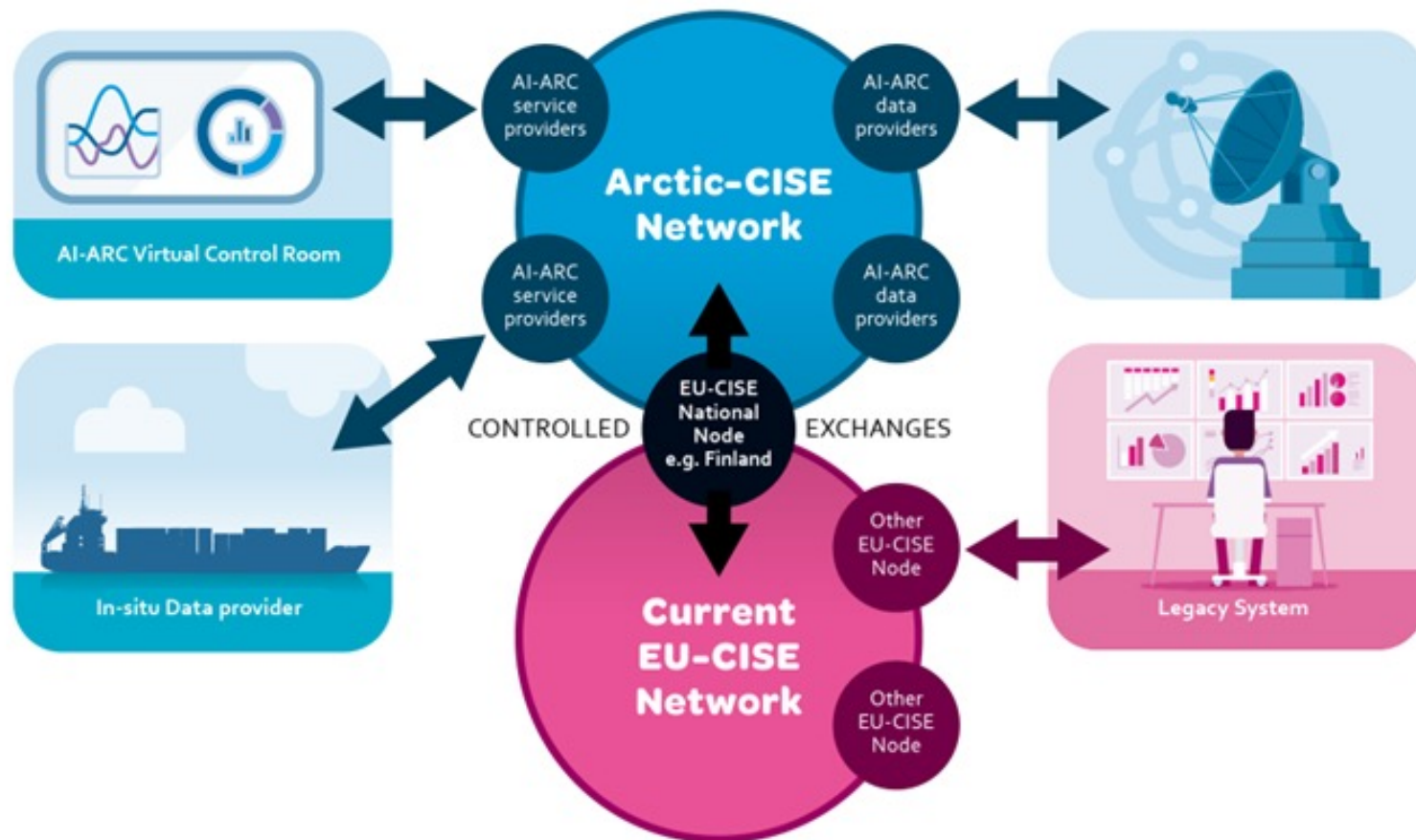
* Trade Volume Prediction Based on a Three-Stage Model When Arctic Sea Routes Open, 2021, www.mdpi.com/2073-8994/13/4/610





AI-ARC KEY FEATURES – Service based architecture

- Innovative AI based platform
- Detecting anomalies in real-time
- Powerful shared situational awareness using Virtual Reality
- Driven by multiple data sources
- CISE-compatible architecture
- Multi-factor reliability-screening for false alerts
- Modular design for additional service integration



CISE: Common Information Sharing Environment (CISE) operated by EMSA - European Maritime Safety Agency



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101021271



VIRTUAL CONTROL ROOM (VCR)

Digitaler Lagetisch (DigLT) – Digital Map Table - Fraunhofer

- System for distributed situation visualization and planning both web-based and in Virtual Reality (VR)
- Any number of users can work independently or together on the same situation
- It combines and displays all the results that are generated by the AI-ARC services
 - Remote collaboration
- Users can be distributed worldwide and meet in the same virtual space
- Intuitive interaction through synchronized content



Key	Value
MMSI	241618000
Heading	230
Sensor Type	"AutomaticIdentificationSystem"
Source Type	"Declaration"
COG	231
SOG	12.3
Time	"2023-06-27T16:28:02.000Z"
UUID	"225cc268-56fa-5d09-a18a-db7c66560126"
Ship Type	["OilTanker"]
Navigational Status	"UnderWayUsingEngine"





Ex. of Demonstrated AI-ARC Services (21 in total)

Protecting Underwater Infrastructure

- Detecting suspicious behaviour above pipes & cables so Authorities can respond

Avoiding Icebergs

- Prediction and Early warning system for nearby ships

Smuggling Detection

- Identify vessels meeting at sea and other suspicious behaviours

Vessel Traffic Control

- Alerts for ships deviating from normal lanes

Search and Rescue Coordination

- In-situ and awareness data between multiple agencies and vessels





Ex. of Demonstrated AI-ARC Services

Metadata

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Vessel and Dark Vessel with Satellite Imagery

Metadata

Key	Value
Geometry	coord's Lat: 69°15'53" N Lon: 51°29'05" W, Lat: 69°15'53" N Lon: 51°29'05" W, Lat: 69°15'53" N Lon: 51°29'03" W, Lat: 69°15'52" N Lon: 51°29'03" W, Lat: 69°15'52" N Lon: 51°29'03" W, Lat: 69°15'52" N Lon: 51°29'01" W, Lat: 69°15'52" N Lon: 51°29'01" W, Lat: 69°15'52" N Lon: 51°29'00" W, Lat: 69°15'52" N Lon: 51°29'00" W, Lat: 69°15'53" N Lon: 51°29'00" W, Lat: 69°15'53" N Lon: 51°29'02" W, Lat: 69°15'53" N Lon: 51°29'03" W, Lat: 69°15'53" N Lon: 51°29'05" W
type	Polygon
Ice Class	Ice Berg
Identifier	generated By ["Legal Name": "192P-Detection"] generated In 2023-10-05T09:23:28.068Z uuid 803ca954-4d75-5772-8481-22467cc0d9fe
Occurrence Confidence	50
Time	2023-07-04T21:41:19.565Z

Description
satellite image from satellite CSK

Icepack Detections with Satellite Imagery





Pollution anomaly automatic detection

MetaData → Satellite_image.png

Mark as seen

Metadata		
AIARC	anomaly Prediction Class	{"ai Arc Anomaly": "Unclear Water", "anomaly Score": 0.7198290824890137}
AIARC	Score	0.7198290824890137
Anomaly Prediction	Type	Unclear Water
Geometry	coord's	Lat: 55°46.18' N Lon: 17°36.48' E, Lat: 55°46.16' N Lon: 17°37.32' E, Lat: 55°45.69' N Lon: 17°37.29' E, Lat: 55°45.71' N Lon: 17°36.03' E, Lat: 55°45.95' N Lon: 17°36.04' E, Lat: 55°45.94' N Lon: 17°36.46' E, Lat: 55°46.18' N Lon: 17°36.48' E
	type	Polygon
Identifier	generated By	{"legal Name": "TAS"}
	generated In	2023-09-04T15:14:26.000Z
	uuid	2b651a2d-0971-505f-b86d-be3722457efd

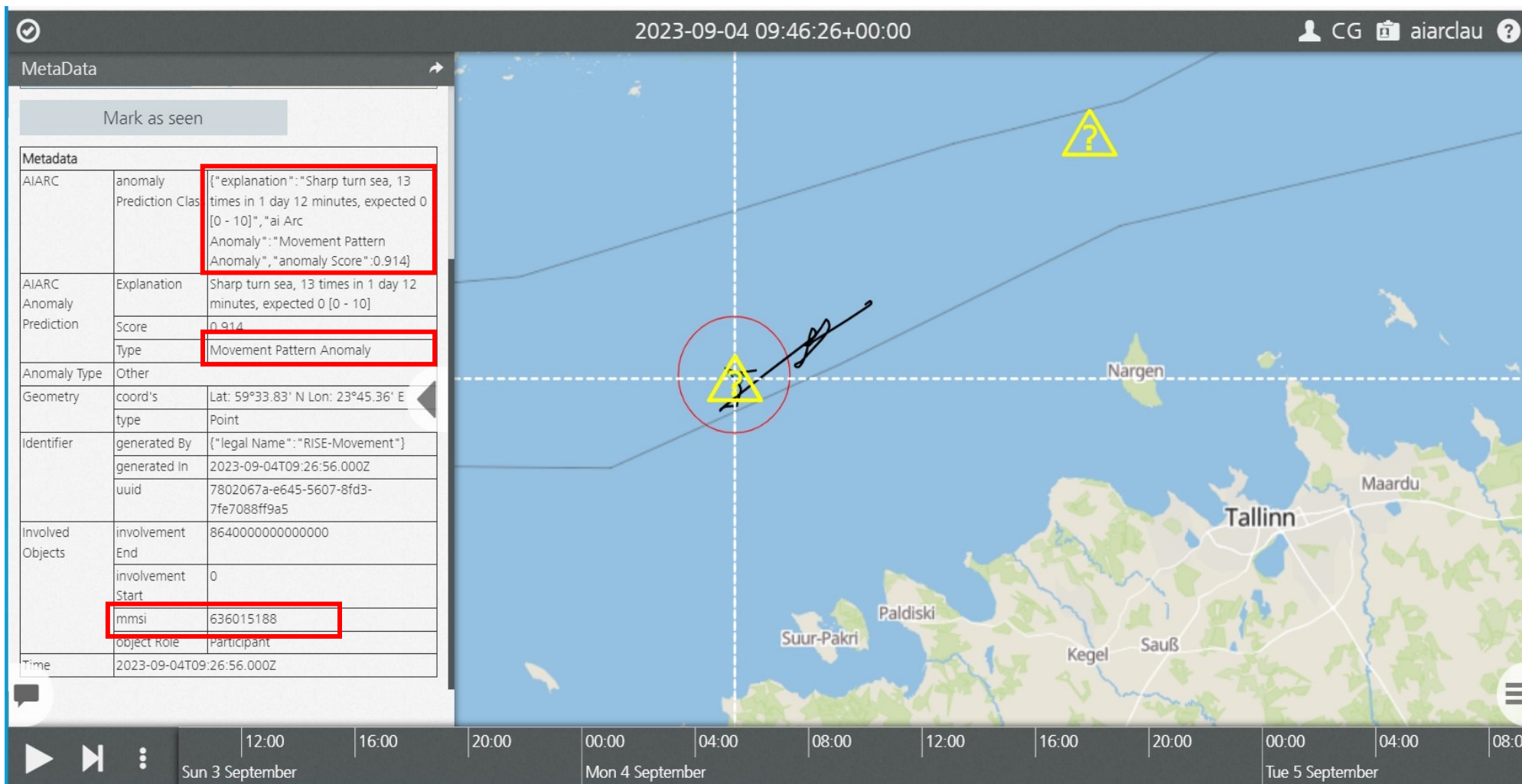
Description
Satellite image

◀ 1/1 ▶





Automatic Movement pattern anomaly

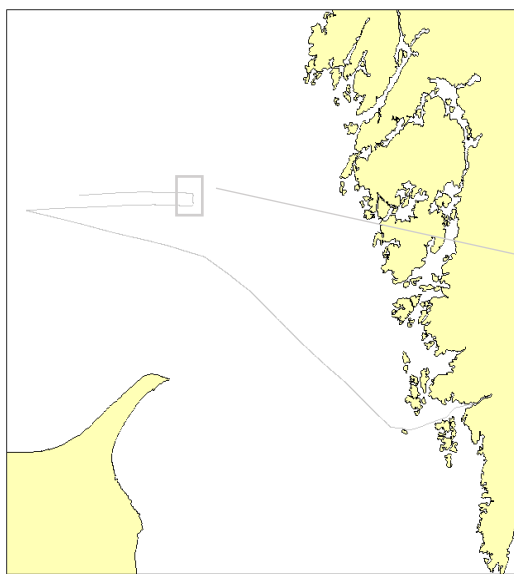


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101021271

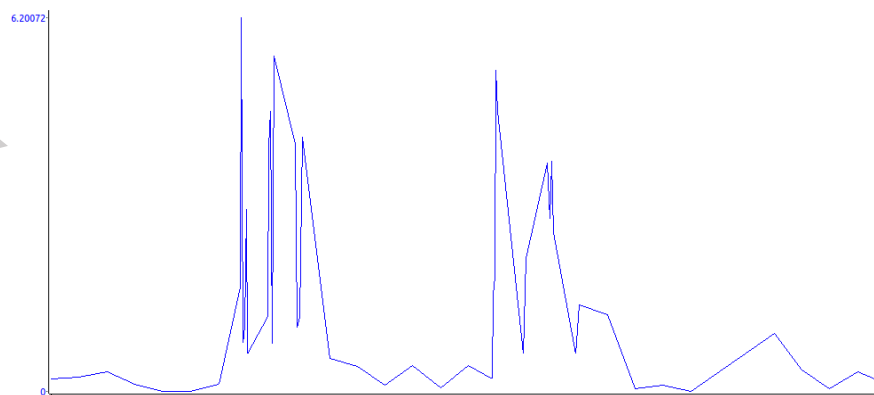


“Sharp turn” vessel detection

- The Sharp Turn detector looks for movement patterns that are characteristic of tank cleaning manoeuvres
- Turning at high speed in a pulsing manner, flushes water back and forth through the tank



Typical track of tank cleaning



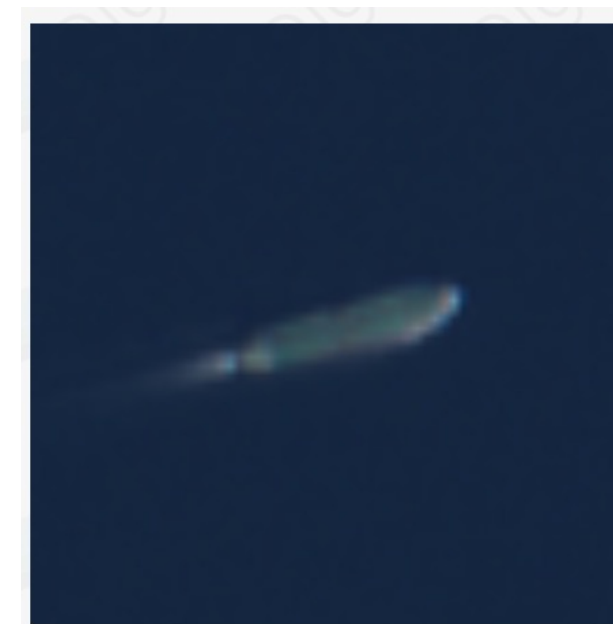
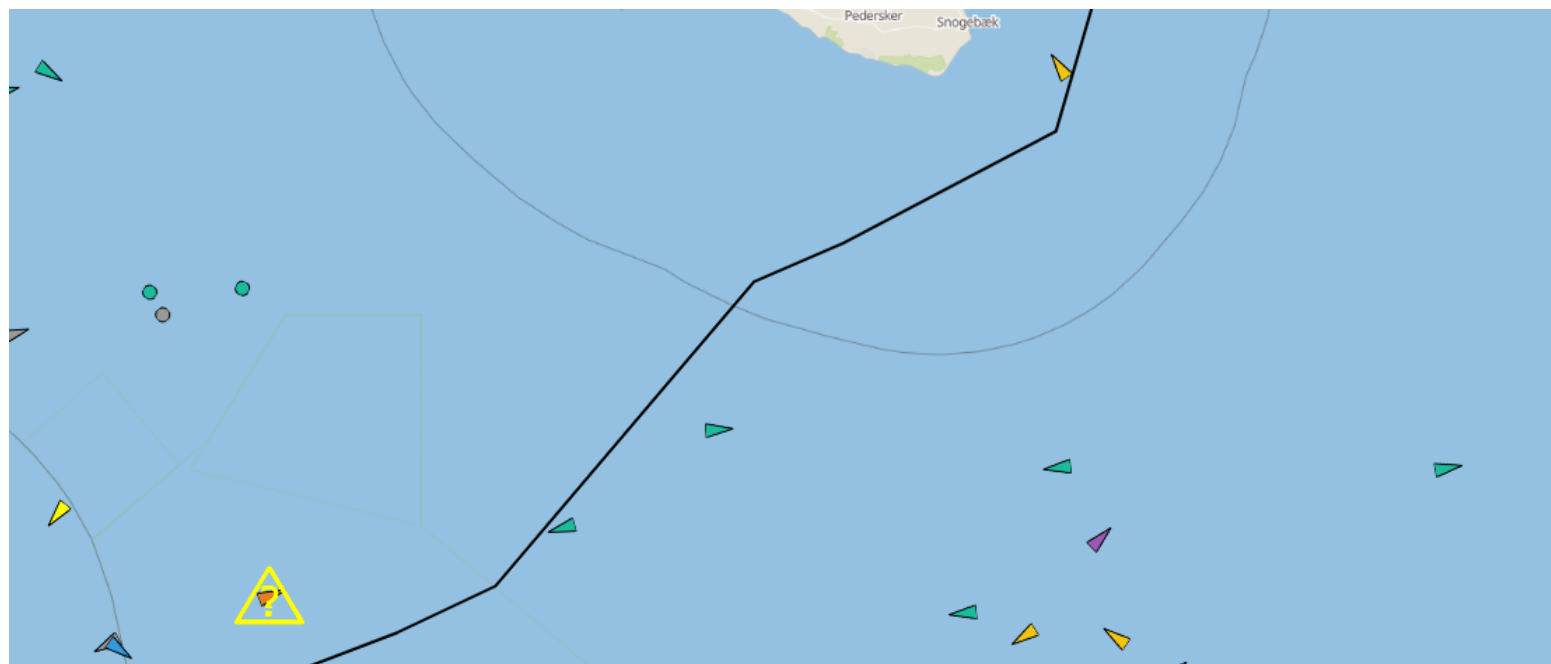
Centripetal force on vessel during turn





Dark vessels can be automatically detected near critical infrastructure

- A dark Vessel is detected (no AIS - Automatic Identification Signal)
- Anomaly alarm if a dark vessel is near critical infrastructure





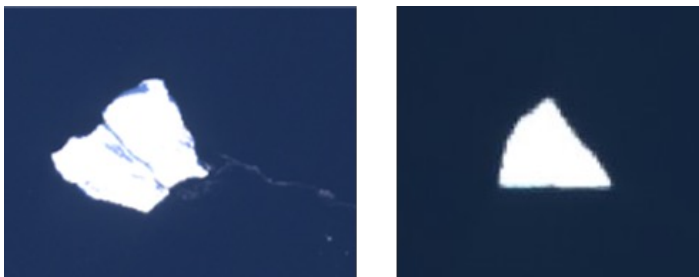
Satellite-Based Vessel and Iceberg Detection

On optical satellite images

Vessels

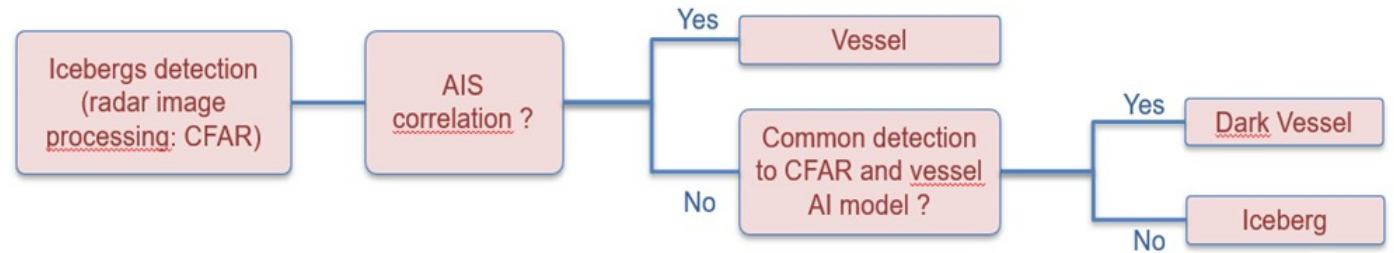


Icebergs

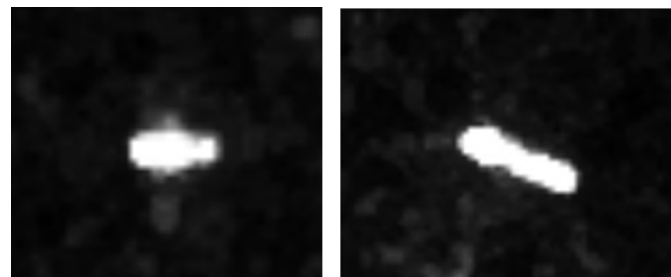


On radar satellite images

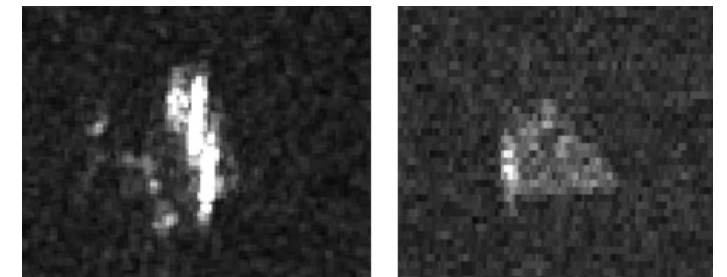
Vessels / Icebergs discrimination on radar images



Vessels



Icebergs





Use case overview – Disco Bay Greenland

Icebergs and vessels detections from radar satellite images:

Sentinel-1:

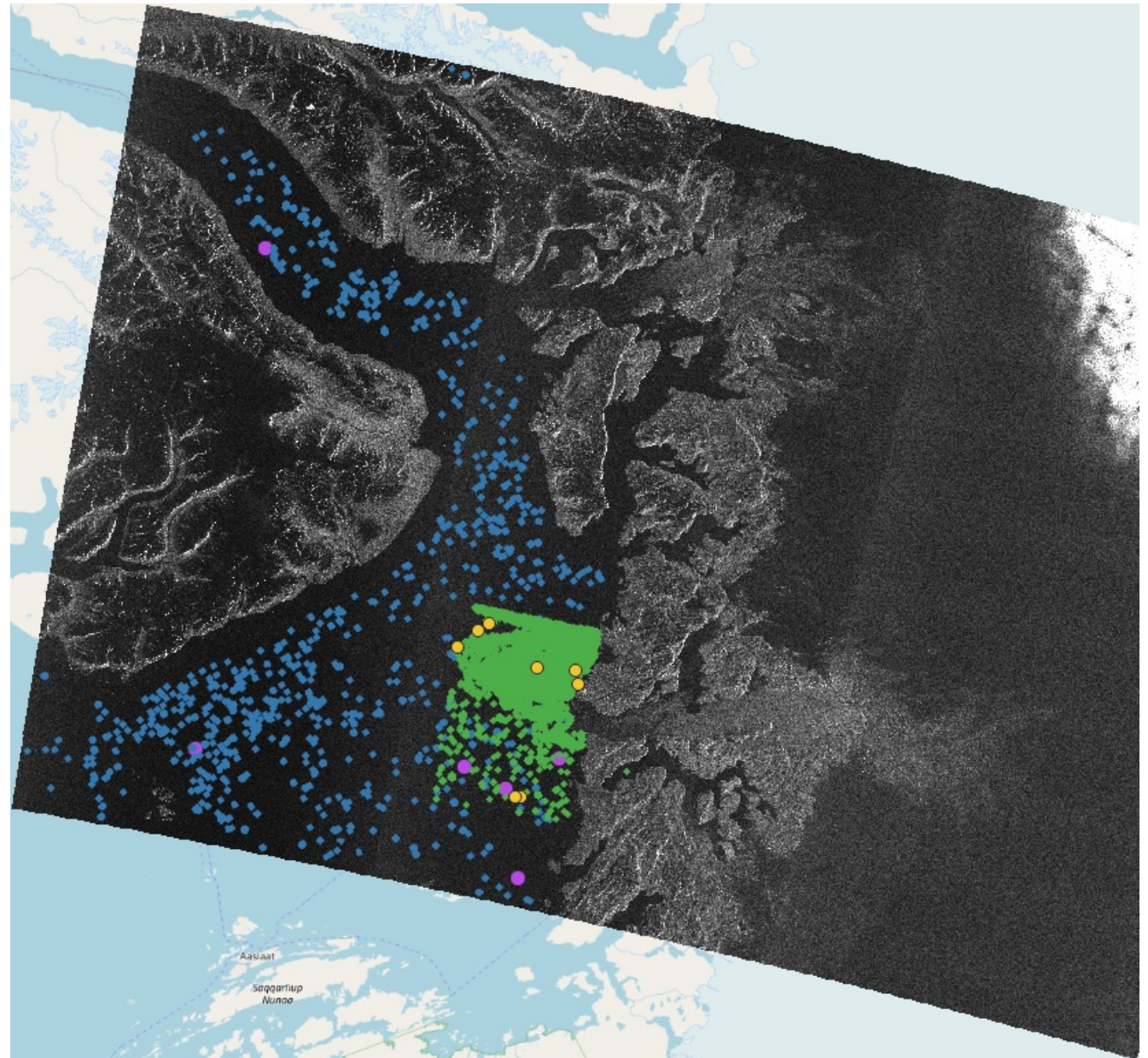
- Resolution: 10m
- Acquisition: 2023/07/04 at 10:00

Cosmo-SkyMed (CSK):

- Resolution: 3m
- Acquisition: 2023/07/04 at 21:41

AIS data: icebergs / vessels discrimination and dark vessel identification

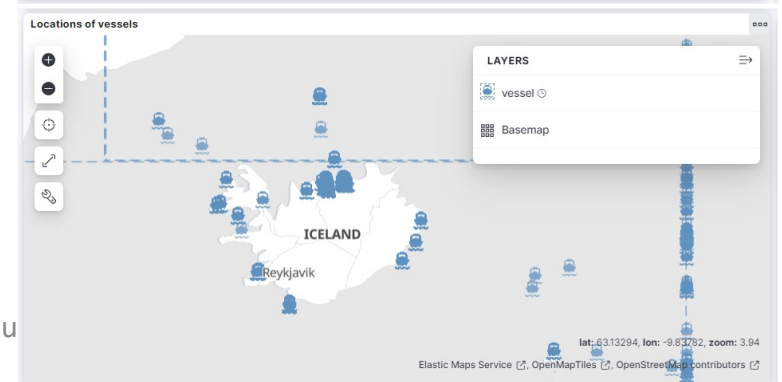
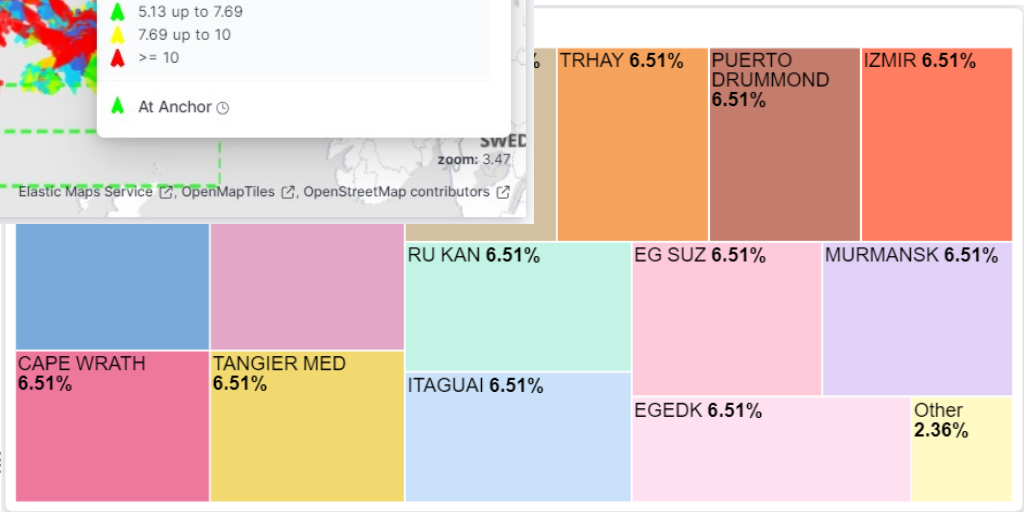
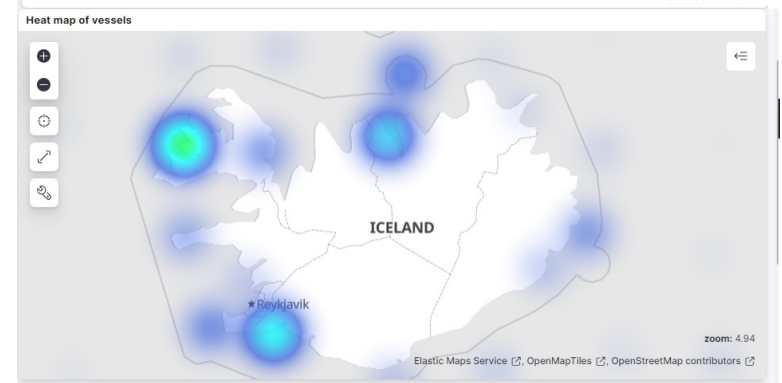
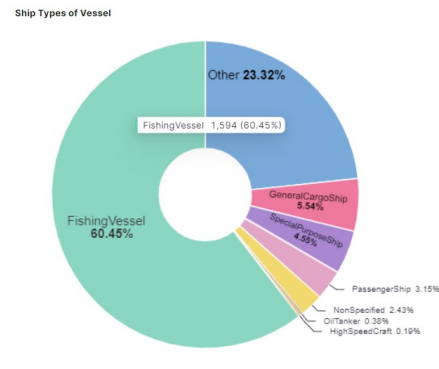
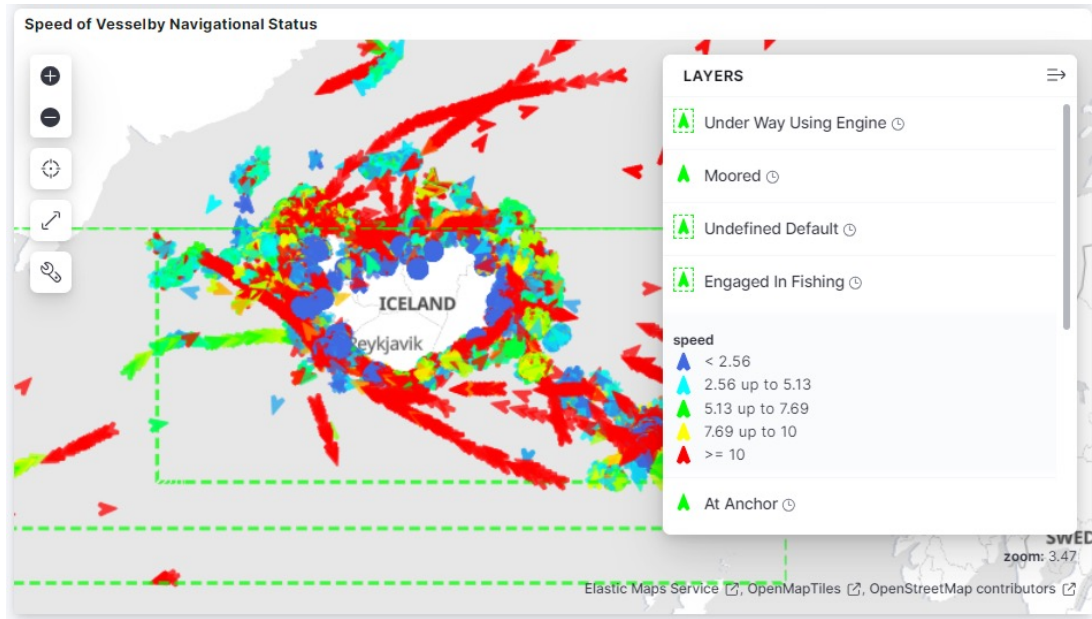
- ◻ Iceberg detections from Sentinel-1
- ◻ Iceberg detections from CSK
- Vessel detections from Sentinel-1
- Vessel detections from CSK





Big Data Analytics & Visualization service for VCR

The tool allows AI-ARC end-users to create dashboards of widgets like pie/bar charts, line graphs and heatmaps over geospatial data at the same like.



This project has received funding

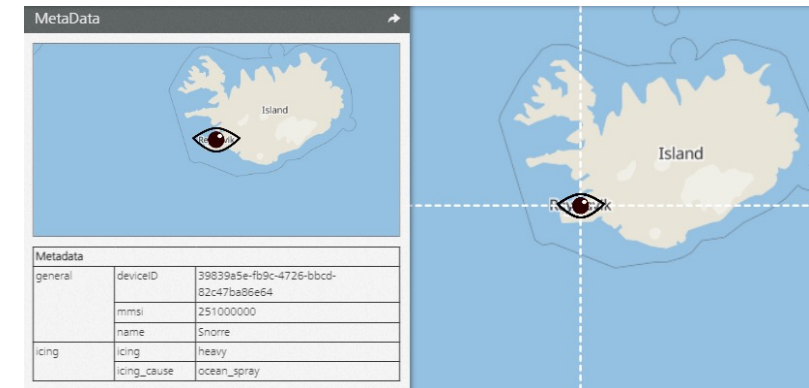


In-Situ Observations

- Report observations with respect to weather, sea status, icing, environmental observations, navigational hazards, etc.
- Additional information might be helpful to Coast Guards and other seafarers to further analyze the situation and get a better understanding
- Observations are displayed on a VCR map (text, photo, video – also online)

The screenshots show the 'New Observation' form with the following fields:

- Date & Time: 2023.09.13 07:11:34
- Latitude: 49°00.43' N
- Longitude: 08°25.45' E
- Sea Status: Rough 2.5-4.0 m
- Sea Temperature: 3 °C
- Sea Ice: None
- Sea Direction: 68
- Icing Report: Light Water-Spray Vessel Icing, Rate > 0.1 - 0...
- Icing Cause: Ocean Spray
- Own Vessel Direction: [empty]
- Own Vessel Speed: [empty] kts





The added value of the Virtual Control Room (VCR)

The VCR creates a new automated maritime anomaly services toolbox that:

- Improves situational awareness and decision-making
- Promotes regional LEA cooperation i.e. coordinated response
- Limitless awareness sharing (public-private)
- Increases communication and effectiveness between maritime security actors
- Reduces the risk of sub-marine attacks due to better awareness
- Sustainable approach: new solutions/anomaly services seamless development and it opens industry participation with new services





VIGIMARE

Vigilant Maritime Surveillance of Critical Submarine Infrastructure

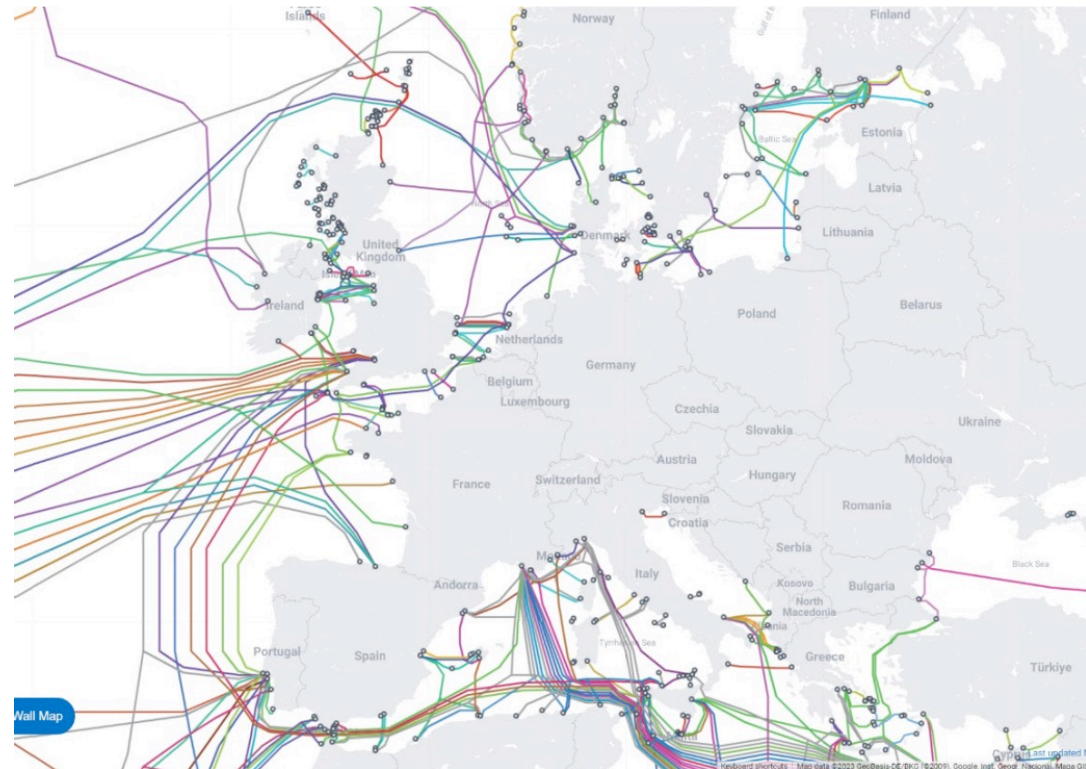
New project Starting September 2024

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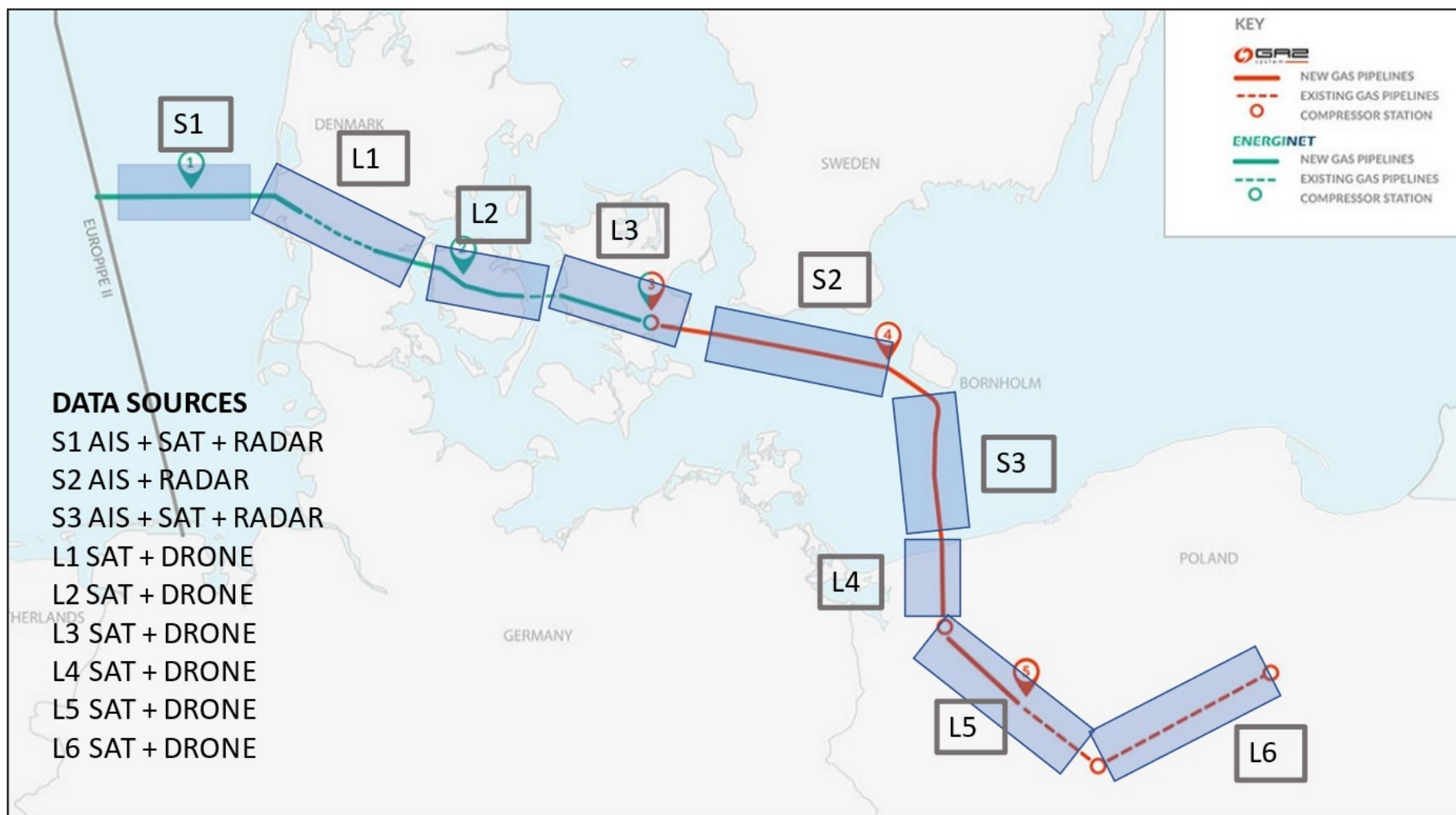
Overview of the new VIGIMARE Project

- The European submarine network is a vital Critical Infrastructure for the EU member states, and any failure or damage to it could potentially have an enormous effect on the societies in the EU member states.
- Due to the rapidly evolving threat and geopolitical landscape, especially with incidents like the sabotage of the Nord Stream 1 and 2 gas infrastructure, organizations overseeing Critical Infrastructure face significant challenges.
- The EU Submarine network includes telecommunication cables, gas pipelines, and power cables.
- As the gas pipeline network runs both offshore and onshore, the project will also expand its situational awareness to the onshore pipelines, in order to build a comprehensive solution for the Critical Infrastructure Operators.





The Baltic Pipe example – data for anomaly detection (Radar, AIS, DAS, SAT, Drone etc.)





VIGIMARE Objectives

1. Provide an information sharing environment to the Critical Infrastructure Owners (CIO) against threats to the EU submarine Critical Infrastructure
2. Increase the resilience of CIOs against physical, cyber and hybrid threats by implementing risk preventing and risk reducing measures
3. Strengthen the situational awareness of European maritime areas, both offshore and onshore, in order to recognize physical, cyber and hybrid attacks and incidents (both man-made and natural) for both CIOs and the member states, enabling better planning of the response and repairs.
4. Support the EU member states to fulfil CER and NIS-2 directives' requirements.



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