

## Artificial Intelligence-Based Virtual Control Room for the ARCtic

A Suite of Services for Mariners, SAR and Emergency Responders

Service Catalogue

### The Challenge

Climate change is causing Arctic ice to shrink to smaller areas in the summer season. Northern sea routes are opening for longer periods and ship traffic of all kinds is increasing – including cargo, fishing and cruise vessels. Safety and environmental risks are growing in northern waters, driving the need for increased navigational safety, shared situational awareness, and coordination between SAR and Emergency Preparedness and Response actors. Meanwhile, illegal maritime activity and threats to marine infrastructure require effective, timely countermeasures.

### **The AI-ARC Project**

- Improves situational awareness for SAR, Security & Civilian Mariners
- Increases safety of navigation
- Automatically detects suspicious activity of various kinds
- Fosters much needed Arctic cooperation e.g. oil spill response
- Increases communication and effectiveness between all maritime actors
- Improves coordination of rescue assets & ice breakers

### The AI-ARC VCR Solution

Create an innovative AI-based platform

- Using a Virtual Control Room (VCR) and Digital Map Table
- With near-real time data eg Ship AIS, weather, satellite, etc
- To provide powerful situational awareness
- For improved decision-making and safety
- For all maritime actors

## Virtual Control Room (VCR) – Supporting Decision Making

### **DigLT Map Display**

A software system for multi-user shared situation visualization and analysis with an open and modular architecture. Besides common GIS features, the DigLT offers a timeline for past, present, and future situational awareness in four dimensions. It supports smartphones, tablets, PCs, or large screens as well as a virtual reality map display that offers a fast and natural remote collaboration with a true three-dimensional display of geodata.





Devices supported by DigLT Software

## Big Data Analytics and Visualization Service

Provides big data search, analytics and visualization capabilities to present validated data and AI algorithm results, as graphs, heatmaps, etc, to help decision-makers and users of the VCR platform collaborate effectively, and for decision-support in incident management.



Sample heatmap for vessel behaviour analysis



Example of maritime situation within the DigLT

### AI-ARC Messaging System using CISE Data Model

### Kafka Messaging Service

The AI-ARC Messaging Service is configured following the standard CISE building blocks such as ontology, data model, and message structure, for future ease of integration of AI-ARC with the CISE platform. AI-ARC is currently using Kafka, an open-source distributed data communication system that enables management of a large number of operations in real time by multiple clients. The Messaging Service is run on a cluster of several servers that can span multiple data-centres or cloud regions.



### **Blue Force Tracking (BFT)**

BFT beacons provide a secure Line of Sight tactical data link capacity for platforms operated by coastguards. Beacons deployed on ships or air vehicles are acting as trust builders proposing multiple services. Positions of own assets & tracks are transmitted regularly to a coastal station in as secure manner providing a trusted maritime situational awareness of any control room. Waterproof and protected beacons are deployable on any kind of vessel down to the size of a RHIB.

### Data Acquisition and Fusion Services

Merging and verifying data from multiple sources – from vessels, actions, locations, agents or objects – to support end user services such as behaviour prediction, risk assessment, anomaly detection, visualization of analytics and decision making. Access to the fused data is provided through the Kafka platform to the different AI-ARC partners and end users for use in the various AI algorithmic and visualization services.



Tracking of BFT beacon

## Artificial Intelligence Services – for Maritime End-Users

### **Predictive Artificial Intelligence**

## Prediction of Icepack & Iceberg Movement

Prediction of icepack and ice cover situation along shipping lanes using weather information, radar, optical images and maritime traffic data. Prediction of need for icebreaker aid in an area, via ice status of shipping lanes and icebreaker movement.

Iceberg track prediction is based on using a deep neural network method to analyse historical track records from satellite images, together with weather and sea conditions.



Ice cover at Gulf of Bothnia, Baltic Sea Image courtesy of Sentinel satellite

### Vessel Traffic Prediction Service

Vessel movement prediction is carried out over both short-term and longer timeframes using a Machine-Learning approach on AIS data, that is specifically designed for rapid processing. Deviations from predictions by actual ship movements are detected; and heatmaps of historic vessel movement events are generated, over the sea area of interest.

### Search and Rescue – Wide Area Search

A service for SAR authorities to predict the drift track of a missing vessel, combined with dynamic search pattern updates to the SAR vessel bridge. Based on last known position, weather and ocean current data, combined with satellite based image recognition data. Improves coordination of SAR assets in a wide area search.



Example of a prediction (red) of a simple ship movement Eastward. The realized movement is shown in blue.



Image: Anders Martinsen

### **Anomaly Detection and Intent Recognition**

### **Vessel Behaviour**

A suite of services based on a variety of anomalydetection methods – AI, ML & deep learning – to identify misalignments, deviations and outliers in the behaviour of vessels, using their positions and trajectories.

#### **Examples of behaviour of interest**

- Deviations from vessel's usual movement pattern
- Vessels rendezvous at sea

Vessel halted over or tracking subsea infrastructure e.g. pipeline or cable

### **Environmental Emergency**

Automated detection of oil spills or other environmental emergencies based on processing Earth Observation (Satellite) data. Results are visualized in AI-ARC platform, greatly enhancing the probability of detecting unexpected phenomena.



Methane venting from damaged Nordstream pipeline. AI-ARC for detecting suspicious ship behaviour above subsea infrastructure

- Vessel with intermittent AIS signal or 'spoofing' AIS
- Illegal fishing actions: factory ship with fleet; zone breach



Example of anomaly detection: discharge of diesel to river from power station at Norilsk, Russia, May 2020

### **Safe Navigation**

### Satellite-Based Sea Ice Coverage Maps

Sea ice concentration maps are derived from CMEMS (Copernicus Maritime Environment Monitoring Service) daily data. Maps are provided via the AI-ARC system to aid safe navigation and route planning.



Example of CMEMS ice map

# Reliability Assessment of ML-Services

A service to assess AI models based on their reliability in terms of the technical aspects: transparency, performance and robustness.

### Risk Index Computation Service

Provides end users with a visual 5-level risk indication for navigation based on a multi-criteria model, dynamically updated, based on vessel data, meteorological and ocean conditions.

#### For more information

Key persons and Contact Details



**Project Coordinator** Isto Mattila isto.mattila@laurea.fi



**Project Manager** Johanna Karvonen johanna.karvonen@laurea.fi

Keep up to date with latest information on our social media and website:





