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Scenarios

Scenarios will show how land based Maritime Domain Awareness system and sensors are used to improve situational awareness and decision support tools
for operators in a Remote Operation Center for autonomous ships

massterly
a Kongsberg Wilhelmsen joint venture
KONGSBERG
SINTEF
NTNU

Scenarios in IMAT

- **Scenario 0 – Plan operation - Situational Awareness**
- Scenario 1 – Normal operation
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- **Scenario 7 – Close Quarter Detected by Infrastructure**
- Scenario 8 – Approaching harbour

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Infrastructure - Sensors - Products Used for Scenarios

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ROC – Building the Situational Awareness

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Drone sensor package

SeaAware

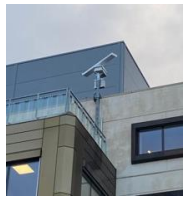
MBR

Radar1

Radar Interface

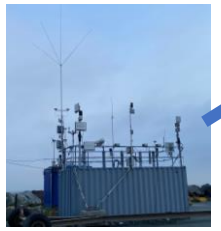
MBR

Radar2



Radar Interface

AIS

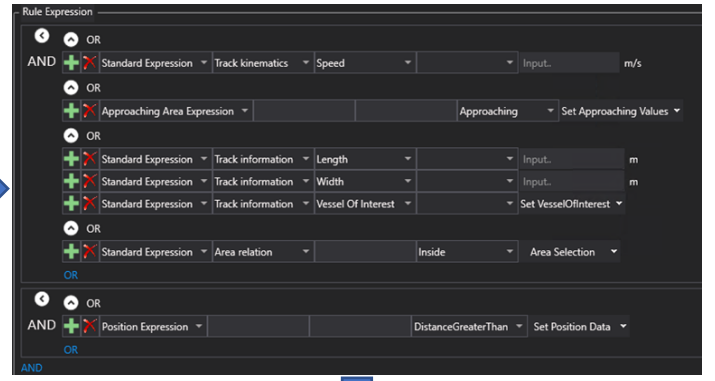


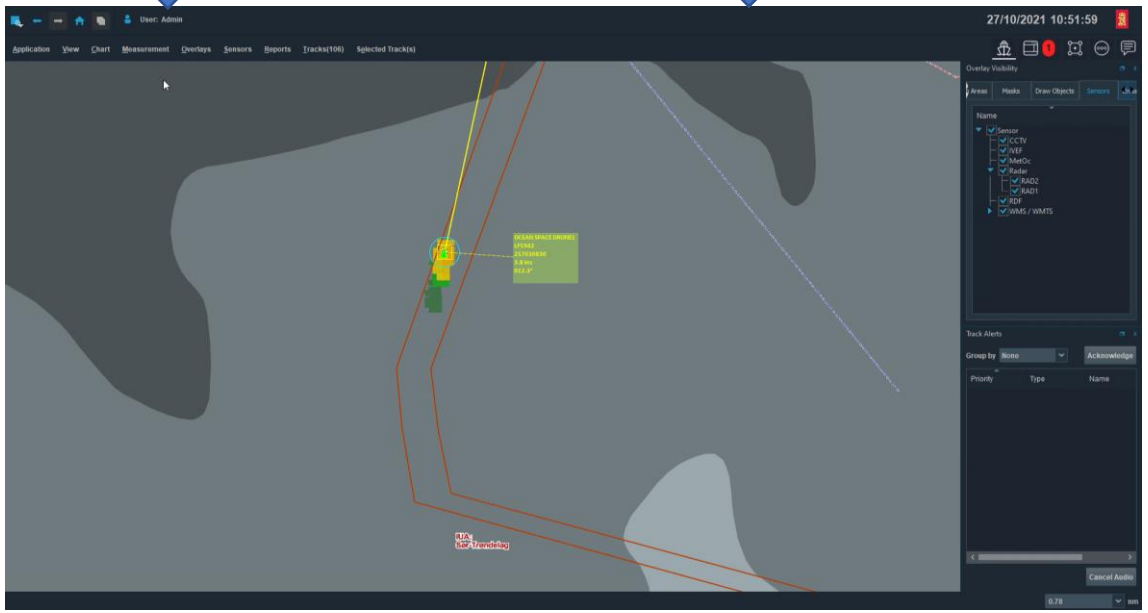
Camera

ROC

C-Scope

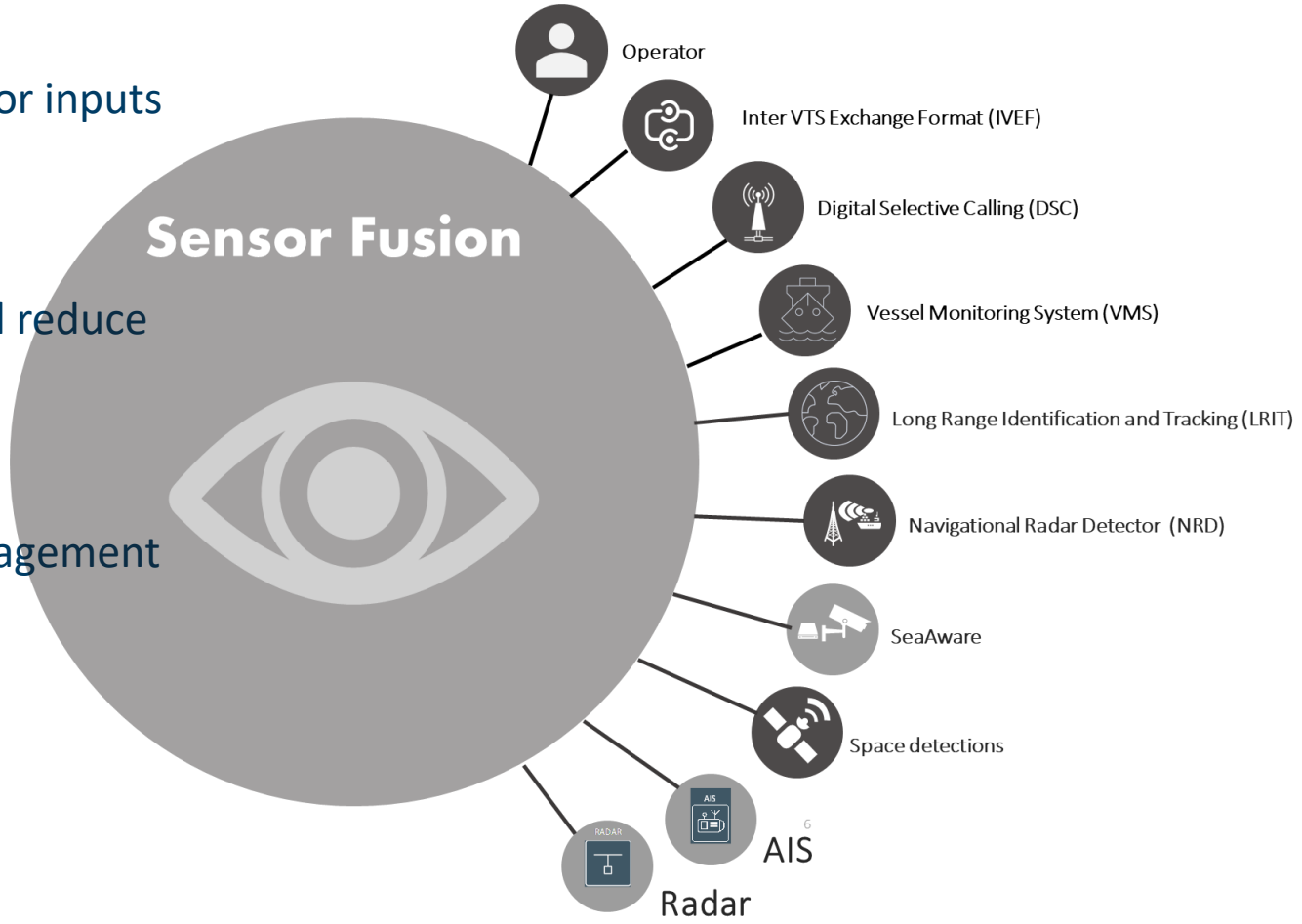
Sensor Management & Sensor Fusion





C-Scope Sensor Fusion

- Best possible situational picture based on sensor inputs
- Correlation analysis of sensor tracks
- Track fusion to utilize available information and reduce uncertainty
- Infolink
  - Updating vessel properties based on Management Information system
- High track capacity
  - Beyond 50.000 tracks

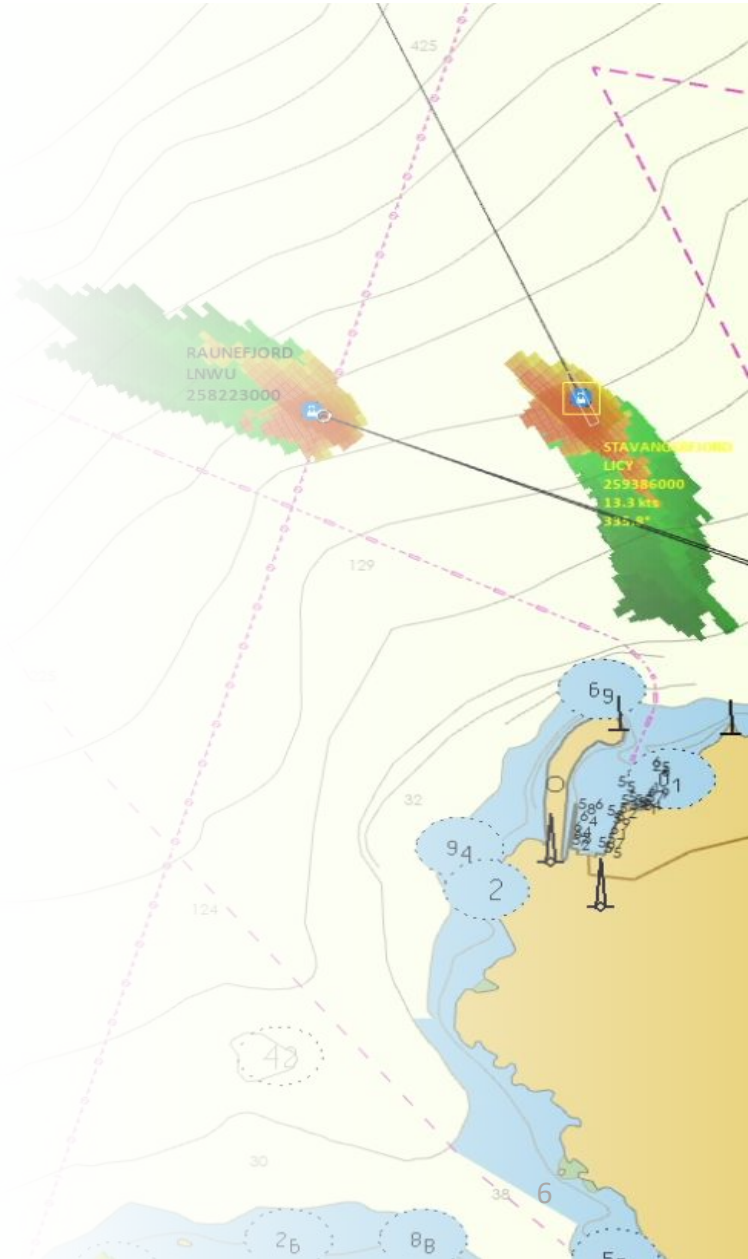


Building situational picture

C-Scope Sensor Fusion

- RADARs offer precise measurements of vessel positions.
- System owner has control of the RADARs.
- RADAR tracking offers calculation of position, speed and course, and the uncertainties of these.
- The uncertainty of a track's properties are based on the RADAR's measurement uncertainty in azimuth and range, and the how the track behaves over time.
- The track's uncertainty is expressed as the quality of the track. Less uncertainty gives higher quality.

- AIS is a collaborative system that has the capability to offer great accuracy and low uncertainty of a vessel's position, course and speed.
- AIS offers identification of vessels.



Decision Support

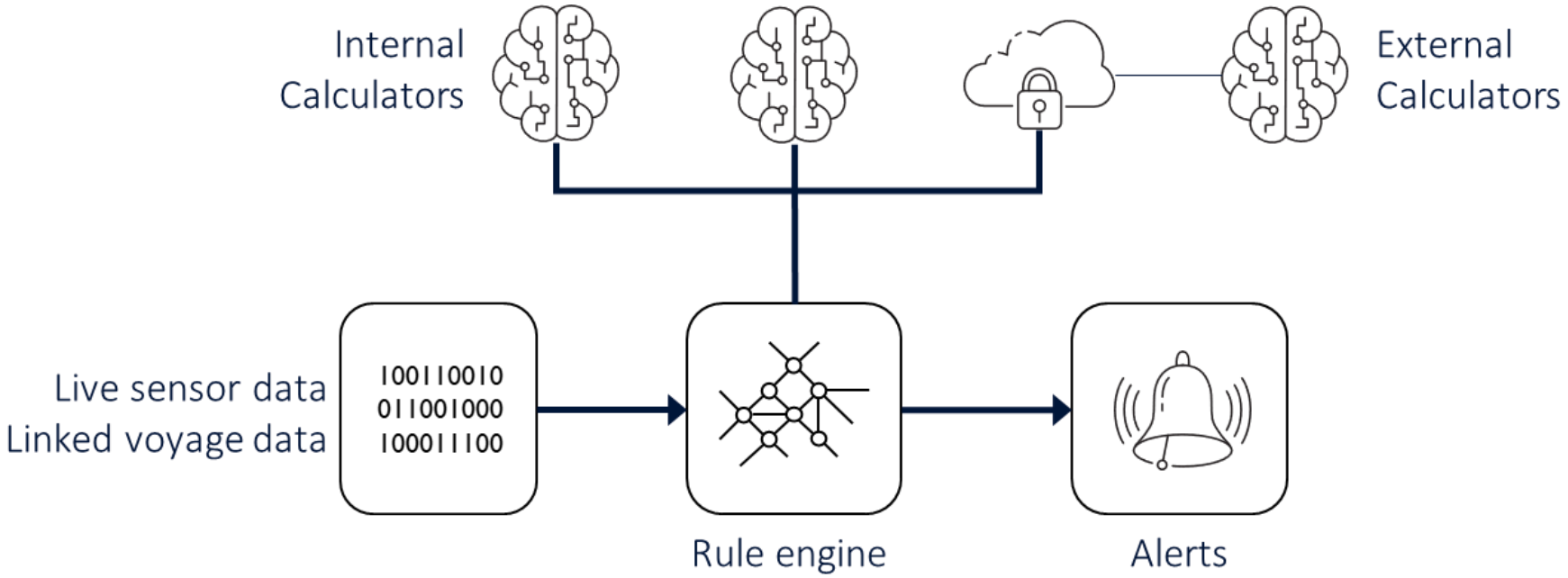
Alert service for automatic monitoring traffic situations

- Next generation automatic traffic situation monitoring
  - A move from static to dynamic rule library
  - Allows for monitoring local legislation
  - Support a large number vessels
- Specialized for meeting changing needs
  - Able to run hundreds of user defined rules
  - Highly configurable to meet specific operational needs
  - Rules can be defined using logical expressions containing
    - Geographic areas
    - Vessel information from RADAR, AIS, databases and more
    - Results from advanced algorithms detecting collision, grounding, COLREGS violation and more

Decision Support

Alert service for automatic monitoring traffic situations

- Supports integration of 3rd party solutions:
  - Plug-in design that facilitates testing out new algorithms. E.g. from research projects.
  - Advanced calculations for situation detection from local suppliers
  - Reporting to external systems like national databases or notification services



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Scenarios in IMAT

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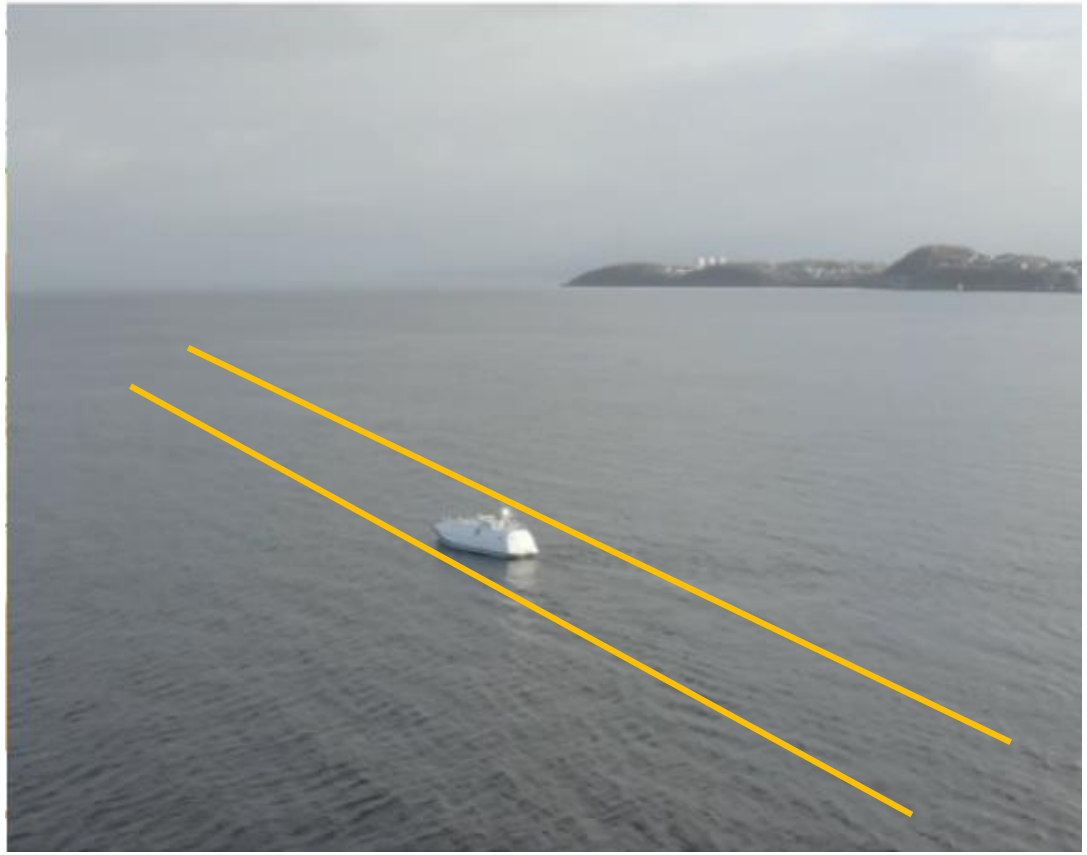
Motivation

Example case:

A vessel is sailing autonomously within a given route.

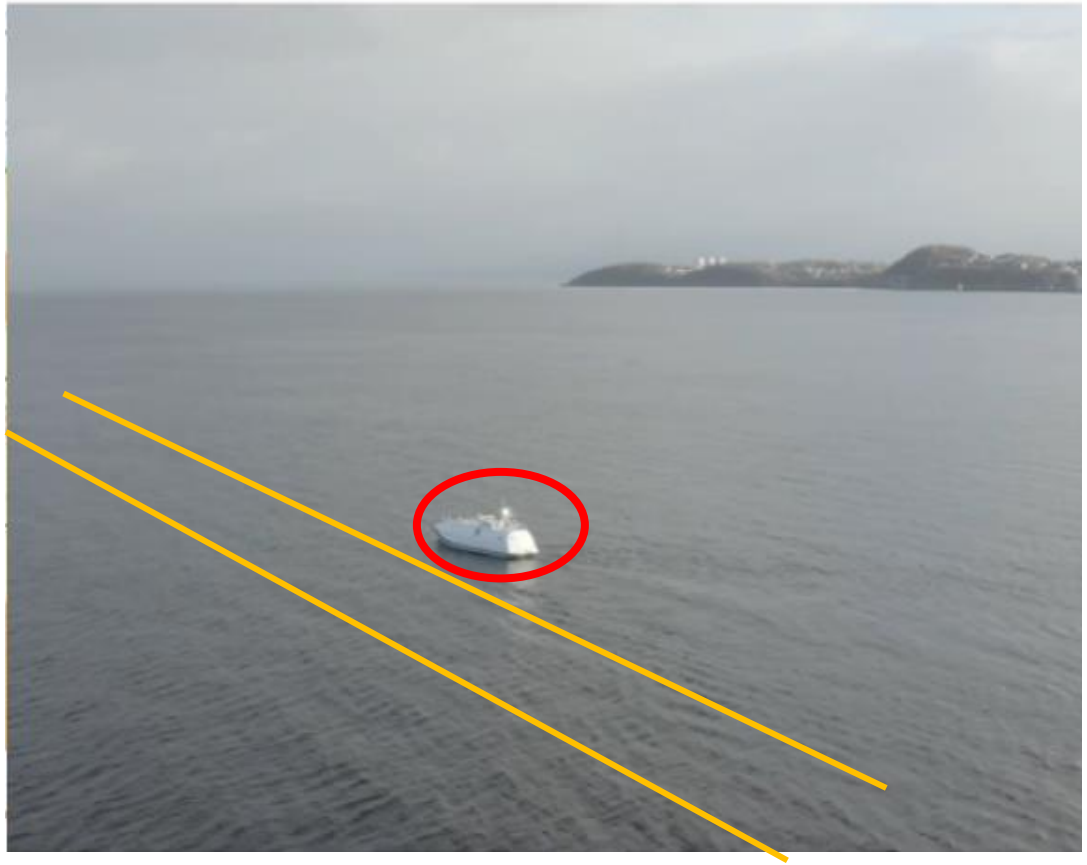


ROC

Motivation

Example case:

A vessel is sailing autonomously within a given route.



ROC

What happens if the vessel deviates from planned route?

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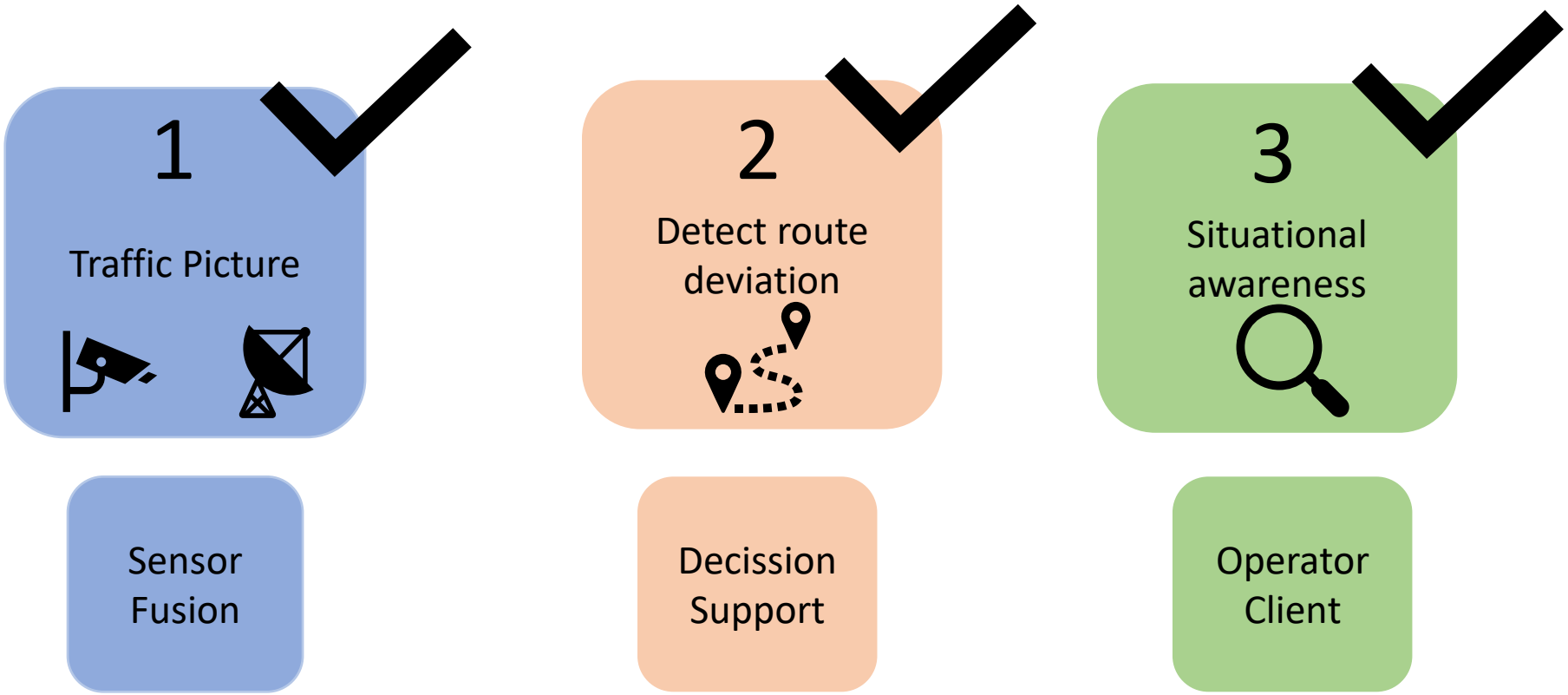
Process



Demonstration

- Goal: verify route deviation based on land-based infrastructure and algorithms in C-scope

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Verify technical infrastructure availabilty

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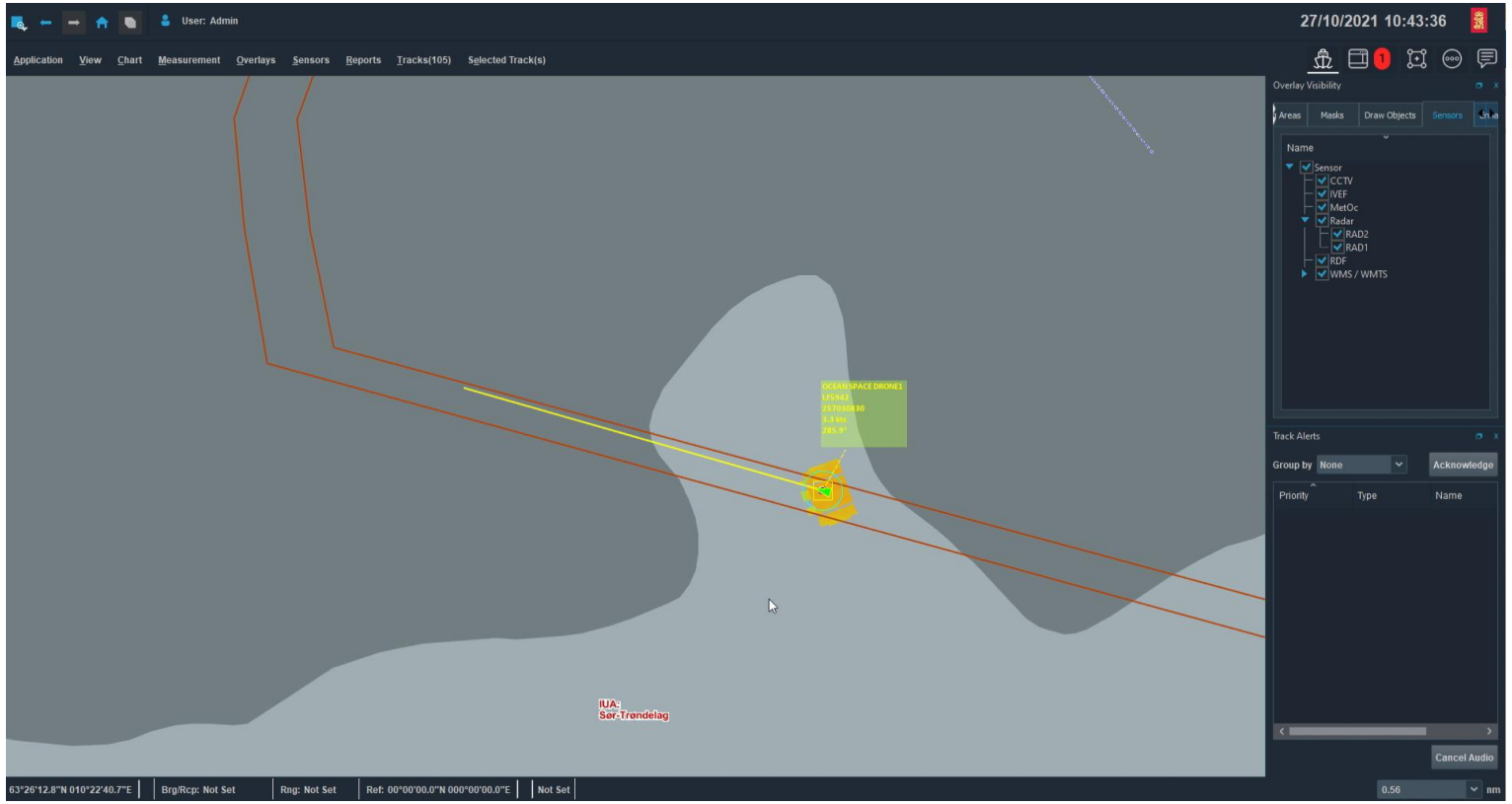
C-Scope



Track Portrayal

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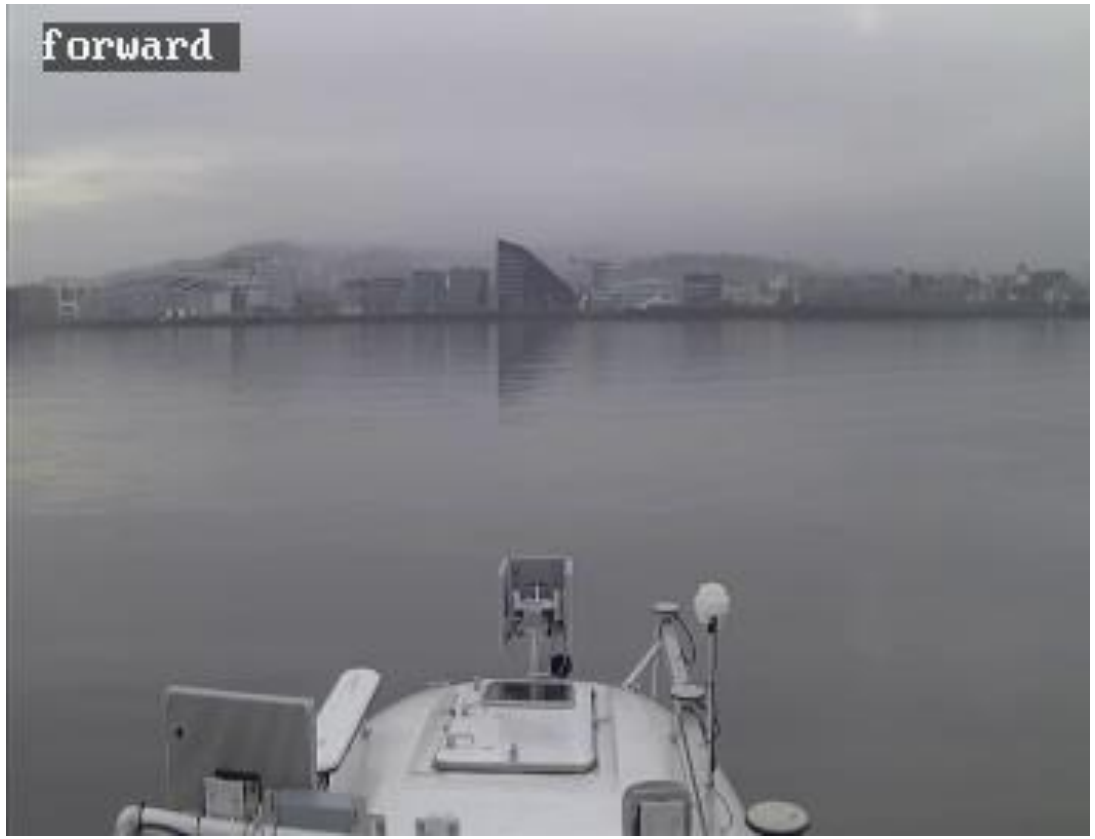
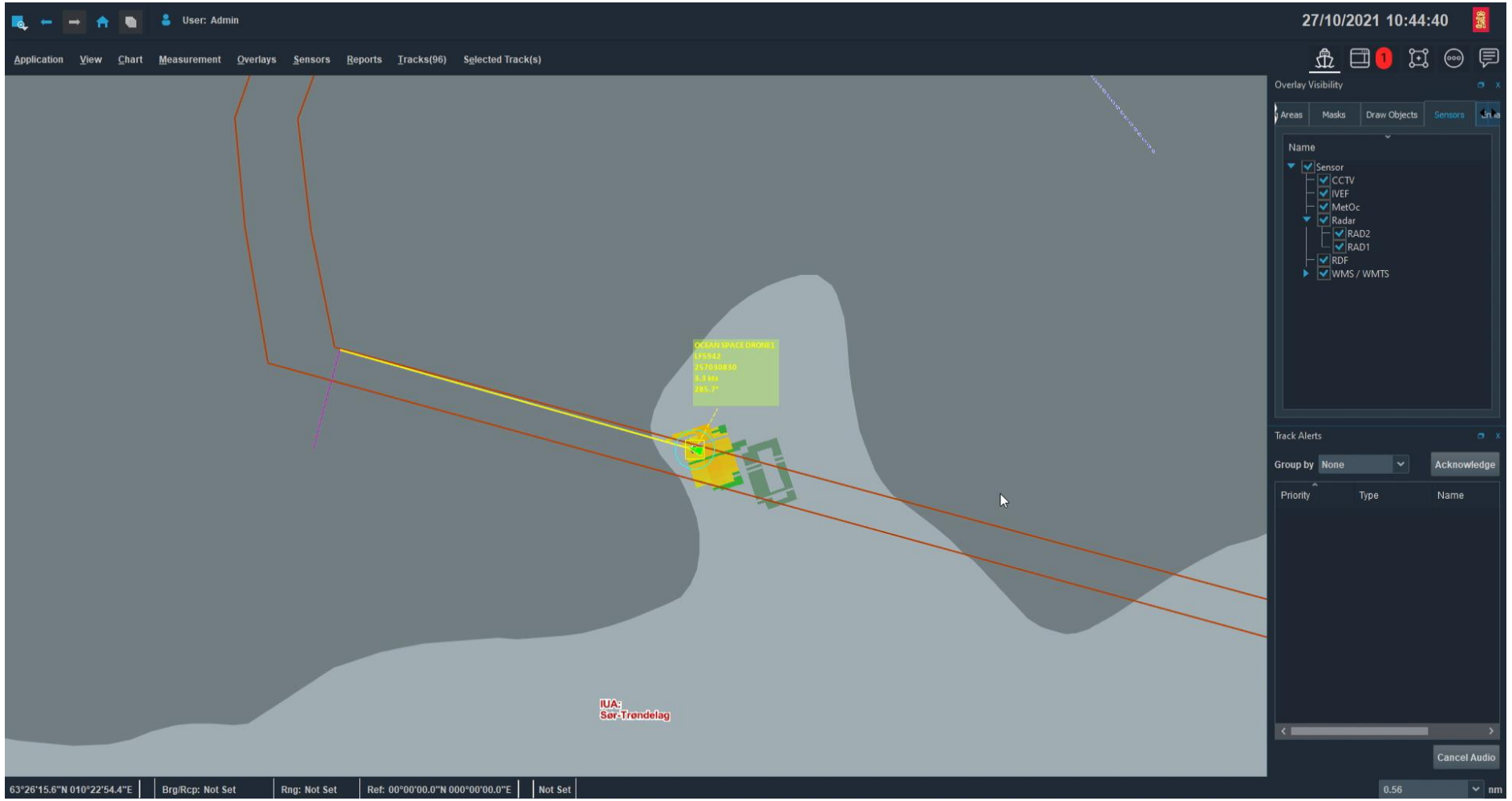
Verify video stream from vessel in ROC



Verify that vessel is following route

C-Scope

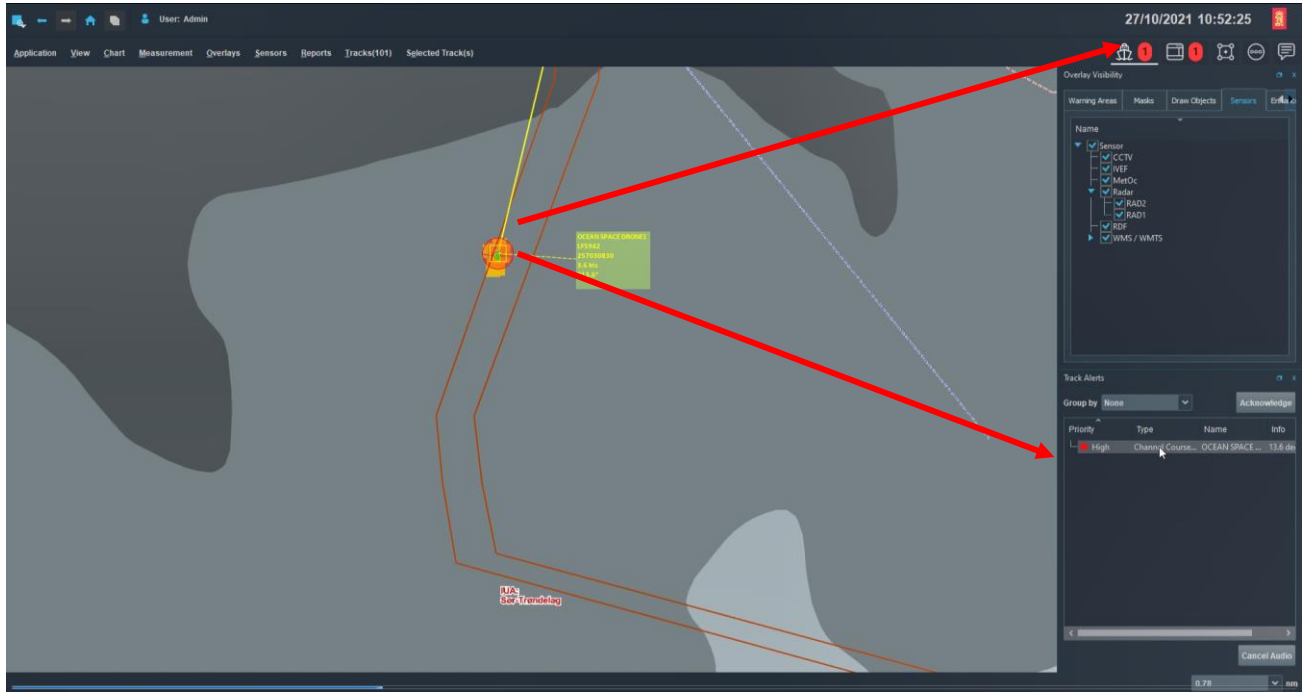


Alert the operator if anomalies are detected

Verify that the vessel continues operation on track after warning is off

1

Drone is outside route -> Warning



2

Drone goes back to the route

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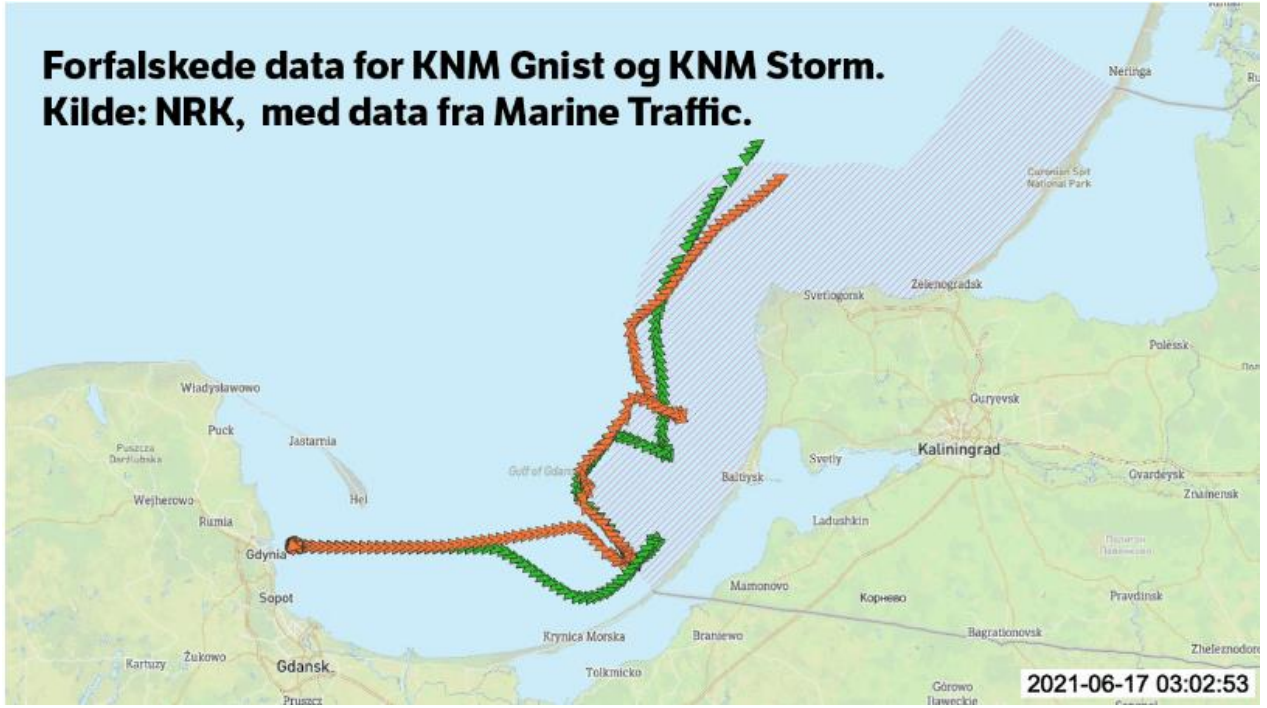
25. SEPTEMBER 2021 – 64 KOMMENTARER

Norske marineskip ble manipulert inn i russisk farvann

Det siste året har et mysterium utspilt seg til sjøs: På uforklarlig vis har krigsskip fra Norge og en rekke andre Nato-land tilsynelatende seilt i russisk farvann.



https://nrkbeta.no/2021/09/25/norske-marineskip-ble-manipulert-inn-i-russisk-farvann/

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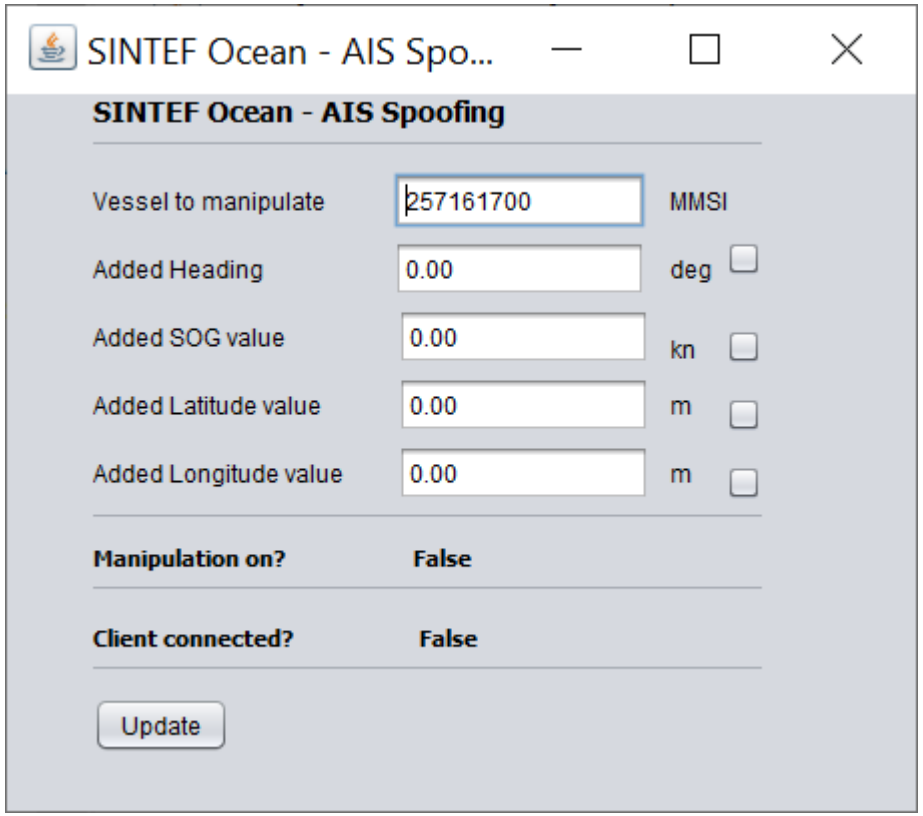
*Can use of **land-based surveillance systems and sensor infrastructure** increase **safety** and **efficiency** for navigation at sea?*

AIS spoofing

Program to introduce real time changes in the vessel AIS position - spoofing



Scenario 4a – Subject to AIS spoofing

Outside radar coverage

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Drone sensor package

SeaAware

MBR

Radar1

Radar Interface

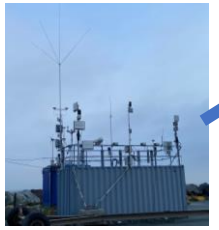
MBR

Radar2

Radar Interface

Spoofer

AIS

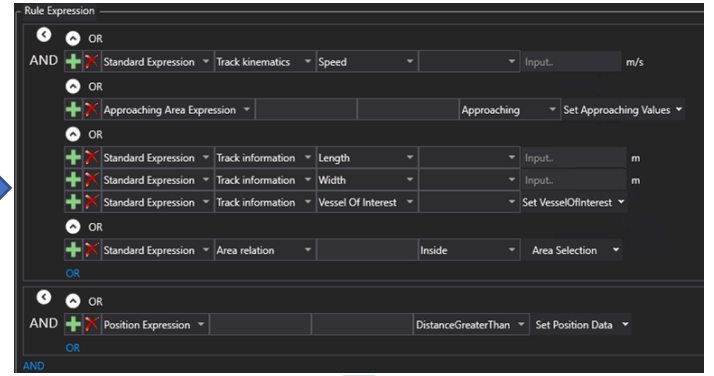


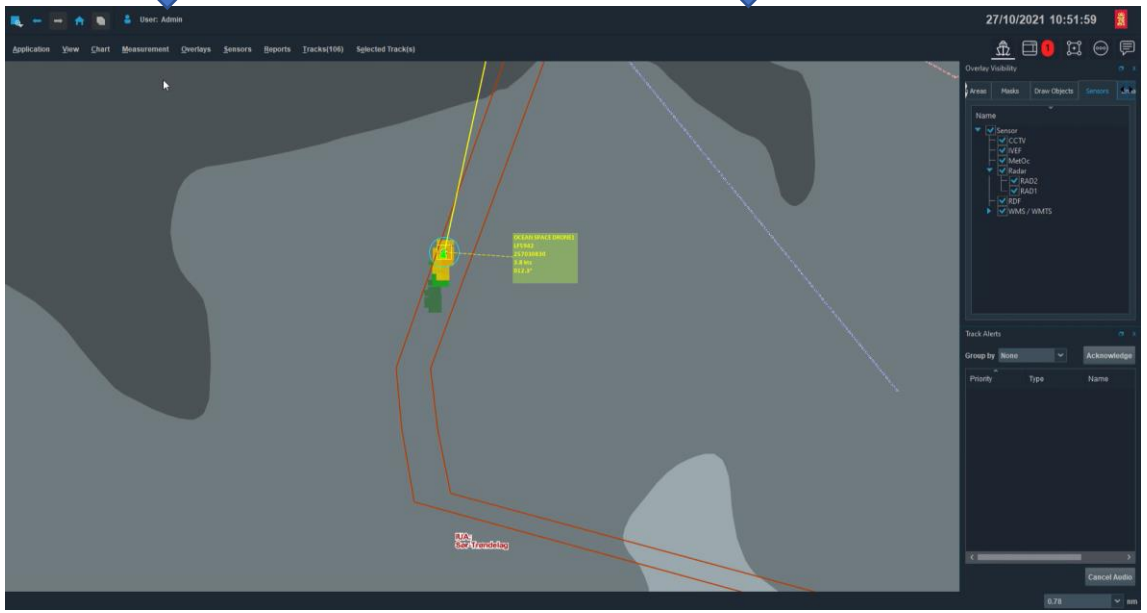
Camera

ROC

C-Scope

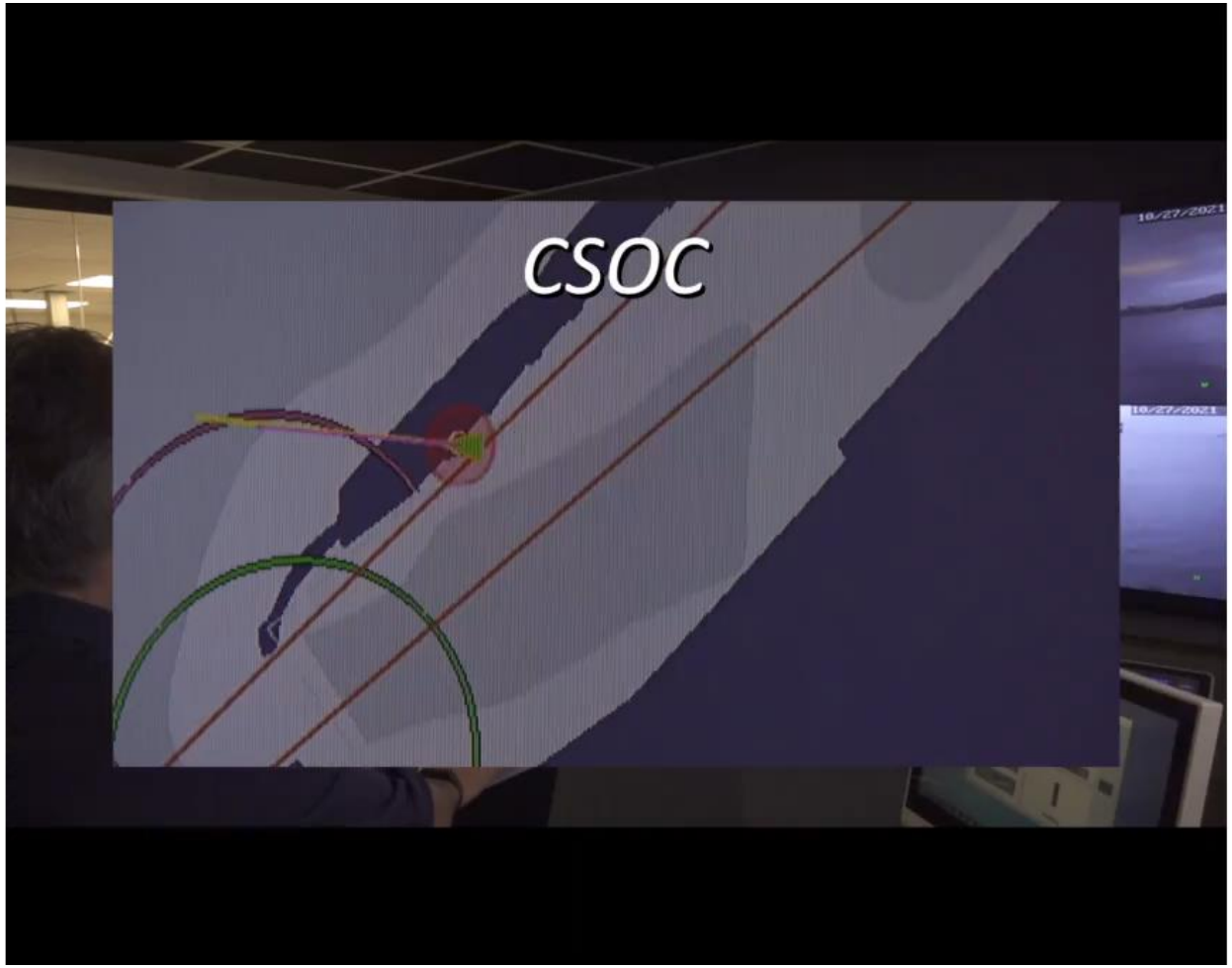
Sensor Management & Sensor Fusion





Scenario 4a – Subject to AIS spoofing

Outside radar coverage



Scenario 4b – Detect spoofing in AIS

Inside radar coverage

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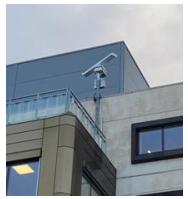
Drone sensor package

SeaAware

Radar1

Radar Interface

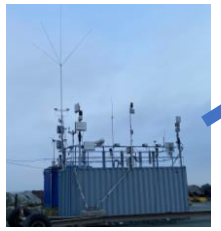
Radar2



Radar Interface

Spoofer

AIS



Camera

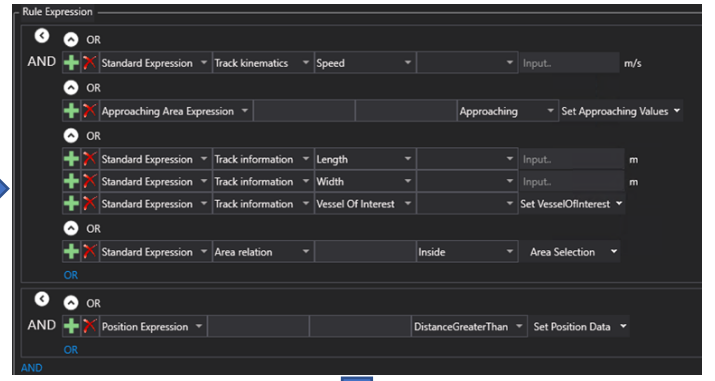
MBR

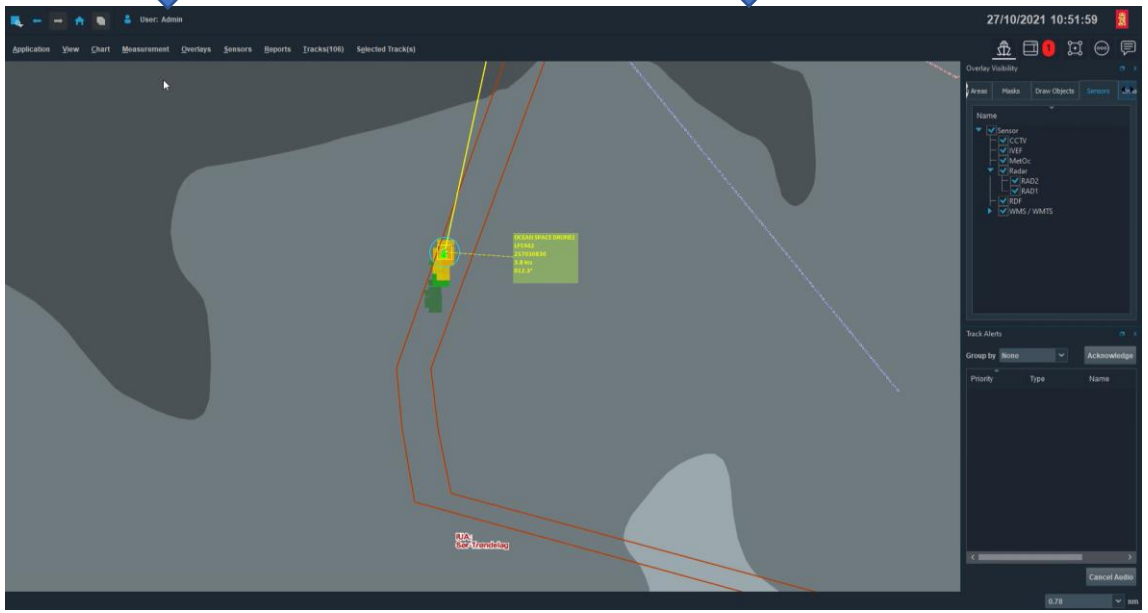
MBR

ROC

C-Scope

Sensor Management & Sensor Fusion





Scenario 4b – Detect spoofing in AIS

Inside radar coverage

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Scenario 4b – Detect spoofing in AIS

Inside radar coverage

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C-Scope

- Verify that C-Scope identifies the mismatch between AIS signals and radar
- Spoofed AIS message is ignored in C-Scope since there is a mismatch between AIS and the radars
- Land based infrastructure ensure continued safe operation

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Motivation

Example case:

Autonomous vessel is being monitored from a ROC.

ROC

How can the ROC operators early detect possible collisions?

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Method/Process

1
Situational awareness

2
Predict traffic

3
Detect close quarter

Infrastructure -> situational awareness

1
Situational awareness

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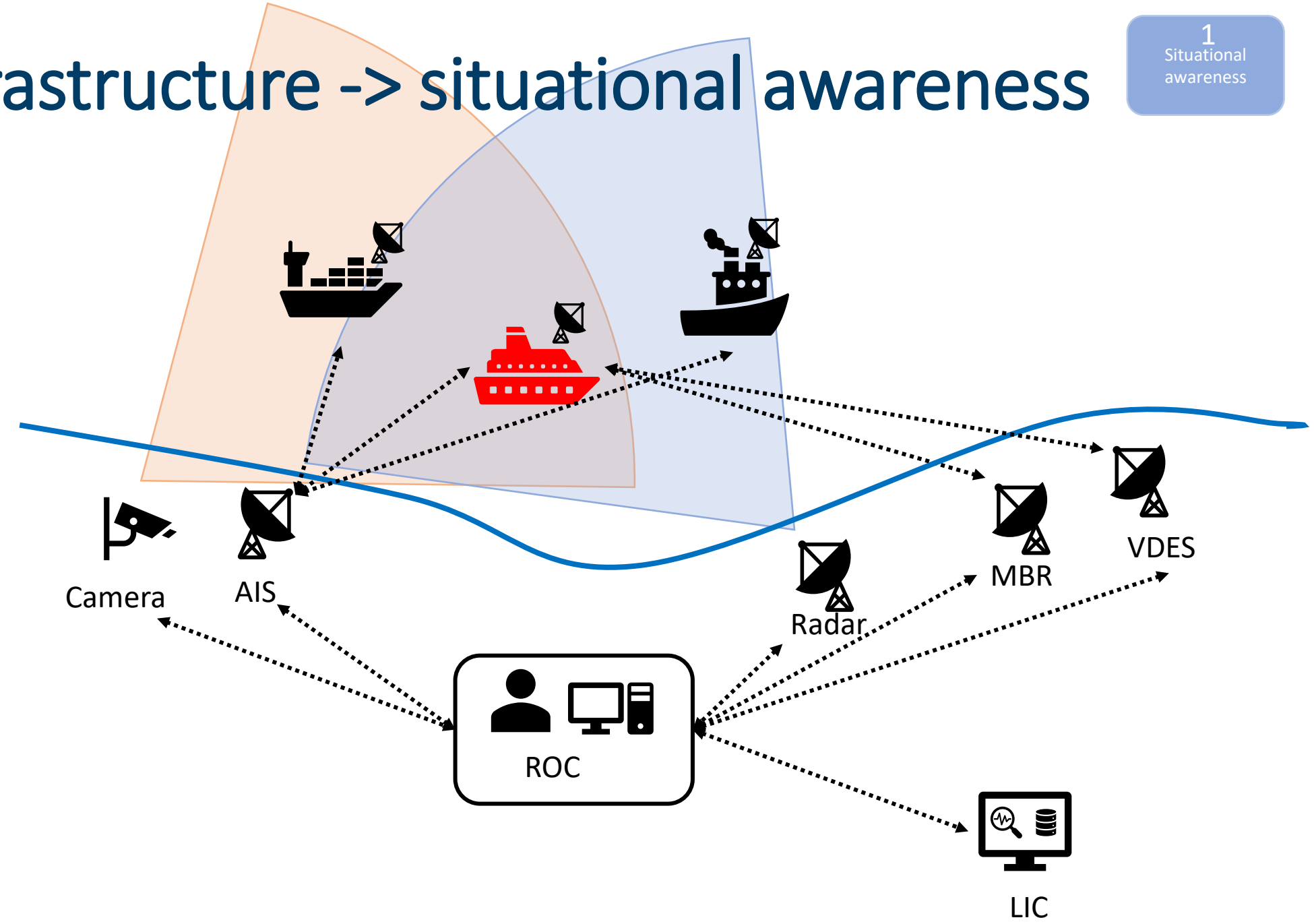

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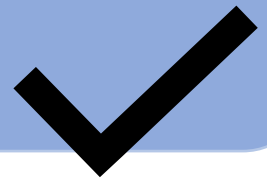
Method/Process

1
Situational awareness

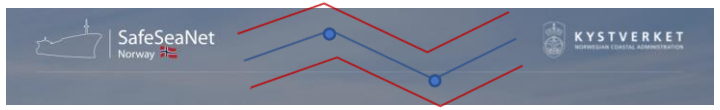


2
Predict traffic

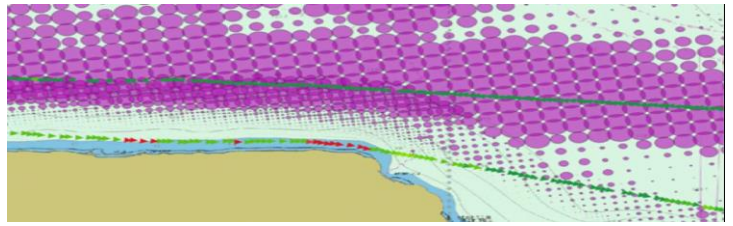
3
Detect close quarter

How is traffic predicted using C-Scope?

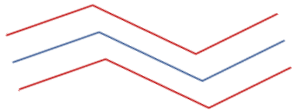
- Automatic surveilance assignments
- Using sailing plan (if available)
- Sailing plan options:
  - Received from nav/bridge system (or national singel window)

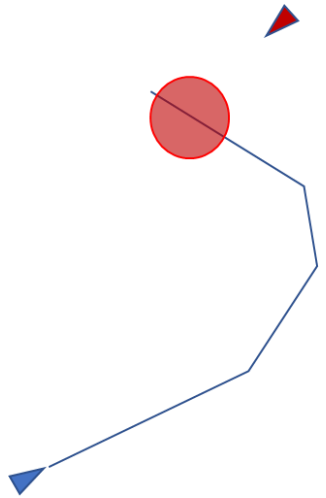


  - Calculated median-route (big data)

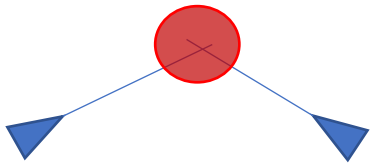


  - Manual assigned route template





- Linear prediction if no sailing plan



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Method/Process

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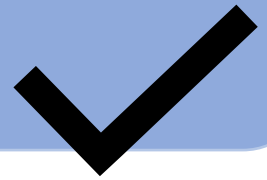
Situational awareness



2
Predict traffic

3
Detect close quarter

How is close quarter detected in C-Scope?

3
Detect close quarter

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- Rule-based CPA/TCPA parameter settings
  - Criteria examples : vessel type, dimention, day/night

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Method/Process

1
Situational awareness

2
Predict traffic

3
Detect close quarter

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Demonstration

- Simulate a close quarter (possible collision)
- See if C-Scope alerts operator of close quarter.

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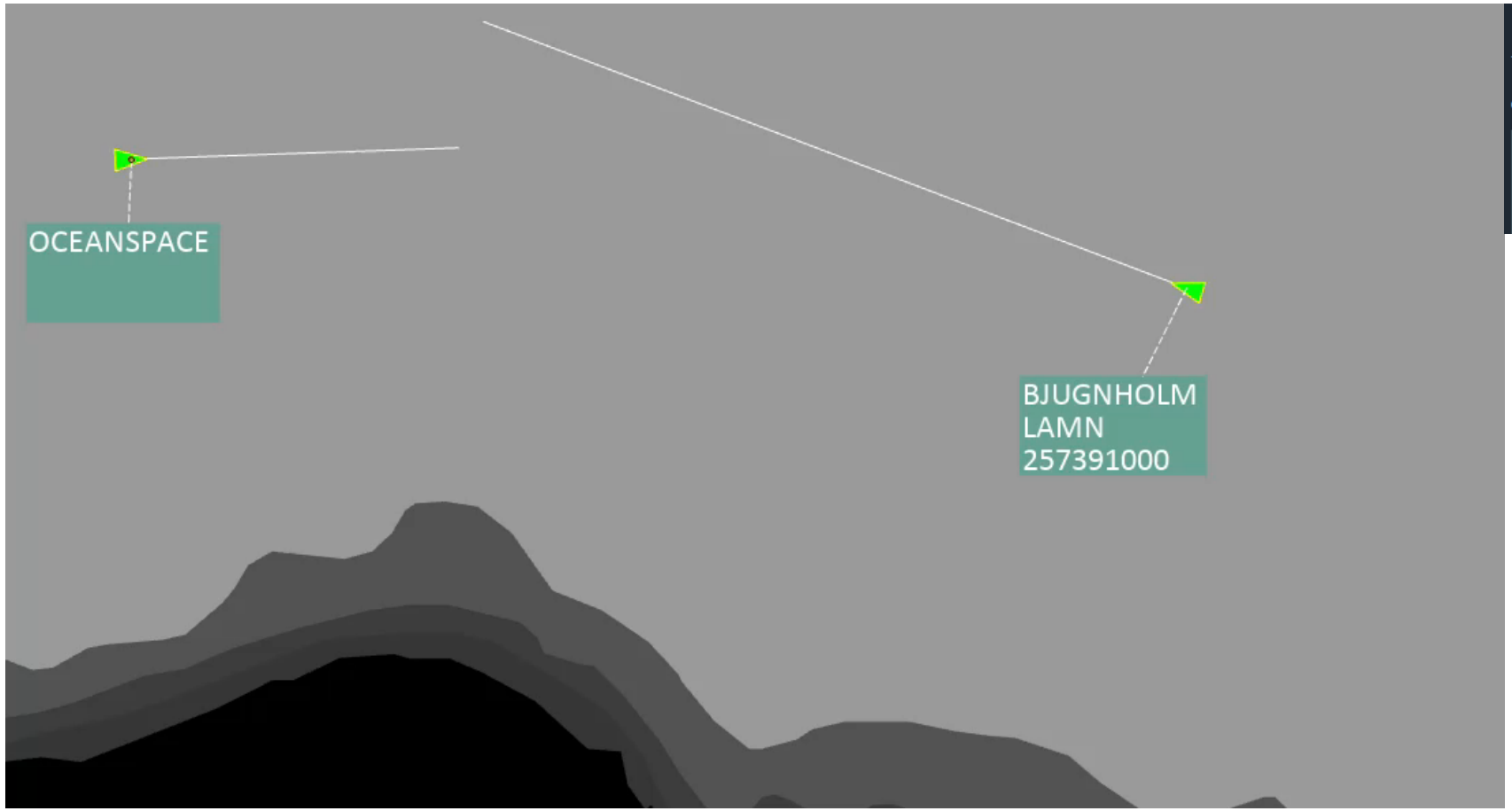
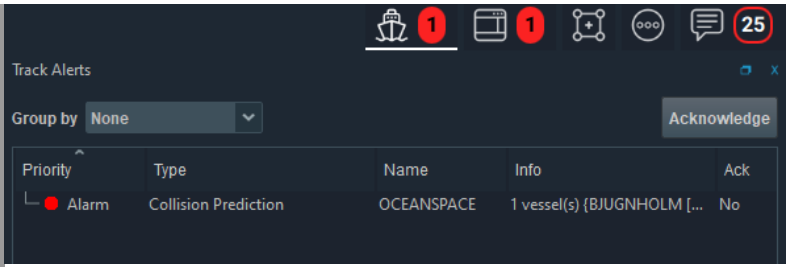
Close Quarter





Conclusion

- Observe vessels using the installed infrastructure
- Can detect route deviation from pre-defined route using C-scope in ROC.
- Close quarter algorithm works
- Early alert to the operator if a situation is evolving
- Important with land-based sensors to cover situational awareness around an autonomous vessel – even with ships and objects that do not have AIS transponder onboard (i.e kayak, leisure vessel ….)
- Observe vessels using the installed infrastructure
- Can detect route deviation from pre-defined route using C-scope in ROC.