

GMV Maritime Services

GMV: A GLOBAL GEOSPATIAL ANALYTICS PARTNER

FROM DATA PROCESSING TO ADDED-VALUE SERVICE PROVISION

Multinational technology group



Headquarters in Spain (Madrid)

Over 2,500 employees



Private capital

Subsidiaries in 10 countries



Founded in **1984**



AEROSPACE DIVISION



KEY REFERENCES



GEOSPATIAL



Operational service provider of Copernicus Security and Emergency

**Decision support and early warning
Cloud Data Acquisition & Processing
Geospatial Data Science
AI Analytics**



GMV: SECURITY EXPERIENCE



SUPPORT TO EU EXTERNAL ACTIONS

- Overview/Detailed topo-information
- Identify belligerent actions
- Tracking exodus
- Contingency plans
- Evacuation & rapid reaction
- Post conflict recovery



INFRASTRUCTURE PROTECTION

- Civil critical infrastructure: pipeline airports, ports, industrial sites, depots, dams, roads...
- Critical geographic elements
- Digital maps
- MGCP GDB
- Strategic briefing reports



MARITIME SURVEILLANCE

- Vessel detection & categorization
- Law verification
- Tracking large volumes of vessel position information
- Integrate EO+AIS
- Port monitoring
- Coastal crime
- Suspicious ship track
- Oil spills
- NRT traffic control



LAND BORDER SURVEILLANCE

- Overview/Detailed topo-information
- Identify treaties transgressors
- Illegal human trafficking
- Illegal infrastructures
- Automatic intrusion detection

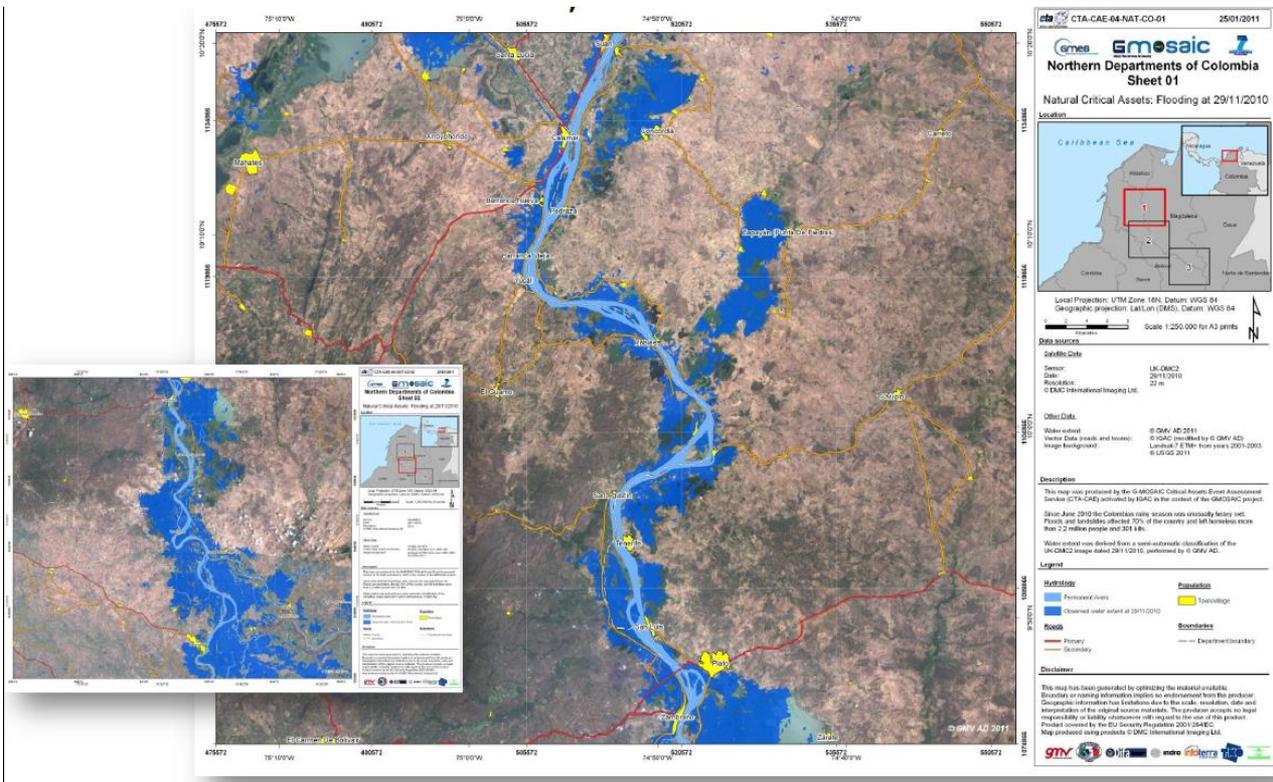
GMV: SECURITY EXPERIENCE: Support External Actions

Situational awareness



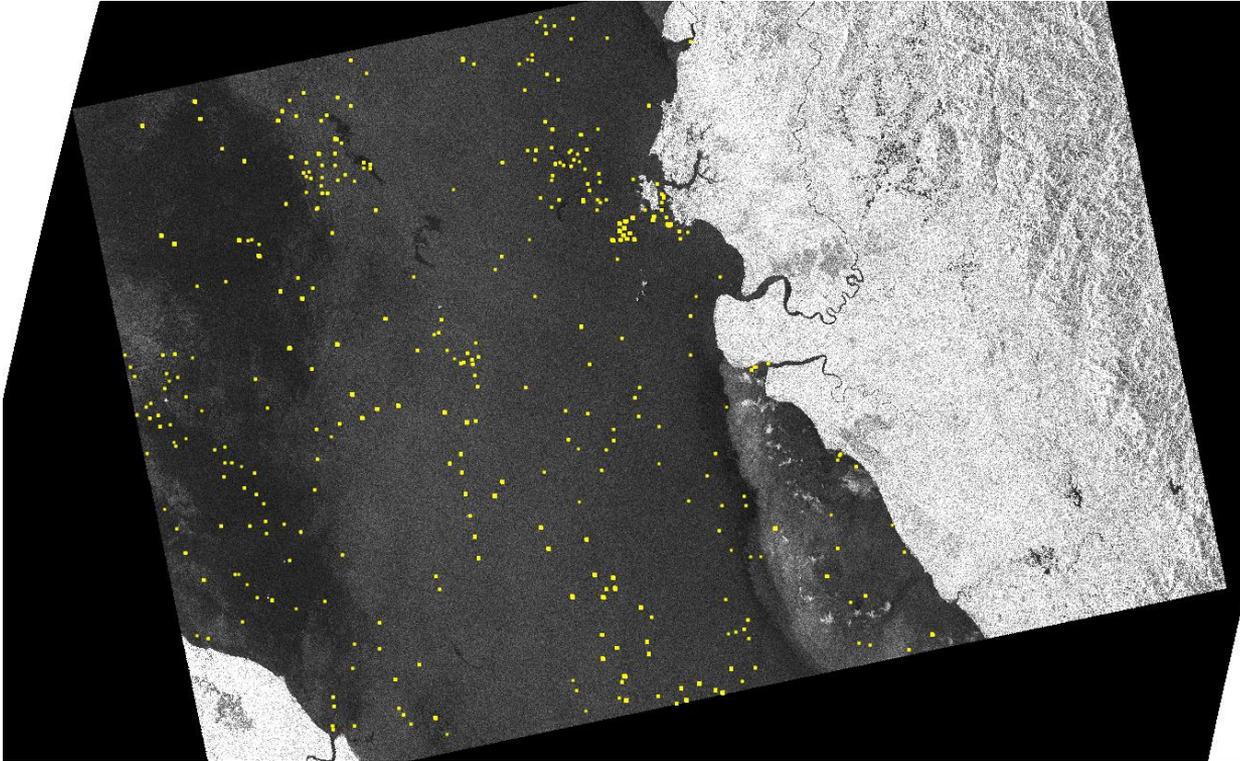
GMV: SECURITY EXPERIENCE: Infrastructure Protection

Pre- and post-event assessment



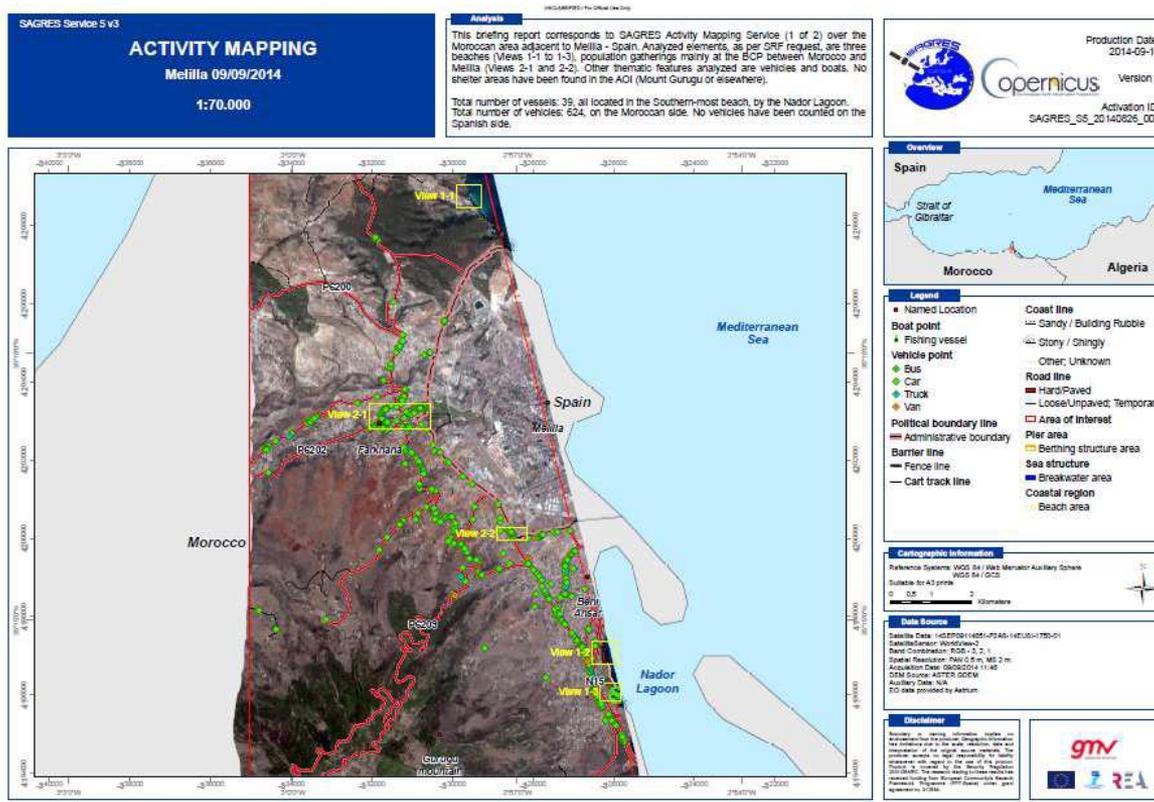
GMV: SECURITY EXPERIENCE: Maritime Surveillance

Operational surveillance service with fusion of different data sources



GMV: SECURITY EXPERIENCE: Land border surveillance

Pre-frontier situational maps

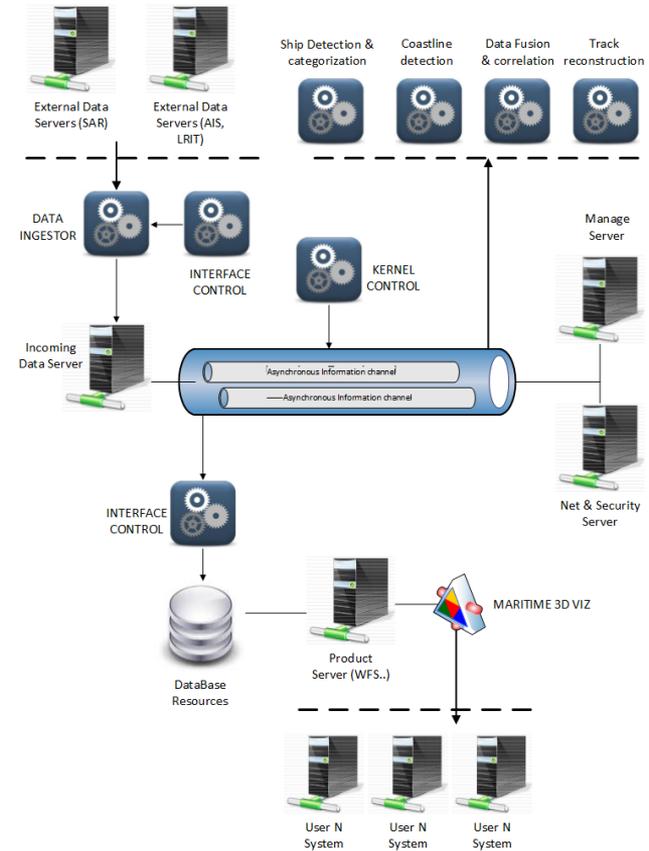


Eomarine: Marine Monitoring Service

Eomarine: a monitoring platform for marine and maritime services

SERVICE ORIENTED ARCHITECTURE (SOA)

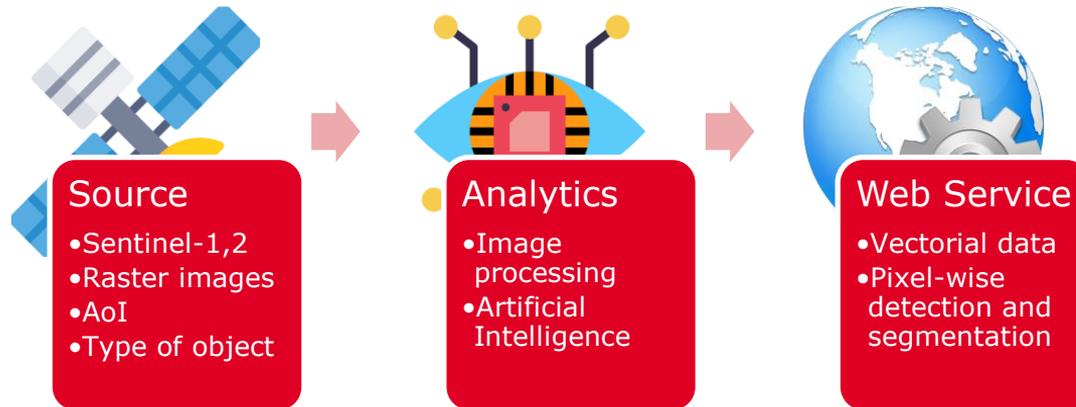
- ✓ Decoupled modules
- ✓ Kernel with DB, management and security functions;
- ✓ Flexible visualization: GMV's solution (SOCRATES SO) or 3rd party visors;
- ✓ Automatic data input feeding.
- ✓ Compliant with OGC and EMSA standards
- ✓ Main services: Ship Detection, Ship Categorization, Oil Spill Detection and Segmentation, Marine Litter Detection



Eomarine: a monitoring platform for marine and maritime services

DATA ANALYSIS SERVICES UNDER THE AI PARADIGM

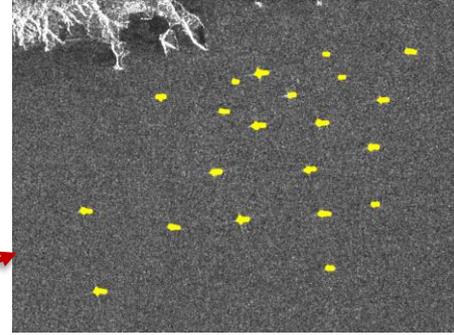
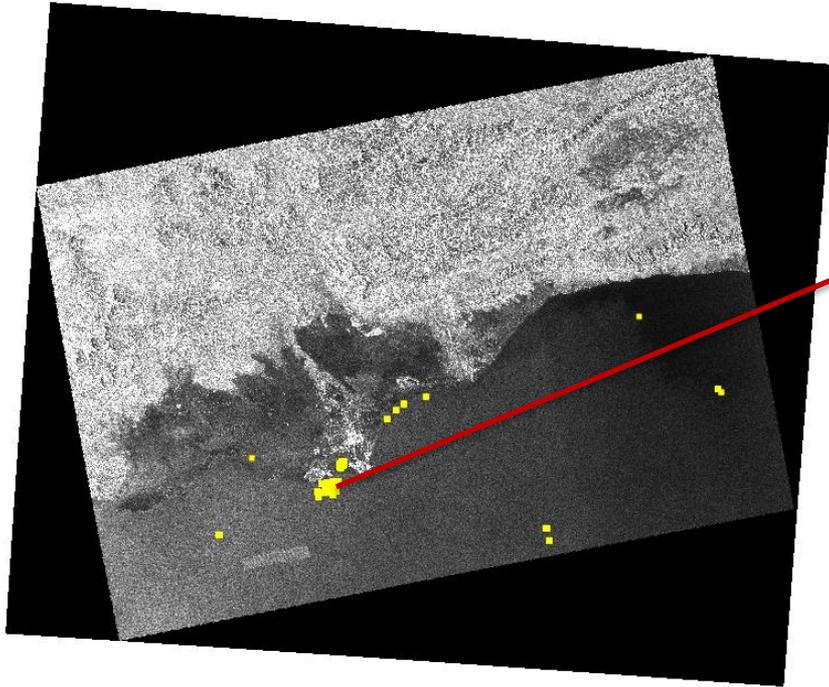
- **Specific net configurations to deal with particular target characteristics**
- **Training stage in accordance to pre-build training dataset**



Eomarine: AI-based Ship Detection

Eomarine: a monitoring platform for marine and maritime services

VESSEL DETECTION AND SEGMENTATION

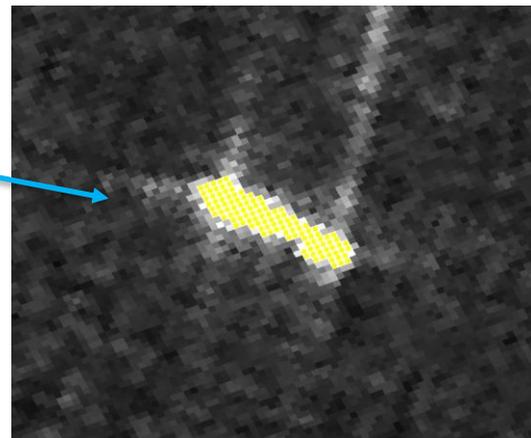
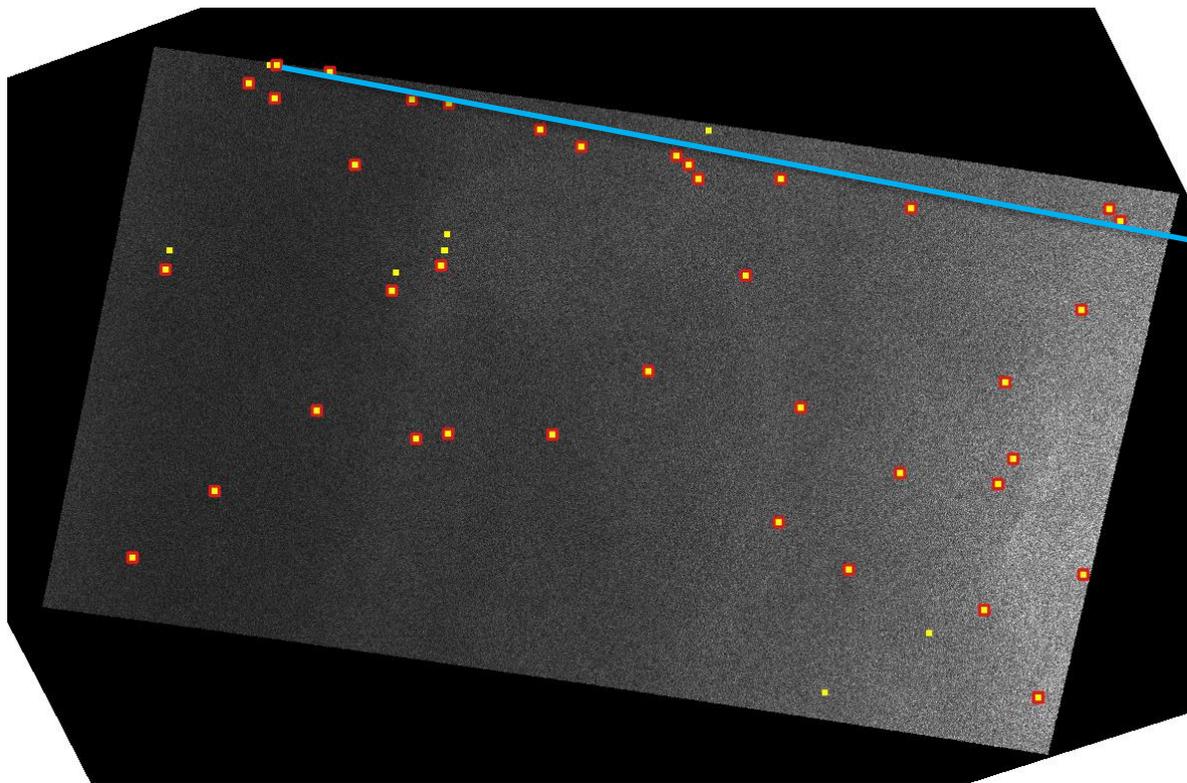


Metric for this image	
Vessel detected	0.98
Intersection over Union(IoU)	0.94

AI model directly and automatically segmentates the radar signature of ships with no support from operator

Eomarine: a monitoring platform for marine and maritime services

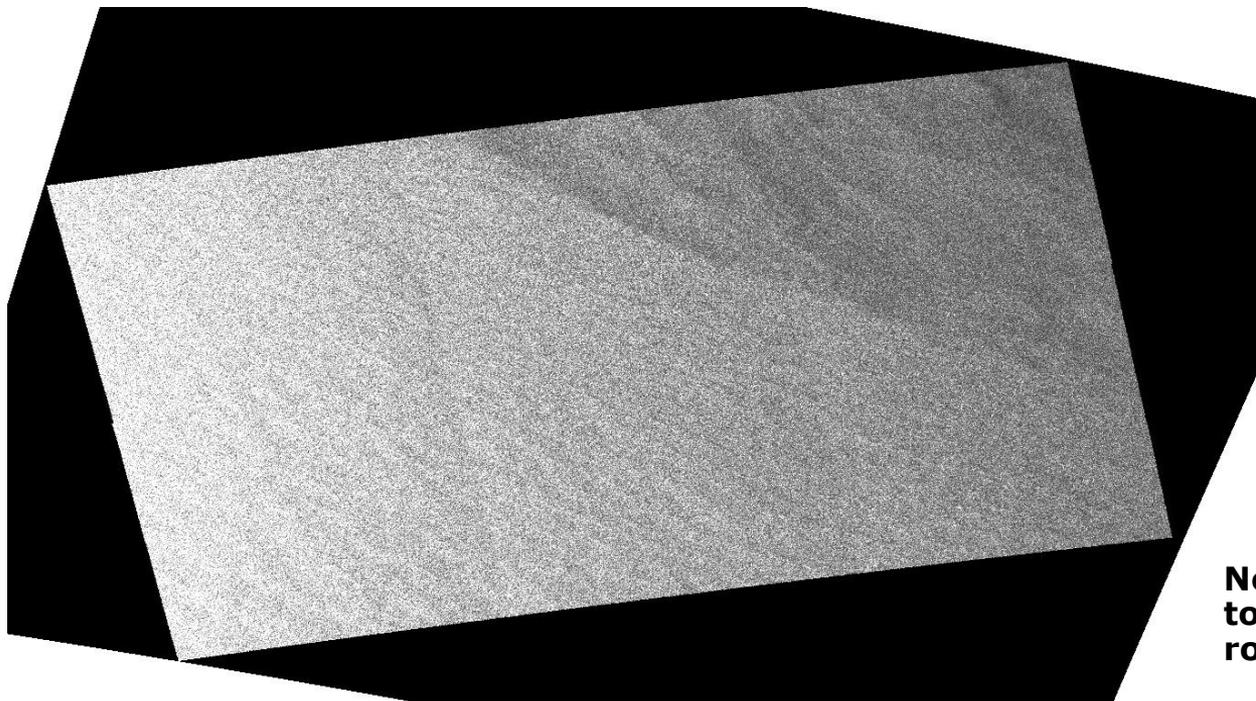
VESSEL DETECTION AND SEGMENTATION



Cross-check over traditional methods: AI performs equal or better by adding automatic segmentation

Eomarine: a monitoring platform for marine and maritime services

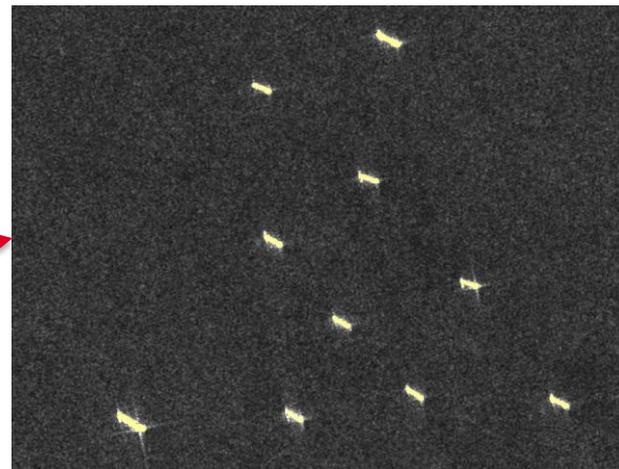
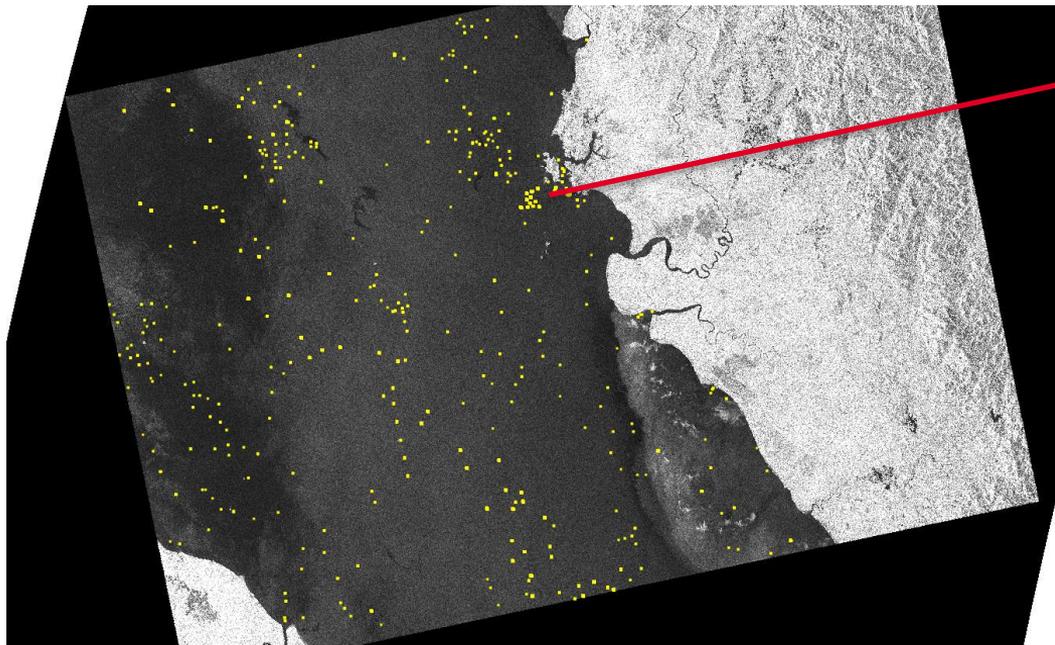
VESSEL DETECTION AND SEGMENTATION



No influence of bright scattering towards false alarms. The system is robust against ship-like artefacts

Eomarine: a monitoring platform for marine and maritime services

VESSEL DETECTION AND SEGMENTATION



High performance in busy areas with numerous artefacts. Probability of detection is larger than 95% (including small ships), while false alarm below 5%

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VESSEL DETECTION AND SEGMENTATION

Metrics	Performance - Avg
Intersection over Union(IoU)	0.91
Hit Rate = $TP / (TP + FN)$	0.94
Critical Succes Index = $TP / (TP + FN + FP)$	0.93

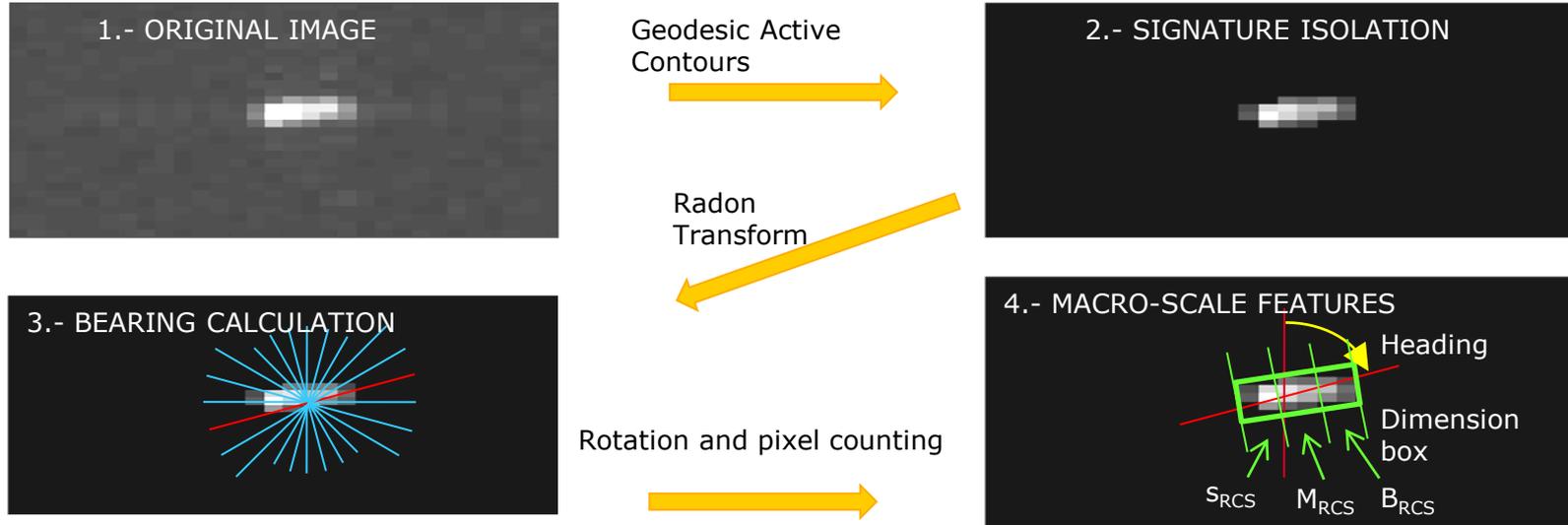
Metrics obtained after processing 10 images with more than 1000 ships within.

TP → Target Positive
FN → False Negative
FP → False Positive

Eomarine: AI-based Ship Categorization

Eomarine: a monitoring platform for marine and maritime services

VESSEL CATEGORIZATION



5.- PARAMETRIZATION

$$P = \{B_{RCS}, M_{RCS}, S_{RCS}, L, B\}$$

6.- FUZZY LOGIC BASED RULE APPLIANCE

Eomarine: a monitoring platform for marine and maritime services

VESSEL CATEGORIZATION

Validation with AIS with 70% of success rate over more than 1000 ship detections

Fully automatic and working over a single channel SAR image

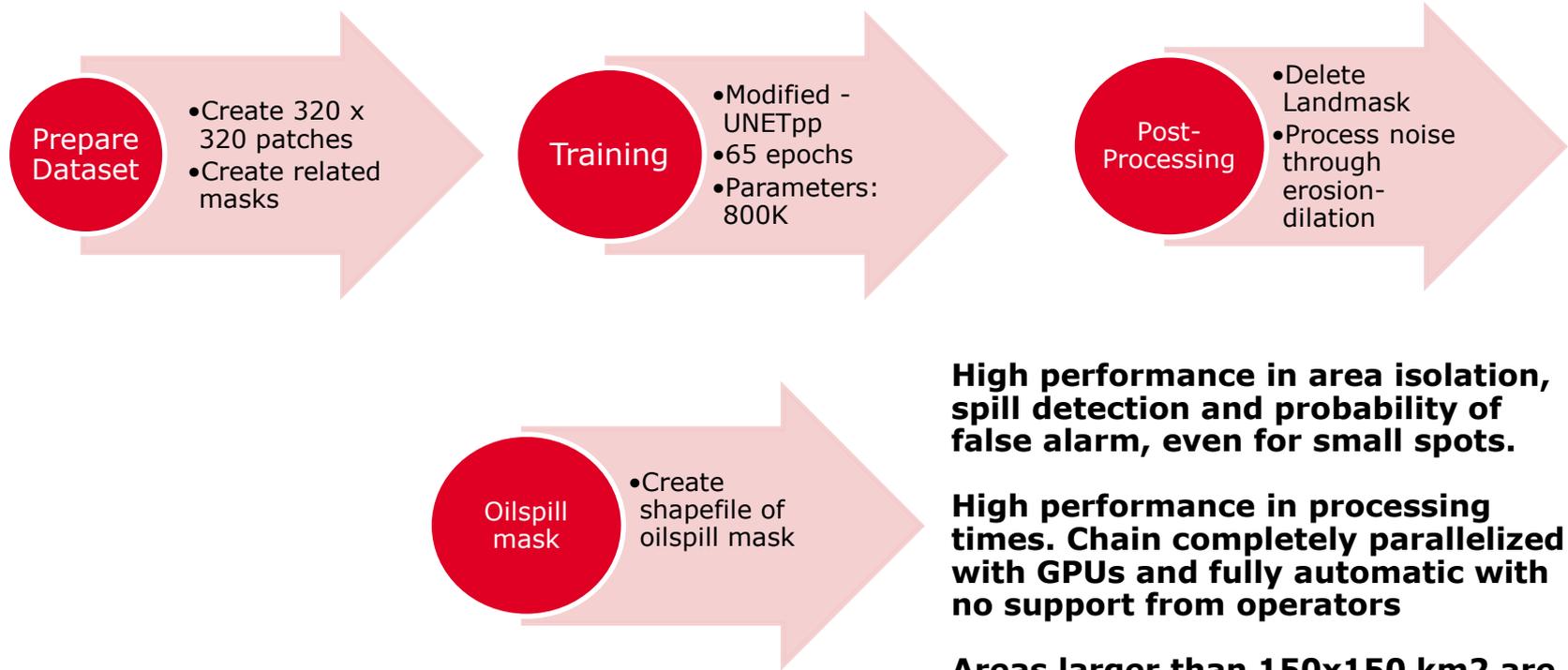
Based on categories with simulated signatures

Category SAR	Category AIS	Ship name AIS	Check
Coaster	Fast Ferry	Avemar dos	<input checked="" type="checkbox"/>
Oil Tanker	Container	MSC Levina	<input type="checkbox"/>
Bulk	Bulk	Maersk Nagoya	<input checked="" type="checkbox"/>
Goods Cargo	Oil Tanker	Hekabe	<input type="checkbox"/>
Oil Tanker	Oil Tanker	Omega Theodore	<input checked="" type="checkbox"/>
Gas Cargo	Oil Tanker	Jag Pratap	<input type="checkbox"/>
Bulk	Bulk	Stena Poseidon	<input checked="" type="checkbox"/>

Eomarine: AI-based Oil Spill Detection

Eomarine: a monitoring platform for marine and maritime services

OIL SPILL DETECTION AND SEGMENTATION



High performance in area isolation, spill detection and probability of false alarm, even for small spots.

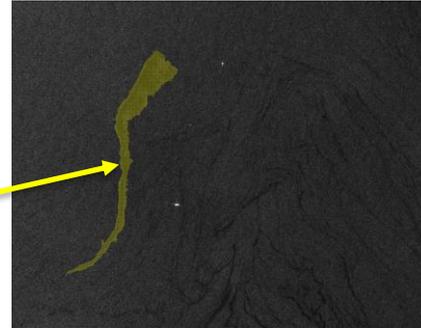
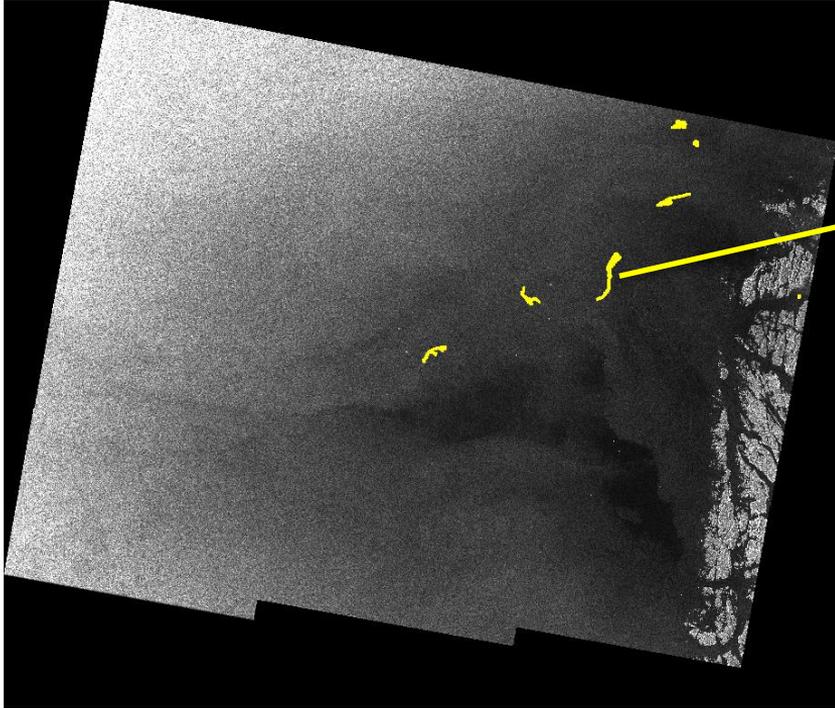
High performance in processing times. Chain completely parallelized with GPUs and fully automatic with no support from operators

Areas larger than 150x150 km² are processed at the order of minutes (nominally 5 min.)

Eomarine: a monitoring platform for marine and maritime services

OIL SPILL DETECTION AND SEGMENTATION

Possible Oilspills, Norway , 2019

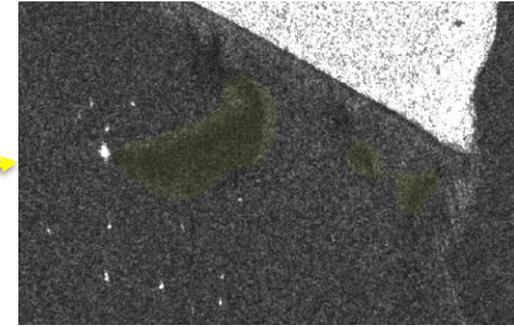
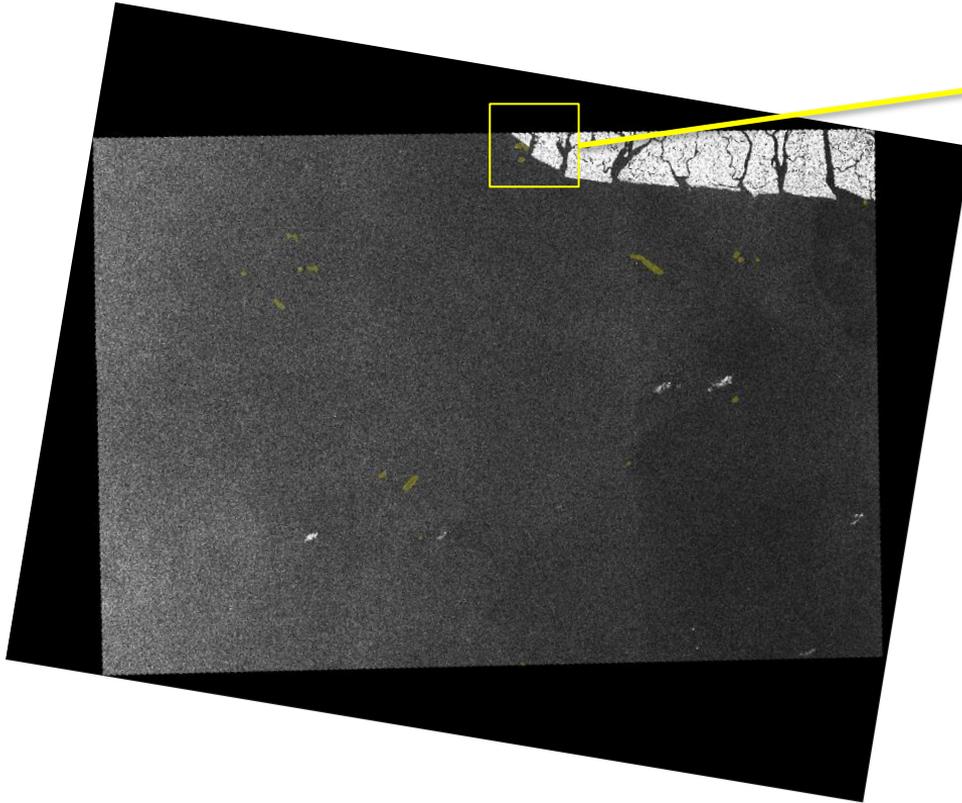


Metric	
Area searched	48167km ²
Oilspill area detected	33km ²
Oilspill area Missed	4km ²
Intersection over Union(IoU)	0.88

Eomarine: a monitoring platform for marine and maritime services

OIL SPILL DETECTION AND SEGMENTATION

Possible Oilspills, Niger delta , 2019



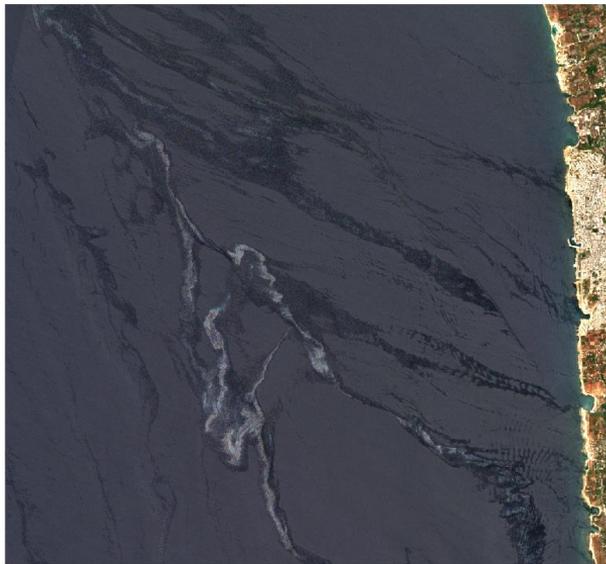
Detected leak from oilrig

Metric	
Area searched	42500 km^2
Oilspill area detected	16 km^2
Probable Spill	4 km^2
Oilspill area Mis-identified	0.2 km^2
Intersection over Union(IoU)	$\simeq 0.95$

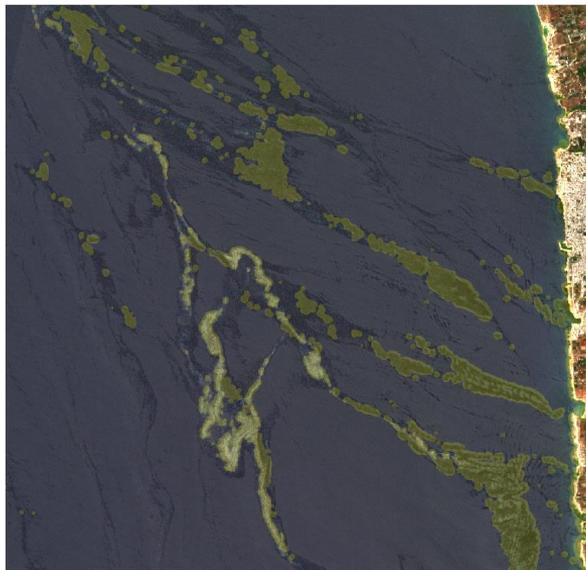
Eomarine: a monitoring platform for marine and maritime services

OIL SPILL DETECTION AND SEGMENTATION

Possible Oilspills, Syria , 2019



Sentinel-2 image



Detected oilspill by our model

Flow adapted to optical images with the same performance than the radar ones

Eomarine: AI-based Marine Litter Detection

Eomarine: a monitoring platform for marine and maritime services

MARINE LITTER DETECTION AND SEGMENTATION



plastic fraction ≈ 0.28

Flow working on optical image by applying a minimization function over training data

Chain fully automatic and capable on providing plastic fraction index per each pixel (from 0 to 1)

Plastic type = Light Blue, PET and Plastic Float

Automatic removal of land mask by morphologically overlapping

Eomarine: a monitoring platform for marine and maritime services

MARINE LITTER DETECTION AND SEGMENTATION

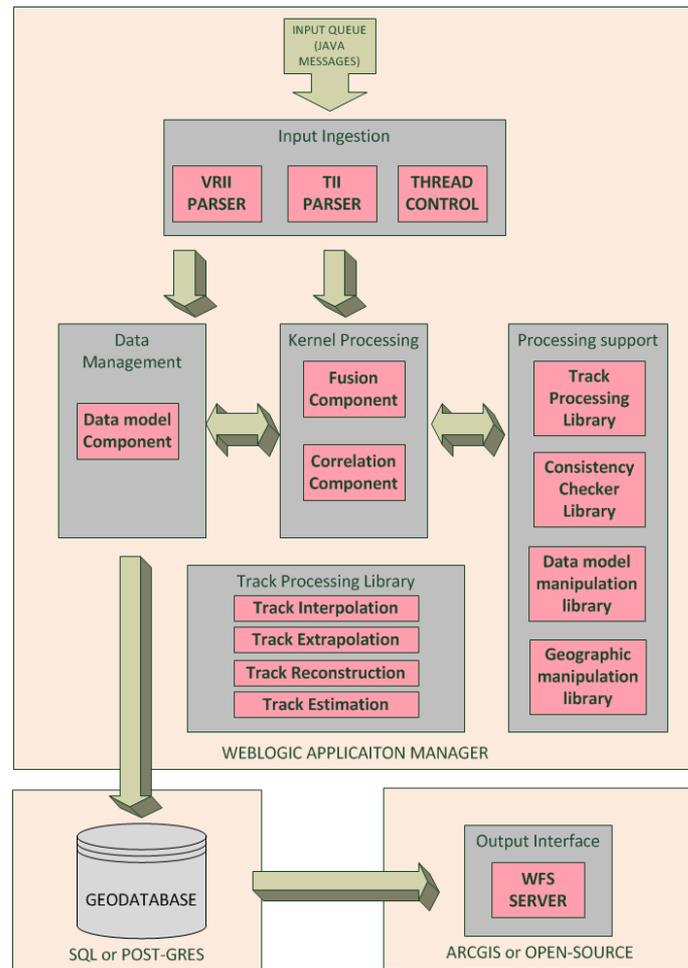
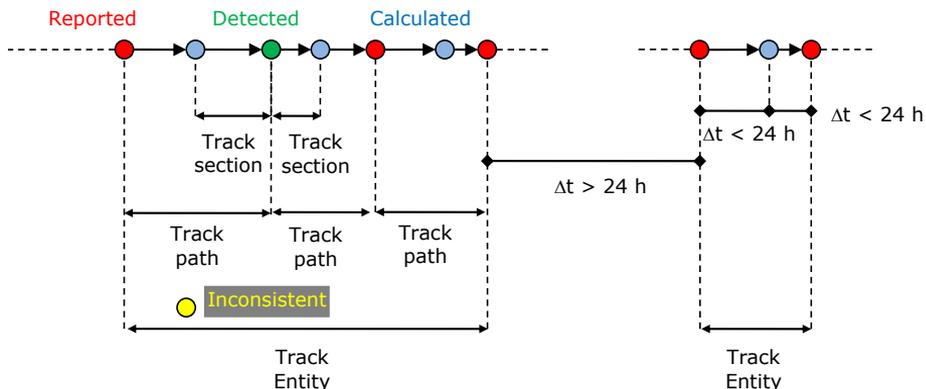


Metric	
Type of Plastic	<i>PET – water bottles</i>
Minimum plastic per pixel detected	20%

Eomarine: Data Fusion

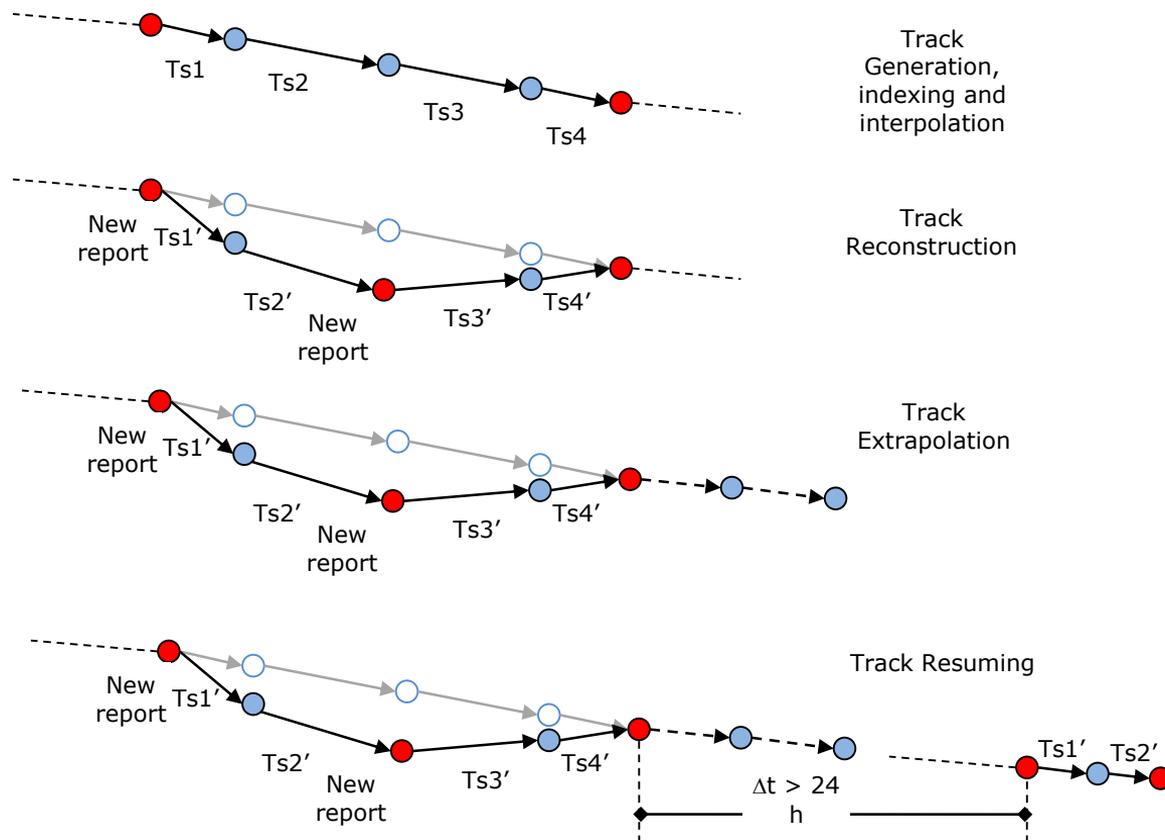
Eomarine: Data Fusion

- **Independent libraries available for specific features**
- Target Correlation
- Consistency Checker
- Track reconstruction with constraint avoidance (coastline, corridor...)
- Track Interpolation
- Track Extrapolation



Eomarine: Data Fusion

- Different functions are used



Eomarine: Visualization support

Eomarine: SOCRATES OC

Integration of a complete HMI suite with advanced functionalities

The screenshot displays the Eomarine HMI interface. At the top, the browser address bar shows 'localhost:8080/crmv/user-site/UserSite.html#'. The main header includes 'NODE VALENCIA 01', 'all', and 'ONLINE 30/May/2014 11:25 (UTC+2)'. The central area is a map of Valencia, Spain, with a popup window for the ship 'GENRED'. The popup contains the following details:

- IMO:** 7324091
- Type:** Passenger, all ships of this type
- Status:** Under way using engine
- Flag:** United Kingdom of Great Britain and Northern Ireland (GB)
- Destination:** LYMNING-VADM
- E.T.A.:** 09:30 (UTC+2) 11/Sep/2014
- Location:** [0°19'33"W,39°27'12"N]
- Updated:** 11:14:00 (UTC+2) 30/May/2014
- Description:** aas

Below the popup are links for 'Details', 'Show Course', and 'Messages'. The bottom of the interface shows a status bar with a red alarm icon, a speaker icon, and a 'Do not sound' checkbox.

The screenshot displays the Eomarine HMI interface with an 'Incidents' list overlay. The header is identical to the previous screenshot. The 'Incidents' list is titled 'Incidents (49 items)' and includes a search bar and sorting options. The list contains the following items:

- Inmature exit** [11:23:44 (UTC+2) 30/May/2014]
- Exploitation of prostitution of others** [11:23:20 (UT...
- Hashish** [11:22:54 (UTC+2) 30/May/2014]
- Oil pollution**
- Man made fire** [17:33:24 (UTC+2) 28/May/2014]
- Flood** [17:32:28 (UTC+2) 28/May/2014]
- Wild fire**
- Shooting Rookie**
- Riots in Newport**
- Document Falsification/Fraud** [09:54:42 (UTC+2) 27/Ma...
- Opium** [09:55:37 (UTC+2) 27/May/2014]
- Amphetamine** [09:55:23 (UTC+2) 27/May/2014]
- Other drugs** [09:55:11 (UTC+2) 27/May/2014]
- Other drugs** [09:54:56 (UTC+2) 27/May/2014]

The bottom of the interface shows a status bar with a red alarm icon, a speaker icon, and a 'Do not sound' checkbox.

Eomarine: a monitoring platform for marine and maritime services

ROADMAP

Train Ship Detection module with optical data to allow automatic integration of optical and radar data for more frequent scenario update

Extend the tests of oil spills and marine litter

Provision of an online service to get updates through web interface over user-defined spatial-temporal windows