



## SATELLITE-BASED MARINE MONITORING - PEW

Rob AYASSE, International Sales Manager | Energy, Environment & Security

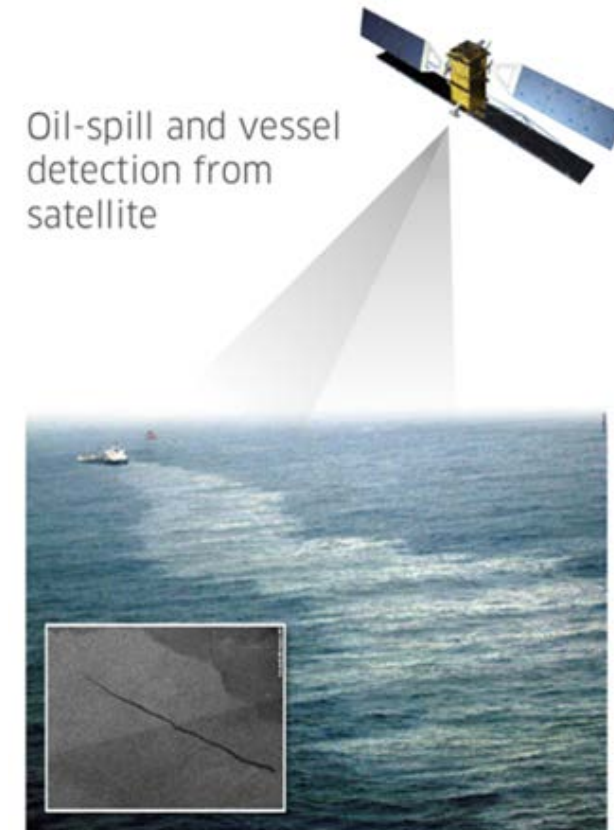
WORLD CLASS – through people, technology and dedication

**KSAT**   
KONGSBERG  
KONGSBERG SATELLITE SERVICES

# SERVICE-BASED MARITIME MONITORING

## EXECUTIVE SUMMARY

- Maritime monitoring as service – no hardware, no software
- Multi-mission provider: virtual constellation of 26 SAR & optical satellites
- Order Desk provides “one stop shop” for planning, ordering, amending, outreach to all satellite owners
- Output: fully analyzed Vessel Detection Reports with target identification
- Near Real-Time delivery: ~45 minutes from image acquisition
- Delivery format: PDF report, secure web-space, secure FTP download, GIS formats for VMS ingestion



**KSAT – WHO WE ARE**  
VESSEL DETECTION  
KEY TAKEAWAYS





# KSAT HQ IN TROMSØ 69N

- Established in 1967
- Kongsberg Satellite Services since 2002
- World leading commercial satellite center
- Don't own satellites – virtual constellation



KONGSBERG



ARCTIC  
TROMSØ

PART OF KSAT GLOBAL GROUND  
STATION NETWORK

# WHO WE ARE

## LEVERAGE KSAT'S OPERATIONAL BACKBONE



- KSAT can acquire satellite imagery anywhere on globe, process, develop vessel detection report, deliver to INS, in ~45 minutes
- Extensive Near Real-Time Capability @ Svalbard Island

**World's Most Comprehensive Ground Station Network**





# WHO WE ARE

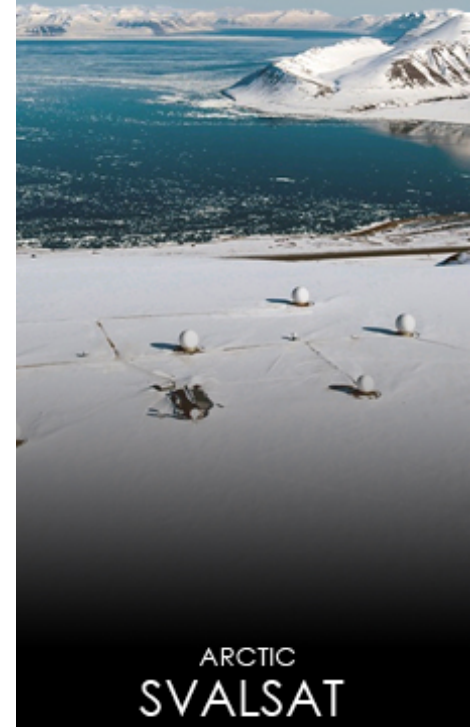
## LARGEST GROUND STATION - HIGH ARCTIC SVALSBARD

- 2500 people
- 3000 snowmobiles
- 3000 Polar Bears

78°N



KONGSBERG



ARCTIC  
SVALSAT

PART OF KSAT GLOBAL GROUND  
STATION NETWORK

# WHO WE ARE



**ONLY STATION TO CAPTURE DATA FROM ALL 14 PASSES OF POLAR ORBITS**

- 80+ antennas, Staffed permanently by 25 personnel
- Enables us to provide a unique, genuine, Multi-Mission “Near Real-Time” Service





# EFFECT OF UNIQUE POLAR POSITIONING

82 satellites

WORLD LEADER



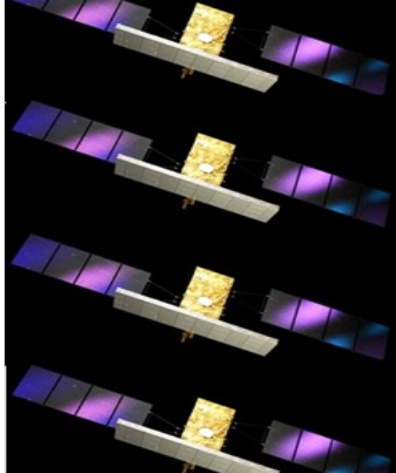


# WHO WE ARE

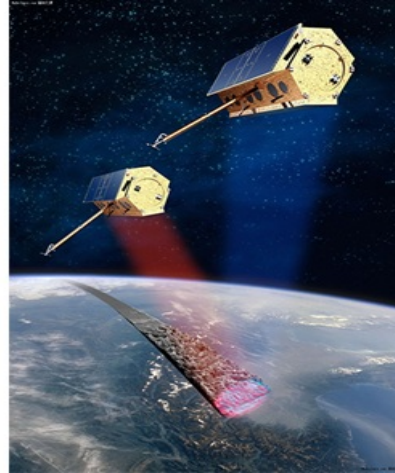
## SYNTHETIC APERTURE RADAR SATELLITES FOR VESSEL DETECTION



**RADARSAT-2**



**COSMO-SkyMed**



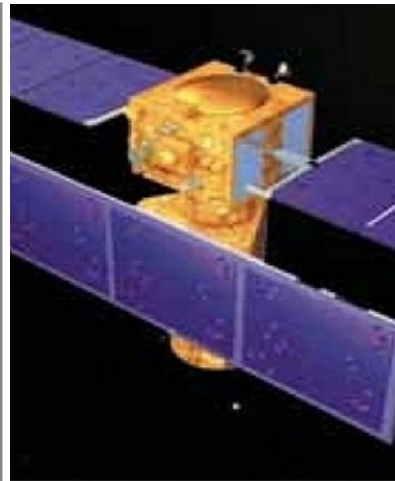
**TerraSAR-x**



**SENTINEL-1A**



**PAZ (2016)**



**RISAT-1**

### AVAILABLE PLATFORMS

- 9 SAR satellites for vessel detection (PAZ March 2016)
- All polar orbiting
- Only KSAT can acquire imagery from all, do in-house processing, in Near Real-Time



**KSAT Vessel Analysts Available 24/7/365**

# WHO WE ARE

RADARSAT-2 COVERAGE – 22 APRIL 2015



## WITH A SINGLE SATELLITE PROVIDER

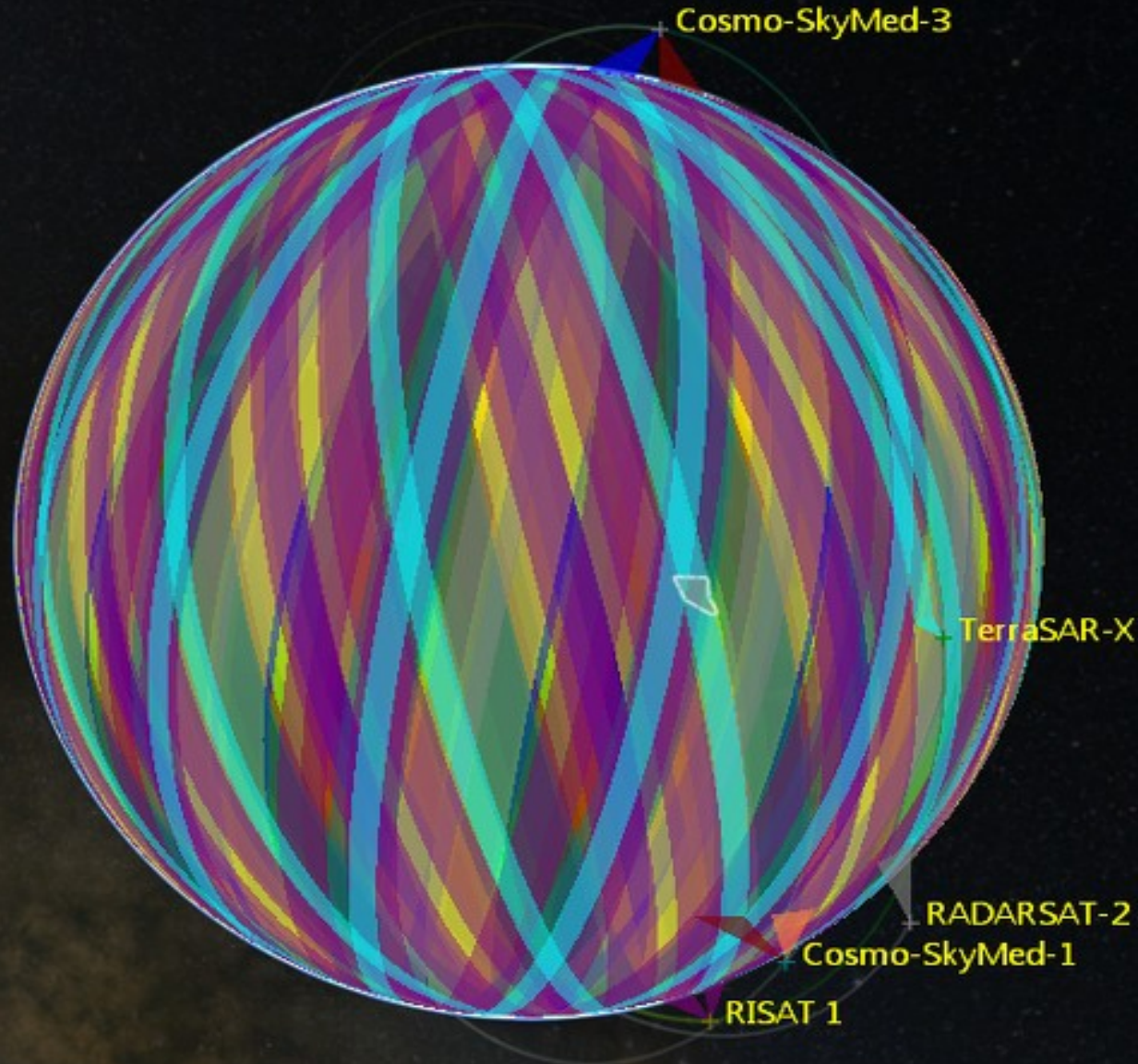
- Large swathes of uncovered ground on any average day
- Closer to equator: more acute the challenge

RADARSAT-2



# WHO WE ARE

COVERAGE OF ALL AVAILABLE – 22 APRIL 2015



## WITH MULTI-MISSION SATELLITE PROVIDERS

- Much higher chances of capturing required imagery
- Redundancy in case of technical issues
- Greater acquisition speed
- Optimal solution for providing actionable information

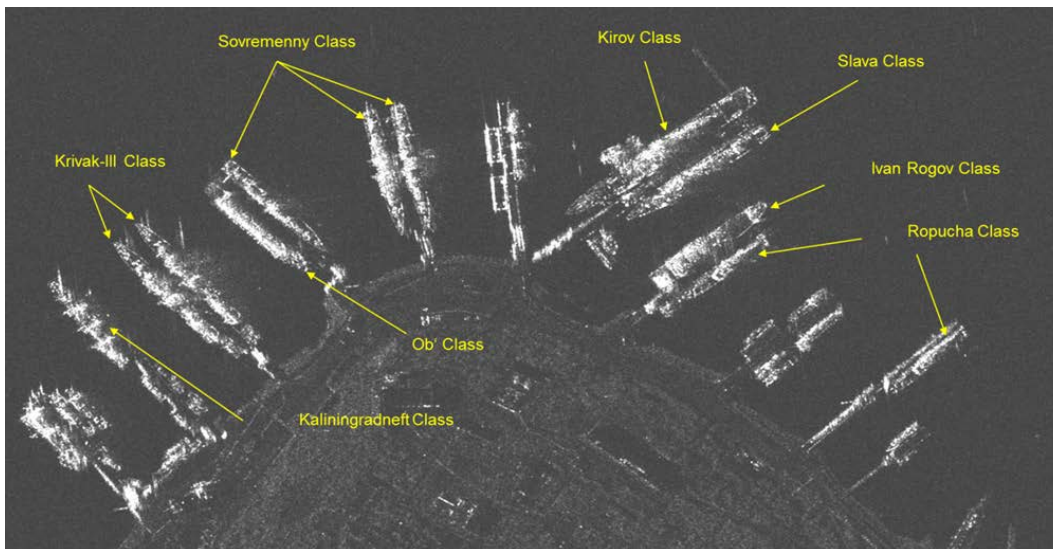
# WHO WE ARE

## KSAT SAR-BASED VESSEL DETECTION APPROACH

- Automatic vessel detection algorithm
- Analyst validates, adds or removes targets
- Takes into account range of ancillary data
  - Met ocean conditions
  - Known fishing hot spots, protected areas
  - Seasonal & regional fishing norms
- Range of possible resolutions

## Regular Area Monitoring:

| Satellite                              | Image size    | Area covered              | Resolution | Minimum vessel size |
|--|---------------|---------------------------|------------|---------------------|
| RISAT-1<br>CRS                         | 225x300<br>km | 67,500<br>Km <sup>2</sup> | 50m        | 25m                 |
| Radarsat-2<br>ScanSAR<br>Narrow        | 300x300<br>km | 90,000<br>Km <sup>2</sup> | 50m        | 25m                 |
| TerraSAR-<br>X/Tandem-X<br>WideScansar | 200x270<br>km | 54,000<br>Km <sup>2</sup> | 40 m       | 20m                 |



## Intelligence-Driven “Hunting”:

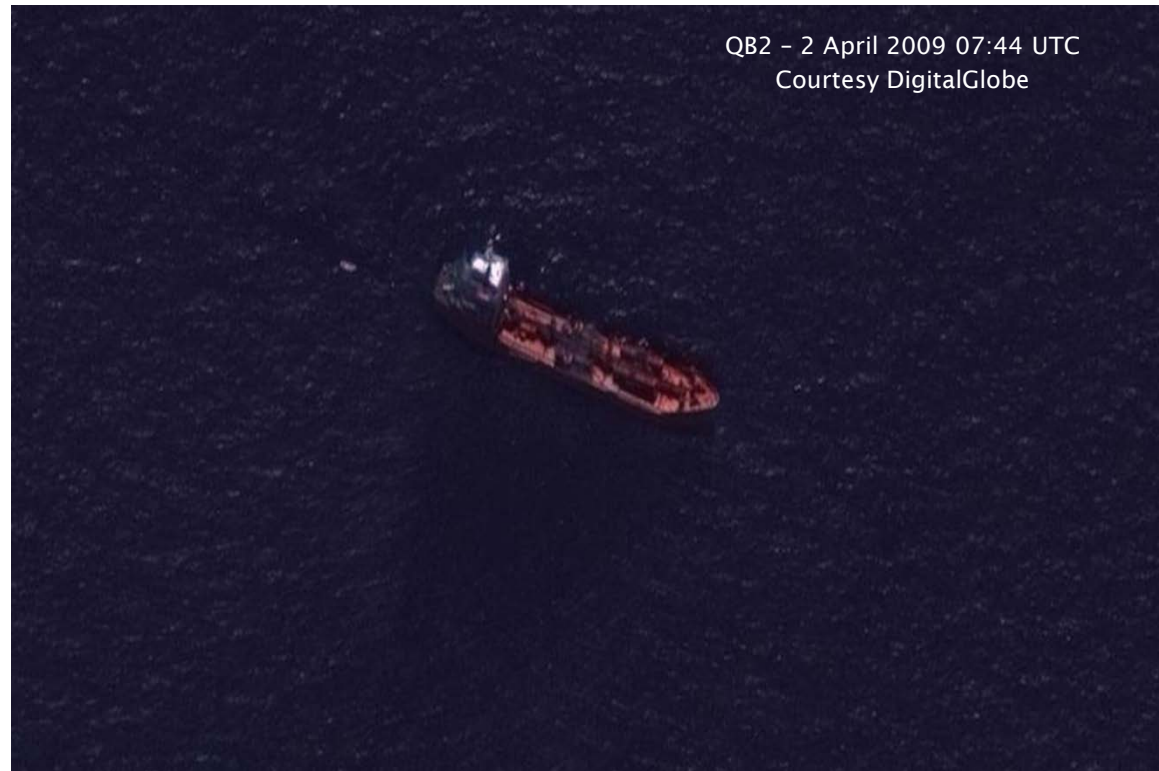
- “Spotlight” or “Fine Resolution Mode”:  
1m
- Image size ~100SQKM
- Ideal for monitoring harbours, specific fishing hot spots or logistical hubs



# WHO WE ARE

## ENHANCED VESSEL RECOGNITION – OPTICAL IMAGERY

- Optical imagery for enhanced vessel recognition
- Pass to enforcement authorities
- Serve as evidence in court
- Available Optical Platforms:
  - WorldView-1,2 and 3
  - GeoEye-1
  - SPOT 6 and 7
  - RapidEye
  - IRS
  - Pleiades 1A and 1B
  - Eros-B
  - DMC-2
  - Theos
  - FormoSat-2
  - KOMPSAT 2, 3 and 5
- Challenges: daylight, clouds, smog, delivery times

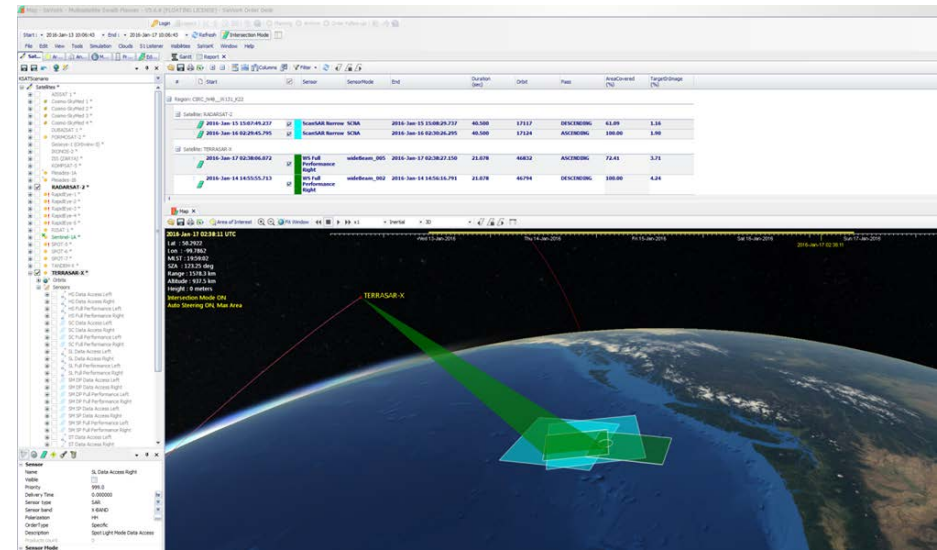


**Optical Image of Pirated Norwegian Tanker Found by KSAT During Counter-Piracy Monitoring off Somalia in 2009**

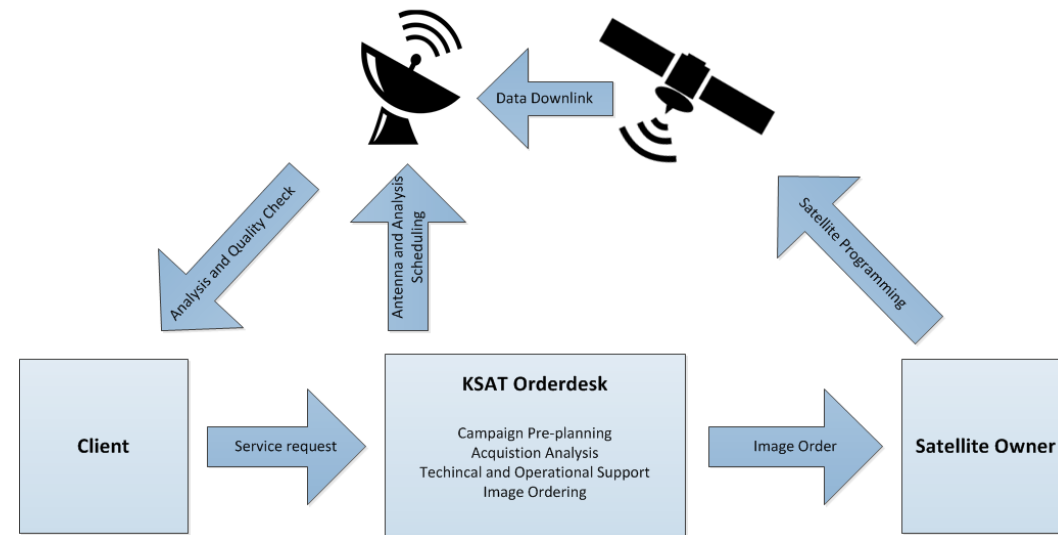
# WHO WE ARE

## KSAT ORDER DESK – YOUR SINGLE POINT OF CONTACT

- Single access point to KSAT’s virtual constellation (26 satellites)
- Direct link with satellite owners
- Responsible for:
  - Pre-campaign support
  - Coverage Analysis
  - 24/7 Multi-mission ordering
  - Technical and Operational Support
- Use proprietary planning tool Savoirk



The Savoirk Planning Tool: Order Desk Sees ALL Available Imagery Acquisitions



KSAT’s Order Desk: “One-stop shop” at the Heart of the NRT Vessel Detection Service



# WHO WE ARE

## THREE MAIN LINKS IN SATELLITE INFORMATION CHAIN: MULTI-MISSION NRT

### DATA ACQUISITION

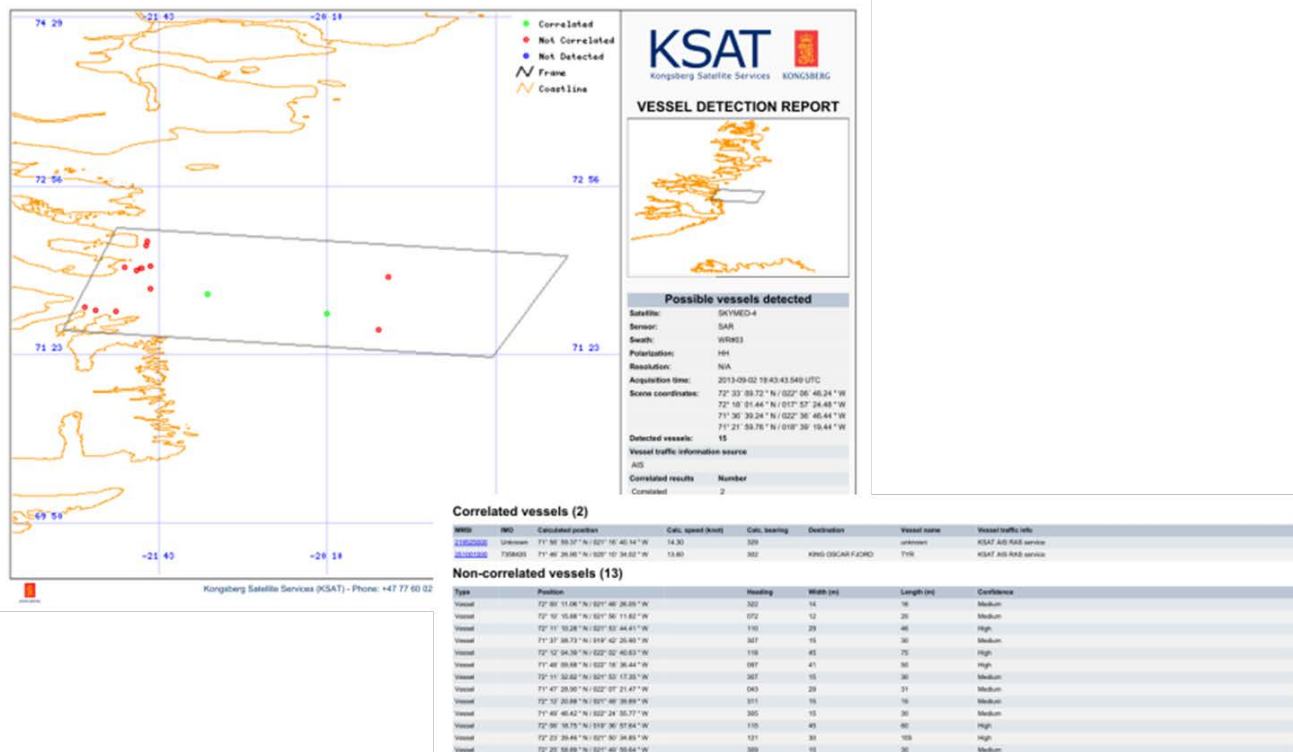
- Data capture from 14 of 14 polar passes
- Gives maximum 100 minutes

### ANALYSIS & INTERPRETATION

- 24/7/365 monitoring by TEOS
- Unbiased multi-mission data – fused solutions
- Pioneer of oil spill detection

### NEAR REAL-TIME DELIVERY

- As short as 15 minutes for SAR, 2.5 hours for optical data
- Fast – accurate - ACTIONABLE



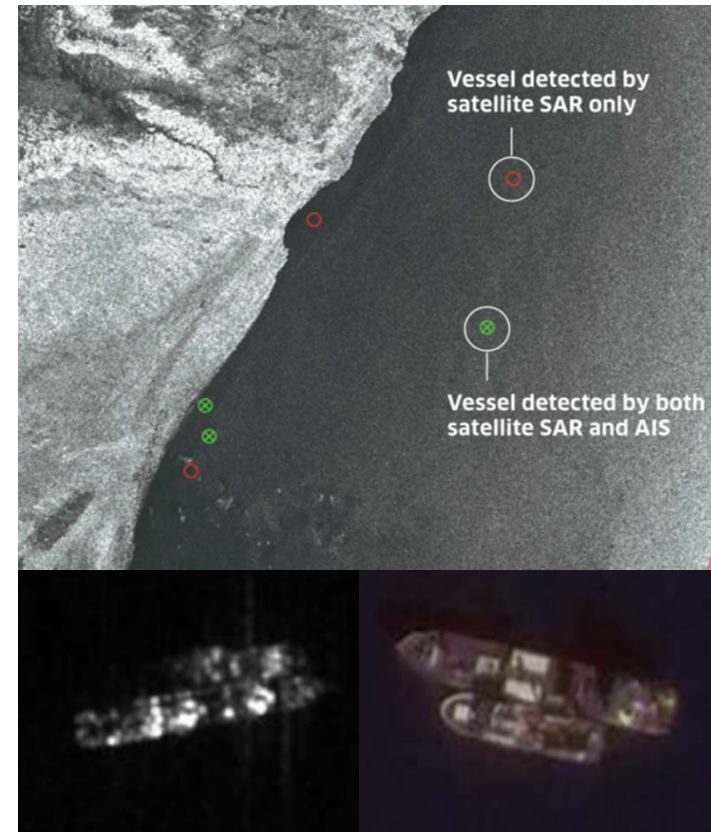
KSAT – WHO WE ARE  
**VESSEL DETECTION**  
KEY TAKEAWAYS



# VESSEL DETECTION (IUU FISHING)

## KSAT'S SATELLITE-BASED VESSEL DETECTION SERVICE

- 10 years monitoring fisheries in North Atlantic; Easter Island EEZ (PEW Charitable Trust); Liberia and Senegal (World Bank).
- Steps in daily, Regular Area Monitoring:
  1. Area of Interest (AOI) monitored with Synthetic Aperture Radar (SAR): detect vessel
  2. Correlation - Automatic Identification System (AIS) data
  3. Vessel seen on SAR, not AIS: suspicious
  4. Enforcement authorities: shorter list of targets
- Reports to customer **normally in 45 min** (15-120). Follow-up analysis:
  1. Behaviour analytics - focus on suspicious vessels
  2. High-res optical images - recognition of target
- Also deliver vessel detection combined with oil spill



Top - SAR Image with Correlated AIS; Left - SAR vessel detection; Right - Optical

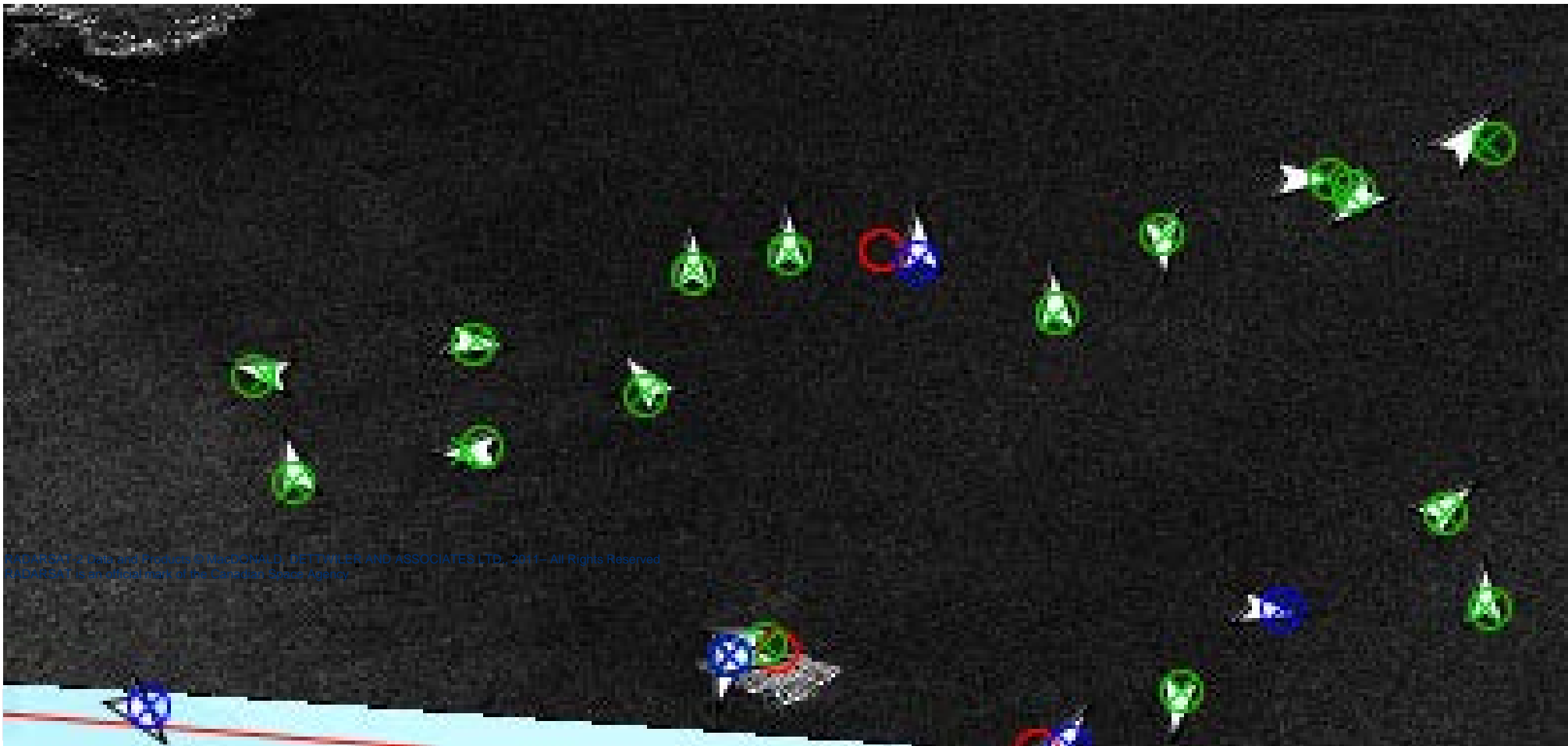


# VESSEL DETECTION (IUU FISHING)

## USE OF SAR & AIS CORRELATION

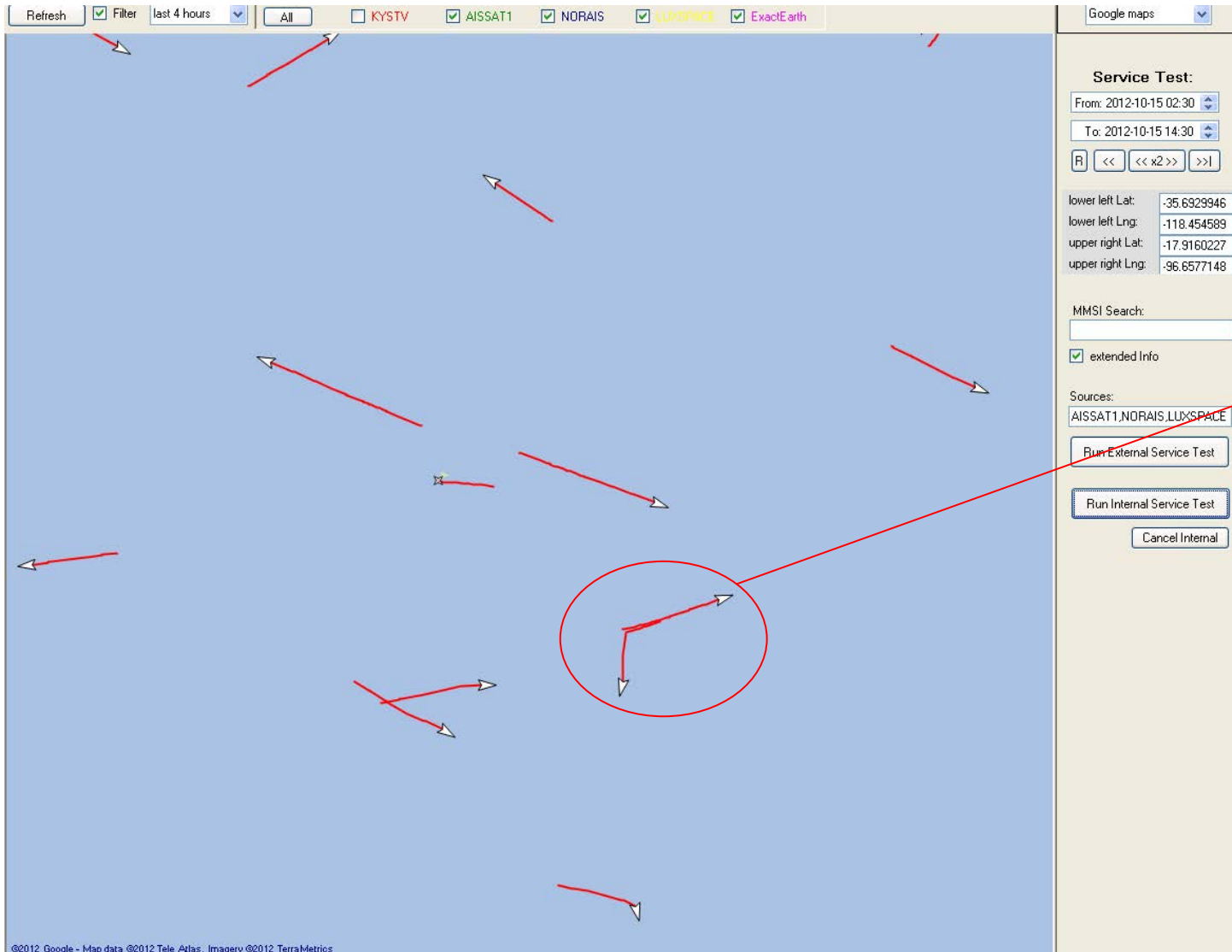
### Narrow Target List - Hunt Red Circles

- Green: seen on SAR & AIS
- Blue: AIS only
- Red: seen on SAR, no AIS – further scrutiny



# VESSEL DETECTION (IUU FISHING)

## EASTER ISLAND: VESSEL TRACKING WITH SATELLITE AIS (2013)



### EASTER ISLAND

- Year-long project with PEW Trust
- Demonstrated urgent need for fishery monitoring

Spanish fishing vessels:  
Arnela (IMO:9297993) Glacial (IMO:9372157)



Based in Vigo, Glacial is a modern longliner, that has been specially designed to operate in the Indian and Pacific Ocean. Finalized her construction in October 2005, she has been equipped with a 47.7m long hull and an sympathetic 1020cv engine.

SAT-AIS coverage obtained around Easter Island with KSAT/FFI, exactEarth and LuxSpace

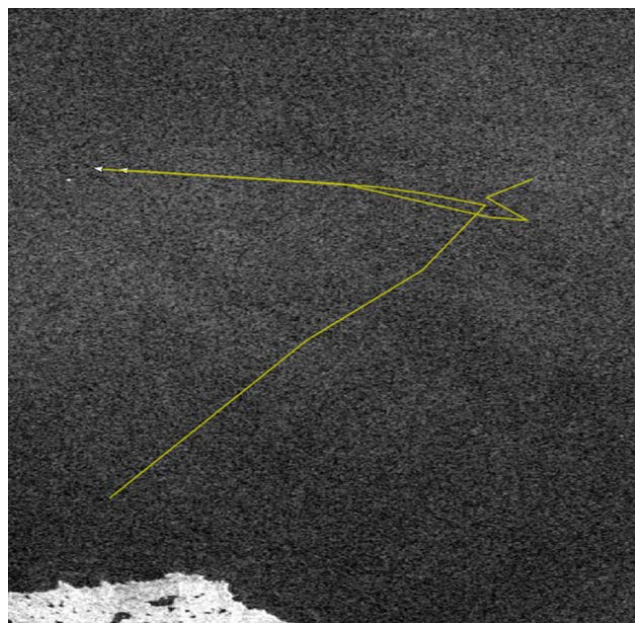
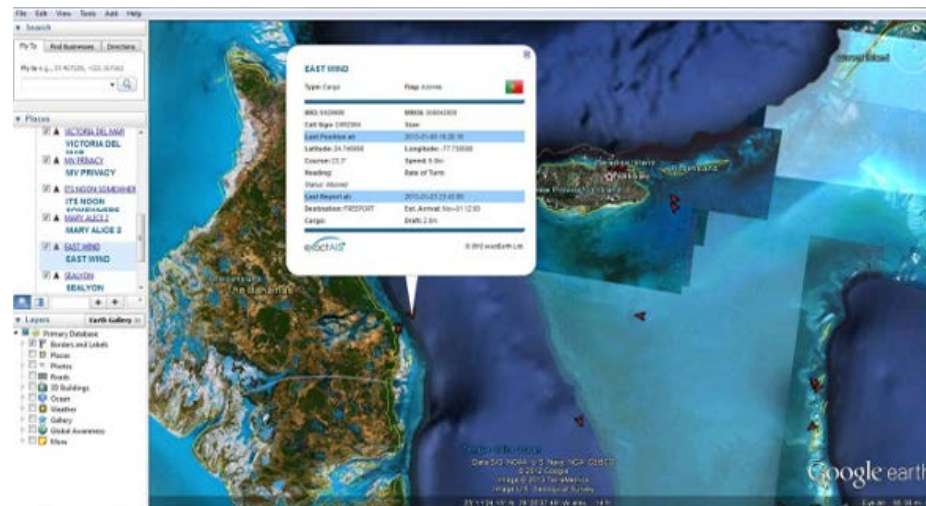
# VESSEL DETECTION (IUU FISHING)

## VESSEL BEHAVIOR ANALYTICS

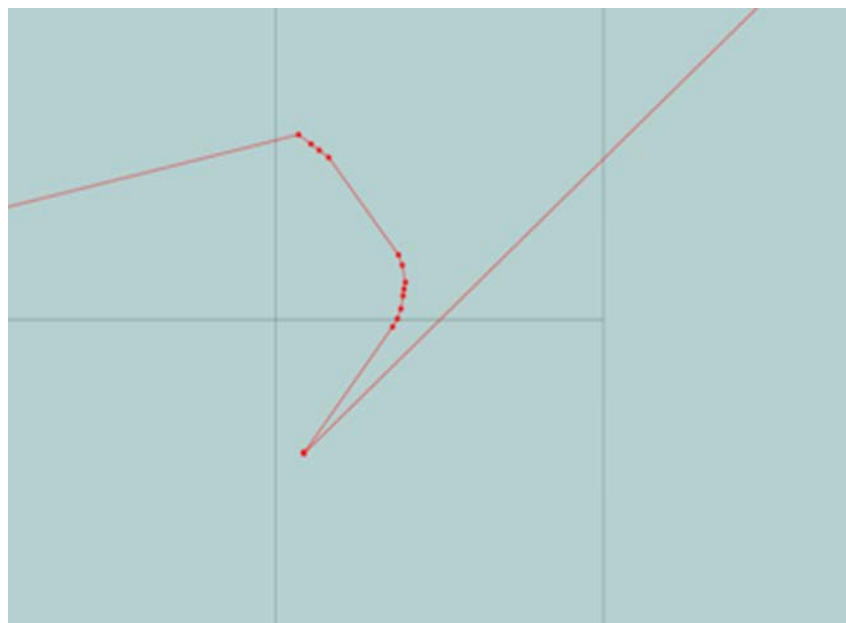
### Not All IUU Fishing Vessels Dark

- AIS on-off
- AIS spoofing
- Restricted areas
- Logistic support
- Suspicious sailing tracks
- Fishing types: long-line, trawling, bottom-drag

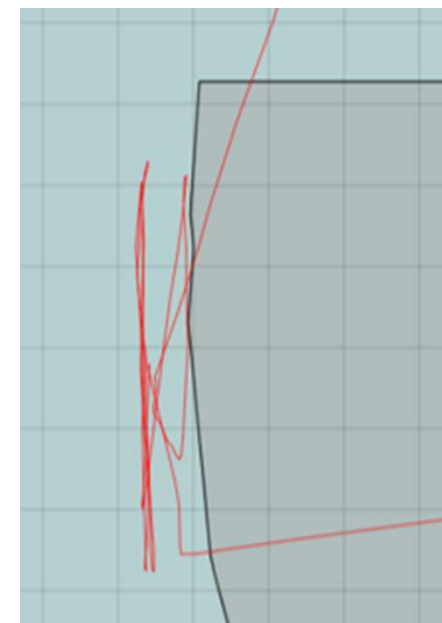
ExactEarth  
GeoSpatial  
Web Services



SAR & AIS: Trans-Shipments (catch)



AIS "banana track": Trans-shipments (fuel)



Reefer Track Along EEZ



# VESSEL DETECTION (IUU FISHING)

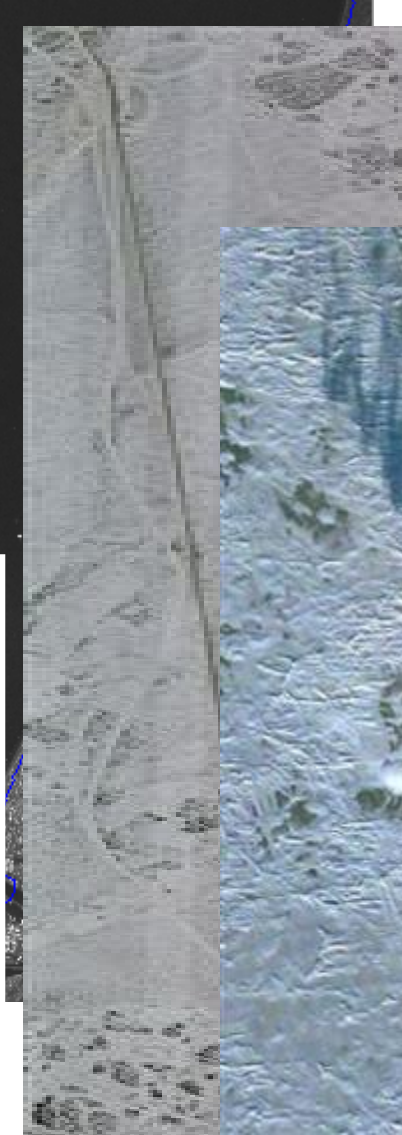
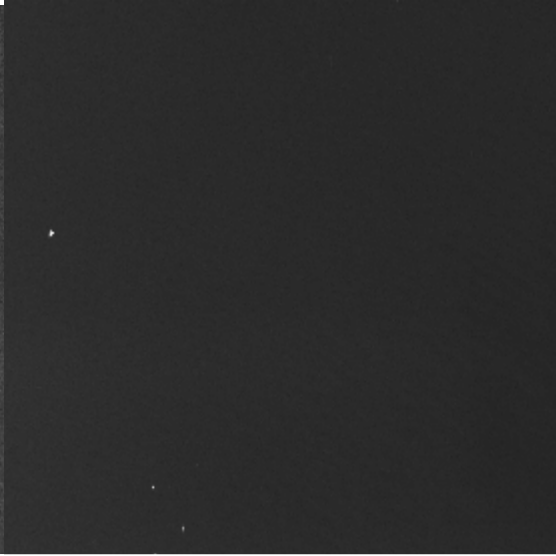
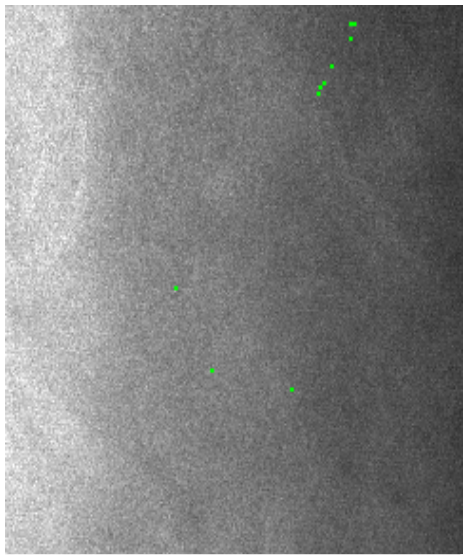
## TIERED PROTECTION – SATELLITE AND MPAs, VESSELS, UAVs



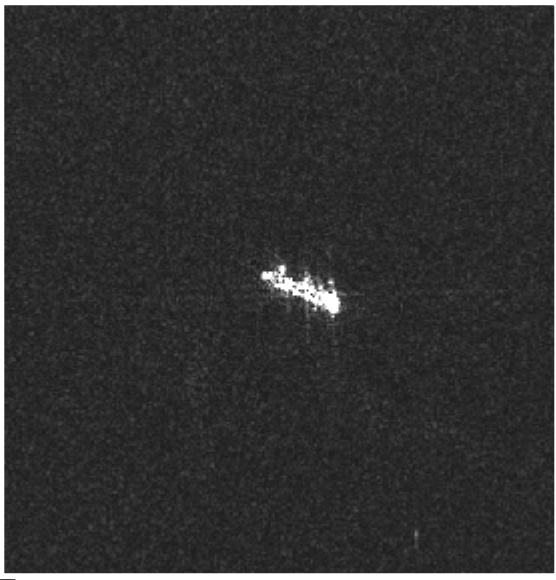
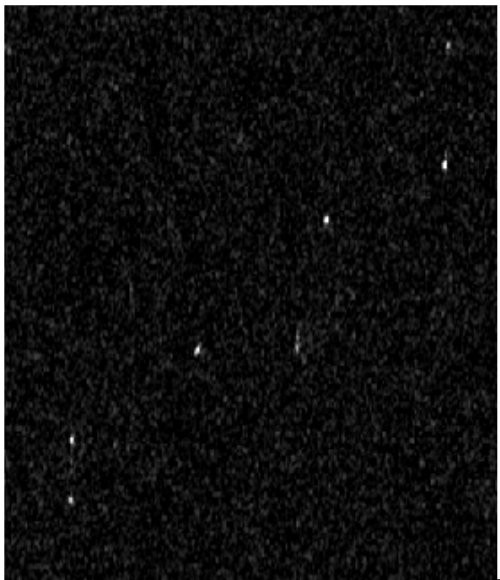
- Integrated, tiered fisheries protection: balance effect/cost efficiency
- KSAT assets identify IUU risks, patterns
- Local aircraft, vessels, UAVs or wave gliders then provide close-up TARGETTED response
- Achieves superior use of scarce resources

# VULCAN'S INITIAL OPERATING CAPABILITY

## SAR IMAGING MODE TRADE-OFF: PROGRESSIVE RESOLUTION



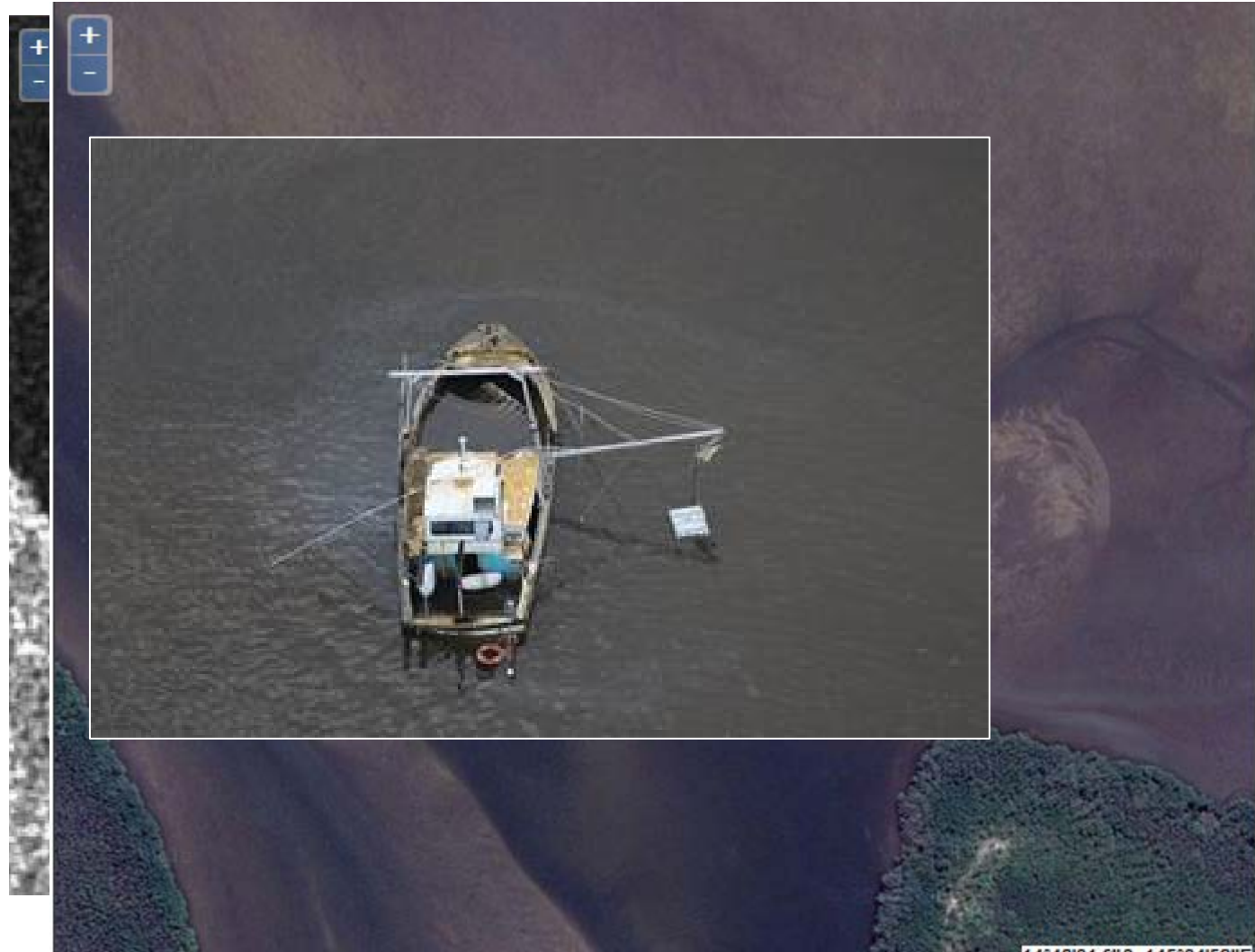
20 km swath optical  
0,5 m resolution





# VESSEL DETECTION (IUU FISHING)

FROM SAR VESSEL DETECTION TO IDENTIFICATION & ENFORCEMENT

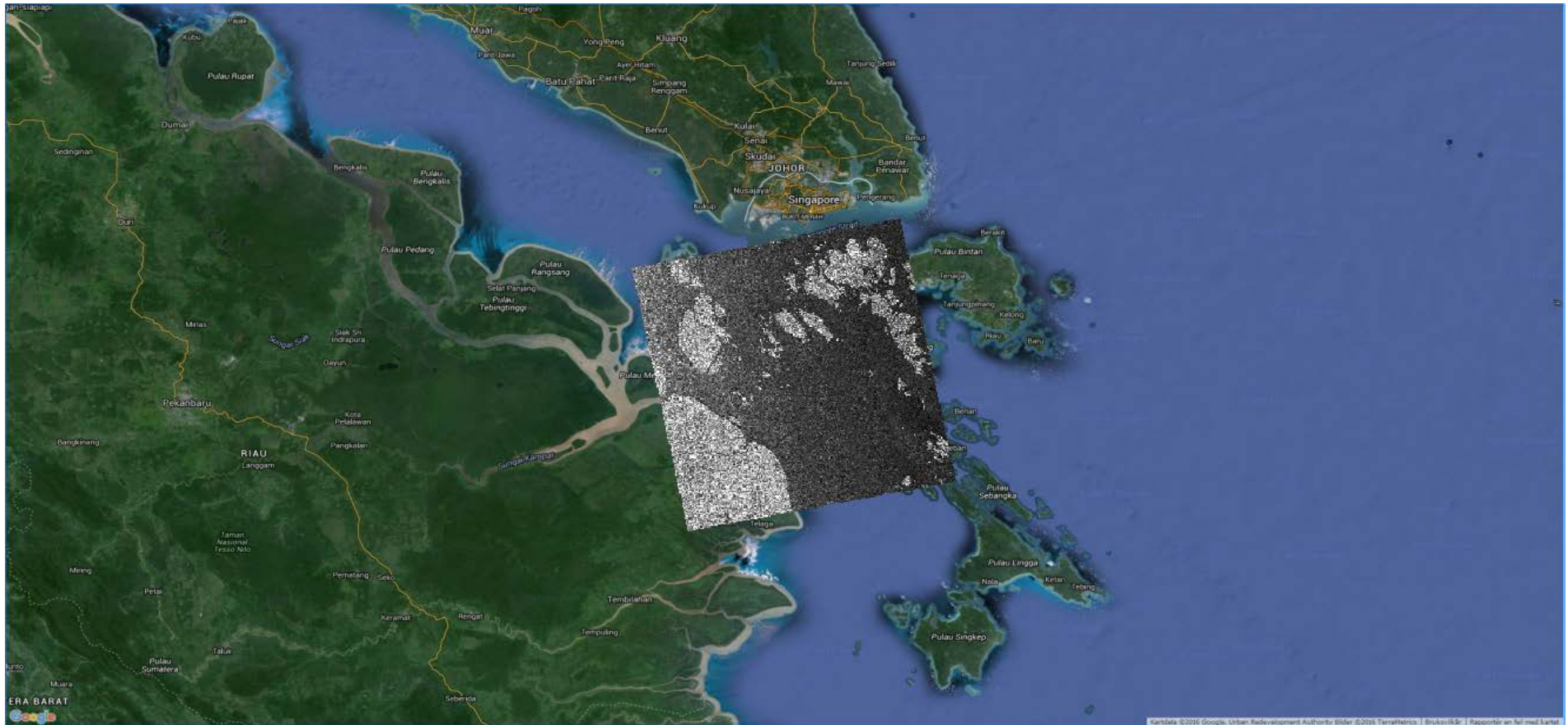




# IMAGERY PROVIDED TO CATAPULT FOR VESSEL DETECTION

## February 7 2016

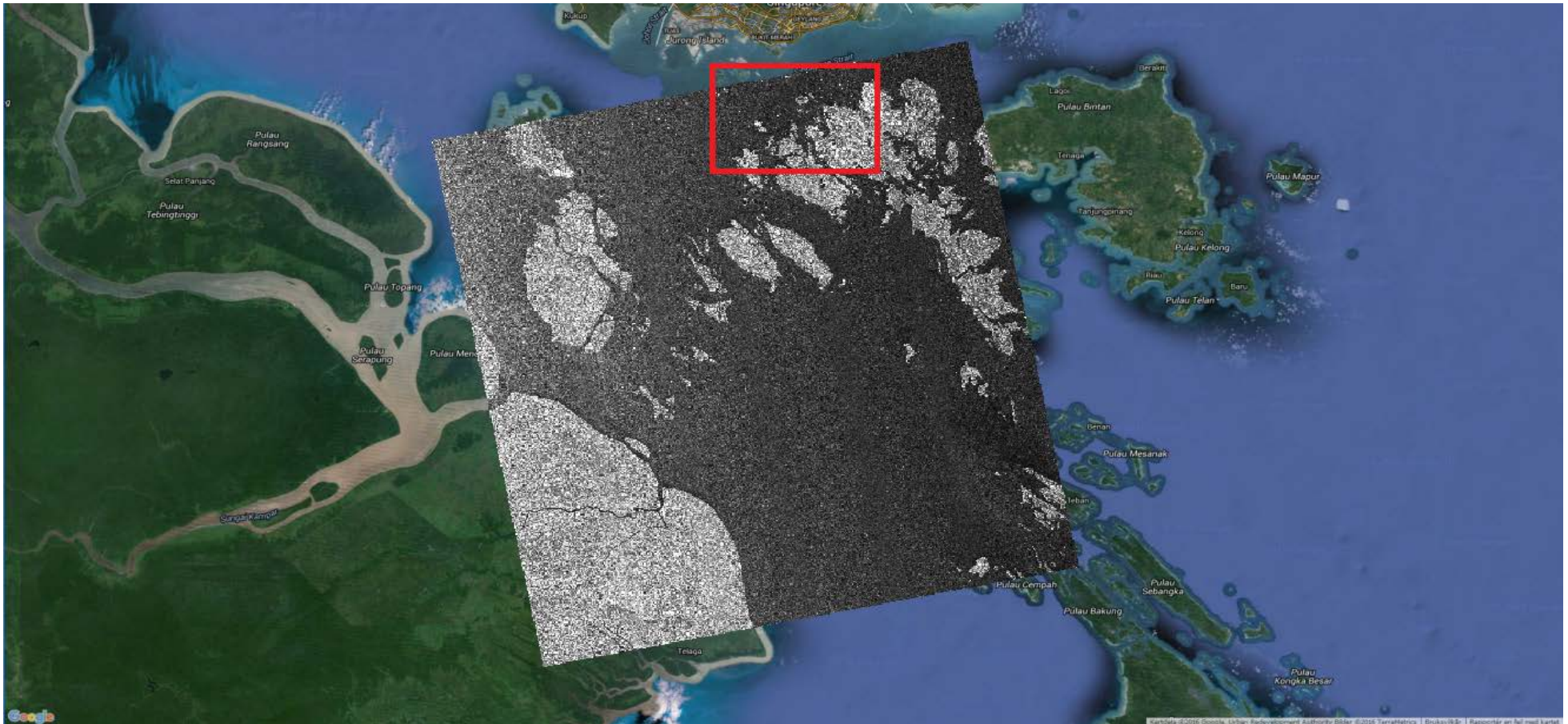
RISAT-1 MRS - Over the Malacca strait- 25/6 2015  
25 m resolution – 115 km swath width - VV polarization



# IMAGERY PROVIDED TO CATAPULT FOR VESSEL DETECTION

## February 7 2016

## Overview 2

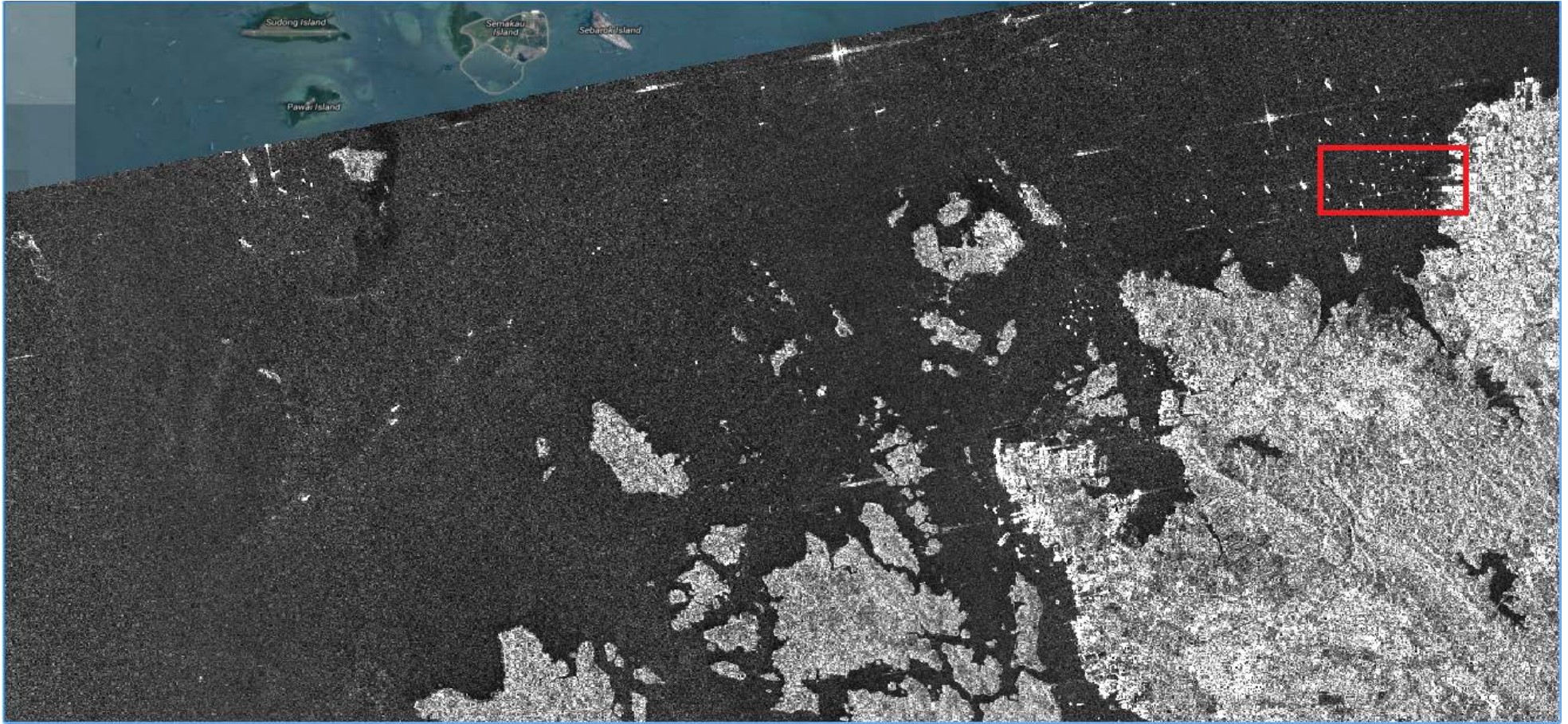




# IMAGERY PROVIDED TO CATAPULT FOR VESSEL DETECTION

February 7 2016

## Vessel activity



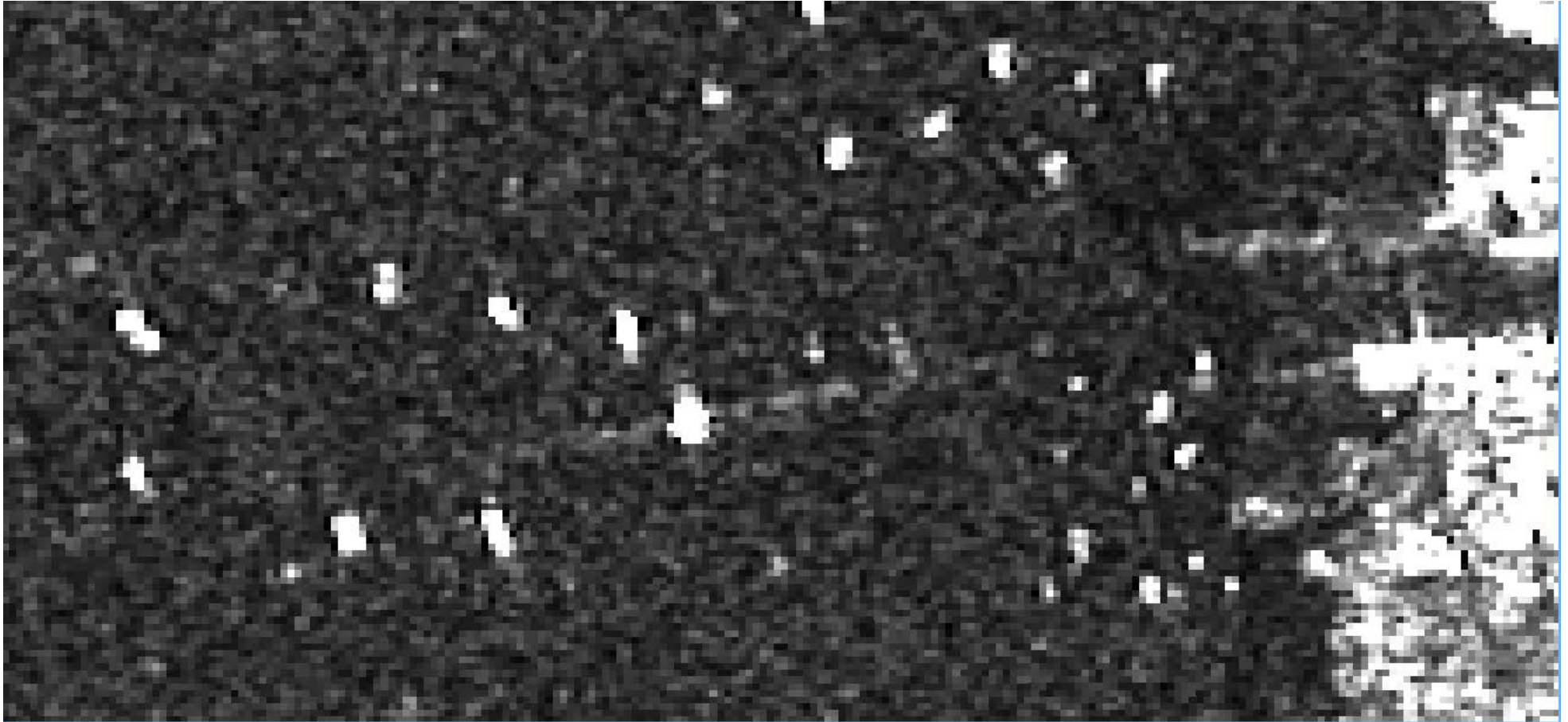


# IMAGERY PROVIDED TO CATAPULT FOR VESSEL DETECTION

February 7 2016

**KSAT**  
KONGSBERG  
KONGSBERG SATELLITE SERVICES

Approximate vessel sizes 20-100 m



# IMAGERY PROVIDED TO CATAPULT FOR VESSEL DETECTION

## February 7 2016

Google earth same area



# VESSEL DETECTION (IUU FISHING)

## LIBERIA & SENEGAL: VESSEL DETECTION SATELLITE SAR, CORRELATED AIS



The World Bank

### BACKGROUND

- World Bank, FACT, European Space Agency, Liberia and Senegal
- Vessel Detection Services by KSAT (AIS from eXactEarth)

### OBJECTIVES

- Detect IUU fishing, related logistic support
- Trend analysis of IUU areas, hot-spots
- Proximity of IUU fishing to sensitive habitats
- Unreported fishing vessels in harbors
- Characterization of IUU activity around West Africa
- Detect 25m+ ocean-going illicit non-African fishing vessels



European Space Agency



### OUTPUT

- 5-7 Vessel Detection Reports per week
- Multi-mission (5 satellites), Near Real-Time delivery
- Final results being compiled, assessed, by ESA

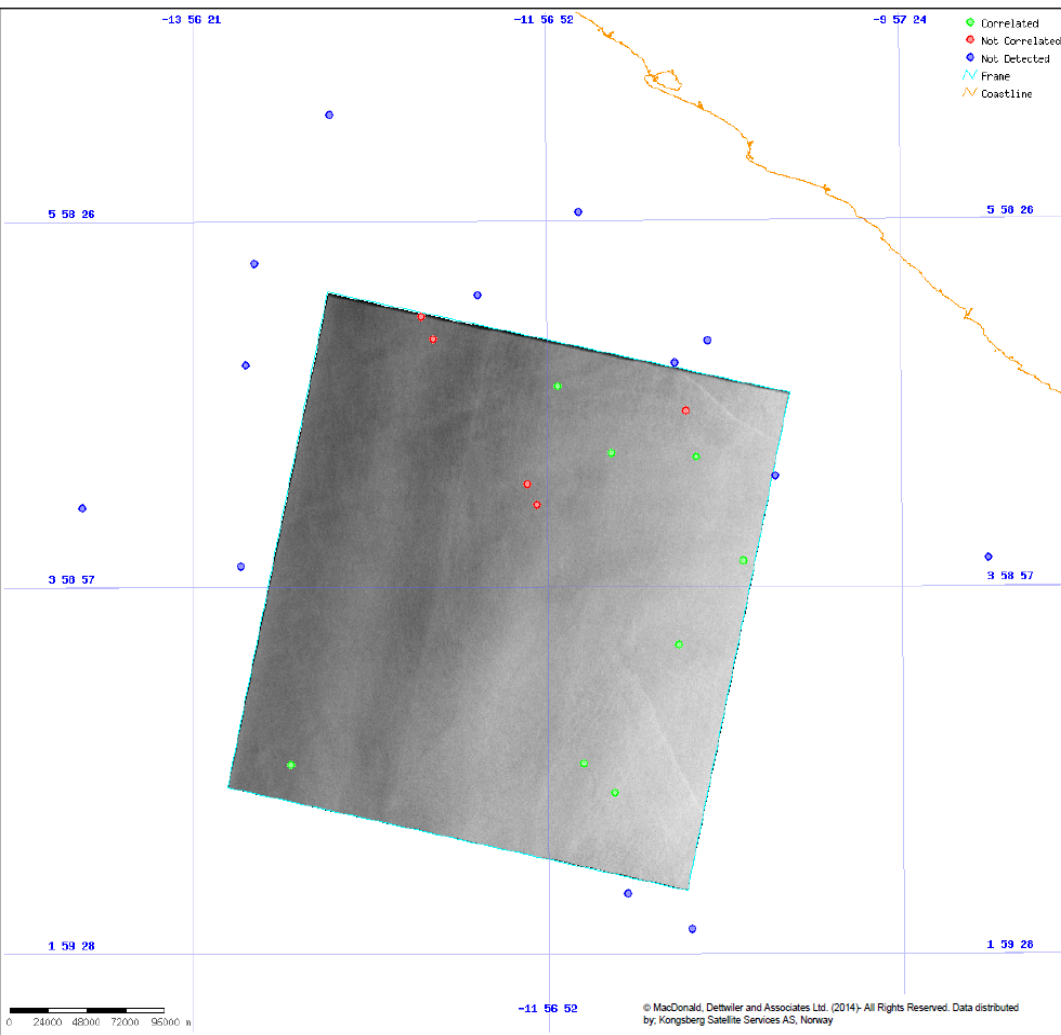


# KSAT VESSEL DETECTION ACTIVITIES (IUU)

LIBERIA & SENEGAL: VESSEL TRACKING WITH SATELLITE AIS & SAR (REPORT - 1 JULY)

## ANALYSIS FORESEEN

- Identification of anomalous behavior
- Proximity of vessels to each other
- Commercial vessels without transponder identification (reefers)
- Vessels in restricted areas
- Unreported presence of fishing vessels in harbors
- Stats on licit and IUU fishing to inform enhanced management policies
- IUU hot spots
- Proximity of IUU fishing to sensitive habitats
- Characterization of fishing activity levels, spatial distribution, over coastal West Africa



### VESSEL DETECTION REPORT

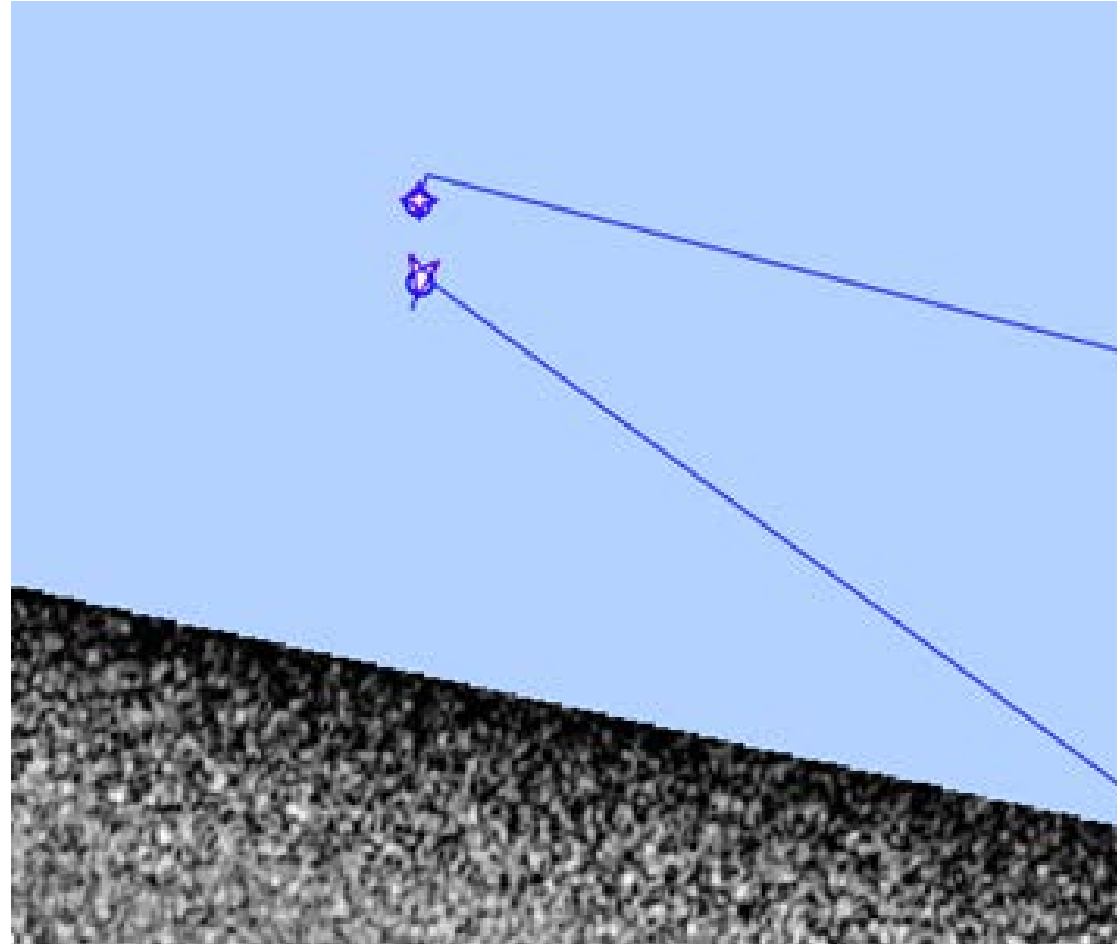
| Possible vessels detected         |  |
|-----------------------------------|--|
| Satellite:                        | RADARSAT-2   |
| Sensor:                           | SAR  |
| Swath:                            | SCNB   |
| Polarization:                     | HH HV  |
| Resolution:                       | 50 meters  |
| Acquisition time:                 | 2015-07-01 06:31:36.121 UTC  |
| Scene coordinates:                | 05° 35' 26.73 " N / 013° 10' 46.71 " W<br>05° 02' 01.31 " N / 010° 35' 11.69 " W<br>02° 54' 01.08 " N / 013° 45' 02.39 " W<br>02° 19' 59.48 " N / 011° 10' 05.32 " W |
| Detected vessels:                 | 13   |
| Vessel traffic information source |  |
| AIS                               |  |
| Correlated results                | Number   |
| Correlated                        | 8  |
| Non-correlated                    | 5  |
| Not detected in SAR               | 14   |
| Comments                          |  |
| N/A                               |  |

# VESSEL DETECTION (IUU FISHING)

## LIBERIA & SENEGAL: VESSEL TRACKING WITH SATELLITE AIS & SAR

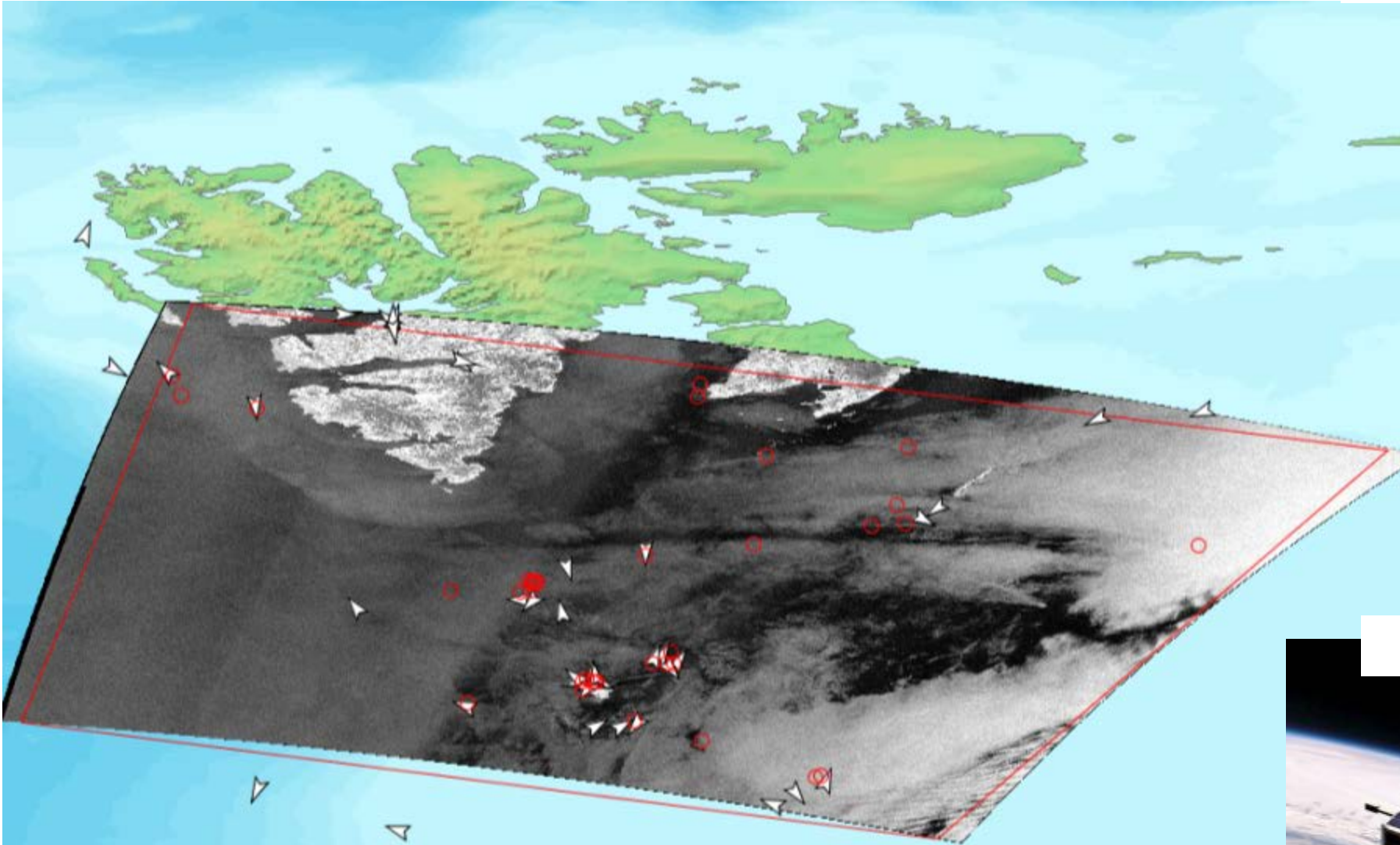
### SUSPICIOUS BEHAVIOUR – 1 JULY 2015

- “Reefers” are refrigerated ships ideal for transporting caught fish
- KSAT Vessel Detection report shows two reefers, FRIO PACIFIC and FRIO KYKNOS meeting
- Could be for trans-shipment of catch
- Just off the SAR image area but detected with SATAIS

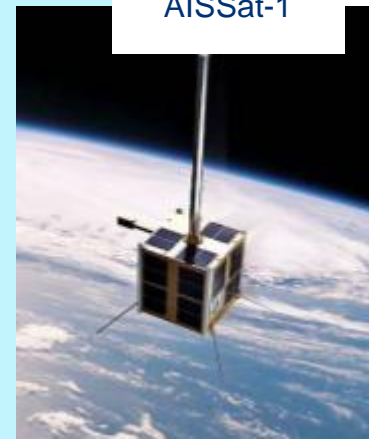


# KSAT VESSEL DETECTION ACTIVITIES (IUU)

BARENTS SEA MONITORING BY NORWEGIAN COAST GUARD (RADARSAT-2 AND AISSAT-1)



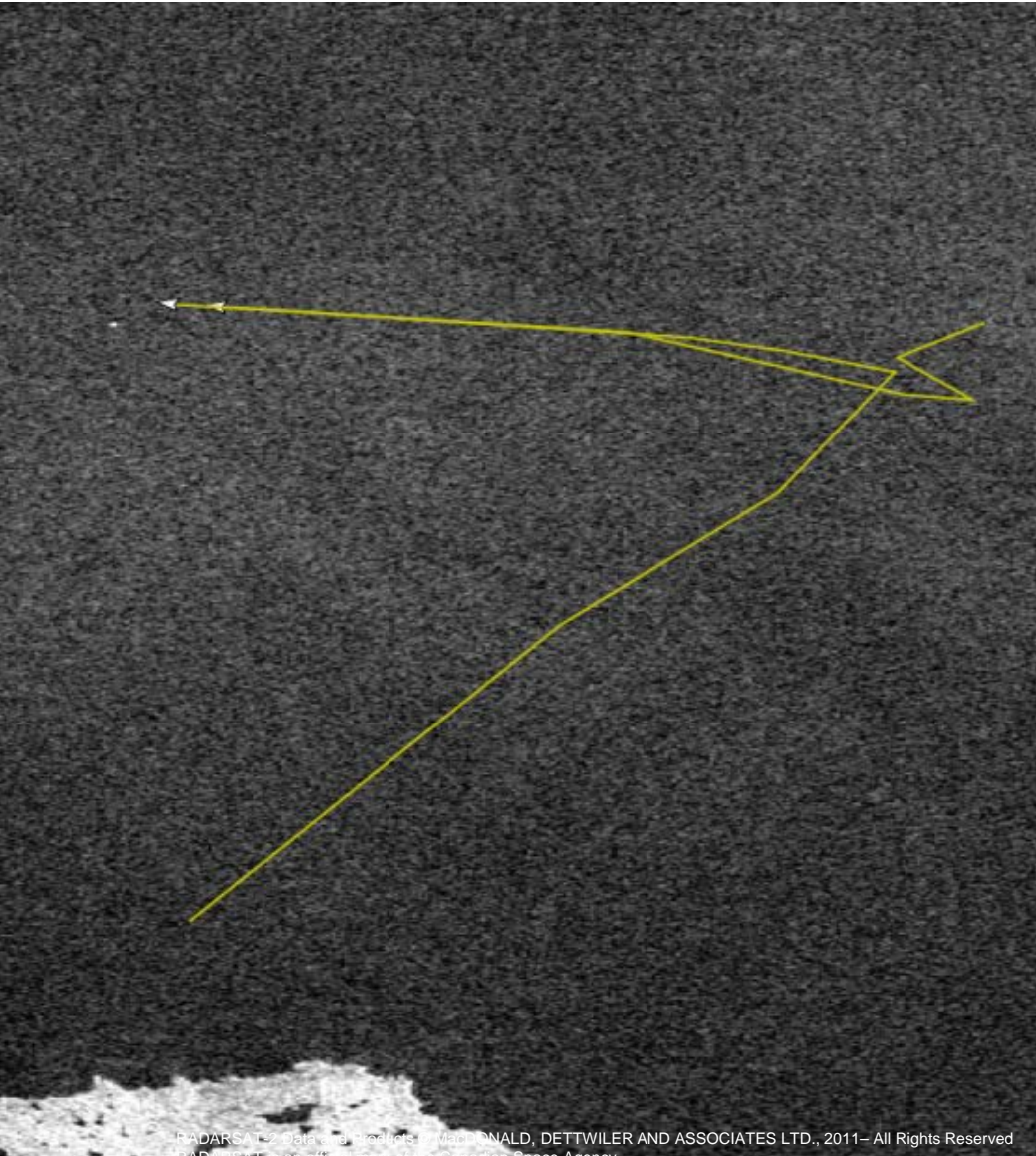
AISSat-1





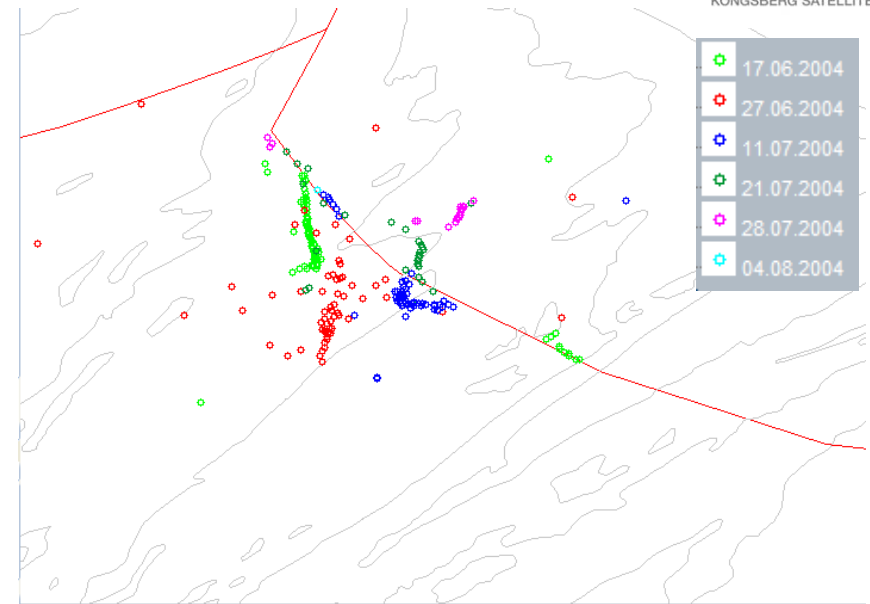
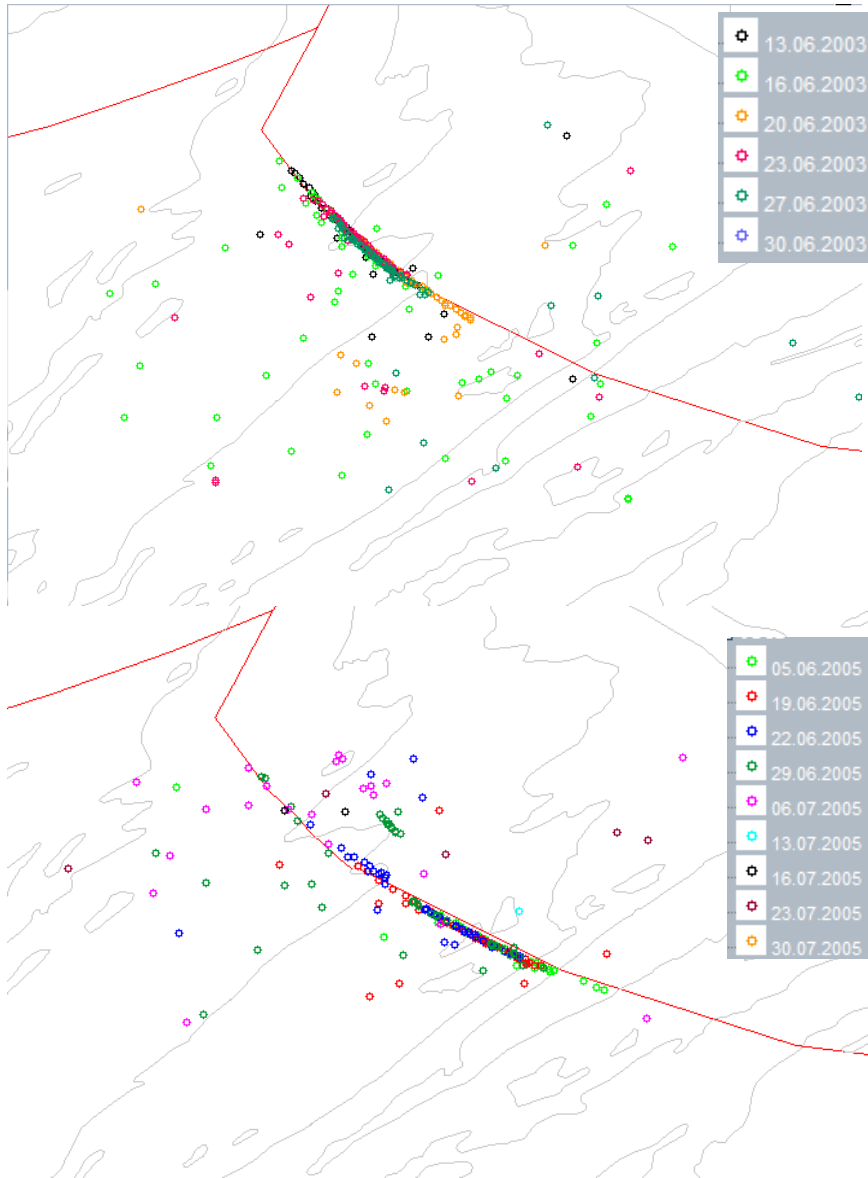
# KSAT VESSEL DETECTION ACTIVITIES (IUU)

## IDENTIFICATION OF TRANSHIPMENT ACTIVITY



# VESSEL DETECTION (IUU FISHING)

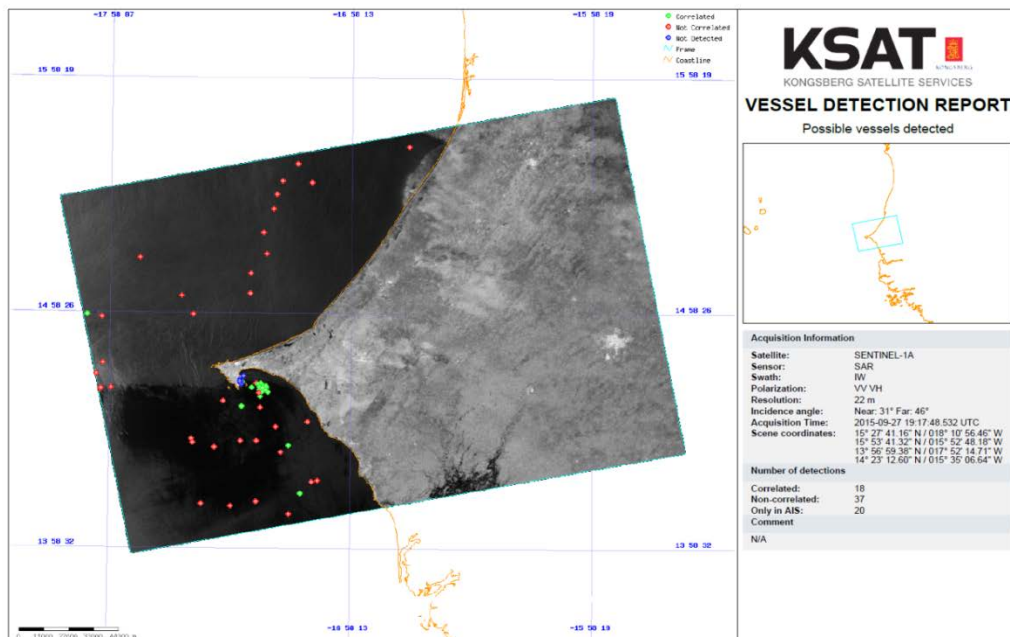
## ESTABLISH FISHING PATTERNS (2003-2006)



- European Commission (Joint Research Centre) monitored fishing activities in the NE Atlantic for several years
- KSAT delivered the satellite images

# VESSEL DETECTION (IUU FISHING)

## VESSEL DETECTION REPORTS – PDF, ELECTRONIC GIS FORMATS



### Detected vessels - correlated with AIS

|  |   |   |  |   |   |
|--|---|---|--|---|---|
|  | <b>MMSI</b> 477037100<br><b>IMO</b> 9609636<br><b>Name</b> SILVERMINE<br><b>Length/Width</b> 677m / N/A<br><b>Destination</b> N/A   | <b>Position</b> 15.6940N 18.2264W<br><b>Heading</b> 359<br><b>Speed</b> 10 kts<br><b>Confidence</b> 1.0 |  | <b>MMSI</b> 530004308<br><b>IMO</b> 9333125<br><b>Name</b> S. ATLANTIC<br><b>Length/Width</b> 125m / N/A<br><b>Destination</b> HIGH SEA | <b>Position</b> 15.4673N 18.1285W<br><b>Heading</b> 170<br><b>Speed</b> 11 kts<br><b>Confidence</b> 1.0 |
|  | <b>MMSI</b> 235081745<br><b>IMO</b> 9302657<br><b>Name</b> EDITH KIRK<br><b>Length/Width</b> 250m / N/A<br><b>Destination</b> N/A   | <b>Position</b> 16.1023N 18.3376W<br><b>Heading</b> 10<br><b>Speed</b> 12 kts<br><b>Confidence</b> 1.0  |  | <b>MMSI</b> 351887000<br><b>IMO</b> 9197289<br><b>Name</b> NPS CENTURY<br><b>Length/Width</b> 554m / N/A<br><b>Destination</b> N/A      | <b>Position</b> 15.4048N 18.1673W<br><b>Heading</b> 180<br><b>Speed</b> 11 kts<br><b>Confidence</b> 1.0 |
|  | <b>MMSI</b> 256592000<br><b>IMO</b> 9389930<br><b>Name</b> PRIVSEA<br><b>Length/Width</b> 356m / N/A<br><b>Destination</b> MONROVIA | <b>Position</b> 14.9622N 17.9969W<br><b>Heading</b> 100<br><b>Speed</b> 13 kts<br><b>Confidence</b> 1.0 |  | <b>MMSI</b> 256345000<br><b>IMO</b> 9497579<br><b>Name</b> PAOLA<br><b>Length/Width</b> 430m / N/A<br><b>Destination</b> N/A            | <b>Position</b> 14.0969N 18.0004W<br><b>Heading</b> 178<br><b>Speed</b> 11 kts<br><b>Confidence</b> 1.0 |
|  | <b>MMSI</b> 357231000<br><b>IMO</b> 9275381<br><b>Name</b> ATHENA<br><b>Length/Width</b> 215m / N/A<br><b>Destination</b> N/A       | <b>Position</b> 14.4024N 17.9195W<br><b>Heading</b> 169<br><b>Speed</b> 16 kts<br><b>Confidence</b> 1.0 |  | <b>MMSI</b> 53002070<br><b>IMO</b> 9254867<br><b>Name</b> STAR ALINE<br><b>Length/Width</b> 327m / N/A<br><b>Destination</b> N/A        | <b>Position</b> 13.9253N 17.8592W<br><b>Heading</b> 174<br><b>Speed</b> 13 kts<br><b>Confidence</b> 1.0 |

## Delivery of Vessel Detection Reports

- PDF email report (SMS notification if wanted)
- KSAT Web Portal (current reports, archive, in secure customer cloud space)
- Secure FTP download
- Standard electronic GIS formats – ingestion into systems of enforcement authorities



## Correlated vessels (8)

| MMSI                      | IMO     | Calculated position                    | Calc. speed (knot) | Calc. bearing | Destination | Vessel name     | Vessel traffic info |
|---------------------------|---------|--|--------------------|---------------|-------------|-----------------|---------------------|
| <a href="#">538005345</a> | 9874189 | 04° 41' 10.27 " N / 011° 06' 50.76 " W | 15.50              | 299           |             | GLOVIS SUPERIOR | KSAT                |
| <a href="#">838091917</a> | 9497452 | 03° 01' 37.50 " N / 011° 44' 45.86 " W | 11.30              | 322           |             | VEGA NEPTUNE    | KSAT                |
| <a href="#">240653000</a> | 9304617 | 04° 42' 41.62 " N / 011° 35' 21.03 " W | 11.80              | 121           |             | MINERVA DOXA    | KSAT                |
| <a href="#">212084000</a> | 9277747 | 05° 04' 34.02 " N / 011° 53' 16.30 " W | 13.40              | 130           | LOME        | VENUS R         | KSAT                |
| <a href="#">564853000</a> | 9424613 | 02° 52' 00.24 " N / 011° 34' 30.51 " W | 12.40              | 325           |             | THOR FORTUNE    | KSAT                |
| <a href="#">224739000</a> | UNKNOWN | 03° 40' 12.55 " N / 011° 12' 44.39 " W | 7.70               | 109           |             | unknown         | KSAT                |
| <a href="#">538003882</a> | 9422524 | 03° 01' 09.04 " N / 013° 23' 38.06 " W | 11.00              | 136           | GAMBA       | DUBAI ANGEL     | KSAT                |
| <a href="#">205548000</a> | 9418692 | 04° 07' 34.93 " N / 010° 51' 05.41 " W | 10.70              | 121           |             | FELICITY        | KSAT                |

## Non-correlated vessels (5)

| Type   | Position                               | Heading | Width (m) | Length (m) | Confidence |
|--------|--|---------|-----------|------------|------------|
| VESSEL | 04° 28' 03.49 " N / 012° 00' 25.54 " W | 126     |           | 191        | High       |
| VESSEL | 04° 56' 23.61 " N / 011° 10' 04.50 " W | 102     |           | 50         | High       |
| VESSEL | 05° 27' 32.67 " N / 012° 39' 24.33 " W | 129     |           | 336        | High       |
| VESSEL | 04° 32' 30.40 " N / 012° 03' 44.15 " W | 096     |           | 251        | High       |
| VESSEL | 05° 19' 53.47 " N / 012° 35' 21.04 " W | 122     |           | 293        | High       |

## Not detected in SAR (14)

| MMSI                      | IMO     | Calculated position                    | Calc. speed (knot) | Calc. bearing | Destination | Vessel name          | Vessel traffic info |
|---------------------------|---------|--|--------------------|---------------|-------------|----------------------|---------------------|
| <a href="#">209309000</a> | UNKNOWN | 06° 01' 20.60 " N / 011° 46' 00.05 " W | 13.60              | 302           |             | unknown              | UNKNOWN             |
| <a href="#">235087392</a> | 9419735 | 04° 08' 16.57 " N / 009° 28' 33.89 " W | 13.80              | 094           |             | MARIANNE KIRK        | UNKNOWN             |
| <a href="#">244379000</a> | 9153642 | 04° 05' 59.13 " N / 013° 40' 29.71 " W | 9.80               | 096           |             | JUMBO VISION         | UNKNOWN             |
| <a href="#">304513000</a> | 9259381 | 05° 19' 07.77 " N / 011° 02' 29.57 " W | 16.50              | 123           | LOME        | JAN DAVID S          | UNKNOWN             |
| <a href="#">311066300</a> | 9575577 | 04° 25' 08.34 " N / 014° 33' 50.98 " W | 12.40              | 316           |             | SONANGOL PORTO AMBOI | UNKNOWN             |
| <a href="#">311579000</a> | 9247431 | 05° 44' 41.22 " N / 013° 35' 53.37 " W | 14.20              | 301           |             | ASIAN SPIRIT         | UNKNOWN             |
| <a href="#">311675000</a> | 9284362 | 05° 11' 31.84 " N / 013° 38' 48.55 " W | 13.60              | 321           |             | AFRICAN HAWK         | UNKNOWN             |
| <a href="#">352515000</a> | 8324244 | 05° 12' 17.27 " N / 011° 13' 47.00 " W | 6.00               | 194           |             | FRIO PACIFIC         | UNKNOWN             |
| <a href="#">355038000</a> | 9134816 | 05° 34' 19.16 " N / 012° 20' 13.28 " W | 11.10              | 122           |             | BLUE PHOENIX 1       | UNKNOWN             |
| <a href="#">358728000</a> | 9035072 | 05° 11' 57.62 " N / 011° 13' 46.52 " W | 5.50               | 197           |             | FRIO KYKNOS          | UNKNOWN             |
| <a href="#">538005404</a> | 9891735 | 02° 19' 05.21 " N / 011° 30' 12.78 " W | 13.30              | 262           |             | STI WEMBLEY          | UNKNOWN             |
| <a href="#">564163000</a> | 9873824 | 02° 07' 34.04 " N / 011° 08' 36.45 " W | 10.40              | 145           |             | CENTAURUS OCEAN      | UNKNOWN             |
| <a href="#">568311000</a> | 9325001 | 06° 33' 21.04 " N / 013° 10' 03.56 " W | 13.80              | 322           |             | WINNING CONFIDENCE   | UNKNOWN             |
| <a href="#">836016803</a> | 9830016 | 04° 35' 05.69 " N / 010° 39' 52.86 " W | 10.40              | 117           |             | EKARMA               | UNKNOWN             |

# VESSEL DETECTION (IUU FISHING)

## VESSEL DETECTION REPORTS – PDF, ELECTRONIC GIS FORMATS

### Delivery of Vessel Detection Reports

- PDF email report (SMS notification if wanted)
- Secure KSAT-hosted cloud space
- Secure FTP download
- Standard electronic GIS formats – ingestion into VMS systems of enforcement authorities
- Delivery to Vulcan: **45-60 minutes after image acquisition** (range: 15 to 120 minutes in extreme cases)

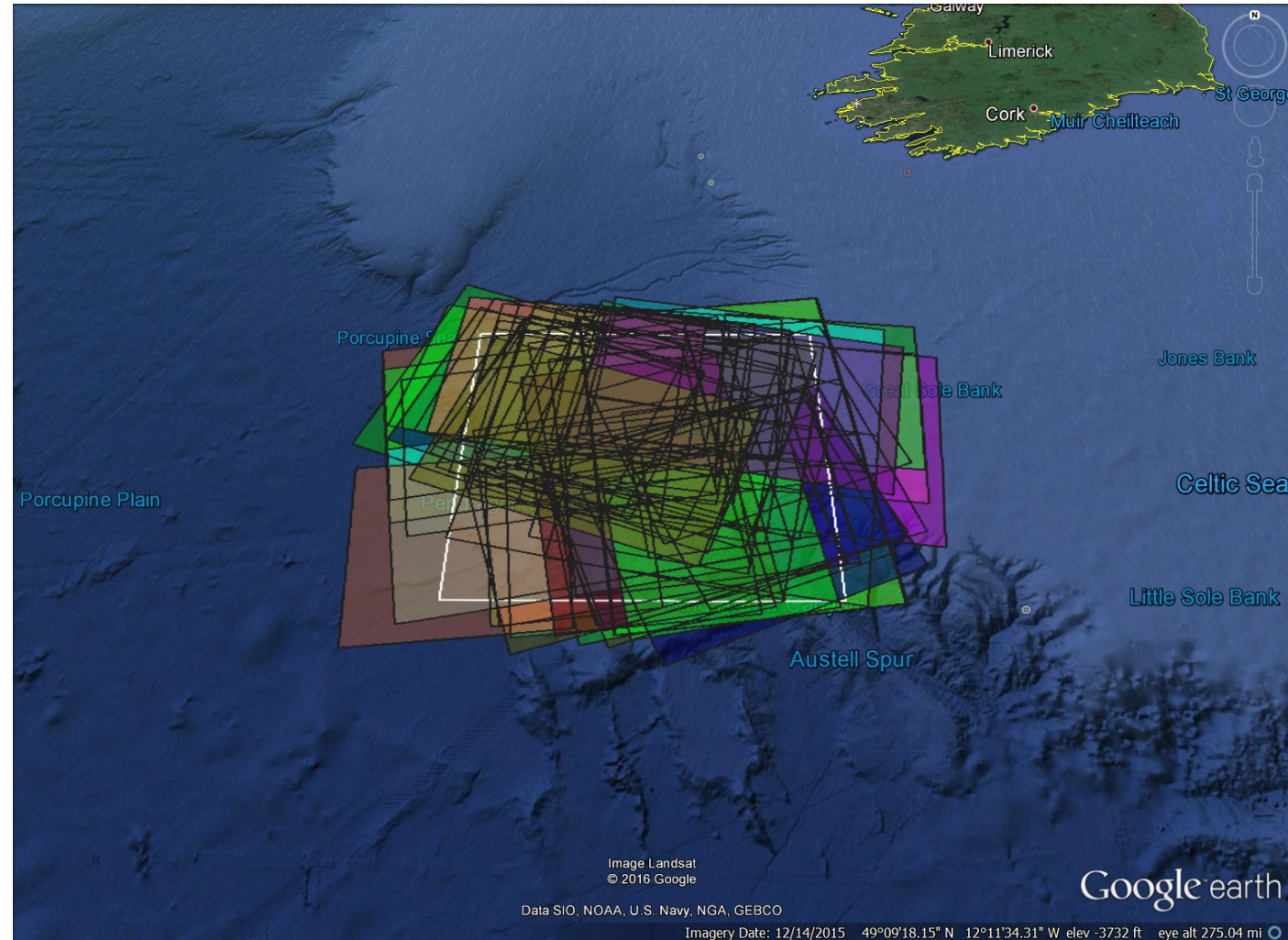
The screenshot displays the 'Kongsberg Satellite Services Delivery Portal' interface. The top navigation bar includes 'Summary', 'Oil spill detection', 'OPV Modis', and 'Site information'. The main area features a satellite map of the North Atlantic region with yellow and red vessel tracks. To the right, there is a search and results section with buttons for 'Search', 'Result', and 'Guide'. Below these are options for 'Offshore installations' and 'Features for the active product'. A table lists the search results, showing details for several RADARSAT-2 satellite acquisitions.

| Satellite  | Time                       | Unselect                            | Status  | Extra   |
|------------|----------------------------|-------------------------------------|---------|---|
| RADARSAT   | 2012-10-22<br>06:05:56 UTC | <input type="checkbox"/>            | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |
| RADARSAT-2 | 2012-10-21<br>17:15:16 UTC | <input checked="" type="checkbox"/> | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |
| RADARSAT-2 | 2012-10-21<br>17:15:16 UTC | <input type="checkbox"/>            | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |
| RADARSAT-2 | 2012-10-20<br>17:43:43 UTC | <input type="checkbox"/>            | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |
| RADARSAT-2 | 2012-10-20<br>06:16:04 UTC | <input type="checkbox"/>            | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |
| RADARSAT   | 2012-10-19<br>17:20:20 UTC | <input type="checkbox"/>            | Success | <a href="#">Oil report</a><br><a href="#">Details</a> |

KSAT's Secure Delivery Portal – Vulcan Will Have its Own Web Space With Archive & New Reports

# VESSEL DETECTION (IUU FISHING)

MONITORING THE IRISH EEZ ( MONTHS STARTING 1 JUNE 2016)



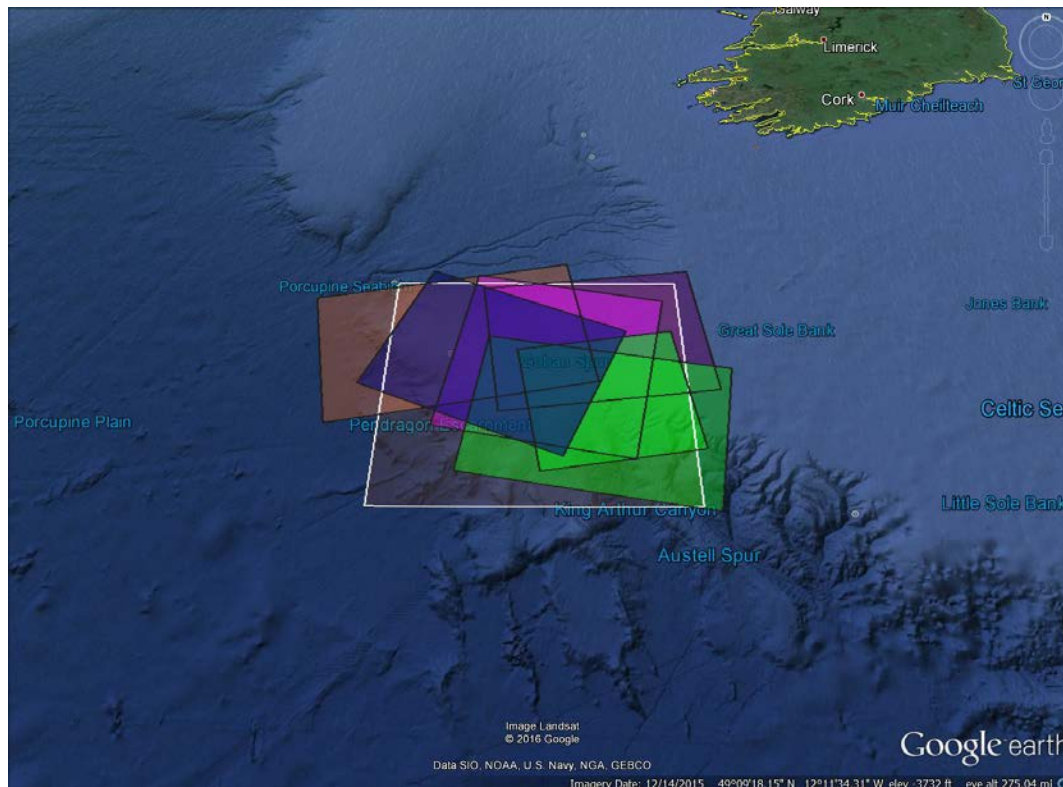
- AOI: 180 x 165 (29,700 SQKM)
- Illustrative imagery acquisition opportunities 17-24 February 2016
- 99 possible scenes
- Cover full AOI every second day



# VESSEL DETECTION (IUU FISHING)

MONITORING THE IRISH EEZ ( 17 FEBRUARY 2016)

- KSAT project manager & Order Desk/INS agree priorities
- At least 6 SAR acquisition chances daily
- Order Desk chooses 1 or 2 based on amount of area covered, exact location
- Order Desk schedules with individual satellite owners
- Orders placed at least 12 hours ahead
- Once ordered, process enters standard daily work flow

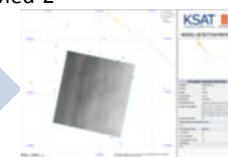


| Start           | Area Covered | Target In Image | Satellite      |
|-----------------|--------------|-----------------|----------------|
| 2/17/2016 6:21  | 37.42%       | 69.06%          | Cosmo-SkyMed-3 |
| 2/17/2016 6:39  | 37.54%       | 85.99%          | Cosmo-SkyMed-2 |
| 2/17/2016 7:07  | 48.32%       | 99.14%          | RISAT 1        |
| 2/17/2016 18:43 | 27.86%       | 98.30%          | RADARSAT-2     |
| 2/17/2016 18:46 | 43.10%       | 87.19%          | Cosmo-SkyMed-4 |
| 2/17/2016 19:58 | 43.05%       | 96.07%          | Cosmo-SkyMed-2 |

**Routine Work Flow**



**Normally 45-60 Minutes End to End**

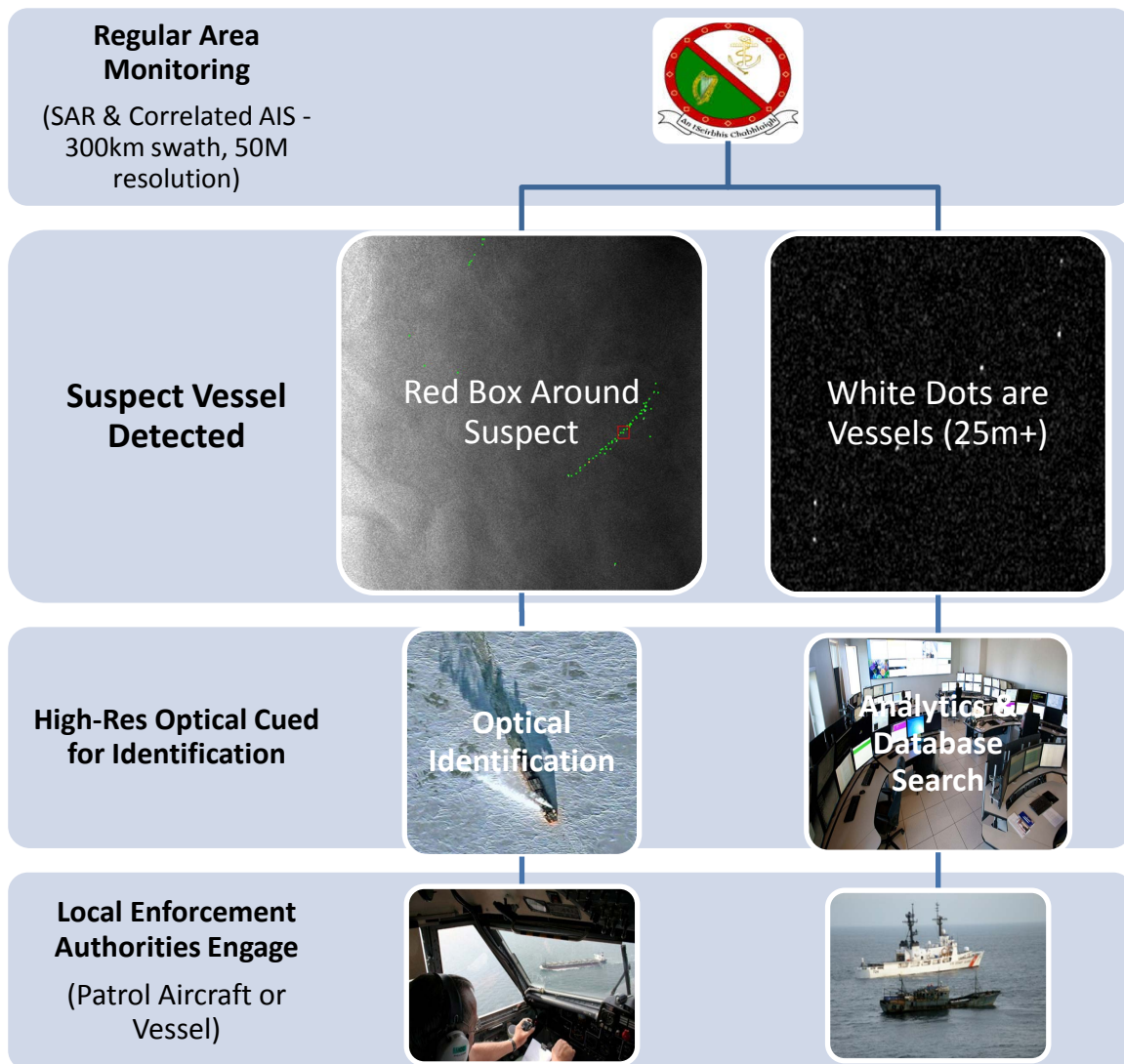
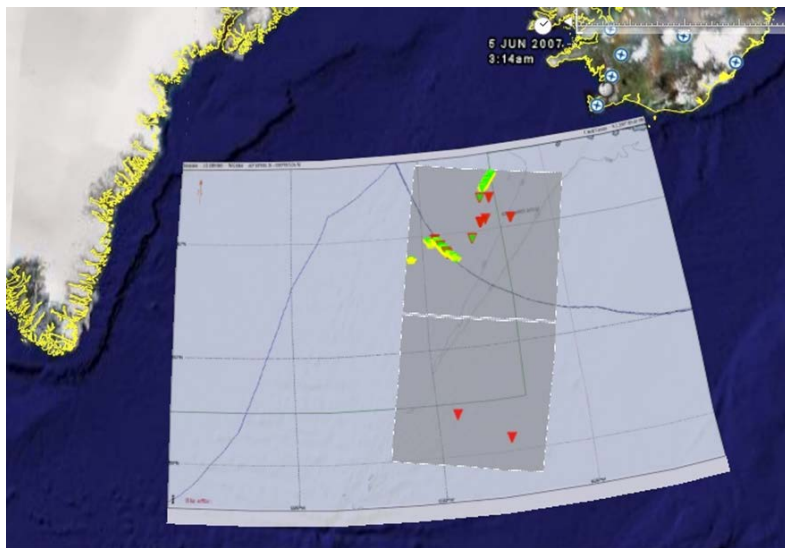


# VESSEL DETECTION (IUU FISHING)

## COUNTER-IUU OPERATIONAL MODES – REGULAR AREA MONITORING

### Regular Area Monitoring

- Strategy-driven
- Larger areas
- Aim to cover AOI daily, weekly
- High coverage scenes
- Fast delivery, but tasking can be done in advance
- Vessel behavior analysis per scene
- Framework for other modes



# VESSEL DETECTION (IUU FISHING)

PALAU, INDONESIA – MONITORING SEQUENCE DAY 1

With Today's Ordering Limitations – 16h delay (local time)

18.03

- SAR Image Acquisition

18.45

- Image downloaded at Svalbard
- Processed, analyzed

19.00

- Vessel Detection Report completed
- Sent to customer
- Suspected trans-shipment noted

20.00

- Analysis, optical order?
- KSAT orders

11.00

- Optical image taken, analyzed
- Directed to law enforcement



|             |                |
|-------------|----------------|
| Ship name   | NOVOAZOVSK     |
| Call sign   | UAWR           |
| IMO number  | 7642613        |
| Ship type   | Fishing Vessel |
| Vessel Opr  | Fishing        |
| Destination | BELLSUND       |
| Length      | 69.8 m         |
| Breadth     | 13.0 m         |



# VESSEL DETECTION (IUU FISHING)

PALAU, INDONESIA – MONITORING SEQUENCE DAY 1

## Intensive Discussions with Airbus – 6h delay

6.03

- SAR Image Acquisition

6.45

- Image downloaded at Svalbard
- Processed, analyzed

7.00

- Vessel Detection Report completed
- Sent to customer
- Suspected trans-shipment noted

8.00

- Analysis, optical order?
- KSAT Orders

14.00

- Optical image taken, analyzed
- Directed to law enforcement



**AIRBUS**  
DEFENCE & SPACE

# VULCAN'S INITIAL OPERATING CAPABILITY

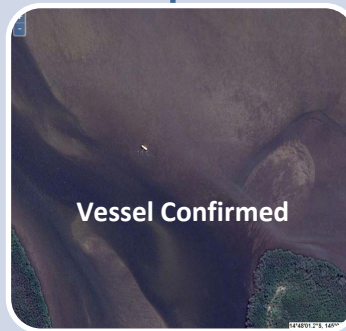
## COUNTER-IUU OPERATIONAL MODES – INTELLIGENCE-DRIVEN HUNTING



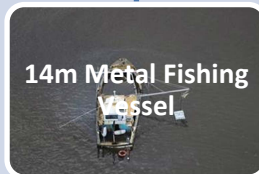
**Intelligence-Driven Hunting** (SAR & Correlated AIS - 10km swath, 1M resolution)



**Small (14m) Target Vessel Hunted Based on Intel**  
(Found with SAR, Optical then Cued)

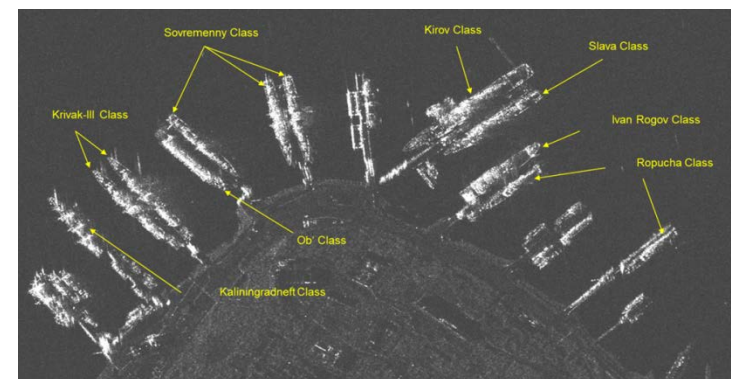


**Authorities Alerted, Get Eyes on Target**



## Intelligence-Driven Hunting

- Intelligence driven
- Semi-automatic vessel detection – looking for known specific target
- High resolution data for classification and identification
- Fast tasking
- Fast delivery
- Ideal for harbor monitoring, surveillance of fishing and logistical hot spots



# VESSEL DETECTION (IUU FISHING)

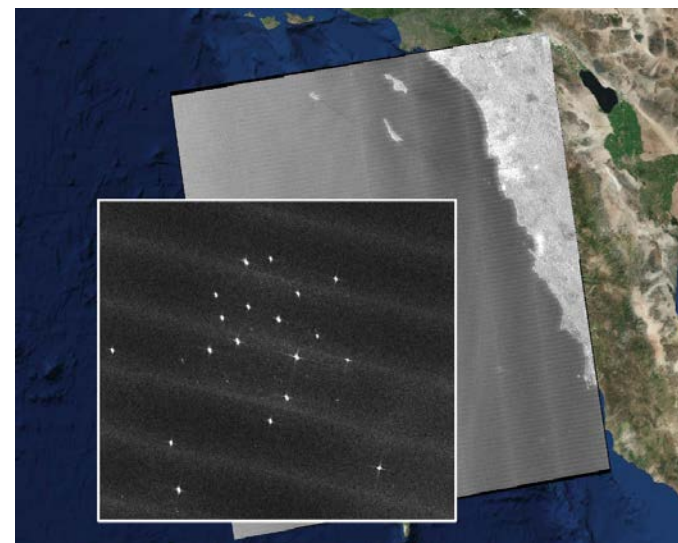
## KEY LIMITATIONS

### Technical Limitations with Current State of the Art

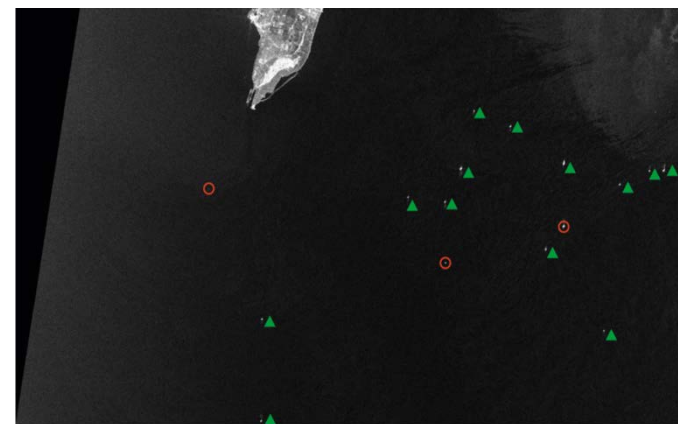
- SAR & optical satellite latency, revisit times
- Tasking timelines
- Near Real-Time processing of optical

### Short-Term Service Enhancements

- Wake detection with speed estimation
- Confidence Estimation: show certainty levels of suspect vessels
- SAR 2 SAR correlation: analyse vessel movements from 2 SAR scenes (1 to several hours apart)
- Detection Capability Map: show vessel sizes reliably detected based on ambient conditions
- New monitoring modes: 225,000SQKM coverage, detect 10m+ vessels (single pass, same timelines)
- Process delivery times will remain 45-60 minutes from acquisition to delivery *but* enhanced depth/quality of



**New Modes: Monitor 250% more ocean, Same or better Detection Capability**



**Better, Higher Confidence Targeting**



KSAT – WHO WE ARE  
VESSEL DETECTION  
**KEY TAKEAWAYS**



# KEY TAKEAWAYS

## SATELLITE-BASED MARITIME MONITORING OFFERS . . .

- Early detection of IUU activity, oil spills
- Targeted enforcement response
- Best possible cost/benefit balance
- Will deliver enhanced:
  - Maritime Domain Awareness
  - Deterrence effects
  - Data to support better targeting of scarce resources

## ENGAGE WITH US FURTHER

To develop customized solutions for individual needs - around the equator, or around the globe

KONGSBERG SATELLITE SERVICES