Celebrating 10 years CleanSeaNet service Cooperation between ESA and EMSA

Welcome

Leendert Bal / Head of Department
Department C: Operations

Lisbon / 14 November 2017

EMSA
European Maritime Safety Agency

Conference sessions

- **Session 1**
  - ✓ CleanSeaNet 10 year anniversary
- **Session 2**
  - ✓ (a) ESA/EMSA collaboration
  - ✓ (b) EMSA's involvement in the Copernicus Programme
- **Session 3**
  - ✓ Defining the future

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EMSA
European Maritime Safety Agency

Celebrating 10 years CleanSeaNet service

10 years of CleanSeaNet

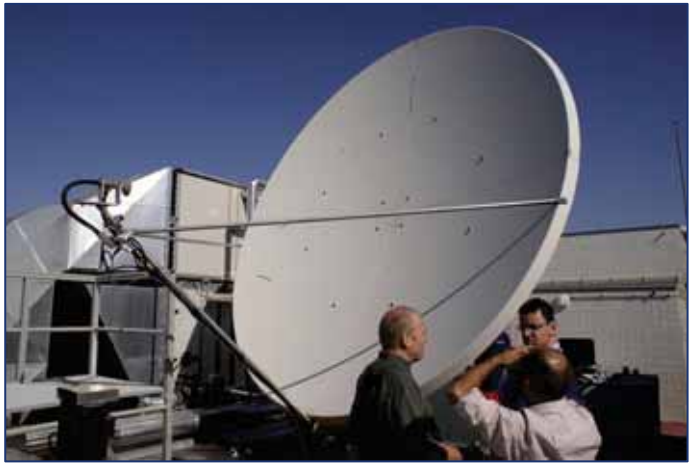
Leendert Bal / Head of Department
Department C: Operations

Lisbon / 14 November 2017

EMSA
European Maritime Safety Agency

Starting CleanSeaNet

- Article 10 of Directive 2005/35/EC of 7th of September 2005: EMSA to ***"work with the Member States in developing technical solutions and providing technical assistance in relation to the implementation of this Directive, in actions such as tracing discharges by satellite monitoring and surveillance."***
- ESA-MarCoast project
- KSAT services
- JRC-EGEMP meetings
- Clarification meetings with industry and Member States in 2005
- CleanSeaNet operational Apr.2007

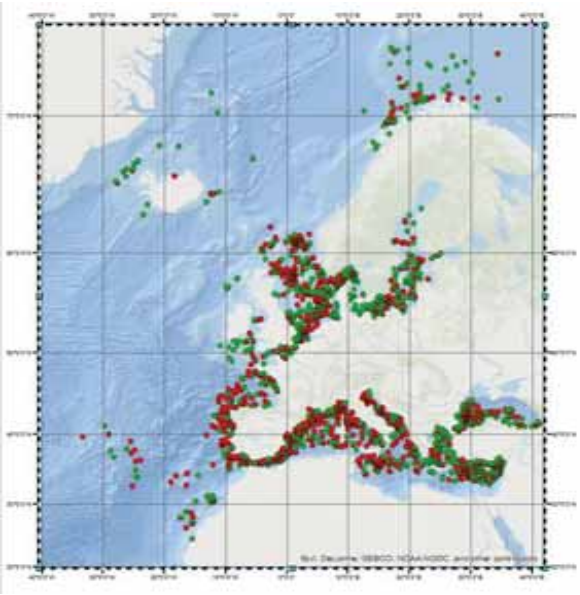


CleanSeaNet

- **Routine monitoring of all European waters for ship-source discharges**
  - ✓ Detection of possible oil spills and other discharges
  - ✓ Identification of polluters by combining CleanSeaNet and vessel traffic data
  - ✓ Information is delivered to users in quasi real time (less than 30 minutes after satellite overpass)

- **CleanSeaNet support to emergencies**
  - ✓ 31 oil spill emergencies supported

CleanSeaNet
Current figures (2016 results)



CleanSeaNet statistics 2016

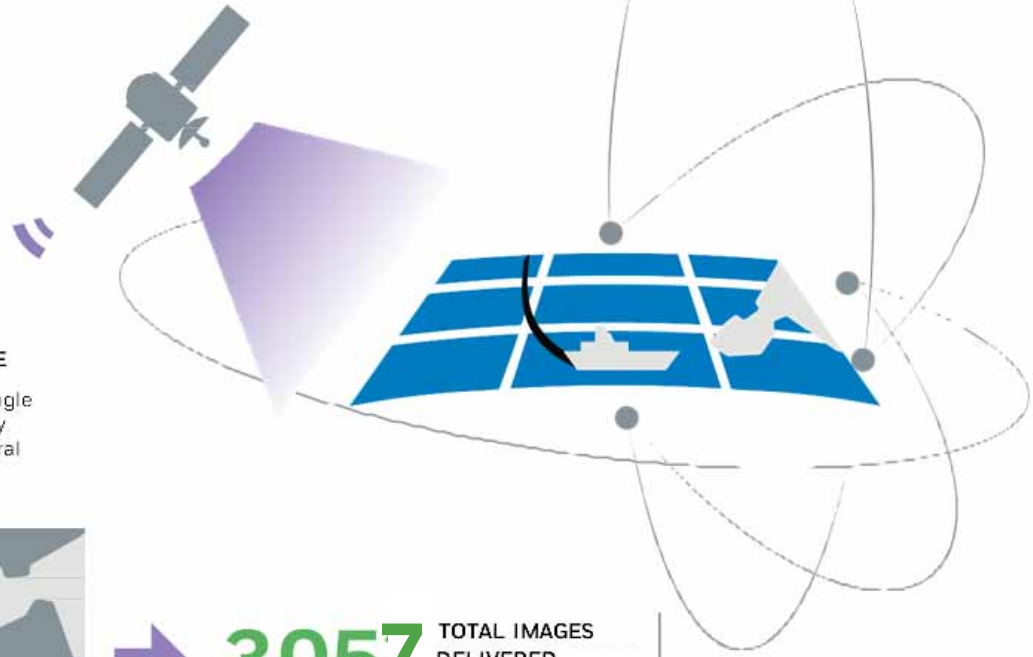
30 minutes

NEAR REAL TIME SERVICE

between satellite image acquisition and reporting of detection results to the affected coastal state

EMSA SATELLITE PORTFOLIO EXPANDED

in addition to Radarsat-2, currently EMSA's portfolio includes the Sentinel-1, the TerraSar-X and the Tandem-X constellation



500

KM ² PER IMAGE

making every single image potentially relevant for several coastal states

3057 TOTAL IMAGES DELIVERED

POSSIBLE OIL SPILLS DETECTED **3168**

641 000 000 km²

monitored

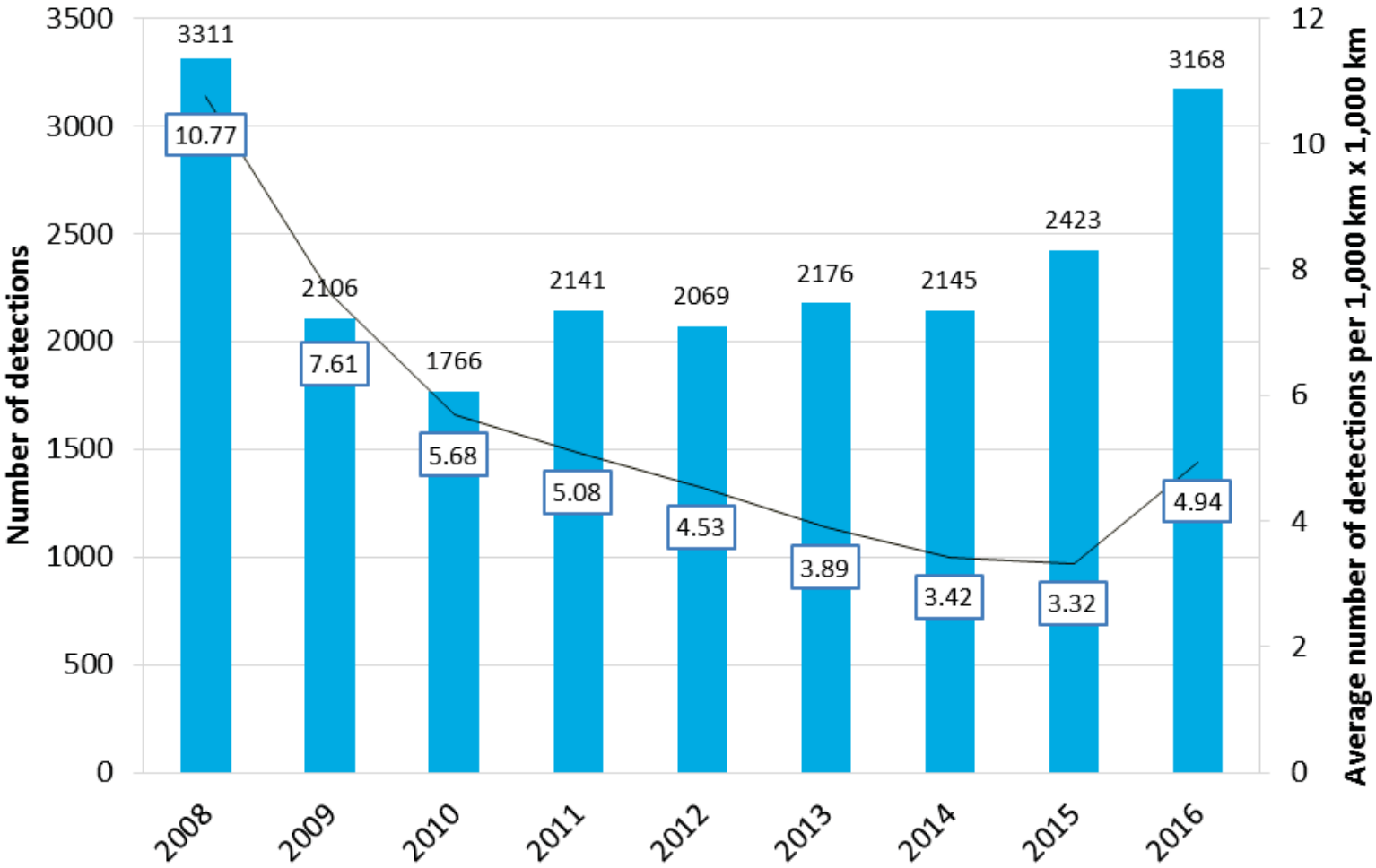
EMSA

CleanSeaNet
Benefits to EU Coastal states

- ✓Sustainable and EU-wide harmonised service
- ✓Use of the same satellite image for multiple Coastal States
- ✓Economies of scale in satellite image and service acquisition
- ✓Optimisation of the use of Coastal States surveillance assets
- ✓Deterrent effect for European waters

EMSA

CleanSeaNet
Long term deterrent effect



EMSA

CleanSeaNet
User Consultation and Training

- **CleanSeaNet yearly User Group**

  ✓Discussion on the use of the service

  ✓ Feedback / operational results

  ✓ Identification of improvements

  Strong link with users

- **CleanSeaNet Trainings**

  ✓Over 20 dedicated trainings provided at EU and National level

CleanSeaNet
Strong industry involvement

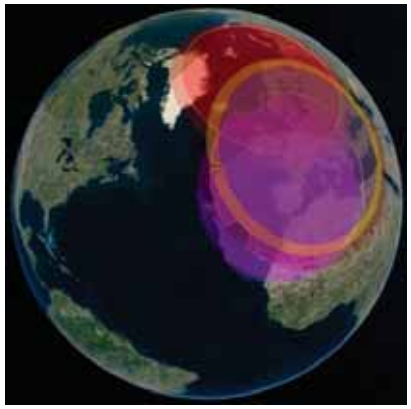
KSAT KONGSBERG
KONGSBERG SATELLITE SERVICES

CLS
COLLECTE LOCALISATION SATELLITES

EUROPEAN SPACE IMAGING®

AIRBUS DEFENCE & SPACE

MDA™



e-geos
AN ASI / TELESPAZIO COMPANY

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

A big thank you !

CleanSeaNet
Cornerstone of EMSA EO Services

OPTICAL MISSIONS

SPOT 6/7

Pleiades 1A/1B

WorldView-1

WorldView-2

WorldView-3

WorldView-4

DEIMOS-2

GeoEye-1

SAR MISSIONS

TERRASAR-X

TanDEM-X

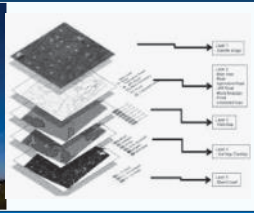
Radarsat-2

Sentinel-1 A

Sentinel-1 B

Cosmo SkyMed

SERVICE PROVIDERS



- CLS
- KSAT
- MDA
- EDISOFT
- EGEOS
- AIRBUS-DS
- EUSI

EMSA

EARTH OBSERVATION DATA CENTRE

CSN Web Portal

IMDatE Web Portal

EODC
Alert mechanism

IMS Mobile app

USERS

CleanSeaNet (Oil spill monitoring)

EU Coastal States

Greenland

SAFEMED / BSCA

BES Islands

Maritime Surveillance

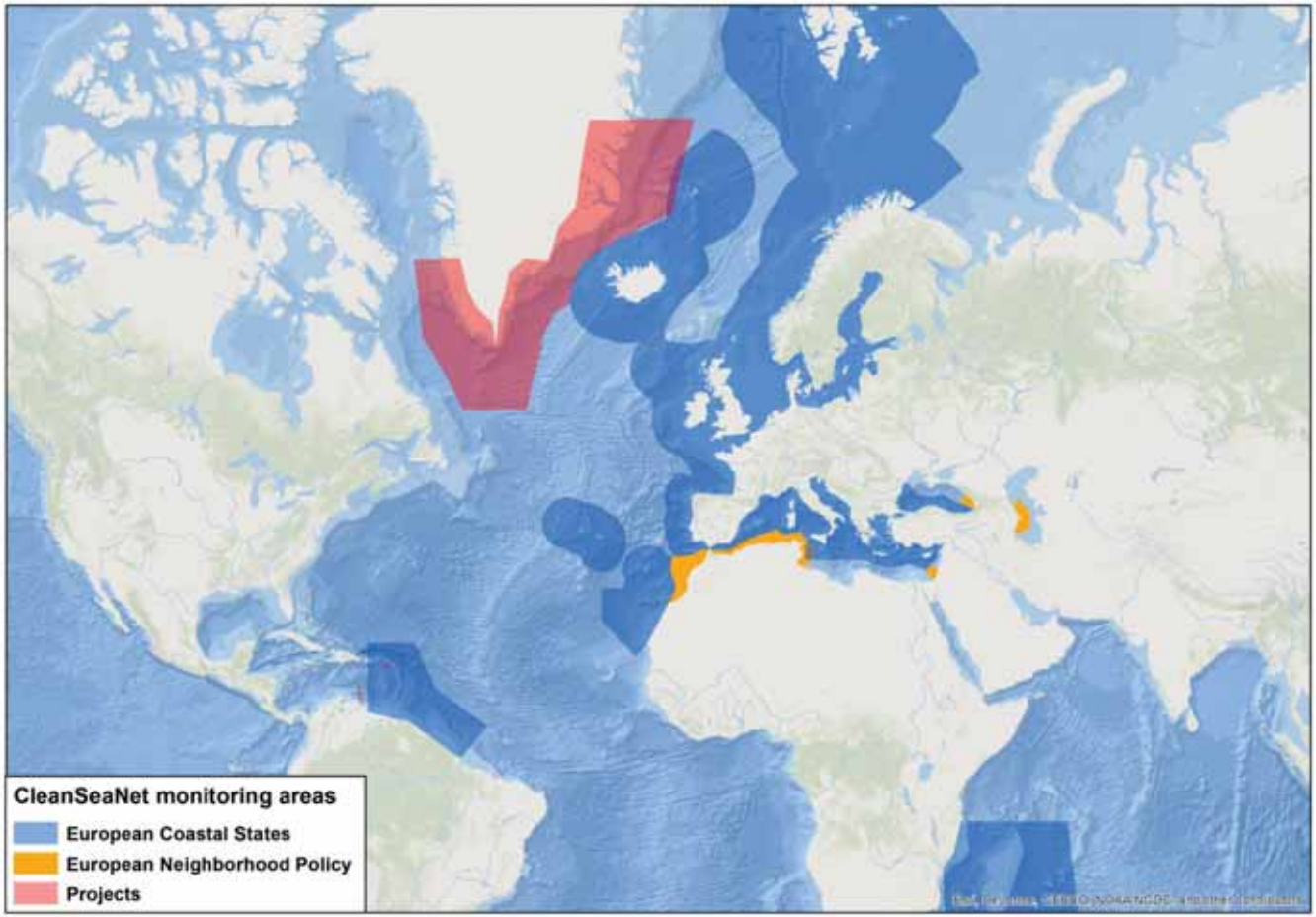
Copernicus
Europe's eyes on Earth

Border control

FRONTEX
EUROPEAN BORDER AND COAST GUARD AGENCY

CleanSeaNet
From Europe to the World

From monitoring EU Waters to surveillance of global areas of European interest



EMSA

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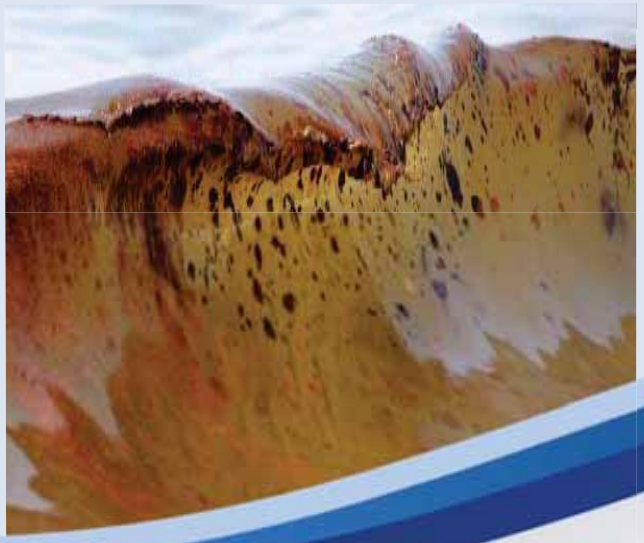
European Maritime Safety Agency

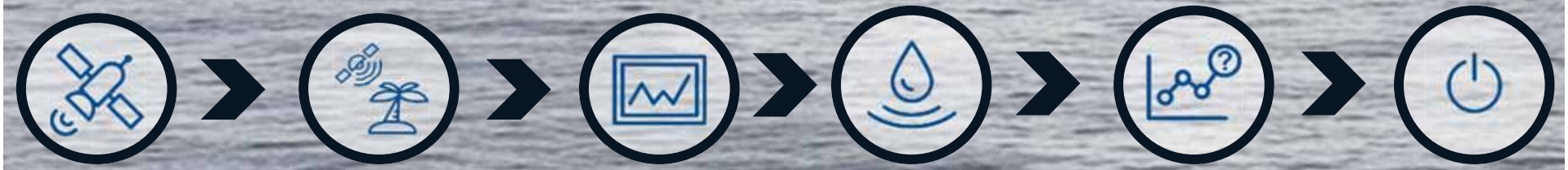


CleanSeaNet 10 Years Anniversary – Portuguese Testimonial

EMSA, 14 – 15 November 2017

AUTORIDADE MARÍTIMA NACIONAL

AGENDA



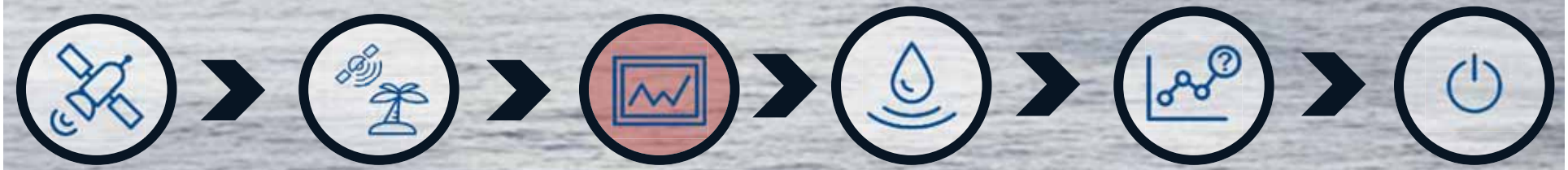
AGENDA

CSN - THE BEGGINING

AGENDA

CSN - TAKE 2

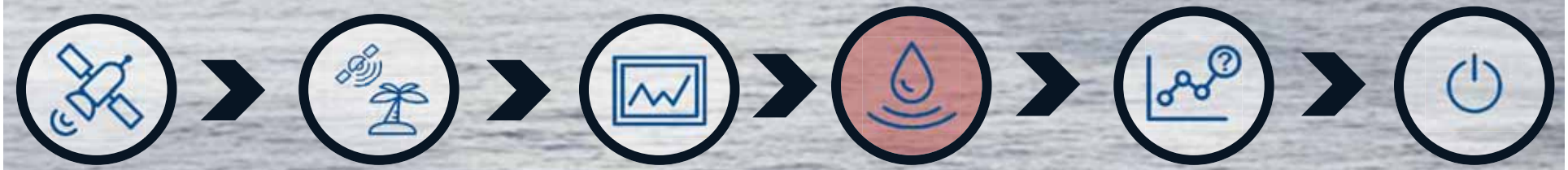
AGENDA



CSN IN

PORTUGUESE NUMBERS

AGENDA



SOME CSN CASES

AGENDA

AND NOW? WHAT ARE WE EXPECTING?

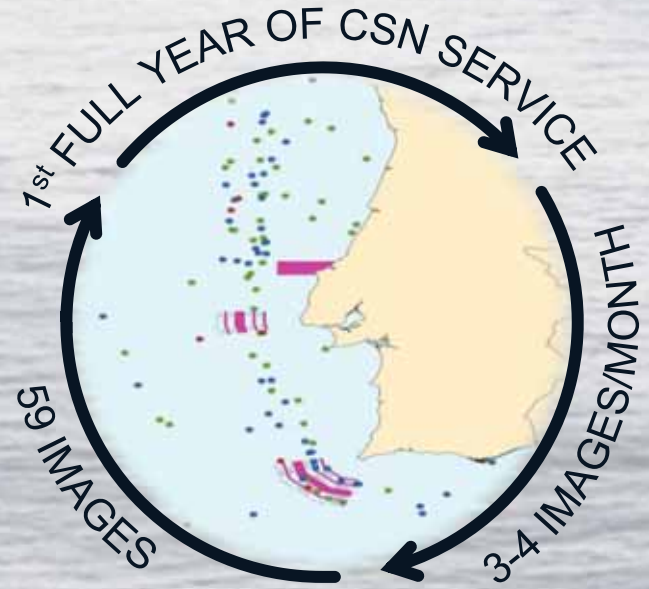
AGENDA

CONCLUSION

CSN – THE BEGINNING

AUGUST 2007

BEGINNING



END OF 2008

Potential spills detected:

69 green

53 blue

12 red

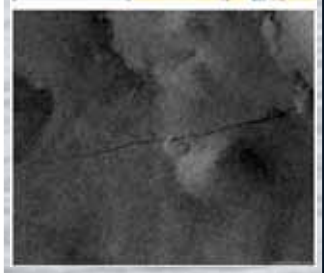
REAL OIL SPILL PROBABILITY

1 confirmed oil spill

USEFUL SERVICE NOT FULLY EXPLOITED

CSN – TAKE 2

SEPTEMBER 2010



2ND GENERATION

TODAY

More reliability on potential detections

Easiness on correlation between vessel(s) and spill(s)

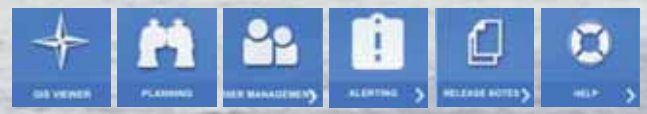
Easiness on identifying some false positives (additional layers with other data)

More spill confirmed

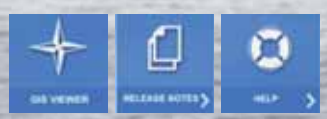
USEFUL SERVICE MORE EXPLOITED

CSN – TAKE 2

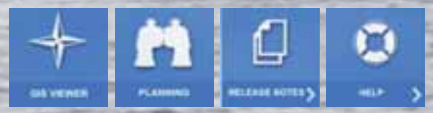
DGAM - SCPM



MRCC LISBOA



FAP – PORTUGUESE AIR FORCE



CGPM – MARITIME POLICE GENERAL COMMAND

MRCC DELGADA

MRSC FUNCHAL

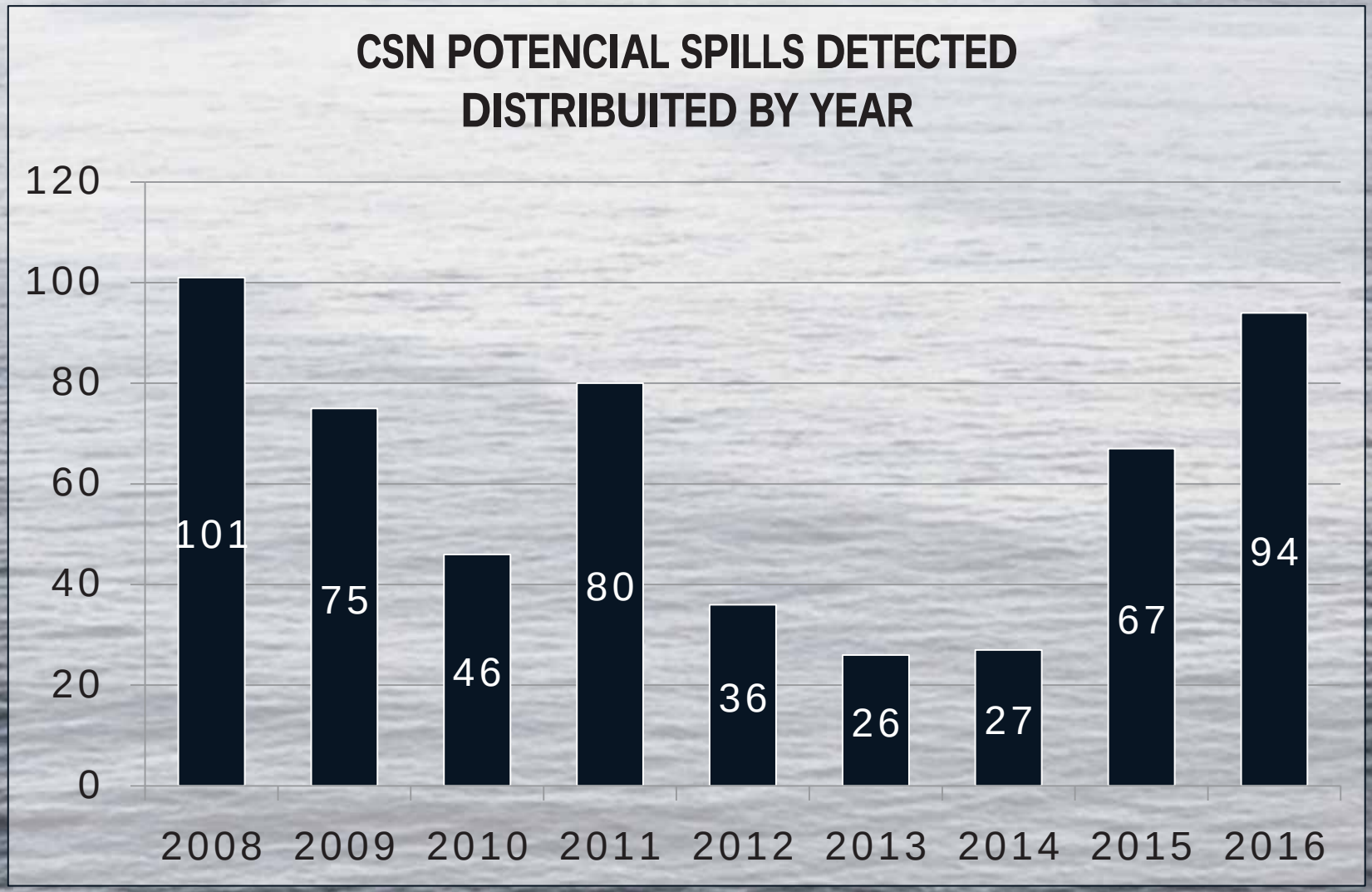
CSN – TAKE 2

ALERT

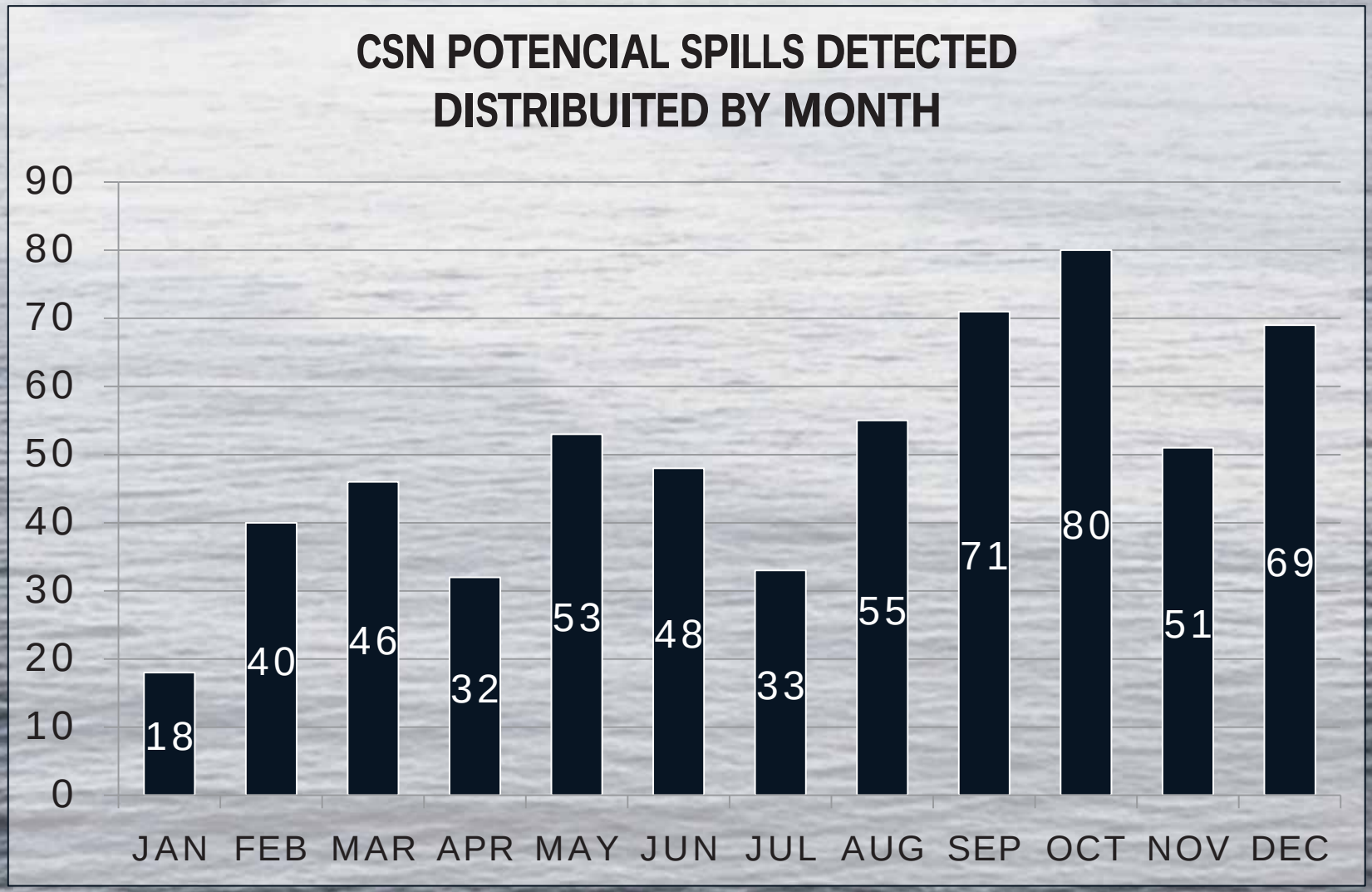
1. **POLREP**
2. **Polluter data collection**
3. **Verification/confirmation of spill in situ**
4. **Inspection/investigation of potential polluter(s)**
5. **Sample collection and further analysis**
6. **Record of all resources used and time spent**
7. **Identification and record of all claims**

ADMINISTRATIVE PENALTY OR CRIMINAL PROCESS

CSN IN PORTUGUESE NUMBERS

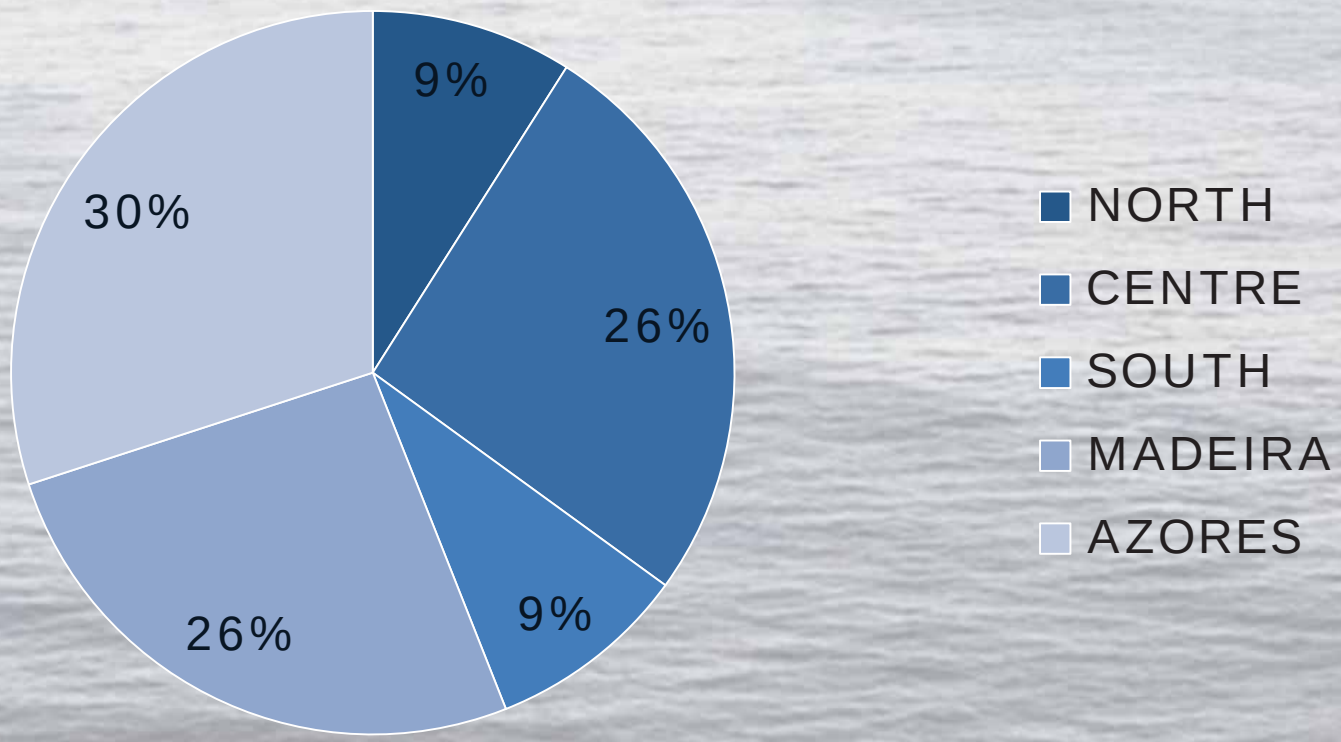


CSN IN PORTUGUESE NUMBERS



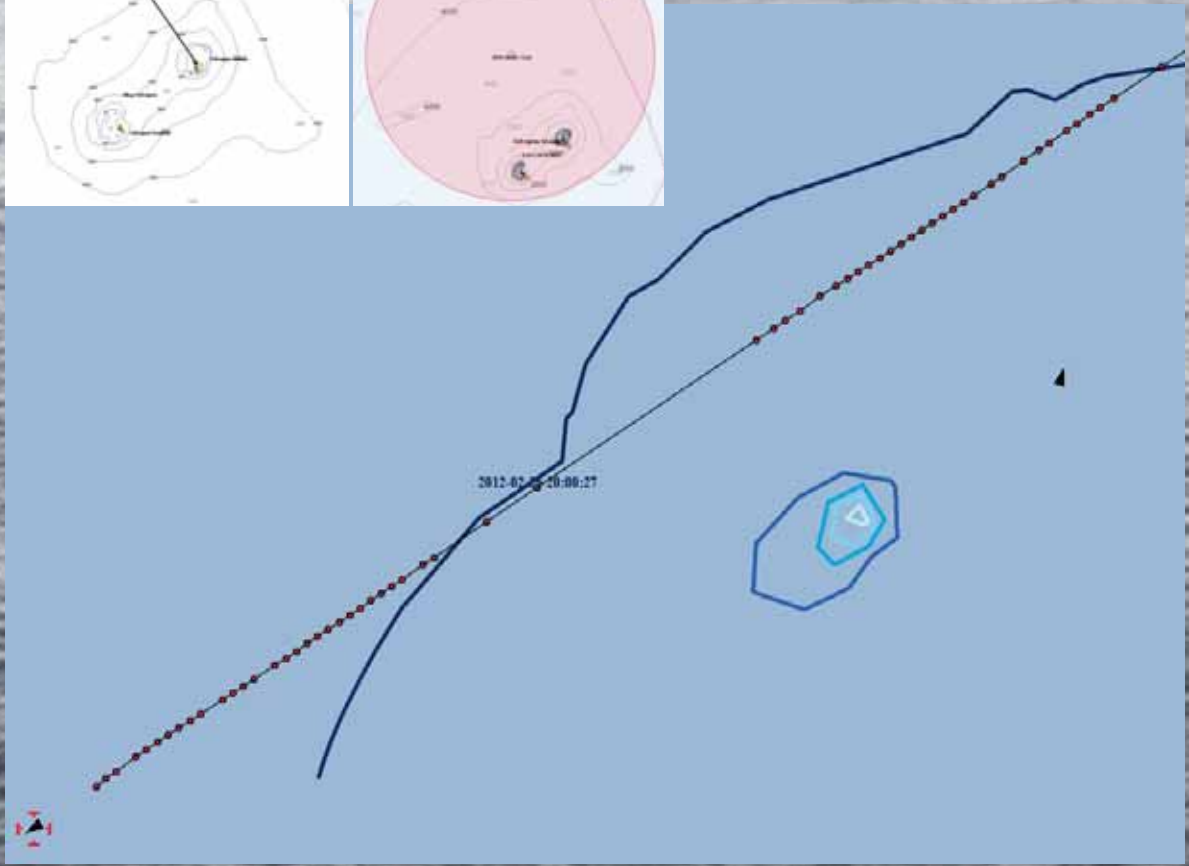
CSN IN PORTUGUESE NUMBERS

CSN POTENCIAL SPILLS DISTRIBUITED BY GEOGRAPHICAL LOCALIZATION



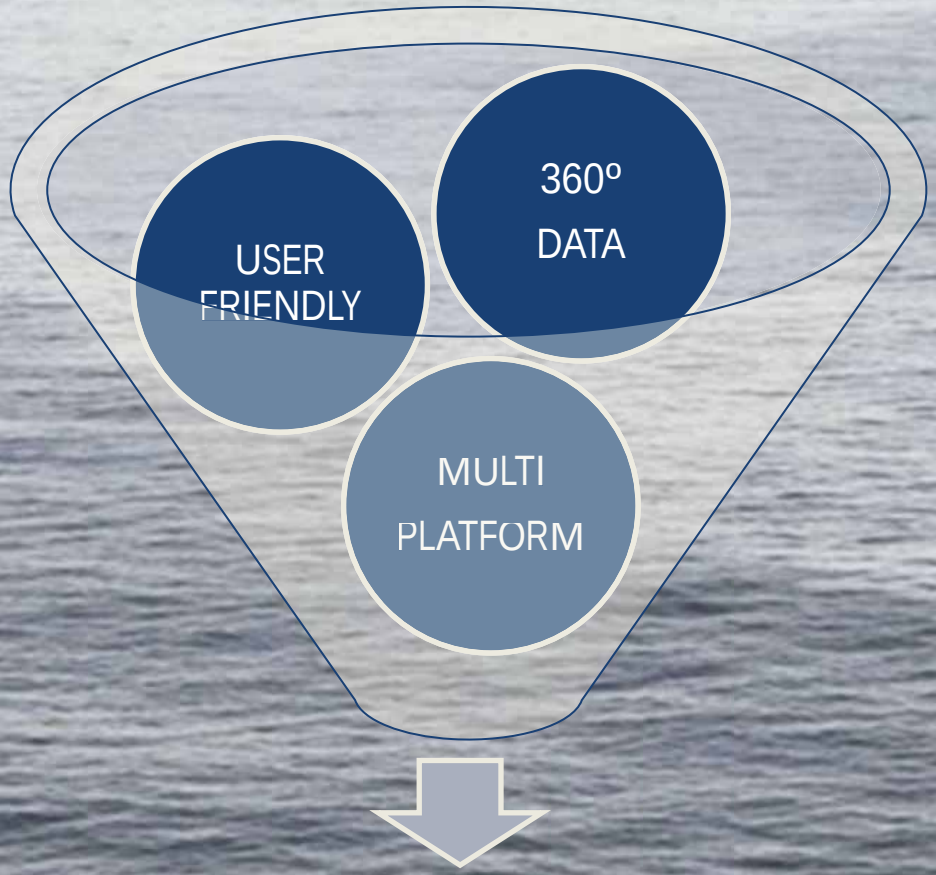
SOME CSN CASES

VESSEL JOALMI



SENTINEL-1: RIA FORMOSA CASE

AND NOW? WHAT ARE WE EXPECTING?



SEG

CONCLUSION

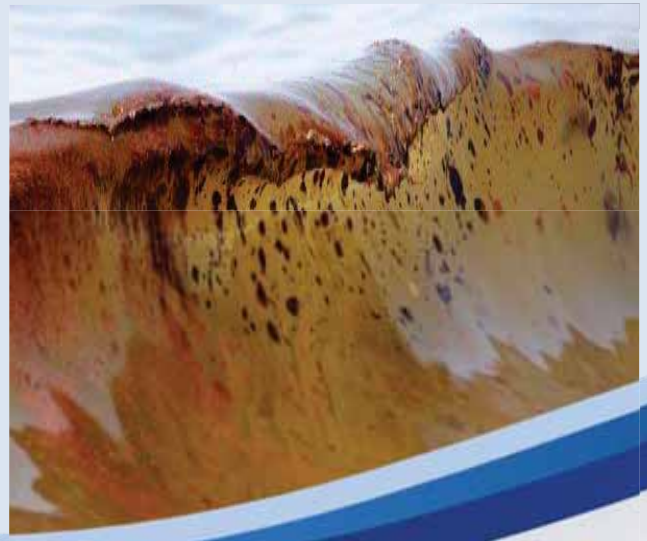
10 YEARS OF CSN

10 YEARS OF CONTINUOS IMPROVEMENTS

10 YEARS OF COLLABORATION

WE ARE LOOKING FOR

THE NEXT 10 YEARS



2TEN TSN-AMB JOANA JERÓNIMO; JOANA.SOFIA.JERONIMO@MARINHA.PT

MARITIME AUTHORITY DIRECTORATE GENERAL – MARINE POLLUTION RESPONSE SERVICE

EMSA, 14 – 15 November 2017

AUTORIDADE MARÍTIMA NACIONAL

Use of the CleanSeaNet service in 2007-2017

Heli Haapasaari
Finnish Environment Institute (SYKE)
14 Nov 2017

SYKE

CSN Users in Finland

- The legislation defines, that main responsibility for surveillance of ship discharges to the Baltic Sea is with the Finnish Environment Institute (SYKE)
- SYKE has agreement with Finnish Border Guard on cooperation in pollution response and on pollution surveillance
- SYKE has financed the oil detection equipment of the FBG's Dorniers
- Currently both SYKE and FBG use the CleanSeaNet and get the alerts
- CSN User Group meetings are highly appreciated. User Group provides platform for interaction between Member States and EMSA experts but also among the Member State representatives.
  - We are happy that the same concept has been adopted for other EMSA services as well!

SYKE

Planning

- The Baltic Sea is quite small, thus the HELCOM aerial surveillance working group defines the number of satellite images (services) that the Baltic Sea states would like receive from EMSA
- FBG takes the satellite overpass schedule into account when planning the Dornier flights
- Flight planning is coordinated also with our neighbors – Estonia and Sweden
- If aircraft flight is not planned and satellite alert indicates possible spill a helicopter is dispatched if possible
- Users appreciate that allocation process is not used anymore

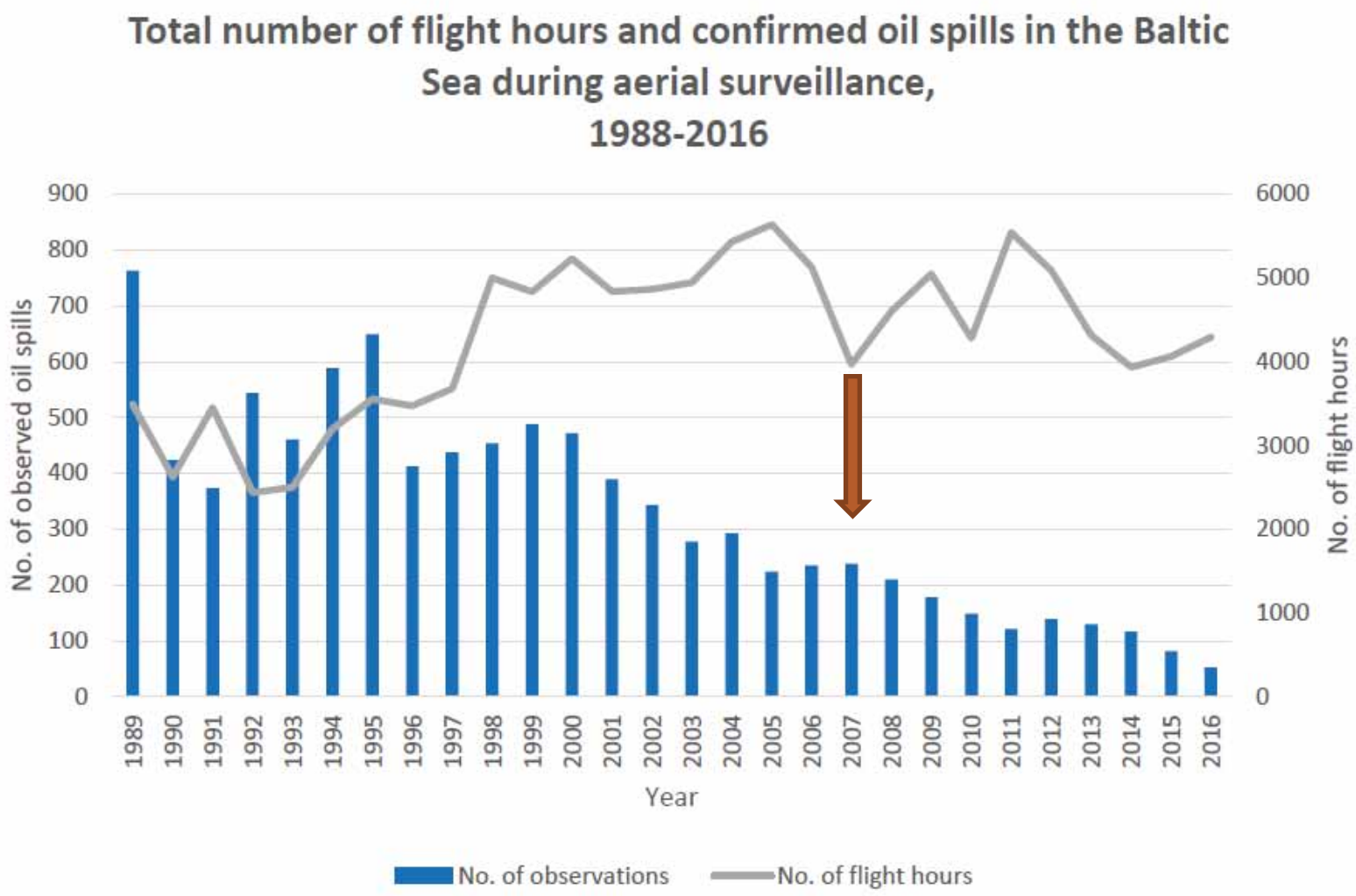
SYKE

Results

- In the Baltic Sea area the amount of oil spill detections and we believe that also of oil discharges has drop significantly during pass 15-20 years
- Discharges of “unknown substances” are more common than earlier
- In 2016 the Baltic Sea was surveilled for oil and other spills with almost 4300 flight hours.
  - 160 detections out of which 53 were confirmed to be mineral oil
  - 9 polluters were identified
  - Total amount of oil was 5,7 m3
- In 2016 CleanSeaNet detected 270 possible spills, 30 were confirmed to be mineral oil or other substance.

SYKE

HELCOM Annual report on Discharges observed during aerial surveillance in the Baltic Sea 2016



SYKE

Thank you!
Obrigada!
Kiitos!

heli.haapasaari@
ymparisto.fi

SYKE

Ministry of Infrastructure and Waterstaat

10 years CSN Service Netherlands

Michiel Visser

Advisor maritime response organisation

Rijkswaterstaat

NL history before CSN (2007)

1993 NL first steps toward satellite pilot project

- TSS(Tromso Satellite Station)
- Framework ESA ERS-1 pilot projects)
- (171 images ERS-1 and 272 flight hours)

Results(general);

- Synthetic Aperture Radar data large potential for detecting slicks
- Fixed overpass times
- Coverage is fixed due to orbital scenarios
- Slicks could not be identified

Recommendation;

- Collect a larger dataset of verified slicks for statistical validation of SAR data

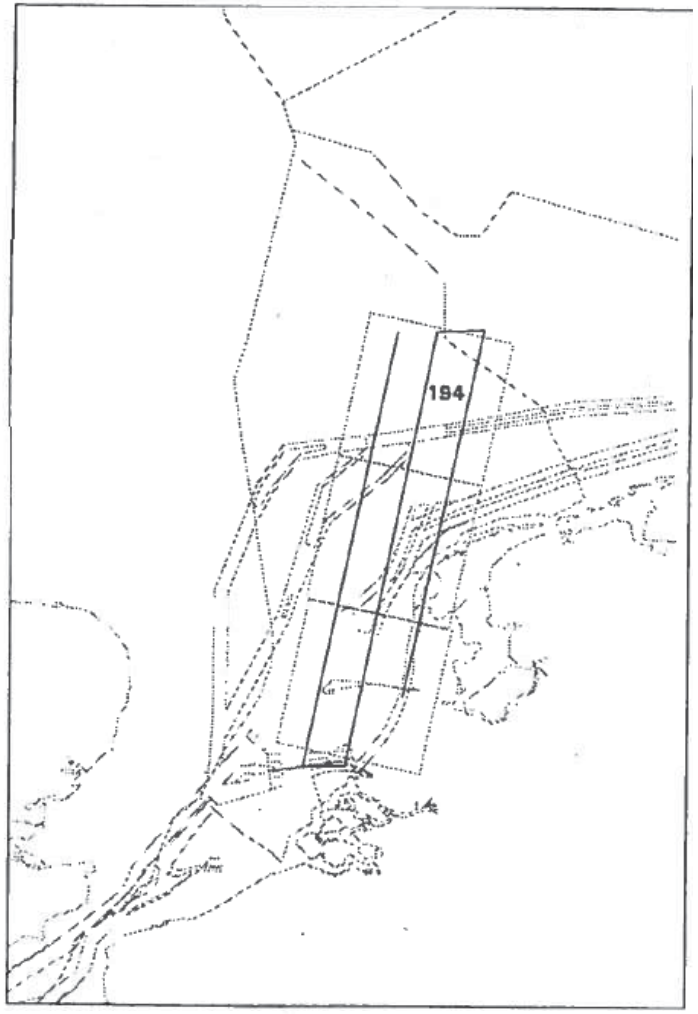


Figure 1 - Tracks flown by the PH-MNZ during the orbits 194

Operational system needs;

- Limited time delay`s
- Robust, easy to use, reliable
- Sustainable

- **1995 Joint Bonn Agreement test**
  - Netherlands(RWS) decide to incorporate satellite imagery beside surveillance program (as early warning system, within 2 hours)

- **1996-2007 Several programs (European cooperation)**
  - 2002 TSS en Qinetiq (Long term Earth Obeservation Market Development of Envisat-Based(Marine Surveillance))
  - 2003 North Sea Demonstration(UK,D NL and TSS)

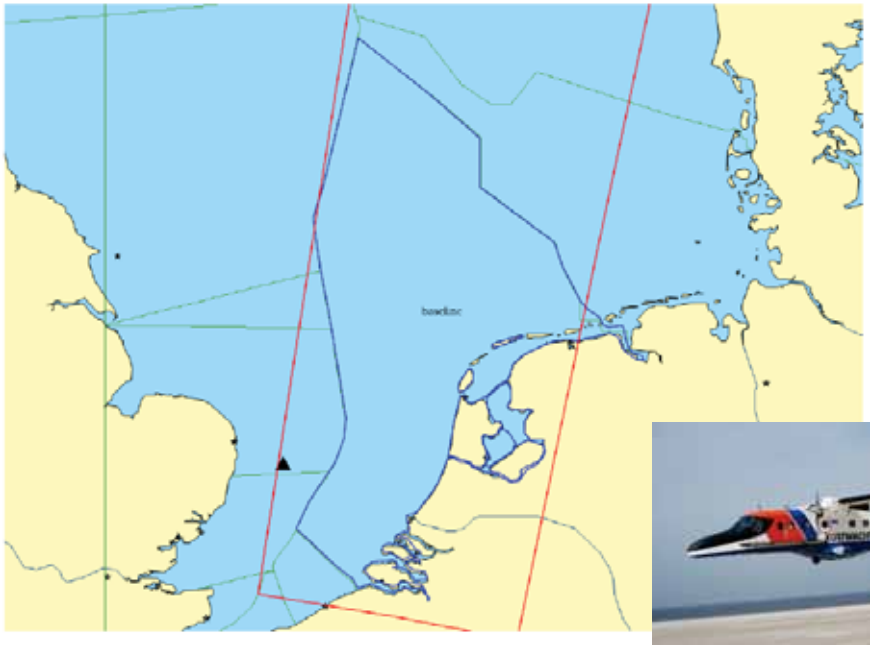
2007-2017 Integration of CSN

Rijkswaterstaat Zee en Delta
(waterquality)

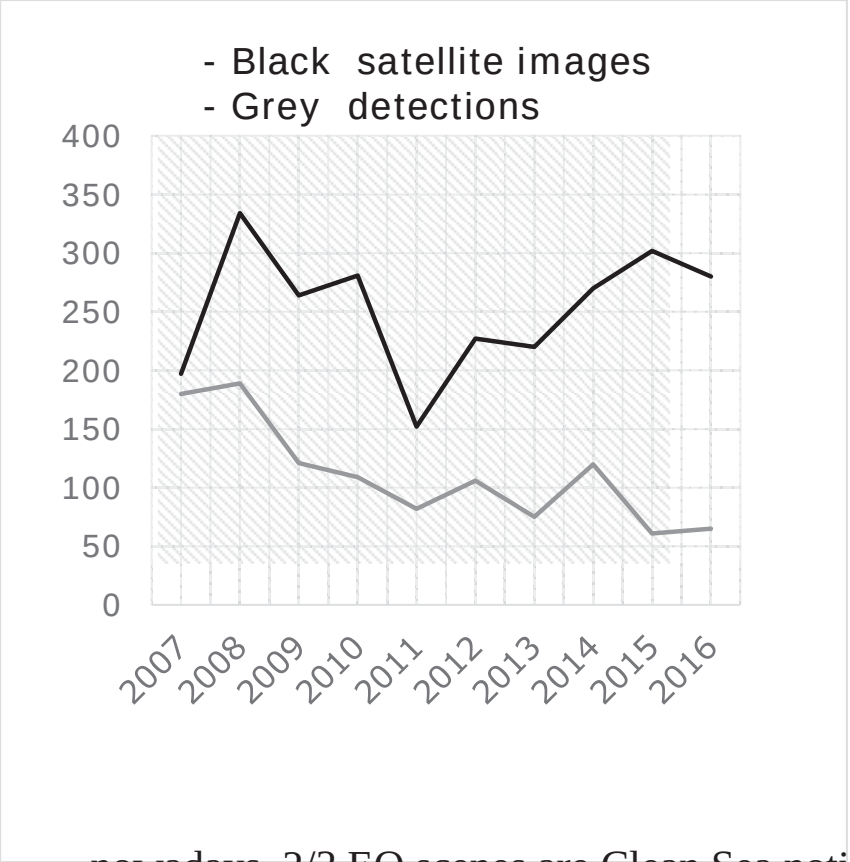
Netherlands Coastguard
(law enforcement)

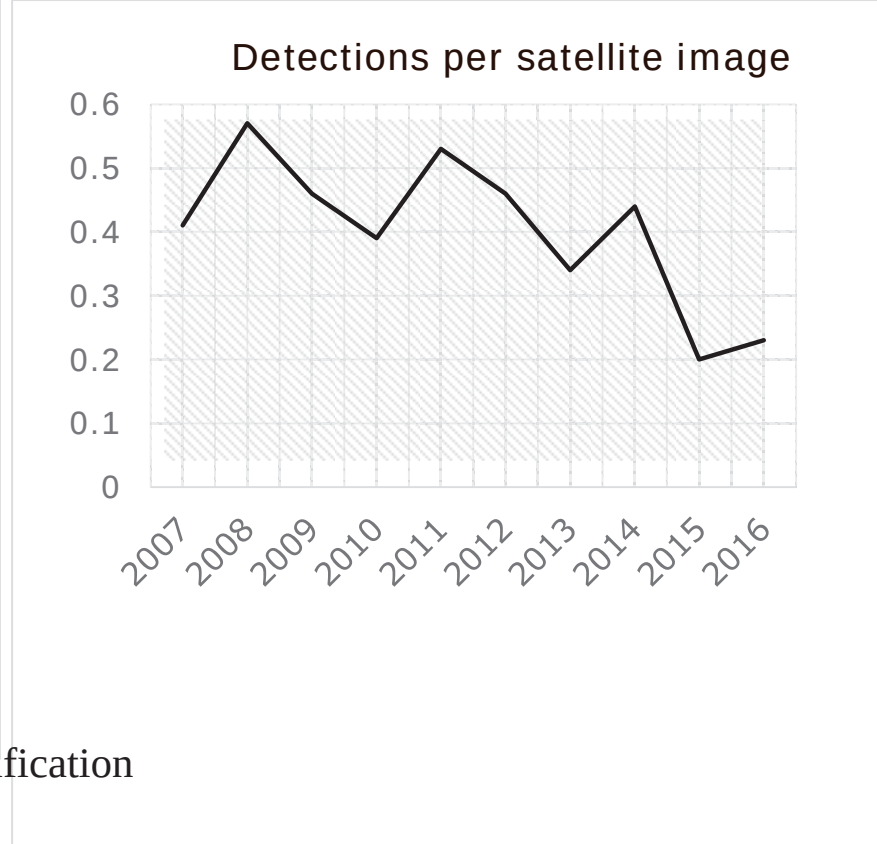
- Integrated with aerial surveillance program(1200 hours)
  (50% EO scenes followed by planned flight or ad-hoc flight)

- Alerting procedure is simple and fast
  (red or yellow alert)



2007-2016





nowadays 2/3 EO scenes are Clean Sea notification

Example pollution offence 2015 Netherlands and German Northsea

- Full sequence of detection and law enforcement

  - CSN Service
  - Aerial surveillance
  - International cooperation
  - Bonn Agreement

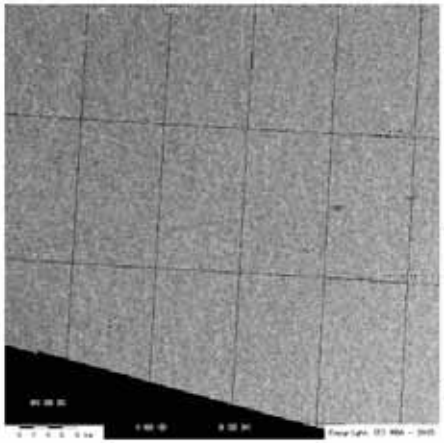
Cleans Sea Net alert report

CleanSeaNet Alert Report **NETHERLANDS** Acquisition: **2015-10-26 06:03:18 UTC**

Scene ID: **1004311** **RADARSAT-2 - SCWA - SCWA** List of Spills GIS Viewer

Details of possible Spill n°1 - OS_1004311_1

Centre Position		SAR Wind at Center		Area	Length	Width	Class	Alert Level	Number of slicks	Oilspill Warning Issued
Latitude	Longitude	Direction (From)	Speed (m/s)	(km²)	(km)	(km)	(A/B)			
54° 38' 17" N	005° 05' 20" E	160.00	6.40	12.35	54.61	1.09	A	Red	3	YES



Meteorological and Ocean Data			
Sea State	N/A	Wave Height	1.2
Met.Wind		Direction (from)	157
		Speed (m/s)	7.2
Current		Direction (from)	N/A
		Speed (m/s)	N/A

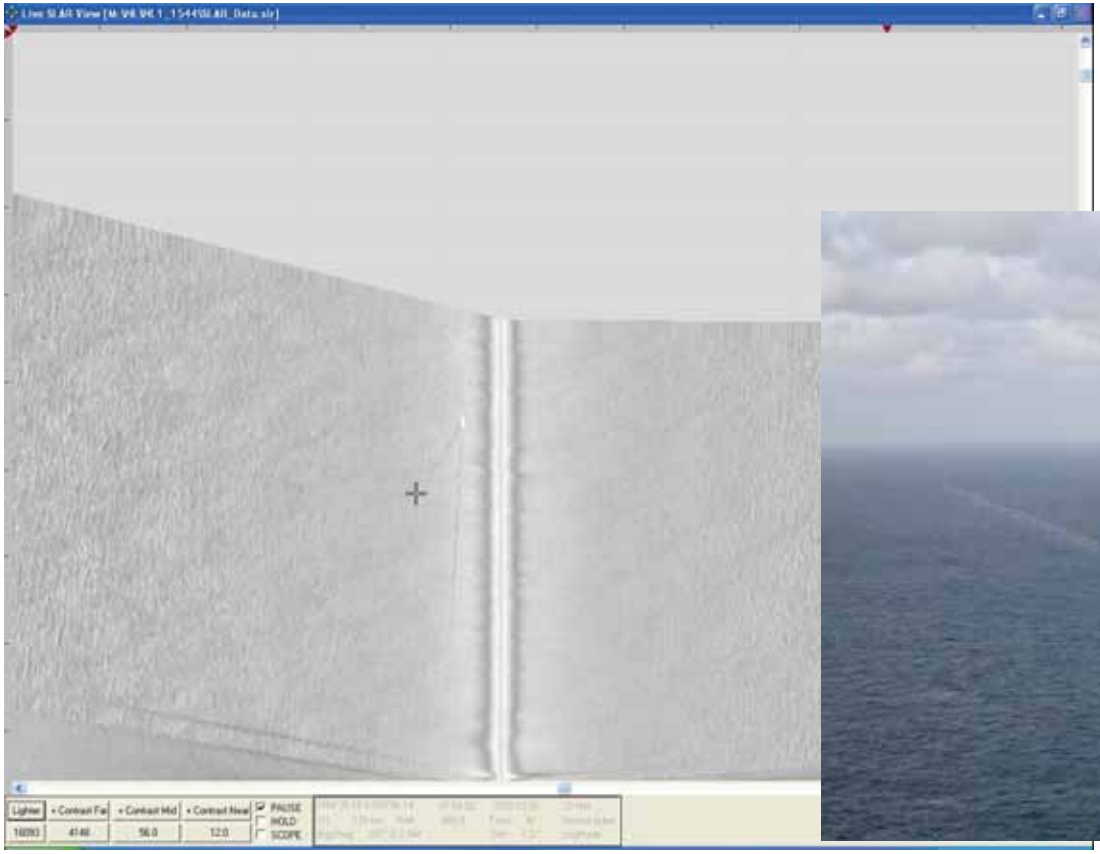
Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix or not available

Comments from Service Provider

Possible source information

N.	Detected	Dist.(Km)	Identified	Type	IMO	Name	MMSI	C/S	Latitude	Longitude	Time (UTC)	Track
1	Yes	2.894575	Yes	VESSEL	N/A	BOMAR JUPITER	538006367	N/A	54° 36' 47" N	004° 36' 56" E	06:03:44.076Z	No

Alerted surveillance



Manifold and pollution

2015.10.26_07.57.32_Flir1.mpg

Example of Coastguard follow up (nov 2017)

- Based on satellite image and AIS
- Paper/desk investigation (vessel type,cargo etc...)
- Vessel contacted
- Vessel stated tankwash operation

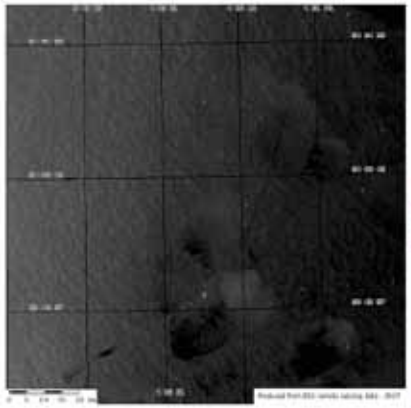
EMSA
European Maritime Safety Agency

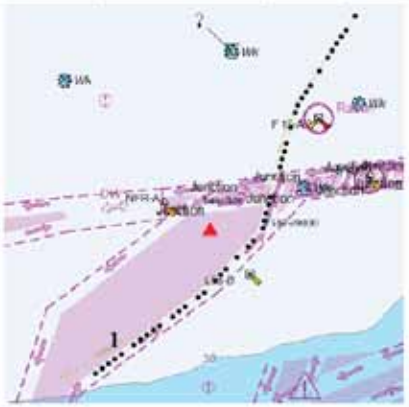
CleanSeaNet Alert Report **NETHERLANDS** Acquisition Start Time: 2017-11-06 17:24:27 UTC

Service Identifier: **1711060008** **SENTINEL-1 - CSAR - IWS** List of Spills GIS Viewer

Details of possible Spill n°1 - OS_1711060008_1

Centre Position		SAR Wind at Center		Area	Length	Width	Class	Alert Level	Number of slicks	Oilspill Warning Issued
Latitude	Longitude	Direction (From)	Speed (m/s)	(km²)	(km)	(km)	(A/B)			
53° 55' 50" N	004° 21' 32" E	212.00	2.62	29.77	127.57	21.06	A	Red	23	YES





Meteorological and Ocean Data			
Sea State	N/A	Wave Height (m)	N/A
Met.Wind		Direction (from)	212
		Speed (m/s)	3.8
Current		Direction (from)	N/A
		Speed (m/s)	N/A

Note: Grey fields are parameters set as "invisible" in the Print Parameters matrix or not available

Comments from Service Provider

Possible source information

N.	Detected	Dist.(Km)	Identified	Type	IMO	Name	MMSI	C/S	Latitude	Longitude	Time (UTC)	Track
1	Yes	3.477923	Yes	VESSEL	N/A	N/A	258749000	N/A	54° 28' 32" N	005° 00' 12" E	17:24:24.852Z	No

Development NL Surveillance program

- Start research for partially replace and/or reduce flight hours for pollution detection. (due to mature CSN service)

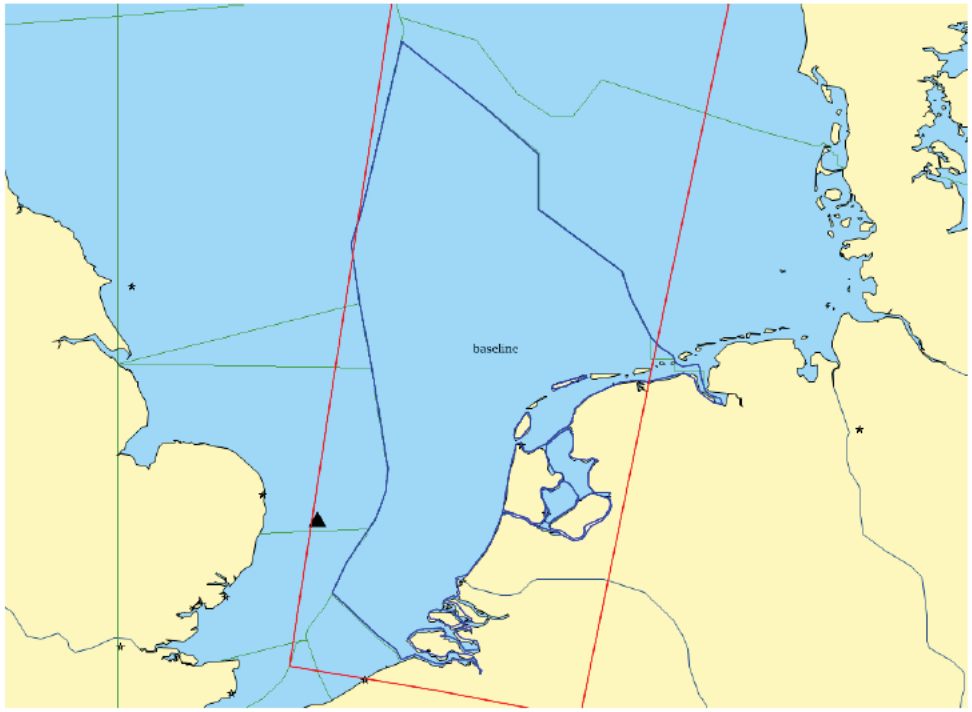
- 2021 renewel contract fixed wing surveillance

- Adjusting the flight operation in coverage and area

- 1 satellite image covering NL EEZ equivelant 4,5 flight hour

- Following the UAV development

- Dutch Carribean



Rijkswaterstaat and the Netherlands Coastguard thanks EMSA for the mature development of the Clean Sea Net service that has been reached in 10 years.

Italian Coast Guard

Italian Coast Guard

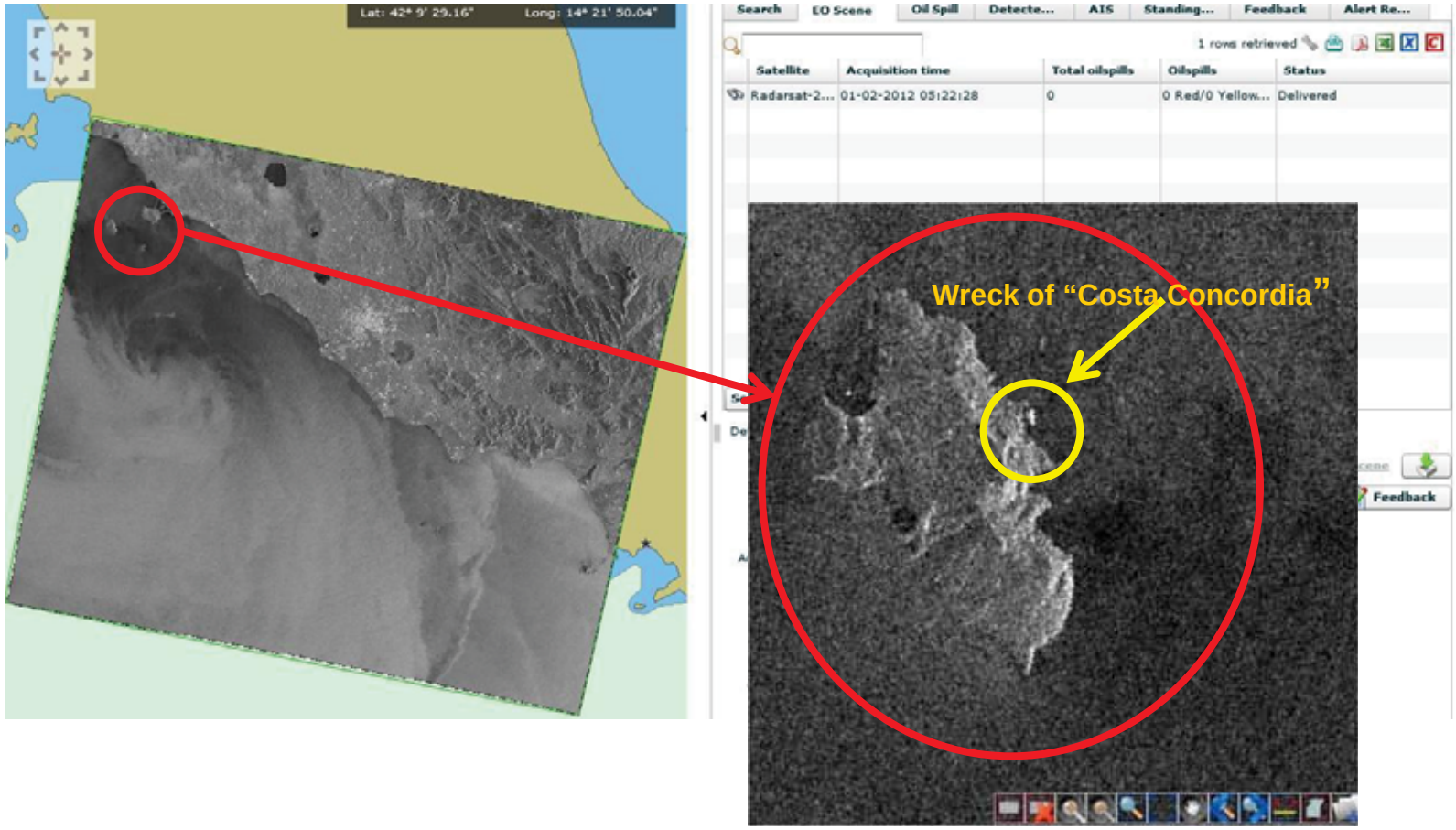
- On January the 13rd 2012, Mv “COSTA CONCORDIA” (italian flag) sunk next the Giglio Island in Tirrenian Sea.
- Tragedy. 32 persons died.
- The risks for the marine enviroment were a true nightmare.

Italian Coast Guard

- Escaped the environmental disaster it was necessary to continuously monitor the wreck.
- EMSA took part in this event through CSN, providing many specific images of the area, required by Italian Coast Guard.

Italian Coast Guard

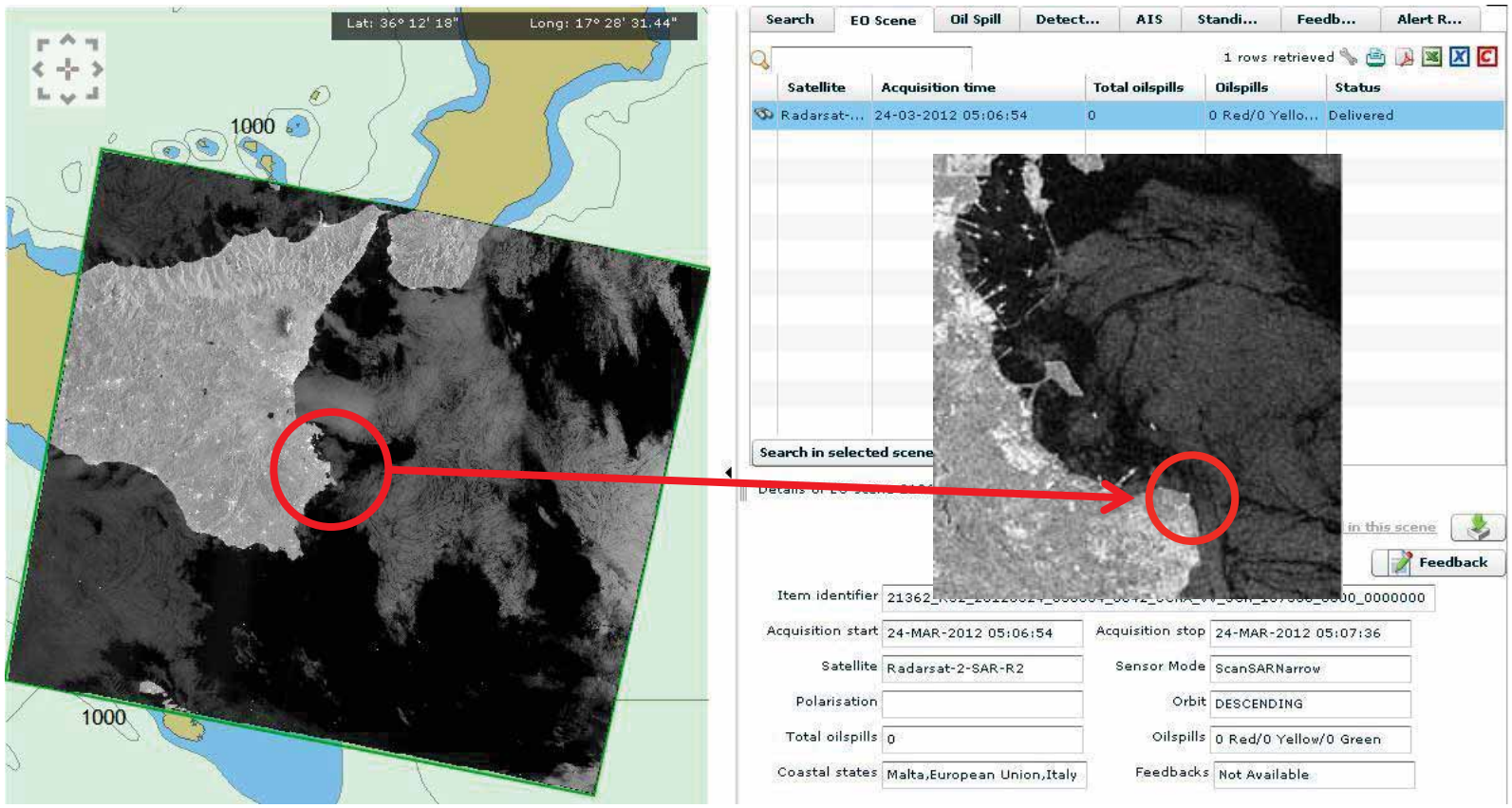
Italian Coast Guard



Italian Coast Guard

- A similar situation occurred on March the 10th 2012, when tanker “Gelso M” (italian flag) aground close to Augusta in Sicily Island, in Ionian Sea.
- Here, the risks for the enviroment were very strong given the vessel tipology (vessel in gas free - high risk of explosion)

Italian Coast Guard



Italian Coast Guard

CSN	totale eventi	Possibili inquinamenti rilevati			riscontro		n. navi interrogate	P.S.C. / F.S.C.		riscontro		mezzi del corpo impiegati		altri mezzi impiegati
Anno*		clean sea	alert report	possible oil slick detected	positivo	negativo		richiesti	eseguiti	navi con deficienze	navi detenute	aerei	mm/vv	
2010	254	161	93	217	13	204	372	64	13	13	6	14	46	0
2011	217	119	99	247	14	233	456	72	49	17	3	11	24	8
2012	281	168	113	254	12	242	373	45	31	1	0	7	44	4
2013	348	258	90	175	13	162	277	44	25	10	1	9	17	3
2014	293	214	79	155	18	137	265	47	33	13	0	3	13	1
2015	291	180	111	291	14	277	363	127	87	23	4	10	19	0
2016	354	225	129	224	13	211	308	110	83	23	2	2	12	3
2017**	299	150	149	265	7	258	382	177	97	12	2	3	7	0

mese	Potenziali inquinamenti rilevati			riscontro		n. navi interrogate	P.S.C. / F.S.C.		riscontro		mezzi del corpo impiegati		altri mezzi impiegati
numero eventi	clean sea	alert report	possible oil slick detected	positivo	negativo		richiesti	eseguiti	navi con deficienze	navi detenute	aerei	mm/vv	
2337	1325	714	1563	97	1466	2414	509	321	100	16	56	175	19

* Dato disponibile dal 1 gennaio 2010
** Aggiornato al 31 agosto 2017

Italian Coast Guard

ORCHESTRA

Italian Coast Guard

TerraSAR Imaging Services

10 Years EMSA CleanSeaNet

DEFENCE AND SPACE

Alexander Kaptein
November 2017

AIRBUS

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10
Years
CleanSeaNet

10
Years
TerraSAR

00
Years
EMSA Cat.1

05
Minutes
StripMap
(6m)

08
Minutes
ScanSAR
(18 m)

10
Minutes
Wide ScanSAR
(40 m)

THX
EMSA
KSAT

AIRBUS

What’s ahead?

Better services: quicker access & analytics

More receiving stations & antennas
e.g. KSAT’s Troll

Better Tools to detect small vessels
e.g. in 3 m data many small ships detected by wake only

More SAR Satellites: Hisdesat’s PAZ (2018), HRWS (2022+)
and many more small sat missions: multi-mission tip & cue

Persistent Monitoring: High Altitude Platforms
e.g. HAPS / Zephyre

Analytics for near-real time operational support
e.g. C5ISR, commercial services on demand

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AIRBUS

Thank you!

Alexander Kaptein
Head of Future SAR Missions
Airbus Defence and Space, Intelligence
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AIRBUS

Celebrating 10 years of the CleanSeaNet service and cooperation between ESA and EMSA

DEFENCE AND SPACE

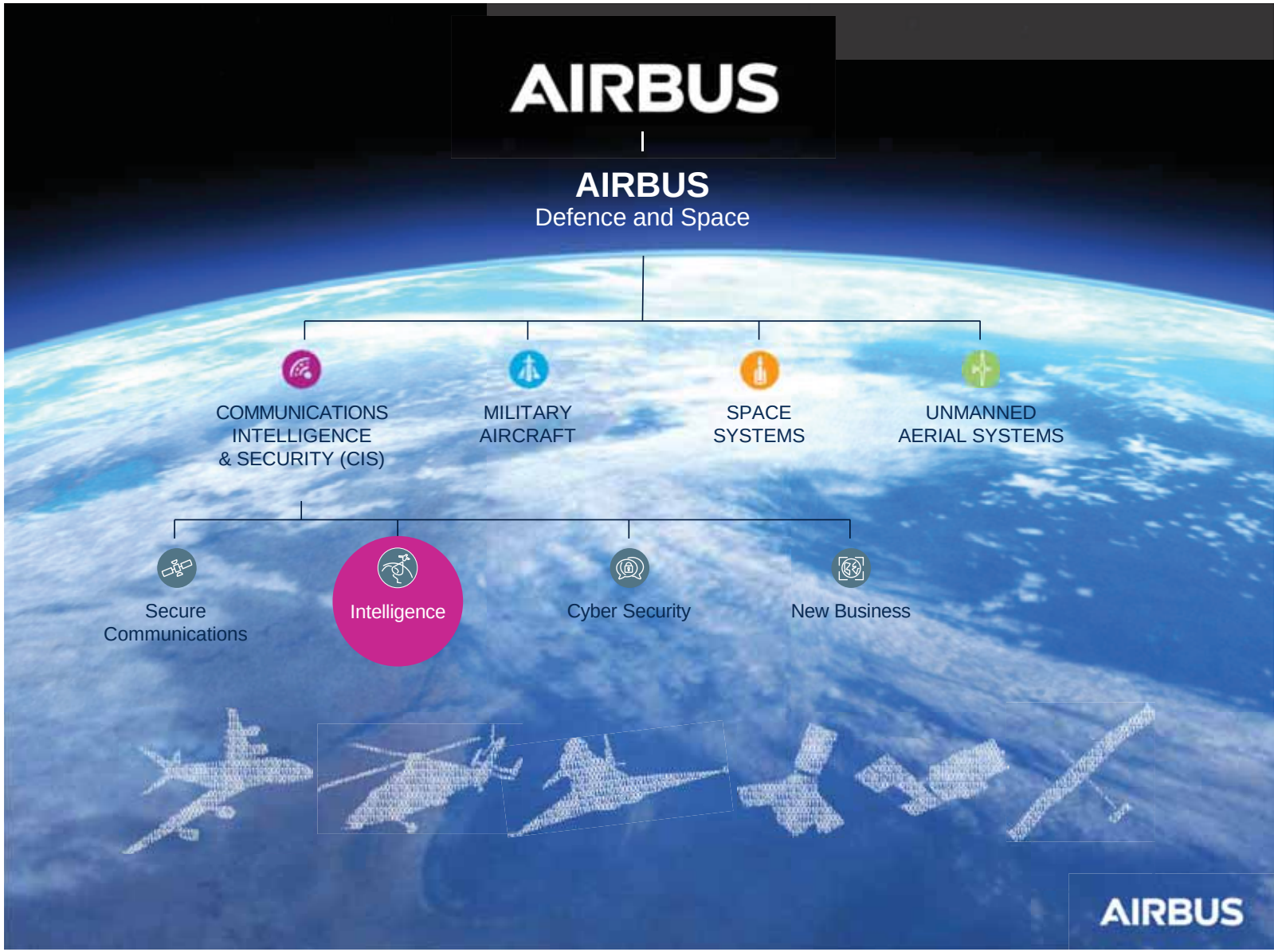
- Olivier SURLY

- 24 October 2017 – RSNF - Elancourt

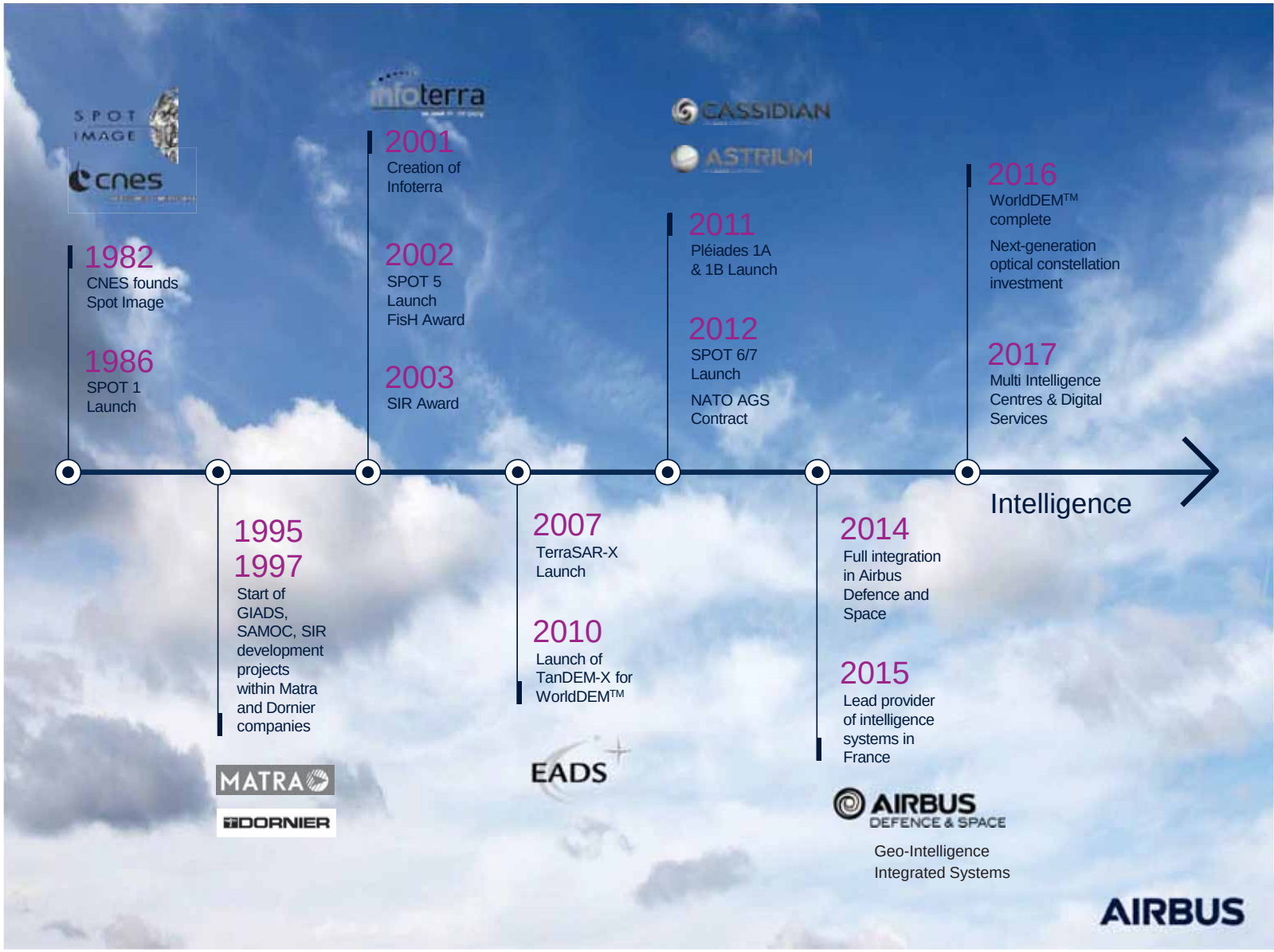
AIRBUS

The **Power** of **AIRBUS**

As part of the Airbus group, we benefit from the **power and strength** of a **global leader** in aerospace, defence and related services, **guaranteeing confidence** in our commitment to provide sustainable Earth observation and defence solutions.



A Legacy of **Experience** & **Expertise**



Multi-Sensor, Multi-Resolution

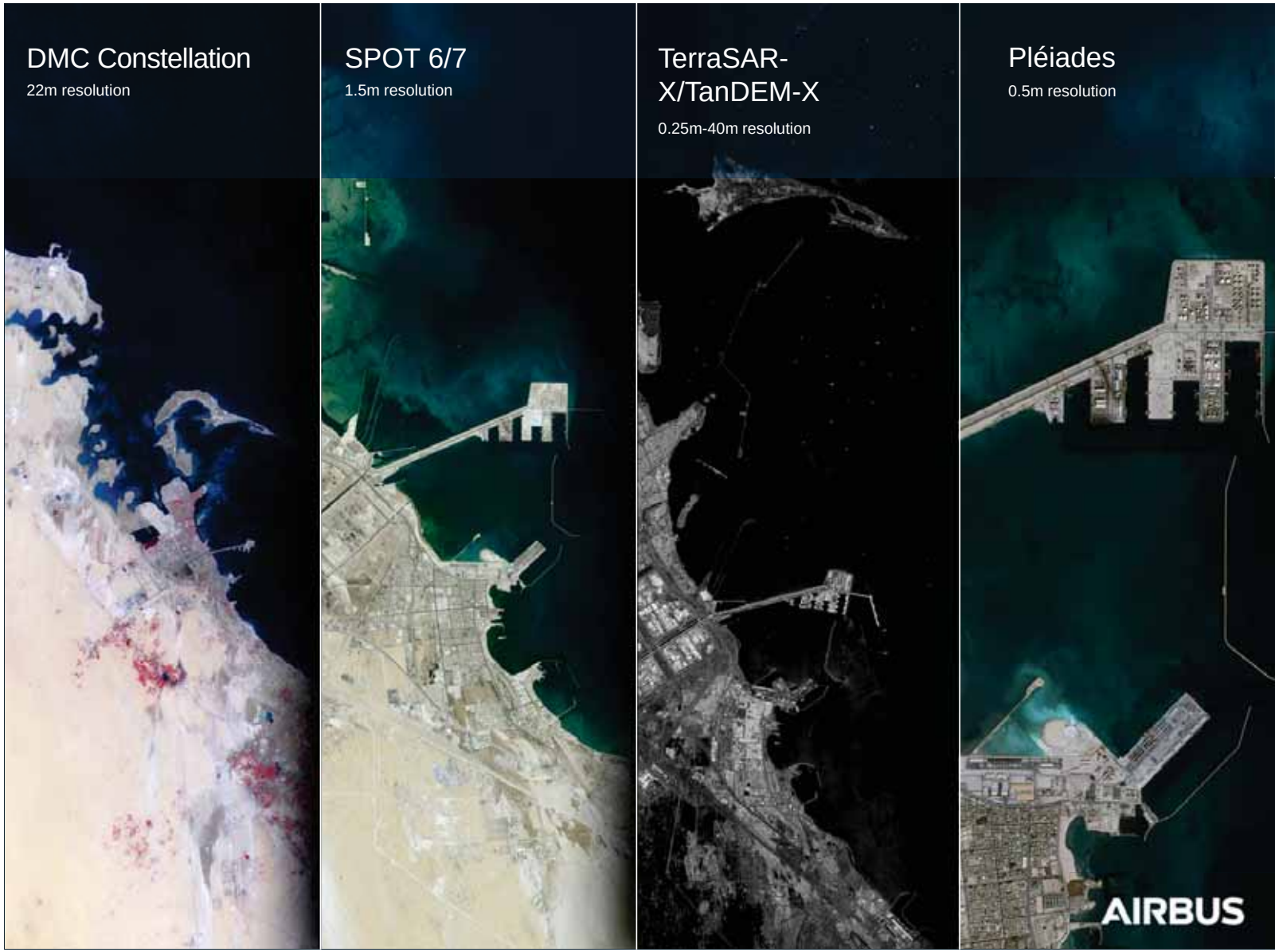
OUR DATA MAKES THE DIFFERENCE

Most comprehensive satellite constellation - 10 optical and 3 SAR satellites & partner satellites

Wide coverage, fine detail, premium reactivity & reliability

>100 Billion km² archive data since 1986

Service continuity guaranteed for the next two decades until 2030 and new data sources and platforms under development



Our contribution to EMSA

- Optical Satellite Imagery &Value-Added Products for Maritime Surveillance,
- Framework contract, 2015-2019
- 2 years plus option for one year extension twice

Spatial resolution range	Satellite missions
VHR-1 (from 0.3 m to 1 m)	Pleiades 1A & 1B Deimos-2
VHR-2 (from 1 m to 4 m)	SPOT 6 & 7 Formosat-2
HR-1 (from 4 m to 10 m)	N/A
HR-2 (from 10 m to 30 m)	Deimos-1

SLA		
Short notice Tasking	Routine Tasking	Archive
24/7 < 24h before acquisition	8H-18H UTC Up to 24h before acquisition	

Deliverables			
EOP	VDE	ACT	CDE
Imagery	Vessel Detection	Extraction Activity Detectio	Change detection Not Yet Applicable

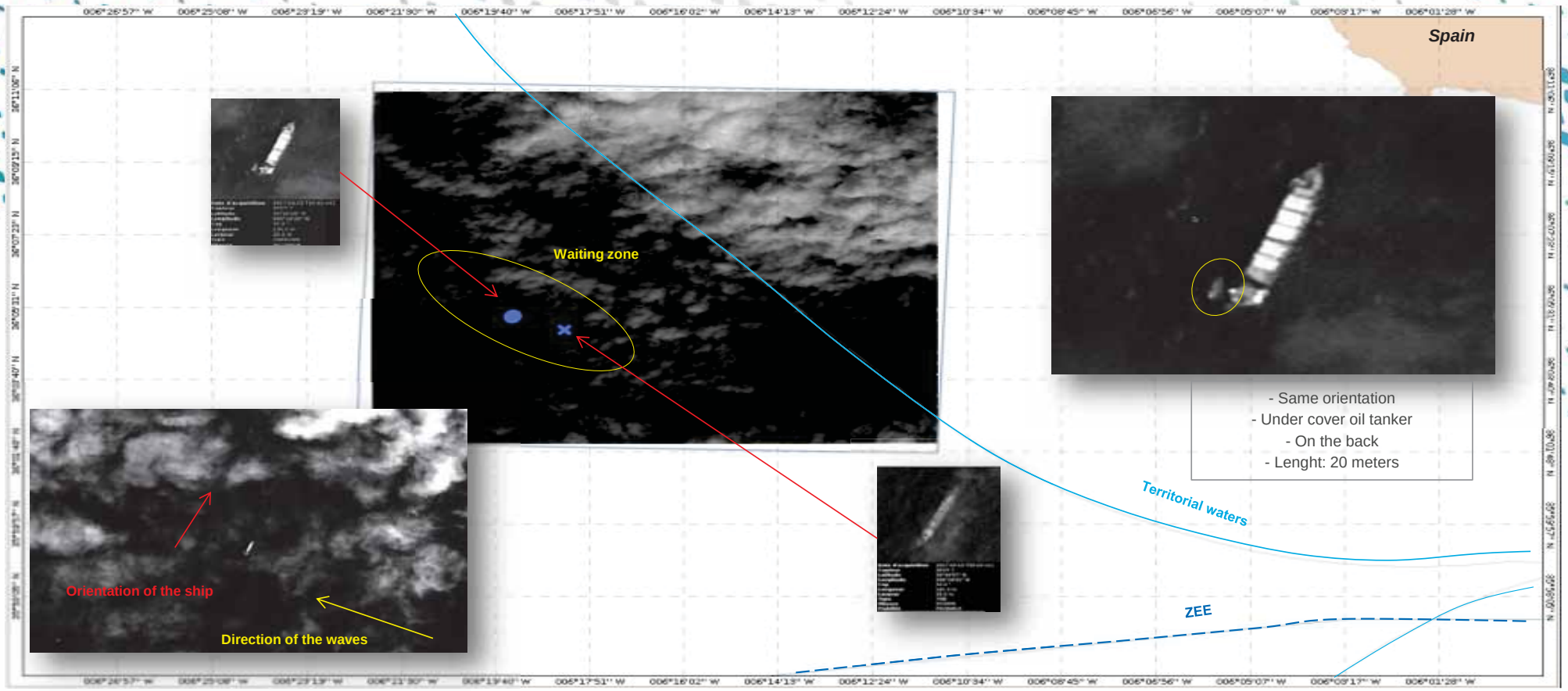
Delivery constraints				
NRT	< 3H	<6H	<24H	>24H

AIRBUS

An exemple of VDE

ServiceID 1703130031
VHR2_NRT_VDE_Cloud Protection 75%
Operation: IMS_LAW (Rendez-Vous At Sea)

Airbus Delivery Results
EOPO/QNO/QUA Delivery Time: 33 minutes
VDE Delivery Time: 42 minutes

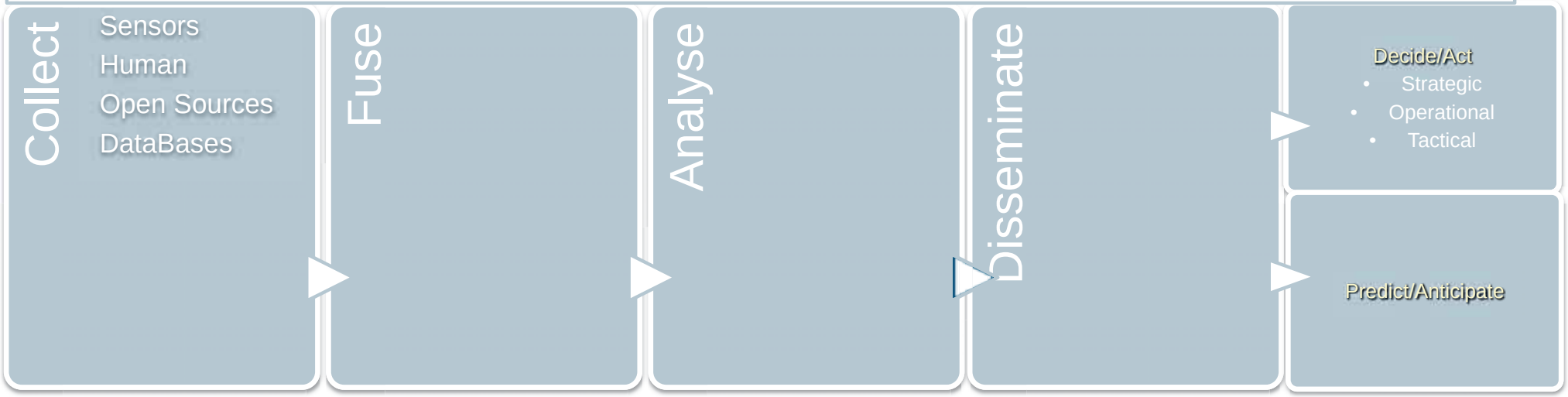


AIRBUS

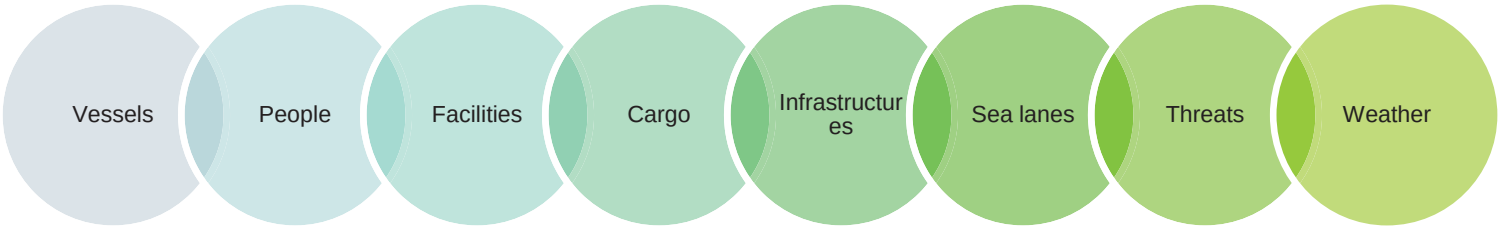
Our ambition: Becoming a reference Maritime Domain Awareness solutions provider (services & Systems)

Maritime Domain Awareness **"…**the effective understanding of anything associated with the global maritime domain that could impact the security, safety, economy, or environment of a Nation.

The effective combination of Intelligence & Situational Awareness



Observable items



AIRBUS

Intelligence

Other Airbus DS

Preferred partners

Airbus, your partner to set-up your MDA system

Keep what you get, add what you miss

Display / Sharing
Data Fusion

- VMS / LRIT
- Maritime Patrol Aircraft / Helicos
- Patrol vessels
- Land-based AIS
- Land-based Cameras
- Land-based Radars
- HUMINT

- Optical Satellites
- Radar Satellites
- SAT_AIS
- HAPS
- UAV
- MetOcean
- OSINT

Reference Layer
Marine charts / Databases

AIRBUS

Intelligence

Visit our website

http://www.intelligence-airbusds.com

FOLLOW US

#AirbusSpace

AIRBUS

Industry perspective: CLS

CleanSeaNet 10 year anniversary celebration

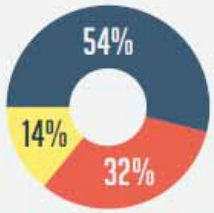
EMSA – 14 nov 2017

CLS
COLLECTE LOCALISATION SATELLITES

ACTIONABLE INTELLIGENCE
FOR MARITIME SURVEILLANCE

SHAREHOLDERS

cnes
Ifremer
ARDIAN



WORKFORCE
WORLD > 650 EMPLOYEES

* HORS FRANCE

EUROPE* 100
FRANCE 370
AMERICAS 150
ASIA/PACIFIC 30

TURNOVER

125 M€
EXPECTED IN 2017

6 KEY APPLICATIONS

SERVICES

MULTI-SOURCE DATA :
SSAS -AIS - SAT-AIS - LRIT - VMS - OPTICAL & RADAR IMAGERY - RPAS - SHIP REGISTRY - MARINE ENVIRONMENT

DATA PROCESSING ANALYSIS & FUSION - MODELING - BIG DATA - ANALYTICS

DECISION MAKING :
PLATFORM - DATA PROCESSING ANALYSIS & FUSION - MODELING - BIG DATA - ANALYTICS

KEY FIGURES

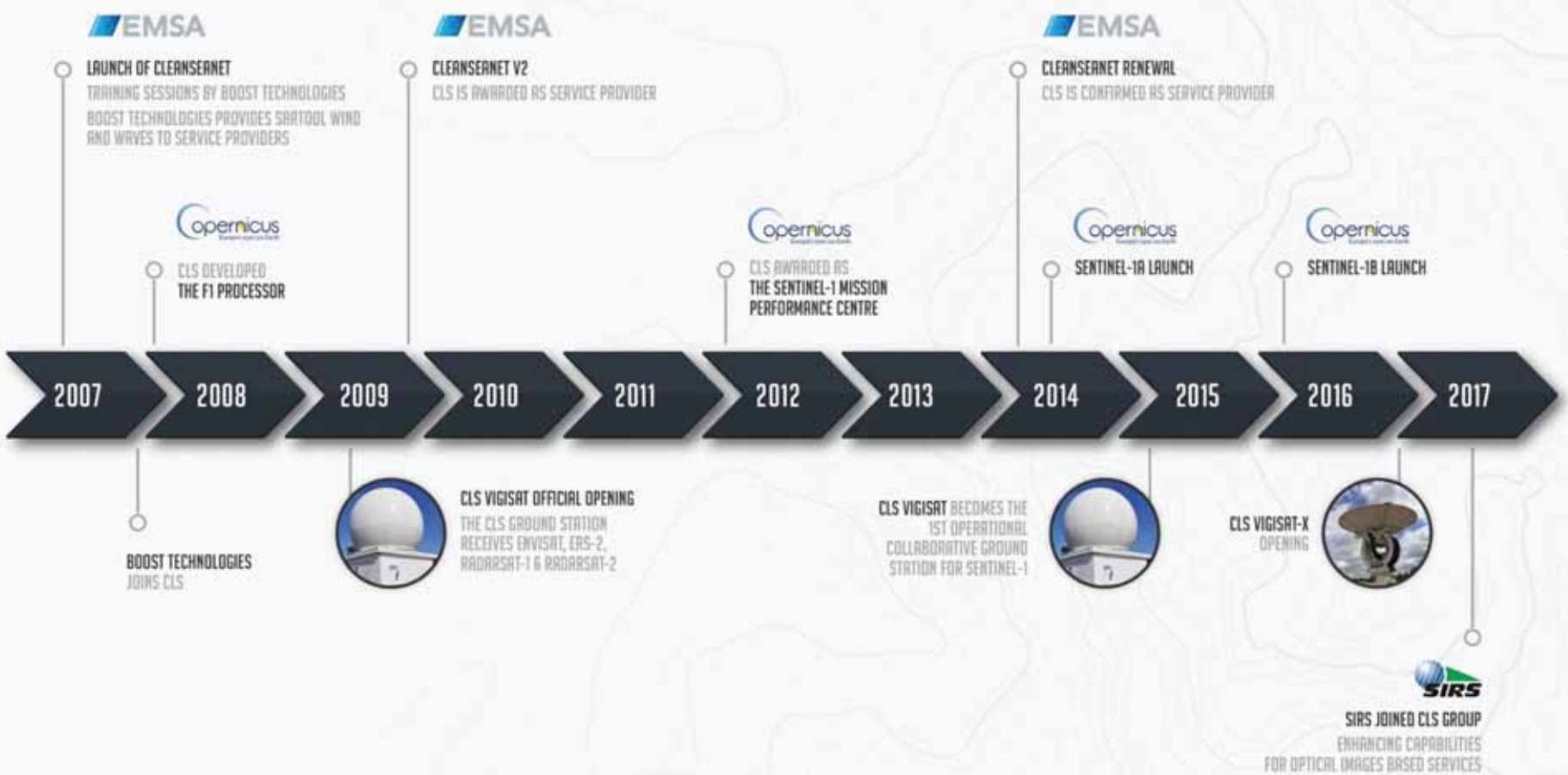
700
EMPLOYEES

24/7
OPERATIONS CENTER

130
SATELLITES USED

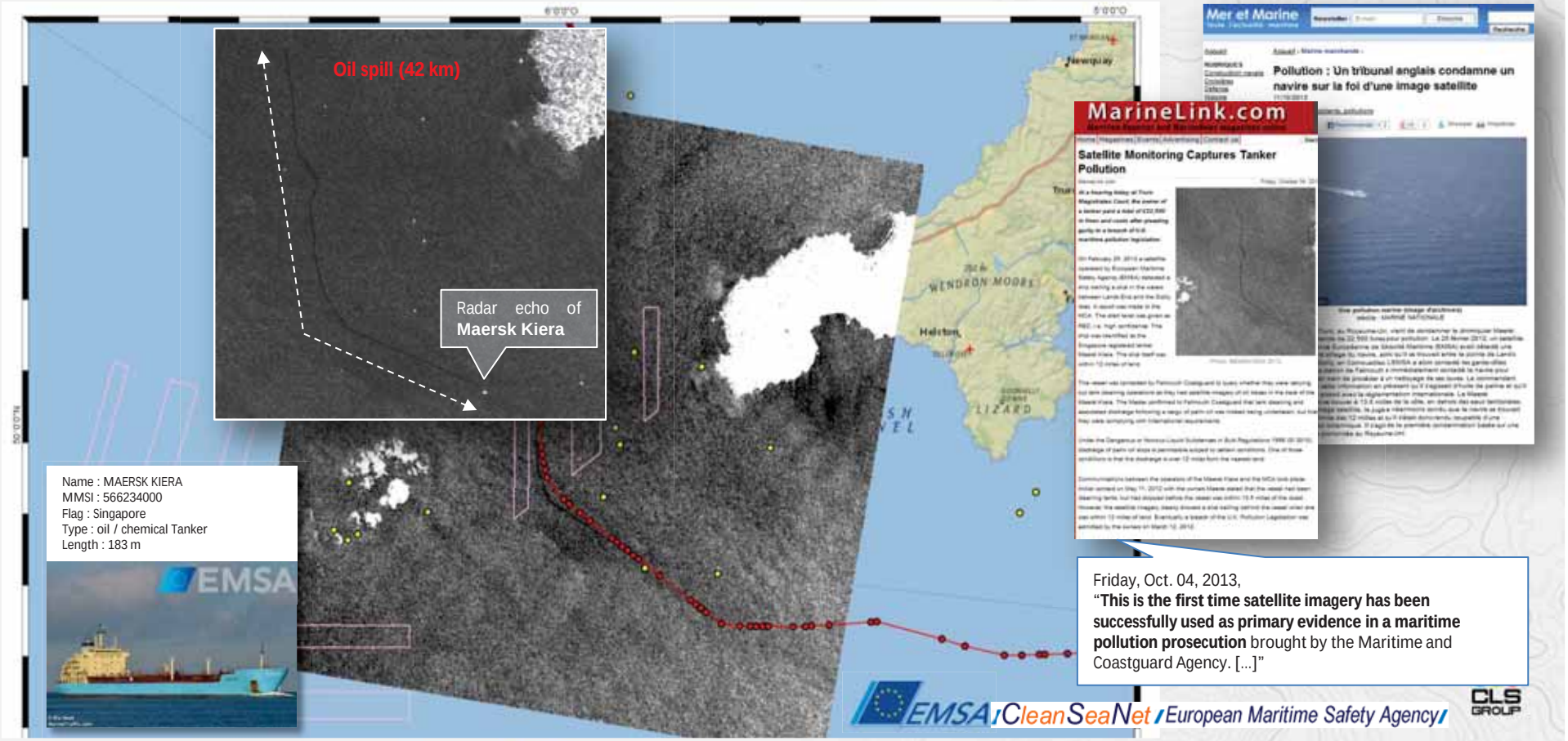
CLS GROUP

10 years' contribution of CLS Group to EMSA CleanSeaNet service



Use cases:
- major oil spill and national response (2012)
- EMSA CleanSeaNet service to support Coast Guard functions (2015)

First case in Europe in a maritime pollution prosecution using SAR imagery
25/02/2012 – CLS VIGISAT



Friday, Oct. 04, 2013,
"**This is the first time satellite imagery has been successfully used as primary evidence in a maritime pollution prosecution** brought by the Maritime and Coastguard Agency. [...]"

Small vessels detected by VIGISAT help rescue 370 migrants in Mediterranean sea 06/10/2015 – CLS VIGISAT

Home / News / Frontex Eurosur Services help rescue 370 people off Libyan coast

FRONTEX EUROSUR SERVICES HELP RESCUE 370 PEOPLE OFF LIBYAN COAST

2015-10-09

More than 370 people were rescued off the Libyan coast this week after their vessels were detected on satellite images taken as part of Frontex's Eurosur Fusion Services. The operation was made possible by the cooperation between experts at Frontex and the European Maritime Safety Agency (EMSA), Italian authorities and EUNAVFORMED.

On Tuesday, 6 October, Frontex Situation Centre in cooperation with EMSA spotted several small boats on a satellite scan of an area close to the Libyan coast, where migrant boats in distress are often detected. The information was passed on to the Italian authorities, which informed the EUNAVFORMED flagship Cavour present in the area.

As a result, more than 370 migrants aboard three rubber boats were rescued and brought to the Italian shores. The people included nine children and four pregnant women.

Eurosur is an information exchange framework designed to improve the management of Europe's external borders.

The Eurosur services already include automated large vessel tracking and detection capabilities, software functionalities allowing complex calculations for predicting positions and detecting suspicious activities of vessels, as well as precise weather and oceanographic forecasts. Fusion Services use optical and radar satellite technology to help locate vessels at sea. Recent upgrades of their technical capabilities make it possible to spot smaller vessels.

Last month, the Greek Coast Guard seized some 5 000 guns and boxes with ammunition aboard a Libya-bound cargo ship that had been monitored by Frontex as part of the Eurosur Fusion Services.

Satellite image with the rubber boats spotted ne Libyan coast

http://frontex.europa.eu/news/frontex-eurosur-services-help-rescue-370-people-off-libyan-coast-MxXy7S

Copernicus Sentinel-1 and CLS related activities, to provide even better CleanSeaNet service

CLS VIGISAT: First operational Sentinel-1 collaborative ground station

- According to the specific requirement of the CleanSeaNet renewal tender (OP/15/2013), service providers were to deliver Sentinel-1 based services 6 months after the completion of the Sentinel-1 commissioning phase.
- In May 2015, VIGISAT, the CLS ground station, was officially recognized as Sentinel-1 collaborative ground station
- In July 2015, VIGISAT became the first operational collaborative Sentinel-1 ground station worldwide
- In October 2015, CLS started to deliver S-1 based CleanSeaNet services, several months ahead over the other services providers.

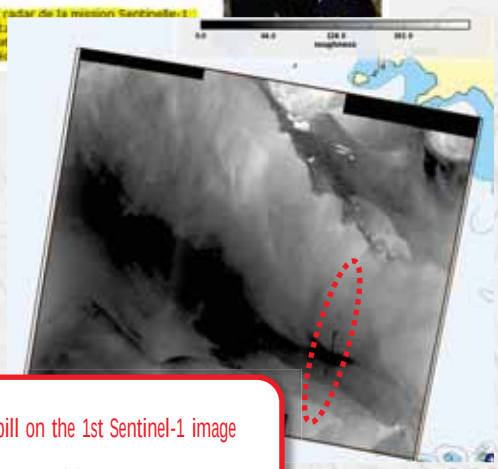
esa space for europe

European Space Agency

ACCÈS GARANTI POUR LA FRANCE AUX DONNÉES DES SENTINELLES

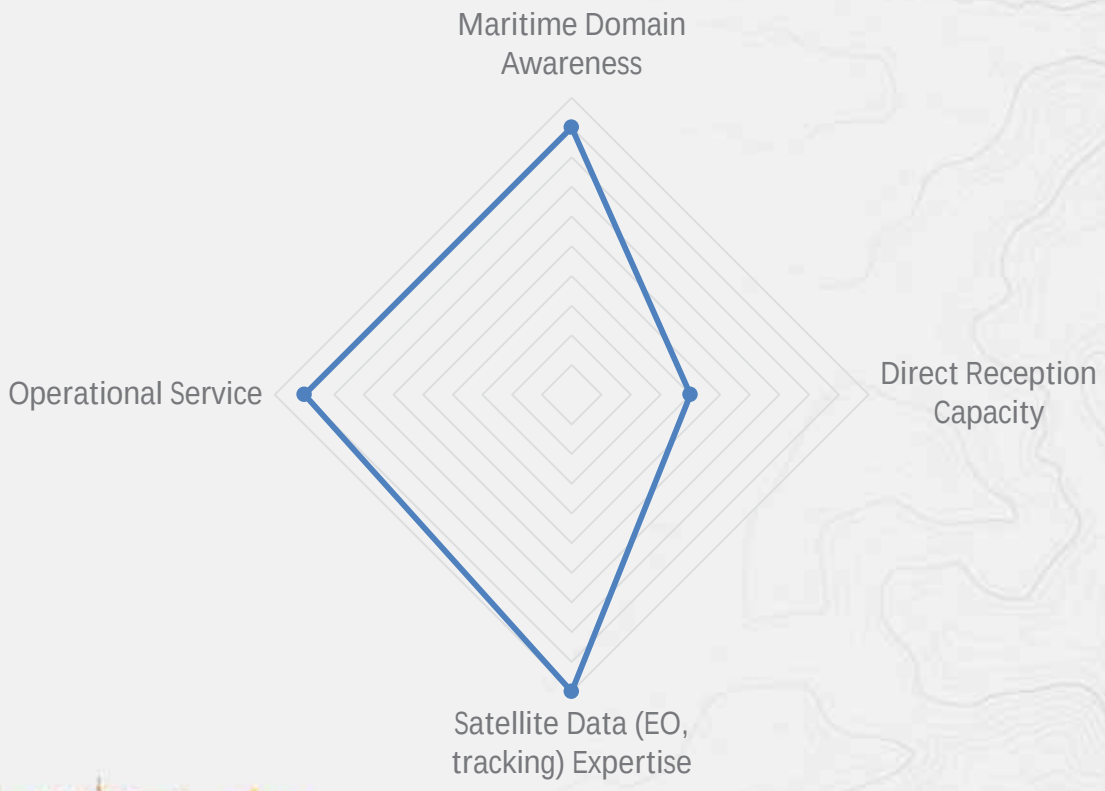
Lors d'un événement qui s'est tenu aujourd'hui au siège de l'ESA à Paris, la France et l'ESA ont signé un Accord de coopération portant sur le segment sol collaboratif des Sentinelles, qui vise à faciliter l'exploitation des données des Sentinelles dans le pays.

Dans le cadre de cet accord, le CNES va installer à Toulouse un « site miroir national » pour héberger et distribuer les données de Sentinelle. C'est ce site qui assurera l'accès et la distribution des données des Sentinelles dans le cadre de services environnementaux et d'information à valeur ajoutée.



An oil spill on the 1st Sentinel-1 image processed by VIGISAT

CLS: High quality CSN service provider



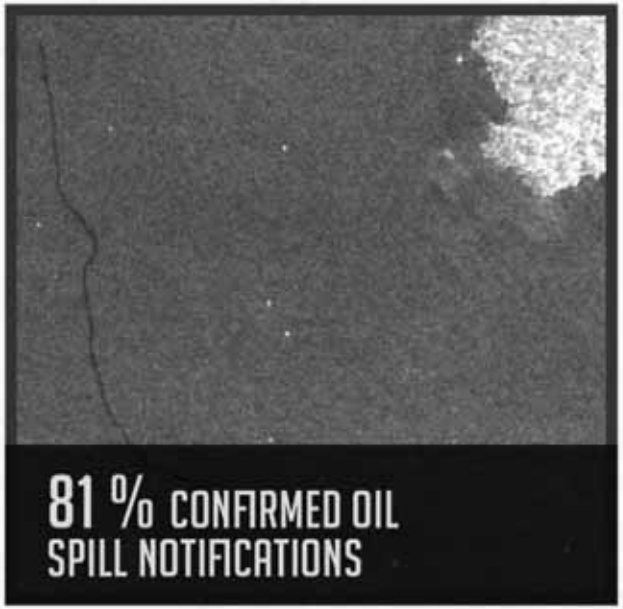
Key Performance Indicators (2017)

78 %

OF EMSA AREAS COVERED BY CLS STATIONS NETWORK

95 %

PERCENTAGE OF IMAGES DELIVERED TO EMSA



Source: CLS

Conclusions

- Proud to provide CleanSeaNet service to EMSA and to support action of EU Member States
- Great illustration of what Europe is capable of
- CLS, exporting this service worldwide
- Hope to see you all for the 20 year anniversary !

Thank you

gfabritius@cls.fr

EDISOFT

DEFENCE & AEROSPACE TECHNOLOGIES

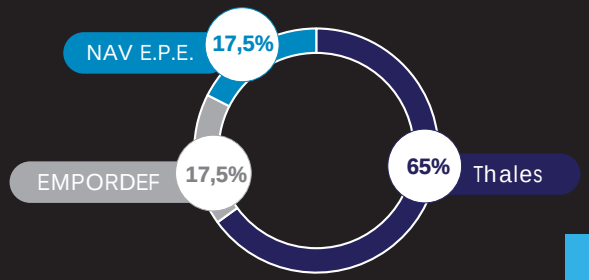
CleanSeaNet

Brief Introduction to EDISOFT

EDISOFT

DEFENCE & AEROSPACE TECHNOLOGIES

A THALES Group Company



NAVAL DEFENCE SYSTEMS

AIR SYSTEMS

SPACE SYSTEMS

EDISOFT Vision

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

- To build a Portuguese Ground Segment Infrastructure with worldwide visibility…

- …EMSA & CleanSeaNet were a key pillar in the materialization of this vision

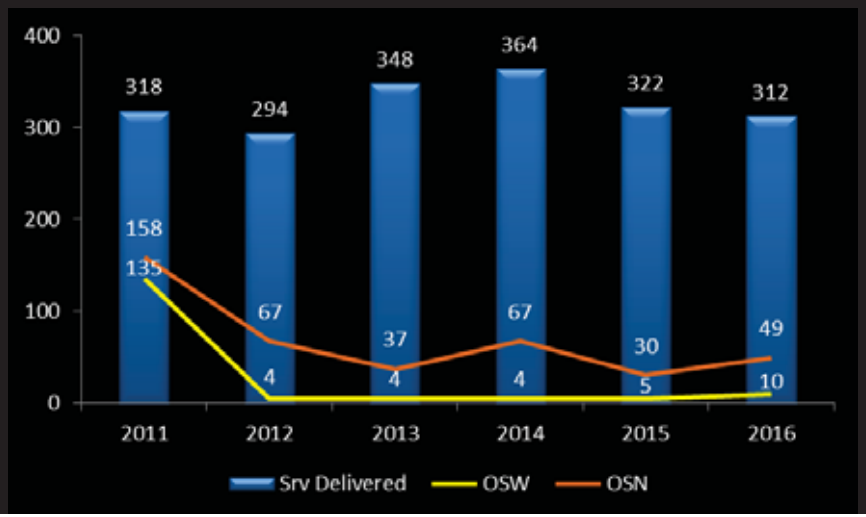
CLEANSEANET Accomplishments

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

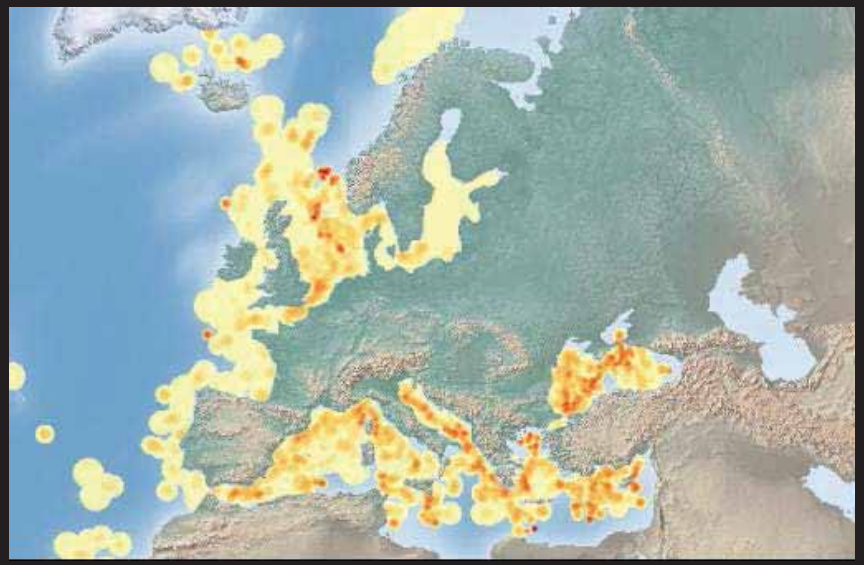
Service Portfolio

- Oil spill detection
- Vessel detection
- Target activity detection
- Enhanced Vessel Detection

Service Statistics (CSN II & III)



Oil Pollution Statistical Analyser (OPSA): generation of robust statistics on spatial and temporal variation in oil spill occurrences



Relative oil spill density map 2013 (default criteria) generated by OPSA tool

Sinking of ‘Oleg Naydenov’

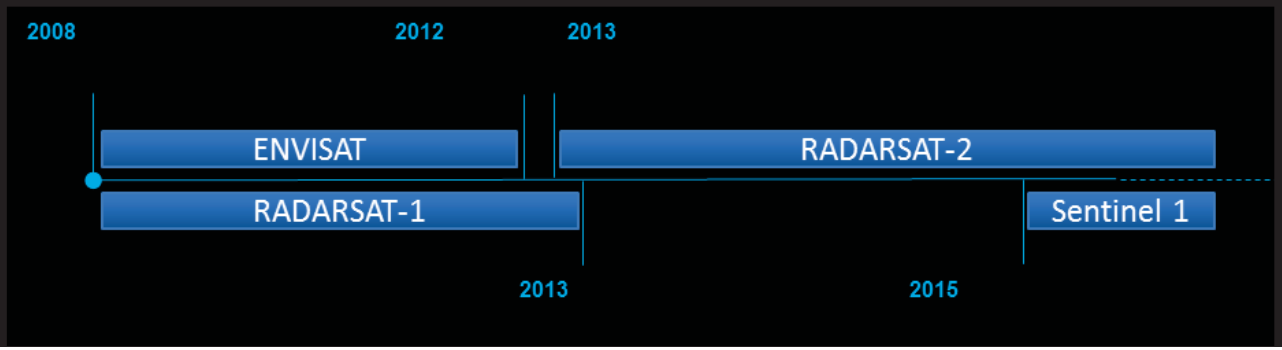
- Date and time of sinking: 22h45m, 14/04/2015
- Amount of Fuel: 1.400 tons
- Place: Canary Islands
- EDISOFT monitored fuel leakage upon EMSA request

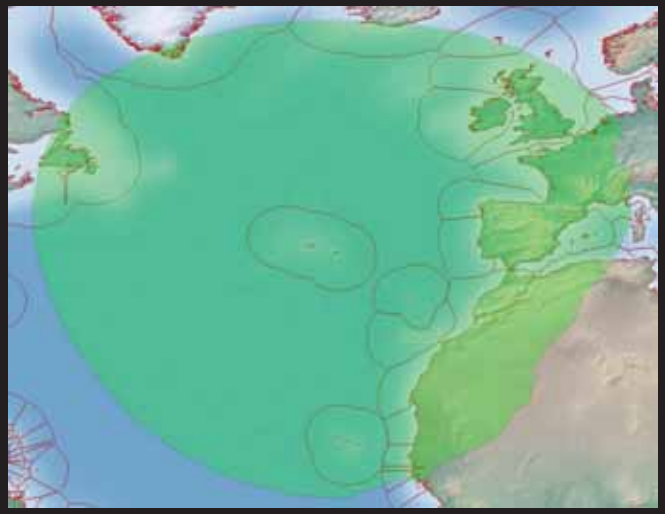
Image acquired in 17/04/2015, two days after sinking

Infrastructure

Santa Maria Ground Station

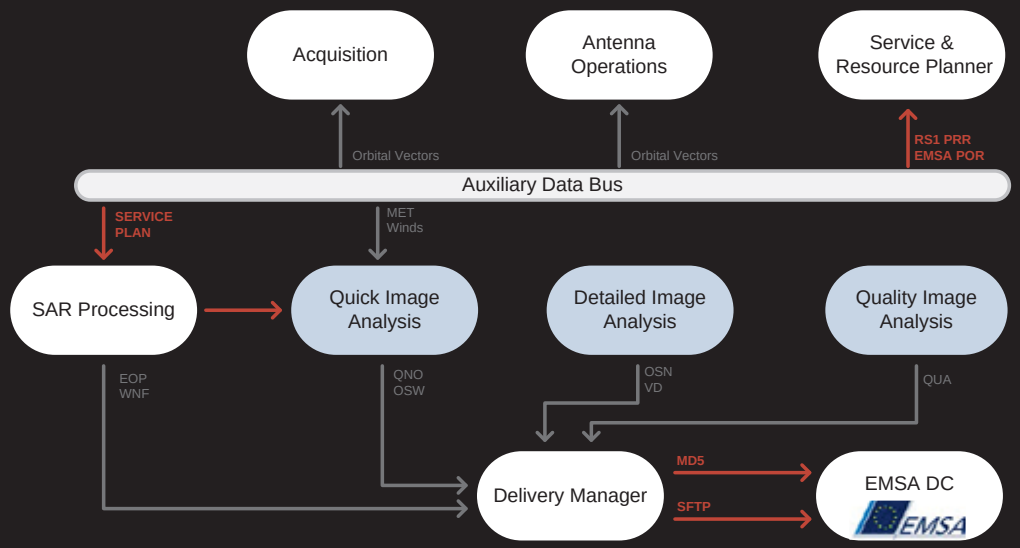
- 5.5 meter diameter antenna
- Parabolic shaped reflector and receives signals in the S-band and the X-band.
- S-band auto-tracking capability
- Antenna can be moved in any direction with a speed of up to 5 degrees per second
- Pointed with accuracy better than 150 thousands of a degree
- Antenna is owned by ESA
- EDISOFT owns the X-band SAR processing capability. This allows the processing of the SAR sensors of Radarsat-2 and Sentinel-1 satellites

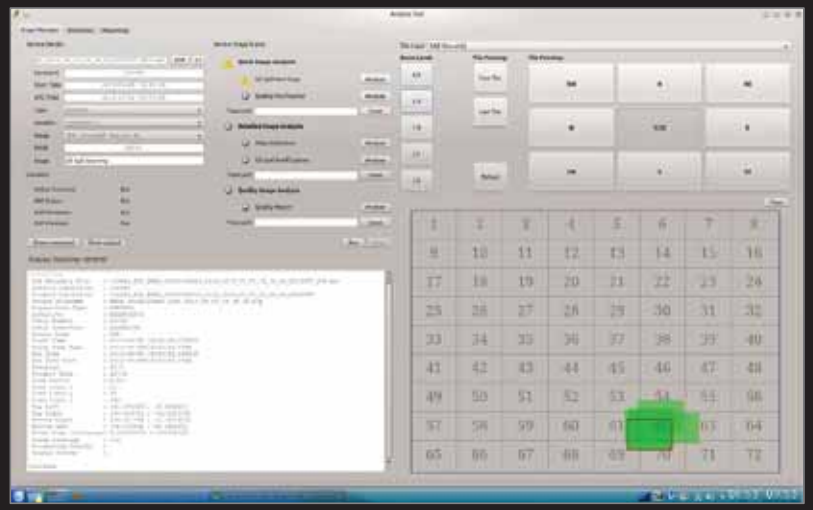




Processing Chain

- CleanSeaNet processing chain fully developed by EDISOFT
- Proprietary Analysis Tool and Geo-Browser





- Upgrade of EDISOFT processing chain to cope with SENTINEL data requirements
- Virtualization of the SENTINEL SAR IPF using Docker

OPENSHIFT by Red Hat

kubernetes

Operations

- Operations fully performed in Azores
- Santa Maria Station staff: 10 persons
- 4 CleanSeaNet service operators
- Backup centre in Lisbon
  - Dedicated communication link to Azores
  - Service-ready Workstations
  - 3 CleanSeaNet backup operators
  - Technical support

Image from Açores archipelago: First Sentinel 1 image processed & acquired by EDISOFT in Santa Maria, Açores using Copernicus collaborative ground station

Research & Development

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

The *EEA Grants Type I – Sentinel Data Reception* project aimed at improving the capabilities of monitoring marine waters on Santa Maria Ground Station, enabling Sentinel-1 data reception and archiving

The *EEA Grants Type IV – Oil Spill and Illegal Fishing* project entailed the implementation of a capacity for early detection of oil spills/discharges and illegal fishing activities in oceanic areas, by correlating Sentinel-1 imagery with non-satellite data.

Automation of the oil spill detection processing chain, integrating auxiliary data (like wind information), together with image and geometry analysis techniques.

Development of a pre-operational service for vessel detection in the Atlantic based on SAR with correlation with non-satellite data sources, such as AIS or LRIT.

Deep exploitation of remote sensing data towards the development of advanced techniques for ship detection and classification purposes.

Demonstration of advanced ship detection algorithms increasing the detection rate and providing useful information for target classification in border surveillance scenarios.

Improvement of oil spill detection algorithms, through the maximization of the informative content obtained with data fusion, the exploitation of different type of data/sensors and the development of advanced image processing, segmentation and classification techniques

Future of Santa Maria Site

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

- **15m antenna currently being erected in Santa Maria**

CleanSeaNet: Trends for the Future

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

- New Threats: Illegal immigration, illegal fishing, protected areas
- Geo-fencing, behaviour detection
- Drone Operations
- Permanent Observation
- Huge Volumes of Data
- EODC – Earth Observation Data Centre

CleanSeaNet Value

EDISOFT
DEFENCE & AEROSPACE TECHNOLOGIES

- Environment protection
- Contributing to the preservation of the Portuguese EEZ
- Promoting Economic Growth in ultra-periferic regions
- Pushing technological innovation

Oil spill monitoring and vessel detection services for EMSA - European Maritime Safety Agency

10 Year Celebration

NOVEMBER, 14TH 2017

e-geos

Content

- e-GEOS Company Overview
- SEonSE: e-GEOS solution for Maritime Surveillance
- e-GEOS experience in EMSA CleanSeaNet
- Maritime Surveillance evolution

e-GEOS

LEONARDO THALES

67% 33%

TELESPAZIO
a LEONARDO and THALES company

- Contracts
- People
- Assets

asi agenzia spaziale italiana

COSMO-SkyMed
exclusive world wide rights

80% e-geos 20%

AN ASI / TELESPAZIO COMPANY

INTERNATIONAL MARKETS 80%

DOMESTIC MARKETS 20%

10+ SATELLITE MISSIONS DATA ACQUIRED.	9+
70millions AGRICULTURAL PARCELS	2500+
750+ MARITIME REPORTS/ YEAR	188+
100m €+ REVENUES	500+ PEOPLE

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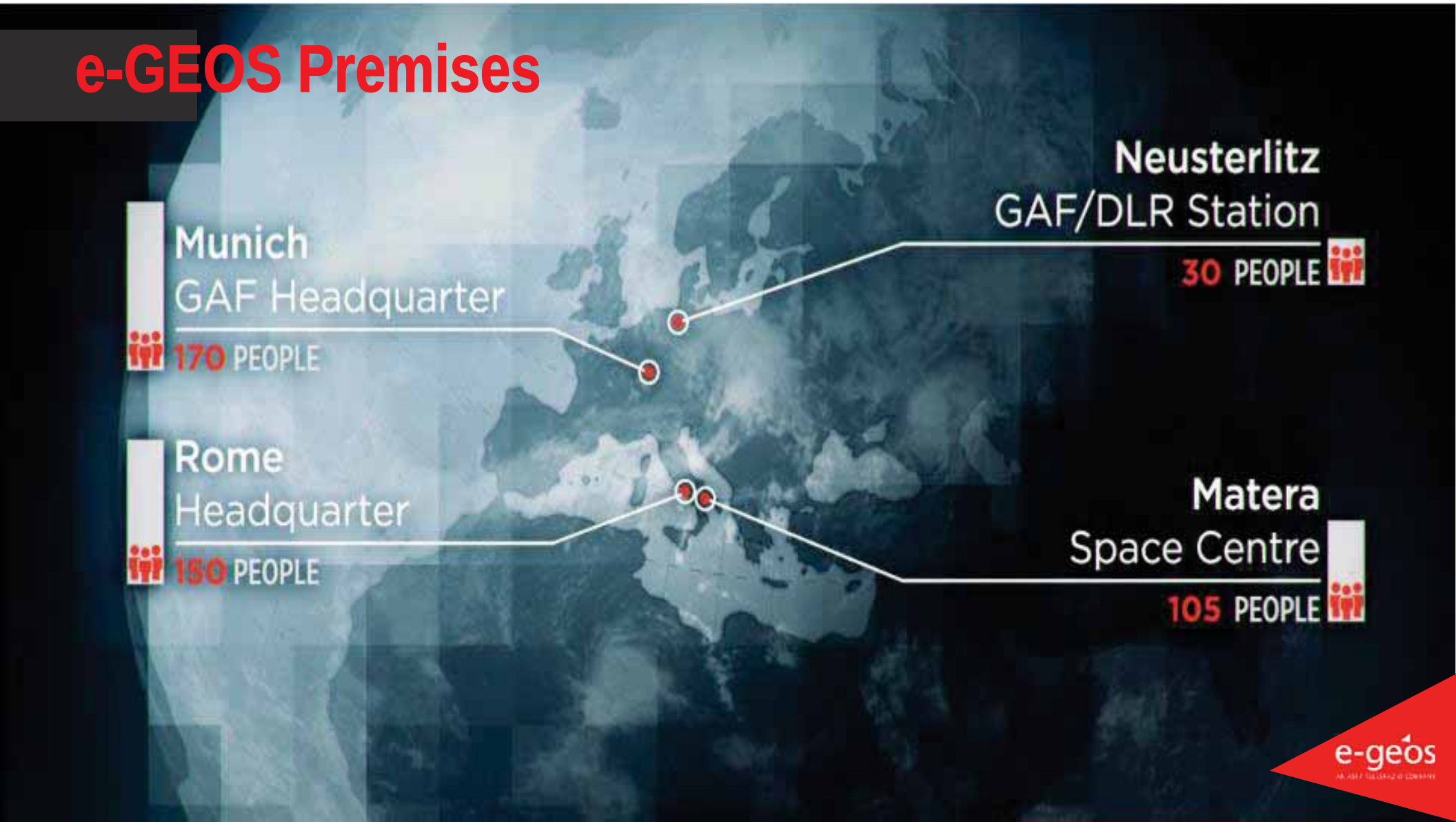
e-GEOS Premises



DATA PORT SERVICES

Acquisition of
FIRST IMAGE of CleanSeaNet Service
ENVISAT 8:33 UTC April 16th 2007

e-GEOS Matera Space Center is the infrastructure for operational services

to receive, generate, store and disseminate Earth Observation data and for Geodesy studies.

Operational EO multi-mission Ground Station

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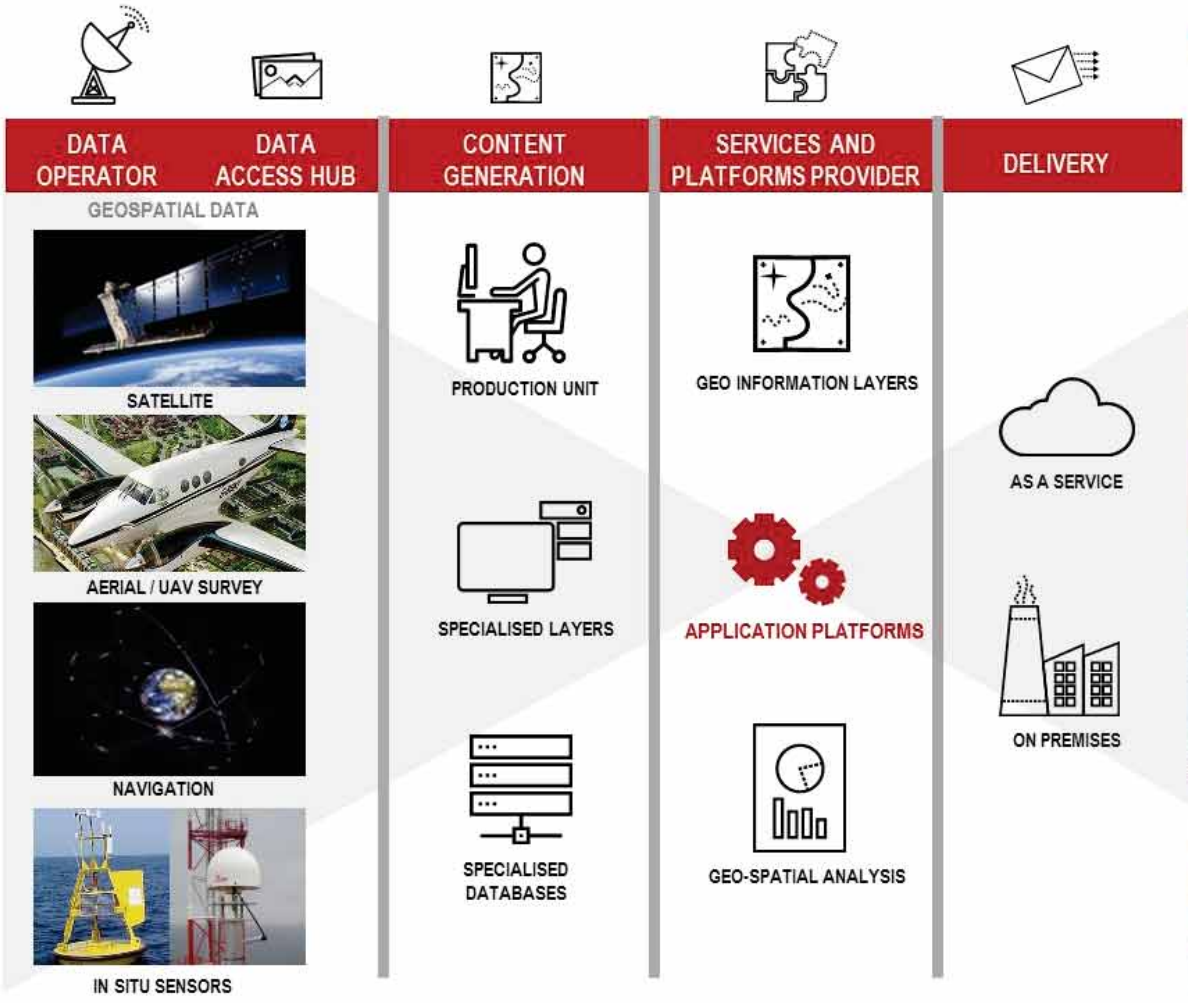
Our Platforms for Market Segments needs



PRIORITY MARKET SEGMENTS

1) Defense & Intelligence
2) Agriculture and Food production
3) Insurance and Asset Management
4) Natural Resources & Risk Management
5) Mining, Oil & Gas
6) Forestry & Climate Change

MARITIME SURVEILLANCE

For supporting **international environmental protection organizations,** defense and marine forces in Maritime Situational Awareness services, for Coast Guards, Enterprises and Governments for **on/off shore activities;** also for **safety, environmental protection, resources management organization.**

SEonSE
Smart Eyes on SEas

Maritime Surveillance Solution providing multi-sensor reports and analysis for :

- Near-Real Time Vessel Detection and tracking, Oil-spill detection
- Wind&Wave analysis
- Ice charting
- Geospatial Analysis and Alert Notifications
- On-Off shore platform / infrastructures Subsidence

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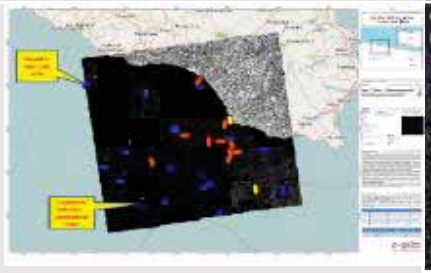
SEOnSE
Smart Eyes on SEas

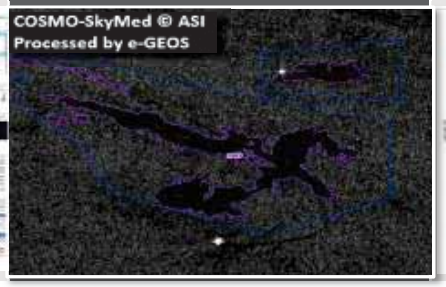
Maritime Services

Vessel detection

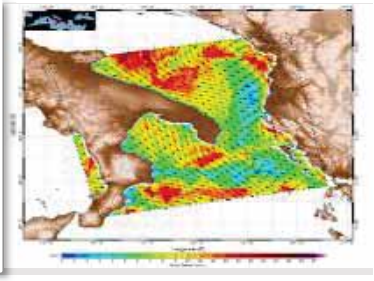
Activity Report



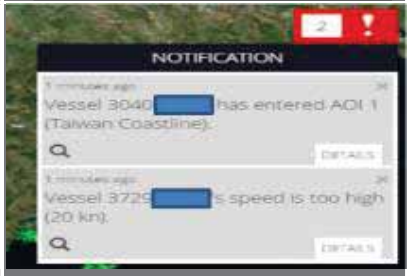
Oil Spill Detection



Wind & Wave



Geospatial Analysis and Alert Notifications



SERVICE STRENGTHS

- Ground Receiving Terminal Network
- Wide and Global coverage
- Multisensor solution
- Validated by Institutional User
- Secure data access
- Experienced Operators on maritime surveillance Satellite image analysis
- Operationa l h24/7
- Fully Automatic and/or supervised processing

e-geos

e-GEOS for CleanSeaNet

7500+
Product delivered

Assets

3 antennas

3 NRT processing chains

10 YEARS
Service

Satellites

Envisat
Radarsat 1
Radarsat 2
COSMO-SkyMed
Sentinel 1A
Sentinel 1B

60+

People

Project Manager
Operational manager
NRT Team
Emergency Team
Algorithm developers
NRT chain engineer

e-geos

e-GEOS for CleanSeaNet …..

e-GEOS for CleanSeaNet

- Oil Spill report **<30 minutes from sensing**
- Local **wind & wave** information from SAR imagery
- **Quality control** procedures applied to services operational production
- **AIS data integration**
- Operational service with **Envisat** and **Radarsat 1**

- Oil spill warning <**15 minutes from sensing**
- **Radarsat 2** integration in Matera **Ground Station**
- e-GEOS develops its own **Global Wind & Wave SW**
- Add on of Services for **Frontex**
- **COSMO-SkyMed**

- Integration of Radarsat 2 high resolution modes
- Integration of Sentinel-1 receiving station in **Matera Space Centre**

2006
2010

1st contract

2010
2014

2nd contract

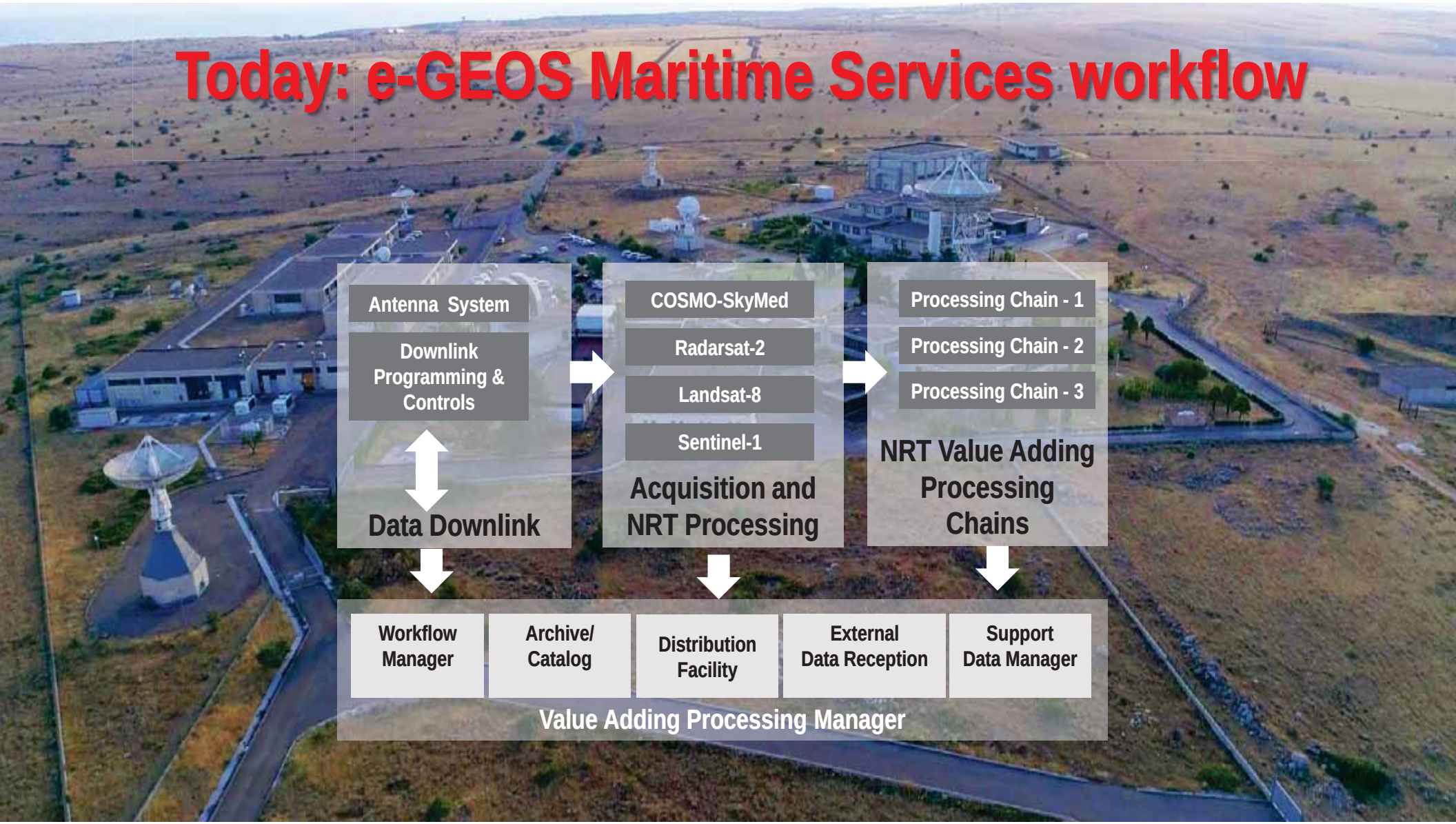
2014
2018

3rd contract

main technological evolutions

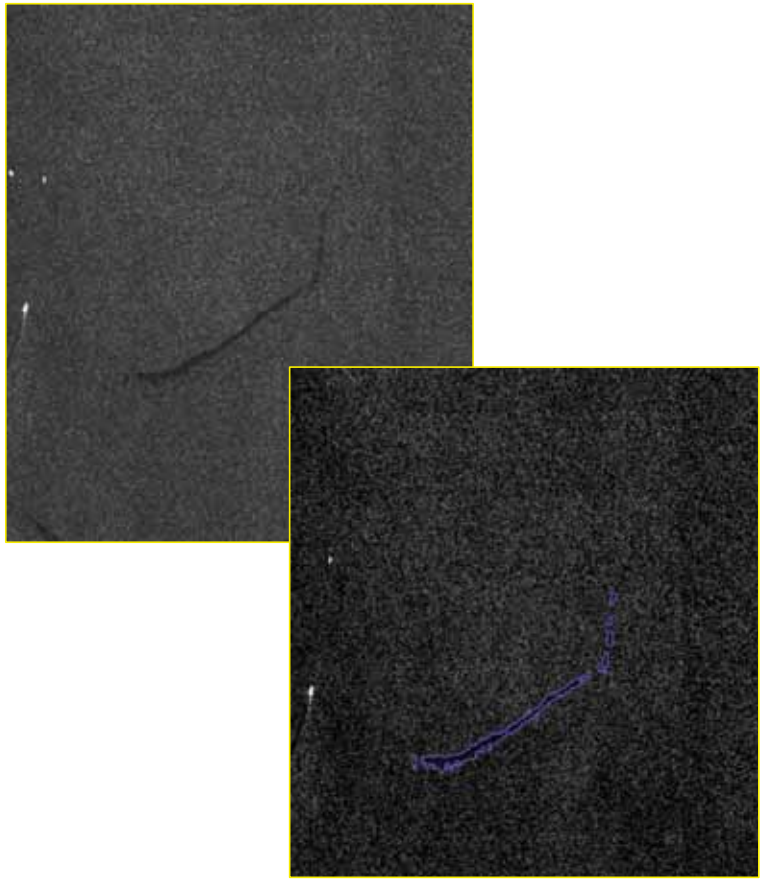
e-geos

Today: e-GEOS Maritime Services workflow

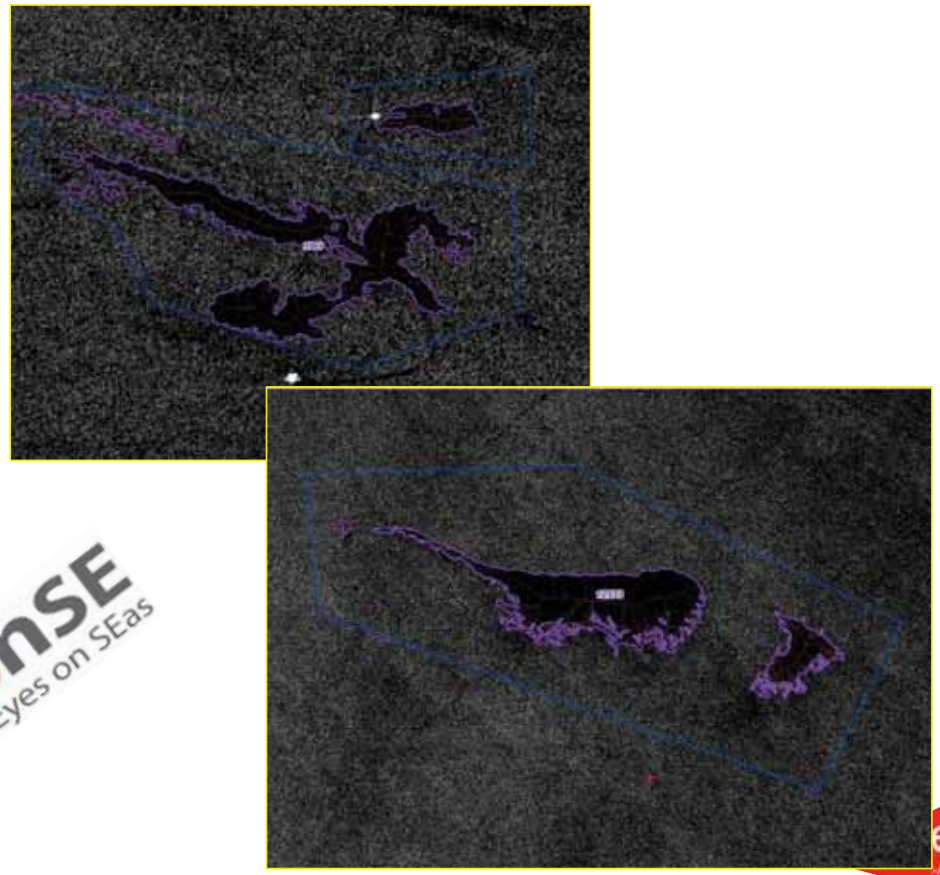


Oil Spill Detection product evolution

Oil Spill Extraction



Oil Spill Parameters Estimation

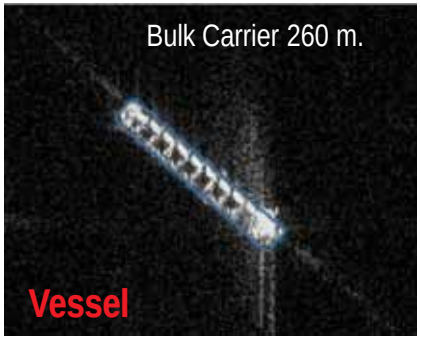


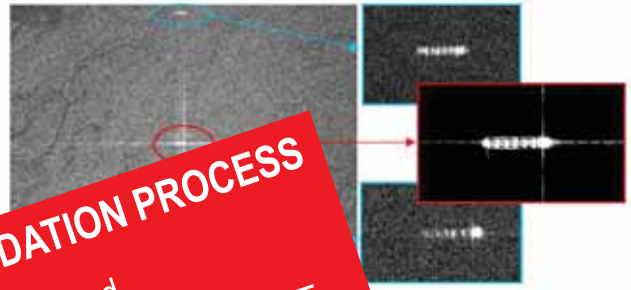
SEOnSE
Smart Eyes on SEas

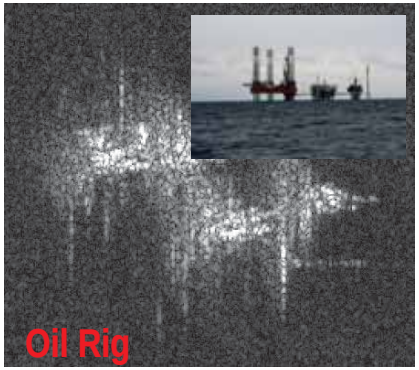
e-geos

Vessel Detection product evolution

Detection & Classification	Automatic Wake Detection	Automatic Ambiguities Removal	Data Fusion







CONTINUOUS VALIDATION PROCESS

4000+ SAR products analyzed

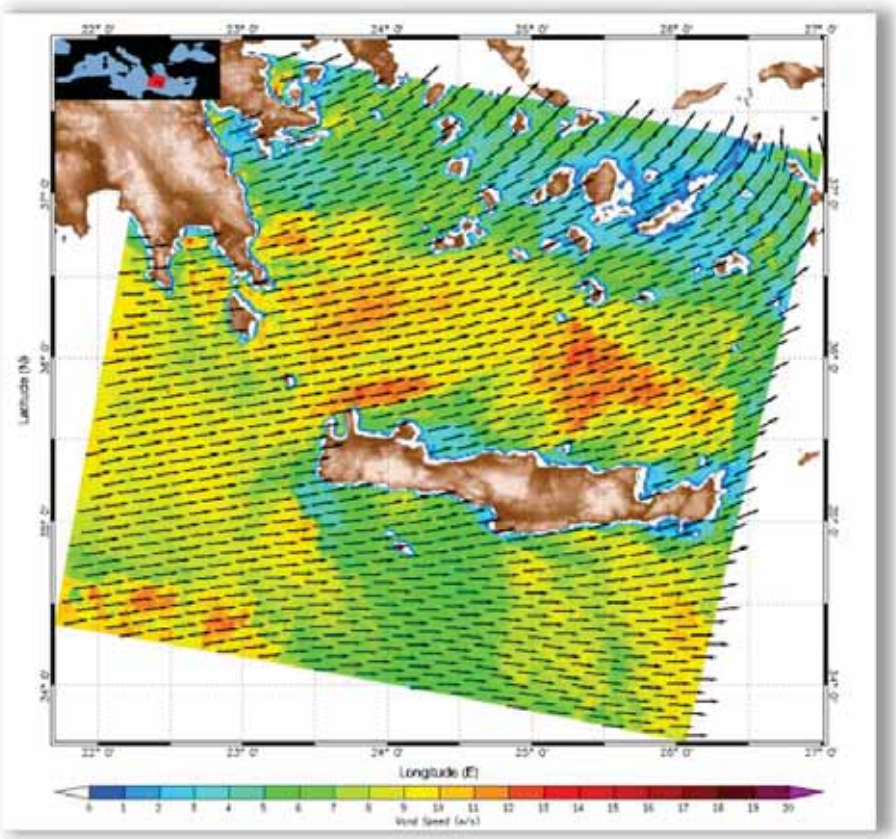
COSMO-SkyMed , Radarsat, S-1,ENVISAT, ALOS Palsar, and ERS2

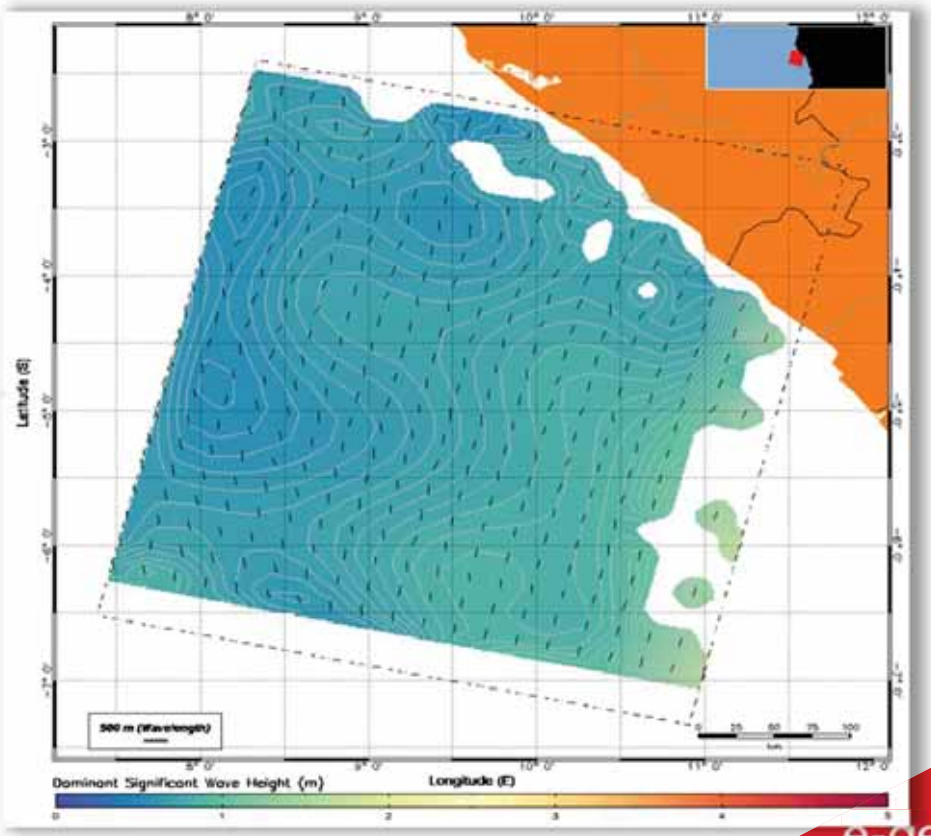
Compared with synchronous legacy systems data

AIS, Satellite AIS, VMS ,Costal Radar

Wind & Wave products

Wind and wave fields extraction from SAR images with e-GEOS proprietary GWW tool



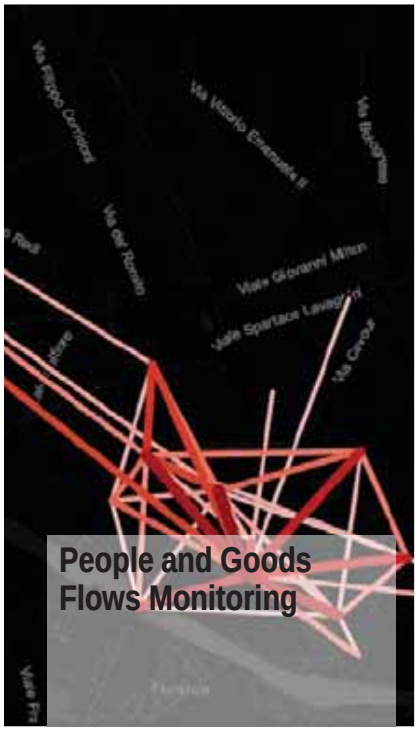


from now ▶ to very next future

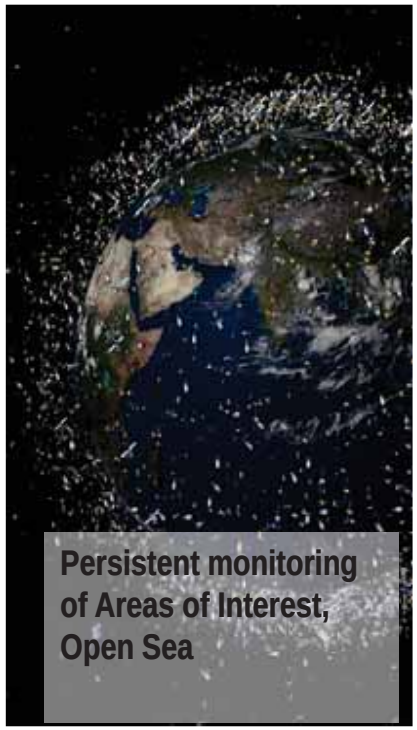
Enhanced Maritime Situation Awareness: Collateral & Space data integration

Navigation

Telecommunication



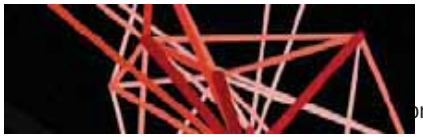
Earth Observation



Open Data

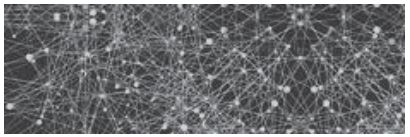
Routes analysis

Mobility Patterns



Mapping and Monitoring

Analytics & Reports



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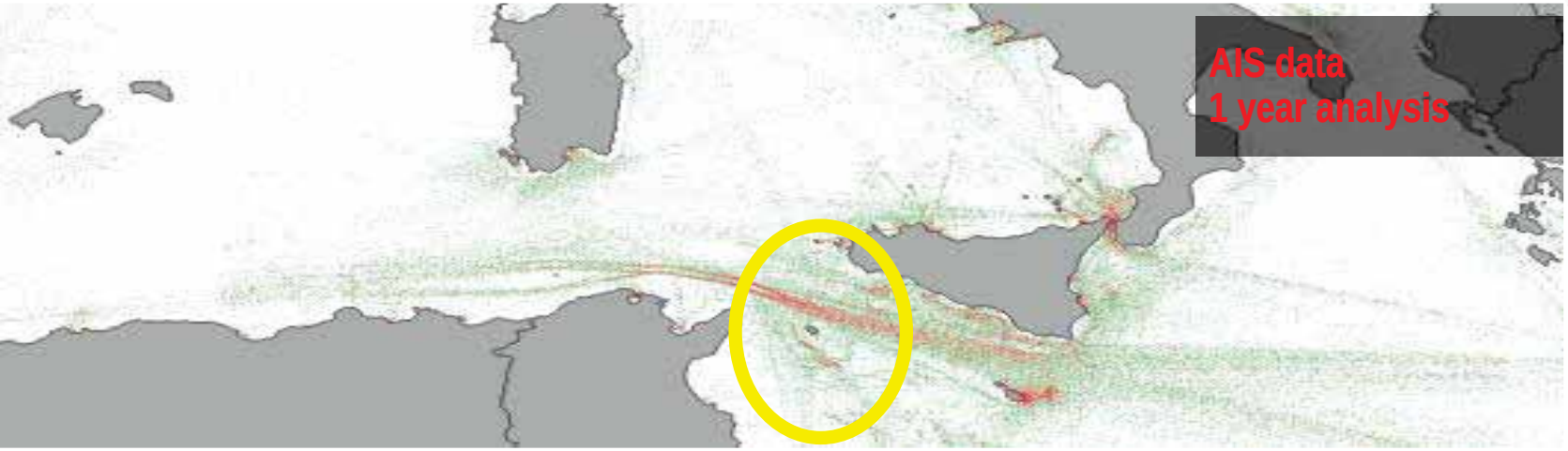
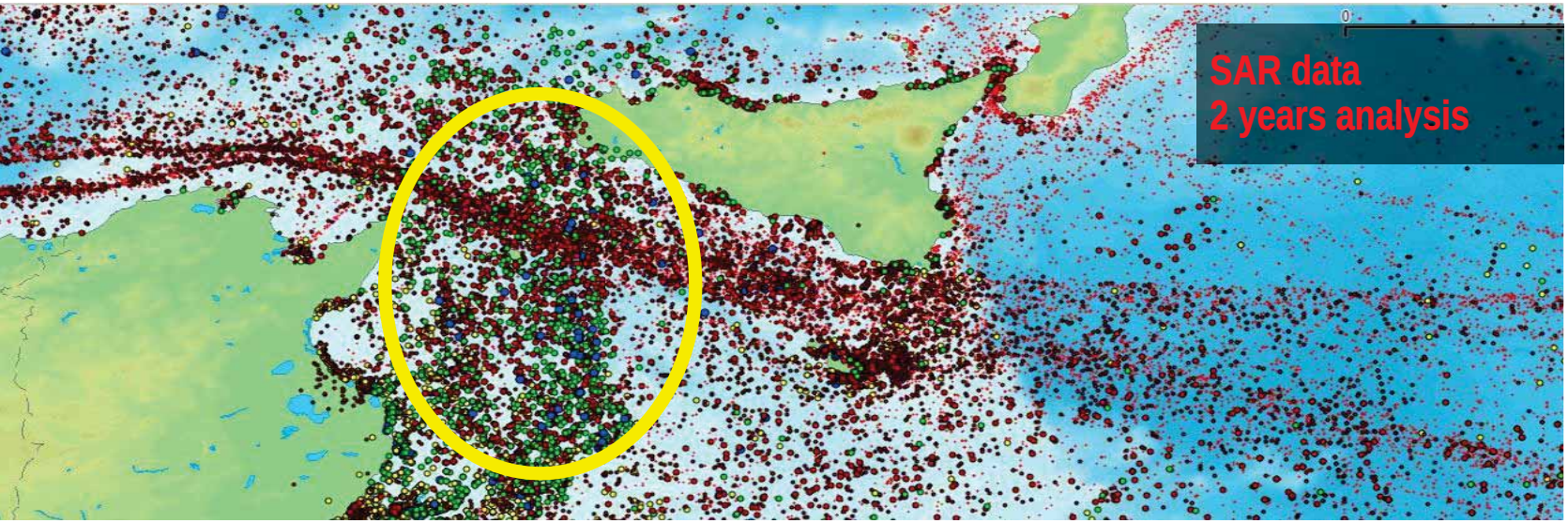
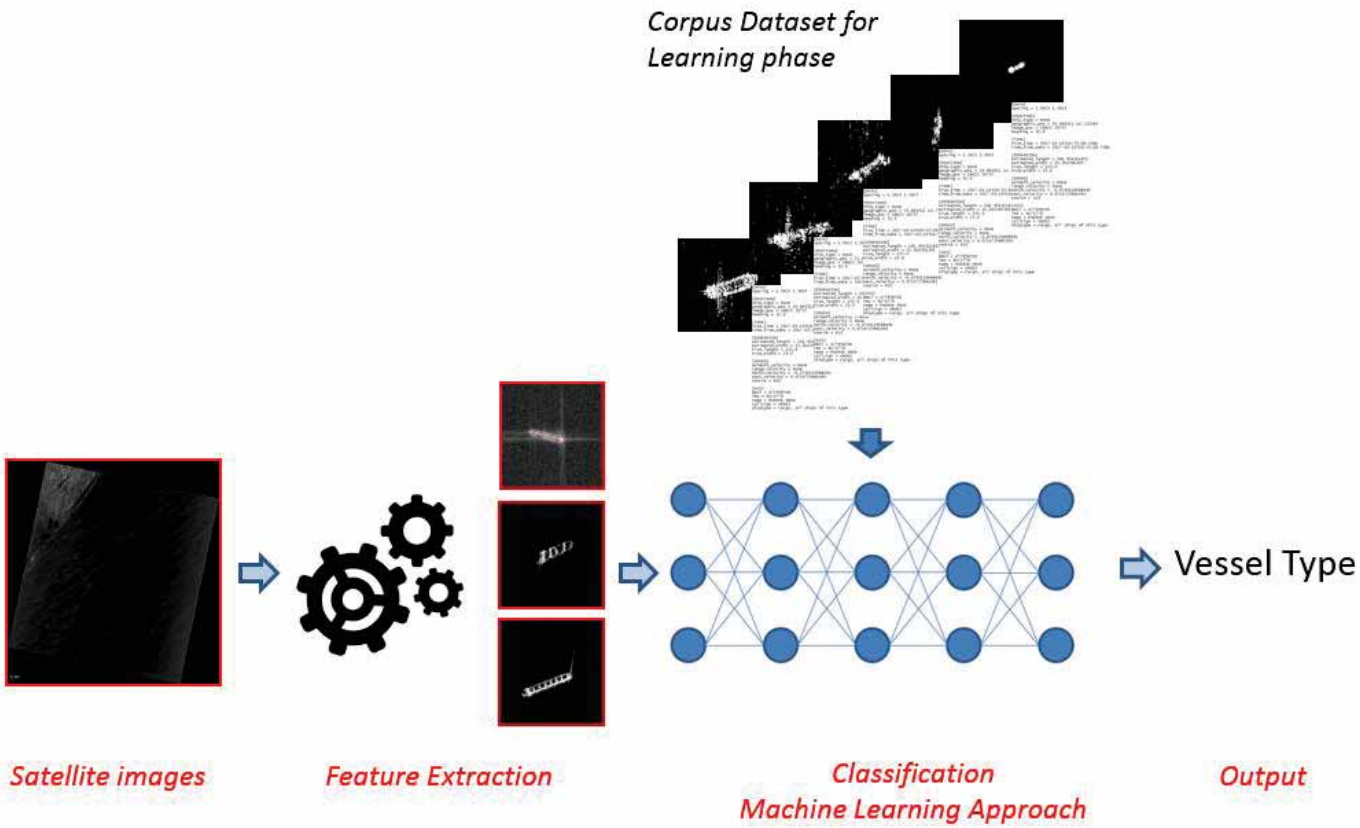
Pattern identification from Big Data Analytics



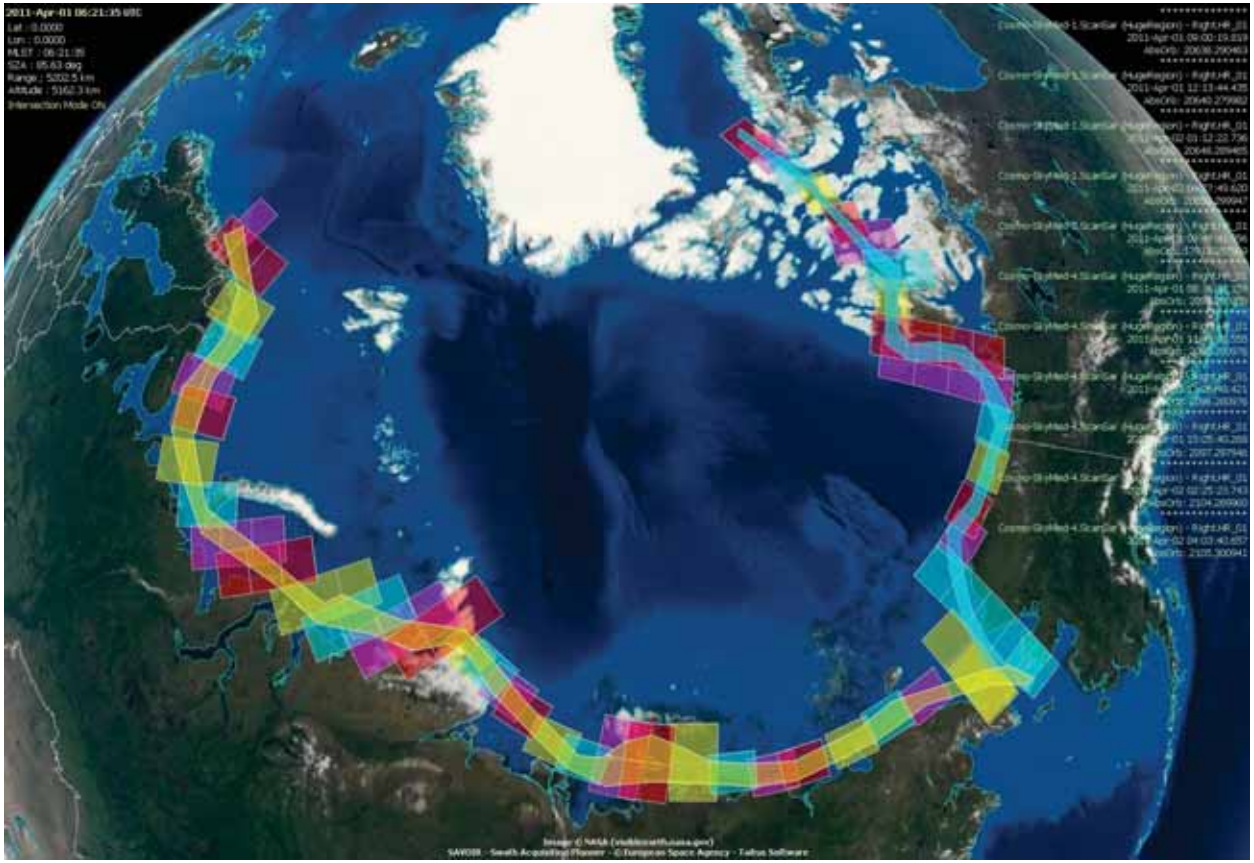


Deep Learning techniques for Vessel Classification



CATEGORY	Vessel Class
MERCHANT SHIP	Generic Merchant ship
	Bulk carrier
	Cargo
	Container carrier
	Oil tanker
	NLS/Chemical/Gas tanker
	Tug boat
PASSENGER SHIP	Generic Passenger ship
	Cruise boat
	Ferry
FISHING BOAT	Generic fishing
	Purse seiner
	Trawler
	Traditional fishing
WARSHIP	Generic Warship
	Aircraft carrier
	Destroyer
	Frigate
	Patrol vessel
	Amphibian ship
	Supply
	Submarines
LEISURE BOAT	Generic Leisure boat
	Yacht
	Sloop
SKIFF	Generic Skiff
	Yawl
SPEEDBOAT	Speedboat
R I B	Rubber inflatable boat
UNKNOWN	

Monitoring Artic shipping routes in NRT every day



COSMO-SkyMed with its 4 satellites guarantees un-matched revisit capabilities, especially close to the Poles.

CSK allows complete area acquisitions **every day** on Artic areas.

e-GEOS experience in CleanSeaNet

e-GEOS is one of the EMSA's Contractor since the beginning of the service, in April 2007

- CleanSeaNet is the first operational EO based service for Maritime Surveillance
  - ➡ matching Operational User Community's needs with first operational NRT Services

- CleanSeaNet success and extensive usage pushes for a continuous evolution of technologies and of Service Level
  - ➡ building world-wide competitiveness by evolving SEonSE value chains to comply with Agency's challenging requirements

e-geos

e-geos

AN ASI / TELESPAZIO COMPANY

All COSMO-SkyMed images © ASI - Agenzia Spaziale Italiana

e-GEOS S.p.A – L.O. Contrada Terlecchie snc – Matera / HQ Via Tiburtina, 965 – Roma

European Space Imaging

Very High Resolution Satellite Imagery for Customers in Europe

Adrian Zevenbergen – Managing Director

EUROPEAN SPACE IMAGING

COMPANY

Company Overview

The leading provider of VHR satellite imagery for customers in Europe operates its own satellite tasking, reception and processing station.

Established in 2002

Based in Munich, Germany

- Operating a multi-mission capable ground station
- Entire DigitalGlobe satellite constellation + archive
- Tailored solutions: products, services, license
- Expert and personalized customer service
- A network of 60+ resellers throughout Europe and North Africa

EUROPEAN SPACE IMAGING

TECHNOLOGY

Ground Station

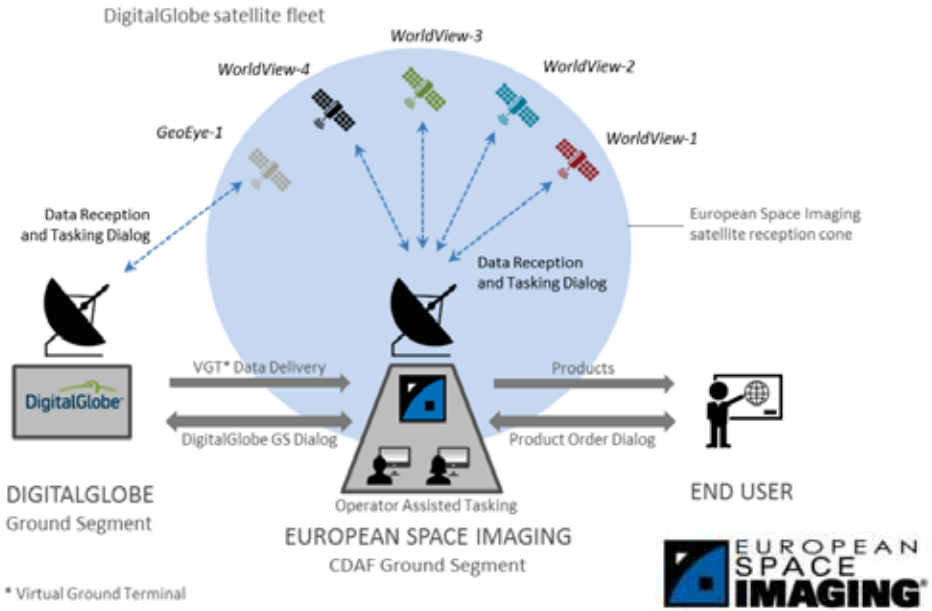
We operate a dedicated ground station
for direct satellite tasking

- Constellation Direct Access Facility (CDAF) located near Munich
- Direct up- and down-link to the WorldView satellites

BENEFITS:

- ✓ Last minute order entry
- ✓ Maximization of collection results
- ✓ Minimize cloud cover
- ✓ Maximize area
- ✓ Maximize collection yield (# targets)
- ✓ Fast production
- ✓ Near real-time delivery

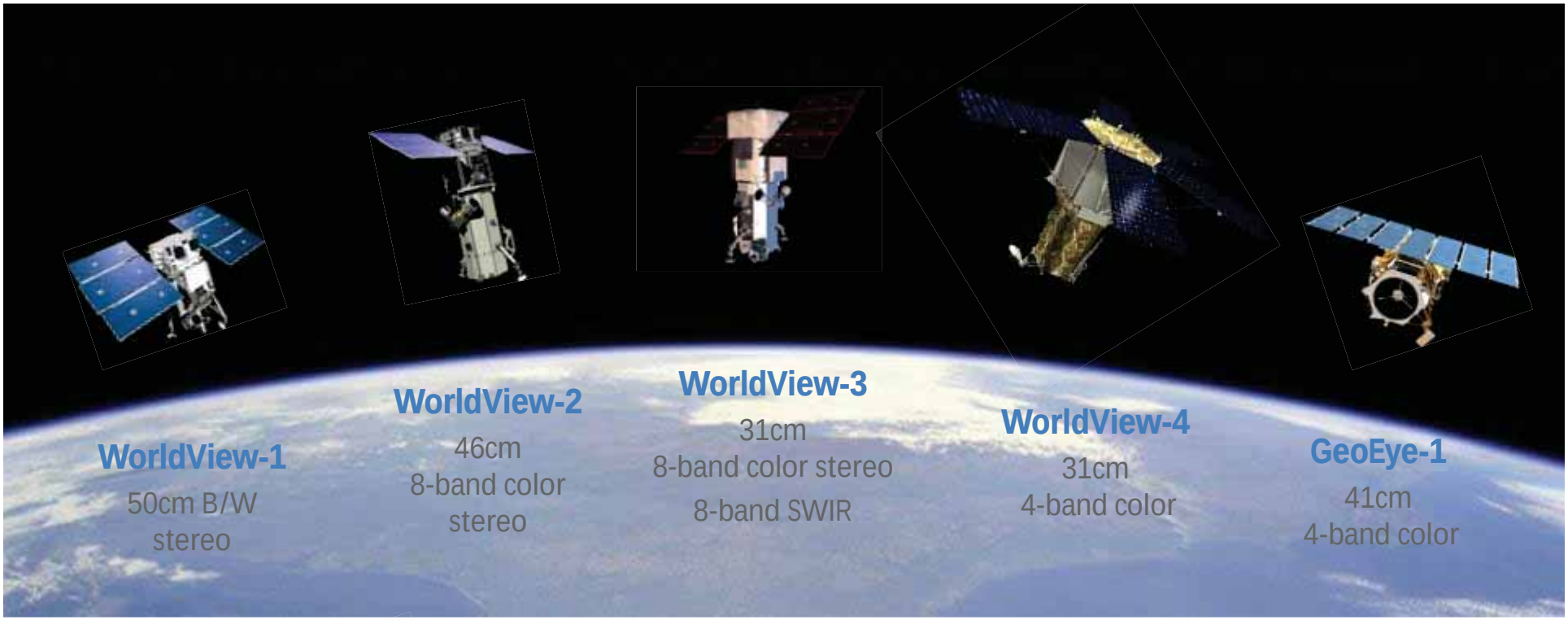
Constellation Direct Access Facility (CDAF)



TECHNOLOGY

Satellites

In orbit:



In archive:

IKONOS
80 cm
4-band color

QuickBird
60 cm
4-band color

EUROPEAN SPACE IMAGING

TECHNOLOGY

Leading Satellite Constellation

- Largest fleet of VHR satellites
  - 5 satellites in orbit

- Highest spatial resolution
  - Up to 31 cm per pixel

- Highest spectral resolution on VHR satellites
  - 8 spectral bands on WorldView-2, WorldView-3 and WorldView-4
  - + 8 extra SWIR bands on WorldView-3

- Largest archived collection
  - More than 5 billion km² imagery
  - Historical imagery back to 1999
  - Growing by more than 3 million km² every day

EUROPEAN SPACE IMAGING

TECHNOLOGY

Spatial Resolution

Produced as 30 cm product (standard)

Delivered at 15 cm product (experimental)

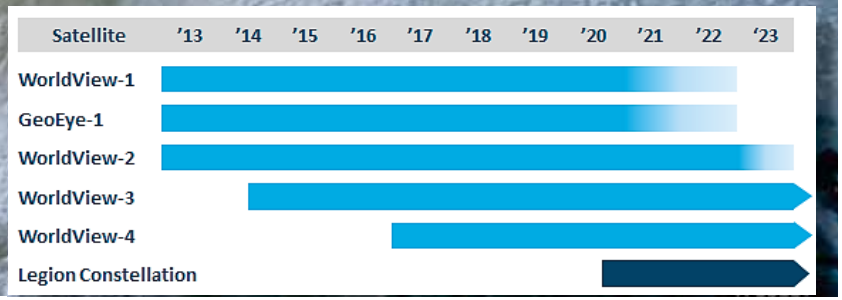
EUROPEAN SPACE IMAGING

TECHNOLOGY

WorldView-Legion

WorldView-Legion is the replenishment program for WorldView-1, WorldView-2, and GeoEye-1

→ Doubles 30cm collection capacity



Optical Satellites Services for EMSA

Faro, Portugal| May 27, 2015| WorldView-2 | 50cm

EUSI's projects in the maritime domain

Optical satellite services for EMSA, phase II

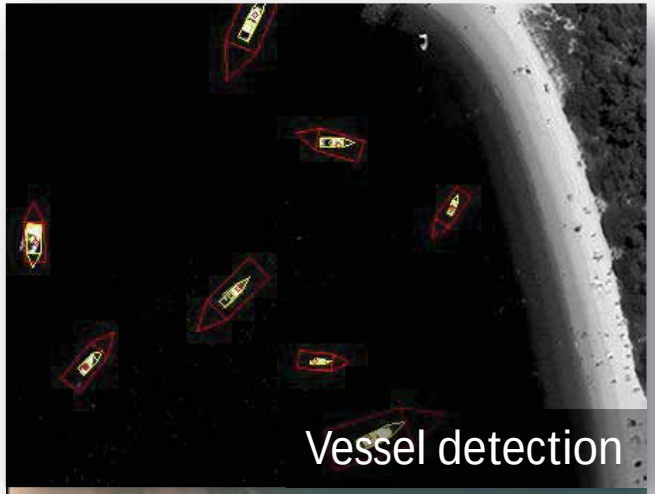
Sponsoring Authority: European Maritime Safety Agency

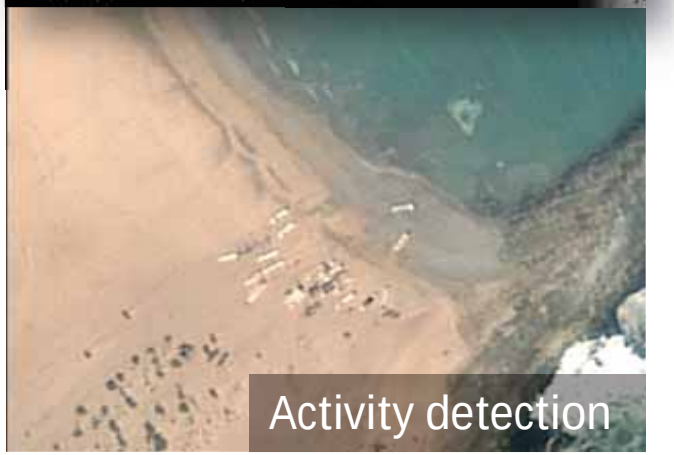
Users: EU bodies and related projects

Need: Monitoring of ports, coastlines and activities at sea, pollution, drug trafficking, human smuggling, border control,...

Challenges:

- Provision of VHR optical satellite data (resolution 30cm - 50cm)
- Time critical delivery (45 min)
- Near Real-Time Monitoring and Mapping for vessel and activity detection, in cooperation with DLR





DLR

EUROPEAN SPACE IMAGING

Examples

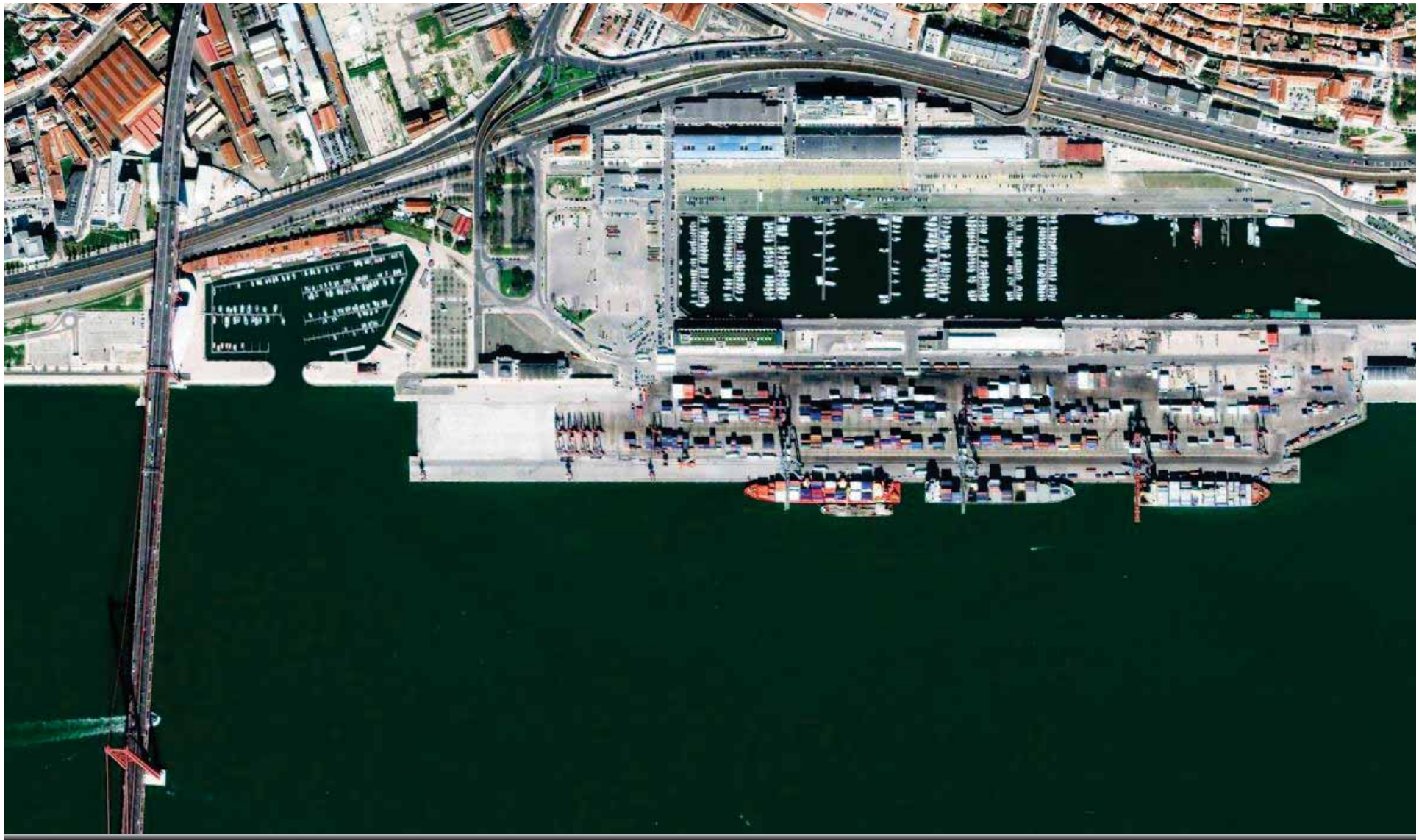
Transhipment

EUROPEAN SPACE IMAGING

Gibraltar | Spain | WorldView-3 | 50cm

Examples

Port Management



Container terminal of Alcântara, Lisbon, Portugal| March 11, 2011| WorldView-2 | 50cm

Examples

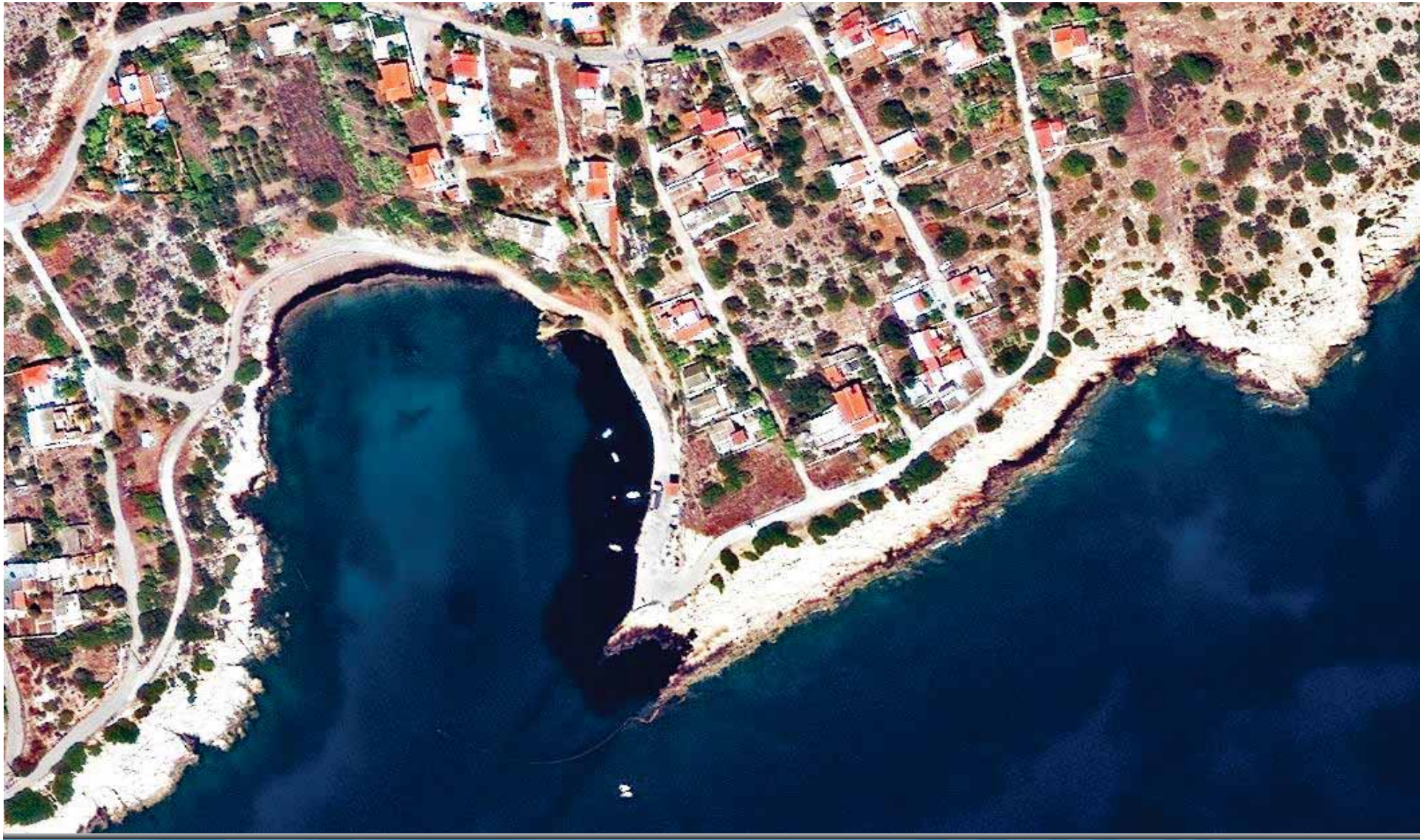
Pollution

Tanker “AGIA ZONI II” sank south-southwest of Atalanti on 09 September 2017 with 2200 metric tonnes of oil

Athens | Greece | September 13, 2017 | GeoEye-1 | 50cm

Examples

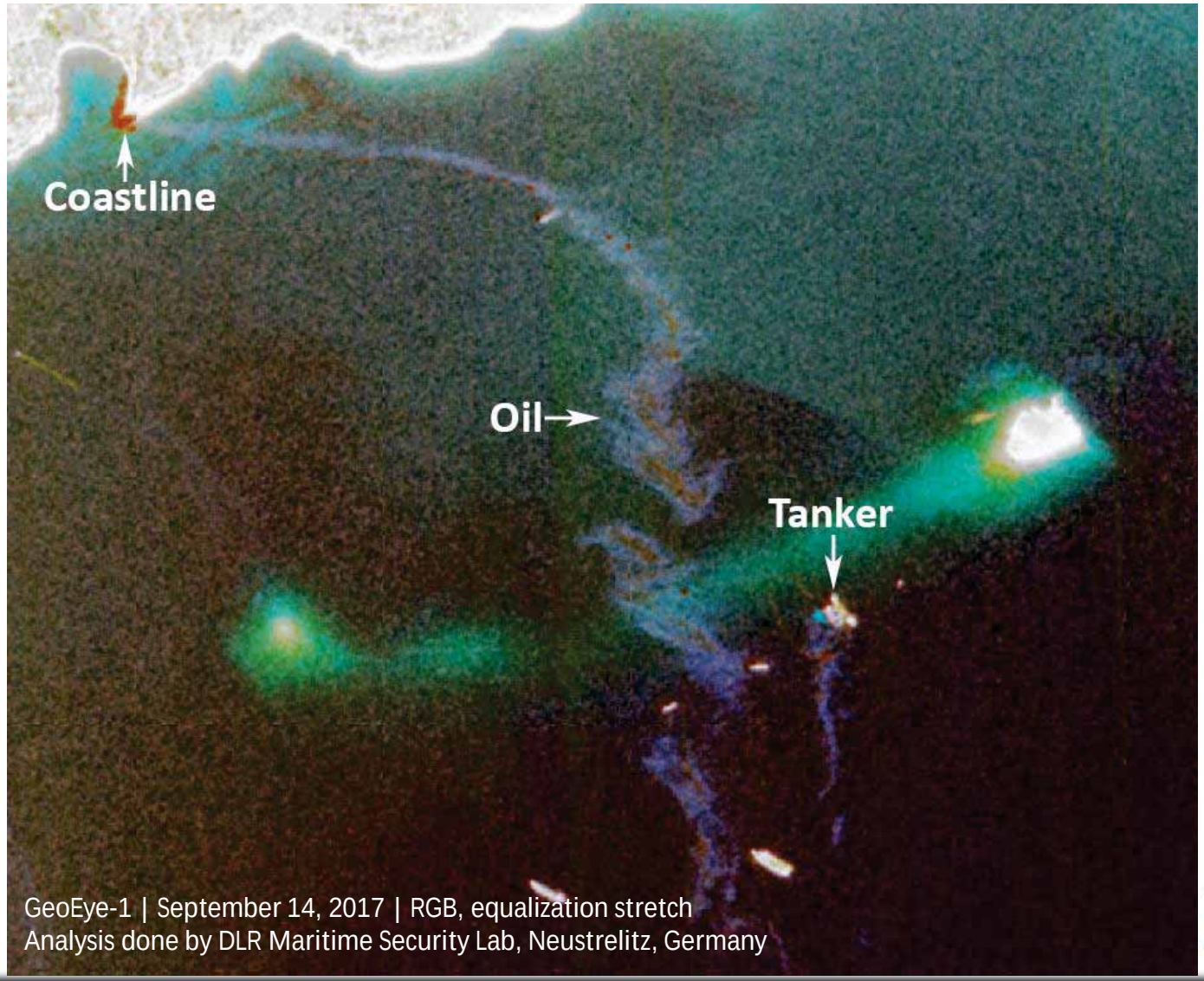
Pollution



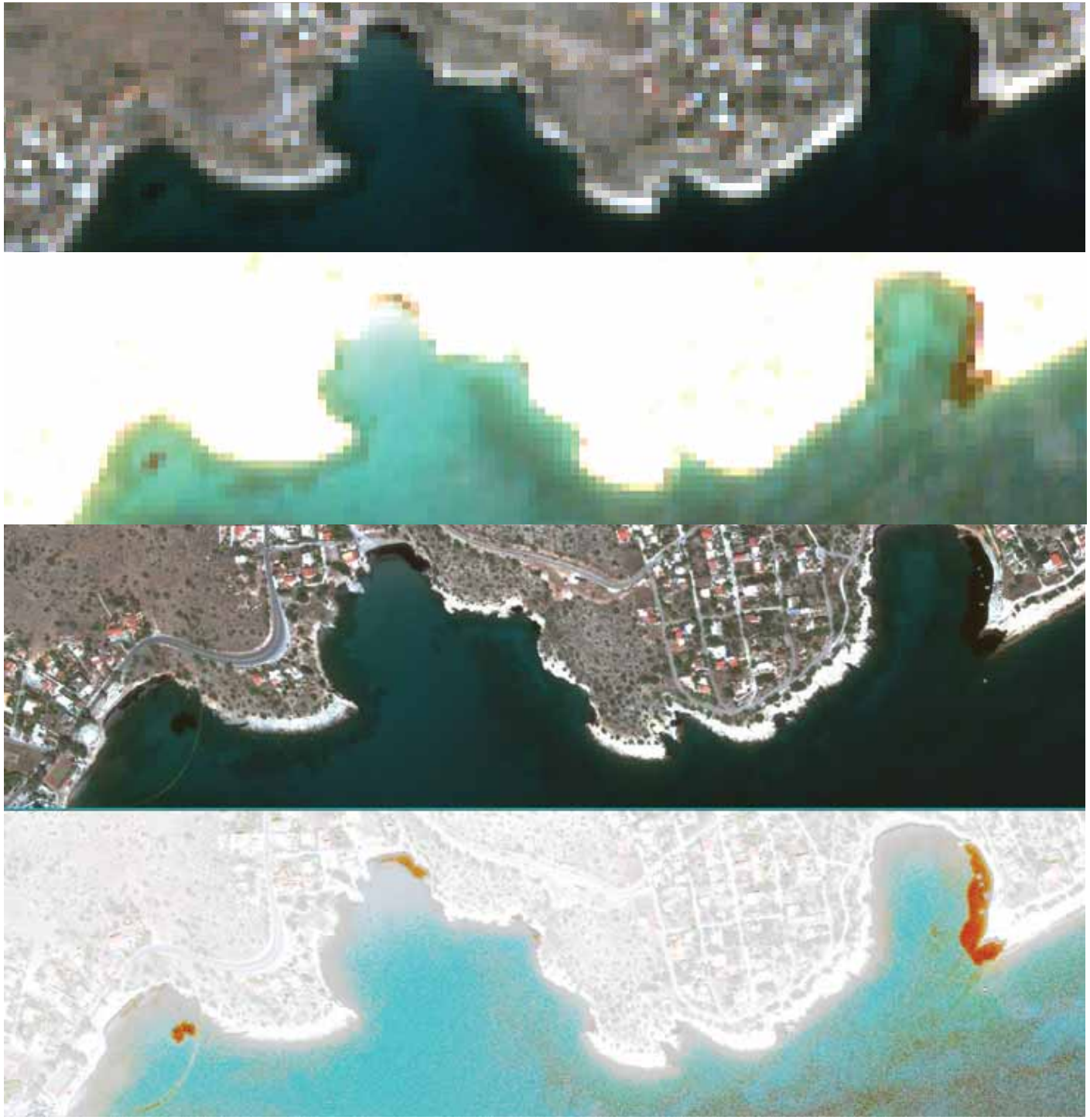
Athens | Greece | September 13, 2017 | GeoEye-1 | 50cm

Examples

Pollution



GeoEye-1 | September 14, 2017 | RGB, equalization stretch
Analysis done by DLR Maritime Security Lab, Neustrelitz, Germany



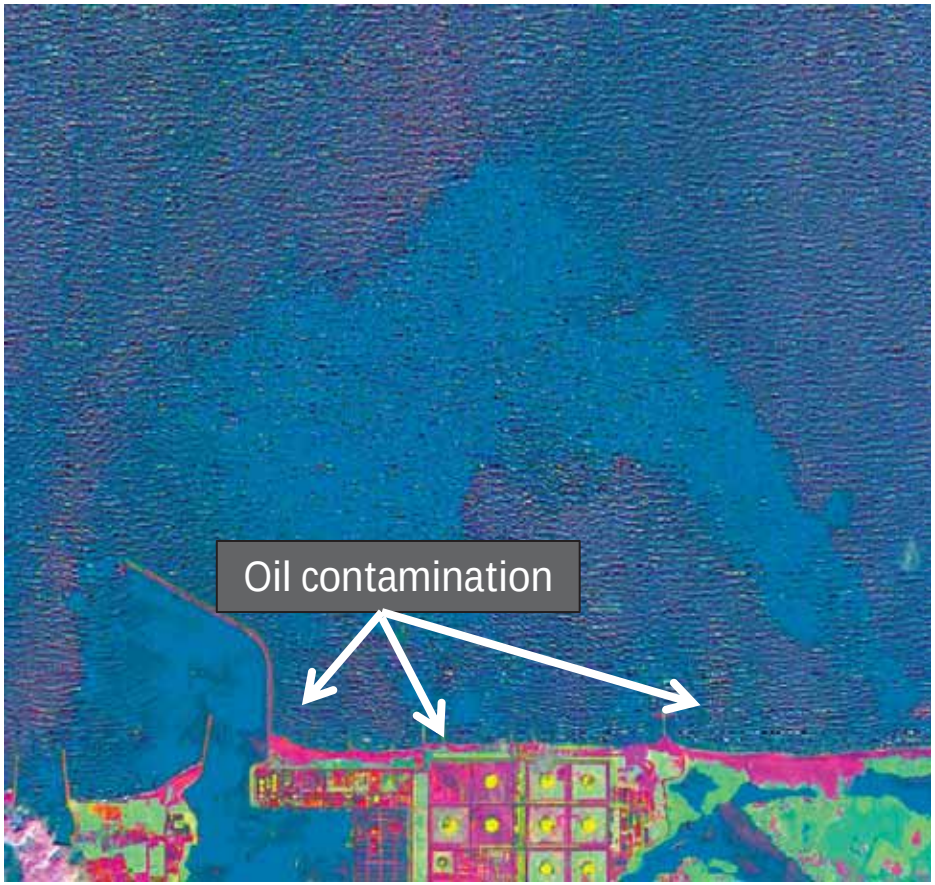
Sentinel-2A | September 13
© Copernicus data (2017)
True color RGB/
radiometrically adjusted

GeoEye-1 | September 13
© European Space
Imaging (2017)
True color RGB/
radiometrically adjusted

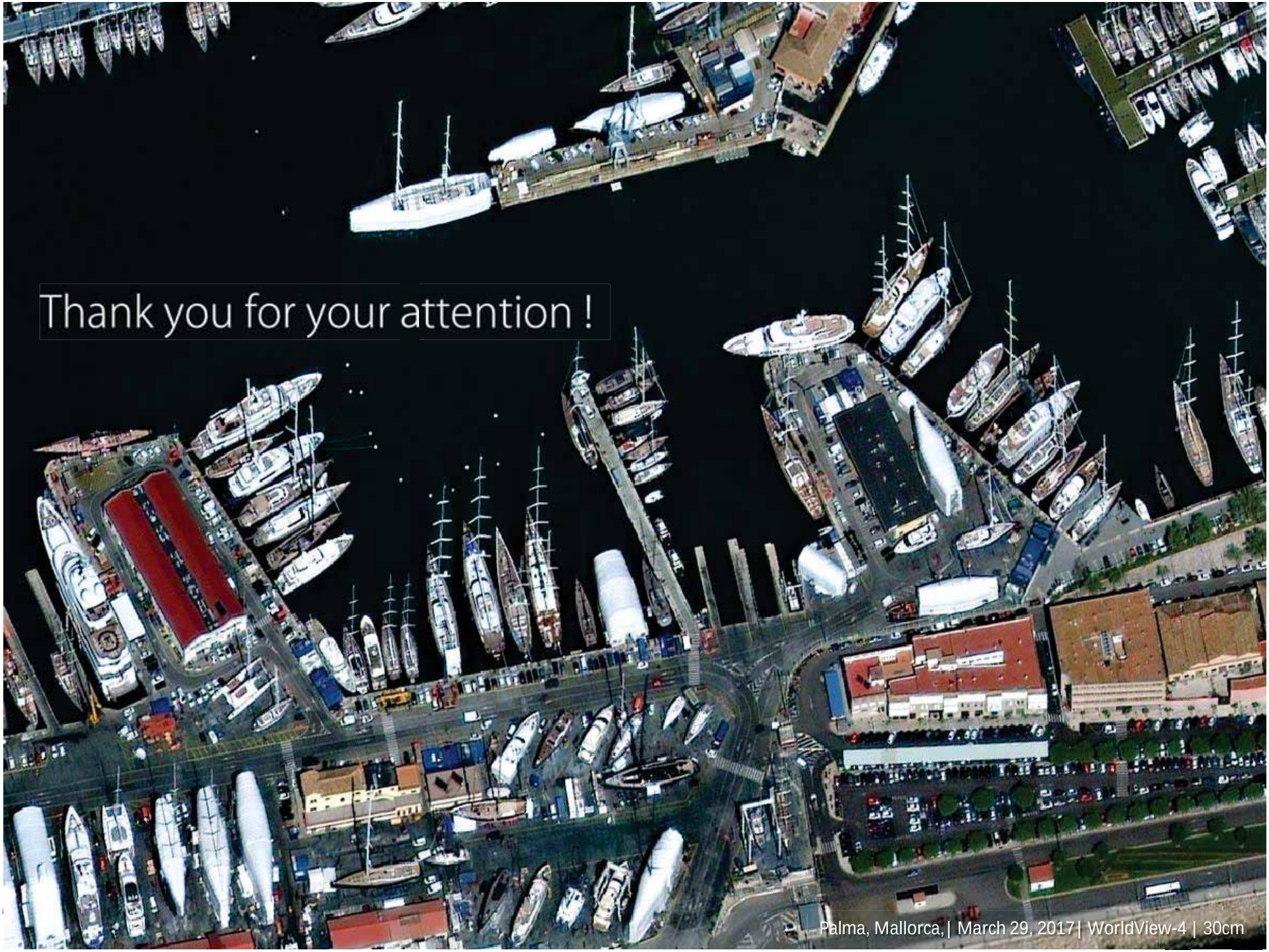
WorldView-3 SWIR

Pollution

Band composite 5-3-2



SWIR principal components 1-2-4


Thank you for your attention !
Palma, Mallorca,| March 29, 2017| WorldView-4 | 30cm

KSAT, KONGSBERG SATELLITE SERVICES

EMSA Celebrating 10 years of the CleanSeaNet

14 November 2017

Line Steinbakk, EES Director Programs

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Congratulation

KSAT before CSN –
Developing the NRT oil monitoring service

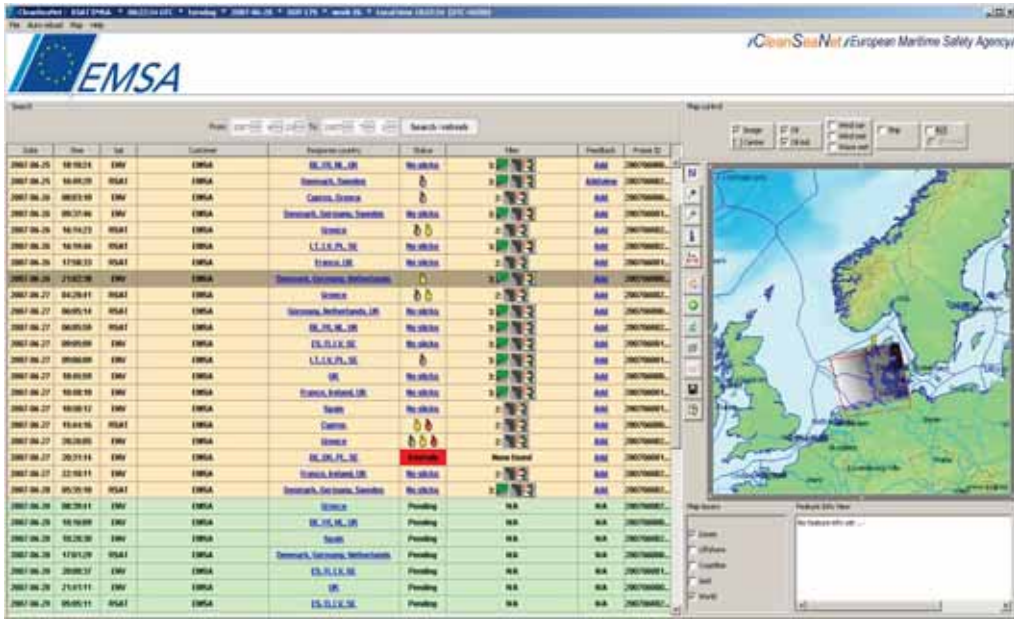
20 years –Developed in Norway from 1995

KSAT before CSN - Dedicated user group

THE WORLD´S NORTHERNMOST GROUND STATION 78°North

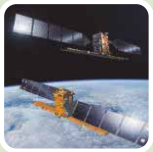
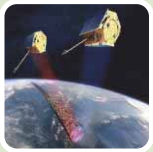
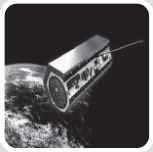
KSAT towards CSN

- Existing users gave very useful feedback
- Feedback was used to further develop and enhance the KSAT oil service
- With this service as basis – KSAT established a consortium with e-Geos and EDISOFT
- The consortium was awarded the first EMSA contract for satellite based oil spill detection and contract for service set up was signed by 12 December 2006
- Four months to set up a European service
- First operational service was delivered to EMSA the 16th April 2007



KSAT in CSN -
Multi-mission services in Tasking area 5-9

KONGSBERG

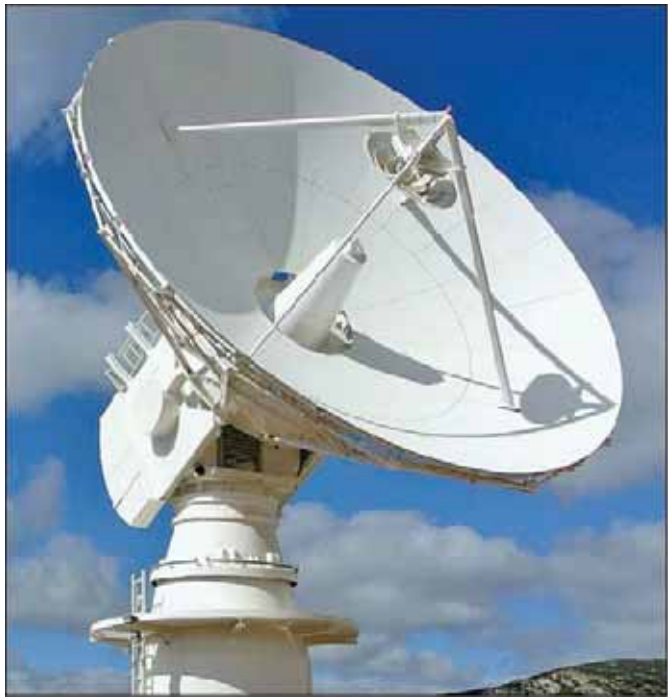
RADARSAT-2	COSMO-SkyMed 1-4	SENTINEL-1a+1b	TerraSAR-X /TanDEM-X	RISAT-1	PAZ
					
In-House Processing					Launch January 2018

KSAT
KONGSBERG SATELLITE SERVICES

Svalbard 78´North

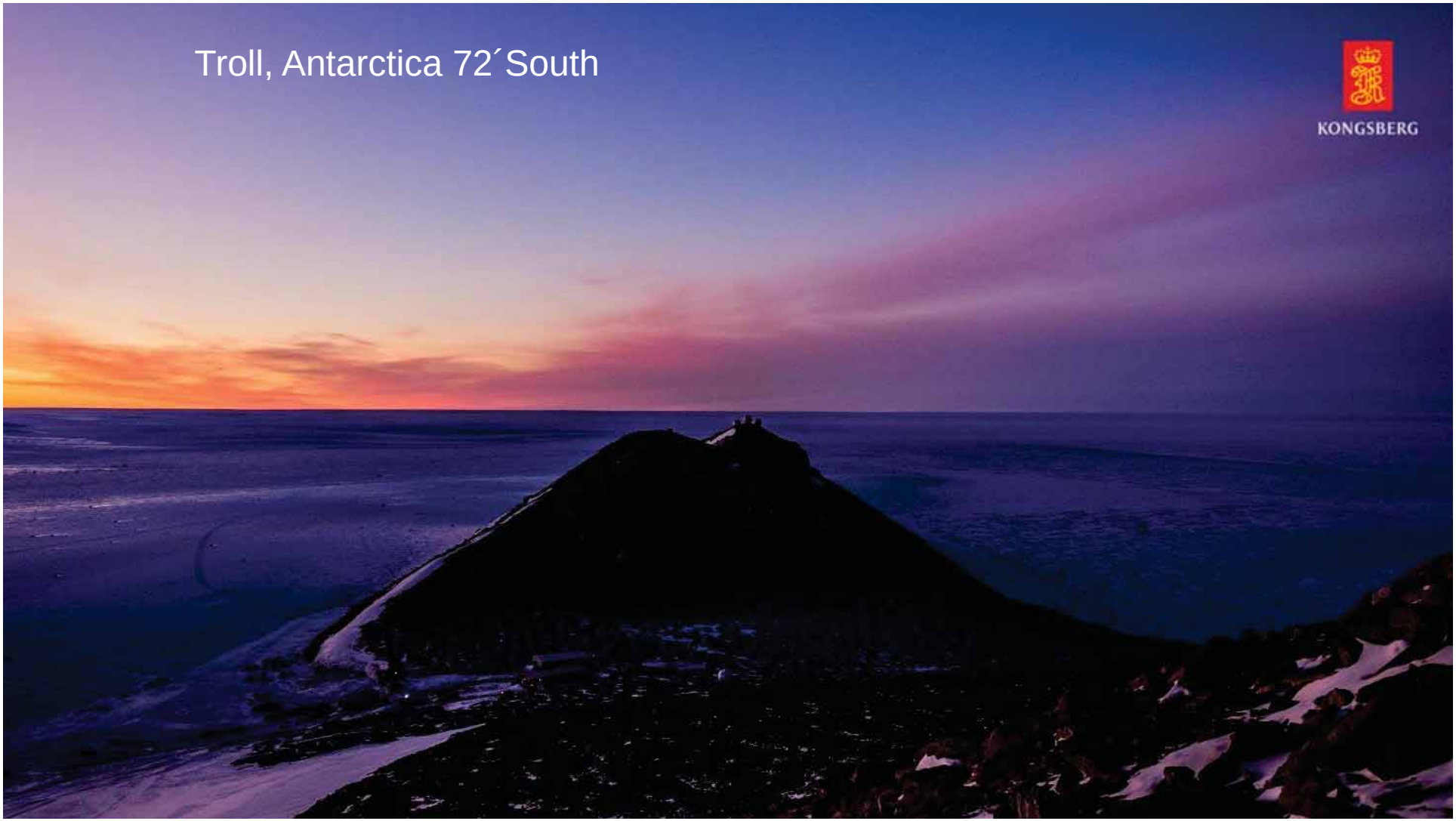
KONGSBERG

Puertollano Spain 38´North

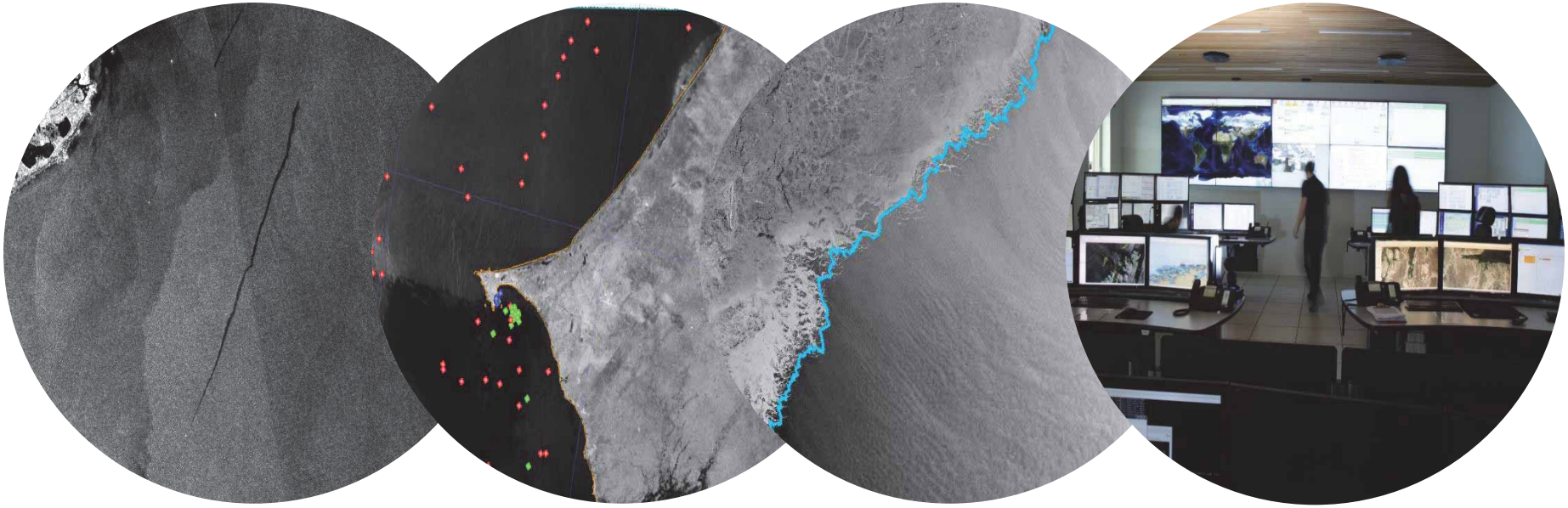


KSAT
KONGSBERG SATELLITE SERVICES

KSAT in CSN - Global services


Troll, Antarctica 72´South
KONGSBERG

KSAT in next generation CSN



Oil Spill | Vessel | Ice edge /Ice berg | 247/ operation

Thank you

10 years of CleanSeaNet with MDA RADARSAT Past – Present – Future

Date: November 14th , 2017

Prepared by: Wayne Hoyle & Susan Nykoluk

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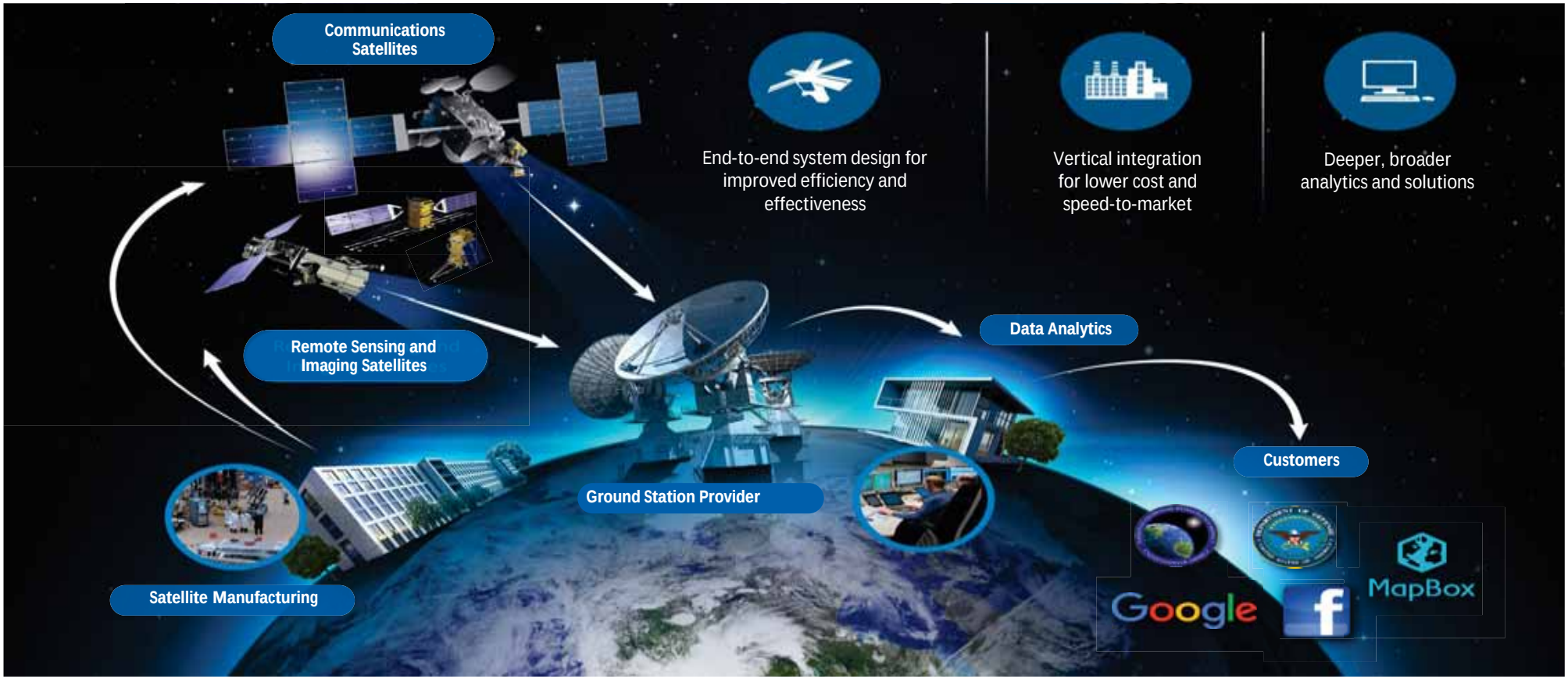
MDA and DigitalGlobe combine to create Maxar Technologies, a leader in space technology



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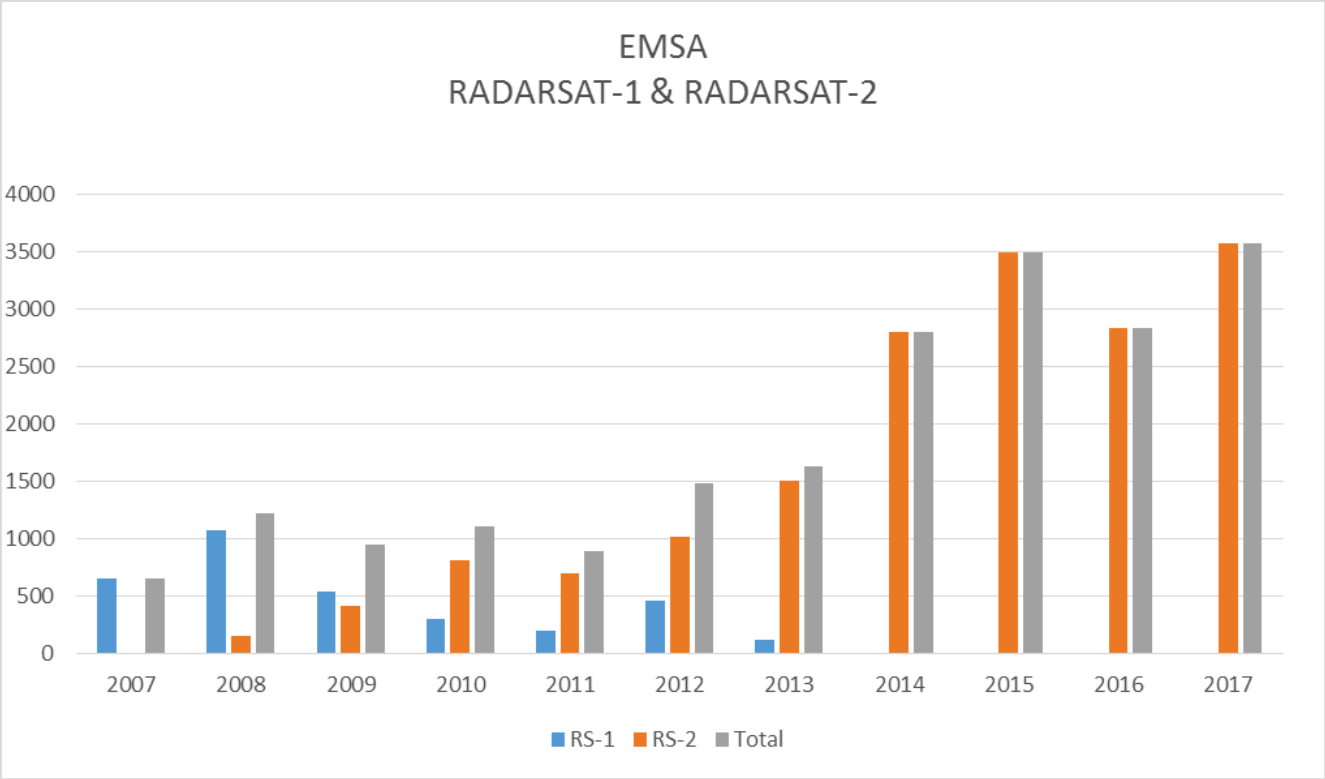
EMSA 10 years Stats
RADARSAT-1 & RADARSAT-2 Usage



Over 20,000 RADARSAT Images in the past decade!

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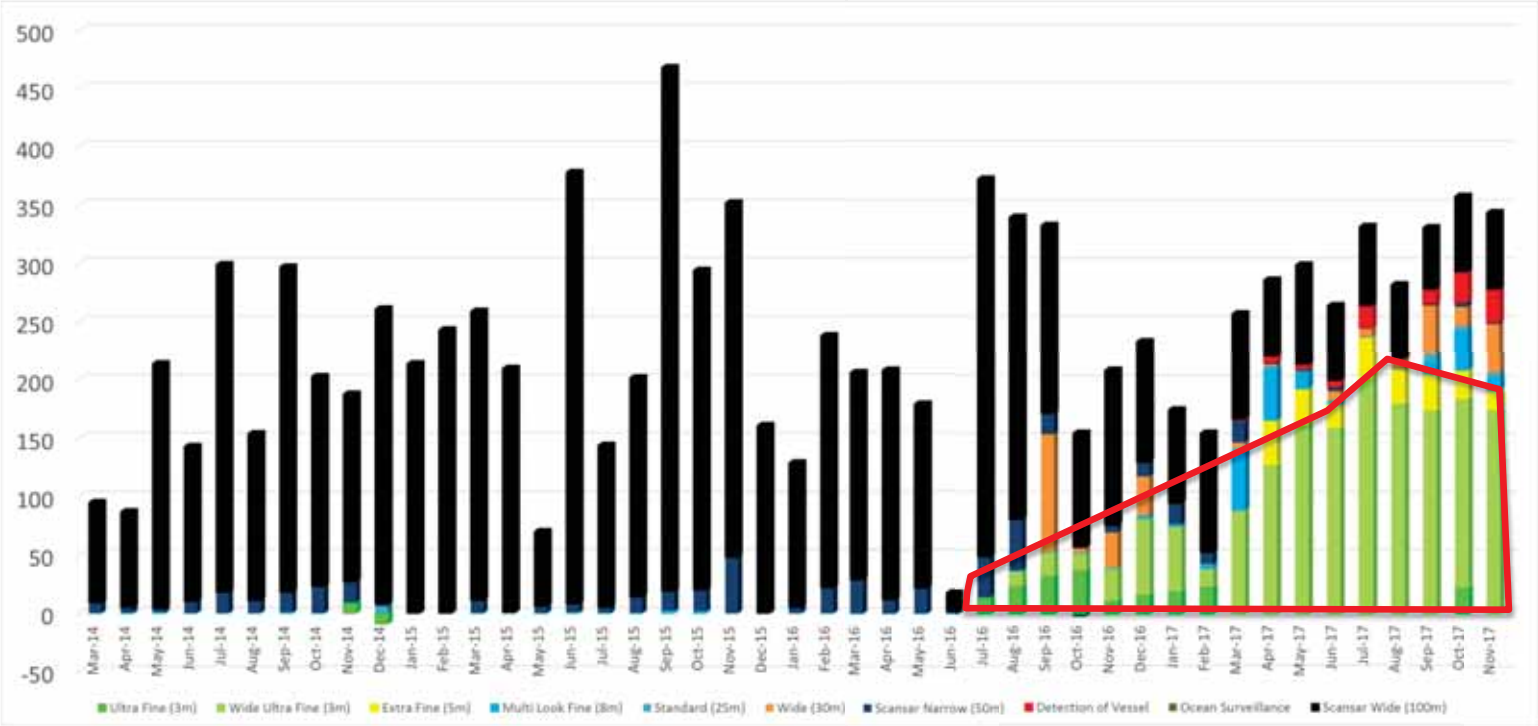
Past - Present
EMSA usage Shift CSN to VDS



EMSA added new use cases as Sentinel 1A/1B came online.
Vessel Detection Services for smaller vessels.

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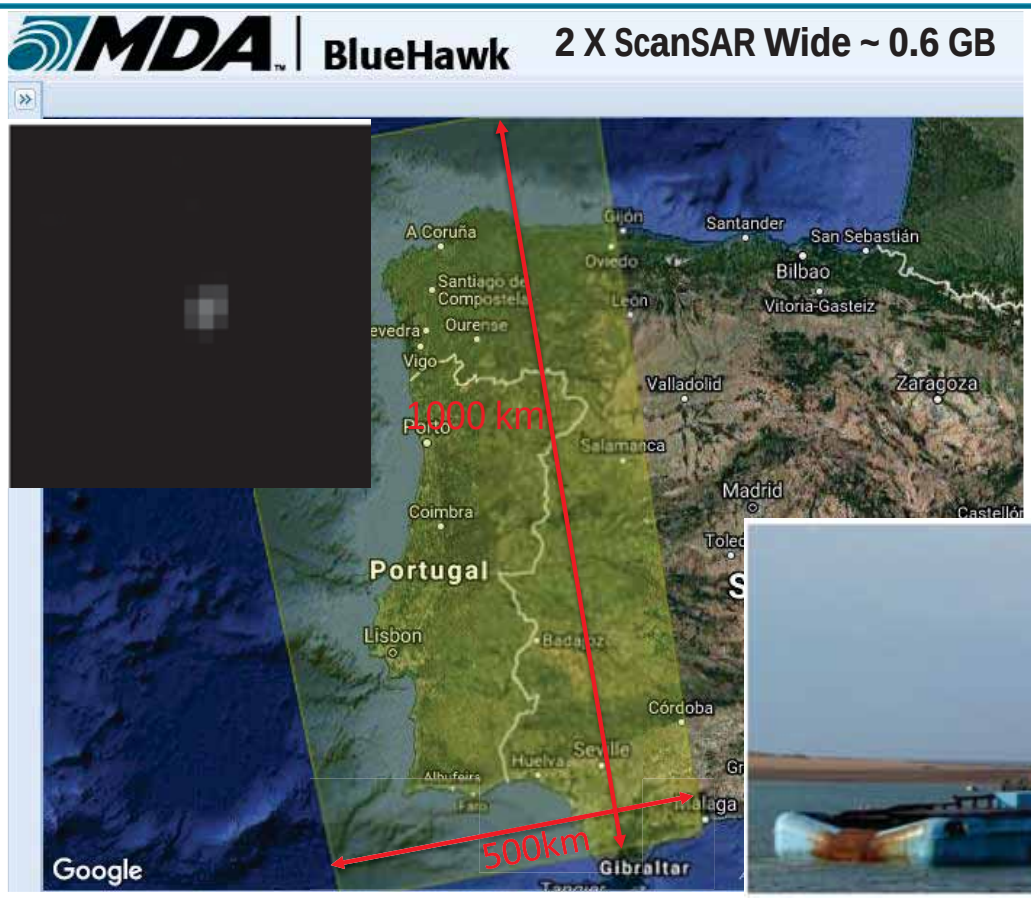
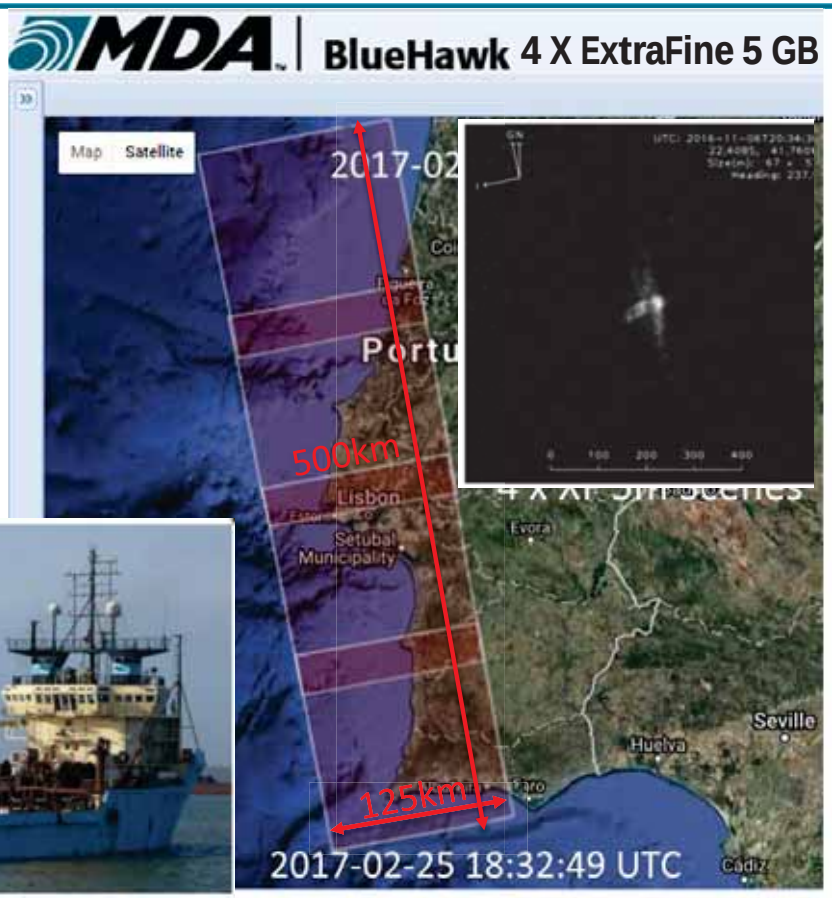
RADARSAT-2 ScanSAR Wide & ExtraFine





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Recent RADARSAT-2 Collections
3m & 5m Resolution

EMSA has growing need for Higher Resolution Broad Area SAR

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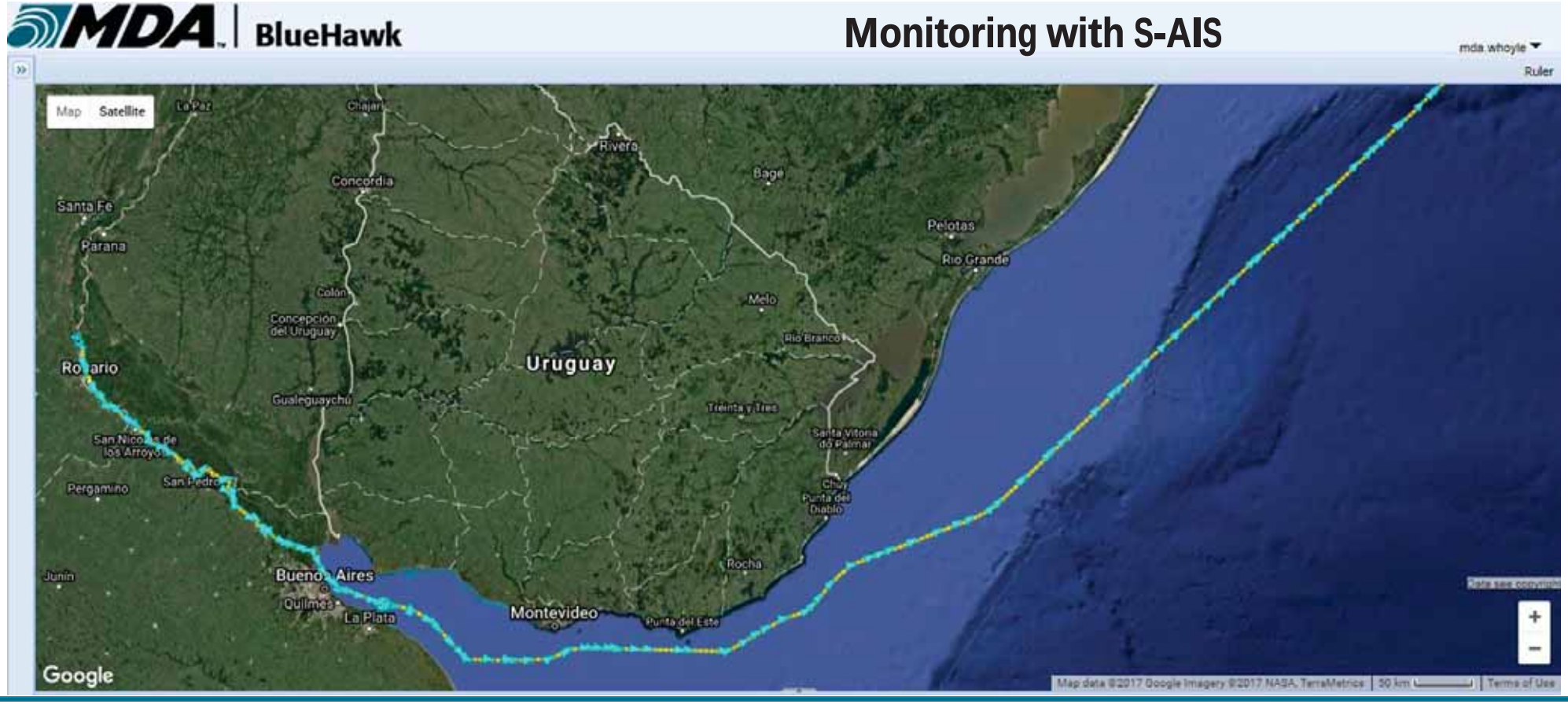
Present - Global Tracking with S-AIS (Game Changer)
Oct 18th, 2017: MV AKILI – loading at Cofco Terminal



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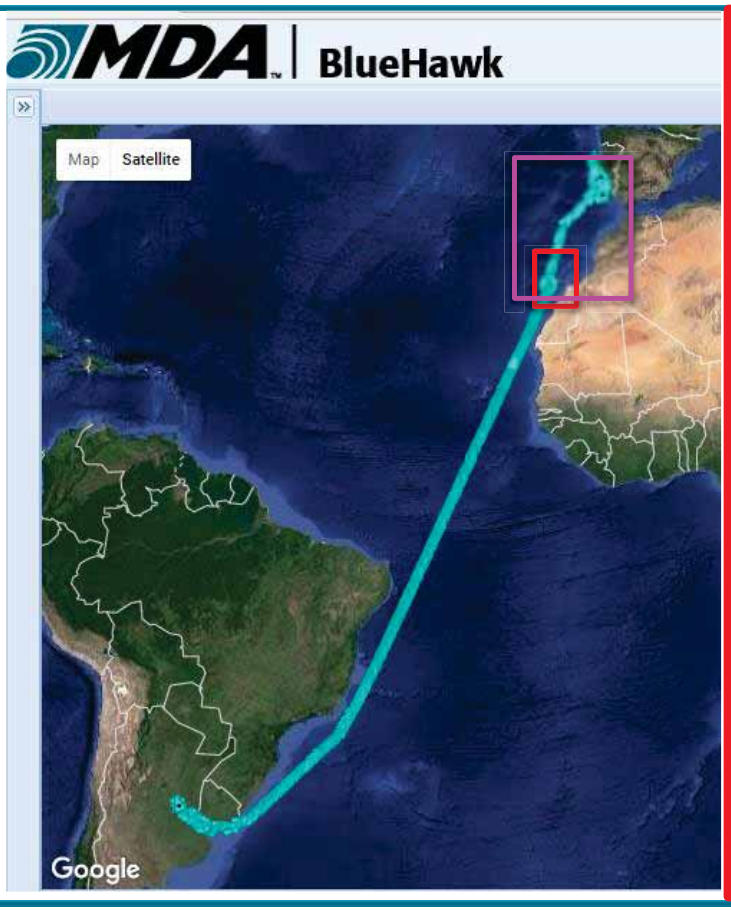
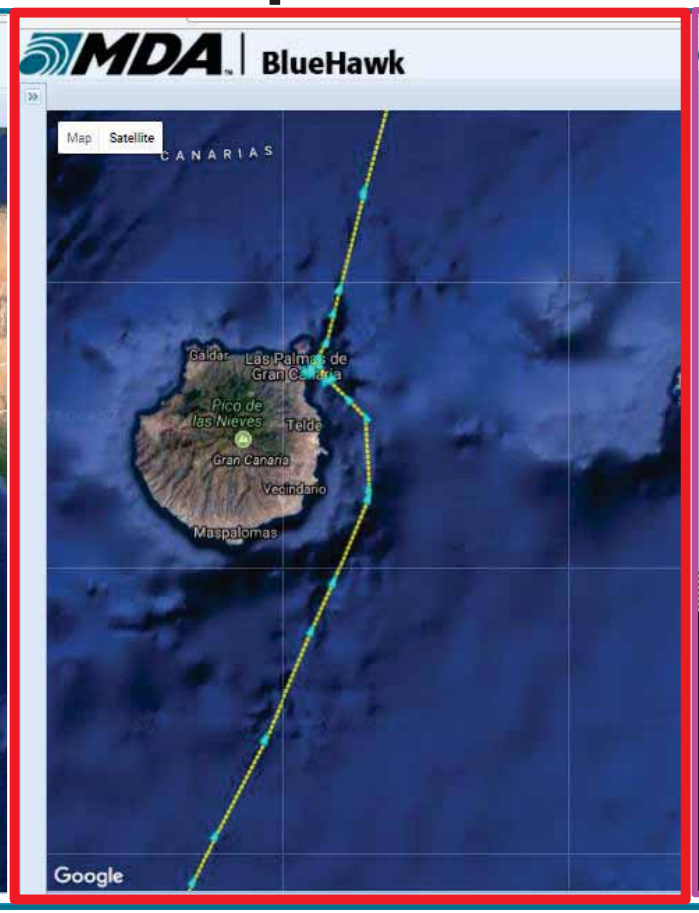
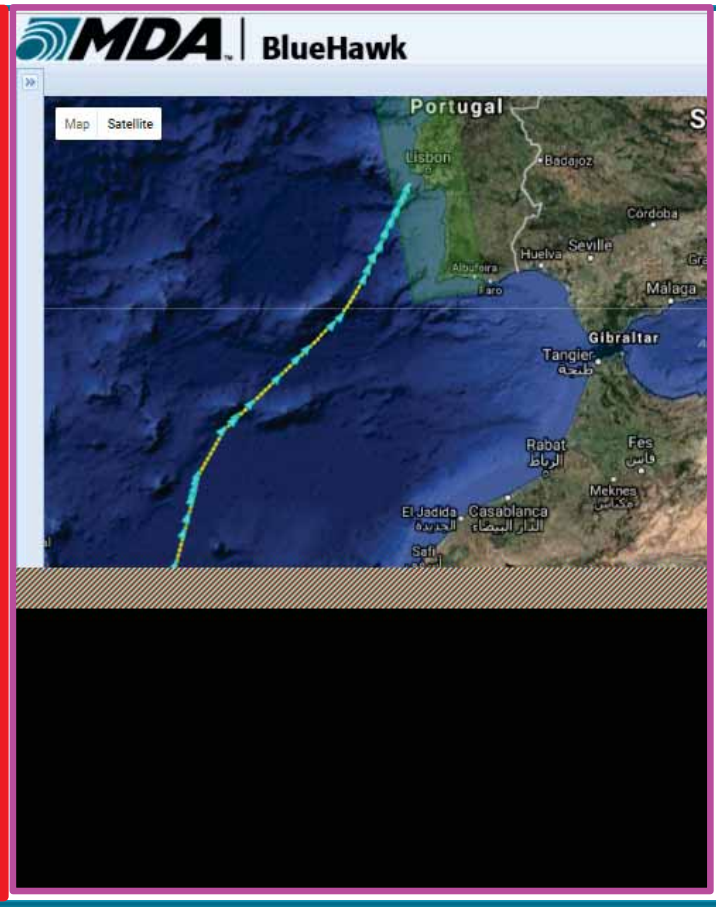
MV AKILI – 20 day voyage to Lisbon with stop in Canarias







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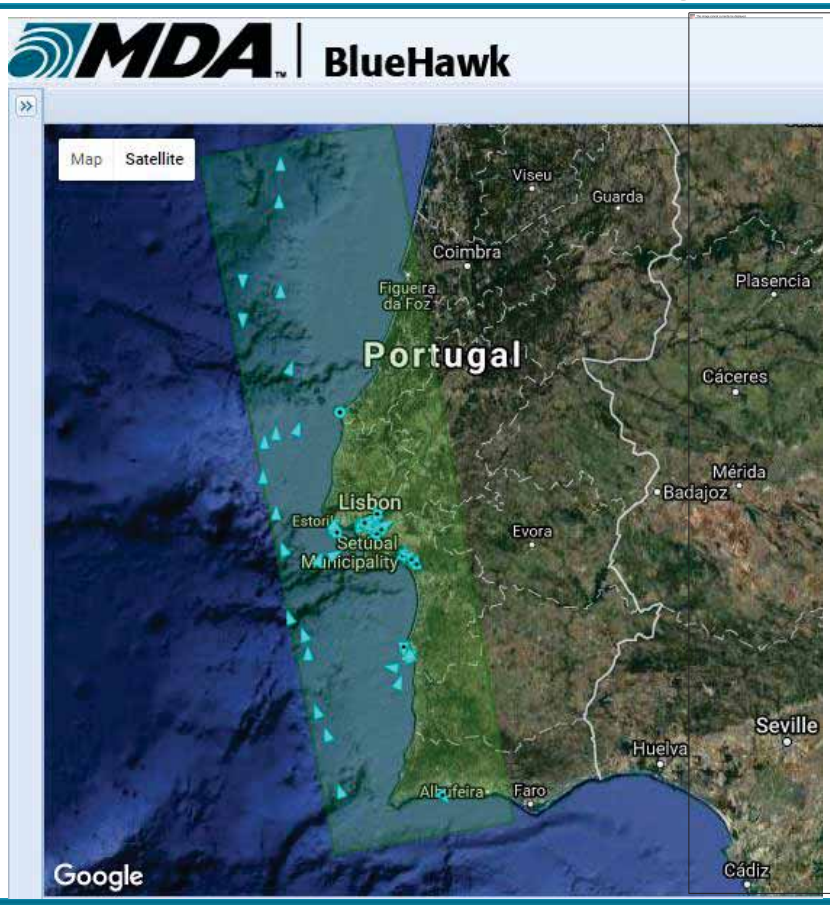
Nov 7th, 2017: MV AKILI – 16 nm outside of Lisbon with DigitalGlobe WorldView 2 50cm



Metadata

Product Type	Pan Sharpened Natural Color
Source	WV02
Source Unit	Strip
Product Class	50 cm
NIIRS	4.90
Acquisition Date	2017-11-07 11:32 UTC
Ingest Date	2017-11-07 16:13 UTC
Age In Days	5
Cloud Cover	0.00%
Has Cloudless Geometry	Yes

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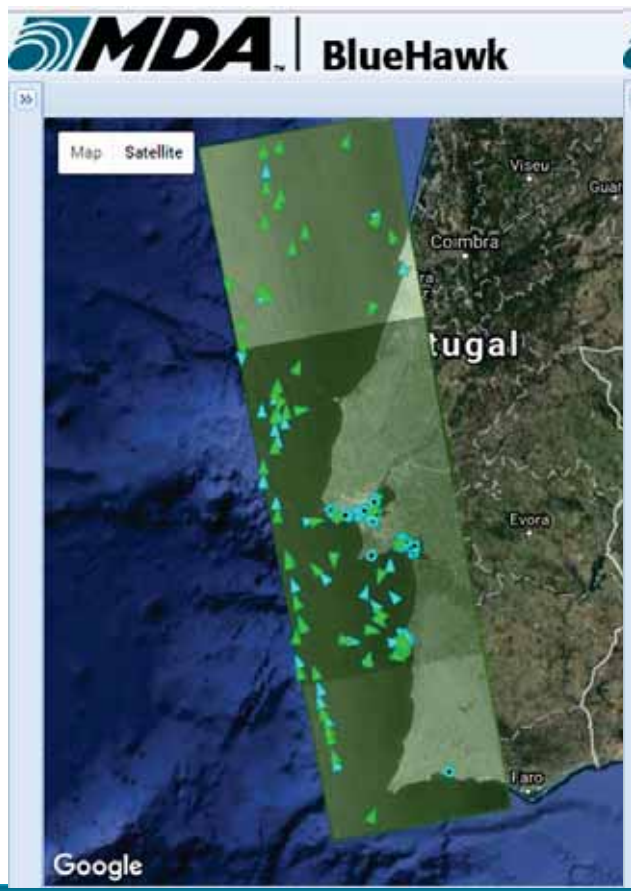
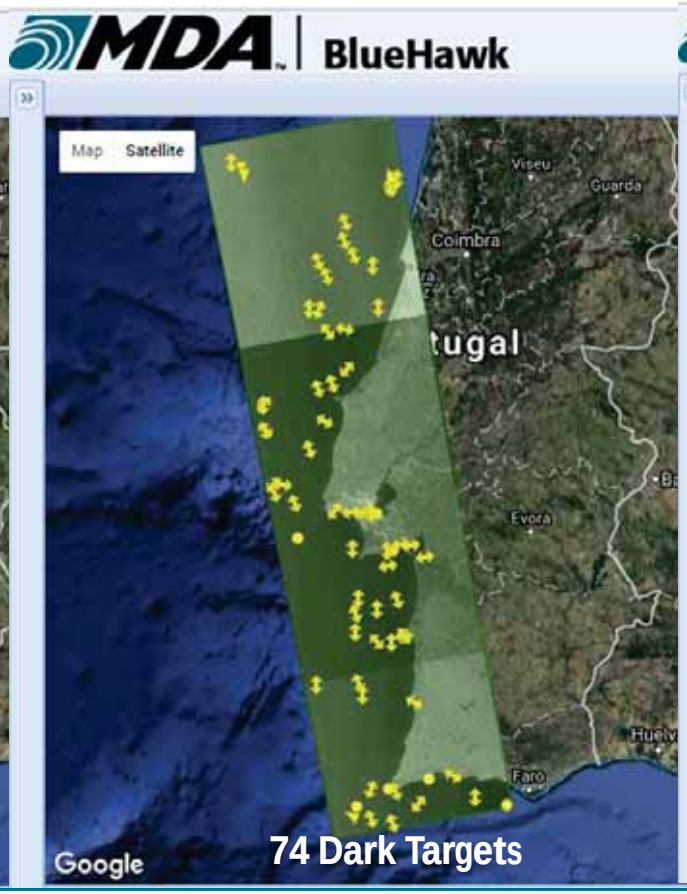
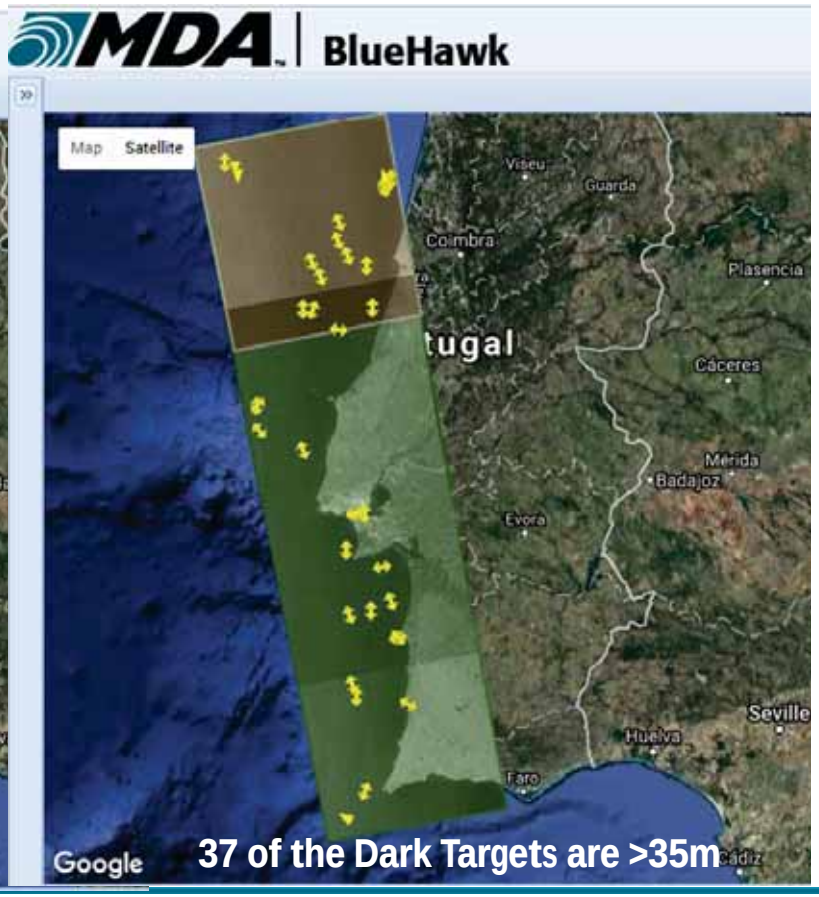
Present – Dark Targets
RADAR detected without AIS







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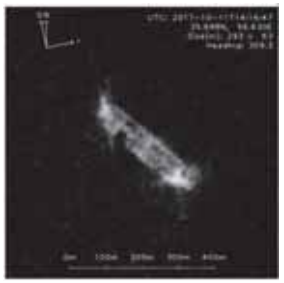
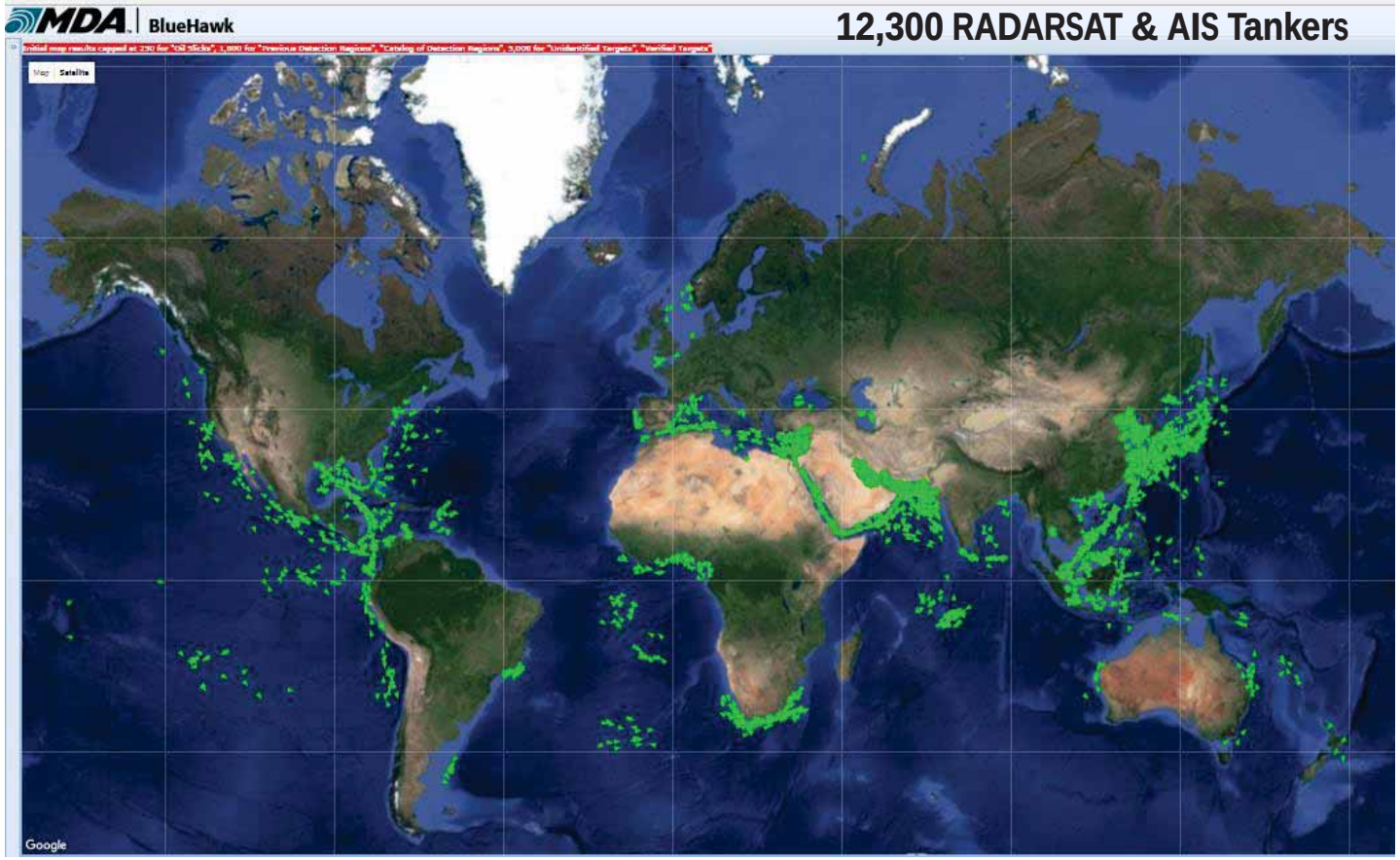
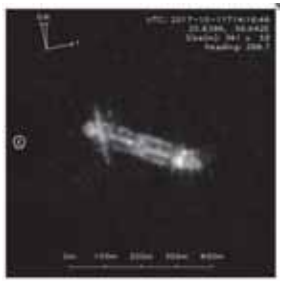
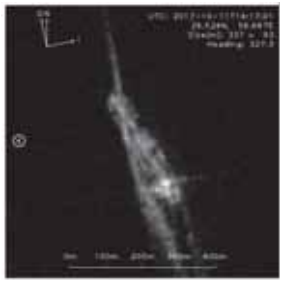
Future – Machine Learning & AI → Automated Dark Target Classification & Risk Assessment → Cross Cueing









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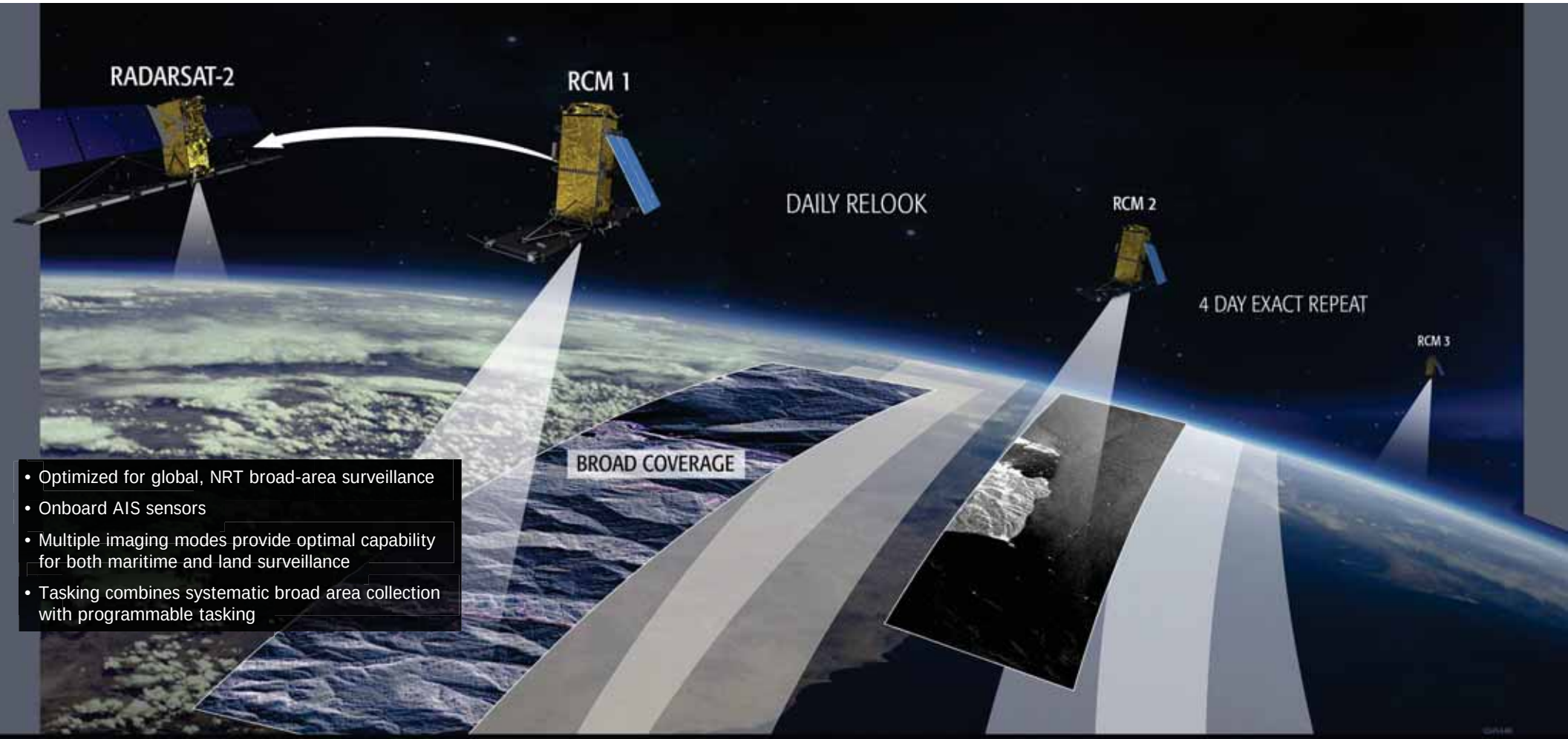

- Optimized for global, NRT broad-area surveillance
- Onboard AIS sensors
- Multiple imaging modes provide optimal capability for both maritime and land surveillance
- Tasking combines systematic broad area collection with programmable tasking

HIGH REVISIT, BROAD COVERAGE, REDUNDANCY

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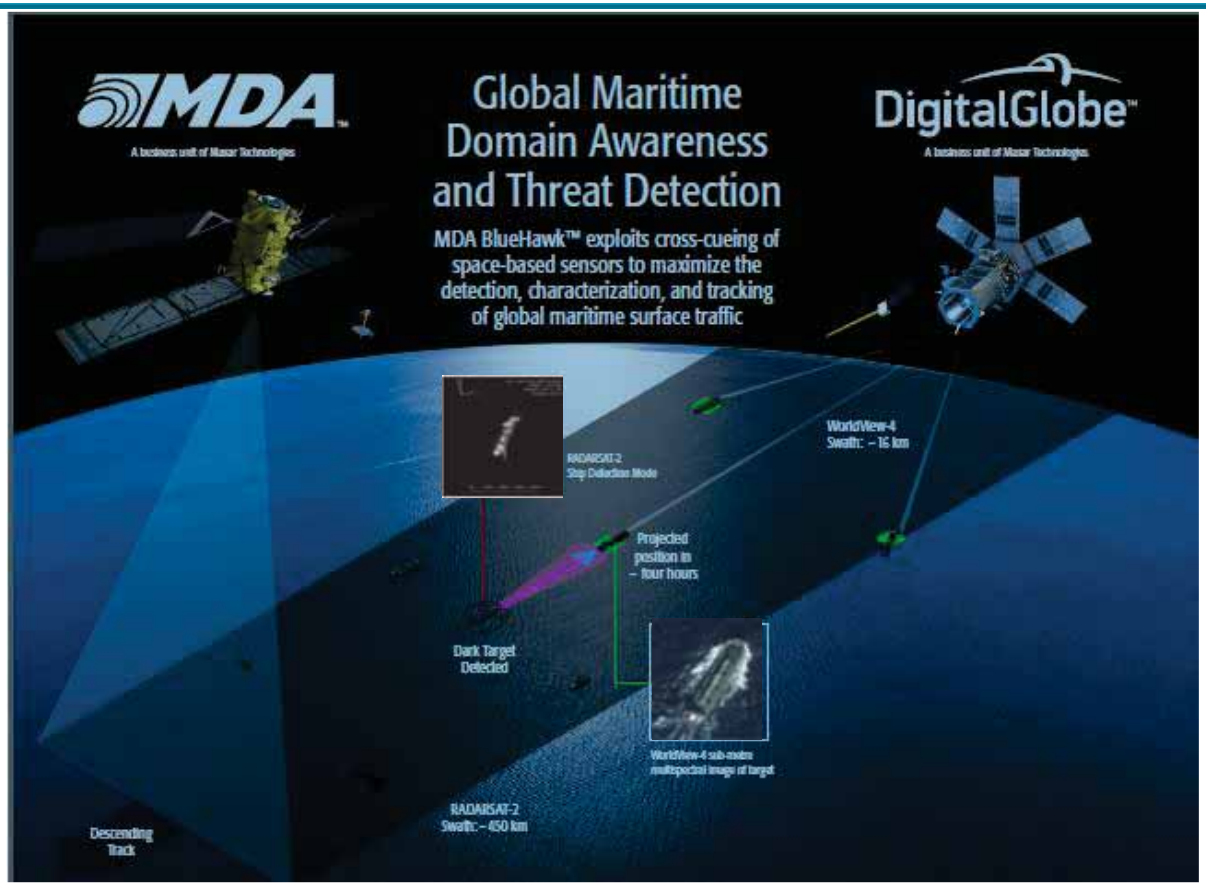
Cross-Cue from RADARSAT to WorldView



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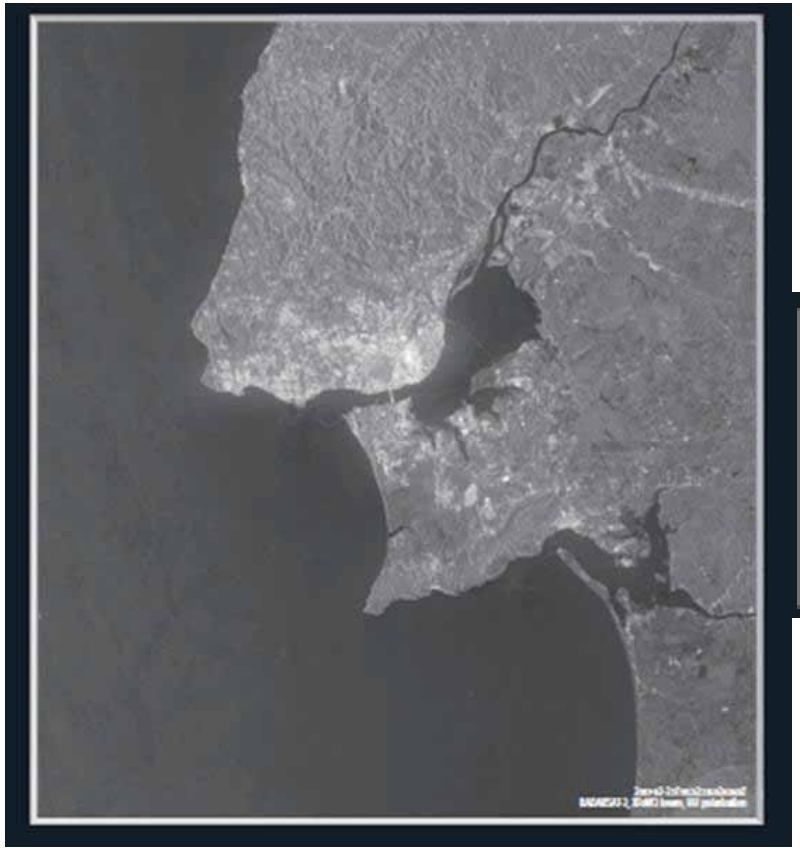
Congratulations & Thank you
EMSA, User Community & Partners



MDA congratulates EMSA on
10 years of CleanSeaNet Services,
delivering over 20,000 RADARSAT images.

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ESA's Evolving Earth Observation Programme

Celebrating 10 years of the CleanSeaNet service and cooperation between ESA and EMSA

EMSA Lisbon, 14-15 November

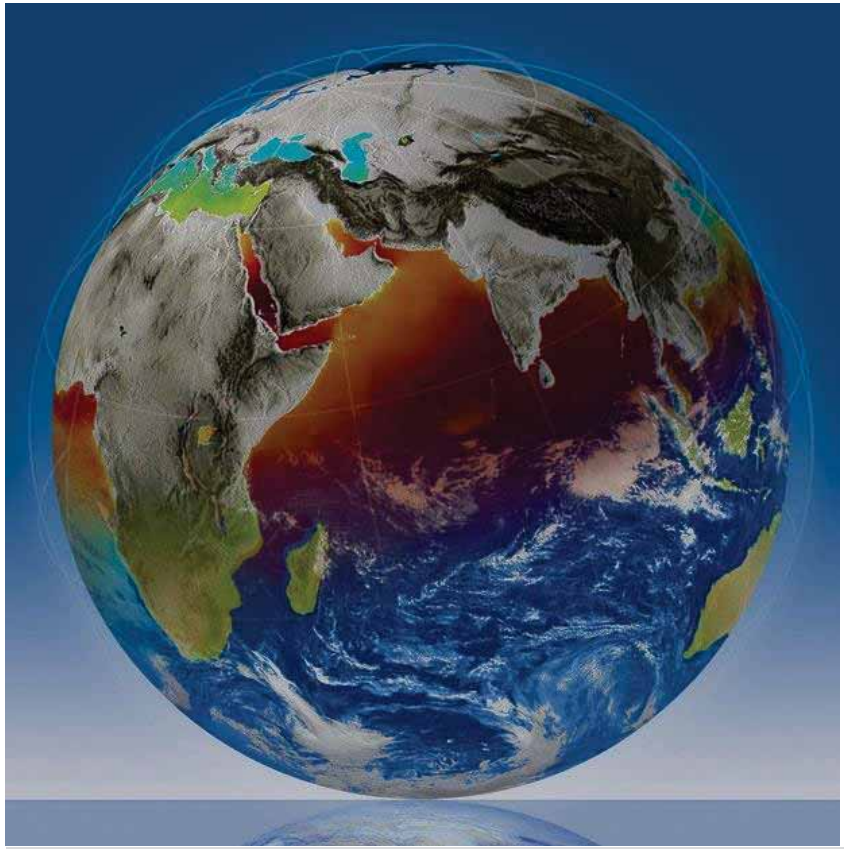
Nicolaus Hanowski, ESA

ESA/ESRIN

Head of Mission Management and Ground Segment Department

esa
ESA–DEVELOPED EARTH OBSERVATION MISSIONS
2010
2015
2020
2025
2030
Meteosat 10 (MSG)
MetOp-B
Meteosat 11 (MSG)
Proba-1
SMOS
GOCE
CryoSat
Proba-V
Swarm
Sentinel-1A
Sentinel-2A
Sentinel-1B
Sentinel-2B
Sentinel-3A
Sentinel-3B
Sentinel-5p
Seasat
Aeolus
EarthCARE
Biomass
FLEX
MetOp-C
Sentinel-5A
MetOp-SG-A1
Sentinel-6A
Sentinel-1C
Sentinel-2C
Sentinel-3C
Sentinel-1D
Sentinel-2D
Sentinel-3D
Sentinel-6B
MetOp-SG-B1
MTG-1
Sentinel-4A
MTG-S1
MTG-I2
Sentinel-5B
MetOp-SG-A2
MTG-I3
Sentinel-4B
MTG-S2
MetOp-SG-B2
Science
esa
Copernicus
Meteorology
EUMETSAT
www.esa.int
European Space Agency

Directorate of Earth Observation Programmes



Budget (2017)

- 1,6 bn Euro

Personnel

- **554** = 320 ESA staff + 234 contractors
- **5 sites**: ESRIN, ESTEC, ECSAT, HQ, EBO

Three main programme lines

- Meteorology
- Copernicus
- Science

28 satellites in development;
12 satellites in operation

Earth Observation: Boundary Conditions

UN Sustainable Development Goals

Evolving IT Possibilities

- Easy Data Access
- 7B cell phones world wide
- Wide availability of mobile broadband subscriptions
- Social media and networks
- Crowd Sourcing/Mapping
- “Big Data”
- Cloud Computing
- Exploitation Platforms

Election Pope Benedict XVI

Election Pope Francis

People

Change of people behaviour

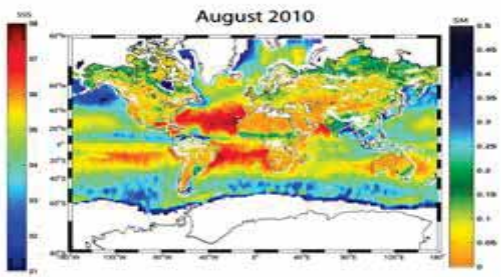
Information technology changes (quickly) the behaviour of people.

Recent examples:

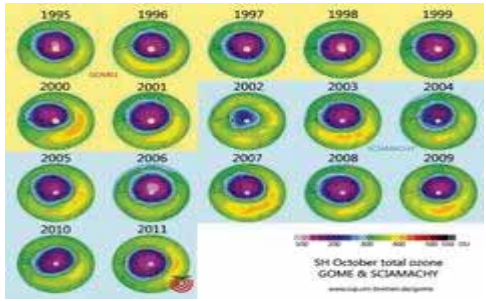
- ✓ *Streaming services* for music/video data (instead of downloading data),
- ✓ **Active** *collaboration* for a common goal (e.g. wikipedia, tripadvisor, …),
- ✓ **Passive** *collaboration* through crowdsourcing (e.g. road traffic information).

The benefits for people is generally to get more information, or faster information, or cheaper information.

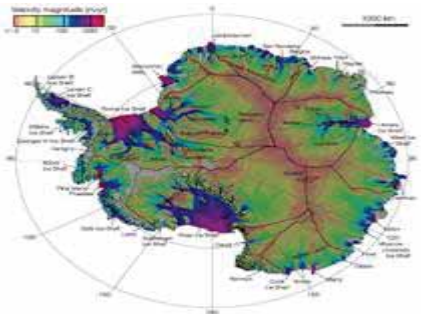
Earth Observation Challenges



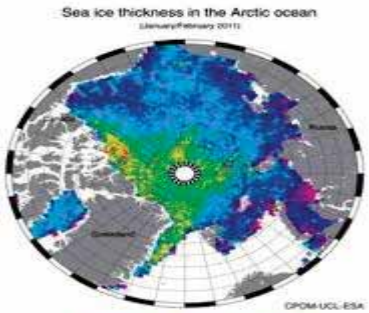
Data volume



Data continuity



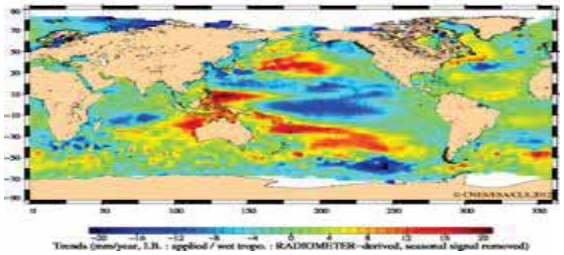
Data sharing



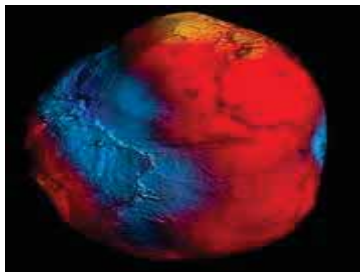
Data quality

Innovation

Timeliness



Synergy between EO missions



Uniqueness

Earth Observation – The User Perspective

"Am I using the latest version of the dataset?"

"My computation takes too much time!"

"I don't like the official dataset but I have a good idea for improving it."

"I cannot do all what I want with the tool box."

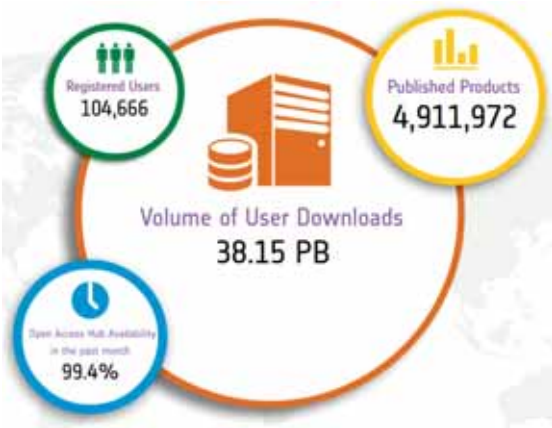
"I don't have enough space to store all my TB data."

"How to share my results (few GB of data) with my peers?"

"Where do I find in-situ data to validate my results?"

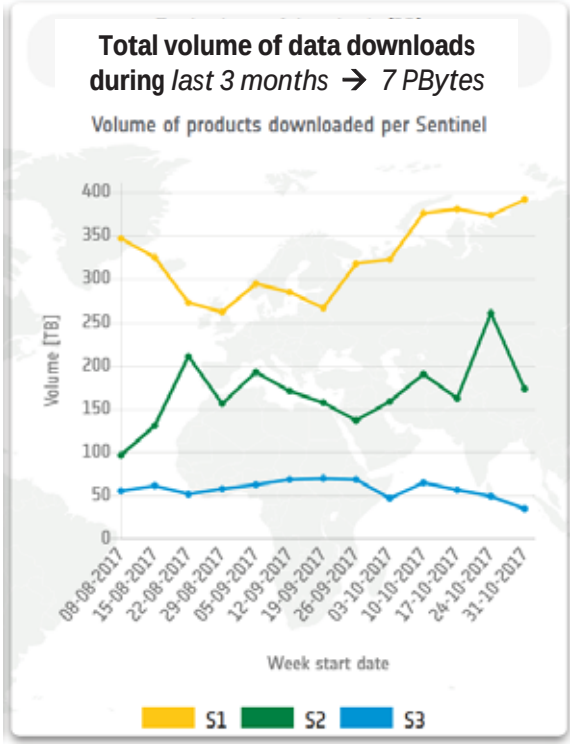
Sentinel Data Access at ESA

- Statistics -



Statistics on
7 November 2017

Total volume of data downloads
during *last 3 months* → *7 PBytes*



→ Facilitating access to (quality) EO data

- EO <u>data policy</u> at ESA (ESA policy and Copernicus policy)
  → free of charge, open (and as full as possible)

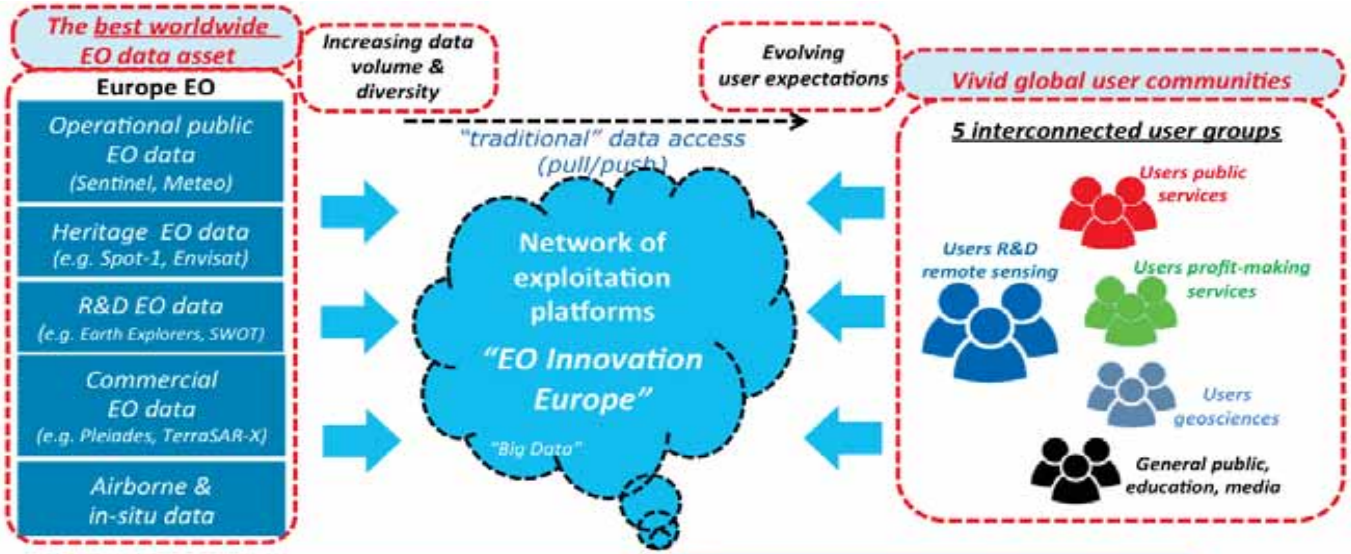
- For all missions: operations concept based on <u>systematic approach</u>:
  → all data are systematically acquired, downlinked & processed to generate and disseminate core products

- Focus on <u>data quality</u> (calibration, validation, product evolution)

→ *Need to anticipate the way users will use EO data in future, e.g.:*

- *toolboxes in virtual research environment,*
- *collaborative exploitation platforms,*
- *merging of EO and non-EO data, etc.*

A Network of European Exploitation Platforms utilising Cloud-Infrastructure



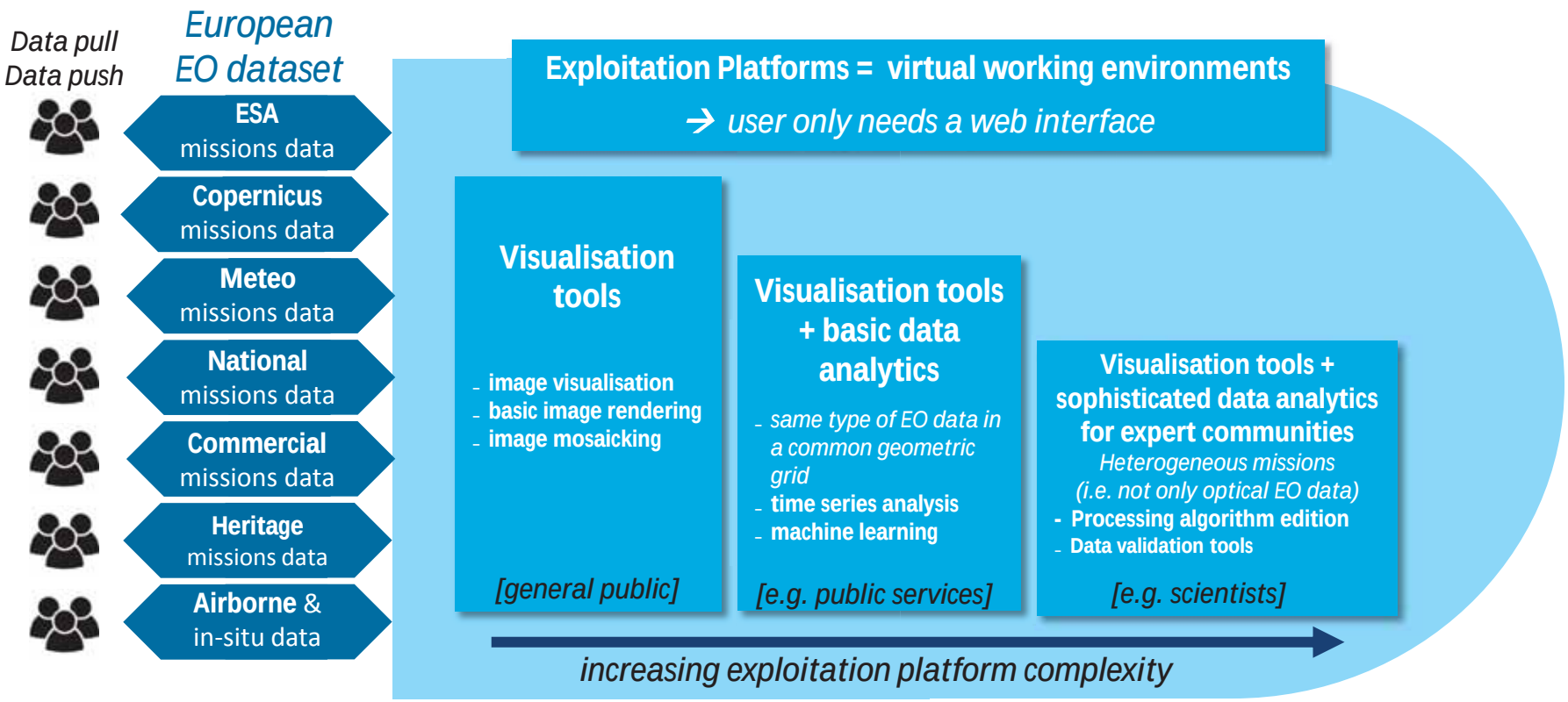
Objectives of the network concept:

- ✓ Enabling large scale exploitation of EO data
- ✓ Stimulating the innovation with EO data
- ✓ Maximising impact of European EO assets and preserving European independence

How:

- ✓ Interoperable/interconnected platforms around a core enabling element
- ✓ Open to multi-source funding initiatives
- ✓ Common governance rules

Exploitation Platforms:
→ different levels of usage and complexity



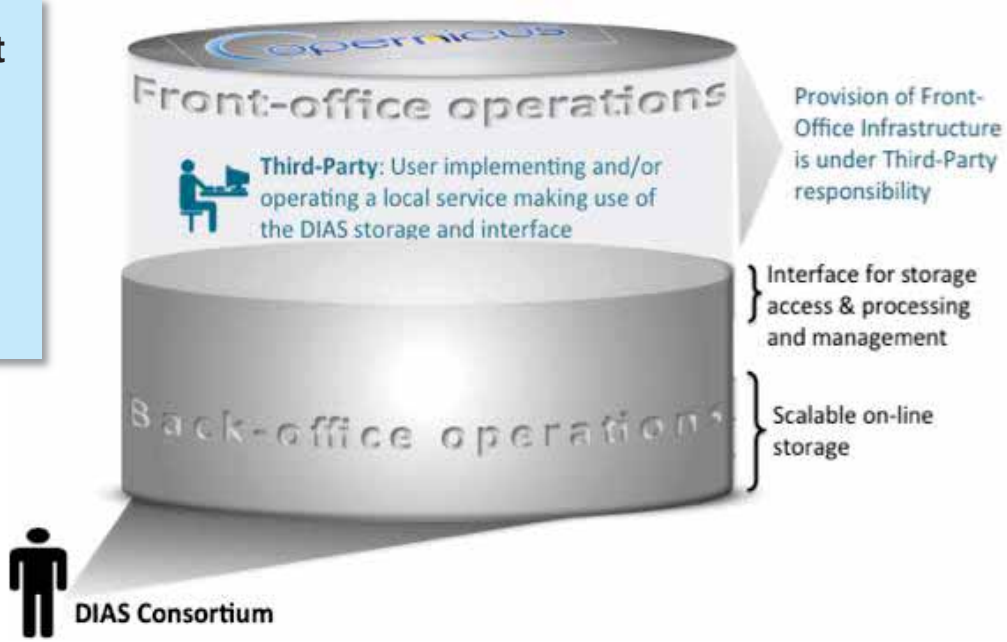
Creating and enabling a European EO data ecosystem for research and business

A common European approach to EO data exploitation with Copernicus data at its core

Implementing ESA "EO-Innovation Europe" concept in full complementarity with the COM initiatives notably the Copernicus <u>Data and Information Access Services</u>

↓

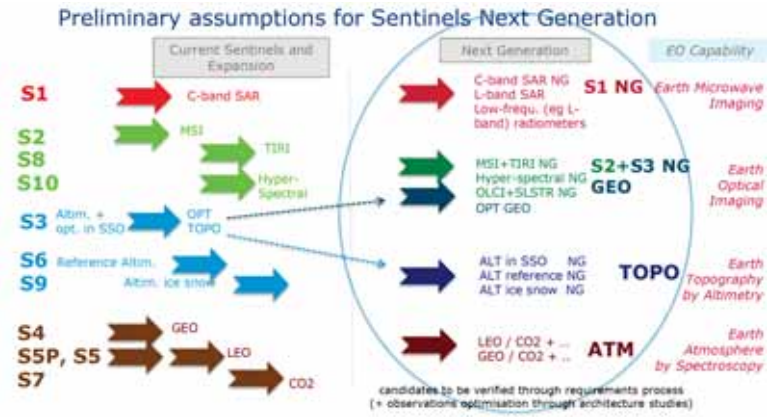
DIAS



Copernicus DIAS procurement is one element of the partnership and aligned programming between EC DG-GROW and ESA

DIAS operations foreseen to start in 2018

Copernicus Evolution



ESA Unclassified - For Official Use

ESA/PB-EO(2017)31
Paris, 5 September 2017
(Original: English)

THE EUROPEAN SPACE AGENCY

EARTH OBSERVATION PROGRAMME BOARD

"Copernicus Evolution"
Draft Copernicus Space Component (CSC) Long Term Scenario
September 2017

CSC Component	M€ in 2018 ec
Seamless continuation of Copernicus (Space Strategy 1.2, Action 1: "commitment to stability")	
Sentinels 1-6 A-D	1,680
Data Buy	300
Sentinel Launch Services	480
Sentinels 1-3 Technological Update (Next Generation)	4,000
New Challenges for Copernicus (Space Strategy 1.2, Action 2: "emerging needs")	
CO2 Observation	900
Thermal Infrared Imaging	375
Polar/Arctic Observations (ice/snow & weather)	440
Hyperspectral Observations	235
Associated Launch Services	290
Total	**8700**

Copernicus Evolution

- ESA Ministerial Council 2016
  - Initial Development Sentinel Expansion – 6 Phase A/B1
  - Mission Concept Study Sentinel Extension
- ESA Ministerial Council 2019
  - Development of Sentinel Expansion
  - Main development Sentinel Extension
- MFF 2021-2027
  - Operation/Launcher/Recurrent Cost; Data Access
- ESA Ministerial Council 2022
  - Development Completion for Sentinel Extension

Copernicus Evolution

ESA – EMSA Cooperation

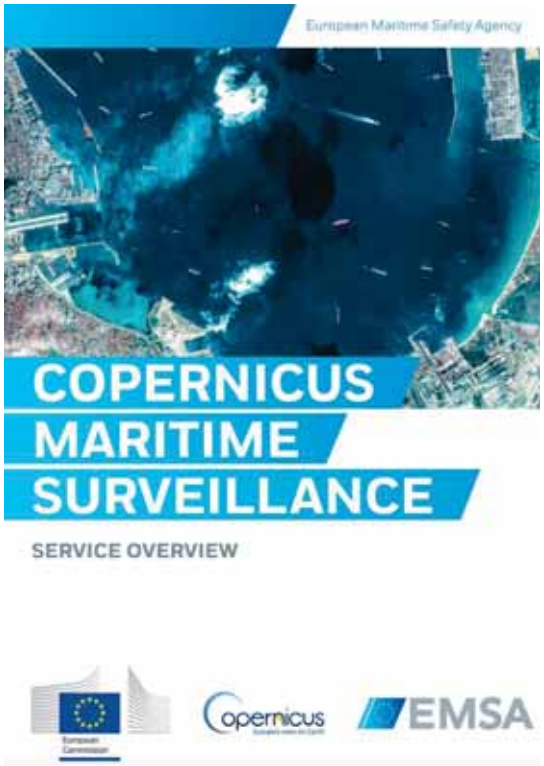
EMSA

European Maritime Safety Agency

Lisbon, 5 December 2007
Ref: H.2/OTR/2007

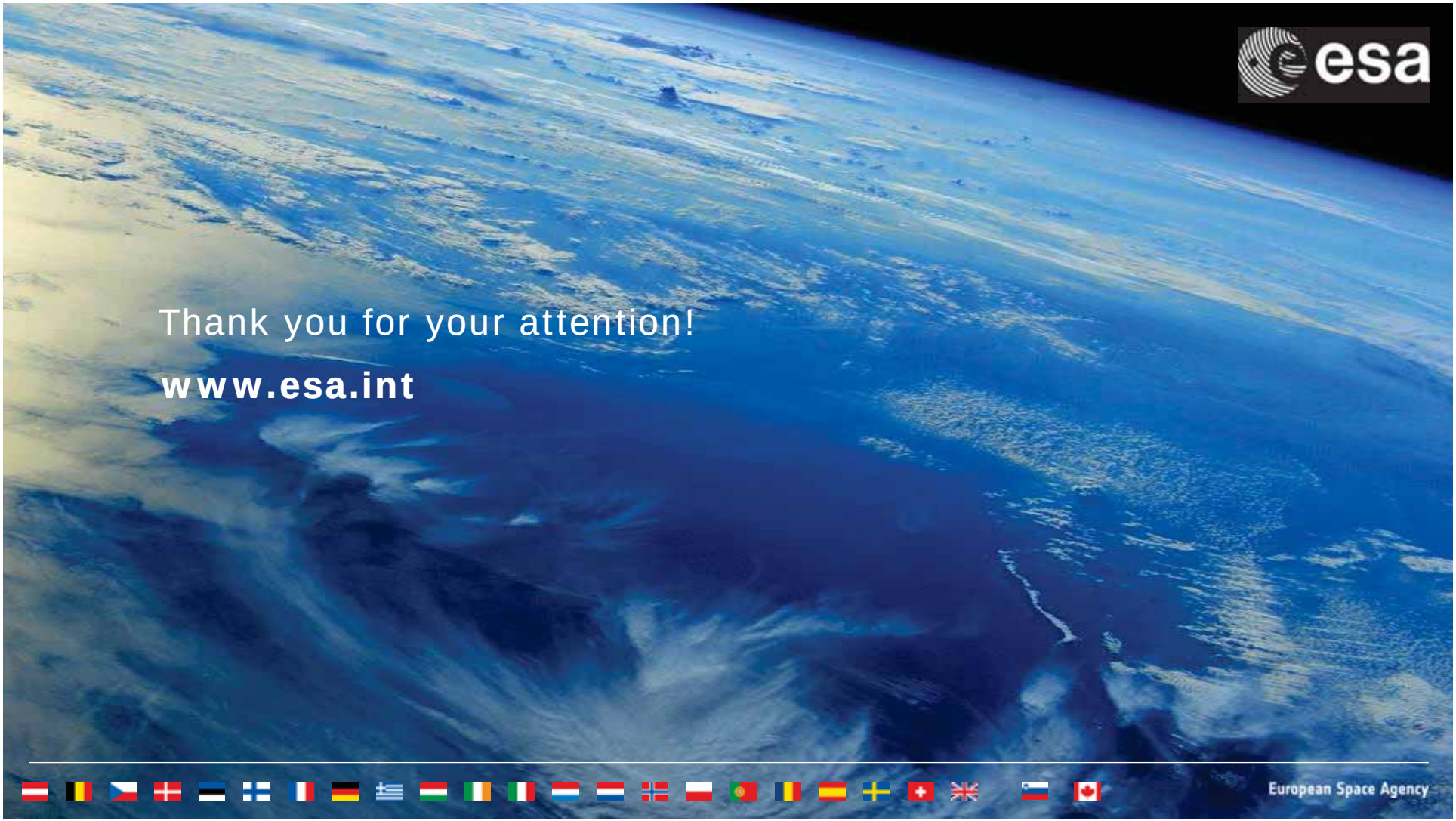
Non-paper

EMSAs view on the GMES programme of EU and ESA;
in particular on the Marine Core Service
updated version



The Future ESA Earth Observation Directorate

- Adapting to external trends and new paradigms in Earth Observation
- Structuring processes and increasing the overall efficiency


esa
Thank you for your attention!
www.esa.int
European Space Agency

Earth Observation support from ESA & Sentinel Missions

Pierre Potin, Sentinel-1 Mission Manager, ESA

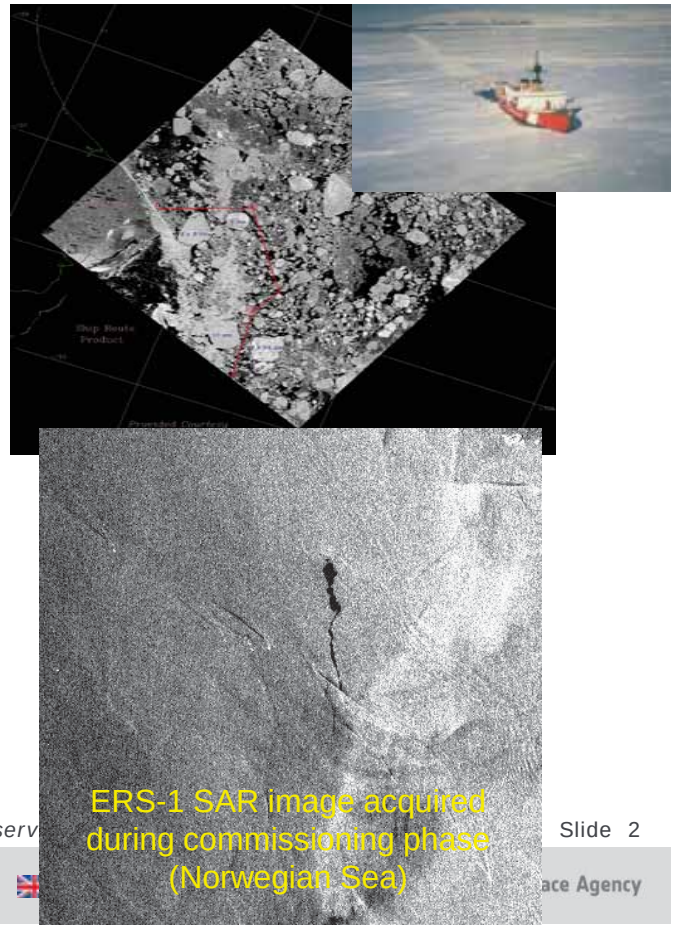
"Celebrating 10 years of the CleanSeaNet service and Cooperation between ESA and EMSA"
14-15 November 2017, EMSA, Lisbon

Why is ESA interested in maritime surveillance?

- Initial EO satellites were intended to demonstrate several maritime applications
  - ERS-1 (1991), ERS-2 (1995) – sea ice, oil spill, vessel detection, surface wind/waves, ocean currents, sea surface temperature, etc
  - Envisat – as ERS (with enhanced SAR capability) plus ocean colour

- ESA exploitation programmes to verify requirements for future satellite systems and build user communities for current systems:
  - Oil spill (initial R&D evolved into pre-operational services as precursor to CleanSeaNet)
  - Pre-operational maritime security service (MARISS)

- ESA activities on GMES/Copernicus Space Component
  - develop (and operate together with EUMETSAT) a series of satellites to respond to operational maritime surveillance requirements (oil spill, sea ice, vessel detection)



ERS-1 SAR image acquired during commissioning phase (Norwegian Sea)

ESA GMES Service Element (GSE) Projects, initiated in 2002/2003, as precursors of operational services based on remote sensing data

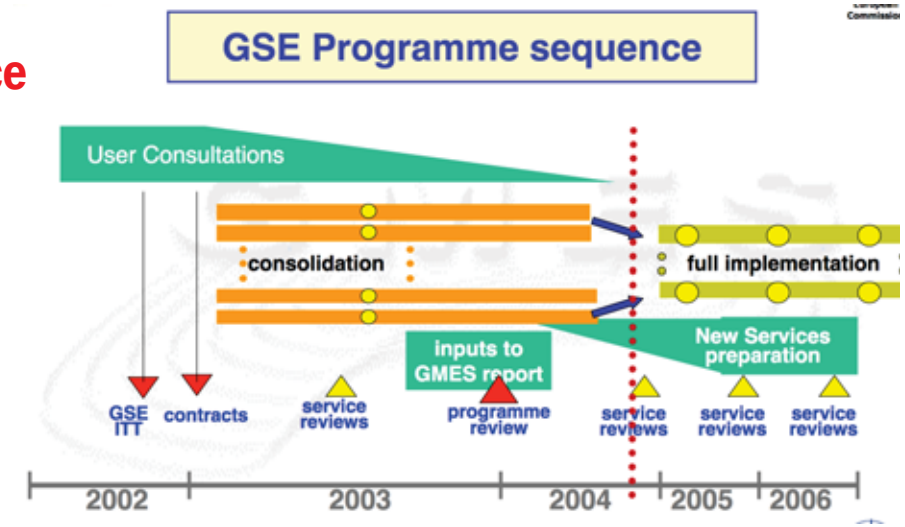
- CoastWatch
- **ROSES**
- ICEMON
- Northern View
- Forest Monitoring
- SAGE
- Risk-EOS
- TerraFirma
- GMES Urban Services
- Food Security
- Respond
- PROMOTE

ROSES, precursor service for oil spill detection

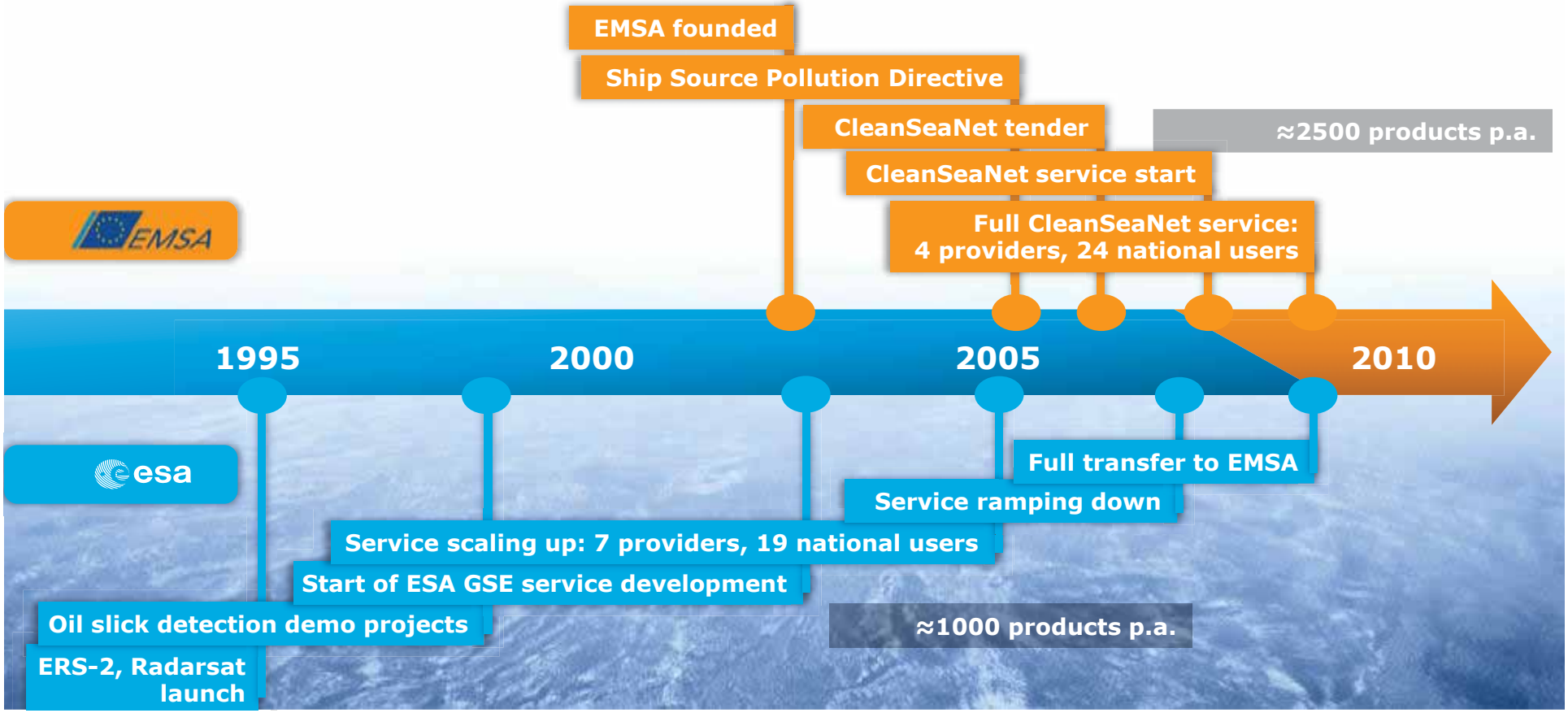
ROSES + CoastWatch led to MARCOAST that started in 2005

EMSA CleanSeaNet

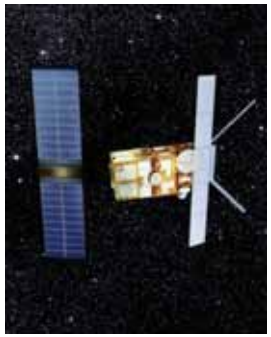
MARISS



Oil Spill Surveillance Service
From R&D/Pre-operations (ESA) to Operations (EMSA)

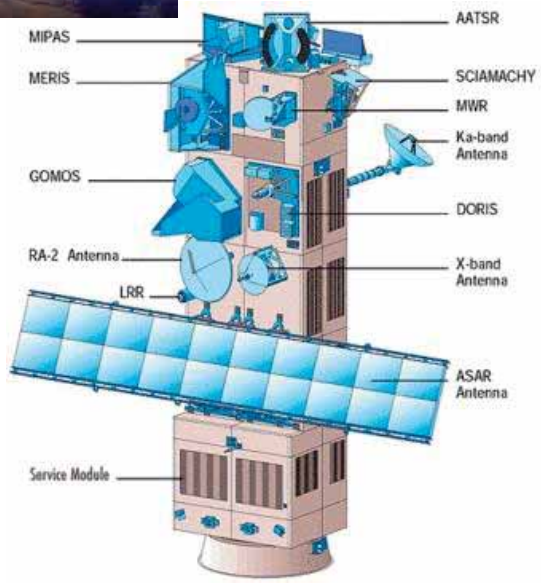


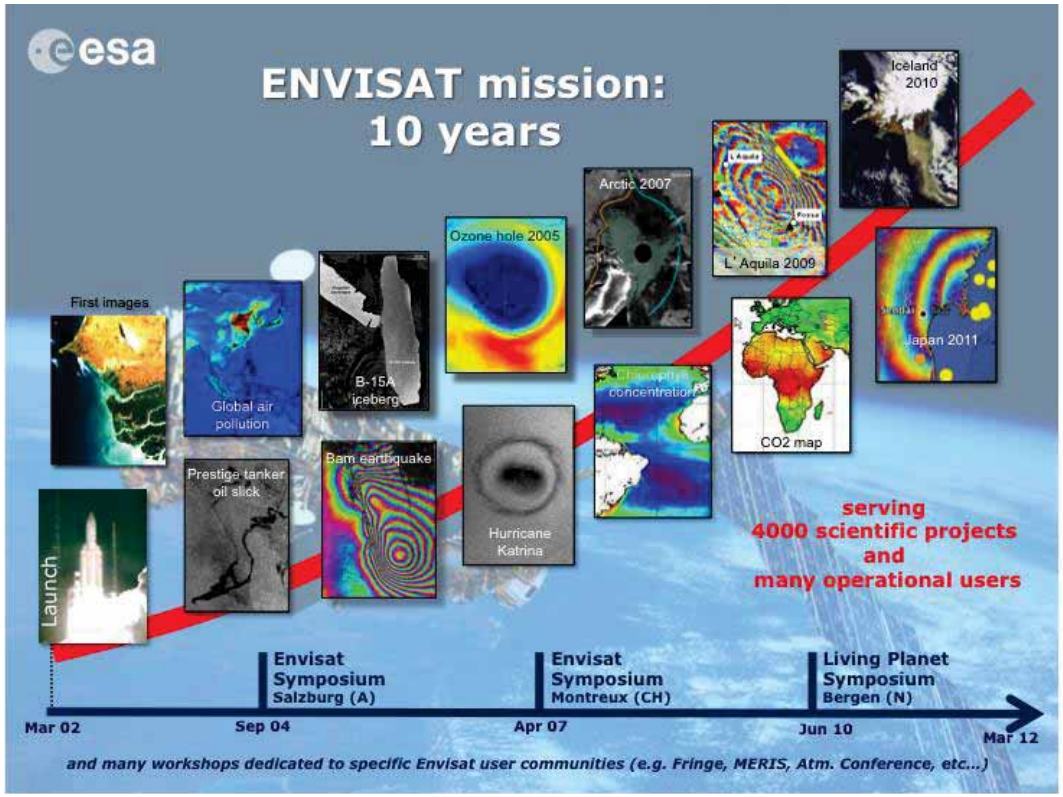
ESA Synthetic Aperture Radar Missions (relevant for maritime surveillance)



- ERS-1 (1991 – 2000)
- ERS-2 (1995 – 2011)
- ENVISAT (2002 – 2012)
- Sentinel-1 (satellites owned by the European Commission, developed and operated by ESA)
    - Sentinel-1A (launched April 2014)
    - Sentinel-1B (launched April 2016)

ENVISAT, an “enabling mission” for the start of GMES / Copernicus





Some key past events observed by SAR missions

EL PAIS

DIARIO INDEPENDIENTE DE LA MAÑANA

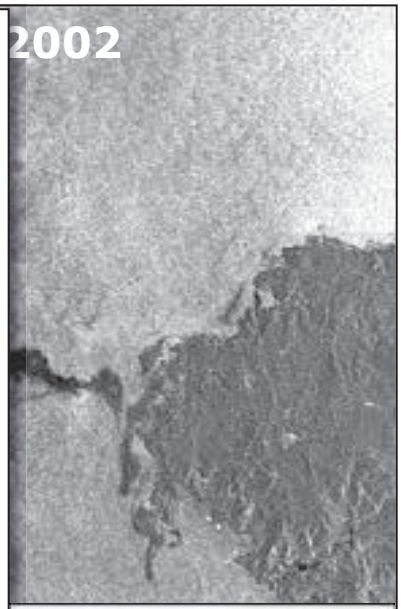
Los equipos de rescate carecen de barcos para atajar la mancha de fuel

Bush pide apoyo para actuar contra Irak a España y al resto de aliados

Rato multa al HSBC con 2,1 millones por las cuentas opacas del 'caso Gescartera'

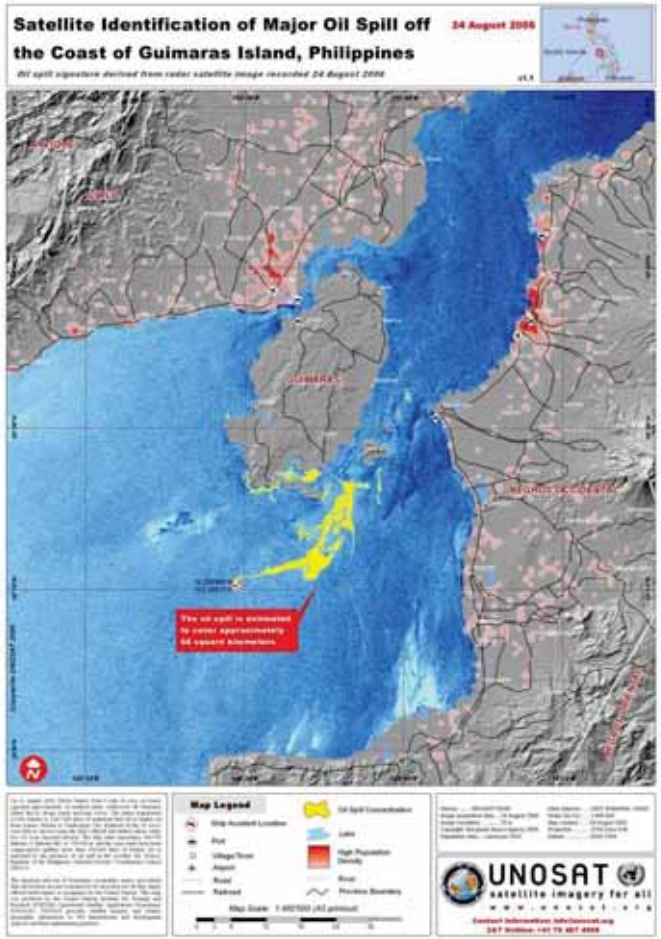
"Nos plantamos porque el teniente abusó sexualmente de la soldado"

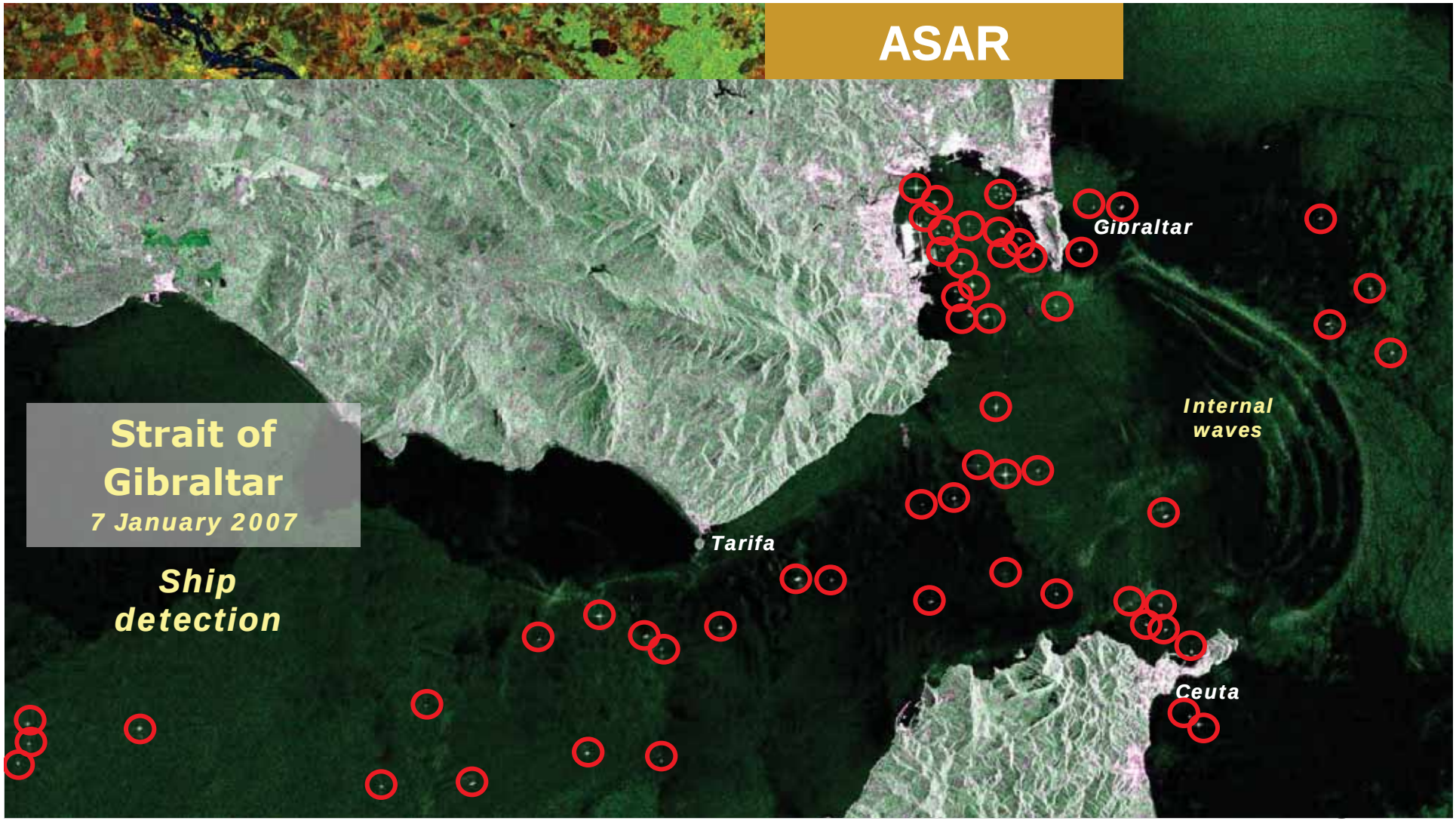
LA ESTELA DE LA CATÁSTROFE



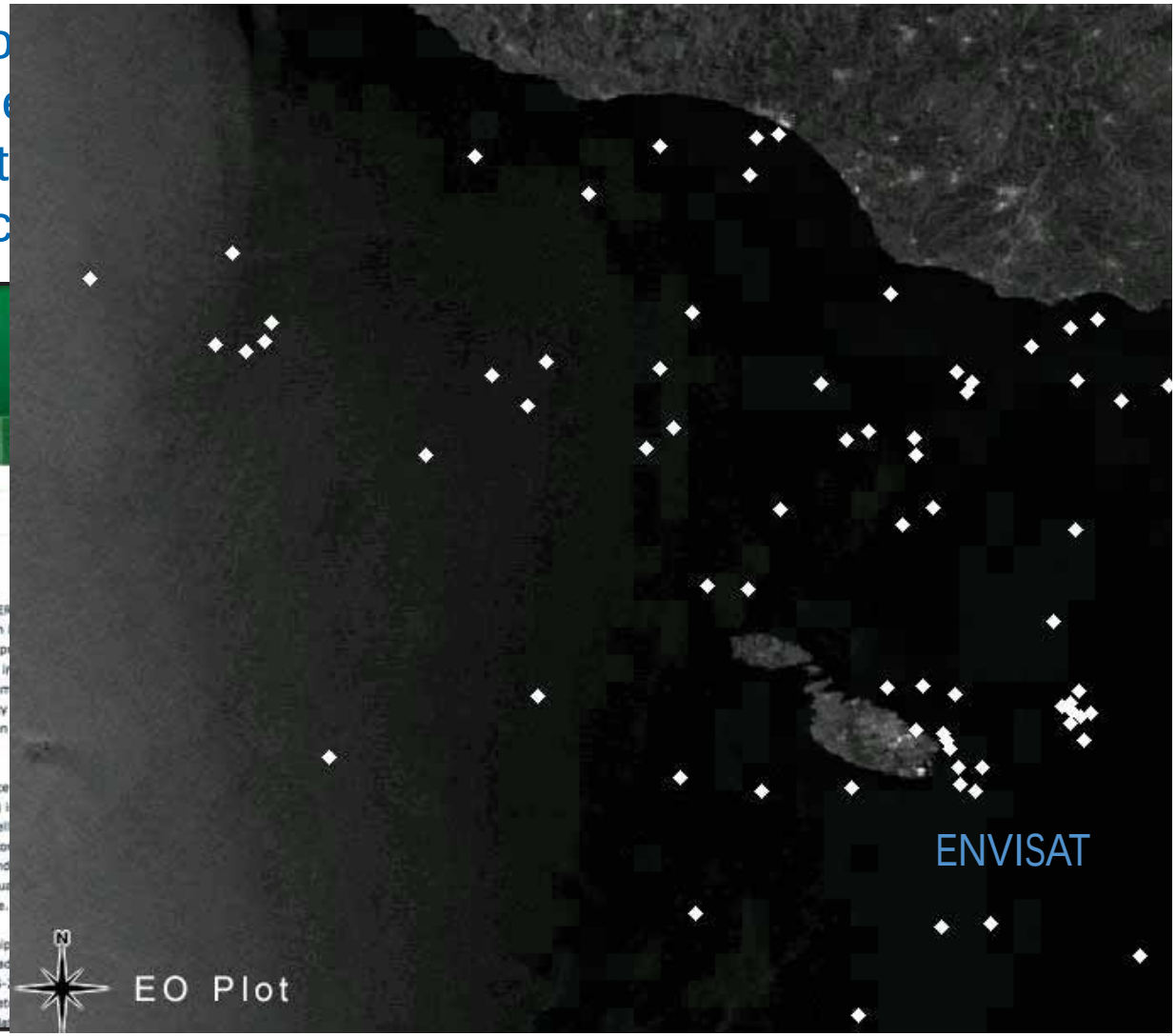
"Prestige" tanker

Galicia (Spain)




ASAR
Gibraltar
Internal waves
Strait of Gibraltar
7 January 2007
Ship detection
Tarifa
Ceuta

ESA precursor activities o
MARISS, an ESA GMES Se
aiming at the demonstrat
surveillance services, in c

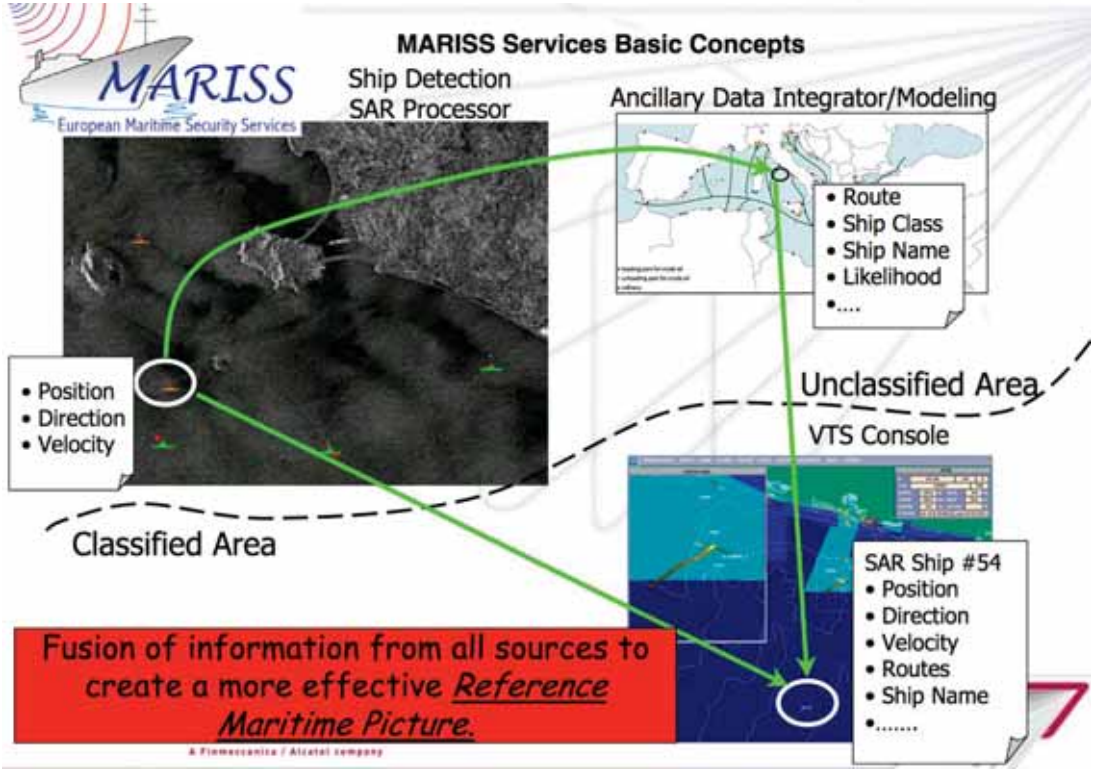


MARISS project phases and concept

- PHASE I, 2005-2006
aims to deliver MARISS precursor security services to selected end-users

- PHASE II, 2006-2008
Security Services Scaling-Up together with innovative services using new EO data

- PHASE III, 2008-2011
dedicated to Security Service Operations providing a fully consolidated and optimised space and user infrastructures context

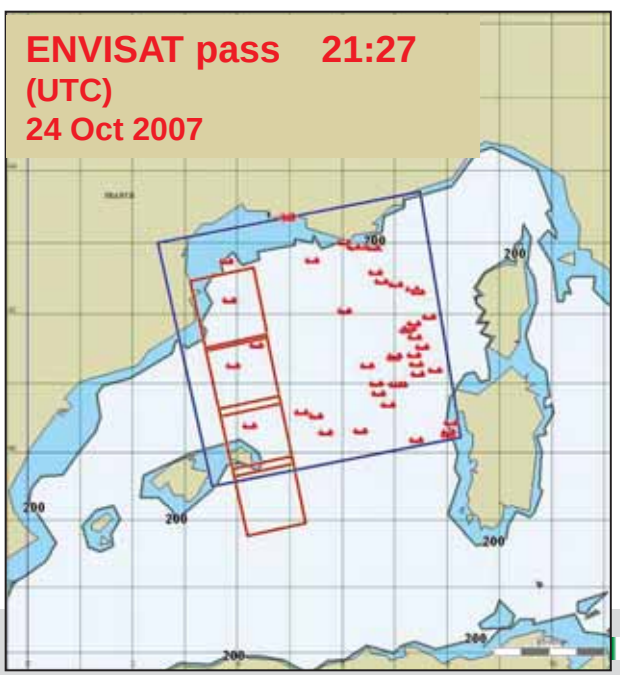


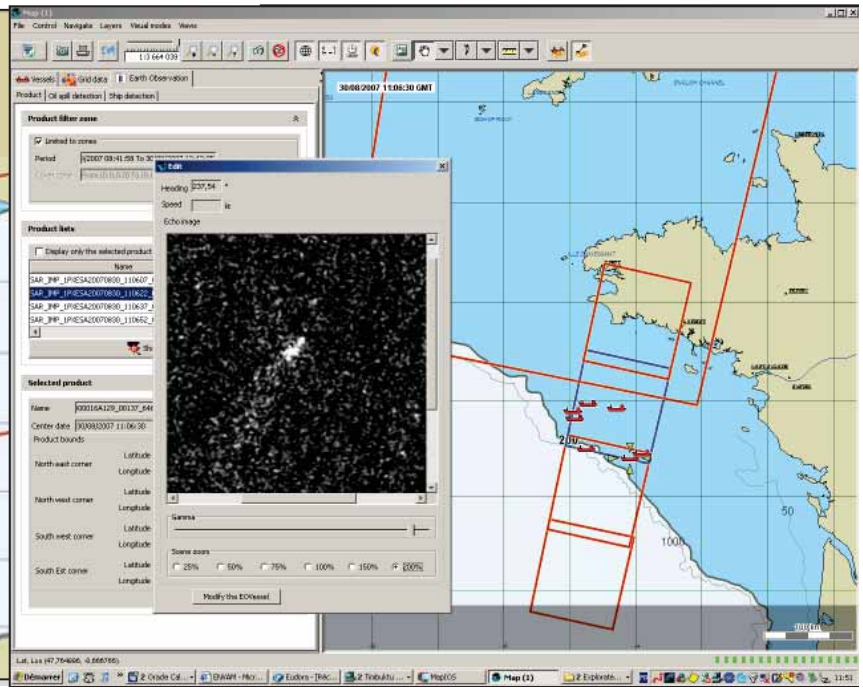
Credits: Telespazio

Synergetic use of ERS-2 and Envisat for maritime surveillance Example in 2007

- Envisat focus on EMSA needs (Wide Swath mode) and ERS-2 on MARISS needs:
  30 minutes time difference
  ➔ quasi simultaneous acquisitions in different modes)
- Reduction of Envisat ASAR mode conflicts

Courtesy:
CLS (GSE MARISS)





First EMSA – ESA Cooperation Agreement

- **First EMSA – ESA agreement signed on 2 March 2007, related to:** "*Use of Space Based Earth Observation for Enhancing Maritime Safety*"

- **Main cooperation activities:**
  - User requirements for EO on maritime surveillance
  - Assessment (...) / access by EMSA of ESA and TPM EO data provided by ESA
  - R&D activities on EO techniques and information services related to operational maritime surveillance

ARTICLE 2 - DESCRIPTION OF ACTIVITIES

The activities of the Parties under this Agreement concern three Activity Domains, namely:

Activity Domain 1: Identification, collection, recording and evaluation of user requirements for space-based earth observation data in order to enhance maritime safety and to combat ship source pollution;

Activity Domain 2: Assessment of the operational status, technical performance, accessibility and availability of satellite data, relevant for EMSA's operational monitoring and surveillance services. This will concern primarily data originated by the payloads of ESA satellites (hereinafter referred to as "ESA Mission Data") and data originated by the payloads of satellites operated by third parties and for which data ESA is granted a right of distribution (hereinafter referred to as "Third Party Mission Data"). Special attention will be dedicated to the near-real-time availability of observations of European coastal waters by ENVISAT/ASAR and successor missions;

Activity Domain 3: Development and validation of earth observation techniques and associated information services at the level of demonstration stage (pre-operational) in particular regarding verification, robustness and maturity suitable for operational maritime use.

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AGREEMENT BETWEEN ESA AND THE EUROPEAN MA SIGNED TODAY

From left to right: Mr Volker Liebig and Mr Willem de Ruiter signing the agreement at EMSA's premises in Lisbon

2 March 2007
de Ruiter, Ex
Maritime Safe
Liebig, ESA's
Programmes,
two agencies,
cooperation i
surveillance.

The signature
stage of EMS
monitoring se
and adjacent
potential oil s

esa

Communication sent by ESA to EMSA in December 2006 on the initial Envisat commitment to support EMSA CSN

date	15-12-2006	ref.	1 / 1
from	Henri Laur EOP-GM		
visa			
to	EMSA att. Olaf Trieschman, Leendert Bal	n	urgent
copy	ESA: G. Kohlhammer, M. Doherty, O. Grabak, G. Campbell, W. Lengert, B. Hoersch		
Subject	ESA Envisat SAR data commitments		

Dear Olaf,

As a follow-up of Dr. Liebig's letter dated 26 October 2006, we would like to reiterate that ESA is fully committed to support EMSA needs for Envisat SAR data throughout the 3 year duration of the initial EMSA surveillance contract. This commitment is independent of potential changes of the ESA Earth Observation data policy, and of the related distribution licenses. The only condition being that the Envisat satellite continues to operate within nominal specifications and with the appropriate operations funding.

For your information, the Envisat distribution licenses with our distributors currently expire on 30 September 2007. The distribution scheme after this date is not yet agreed.

We hope this clarifies the situation with respect to the availability of Envisat SAR data for EMSA activities.

Best regards,

Henri Laur
Head of EO Mission Management Office

2nd EMSA – ESA Cooperation Agreement

- **2nd EMSA – ESA agreement signed on 2 July 2010 (covering 5 years), and a further extension up to 1st July 2020 was established in 2015:** *"… concerning cooperation for the use of space based systems and data in support of maritime activities"*

- **Main cooperation activities:**

- User requirements related to maritime surveillance
- Assessment of operational status, performance, accessibility (…) of satellite data, incl. assistance for data provision relevant to EMSA operational maritime activities
- Development, validation, implementation and operations of space based systems and associated services (…)

ARTICLE 1 - PURPOSE

The purpose of this Agreement is to define the terms and conditions for the cooperation between the Parties concerning the development and operational use of space-based systems, data and techniques in support of maritime activities, such as maritime safety, security, surveillance and combating ship source pollution, and concerning the support to the implementation of European Union policies related to these fields.

ARTICLE 2 - SCOPE AND ACTIVITIES

The cooperation under this Agreement covers the sectors of satellite Earth Observation, telecommunication, navigation, integrated applications, and related services. Within these sectors, the cooperation of the Parties concerns the following activity domains:

- Identification, collection and consolidation of user requirements;
- Assessment of the operational status, technical performance, accessibility and availability of satellite data, including the assistance for the provision of satellite data, relevant for EMSA's operational maritime activities;
- Development, validation, implementation and operation of space based systems and associated services, including fast response procedures for satellite assistance in case of emergency situations.

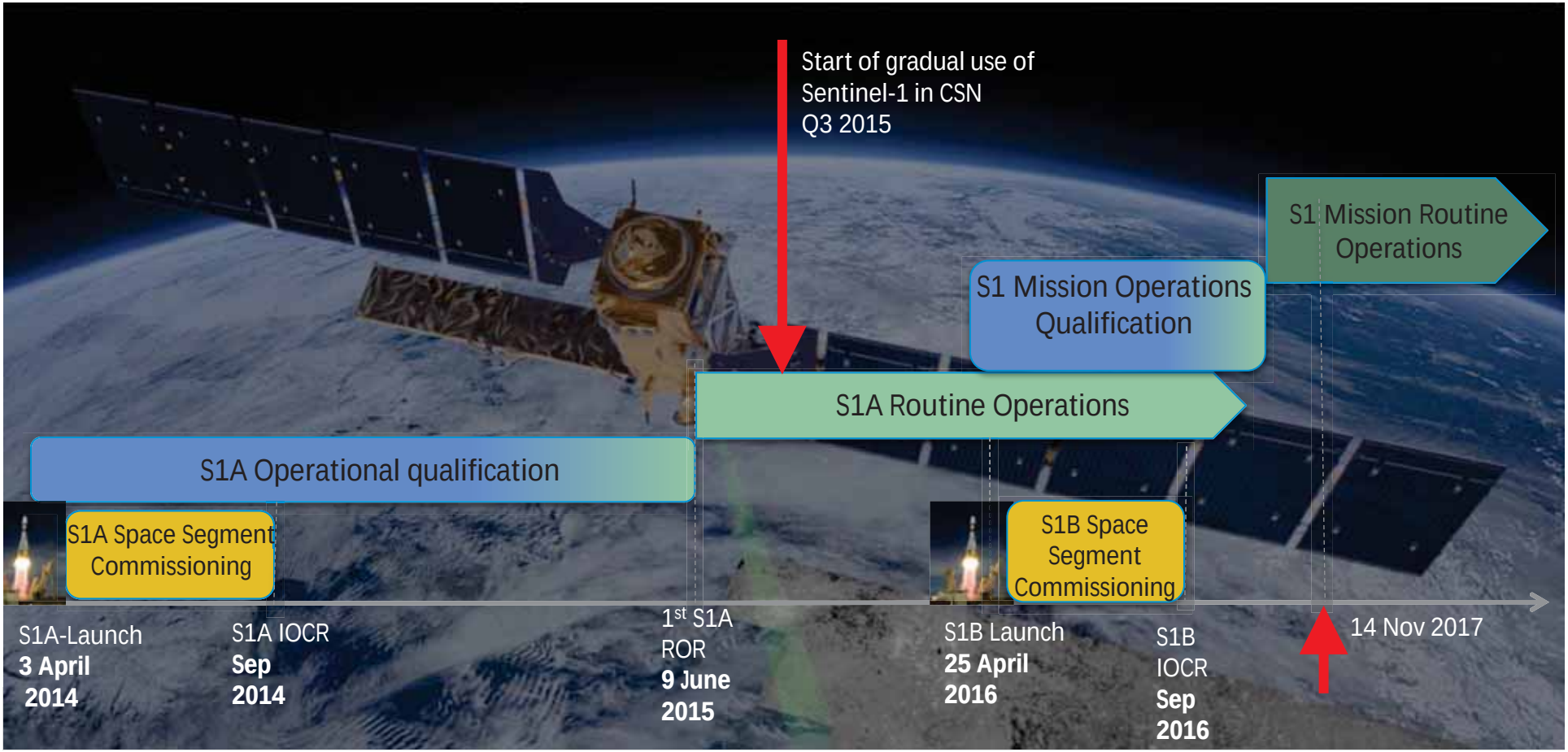
The scope of the cooperation between the Parties is further detailed in the Annexes to this Agreement.

Sentinel-1 –

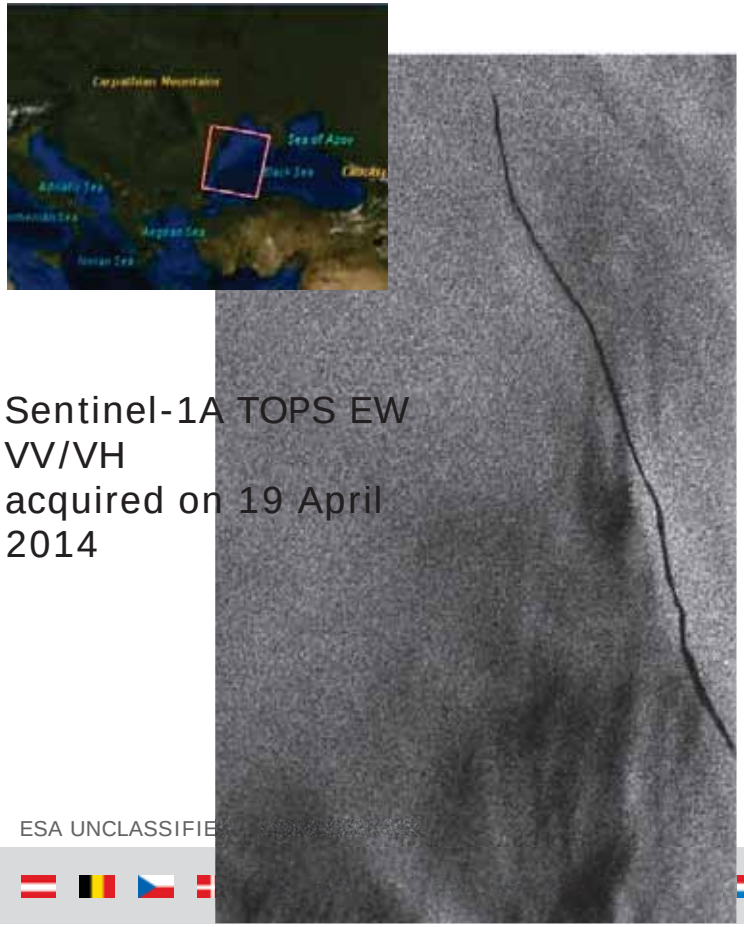
Technical support to EMSA activities

ESA UNCLASSIFIED - For Official Use

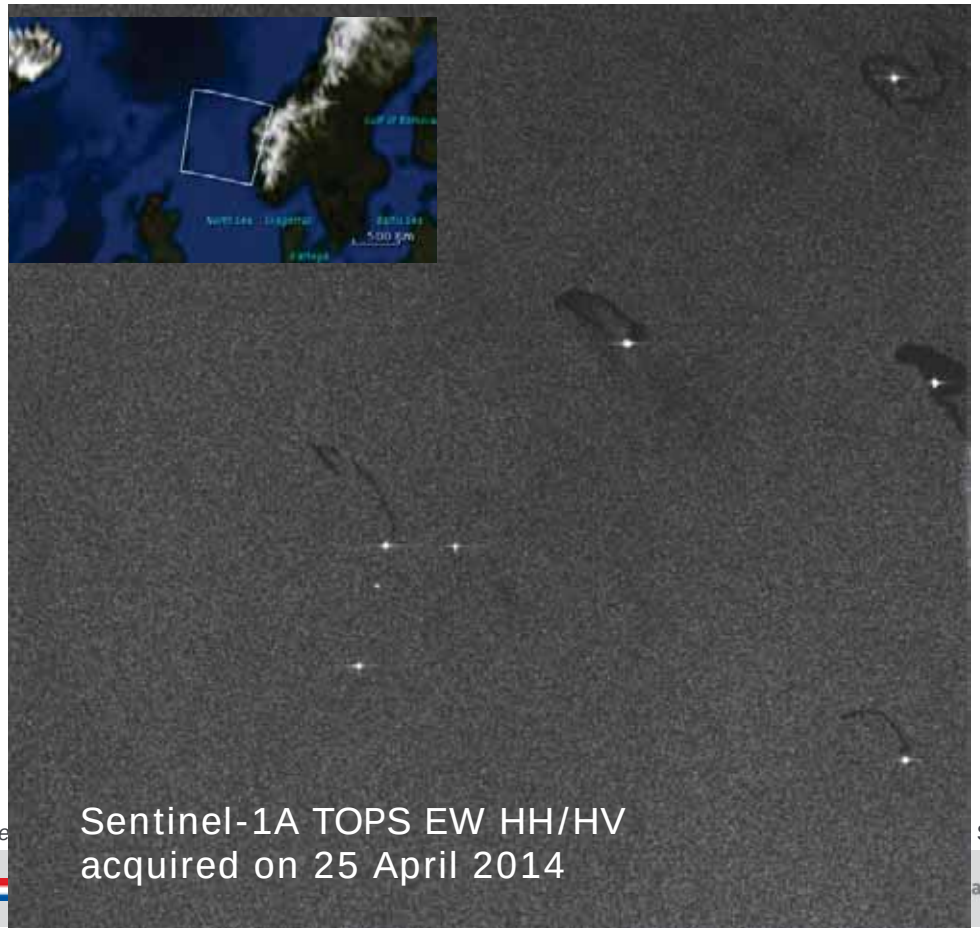
Sentinel-1 Mission Phases



First Oil Spills Detected by Sentinel-1 – April 2014



Sentinel-1A TOPS EW VV/VH acquired on 19 April 2014



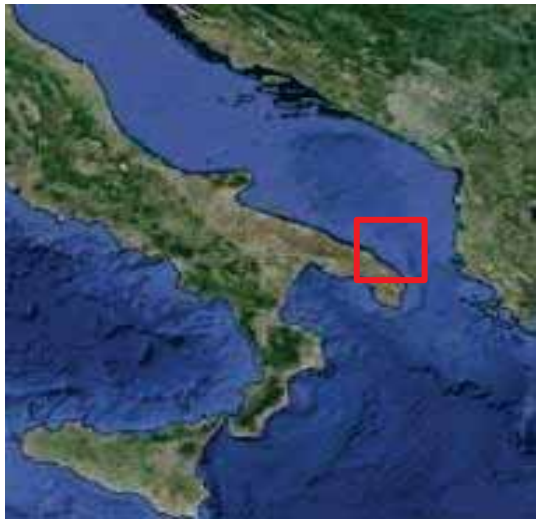
Sentinel-1A TOPS EW HH/HV acquired on 25 April 2014

Oil Discharge Detected by Sentinel-1 – 3 Sep 2014

IW mode

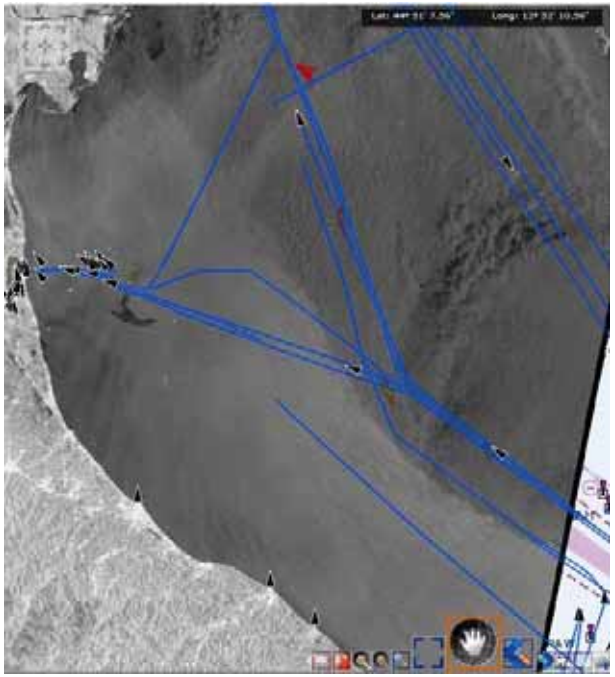
Vertical Polarization

Date: 3.09.2014



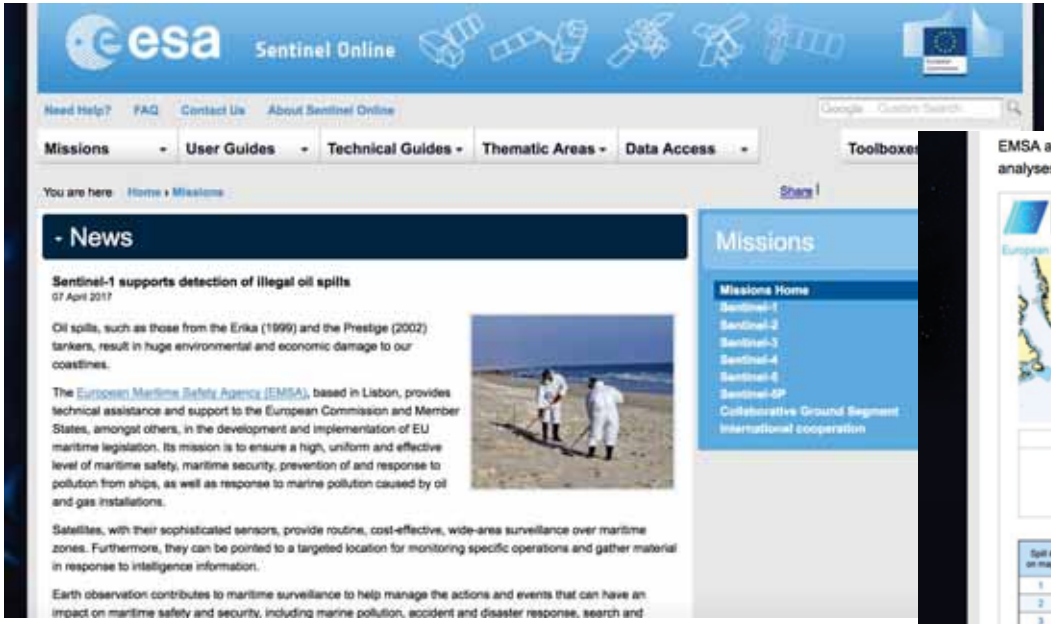
Sentinel-1 operationally used by EMSA for CleanSeaNet

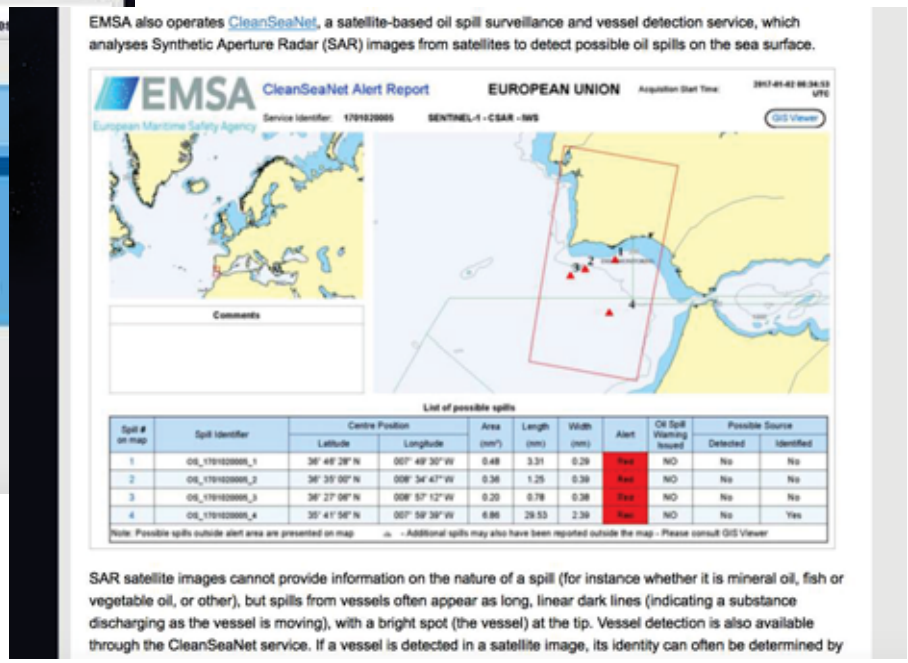
Sentinel-1 represents 85 % of satellite imagery used for CleanSeaNet



Release of joint EMSA-ESA web stories on Sentinel Online portal

"Sentinel-1 supports detection of illegal oil spills", 7 April 2017





EMSA also operates CleanSeaNet, a satellite-based oil spill surveillance and vessel detection service, which analyses Synthetic Aperture Radar (SAR) images from satellites to detect possible oil spills on the sea surface.

EMSA CleanSeaNet Alert Report EUROPEAN UNION

European Maritime Safety Agency

Service Identifier: 1701020005 SENTINEL-1 - CSAR - IWS

GIS Viewer

Comments

List of possible spills

Spill # on map	Spill Identifier	Centre Position		Area	Length	Width	Alert	Oil Spill Warning Issued	Possible Source	
		Latitude	Longitude	(km²)	(km)	(km)			Detected	Identified
1	OS_1701020005_1	36° 44' 28" N	007° 49' 30" W	0.48	3.31	0.29	Yes	NO	No	No
2	OS_1701020005_2	36° 35' 00" N	008° 34' 47" W	0.38	1.25	0.39	Yes	NO	No	No
3	OS_1701020005_3	36° 27' 06" N	008° 57' 12" W	0.20	0.78	0.38	Yes	NO	No	No
4	OS_1701020005_4	35° 41' 56" N	007° 59' 39" W	6.86	29.53	2.39	Yes	NO	No	Yes

Note: Possible spills outside alert area are presented on map ⚠ - Additional spills may also have been reported outside the map - Please consult GIS Viewer

SAR satellite images cannot provide information on the nature of a spill (for instance whether it is mineral oil, fish or vegetable oil, or other), but spills from vessels often appear as long, linear dark lines (indicating a substance discharging as the vessel is moving), with a bright spot (the vessel) at the tip. Vessel detection is also available through the CleanSeaNet service. If a vessel is detected in a satellite image, its identity can often be determined by

Sentinel-1: overall mission status

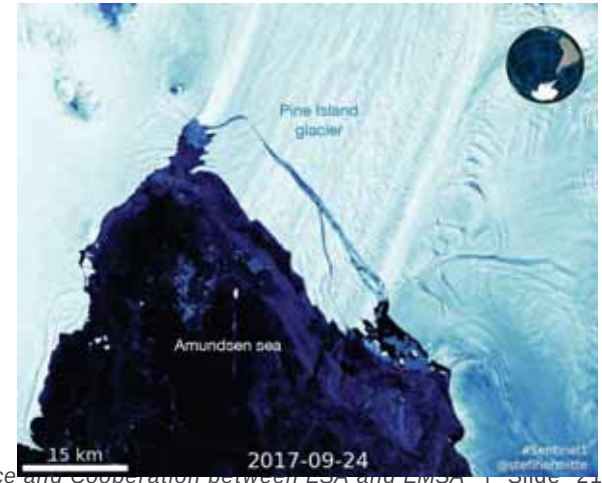
- **Sentinel-1 nominal routine operations continue**
- Sentinel-1A and -1B data routinely provided to Copernicus Services, EMSA CSN and users worldwide
- On-going support to various activations from the Copernicus Emergency Management Service and the International Charter Space and Major Disasters
- Routine operational use of EDRS service for both Sentinel-1A and Sentinel-1B. Tests on Sentinel-1 "pass-through" (real time) operations through EDRS have been performed successfully

- **Sentinel-1 constellation** generates **11 TB** of products **daily**

- **Upcoming activities**

• Assess new observation needs from Member States formulated as part of the Sentinel HLOP revision process

• Identify and implement mission evolution to support new user needs, incl. new products, increased system capacity enabling further mission exploitation, etc.



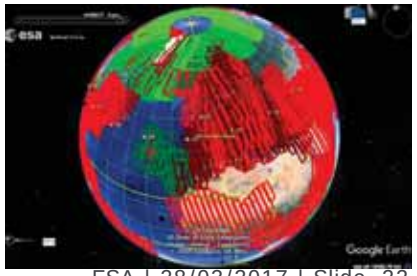
Pine Island Glacier calving into multiple icebergs on 24 Sep 2017

EMSA – ESA Technical cooperation on Sentinel-1 - Preparatory activities -

Preparation of CleanSeaNet operations based on Sentinel-1

-> Tight coordination and cooperative actions started well before the launch of Sentinel-1A:

- Sentinel-1 observation requirements for CleanSeaNet provided by EMSA, definition of related detailed observation plan by ESA
- Set up of operational procedures (planning in particular)
- ESA substantial support provided to EMSA CSN service providers for handling S1 data:
    - provision of ESA-developed processor software
    - technical support in preparation of acquiring / processing Sentinel-1 data
    - etc.

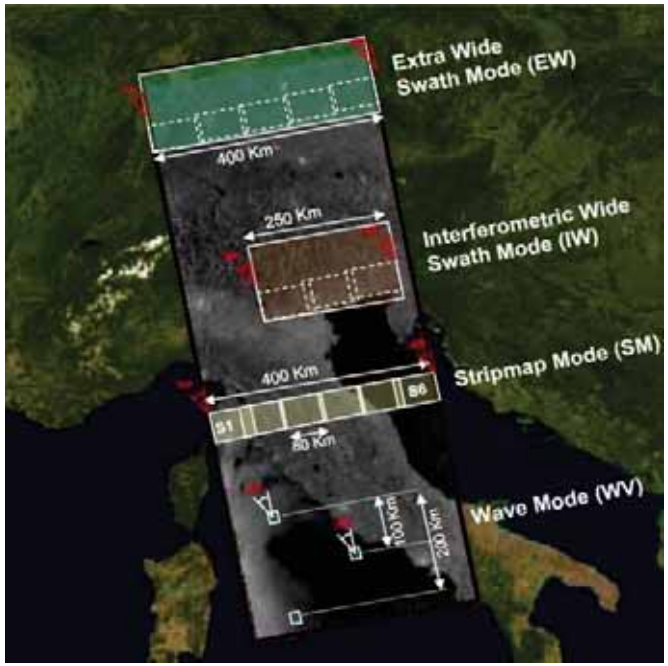


EMSA – ESA Technical cooperation on Sentinel-1 - On-going routine activities -

Sentinel-1 operational support to CSN

- Use of Sentinel-1 imagery as part of the CleanSeaNet service started in Q3 2015, ramping-up towards routine operations
- Specific real-time “pass-through” S1 acquisitions agreed between EMSA and ESA
- Received and processed by the X-band local stations of the EMSA service providers

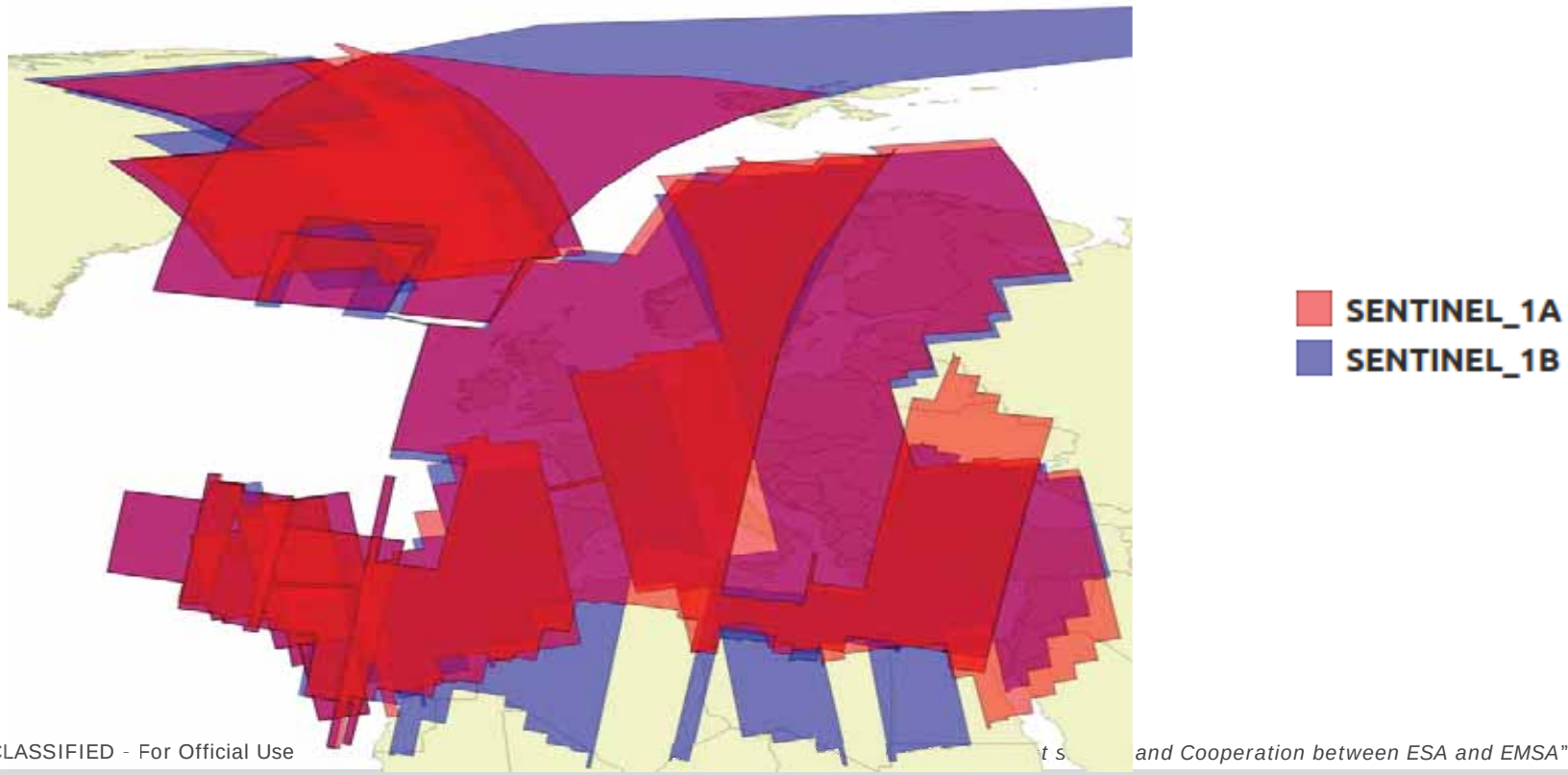
Sentinel-1 observation scenario
SAR Operational Modes



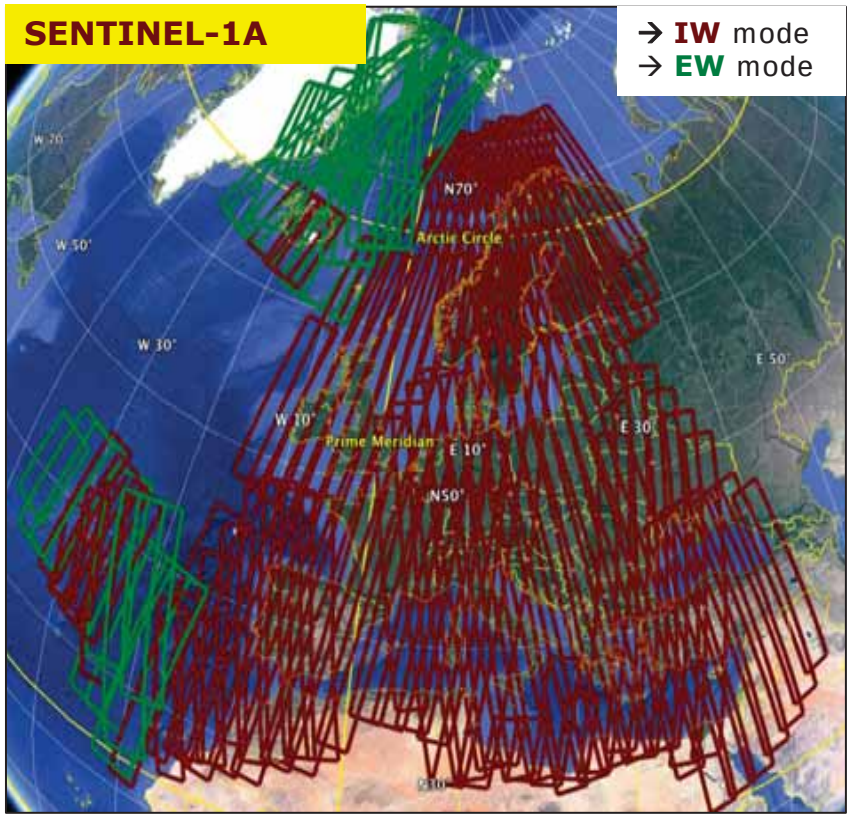
	GRD Level 1 product resolution	Swath Width	Polarisation
EW	50m (3 ENL)	> 400 km	HH+HV or VV+VH
IW	20m (5 ENL)	> 250 km	HH+HV or VV+VH
SM	9m (4 ENL)	> 80 km	HH+HV or VV+VH
WV	50m (140 ENL)	20 x 20 km² at 100 km spacing	HH or VV

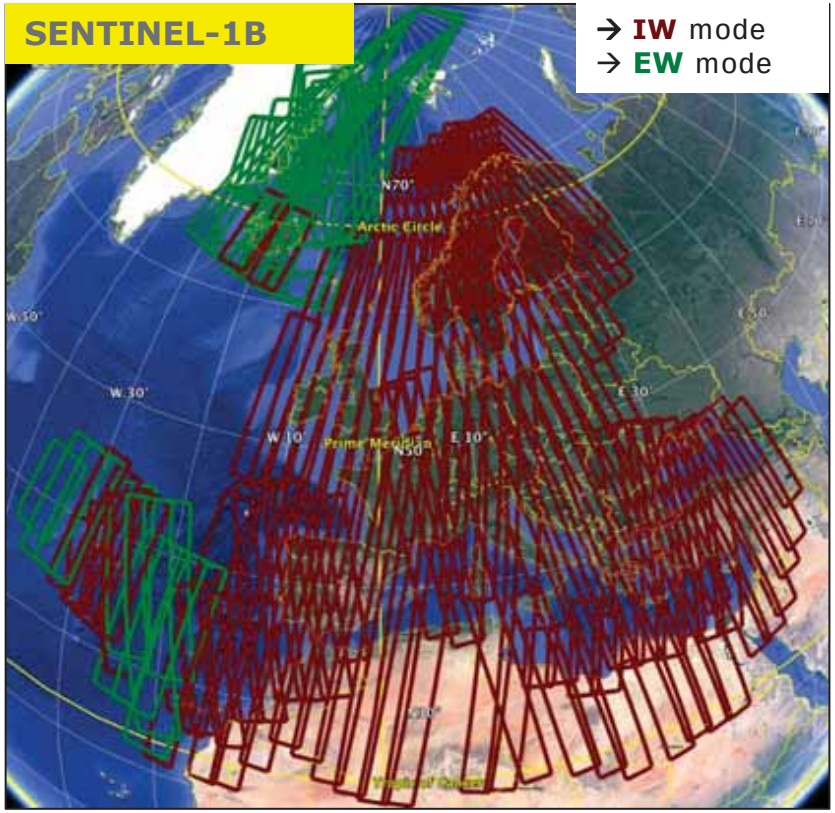
Current Sentinel-1 observations for CleanSeaNet

Long Term Planning GIS map, showing the geometry of the SENTINEL-1 Constellation coverage for EMSA/CSN, provided in direct downlink (pass through)



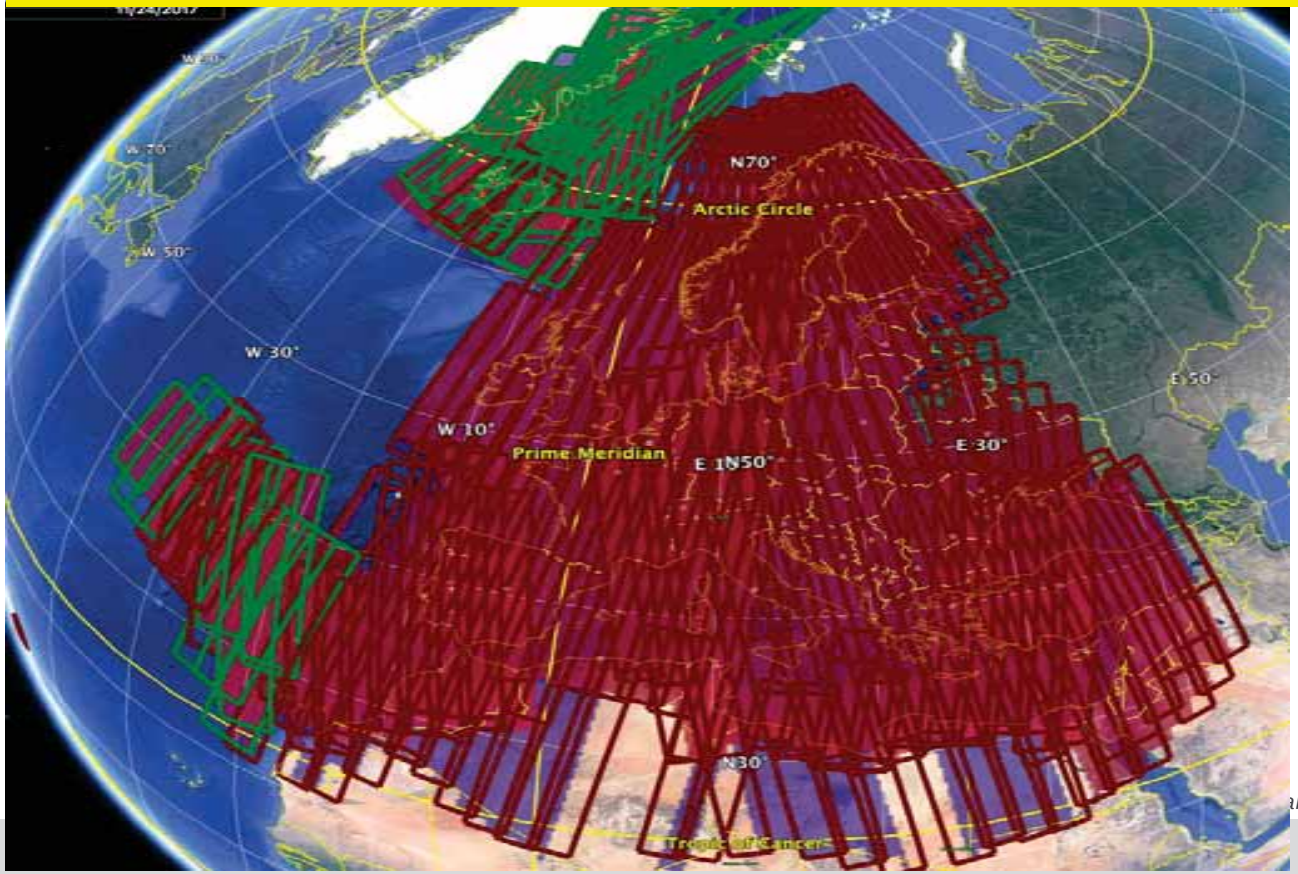
Current Sentinel-1 detailed acquisitions for CleanSeaNet, over a 12 days cycle





Current Sentinel-1 detailed acquisitions for CleanSeaNet, over a 12 days cycle

Full encompassing view: Combined SENTINEL-1 footprints and geometric coverage

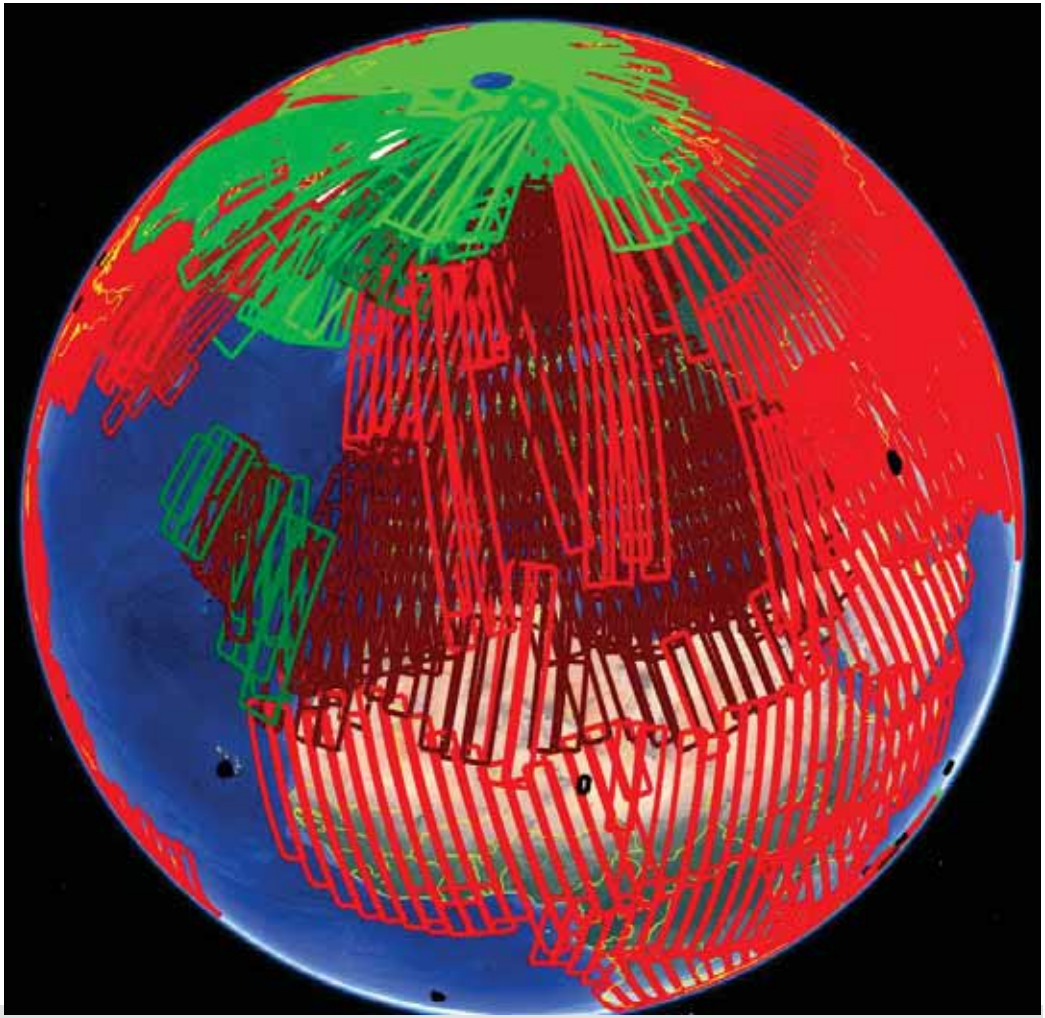


Full set of current Sentinel-1 acquisitions over 12 days

Example of Sentinel-1A + 1B acquisitions over 12 days: period 14 Nov – 26 Nov 2017

Real-time "pass-through" IW acquisitions in dark-red

Real-time "pass-through" EW acquisitions in light green

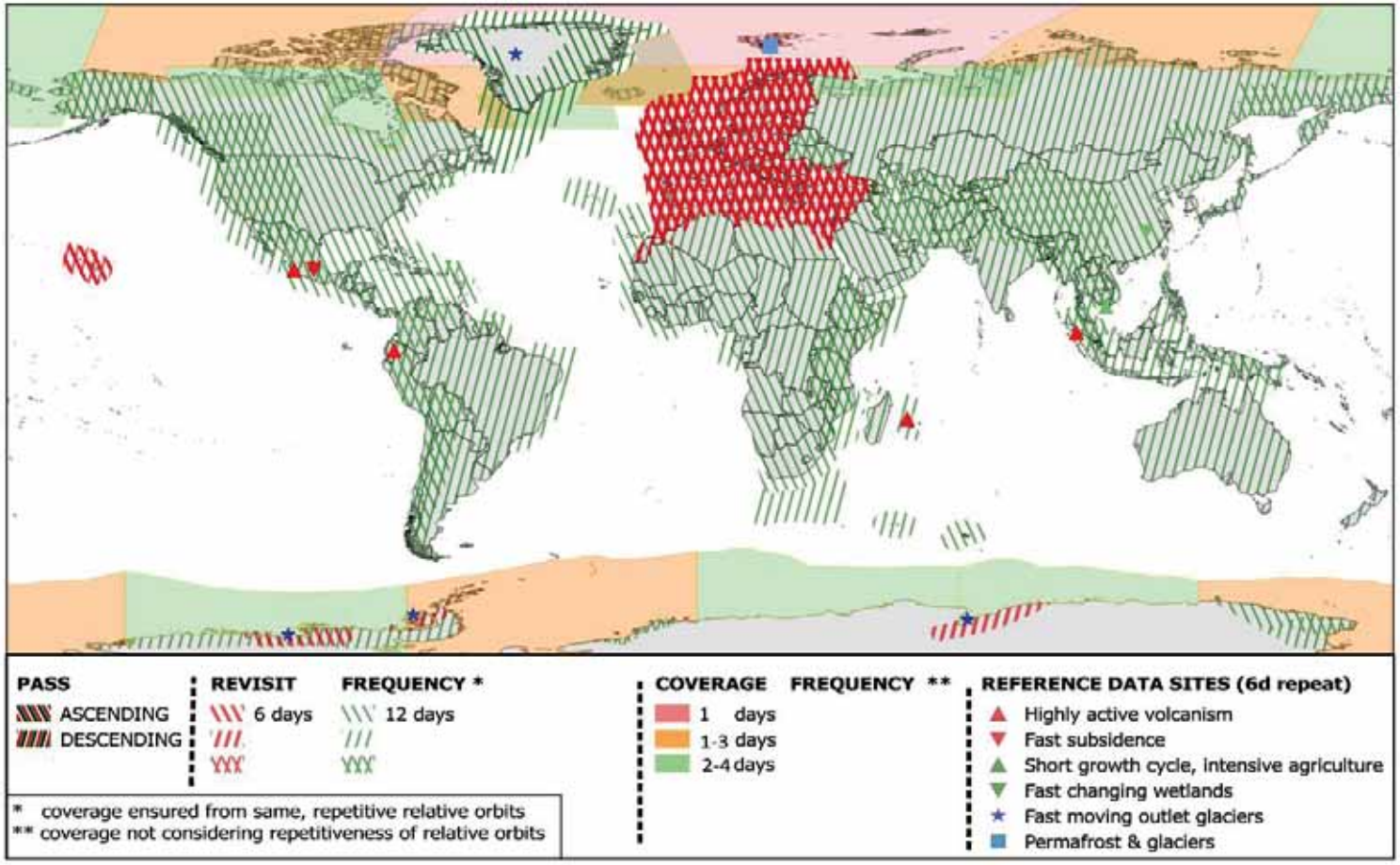


Sentinel-1 Constellation Observation Scenario: Revisit & Coverage Frequency

sentinel-1

validity start: 05/2017

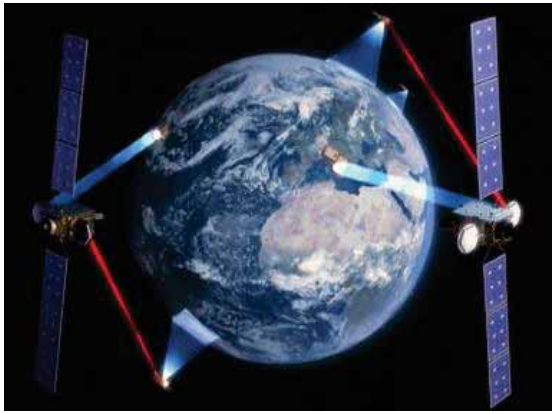
esa



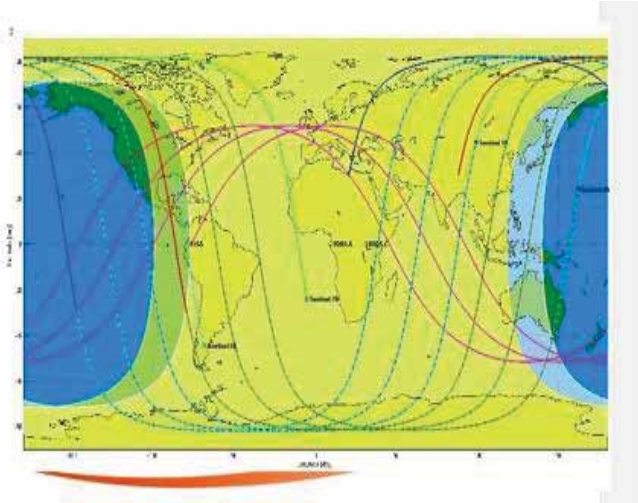
Operational use of European Data Relay System (EDRS)

The European Data Relay System service provides for the Sentinel-1 mission the following assets:

- **increased data download capacity**
- **increased coverage**
- **enhanced timeliness**



EUTELSAT 9B hosting EDRS-A



EDRS-Sentinels indicative geometrical visibility map

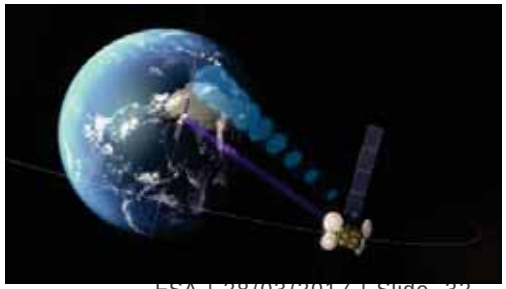
Use of EDRS by Sentinels – Two main operational capabilities exploited by Sentinel-1

- **EDRS is used to downlink a high percentage of data recorded in memory**, outside X-band core stations visibility
  - This in turn increases the volume of data downlinked in pass-through over Europe in visibility of the X-Band core stations, and thus the volume of NRT data generated by the CSC ground segment
  - Similarly, this allows local stations in Europe, in particular part of the EMSA CSN station network, to generate an increased number of products in QRT

- **EDRS allows to perform fast downlink of data acquired outside the X-Band core stations visibility**, in particular in Quasi-Real-Time
  - This will in turn enhance the achieved product timeliness associated to core products generated by the CSC GS

EMSA – ESA Cooperation on Sentinel-1 - Future potential extension-

- **Sentinel-1 support to QRT/NRT EMSA activities outside Europe**
- Sentinel-1 observation requirements for priority areas outside Europe provided by EMSA, as part of the EC survey on the Integrated Ground Segment Task Force, related to “Quasi-Real-Time - QRT” discussions
- New observation requirements may be supported making optimum use of downlink resources, e.g. provided through the EDRS service
- Plan is to start acquisitions through EDRS covering priority areas (e.g. La Reunion waters) in agreement with the Commission

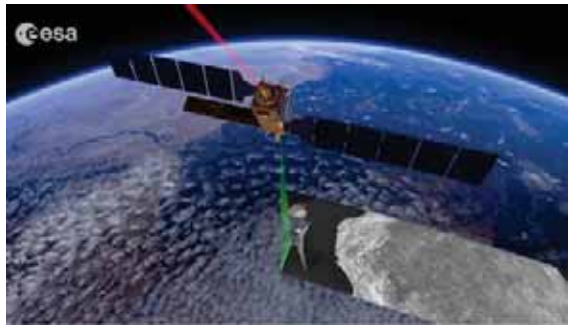


First link between EDRS-A and Sentinel-1A successfully performed on 31 May 2016

Sentinel-1A radar satellite test image taken on 31 May 2016, recorded on-board and relayed to ground by EDRS-A at 08:23 UTC, using Laser Communication Technology – Covering the island of La Reunion and surrounding waters

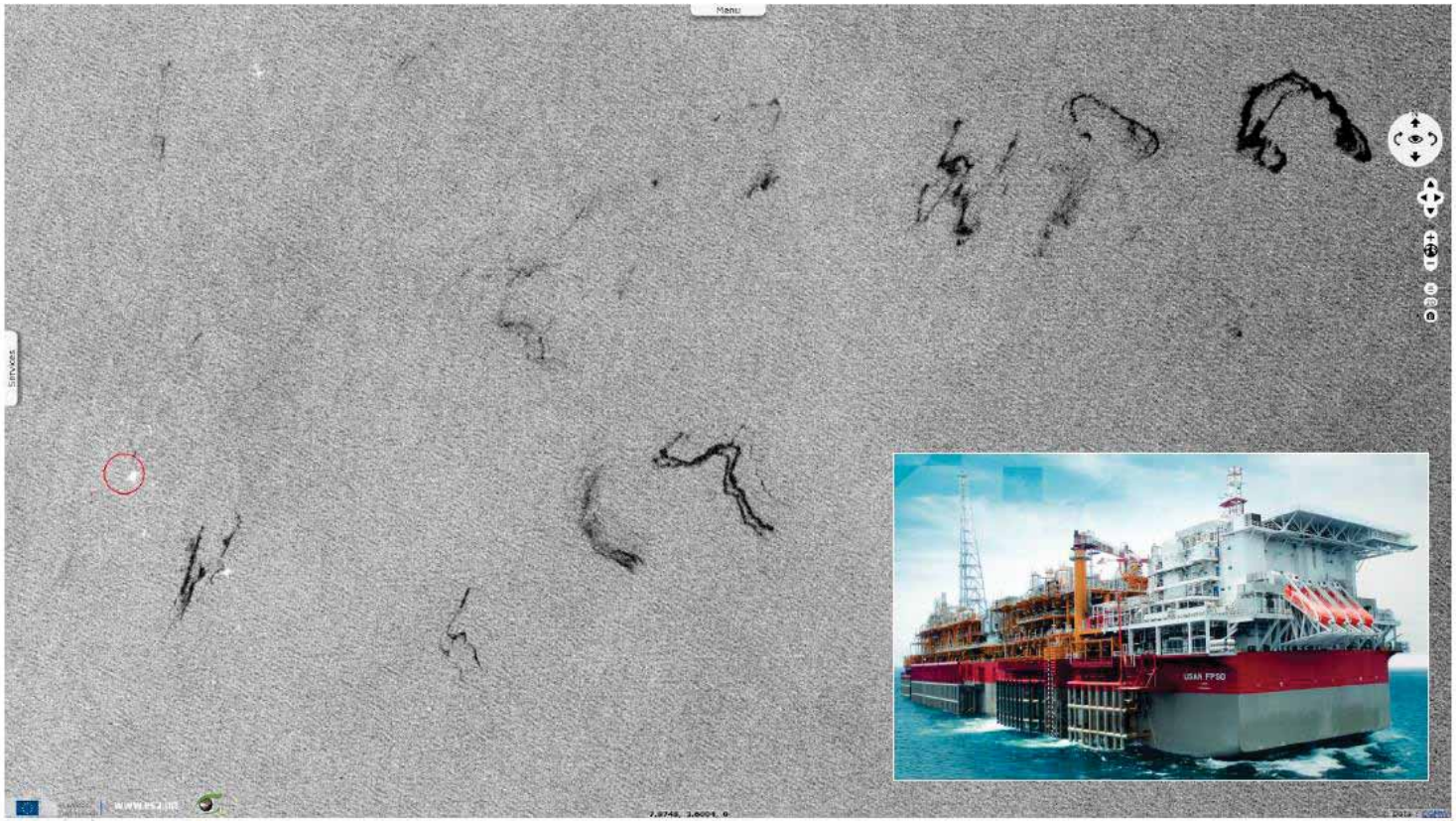
Image taken in Extra Wide Swath mode, suitable for maritime surveillance

EUTELSAT 9B hosting EDRS-A



Sentinel-1A

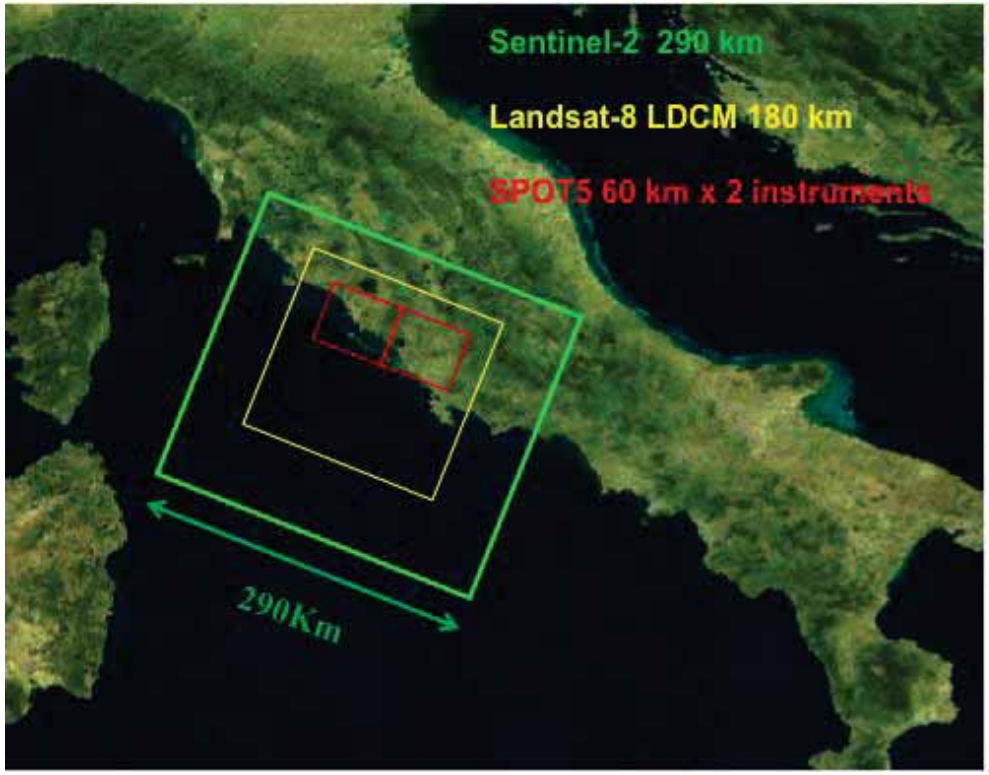
Multiple flowlines spills identified East of the USAN FPSO (Floating Production Storage and Offloading) vessels, Nigeria, Gulf of Guinea

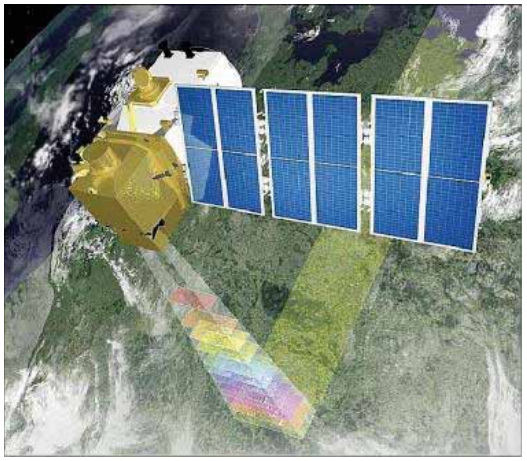


Sentinel-1A imagery, 18.01.2016

VisioTerra

Potential of Sentinel-2 (optical land mission) for maritime surveillance





5 days revisit at equator (cloud free) with concurrent observations of 2 satellites over <u>a very large swath</u>

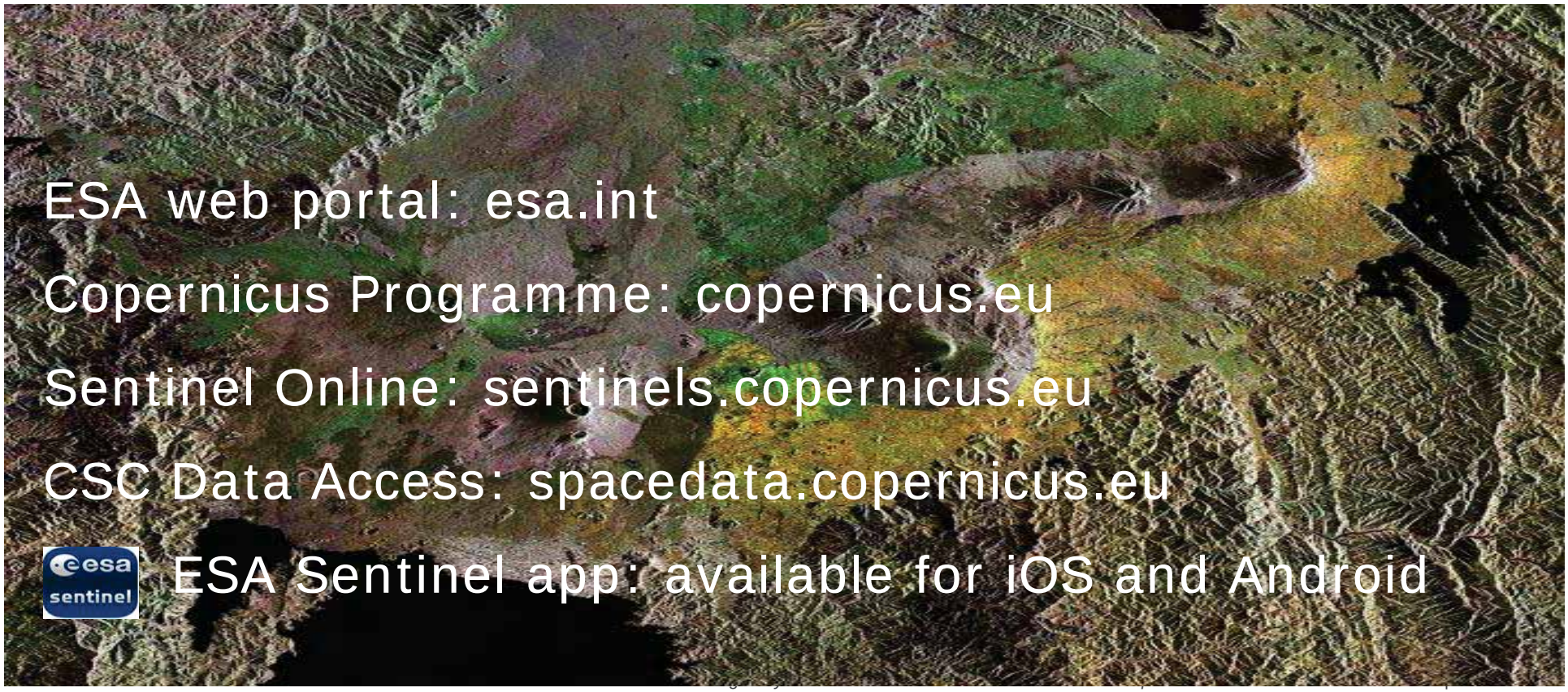
Potential of Sentinel-2 for maritime surveillance

San Francisco Bay

Concluding remarks

- Excellent cooperation between EMSA and ESA since the set up of EMSA in 2002, both on:
    - the service domain, in particular for R&D and as part of the ESA GSE pre-operational services initiated in 2002
    - EO data provision: ERS, Envisat, national / Third Party Missions, then Sentinel-1
- First EMSA-ESA cooperation agreement signed in 2007, then renewed twice
- Routine operational use of Sentinel-1 imagery as part of EMSA CleanSeaNet operations
- Sentinel-1C and 1D satellites, currently under development, will be equipped with an AIS payload
- Formulation by EMSA of needs on future EO missions is key for the definition of new mission concepts

Thank you for your attention !



ESA web portal: esa.int

Copernicus Programme: copernicus.eu

Sentinel Online: sentinels.copernicus.eu

CSC Data Access: spacedata.copernicus.eu

ESA Sentinel app: available for iOS and Android

Business Applications
(Integrated Applications Promotion (IAP))

EMSA-ESA projects and initiatives

- Satellite based AIS (SAT-AIS)
- VHF Data Exchange System (VDES)

TIA-AP
Doc. No.: ESA-TIAA-HO-2017-1214, V2.5
Date: 14/15 November 2017

ESA UNCLASSIFIED - For Official Use

ESA facts and figures

- Over 50 years of experience
- 22 Member States
- Eight sites/facilities in Europe, about 2300 staff
- 5.75 billion Euro budget (2017)
- Over 80 satellites designed, tested and operated in flight

Member States

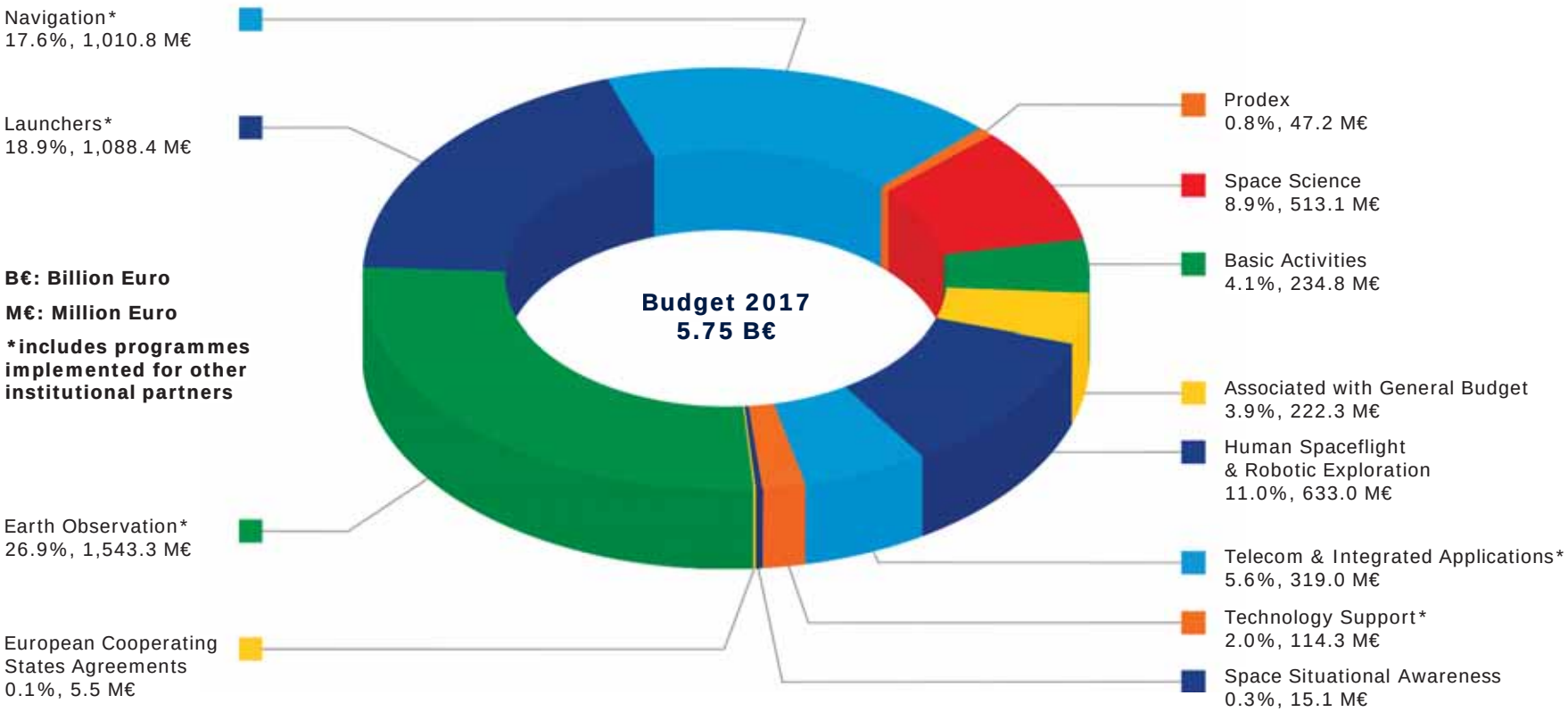
ESA has 22 Member States: 20 states of the EU (AT, BE, CZ, DE, DK, EE, ES, FI, FR, IT, GR, HU, IE, LU, NL, PT, PL, RO, SE, UK) plus Norway and Switzerland.

Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Latvia, Lithuania, Malta and Slovakia. Discussions are ongoing with Croatia.

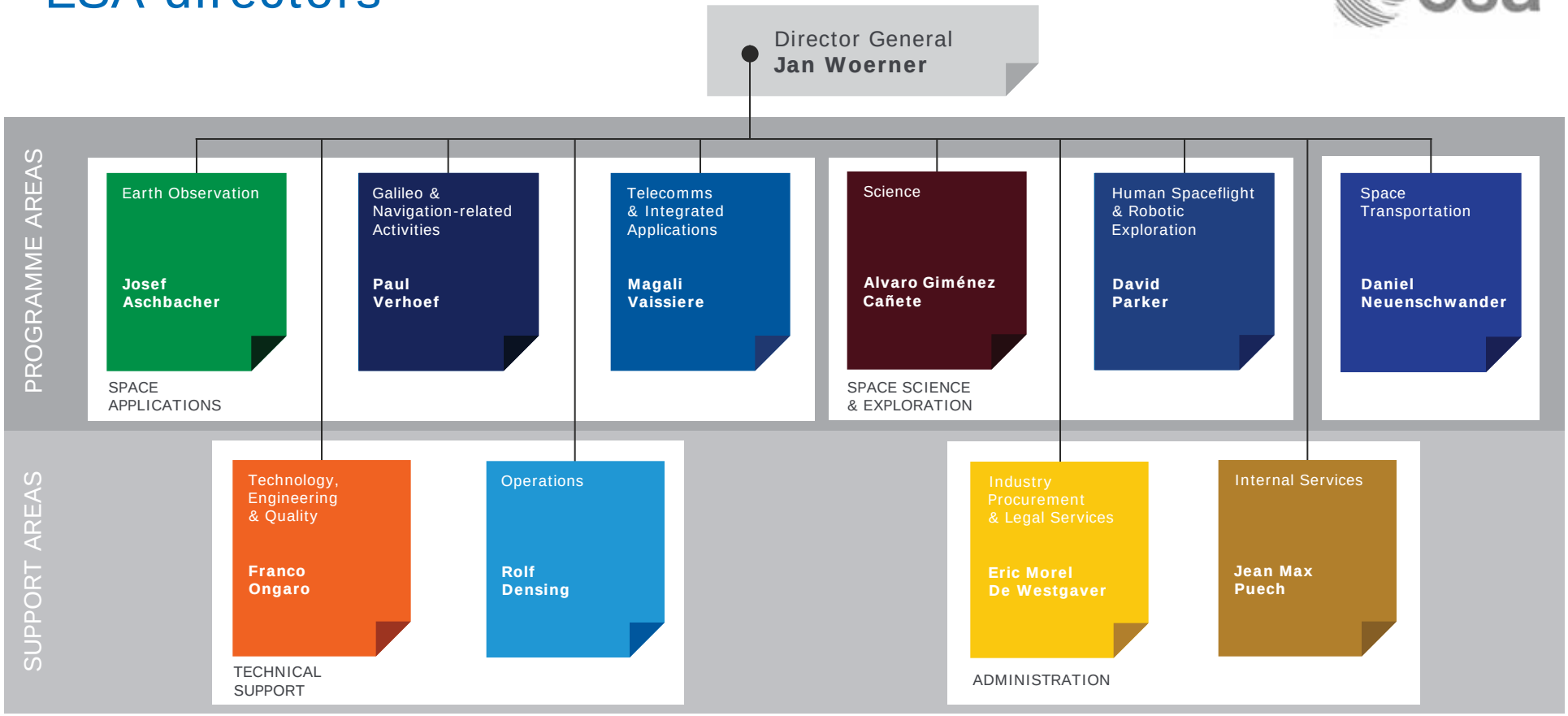
Slovenia is an Associate Member.

Canada takes part in some programmes under a long-standing Cooperation Agreement.

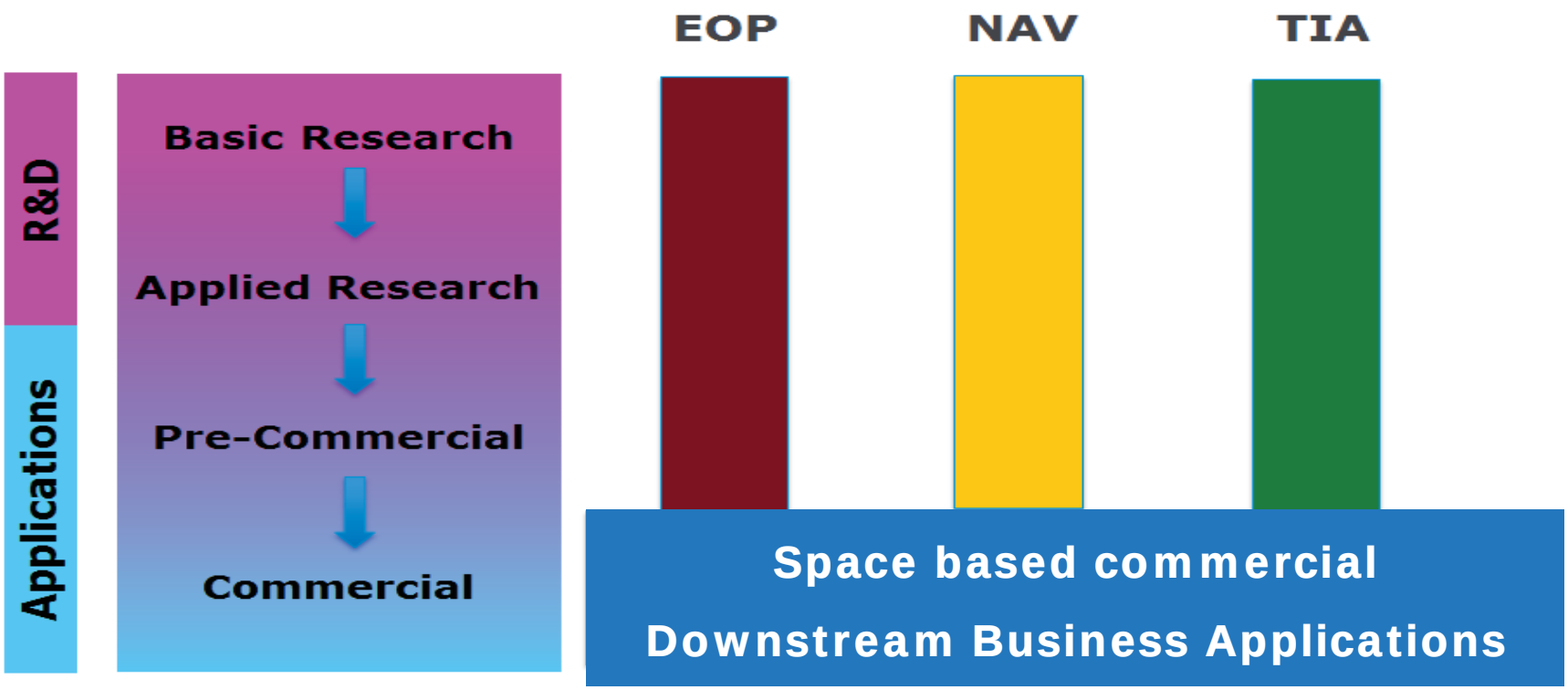
ESA budget for 2017: by domain



ESA directors



Business Applications

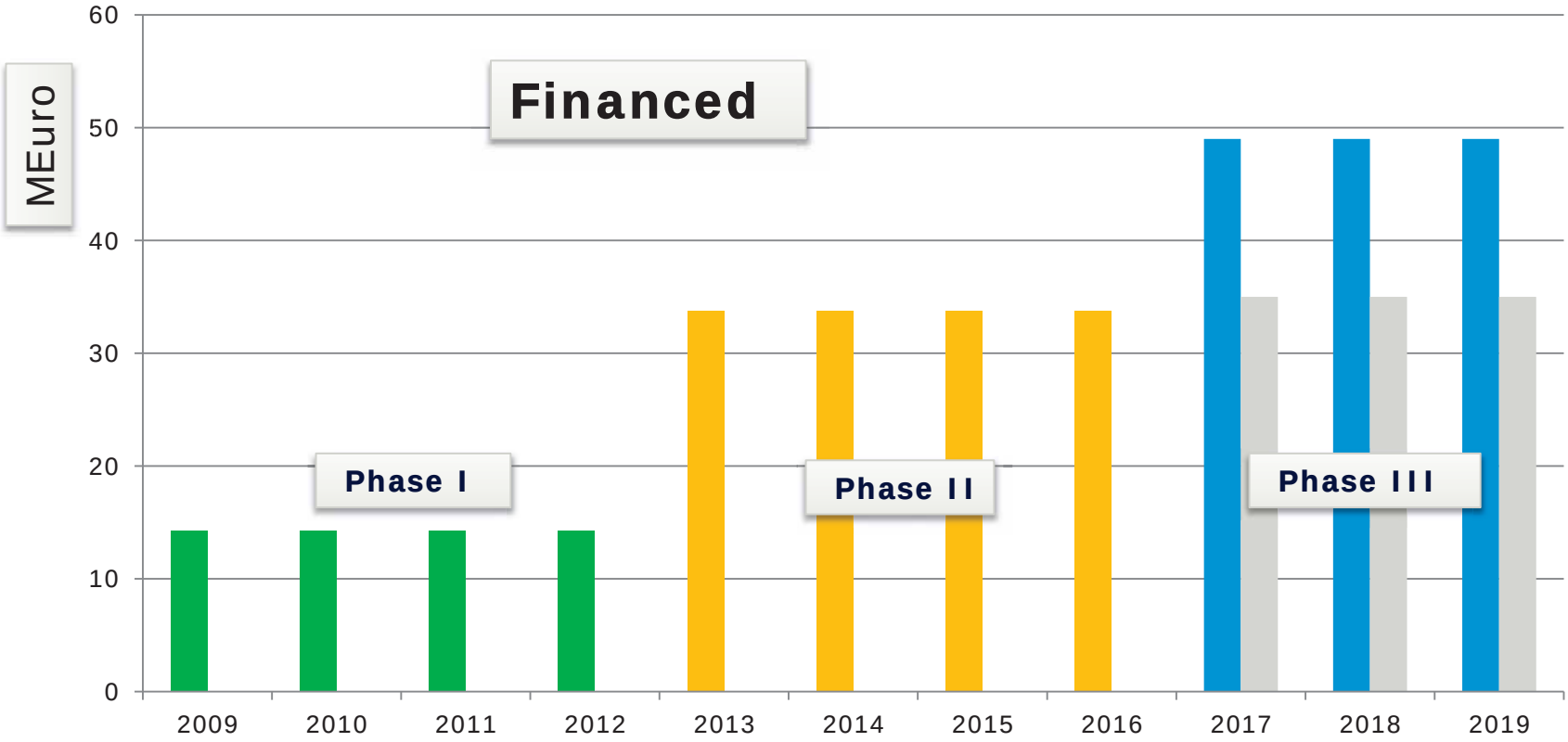


Business Application – Scope & Offer!

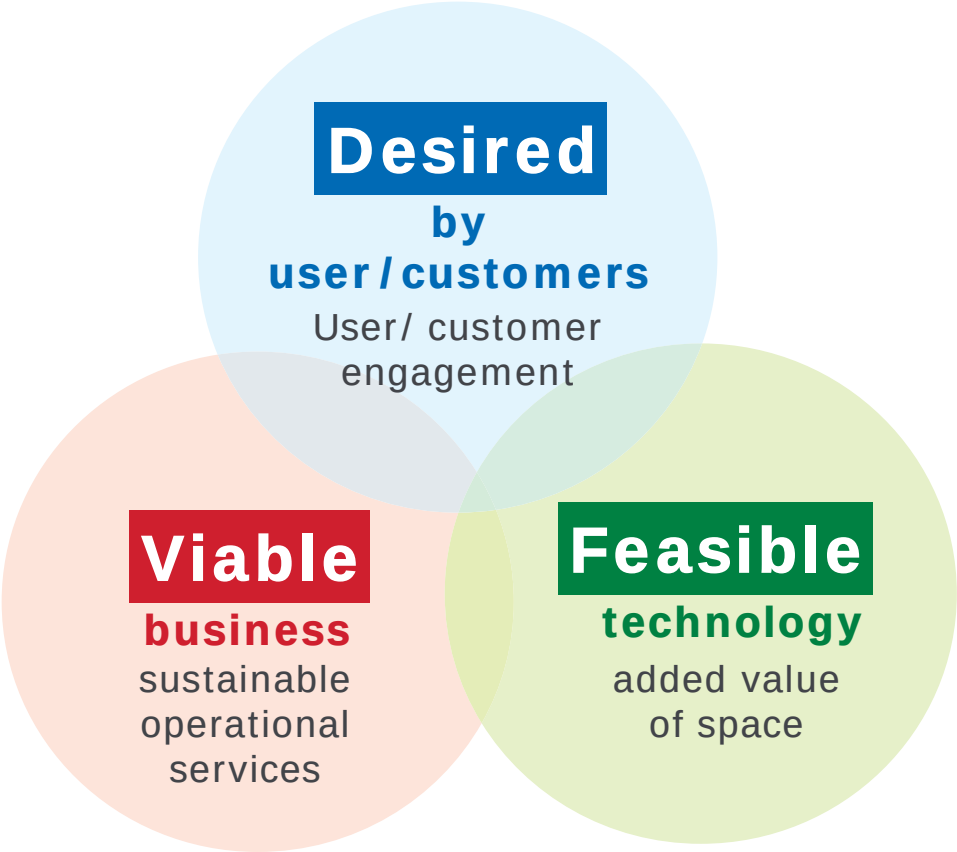
Ministerial Council 2016, Lucerne

Ministers declared support for the ESA Director General's vision for Europe in space and the role and development of ESA.

Business Application
Phase III



What is important?



Activity Implementation

User Demand → **Feasibility Study** → **Demo** → **Operational Service**

Users with demand but no contact to industry

Contact with ESA:

- business.esa.int
- Conferences
- IAP Ambassadors
- Call for user ideas
- Webinars

Funding by ESA:

- 50%* - initiated by industry / partner, involving users, continuous open call
- 75% - Kick-Start Activities
- 100% - ESA initiated tenders in close collaboration with users

Funding by ESA:

- 50%* - initiated by ESA or industry, dedicated tender or continuous open call (AO 6124)

Support:

- PR News Item, Awareness
- Access to investors

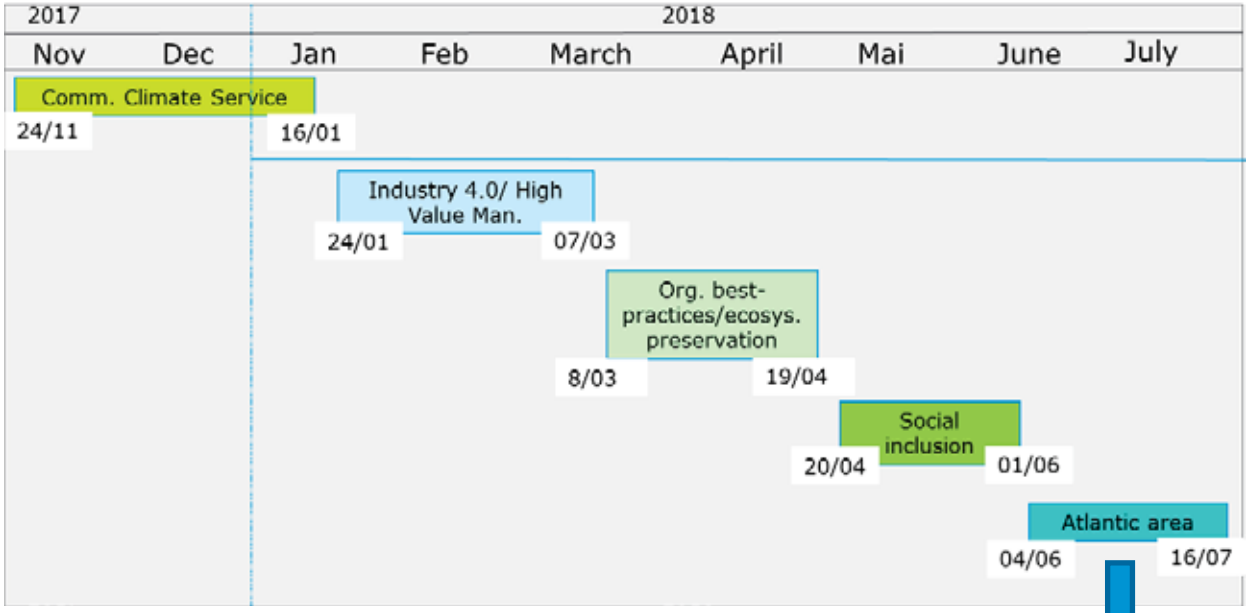
* SMEs can be funded up to 75% upon authorisation by national delegations

Activity Implementation

Kick-Start activities to be initiated by Partners (industry, operator or public institutions) following thematic calls for opportunities, aiming at exploring the viability of new application/service concepts!

- *Intro webinars 2 weeks ahead of each theme call (information on website **business.esa.int/kick-start**)*
- *Theme call opening period of 6 weeks*
- *Simplified application process*
- *Proposal length of 20 pages (template)*
- *Contract signature within 6 weeks from evaluation*
- *60 k€ (75%) ESA funding*
- *Multiple contracts depending on subject and quality*

Kick-Start themes



Topics of relevance

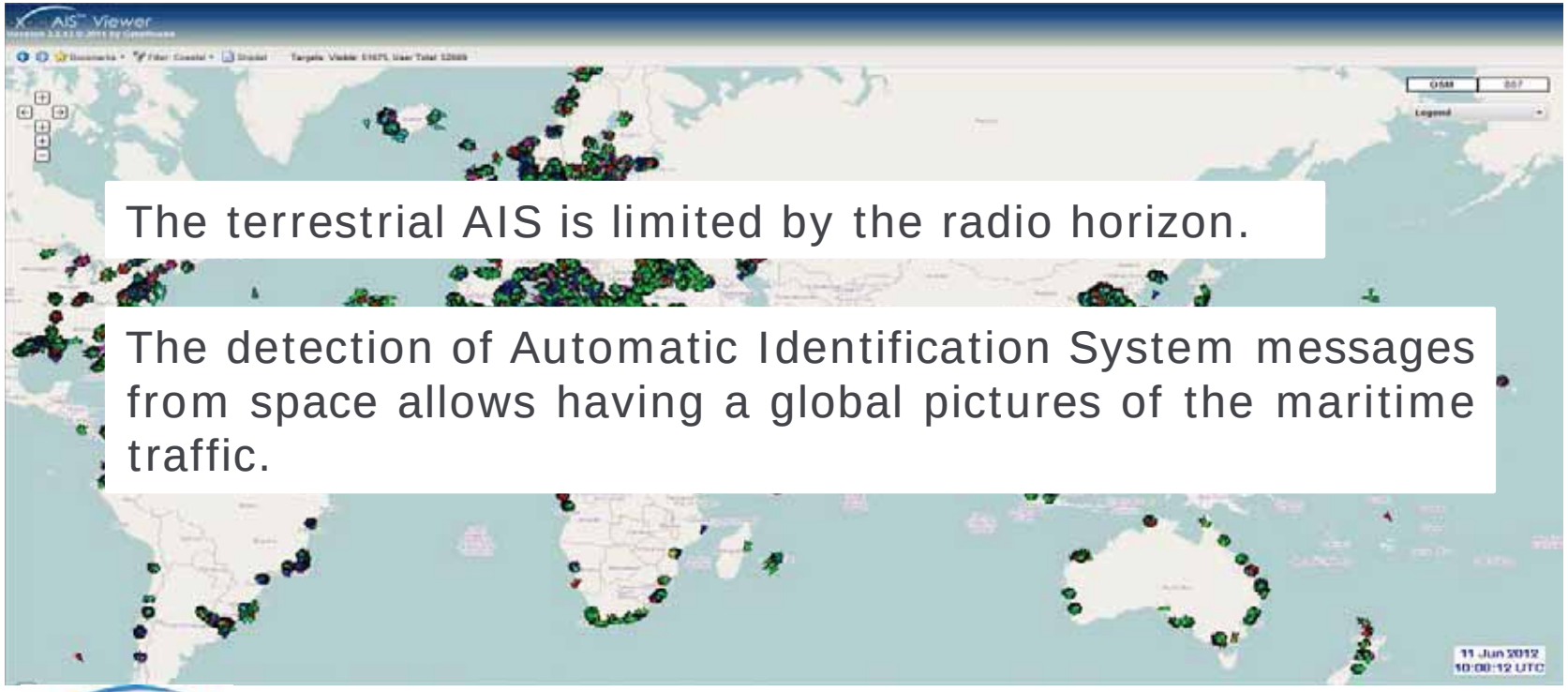
1. Supporting Atlantic economic development
2. E-navigation
3. Integrated Atlantic multi-use platforms
4. AI for Atlantic marine ecosystem

EMSA-ESA Projects and Initiatives

Satellite based Automatic Identification System (SAT-AIS)

VHF Data Exchange System (VDES)

Satellite based AIS - signal detection from space

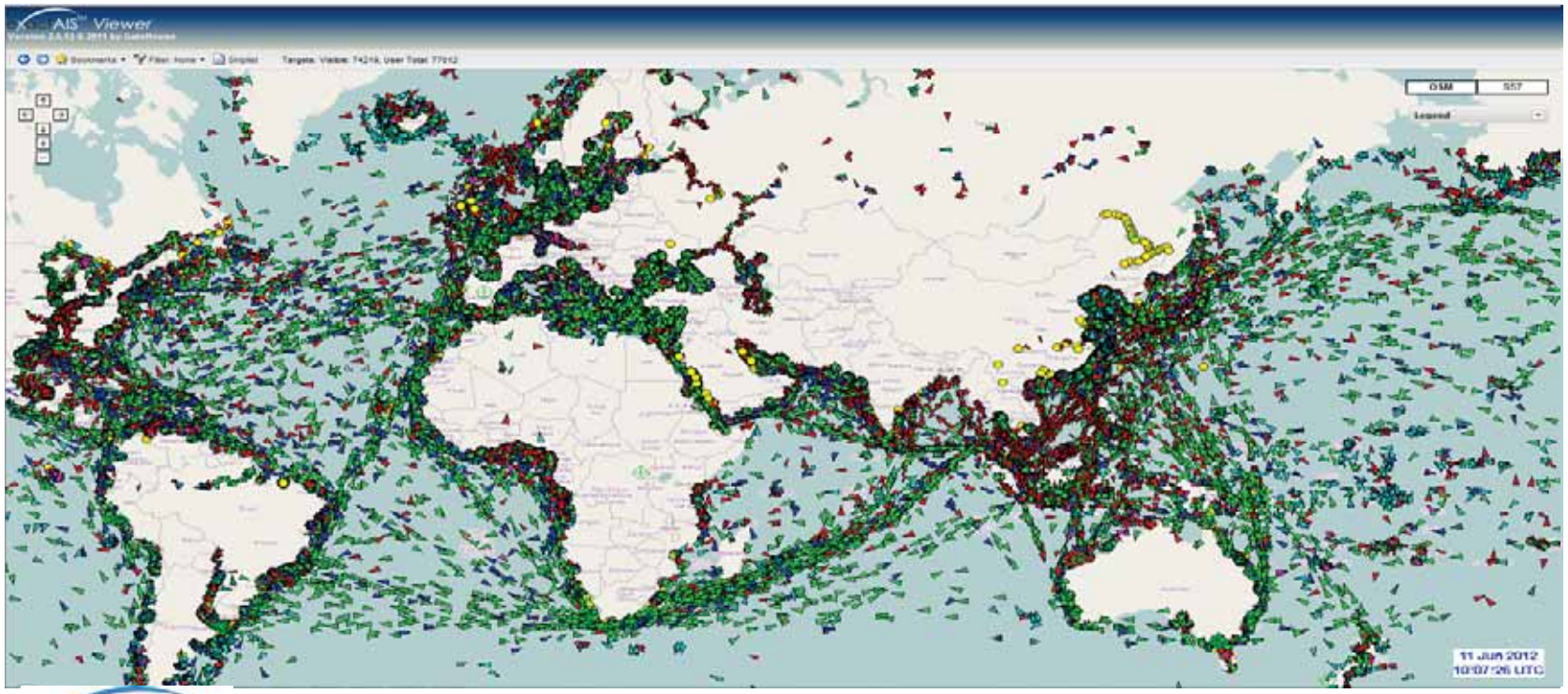


The terrestrial AIS is limited by the radio horizon.

The detection of Automatic Identification System messages from space allows having a global pictures of the maritime traffic.

exactEarth

What difference does Space make?



exactEarth

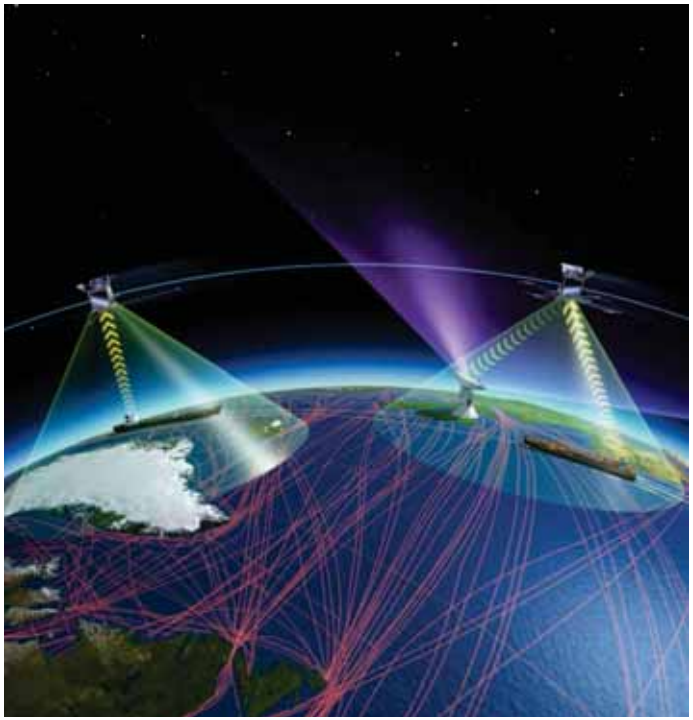
Data Processing Centre (DPC)

Development co-funded by EMSA and ESA.

To collect SAT-AIS messages, ancillary and auxiliary information for generating and distributing enhanced data services to the maritime community.

DPC output:

AIS messages provision;
Enhanced AIS messages service;
Predicted AIS messages service;
AIS messages with EO data service (correlation);
Missing AIS Messages detection service;
Support SAT-AIS information.



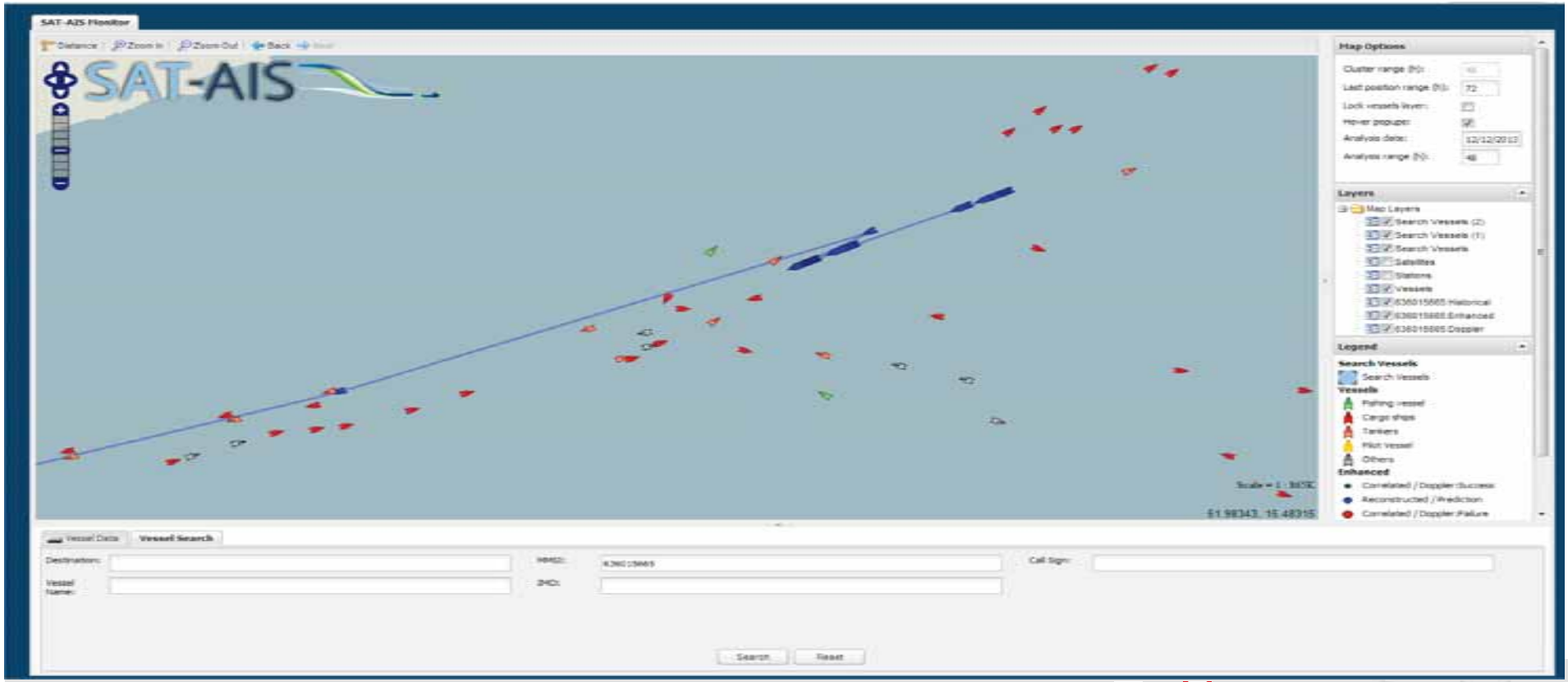
Enhanced AIS messages service

The “Enhanced AIS messages service” provides AIS messages that have been validated or reconstructed using ancillary data and/or the predicted position of the given vessel.

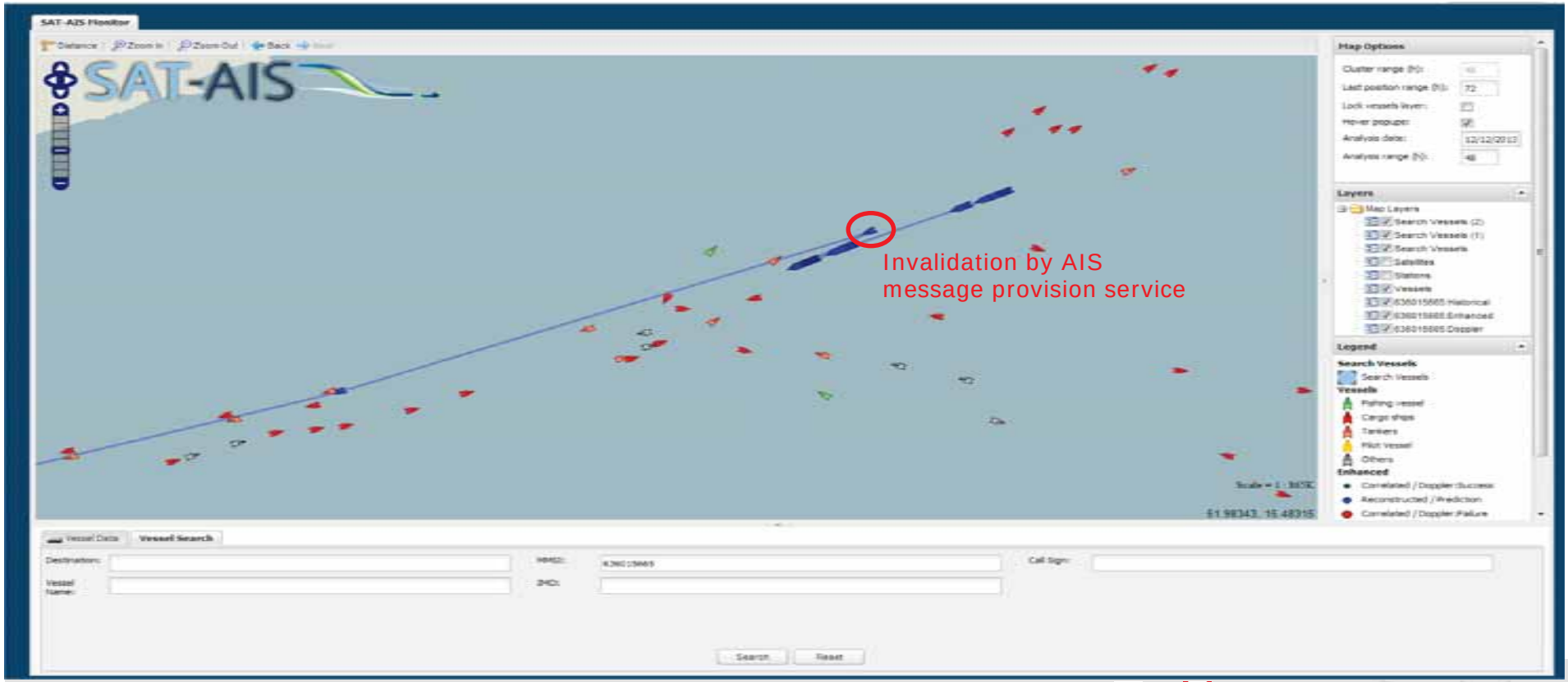
AIS messages validation/invalidation is based on an independent (from vessel position reported in the AIS message) assessment of the vessel position (Doppler computed location)

Reconstruction of invalid positions (from “Well-received AIS messages”) can be made using interpolated/extrapolated positions or Doppler derived positions.

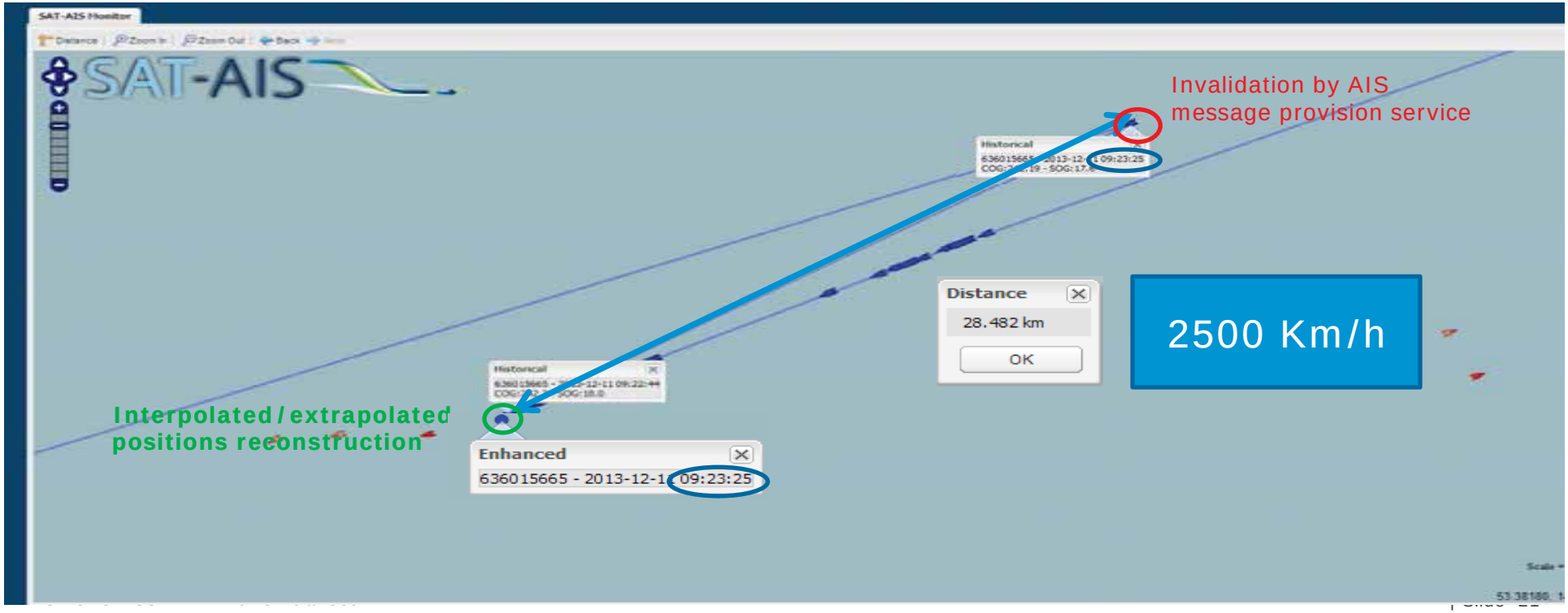
Enhanced AIS messages service



Enhanced AIS messages service

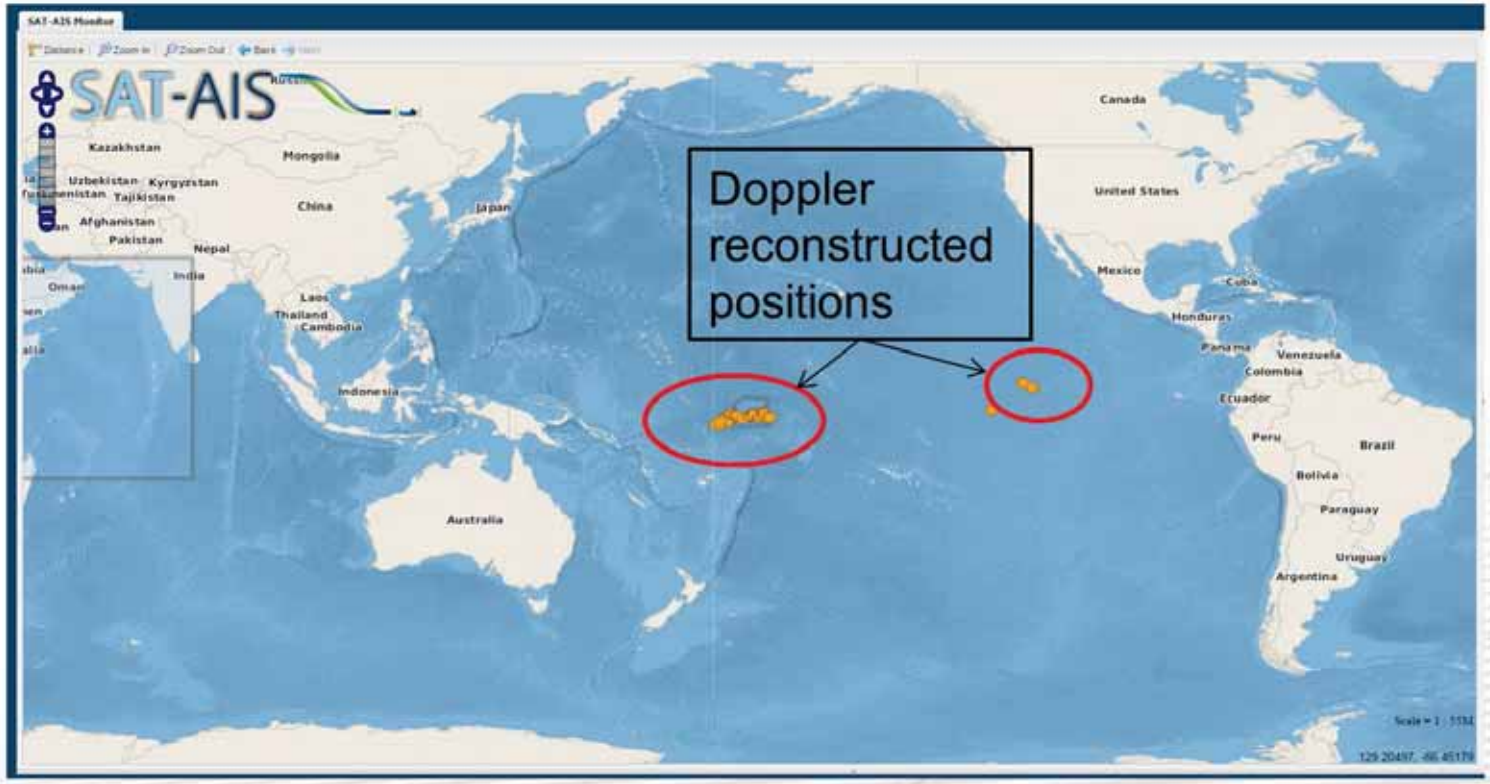


Enhanced AIS messages service



Enhanced AIS messages service

Vessel with no valid GPS position after leaving harbor!



Enhanced AIS messages service

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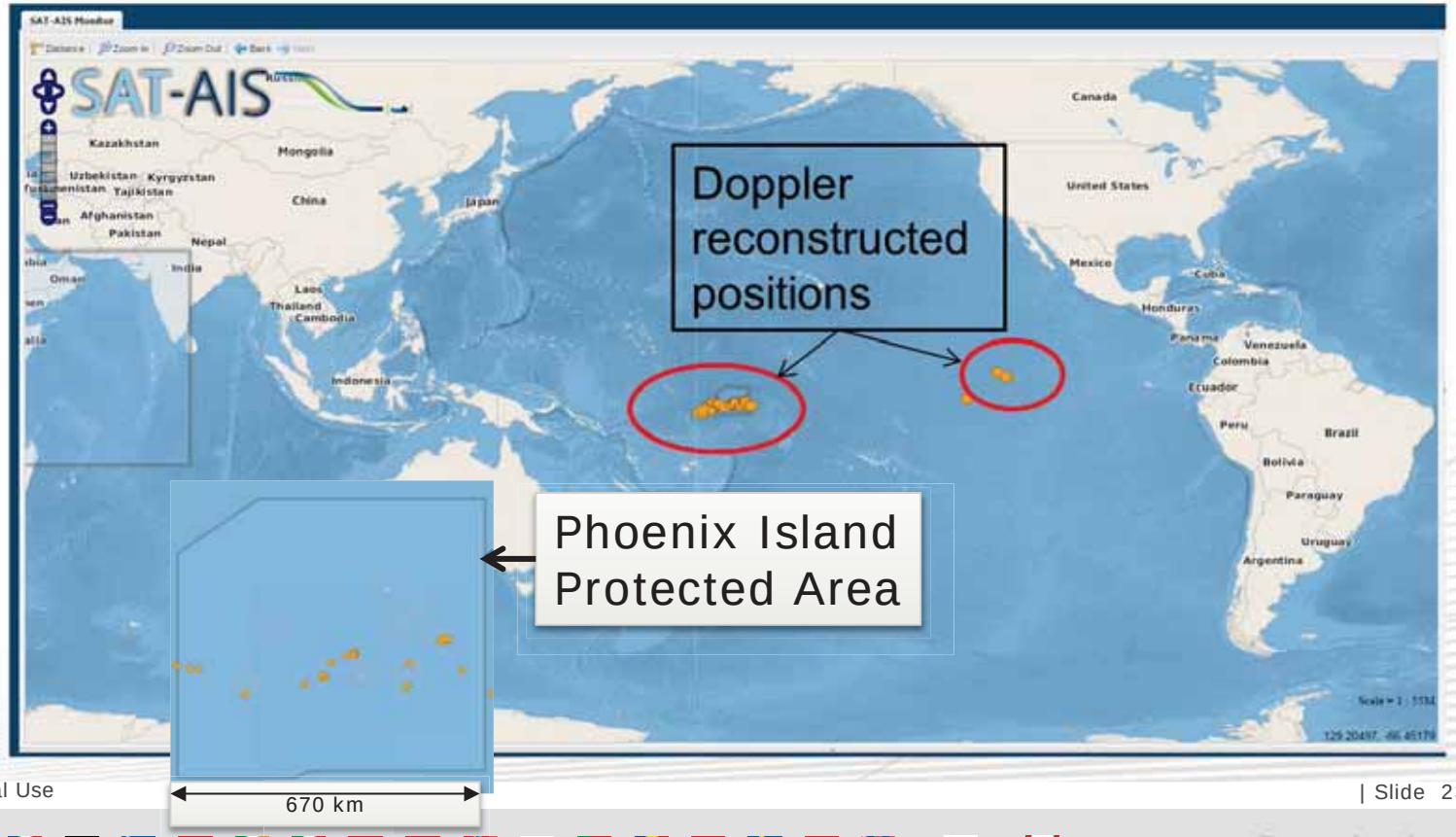
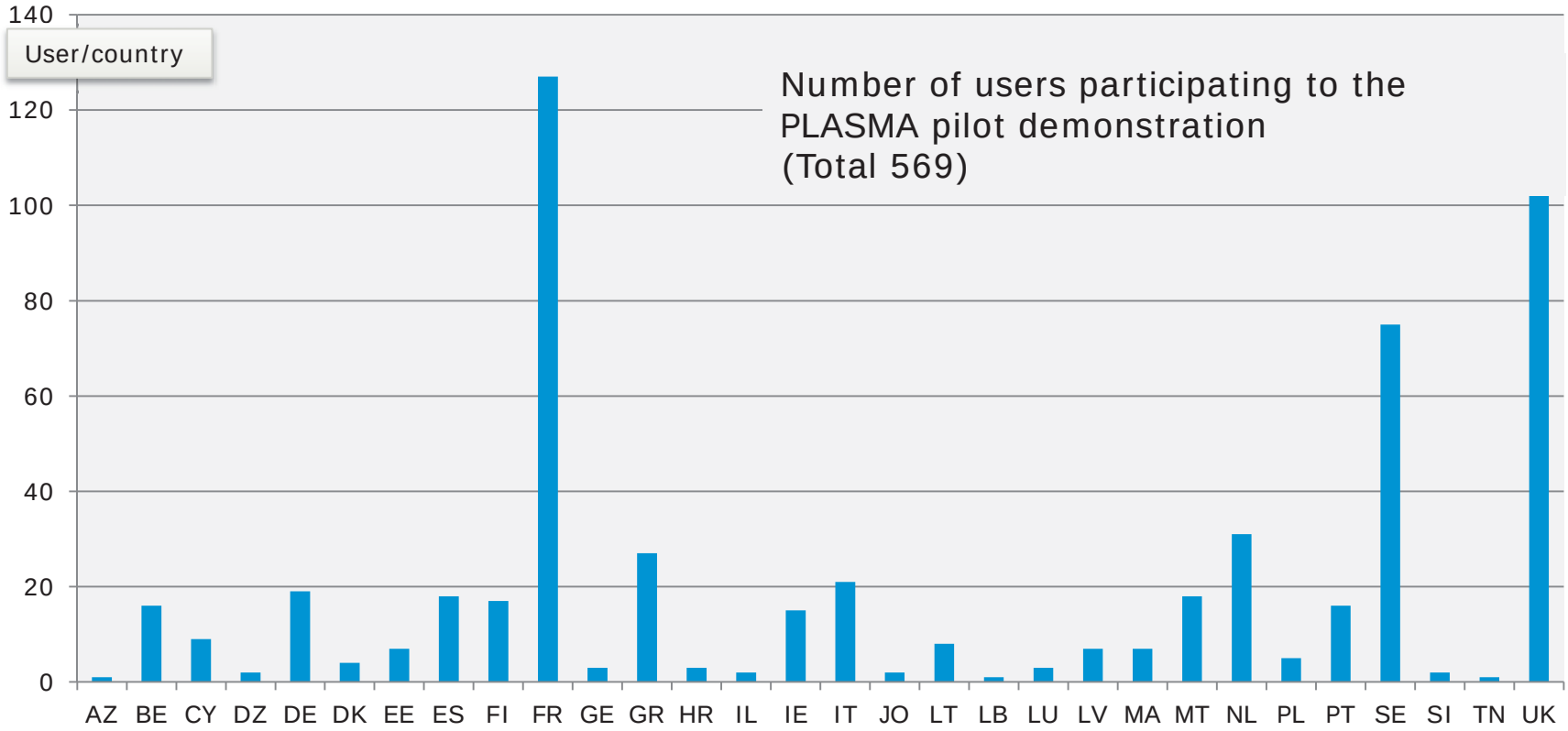


Service Demonstration within the PLASMA* (eExactEarth) project

*Platform for Advanced SAT-AIS Maritime Applications



AIS
SAT-AIS from idea to operational service

1996
Requirements for short/ long range systems were recognised

1998
IMO adopted the AIS performance standard (MSC.74)

2000
IMO amends Safety of Life at Sea Convention, AIS carriage requirements (phased 2002 – 2008)

2002
Mandatory adoption of AIS was shorted to 2004

2007
WRC - satellites can be used to detect AIS transmissions from ships , Satellite detection of AIS is legal

2010
- EMSA/ESA cooperation agreement -ANNEX II Integrated Applications
- ESA – dedicated SAT-AIS programme established

2010 - 2015
SAT-AIS dedicated projects (e.g. DPC) and pre-operational demonstration of SAT-AIS capability

2016
EMSA procurement of SAT-AIS data service (EMSA/OP/09/2016)

SAT-AIS Operational Service

SAT-AIS

SAT-AIS part of the EMSA's integrated maritime service

Traffic monitoring

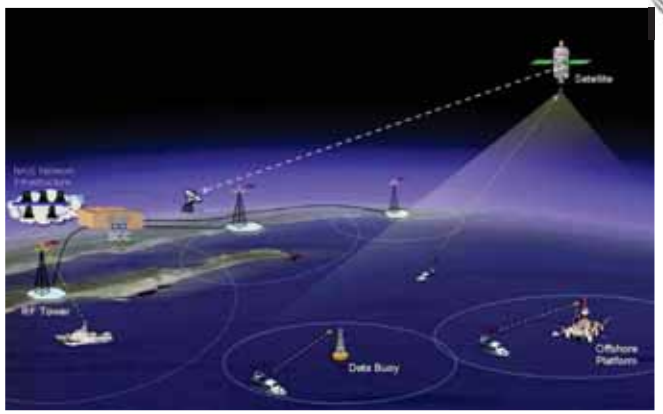
INTEGRATED MARITIME SERVICES

Through the Integrated Maritime Services, there is the operational and technical capability to integrate and correlate data from EMSA applications and external sources. Satellite AIS capabilities have, for example, led to an extended geographical range over which ships can be tracked using the AIS system. New data streams are also in the process of being added as contracts get underway for remotely piloted aircraft systems and as the Copernicus Maritime Surveillance Service offers data from Earth Observation satellites. IMS enables the provision of services responding directly to the specific needs of users. In 2016, services continued to be provided to Member States as well as EU bodies, including Frontex (border control), EFCA (fisheries monitoring), EU Navfor (anti-piracy) and MAOC-N (law enforcement – narcotics). Services were also provided to non-EU countries within the SAFEMED and TRACECA frameworks.

What next – VDES (VHF Data Exchange System)

Satellite: An integrated part of VHF Data Exchange System

- Access beyond Line of Sight at shore
- Wide Coverage Area
- Unique Communication access at high sea
- Reuse the existing ship-borne VHF infrastructure



Scenario	Application
Massive Uncoordinated Access (Uplink)	Machine-to-Machine, Global Sensor
Point-to-Point	ACK, NACK (Downlink), File Transfer (uplink)
Point-to-multipoint (Multicast)	Fleet Management, Ice Map, Fishing Map Distribution
Broadcast	Distress Message, Alarm

VHF Data Exchange System

World Radio Conference 2015

- Implementation of the VHF Data Exchange System concept including a terrestrial component for an ASM (Application Specific Messages) component to enhance maritime radio communications.
- Secondary allocations for two 25 kHz ASM channels for reception by satellite (earth-to-space), opening up opportunities for data transfer from ships via satellite.

Work is on going towards WRC 2019 to allocate channels for two way VHF data communications via satellite.

WRC 20-2015
Resolution 360

→

Agenda Item 1.9.2
for WRC 2019

VDE via Satellite

Since 2013,
ESA has been contributing to

- Technical definition of a VDE Satellite components
- Defend spectrum planning to accommodate VDE-SAT
- Run preliminary studies including potential interference to AIS.
- Show the potential of benefit of VDE-SAT downlink

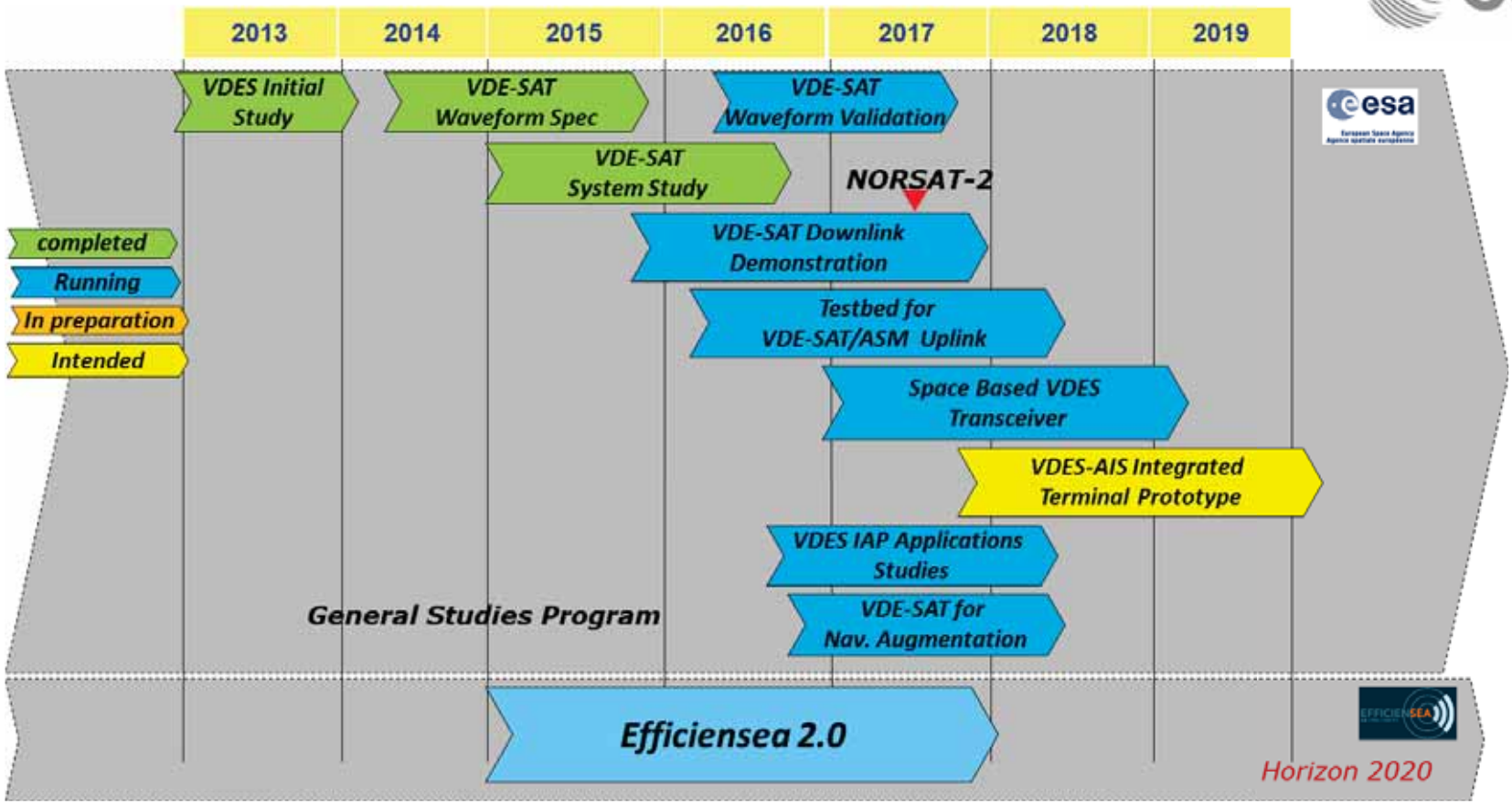
65th International Astronautical Congress 2014

SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)

Mobile Satellite Communications and Navigation Technology (7)

THE ROLE OF SATELLITE IN THE EMERGING MARITIME VHF DATA EXCHANGE SYSTEM

VDES Activities



Feasibility Studies

Assessing the potential of future maritime applications in the context of VDES

Objectives: to identify and assess new downstream services using VDES from technical and commercial viability perspectives, in view of their future development and commercialisation.

- Stakeholders analysis and user requirements analysis
- Service and system specification and concept of operation definition
- Business Case and viability analysis assessment, business plan definition
- Roadmap for future implementation and commercial roll-out. Preparation of Demonstration Project proposal

https://business.esa.int/projects/jericho-vde

Exchange of security Maritime Safety Information, with emphasis on polar regions and SAR (search and rescue) operation coordination

https://business.esa.int/projects/marvelows

To share common information among vessels navigating the same geographical area and exchanging towage information and events with the HQ and automatically produce towage reports

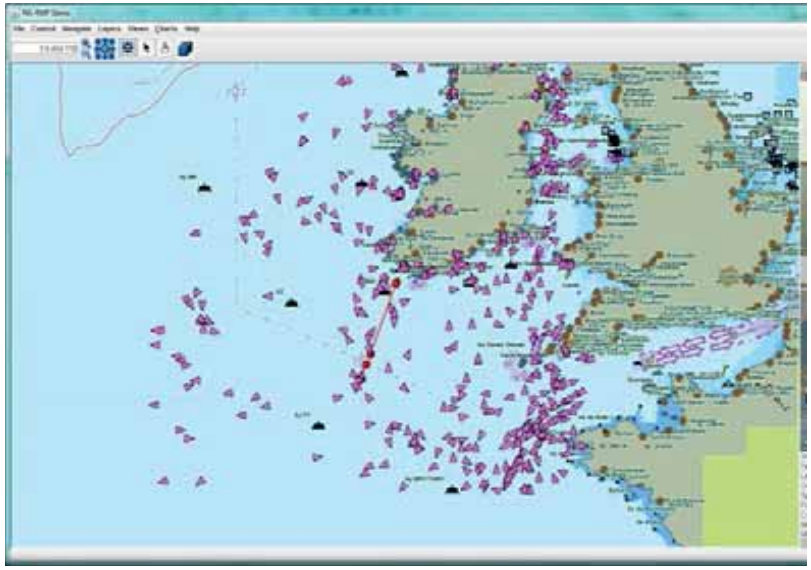
Space-asset Enabled Navigation Services for ECDIS

Providing a common operational picture of ship and shore using the emerging VDES technology to transmit data between merchant ships and a shore-based data repository

Demonstration Project

Next Generation – Recognised Maritime Picture (NG-RMP)

Service that supports early identification of illegal fishing, drug trafficking and supports search/ rescue applications as well as environmental monitoring!



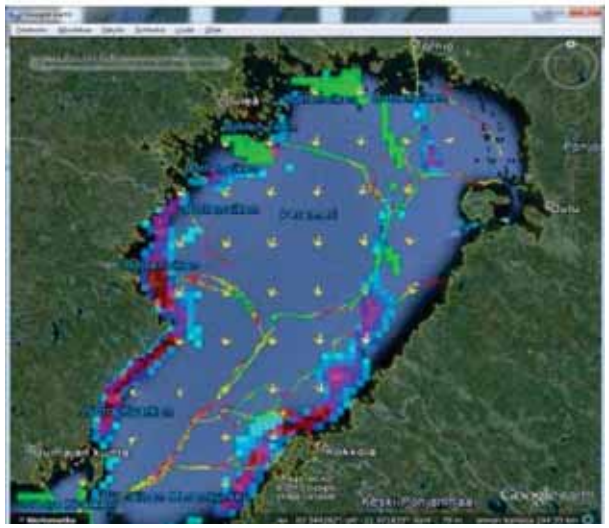
Customers range from Naval Services, through Coast Guards and commercial organisations with an interest in marine information.

Demonstration Project

IceCast

TESTLAB

Service for navigation planning in ice covered water areas, based on IoT based capabilities combined with space based data.

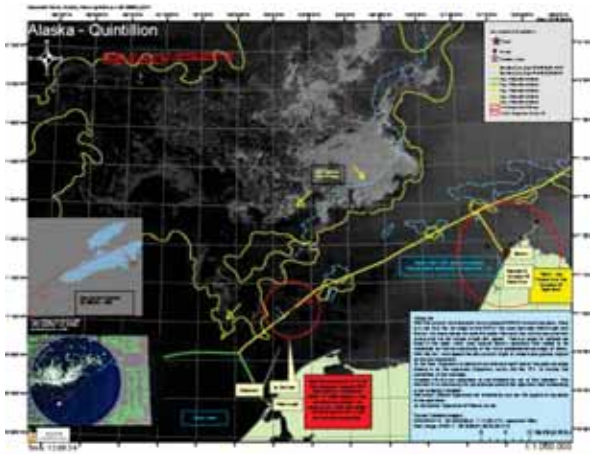


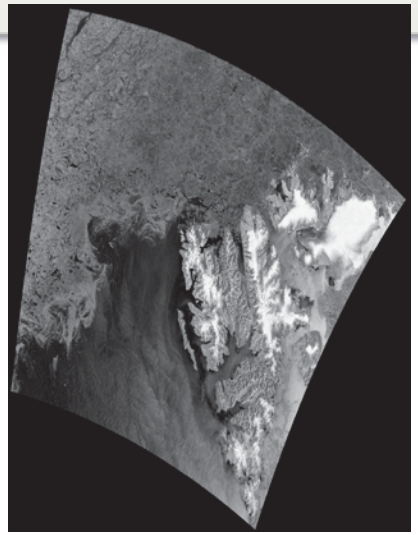
Demo Users: Finnlines (cargo shipping company) ;Navidom (oil tanker owner and operator) ;Port of Oulu (port operations company)

Demonstration Project

MULDIARCOS - MULti-mission Data and Information service for ARCtic OperationS

Services whereby a user onboard a vessel operating in the Arctic region can access, order, and visualize information about available relevant multi-mission data, as well as view archived and pre-planned data with the possibility to order new acquisitions.





Demo Users: Viking Supply Ships, Hurtigruten Group.

Demonstration Project

SIMONA Satellite assets Integration for Maritime situatiON Awareness

Complement and improve existing Maritime Situation Awareness services by providing an **enhanced Common Operational Picture** (eCOP)

-Support Institutional Users (i.e. Italian Navy and Coast Guard) for: a) Maritime Surveillance (illegal trafficking, coastal policy), b)Search & Rescue operations

-Support leisure boat user and professional shipping companies for safe and conscious navigation.

Institutional Users: Use of EO images correlated with AIS data to detect potential "non-collaborative" vessels

Shipping companies/Insurance Companies: can perform Port Monitoring everywhere in the world and assess the navigation risks associated to a certain route.

Leisure boat owners can plan their journey through geo-referenced information and LBS from different sources including local ordinances emitted by the Coast Guard. Plus send an e-call (emergency call) if needed.

Shipping companies: can measure of the impact of specific declared events of oil spill, through EO elaborations

VDES workshop 16th January 2018

Newton Auditorium located in ESTEC, Keplerlaan 1, 2201 AZ Noordwijk, the Netherlands.

Objectives

This workshop aims to provide an overview of the current status of the VDES development, regulatory aspects, potential maritime applications (e-Navigation) as well as planned or on-going pilot activities.

Collocated with the IALA e-Navigation working group meeting hosted at ESTEC from 15 to 19 of January.

HOW TO PARTICIPATE

The participation in the workshop is open to all interested parties. There is no registration fee applicable to the event. However, the registration to attend the event is mandatory in order to access to the ESTEC site.

Important Note: On-line registration is mandatory. No on-site registration is possible.

→ REGISTER NOW

https://business.esa.int/

Business Applications
(Integrated Applications Promotion (IAP))

EMSA-ESA projects and initiatives

- Remotely Piloted Aircraft Systems - RAPSODY and STEAM

TIA-AP
Doc. No.: ESA-TIAA-HO-2017-1214, V2.5
Date: 14/15 November 2017

ESA UNCLASSIFIED - For Official Use

RPAS potential for applications

The development of Remotely Piloted Aircraft Systems (RPAS) offers a wide range of new civil applications for the benefit of European citizens and businesses.

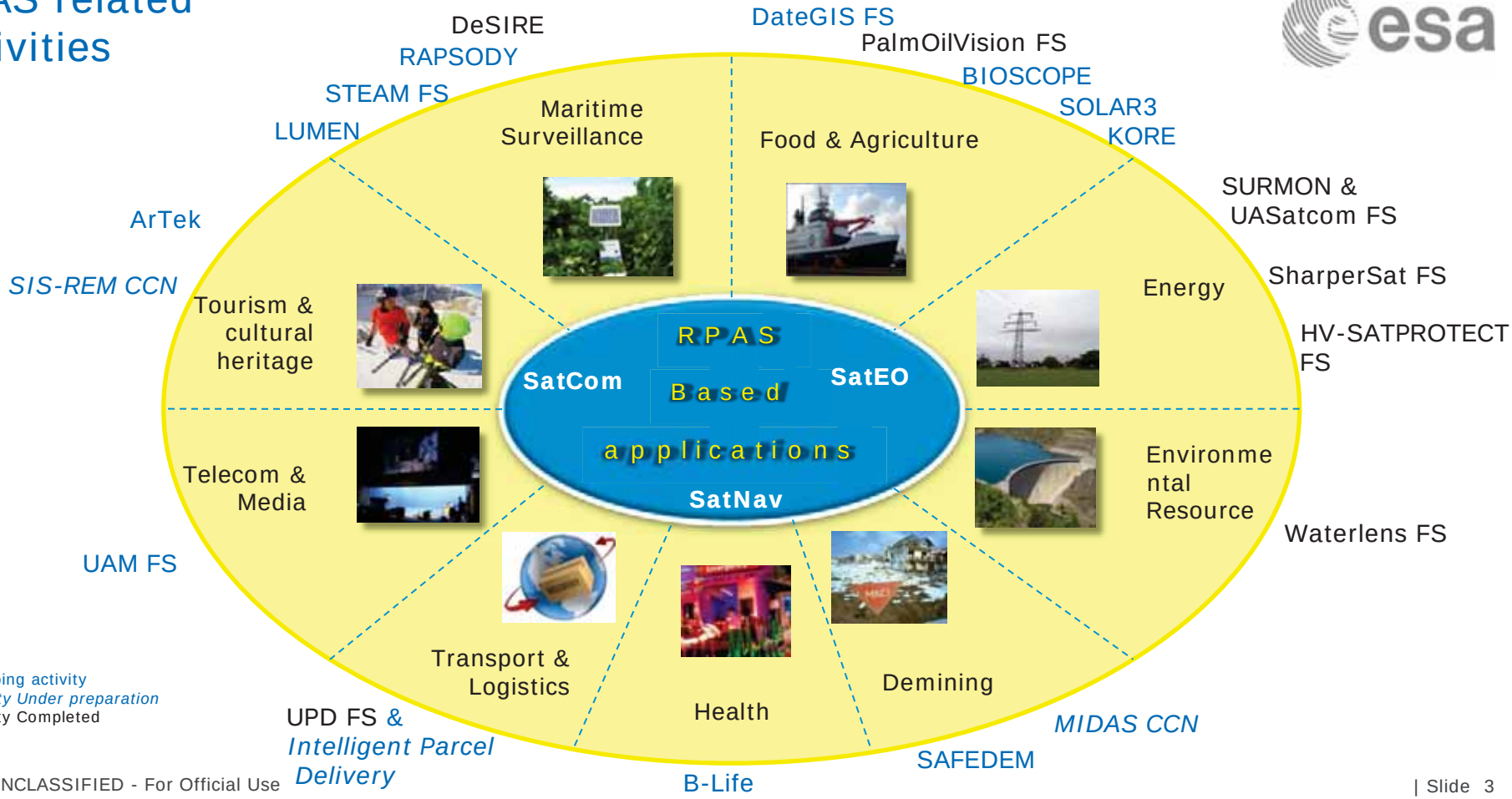
Being remotely piloted, RPAS can perform tasks that manned systems cannot perform or can perform but in a less cost-efficient and/or less safe manner. RPAS are thus well suited for long duration monitoring tasks or risky flights, e.g. into ash clouds.

- ☐ RPAS can efficiently complement existing manned aircraft or satellites infrastructure used by **governments / institutions** in **crisis management, maritime / land surveillance, border control** or fire-fighting

- ☐ RPAS can also deliver profitable **commercial** aerial services in various areas, such as:

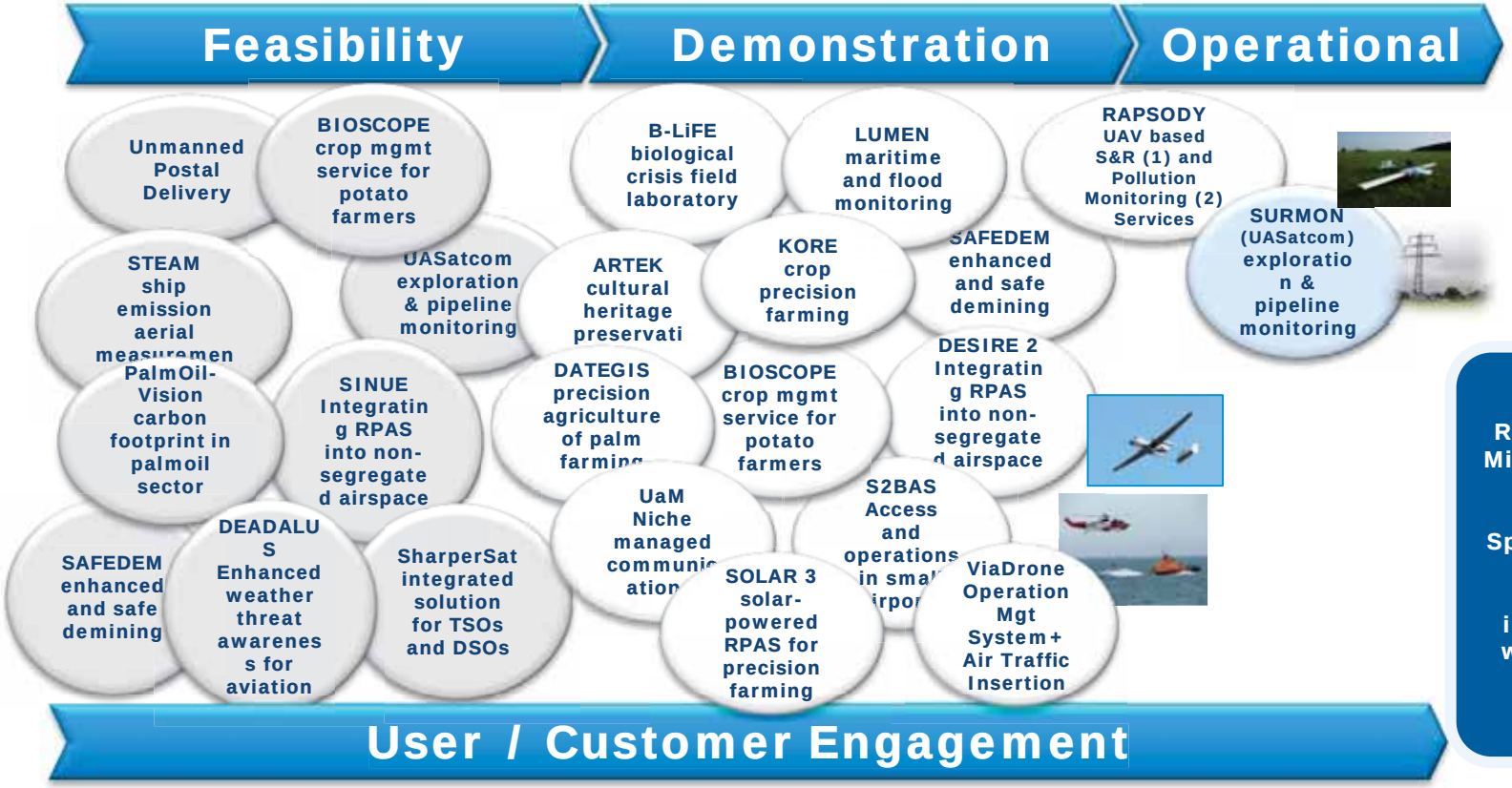
  - precision agriculture and fisheries,
  - power or gas line monitoring,
  - infrastructure inspection,
  - natural resources monitoring,
  - media and entertainment,
  - digital mapping,
  - land and wildlife management,
  - air quality control and management.

RPAS related activities



On-going activity
Activity Under preparation
Activity Completed

Applications activities in the RPAs domain



RPAS range: Micro to MALE RPAS

Space assets: Satcom, SatNav integration with sat EO data

Application needs

Maritime Surveillance

Tourism cultural heritage

Energy

Demining

Transport

Agriculture

Safedem- <2 kg

SURMON – 78 kg

RAPSODY – 150 Kg

DeSIRE- 1250 kg

Flying BRLOS – Satcom equipped

DeSIRE 2- 6600 kg

KORE – 2.5 kg

LUMEN – 40 kg

Micro-RPAS → Light RPAS → MALE

Maximum Take Off Weight

RAPSODY

Remote Airborne Platform with Satellite Oversight DependencY

Providing **Search & Rescue and maritime environment response supporting services** using **RPAS flying in BRLOS**

- **In collaboration with EMSA**
- **With the involvement of maritime safety authorities from Portugal *(AMN)***
- **Using AR5 Evolution RPAS from TEKEVER Portugal**

Exploiting **intelligent RPAS** equipped with **innovative sensors package and onboard advanced data analysis capabilities** to survey wide maritime areas, and reporting its findings **in near real-time through a satcom link** to the operating centre

Pilot operations in July 2017 and Q42017/Q1 2018 in Portuguese Waters, for oil spills detection & characterization and SAR supporting missions

*Prime: **TEKEVER Portugal** (PO)*

Sub-contractors: DSI (GE), TEKEVER UK (UK)

Light UAS in non-segregated airspace for Maritime and Environmental surveillance (LUMEN)

LUMEN aims at developing operational services using light RPAS in support of **Maritime surveillance and Environmental (Flood) monitoring**. For this, LUMEN combines GNSS for navigation of the RPAS and geo-correction of the acquired data, as well as real-time satellite communication to transfer the acquired data from the Ground Control Station to the users.

Target Users:

- The Belgian Federal Ministry of Environment, Division of Marine Environment Service
- Two Flemish administrations responsible for the waterways in the Flemish region
- NOFO (Norwegian Clean Seas Association for Operating Companies)

Status: Pilot phase in Norway in Q2 2018

NRT Imagery and services for

Flood Monitoring

to provide information on the most recent flooded areas

Maritime Surveillance

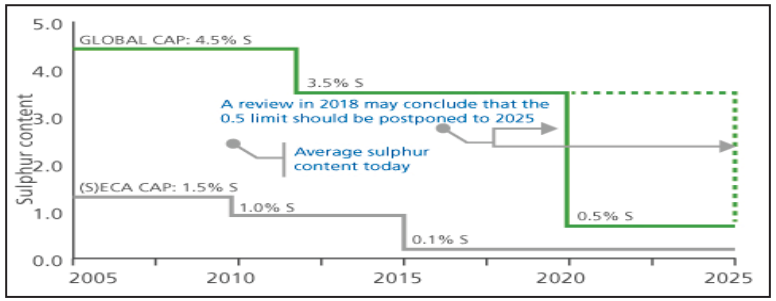
as an aid to detecting and combating pollution at sea.

Prime: Vito (BE)

Sub-contractor (s): Newtec (BE), AGIV (NO), Norut (NO)

STEAM (Feasibility Study)
Ships' **S**ulphur **T**rails **E**missions **A**erial **M**easurements

Starting point: Change of IMO Sulphur Regulation MARPOL Annex VI in Sulphur Emission Control Areas (SECA)



Objective
To investigate the technical feasibility, financial viability and sustainability of a future service aiming at measuring the amounts of sulphur oxides components emitted by vessels travelling inside the Emission Control Areas (ECAs) defined by the International Maritime Organisation (IMO).

Technical feasibility of the STEAM system has been tested in Hamburg during a 4 days campaign in October 2016.

Ship's gas concentration analysis (CO2, SO2, NO2, NO) with the Explicit tools

Danish Ministry of the Environment
Environmental Protection Agency

EMSA
European Maritime Safety Agency

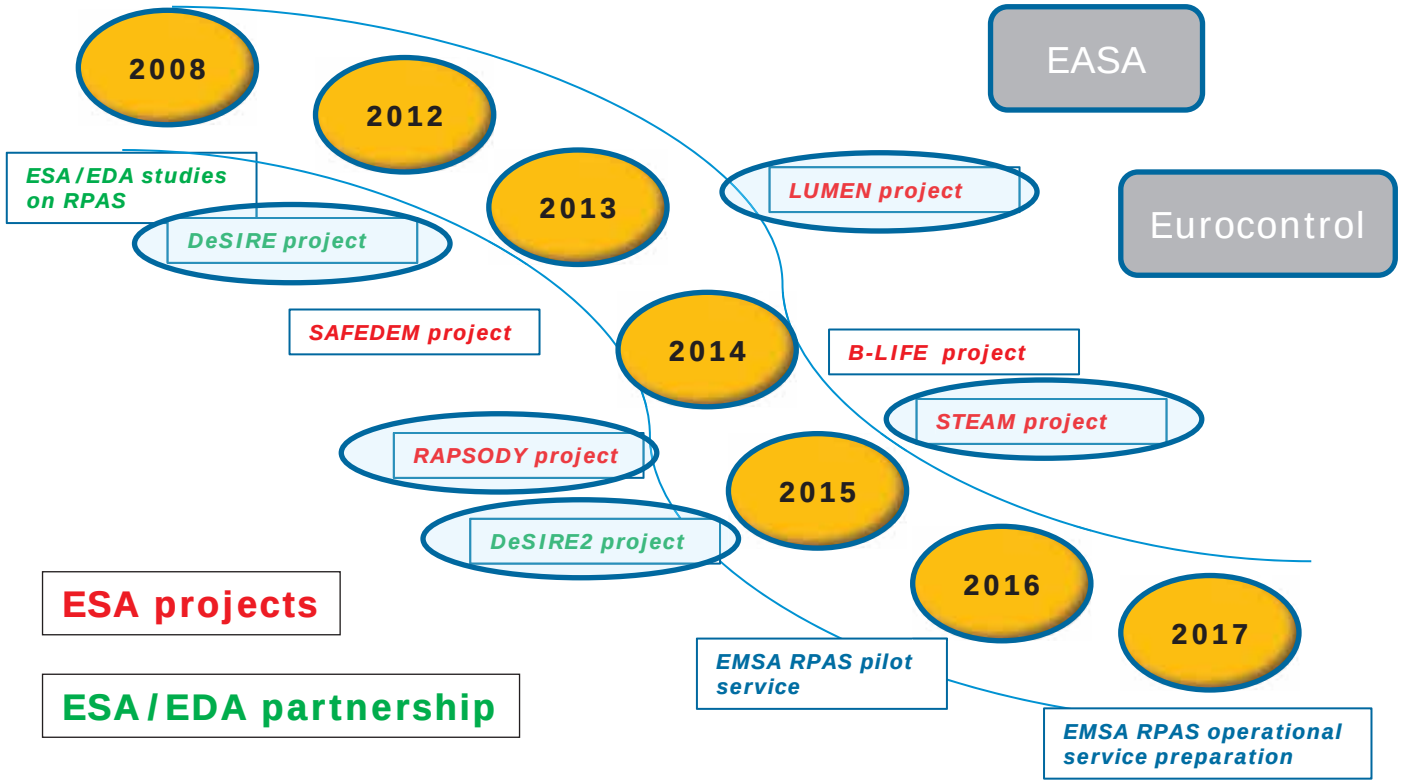
TRIDENT ALLIANCE

explicit

tekever

CLS

RPAS projects: Institutional sector evolution



From RPAs to HAPs
HIGH ALTITUDE PSEUDO SATELLITES

Background

HAPS are aircraft positioned above 20 km altitude, in the stratosphere, for very-long-duration flights counted in months and even years. These unmanned aircraft may be airplanes, airships or balloons.

A number of HAPS development projects have recently reached more advanced development stages in particular in Europe, which indicates that first operational services could be expected by 2018 - 2023.

The use of HAPS is considered for a variety of applications, such as maritime and land surveillance, environmental monitoring, land border control applications, telecommunications, emergency/public safety communications, intelligent transportation systems, etc

HAPS could offer advantages and complementary applications over satellites, terrestrial infrastructures and Remotely Piloted Aircraft Systems (RPAS), at relatively low cost.

Significant uptake of HAPS is expected in the medium/long term (Market volume for HAPS is estimated to grow at 11% CAGR attaining over USD 7 billion by 2024 1)

ESA HAPS Initiative

The European Space Agency has recently initiated a number of activities in view of preparing an ESA programme for HAPS for the next Council Ministerial in 2019.

These activities are aimed at getting an understanding of:

- technology gaps,
- user communities' requirements,
- market opportunities
- industry expectations
- technical and business risks
- regularity risks, constraints and needed actions
- etc

The Workshop "Towards an ESA Stratospheric High Altitude Pseudo-Satellites (HAPS)" http://www.haps4esa.org took place on
09 - 10 October 2017, Noordwijkerhout, The Netherlands

HAPS benefits

- HAPS in comparison to terrestrial networks offer larger coverage area, less interference caused by obstacles and shorter time to deployment.

- HAPS offer improved propagation connectivity conditions with respect to satellites, lower latency, as well as better resolution of images.

- HAPS have the ability to remain continuously over an area for very long periods (persistence), and can be returned for maintenance or payload reconfiguration.

- HAPS are potentially considered very useful to augment existing satellite assets and address current gaps, by providing:
    - continuous measurements a regional scale
    - data relay capabilities
    - higher resolution of EO sensors e.g. 10cm in optical
    - Improved link budget

ENABLERS FROM SPACE

Satellite Communications (SatCom)

- to deploy and remotely command and control HAPS, offering a higher flexibility in their mission
- to relay remote sensing data collected by HAPS' payload to the ground
- to relay data between gateways and HAPS, when HAPS is used for providing broadband/broadcast connectivity

Satellite navigation (SatNav)

- for navigation purposes, relying on GNSS systems and possibly complemented with satellite augmentation systems such as EGNOS
- for geo-localising EO data collected by HAPS sensors

Satellite Earth Observation (SatEO)

- to provide an enhanced operational picture to end users, via the fusion of data collected by remote sensing satellites with data from HAPS

ESA's IAP "SERVICES ENABLED BY HIGN ALTITUDE PSEUDO SATELLITES (HAPS) COMPLEMENTED BY SATELLITES" invitation to tender.

© Vivek M. / Greenpeace

SERVICES ENABLED BY HAPS COMPLEMENTED BY SATELLITES Feasibility Study

Objectives: define and assess technically and economically potentially sustainable services relying on HAPS complemented by satellites

Application domains (non exhaustive):

- EO applications (maritime and land border surveillance, environment monitoring Humanitarian operations)
- Telecommunications applications (Emergency communications, Broadband Access, Mobile internet- 5G type applications, M2M)
- Navigation applications (GNSS Augmentation, Navigation support)

In collaboration with :

EMSA

EUROPEAN UNION SATELLITE CENTRE

SatCen

FRONTEX

EUROPEAN BORDER AND COAST GUARD AGENCY

100% funding, €200k
Duration: 9 months
ITT issued on 1 November 2017, closing date on 24 January 2018
Several parallel contracts possible

More information on https://business.esa.int/funding/intended-tender/services-enabled-high-altitude-pseudo-satellites-haps-complemented-satellites

Involved Users/Stakeholders

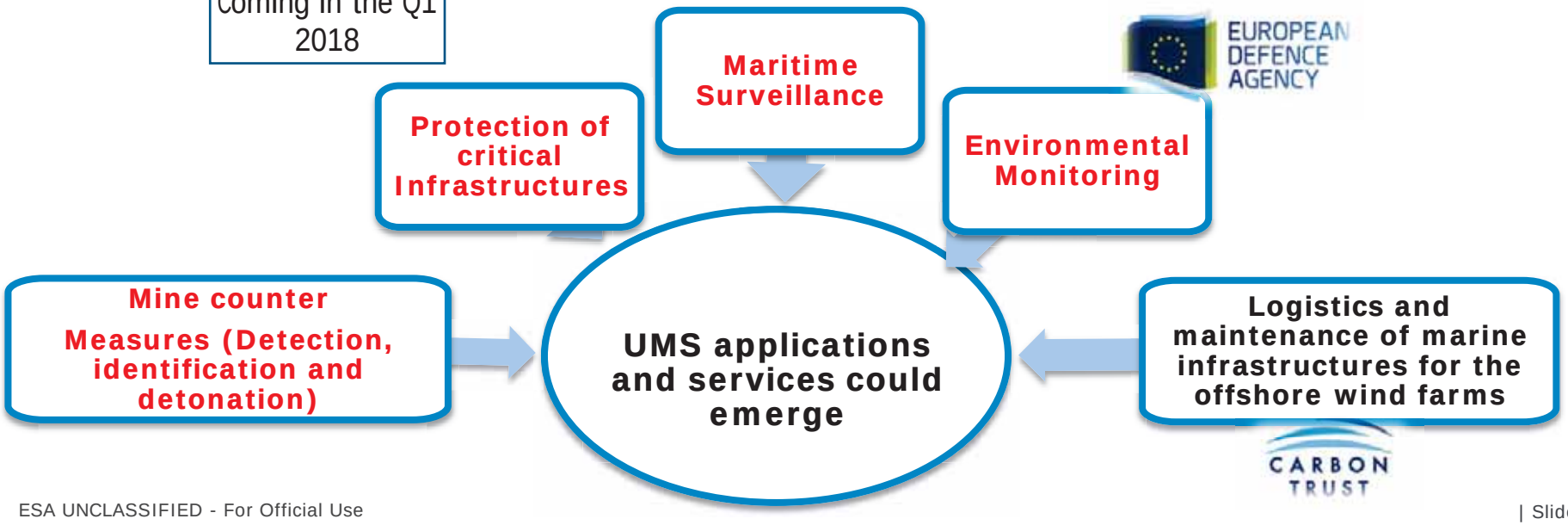
EMSA, Frontex and the EU Satellite Centre (SatCen) have agreed to support the ESA study and provide user requirements and guidance to the team for the services of their interest.

	Application domains of interest
EMSA	Maritime situational awareness and maritime surveillance: pollutions monitoring; vessel detection, monitoring and identification; support to search and rescue; support to Coast Guard Function activities by providing wide area coverage and extended endurance; HAPS for complementing RPAS and EO Satellite operations; HAPS relay communications networks for RPAS and EO satellite
FRONTEX EUROPEAN BORDER AND COAST GUARD AGENCY	Border surveillance in the pre-frontier area (including high seas, coastal areas & ports) for increased situational awareness, support to Search and Rescue (SAR) activities, evidence collection and early warning.
EUROPEAN UNION SATELLITE CENTRE SatCen Analysis for decision making	Support to ISR (Intelligence, Surveillance and Reconnaissance) activities, for border and maritime surveillance, treaty verification, cross-border crime monitoring, (Near Real Time) crisis monitoring and management of natural disasters (floods, wildfires, earthquakes).

Space and Unmanned Maritime Systems (UMS) - based Maritime Services feasibility study

Study Objectives: to identify and characterize UMS based services exploiting at least one space asset, addressing potentially interesting application domains, carry out the analysis of their technical feasibility and commercial viability, select the most promising ones for further development and exploitation, and propose a roadmap for the implementation and demonstration of the proposed services.

Coming in the Q1 2018



The Copernicus Security Service

Rui Meneses
Copernicus Programme
European Commission DG-GROW

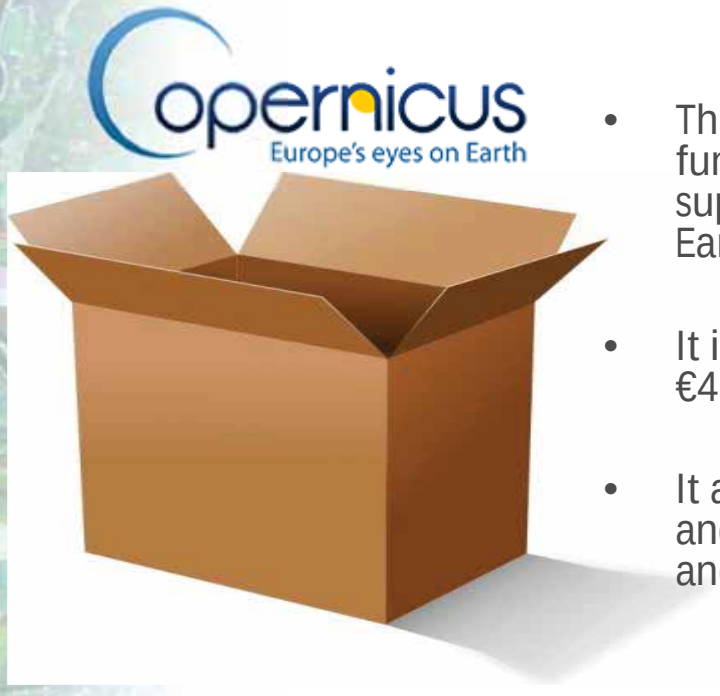
Event on the 10 years of Cleanseanet
EMSA 14-15 Nov 2017

Space

Copernicus EU
Copernicus EU
Copernicus EU
www.copernicus.eu

Copernicus
Europe's eyes on Earth

The Copernicus programme

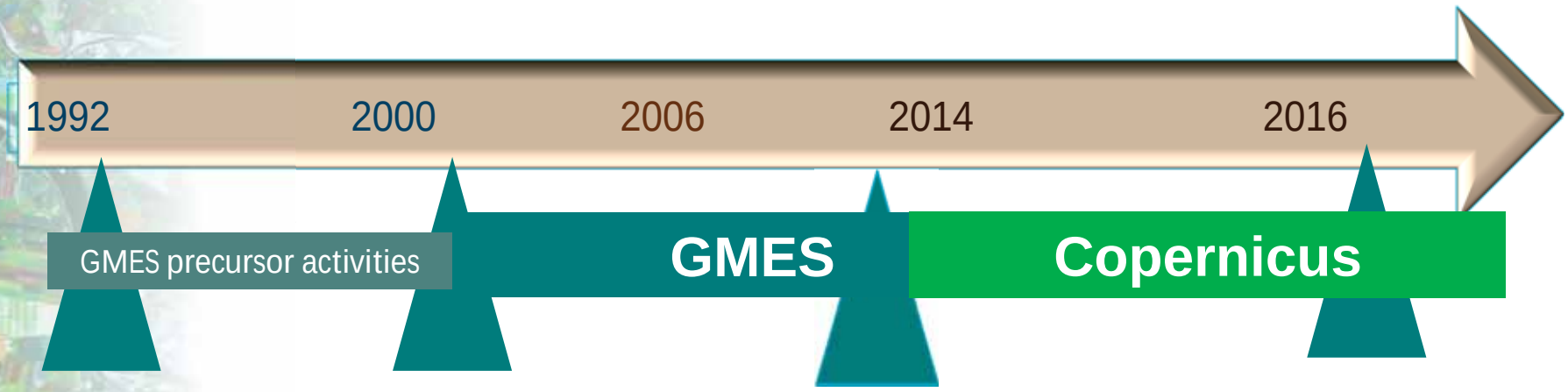


- The **Copernicus programme** is possibly the largest EU-funded programme providing geospatial information support across a broad range of policy areas, based on Earth Observations and in-situ-data
- It is a joint EC-ESA programme with a financing of approx. €4.3bn for the period 2014 to 2020
- It aims at **providing relevant information** to policy-makers and other users, particularly in relation to environment and security

Programme History

Copernicus

- **Copernicus**, formerly known as the Global Monitoring for Environment and Security (**GMES**) is an **EU-led initiative** for an autonomous and operational European Earth monitoring capacities



The Six COPERNICUS SERVICES

Copernicus

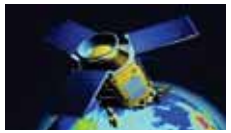
Monitoring the State of the Earth System Environment ...

... Six cross-cutting Thematic Services

✓= operational

✓ = in ramp up

Space Component - Copernicus dedicated Missions



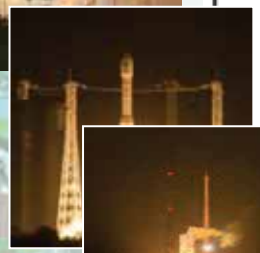
- **S1:** Radar Mission
- **S2:** High Resolution Optical Mission
- **S3:** Medium Resolution Imaging and Altimetry Mission
- **S4:** Geostationary Atmospheric Chemistry Mission
- **S5P:** Low Earth Orbit Atmospheric Chemistry Precursor Mission
- **S5:** Low Earth Orbit Atmospheric Chemistry Mission
- **S6 (Jason-CS):** Altimetry Mission

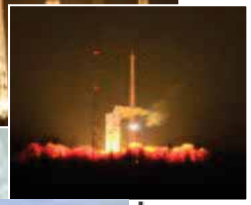
https://sentinel.esa.int/web/sentinel/home

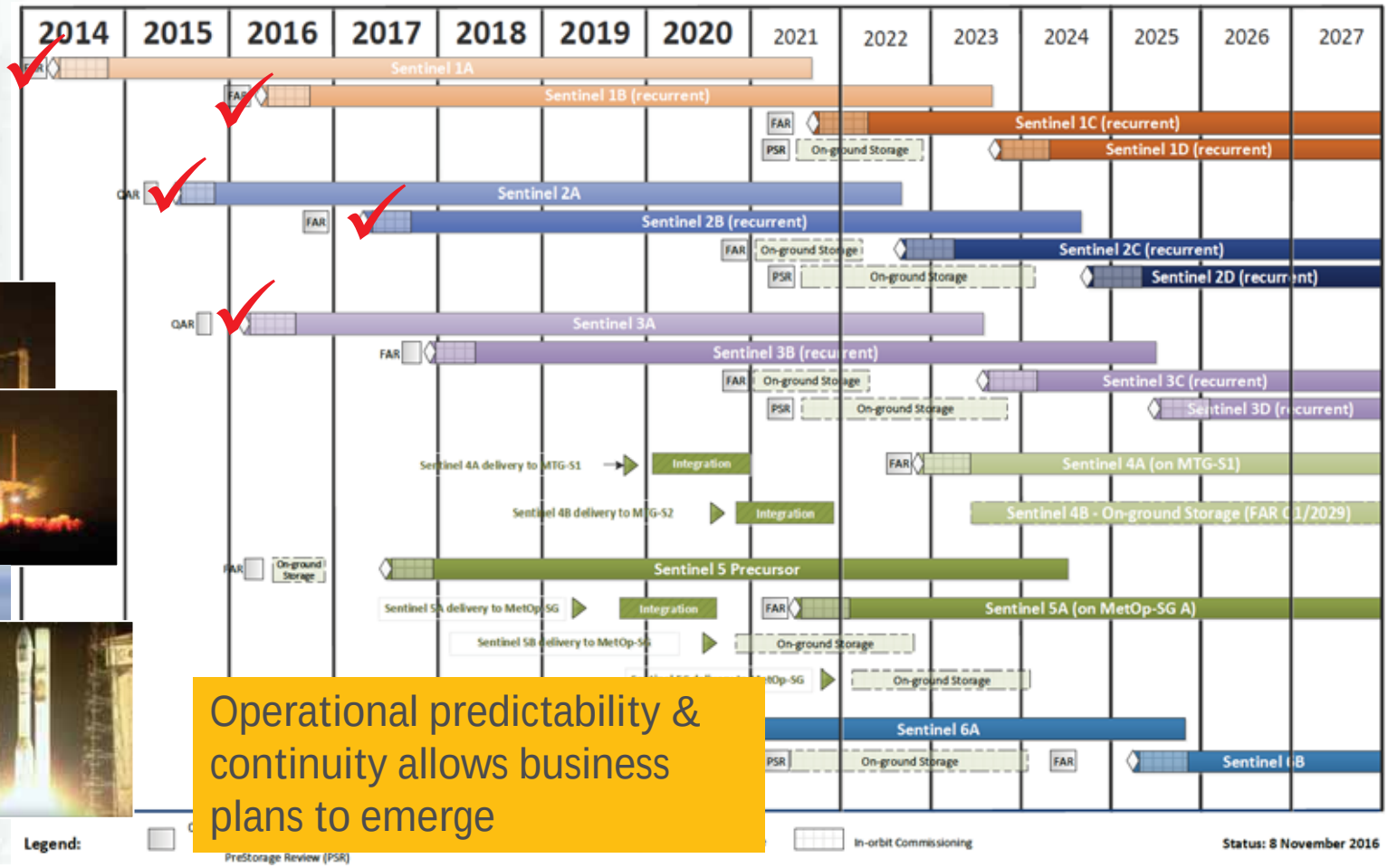
Deployment Schedule

Continuity up to 2030

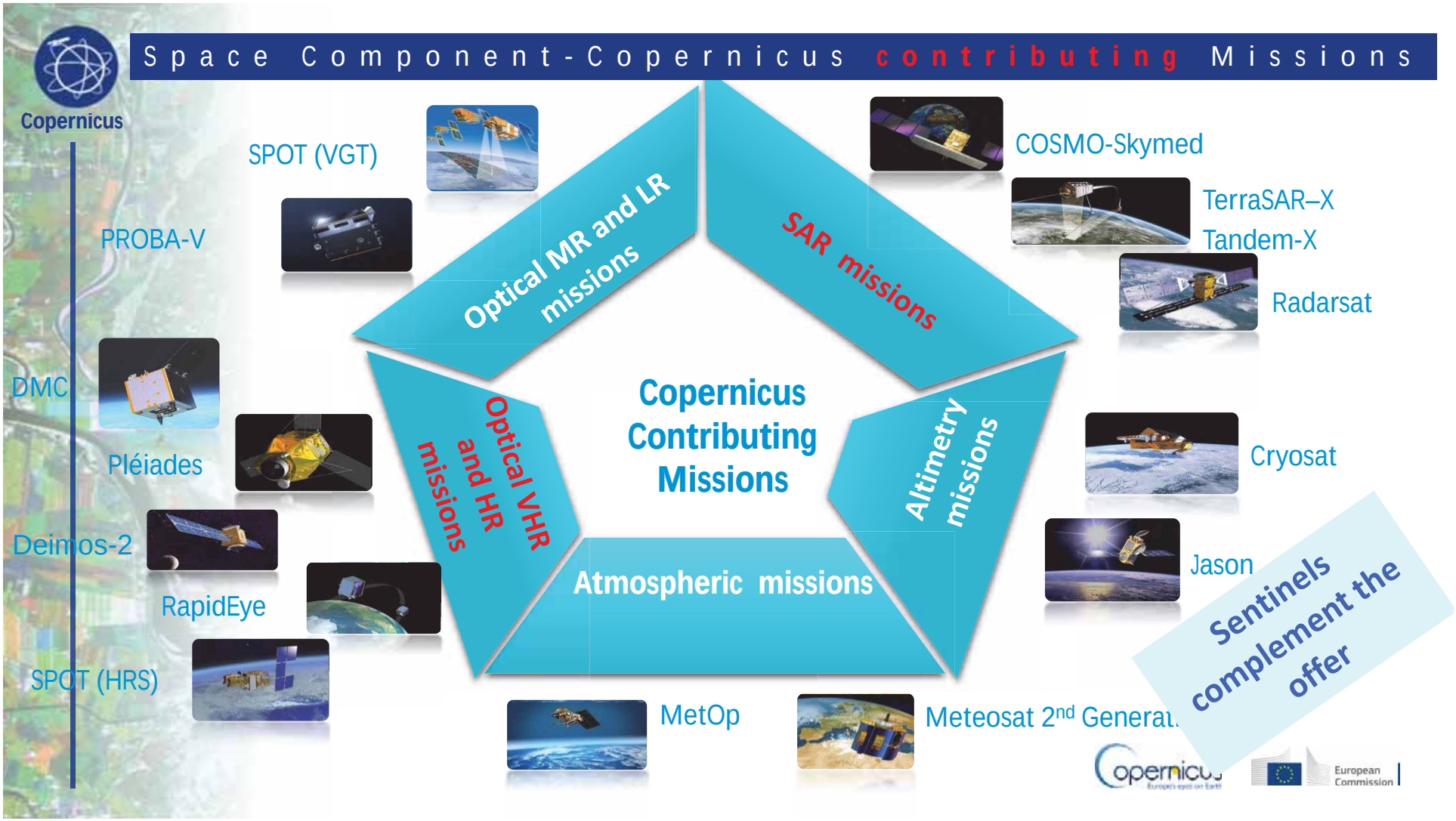
Copernicus







Operational predictability & continuity allows business plans to emerge


Space Component-Copernicus contributing Missions
Copernicus
SPOT (VGT)
PROBA-V
DMC
Pléiades
Deimos-2
RapidEye
SPOT (HRS)
Optical MR and LR missions
SAR missions
Optical VHR and HR missions
Copernicus Contributing Missions
Altimetry missions
Atmospheric missions
COSMO-Skymed
TerraSAR–X
Tandem-X
Radarsat
Cryosat
Jason
MetOp
Meteosat 2nd Generat
Sentinels complement the offer
Copernicus
European Commission

Copernicus

Copernicus

A User-Driven Operational Programme

Strong involvement of users and main stakeholders

OUTCOME:

User up-taking and Implementation Strategy
Operational Specifications

Copernicus Europe's eyes on Earth

European Commission

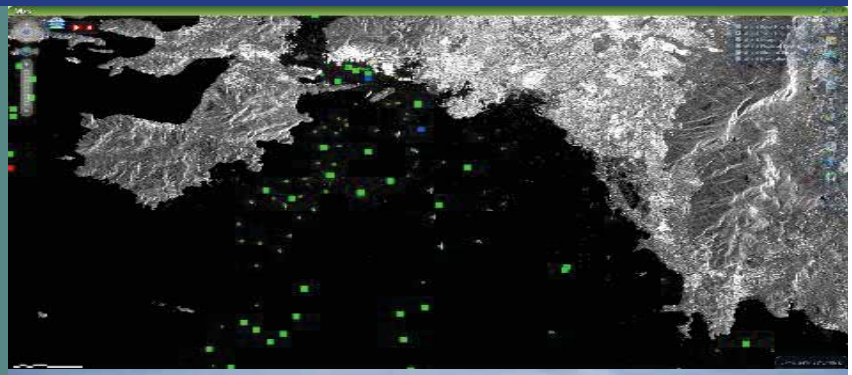
The Copernicus Security Service

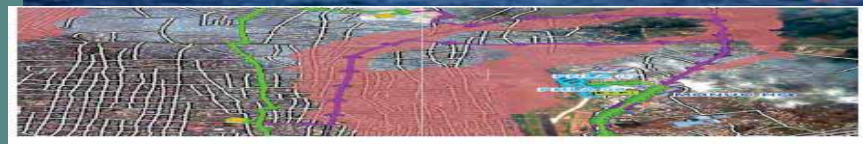
Three application areas:

- Support to EU External Actions
- Maritime Surveillance
- Border Surveillance

Operated through Delegation to

FRONTEX EMSA SatCen





Components and Operators

Copernicus

1 Border Surveillance — 2015

CBS Service Portfolio

FRONTEX

2 Support to EU External Actions — 2016

SEA Service Portfolio

SatCen

3 Maritime Surveillance — 2015

CMS Service Portfolio

EMSA

Inter-Agency cooperation

Industrial Base

Copernicus

1

Support to Border Surveillance

BORDER SURVEILLANCE

FRONTEX is the Copernicus Entrusted Entity for the implementation of the Copernicus Maritime Surveillance Service

Since Nov 2015

17 December2015

Miss Lowri Evans (Director General – DG-GROW) and Mr. Fabrice Leggeri (Executive Director – FRONTEX) sign the Delegation Agreement

Copernicus

European Commission

FRONTEX- Services

Eurosur Fusion Services / Copernicus

- Services enhancing situational awareness and reaction capabilities of EU Member States
- Based on the **Eurosur Regulation** and Copernicus Delegation Agreement

- Interagency cooperation - services delivered in cooperation with:

EMSA European Maritime Safety Agency

EUSC

EUROPEAN FISHERIES CONTROL AGENCY

EUROPOL

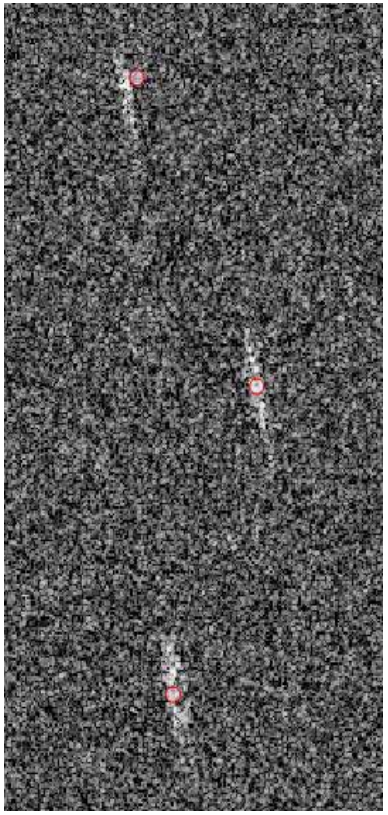
List of Services

On request

- S1 Coastal Monitoring
- S2 Pre-frontier Monitoring
- S3 Reference Mapping
- S4 Surveillance of Maritime Areas of Interest
- S5 Vessel Detection
- S7 Vessel Anomaly Detection

Permanent

- S6 Vessel Tracking and Reporting
- S8 Environmental Assessment



Example - Coastal Monitoring

Copernicus

- Monitoring & analysis on specific **external coastal areas**
- Validating risk indicators
- Predicting patterns

- Contributing to save human lives
- Supporting analysis in tackling cross-border criminality
- Supporting strategic and operational intelligence

Copernicus

European Commission

Copernicus

Added value - Example

VESSEL DETECTION SERVICE - MIGRANTS RESCUED

- 6 October 2015 – 3 boats rescued – 370 ppl on board, incl. 48 women & 9 children
- Cooperation: Frontex – EMSA – Italy – EUNAVFOR MED

MISSION EVENTS
EFS Section has forwarded information to EURONAVFORMED asset that has investigated the targets
INVESTIGATED VESSEL
4 vessel investigated Incident nr. 1322 related to 1325 – Rubber boat with migrants onboard (135 migrants) Incident nr. 1324 – Rubber boat with migrants onboard (108 migrants) Incident nr. 1326 – Rubber boat with migrants onboard (129 migrants) Incident nr. 1323 – Rubber boat with migrants sighted

Copernicus

2

CMS - CopernicusMaritimeSurveillance

MARITIME SURVEILLANCE

EMSA is the Copernicus Entrusted Entity for the implementation of the Copernicus Maritime Surveillance Service

Since Dec -2015

3 December 2015

Miss Lowri Evans (Director General – DG-GROW) and Mr. Markku Mylly (Executive Director – EMSA) sign the Delegation Agreement

EMSA

Copernicus

European Commission

Copernicus

Copernicus Maritime Surveillance

An Integrated approach

Underpinning principle:

Share data (CISE) and Fusion and Analysis techniques

Economy of scale in surveillance costs

Need to take into consideration data policy and sensitivity aspects

Communities:

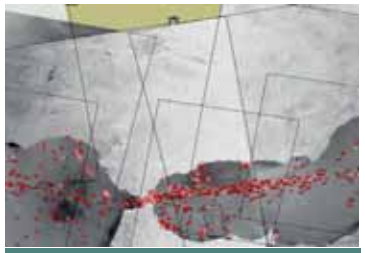
- Border Control
- Maritime Safety and Security
- Defence
- Customs Authorities
- Law enforcement
- Marine Environment
- Fisheries Control

Copernicus Europe's eyes on Earth

European Commission

CMS- Function areas

Fisheries Control



Maritime Safety and Security

Law Enforcement

Customs

Marine Environment Monitoring

Other (defence, anti-piracy)

EMSA European Maritime Safety Agency

Copernicus Europe's eyes on Earth

European Commission

SEA – Support to EU External Actions

SATCEN is the Copernicus Entrusted Entity for the implementation of the Support to EU External Actions Services

Operations as from May 2017

17 October 2016
Miss Lowri Evans (Director General – DG-GROW) and Mr. Pascal Legai (Executive Director – SATCEN) sign the Delegation Agreement

Copernicus

SEA – Support to EU External Actions

SCOPE:

The SEA service aims at assisting the EU in supporting operations outside the EU territory, in particular providing decision makers with geo-information on remote, difficult to access areas, where security issues are at stake. It targets mainly European users but can also be activated by key International stakeholders such as the UN.

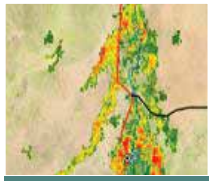
Copernicus Europe's eyes on Earth

European Commission

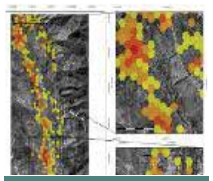
Copernicus

SAE PORTFOLIO

Reference Map



Road Network Status Assessment

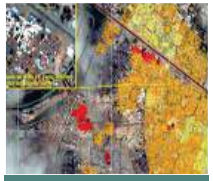


Conflict Damage Assessment

Critical Infrastructure Analysis

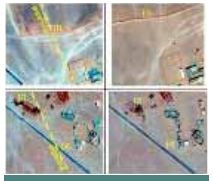
Support to Evacuation Plan

Non-EU Border Map



Camp Analysis

Crisis Situation Picture



Activity Report

Copernicus Europe's eyes on Earth

European Commission

Copernicus

Conclusions

- The Commission has been successfully including EO technology in monitoring of EU policies (eg. BS/EUROSUR, Fisheries control, Maritime pollution etc.).
- Since 2016 -17, Copernicus is delivering EO-based services through FRONTEX (2016), EMSA (2016) and SATCEN (2017), targeted to surveillance and security users.
- A fitness for purpose exercise will follow. Revisiting policy needs is underway.
- Fact: Use of Observations from Space (resolution, revisit time) is limited to a subset of observation requirements ; Data fusion is required to generate added value information
- The existing and planned commercial offer for EO VHR imagery will be increasing significantly, narrowing the gap between what can be provided and what is needed

Copernicus

Way ahead

- Expectations are high also on complementary technology, RPAS as well as other in-situ observation infrastructure (e.g. HAPS, specific Autonomous Unmanned Platforms, etc.) can further narrow the gap between requirements and observation needs. But how can they be integrated in Copernicus?
- The European Defence Action Plan (EDAP) sets the stage for deployment of shared dual-use capabilities. How can we explore this?
- Questions subsist on Governance, Regulatory, and Policy issues:
  - Handling of VHR data (timely tasking and distribution, sharing, processing, digital platforms)?
  - Integration with 'local, higher-resolution data and intelligence' for local needs?
  - Financing (European, Regional , Civil v.s. Defence) – Perimeter of Copernicus finance these ?
  - Overall governance of a more distributed system
- An independent 'Experts' Study is underway – first findings 1st Nov 2017
- A new Copernicus Regulation for the upcoming EU Financial Framework is on the making, which will likely contemplate the expansion of the Security service to respond to (some) of the challenges above.

Copernicus Europe's eyes on Earth

European Commission

Thank you

Copernicus
Maritime Surveillance Service

Pedro Lourenço / Head of Sector
Earth Observation Services

14 November 2017 / copernicus@emsa.europa.eu

Copernicus
The European Earth Observation Programme

EMSA
European Maritime Safety Agency

Copernicus Maritime Surveillance

Copernicus Service Component

Security

- Border Surveillance — FRONTEX
- Maritime Surveillance — EMSA (European Maritime Safety Agency)
- External Actions — EUSC

Restricted access;
specific conditions; delivered directly and securely to user

- Land Monitoring
- Marine Environment Monitoring
- Atmosphere Monitoring
- Emergency Management
- Climate Change

Full and open access;
data accessible to all; mostly available online

All services are fully free of charge
Delivered by Entrusted Entities

Copernicus Maritime Surveillance

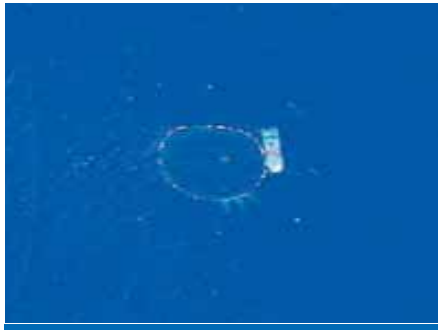
Background

- EMSA is the “Entrusted Entity” for the implementation of Maritime Surveillance Services
- Delegation Agreement signed December 2015
- Services delivered from September 2016
- Budget 2016-2020: 40M EUR
- Budget 2017: 7.4M EUR

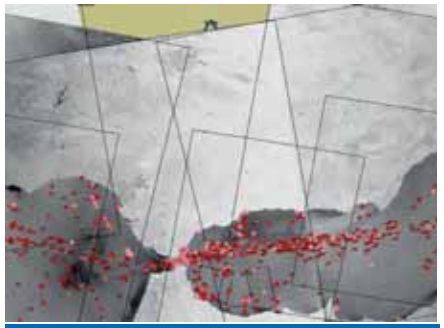
3 December 2015

Miss Lowri Evans (Director General – DG-GROW) and Mr. Markku Mylly (Executive Director – EMSA) sign the Delegation Agreement

Copernicus Maritime Surveillance Function areas served



Fisheries Control



Maritime Safety and Security

Law Enforcement

Customs

Marine Environment Monitoring

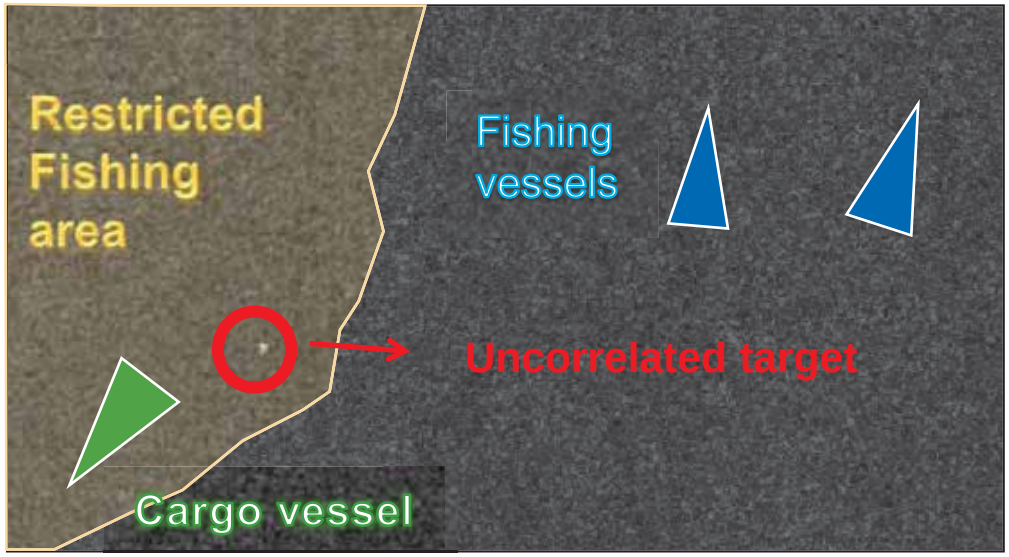
Other (defence, anti-piracy)

CMS - Fisheries Control

Support fisheries control activities

- Monitoring of fishing grounds
- Monitoring of fish cages / farms
- Monitoring of fishing ports

Monitoring restricted areas

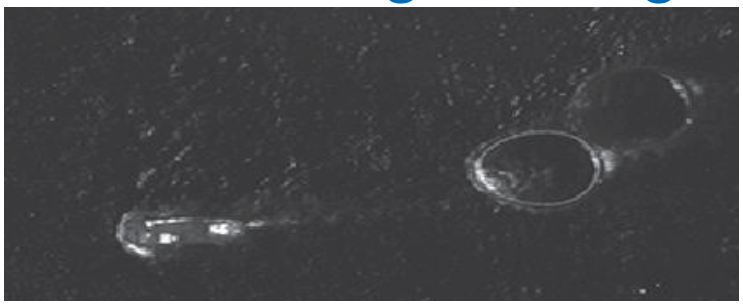


RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD [2015] – All Rights Reserved" and "RADARSAT is an official mark of the Canadian Space Agency

Fishing vessels in port

© CNES 2016, Distribution Airbus DS

Vessel towing fish cages



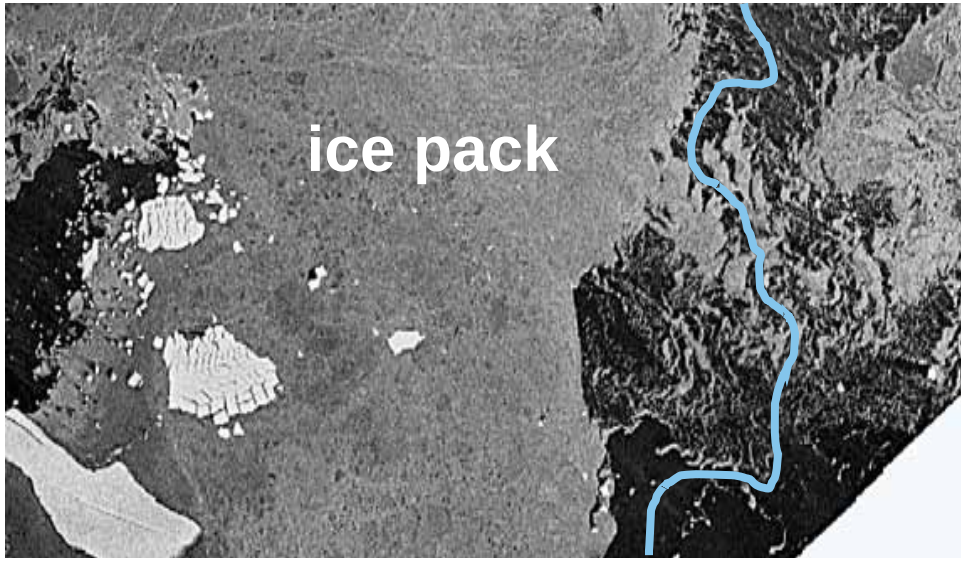
Vessel towing fish cages © European Space Imaging/DigitalGlobe 2013

CMS - Maritime Safety and Security

Maritime safety and security support

- Search and rescue operations
- Safety of navigation - including support to ice monitoring
- Maritime picture compilation

Find a safe navigation route



Activity detection

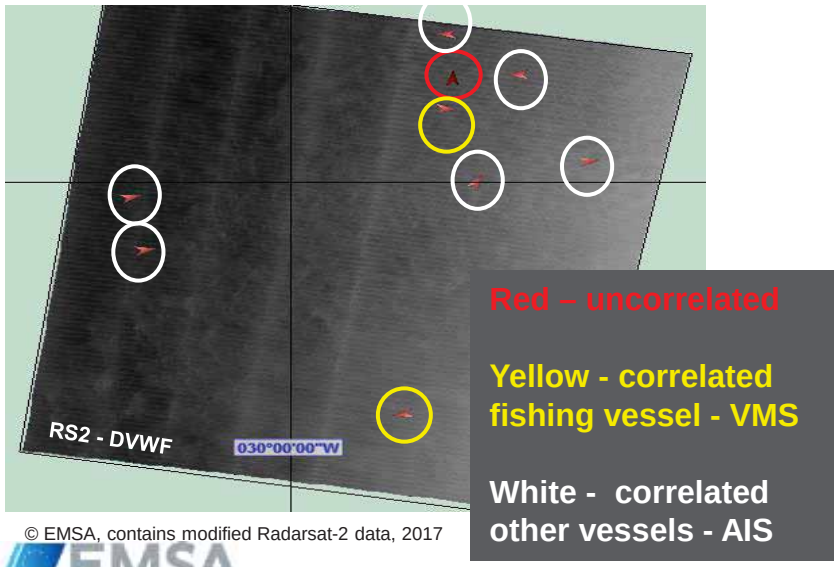
Ice Monitoring –RADARSAT-2 Data and Products © MacDONALD, DETTWILER AND ASSOCIATES LTD, 2016 – All Rights Reserved" and "RADARSAT is an official mark of the Canadian Space Agency

CMS - Law Enforcement

Support to law enforcement activities

- Monitoring of ports and shores for departure of specific ships
- Detection of potentially suspicious vessels (e.g. transhipment of drugs from a larger vessels to small boats)
- Search for non-cooperative targets

Detect suspicious vessels



© EMSA, contains modified Radarsat-2 data, 2017

Vessel reporting in 3rd country port

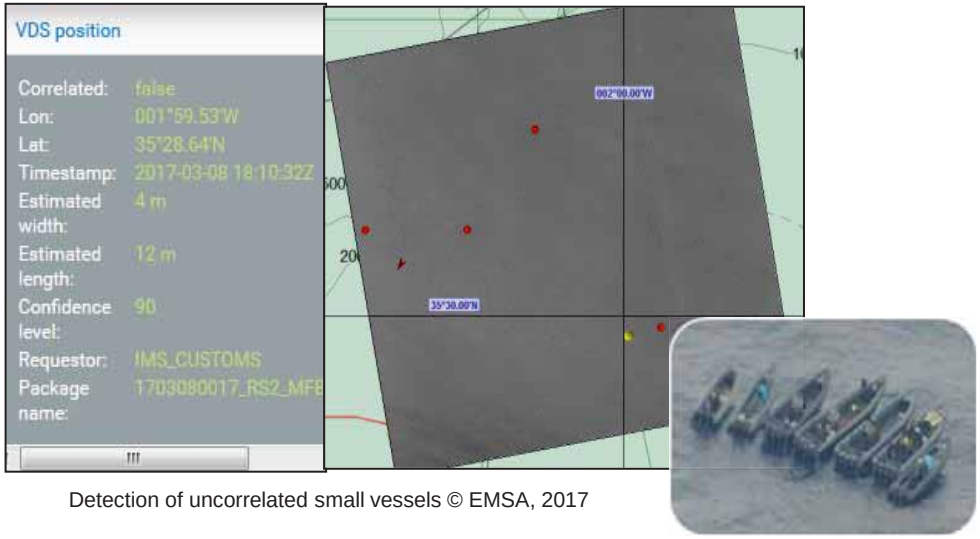
© European Space Imaging/Digital Globe, 2017

CMS – Customs

Support to customs activities

- Detection of potentially suspicious vessels
- Monitoring the ship-to-ship transfers and movement of goods
- Early warning/identification of criminal trafficking of goods

Uncorrelated small vessels



Detection of uncorrelated small vessels © EMSA, 2017

Possible ship-to-ship transfer

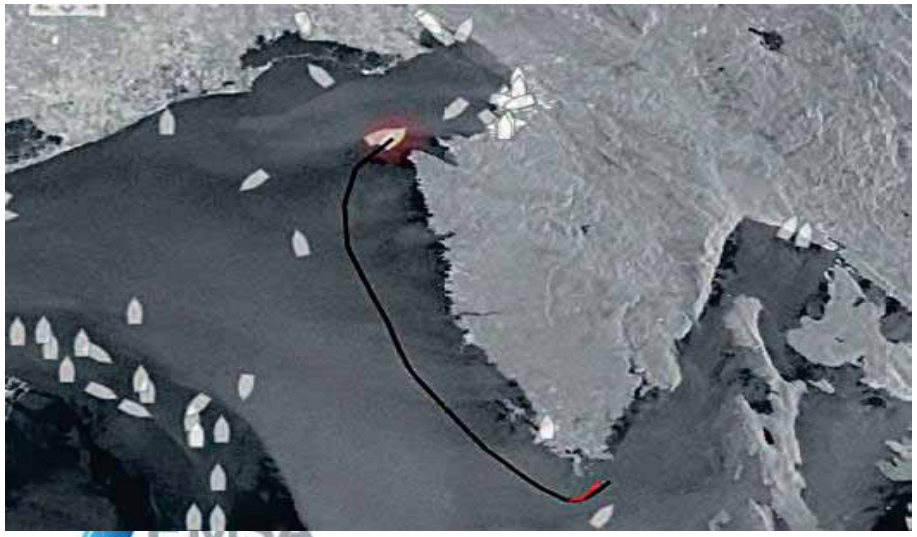
© CNES 2017, Distribution Airbus DS

CMS – Pollution Monitoring

Pollution monitoring support

- Detection of illegal oil discharges and ID possible polluters
- Early warning/identification of incidents/accidents that may have an environmental impact
- Support to pollution response operations

illegal spill and possible source



© EMSA, 2016

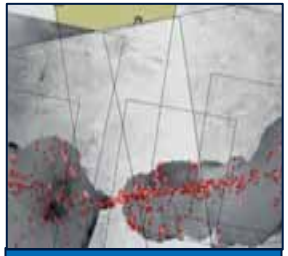
- Extend CleanSeaNet service for pollution monitoring and vessel detection beyond European waters to other areas of interest, e.g. overseas territories

Copernicus Maritime Surveillance Service Delivery

Number of delivered services

Function area	Start of activity	Delivered services
Fisheries Control	Sep 2016	905
Maritime Safety and Security	Nov 2016	154
Law Enforcement	Sep 2016	402
Customs	Mar 2017	491
Other (defence, anti-piracy, support to external entities)	Sep 2016	34
Marine Environment monitoring	Jan 2018	-

Fisheries Control



Maritime Safety and Security

Law Enforcement

Customs

Marine Environment Monitoring

Other (defence, anti-piracy)

1986

EMSA

Copernicus

Overview of users

Users

- European Fisheries Control Agency, EFCA
- Maritime Analysis and Operation Centre – Narcotics, MAOC(N)
- Portuguese Navy
- Spanish Navy
- Spanish Customs
- Cyprus JRCC
- Icelandic Coast Guard
- L'Institut polaire français Paul-Émile Victor (IPEV)
- United Nations Office on Drugs and Crime, UNODC
- French Maritime Affairs (MRCC La Reunion)
- Harbour Police, Hamburg, Germany
- Spanish Maritime Safety Agency (SASEMAR)
- Danish Joint Defence Command

Potentially interested

- Swedish Coast Guard
- Croatian Ministry of Sea, Transport and Infrastructure (Maritime Rescue Coordination Centre, MRCC Rijeka)
- Irish Air Corps
- EUNAVFOR
- Netherlands Coast Guard
- Italian Coast Guard
- French Navy

1 year of operations
430+ users

How to access: Consult CMS Product Catalogue

CMS Products

- **Standard products**
  - SAR
  - Optical
- **Value Added products**
  - Vessel detection
  - Activity detection
  - SAR wind and SAR wave
  - Oil spill detection
- **Fusion products**
  - Correlation w/ AIS, SAT-AIS, LRIT, VMS
  - Alerts and notifications

Contact: copernicus@emsa.europa.eu

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European Commission

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European Maritime Safety Agency

Celebrating 10 years CSN/ESA/EMSA

Session 3: Defining the future

Conference Room

EMSA

Agenda

Time	Agenda Item	Speakers
09:00-09:20	Opening remarks for the day and Introduction to break-out sessions	Markkuu Mylly, Executive Director, EMSA
09:20-09:40	Keynote speech: ESA ECSAT	Andreas Schoenenberg, Head of the Study and Project Management Office, Telecommunications and Integrated Applications (TIA) Directorate, ESA ESTEC
09:40-11:00	Break-out sessions: The future of space-based services for the maritime sector • What next for CleanSeaNet? • Developments in satellite AIS and VDES • The potential of RPAS • New ideas and technologies	Michiel Visser and Sónia Santos (Conference room) Andreas Schoenenberg and Lawrence Sciberras (-01.12) Pedro Galache and Olaf Trieschmann (-01.13) Pierre Potin and Pedro Lourenço (0.41)
11:00-11:30	Feedback to the plenary	Rapporteurs
11:30-12:00	*Coffee*	
12:00-12:20	Keynote speech: European Commission	Magda Kopczynska, Director for Waterborne Transport, DG MOVE
12:20-13:00	Conference conclusions	

Break-out Sessions (9:40-11:00)

- What next for CleanSeaNet?

  Moderators: Michiel Visser (NL) & Sónia Santos (EMSA)

  Conference Room

- Developments in SAT-AIS and VDES

  Moderators: Andreas Schönenberg (ESA) & Lawrence Sciberras (EMSA)

  Room -01.12

- The Potential of RPAS

  Moderators: Pedro Galache (EFCA) & Olaf Trieschmann(EMSA)

  Room -01.13

- New Ideas and Technologies

  Moderators: Moderators: Pierre Potin (ESA) & Pedro Lourenço (EMSA)

  Room 0.41

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Business Applications
(Integrated Applications Promotion (IAP))

Maritime Surveillance
The Role of Space

TIA-AP
Doc. No.: ESA-TIAA-HO-2017-1214, V2.5
Date: 14/15 November 2017

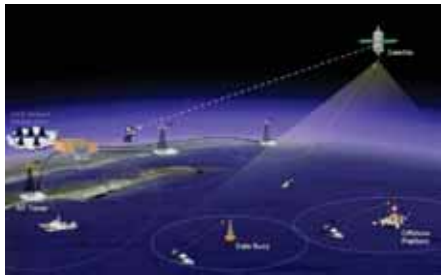
ESA UNCLASSIFIED - For Official Use

Maritime safety and surveillance: new instruments for tackling new needs

Tomorrow

Today

VDES/ VDES-SAT



HAPS

UMS

AIS/SAT-AIS

EO-SAT

RPAS

Maritime safety and surveillance: the role of space

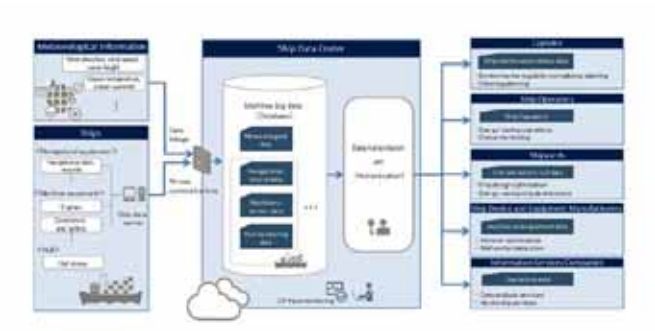
- **Improvement of existing instruments and advent of new instruments**
  - From RPAS initial operations to RPAs full operational utilization in near coastal areas and open seas
  - Utilization of HAPS and UMS
  - From SAT-AIS to VDES-SAT for supporting sharing of information while at sea (obstacles detection, meteocean information, …) and SAR operations
- **Space in support to maritime users**
  - Relay of AIS and VDES data via satellite in non coastal region
  - Enhanced connectivity solutions via 5G networks (terrestrial and satellite) offering low-cost broadband secure connectivity to support RPAS, HAPS and UMS operations

Shipping and Navigation: a sector in evolution

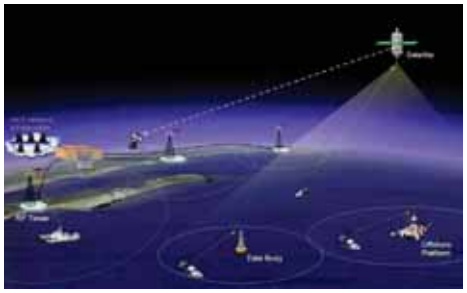
Tomorrow

Today

Maritime Big Data platforms



VDES / VDES-SAT



Autonomous ships

e-Navigation

M2M and IoT

New sector trends

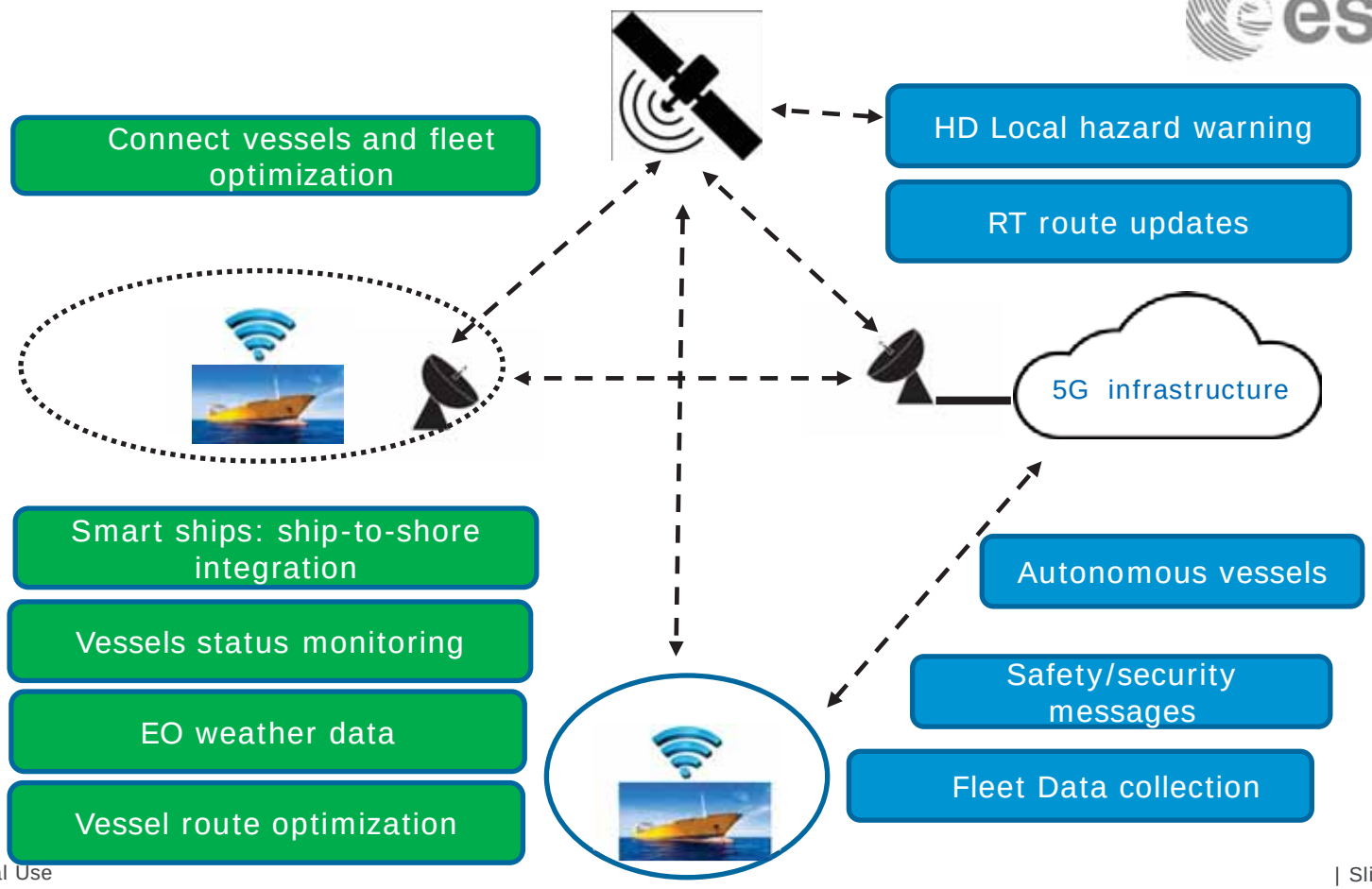
- **Smart vessels:** next major transition for the shipping industry as ships will require high levels of data analytics to operate on-board systems to manage propulsion, navigation and other functions
- **New fuels** and change of fuel balance
- **Virtual/Augmented reality** to aid maintenance/repair operations
- More frequent **extreme weather** disrupting voyages and port activities
- **Environmental laws** enforced in shipping sector
- **Multimodal hubs** Sea; Air; Road; Rail
- **Autonomous Vessels:** vessels with partial help from the remote control centre will be able to manage the voyage on their own.

Shipping sector evolution: the role of space

- The future VDES and 5G technologies will offer relay capability for the **Big Data** set between ships and ship/shore to address e.g.
  - next generation of modular control systems to enable wireless monitoring and control functions on and off board
  - near real time monitoring of cargo, vessels and assets (tailored predictive maintenance instead of fixed maintenance)
  - always connected vessels
- The new precise satellite navigation systems are key enablers of navigation and positioning for marine applications

Use cases for 5G and Maritime

SatCom integrated with terrestrial assets (3G,4G,5G, RPAS) will offer ubiquitous and secure connectivity



European Maritime Safety Agency

Celebrating 10 years CSN/ESA/EMSA

Break-out session 1:
What next for CleanSeaNet?

Moderators: Michiel Visser (NL) & Sónia Santos(EMSA)

Conference Room Lisbon/ 15 Nov 2017

EMSA

Seed Questions - Part 1

➢New functionalities

- Feedback provision via notification email; vessel detection report;
- MS GIS layers of interest in User Interface, eg PSSA areas
- GUI with a pop-up informing that new alert is available in the User AOI.
- SSN Enrichment (eg Cargo information, voyage destination);
- Vessel traffic layers (LRIT and VMS information)
- Drifting models ;

Seed Questions - Part 1

➢New information content

- ❑ Other parameters/information missing in alert report or User Interface:

- Estimation of oils spill age;
- Classification of pollution type (integrating other sensors);
- Estimation of spill volume (integration of new sensors eg (multispectrum sensor, following feedback on mineral oil with BAOAC) ;
- A vessel detection report;
- In case of possible polluters several hits, level of confidence shall be set taken into consideration Anomaly behavior algorithm.
- New sensor(s) data take opportunities for the detection location.

Seed Questions - Part 1

➢Area/Temporal Coverage

- Number of delivered services per year (over 3000 images per year) are sufficient, coverage areas to be updated by MS if needed.
- Increase of delivered services should not impact the NRT delivery.
- Increase of number of delivered services per year if there is a variation of day times.
- Variation of day times (eg. new platforms to be included).
- Need for fast tasking high resolution imagery in specific areas (eg hot spots areas of ship to ship transfer, wreck removals).
- Pinpointing (optical imagery, SAR high resolution)
- Current allocation process agrred.

Seed Questions - Part 2

➢ Meetings and Workshops

- Possibility of a semestrial (video conference) for UG actions follow-up and new system functionalities.
- Service Feedback meeting CSN users; Service and License providers.
- From this group the yearly meeting at EMSA premises is sufficient.

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Celebrating 10 years CSN/ESA/EMSA

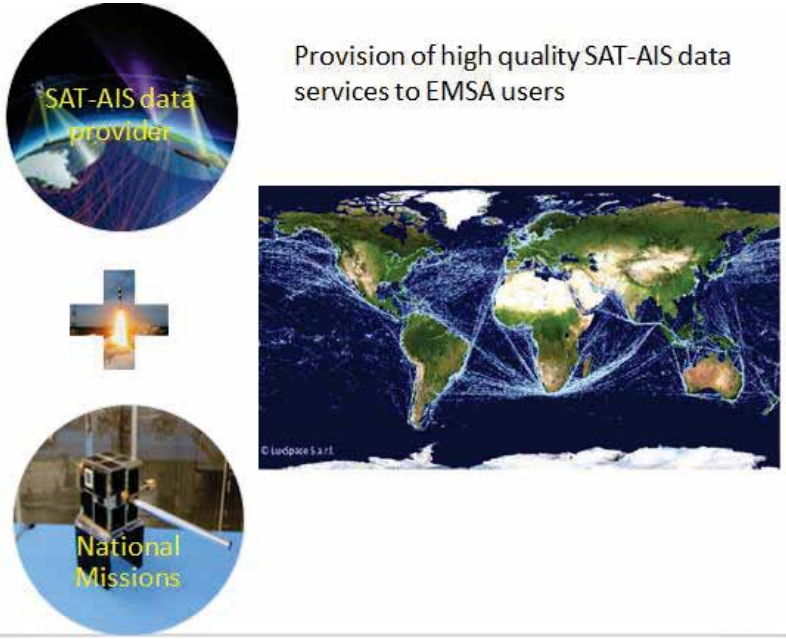
Break-out session 2:
Developments in SAT-AIS and VDES

Moderators: Andreas Schönenberg (ESA) & Lawrence Sciberras (EMSA)

Room -01.12 Lisbon/ 15 Nov 2017

EMSA

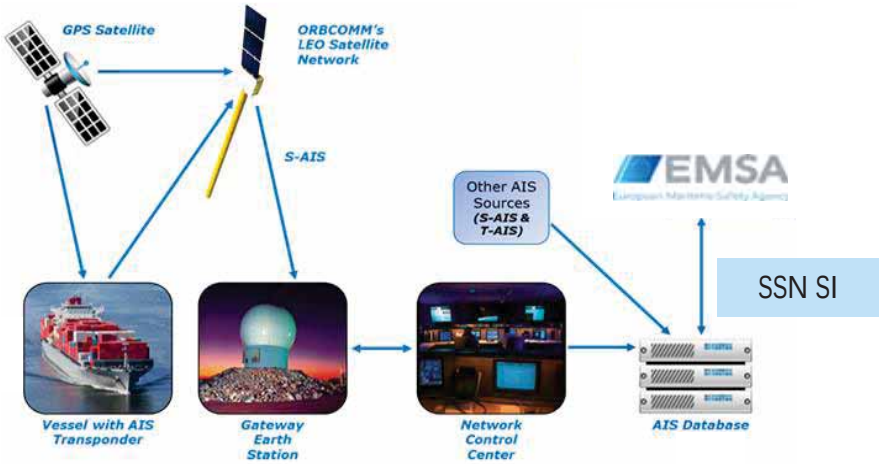
SAT-AIS



Provision of high quality SAT-AIS data services to EMSA users

Detection of AIS signals by low earth orbiting satellites. Enables the monitoring of all AIS-equipped vessels on a global scale through a satellite constellation and a network of ground stations.

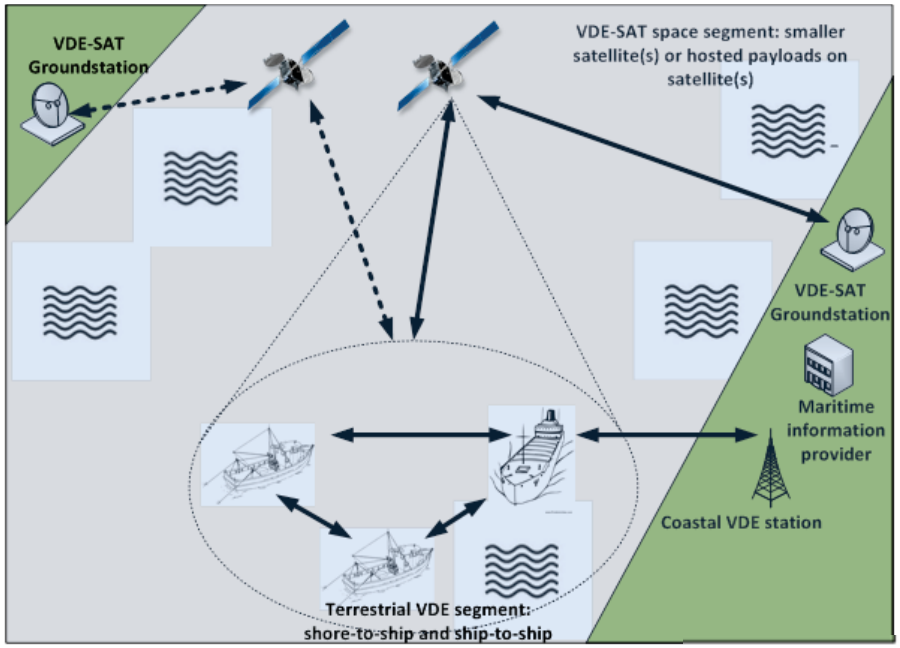
- Has the provision of SAT-AIS data services been beneficial to your area of interest?
- What kind of improvement you would like to see in SAT-AIS data services?
- How do you see SAT-AIS data complementing other data sources?



VHF Data Exchange System (VDES)

Use of AIS technology for VHF data exchange of maritime information services on a global level from ship to shore, shore to ship, and ship to ship.

Terrestrial component - approved by ITU WRC 15.
Satellite Component – VDE-SAT (to be approved by ITU WRC 19).



Source ITU Doc (ESA)

- What kind of VDES services would you like to see?
  - i.e. SAR, reporting formalities, provision of information derived from EO imagery, etc.
- VDE-SAT (space component) enables two-way communications from ship to shore or vice versa. For what purpose could this be used?

Information transfer between terrestrial stations and satellites - higher speed digital data exchange with worldwide coverage.

Feedback: SAT-AIS

- Has the provision of SAT-AIS data services been beneficial to your area of interest?

No present use on operational basis.

Used for testing Coastline applications and for security purposes. Provides the data to Administrations from all flag state vessels. Has the potential to be used for Safety of Navigation, shore-based. Better coverage for remote areas where terrestrial AIS data is not available.

- What kind of improvement you would like to see in SAT-AIS data services?

How to use SAT-AIS data for Unmanned and Manned vessels. Machine to machine connection is needed. Consistency – better update rates – the time it takes to receive two consecutive positions of a single vessel.

- How do you see SAT-AIS data complementing other data sources?

Should substitute LRIT. LRIT is deemed to be obsolete. IMO needs to address this.

Feedback: VDES

- What kind of VDES services would you like to see?
  - i.e. SAR, reporting formalities, provision of information derived from EO imagery, etc.

Exchange of voyage plans > Ship to Ship, Shore-Ship, Navigation warnings, SAR

Safety of navigation. Could be a key platform for exchange of info between Manned and Unmanned vessel.

- VDE-SAT (space component) enables two-way communications from ship to shore or vice versa. For what purpose could this be used?

Can be the basis for use for an extended navigational aids - eNavigation

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Backtracking Issue; "AIS Currents"

New ideas and technologies; Break out session

Marko Perkovic, Milan Batista

Celebrating 10 years CSN/ESA/EMSA

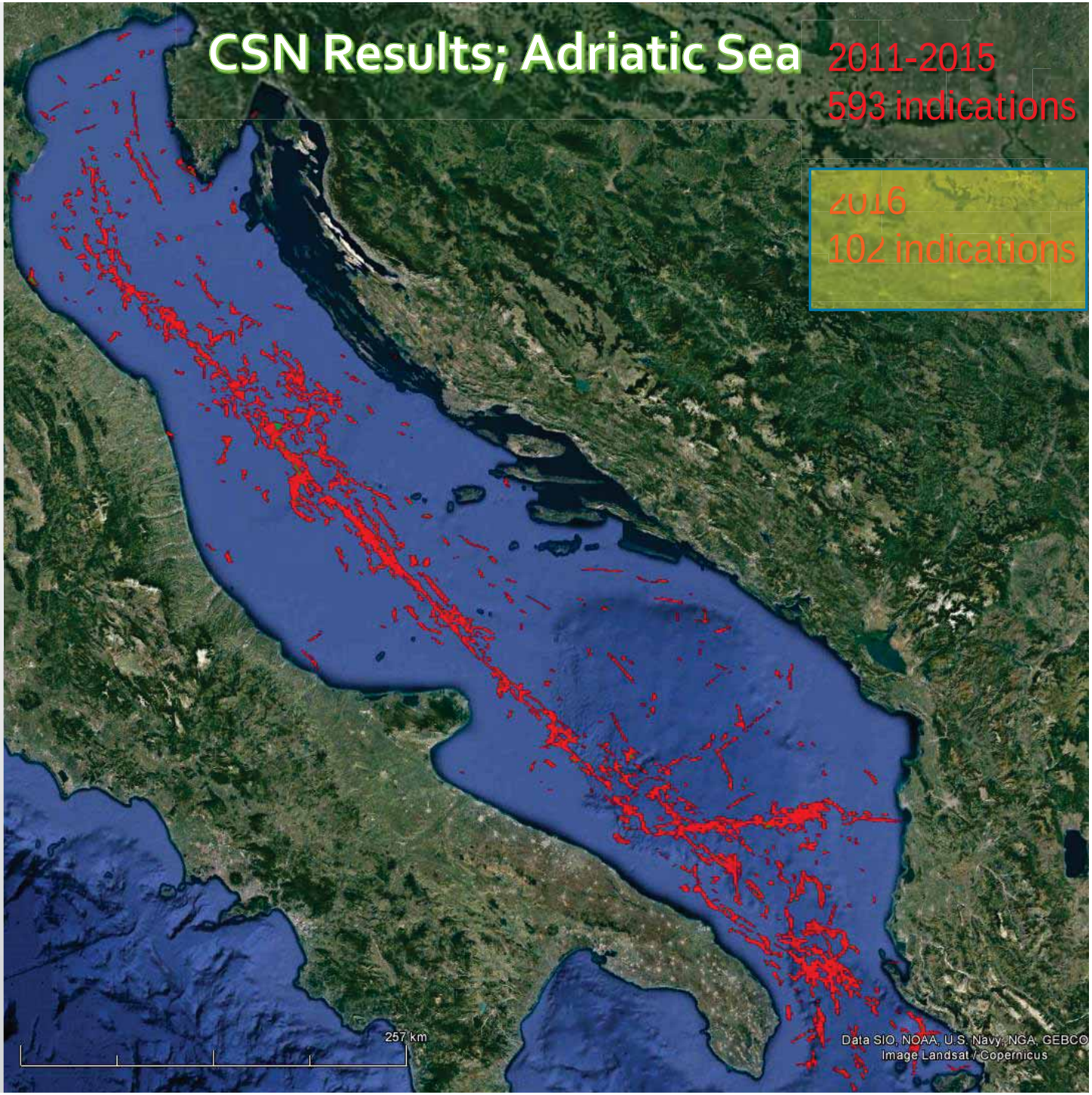
Lisbon, November 15th, 2017

Adriatic Sea; Traffic AIS density

CSN Results; Adriatic Sea

2011-2015
593 indications

2016
102 indications

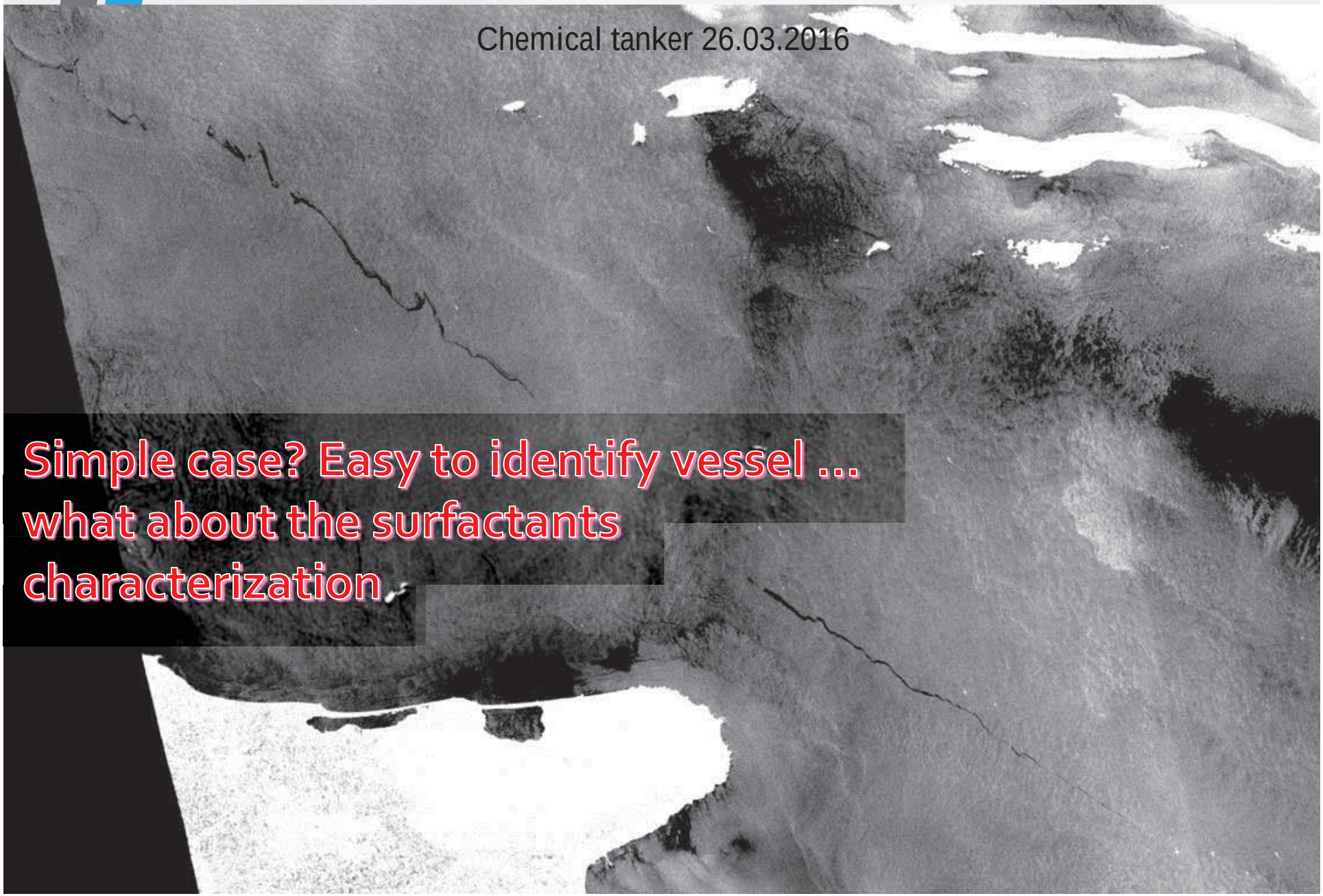


2016
102 indications

34; < 1 km2
56; 1 – 10 km2
9; > 10 km2
3; > 50 km2

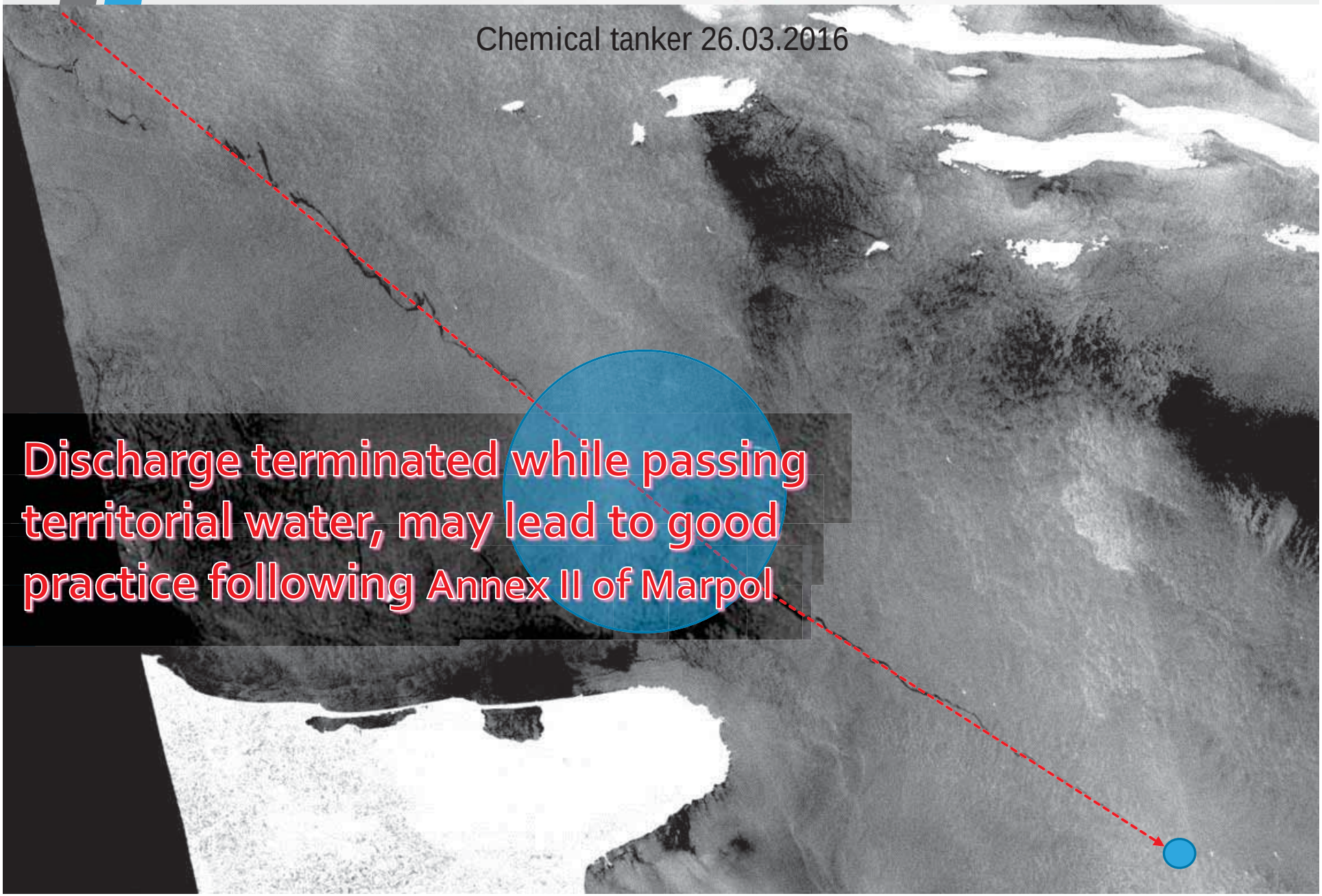
Case Study I; Annex II

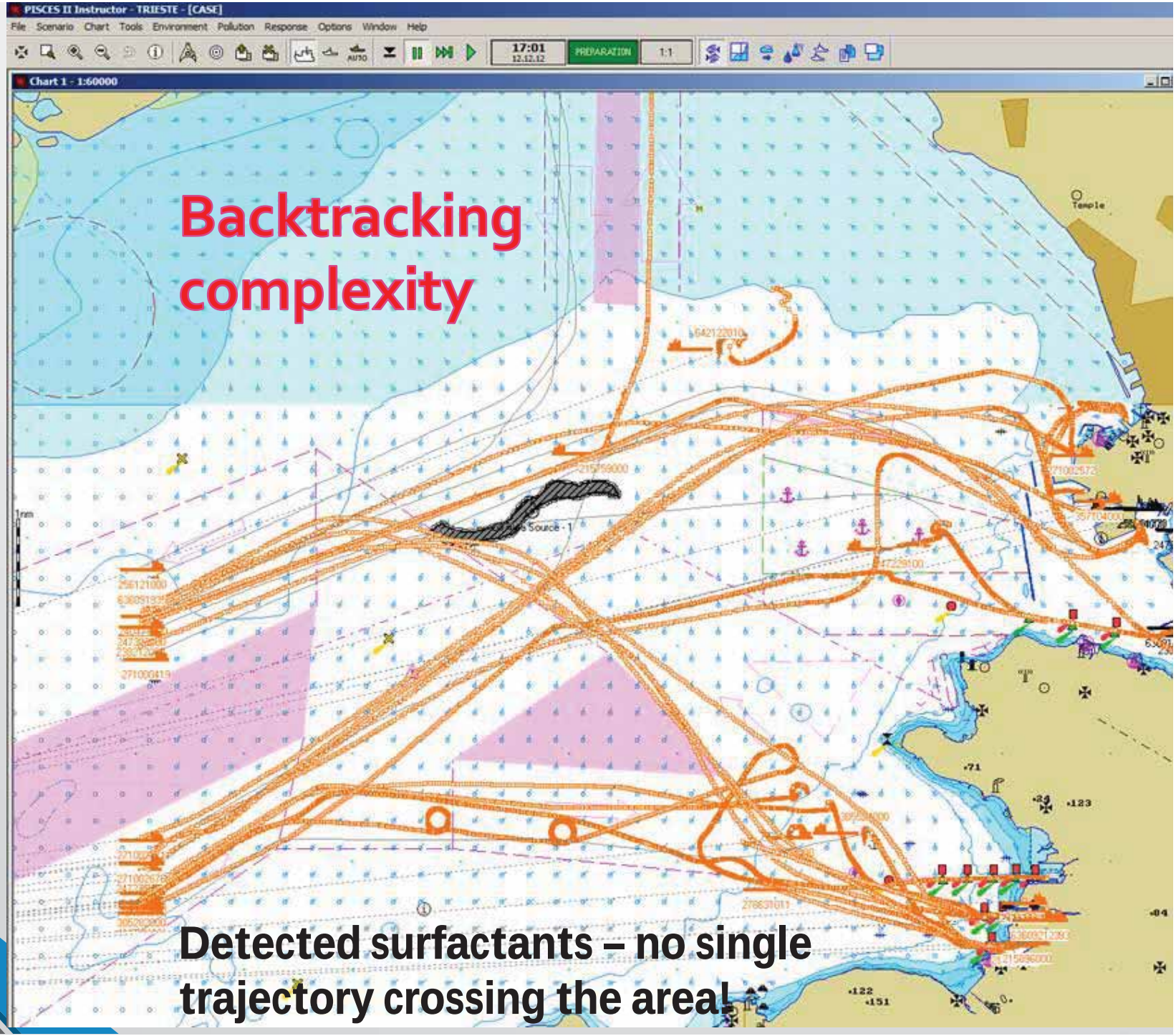
Chemical tanker 26.03.2016



Simple case? Easy to identify vessel … what about the surfactants characterization…

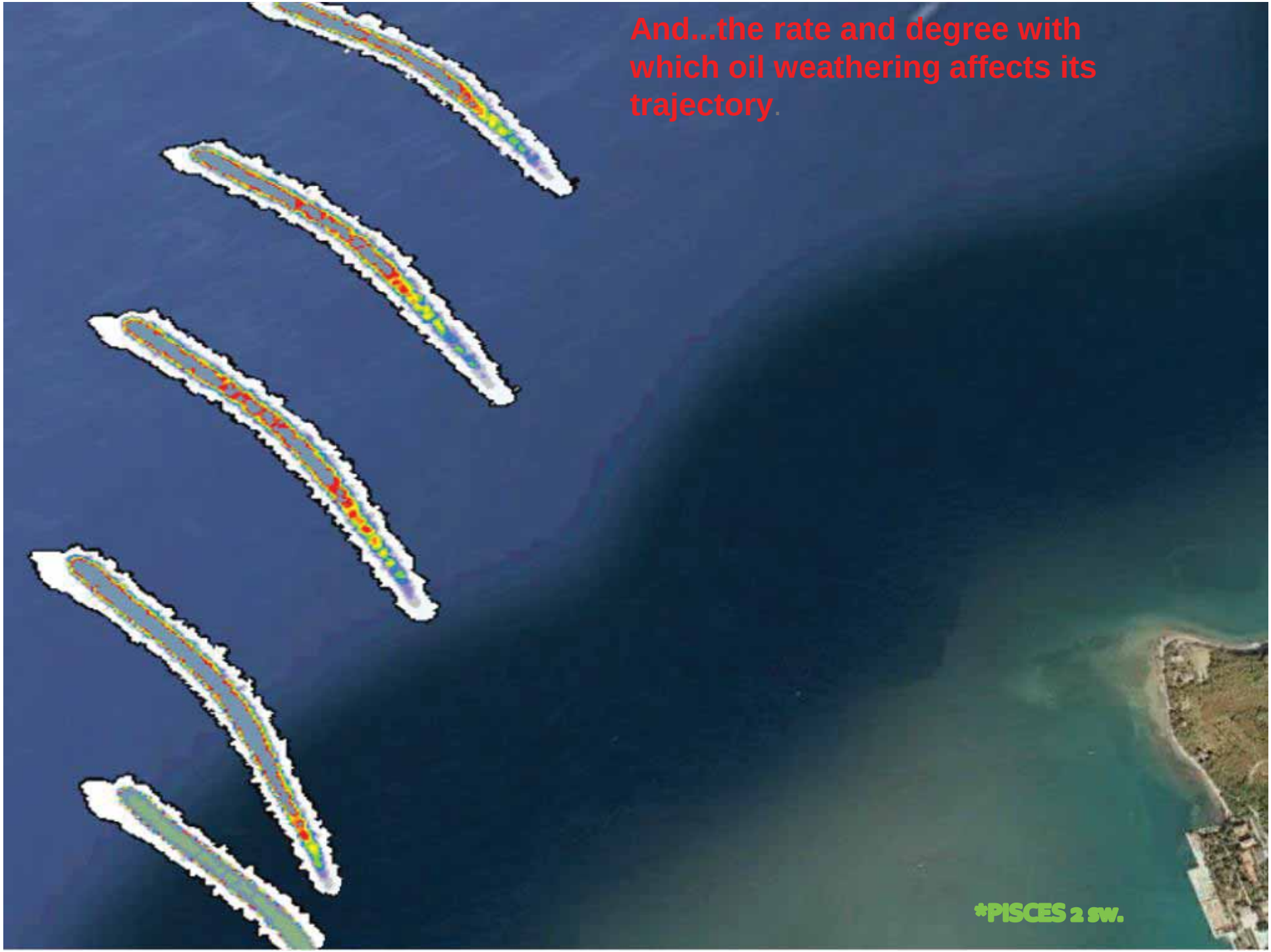
Case Study I; Annex II





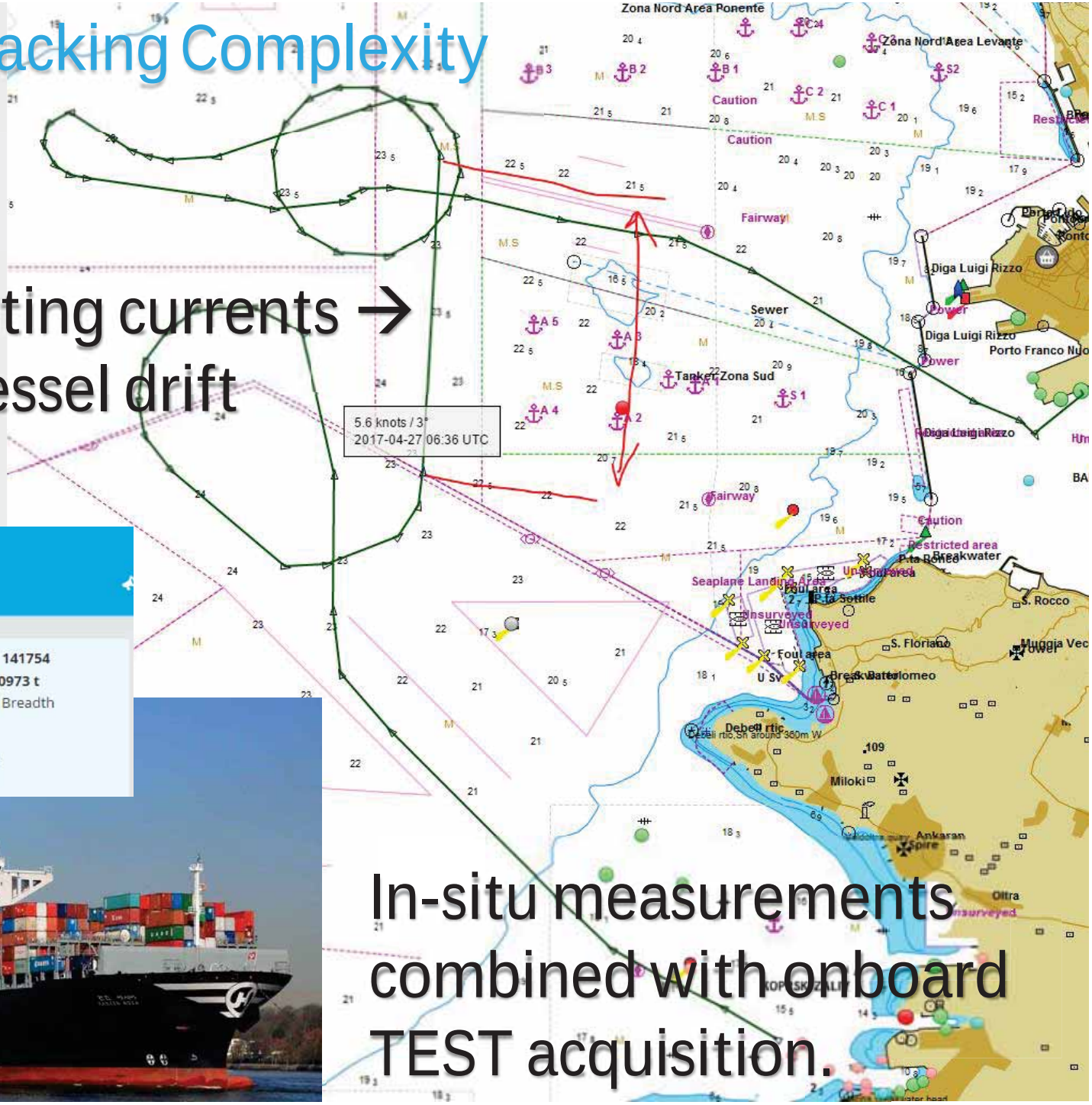
Backtracking complexity

Detected surfactants – no single trajectory crossing the area!


And...the rate and degree with which oil weathering affects its trajectory.
*PISCES 2 SW.

Backtracking Complexity

Calculating currents → from vessel drift



MAERSK EDIRNE

Container Ship

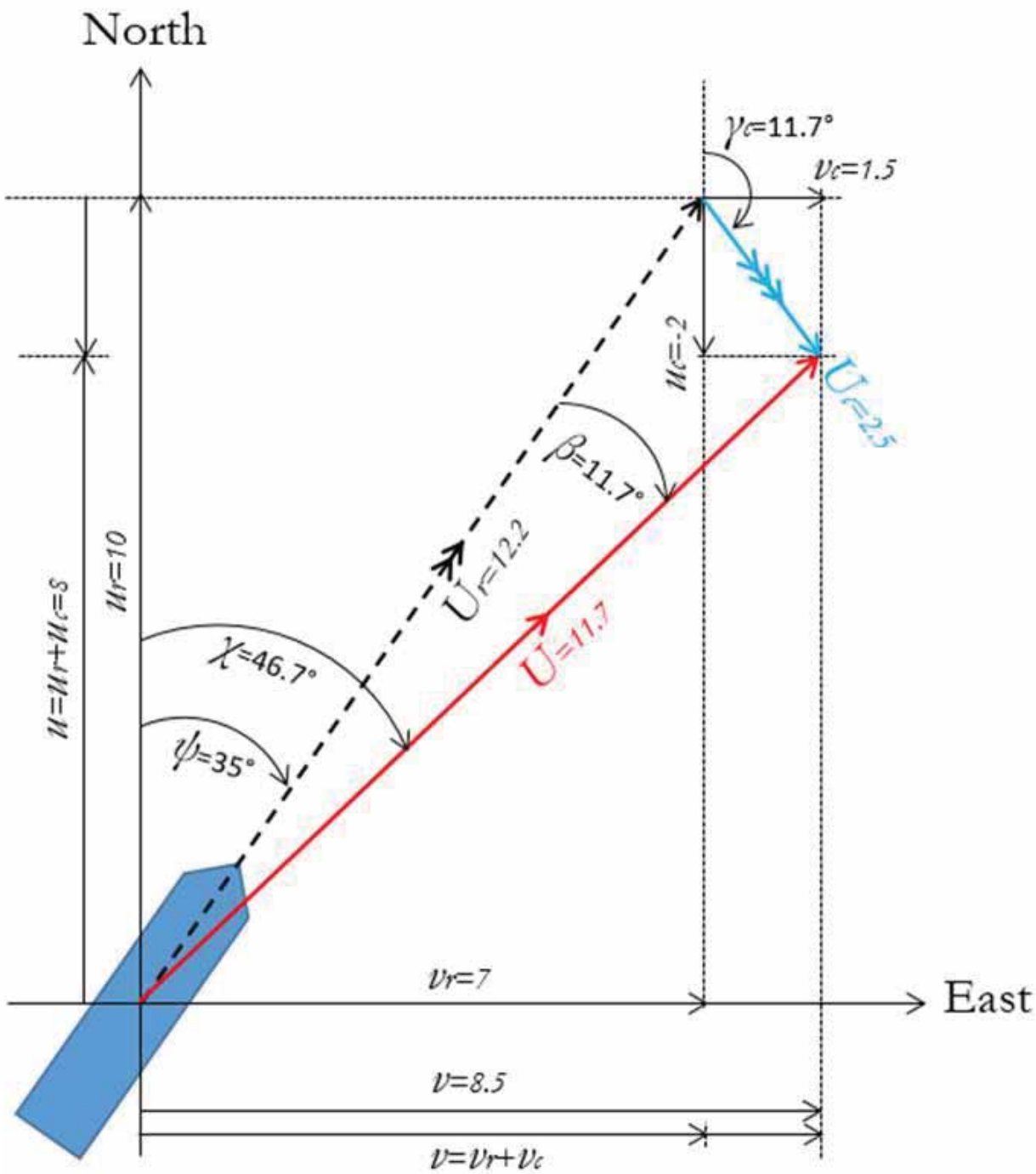
IMO: **9502867**	Gross Tonnage: **141754**
MMSI: **235091397**	Deadweight: **140973 t**
Call Sign: **2FHT8**	Length Overall x Breadth Extreme: **366m × 48m**
Flag: **United Kingdom [GB]**	Year Built: **2012**
AIS Vessel Type: **Cargo - Hazard A (Major)**	Status: **Active**

In-situ measurements combined with onboard TEST acquisition.

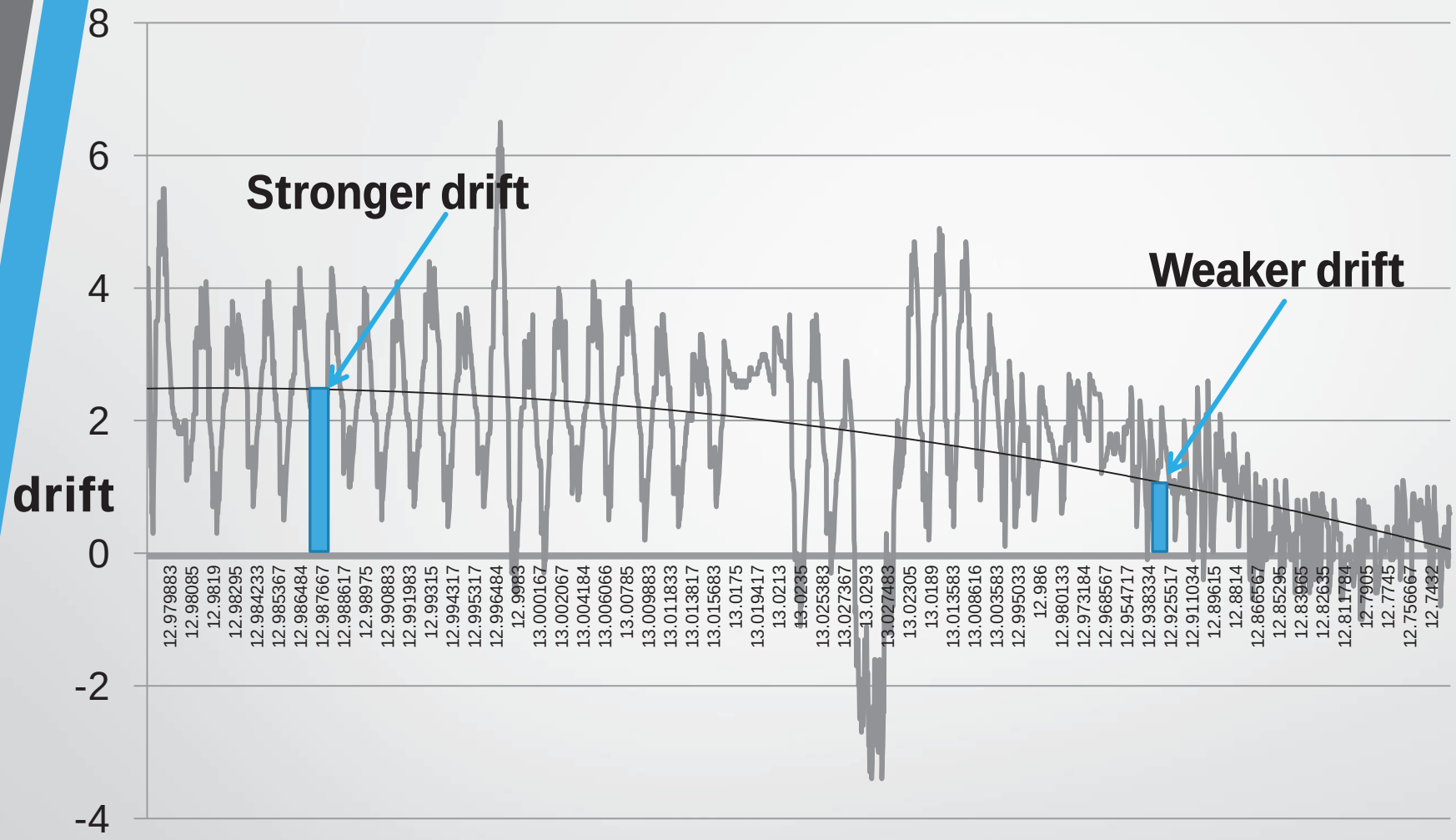
SET and DRIFT

Theory

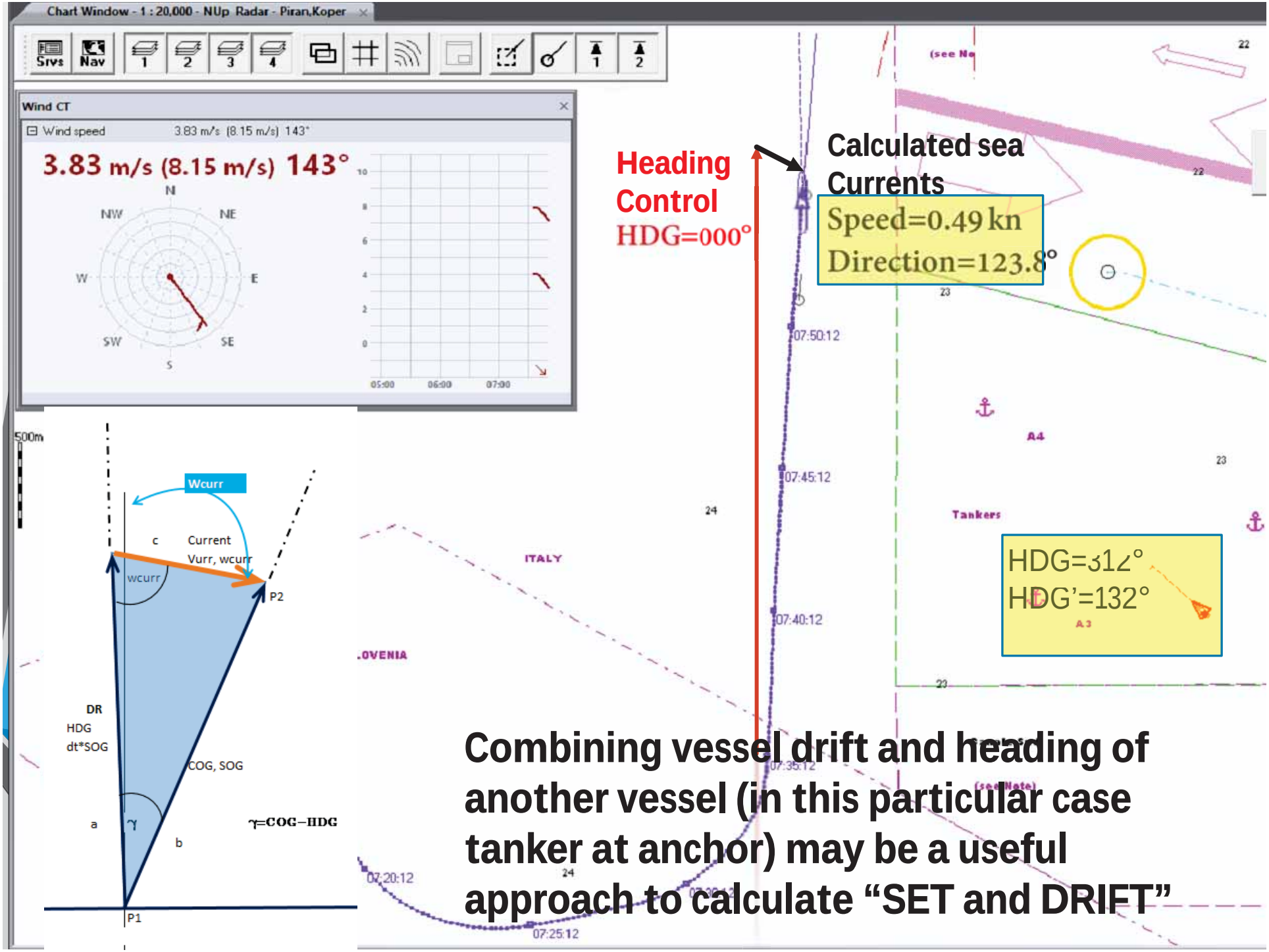
Uc can't be solved from drift observed from a single ship observing at a certain straight leg



$$U_r = \sqrt{(u-u_c)^2 + (v-v_c)^2}$$

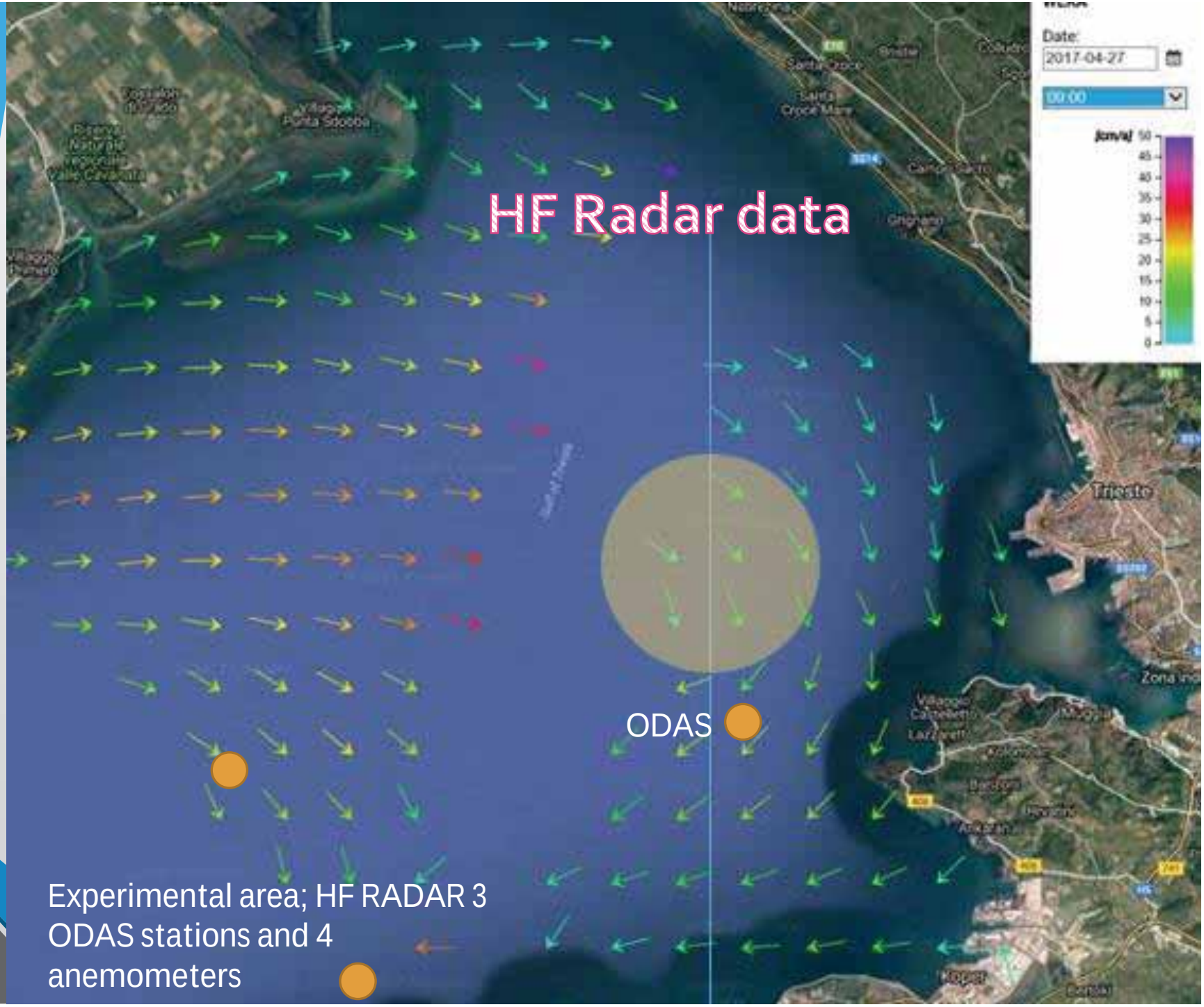


Anyhow, observing a single object ... relative drift comparison is feasible



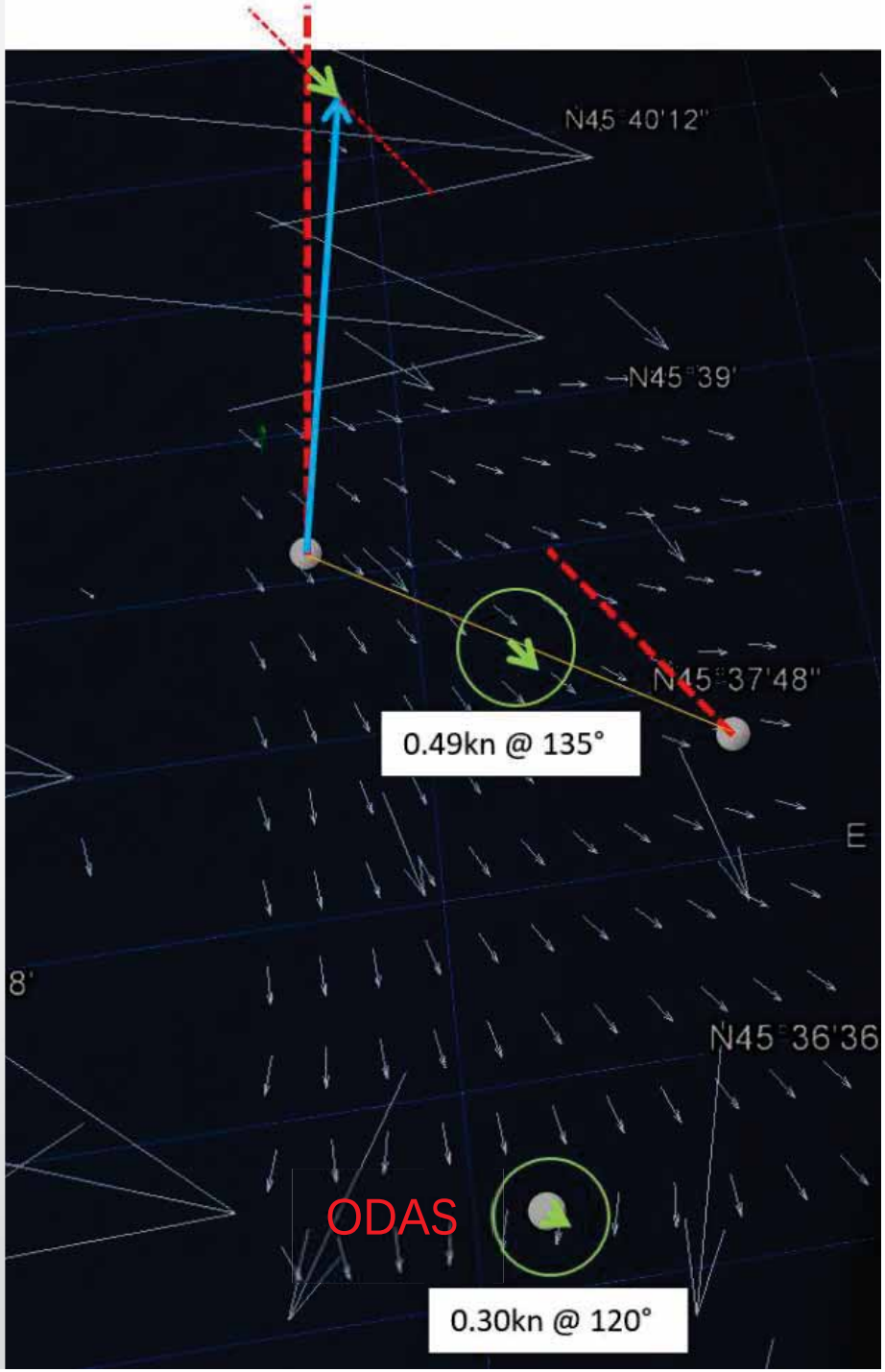
Combining vessel drift and heading of another vessel (in this particular case tanker at anchor) may be a useful approach to calculate "SET and DRIFT"

HF Radar data



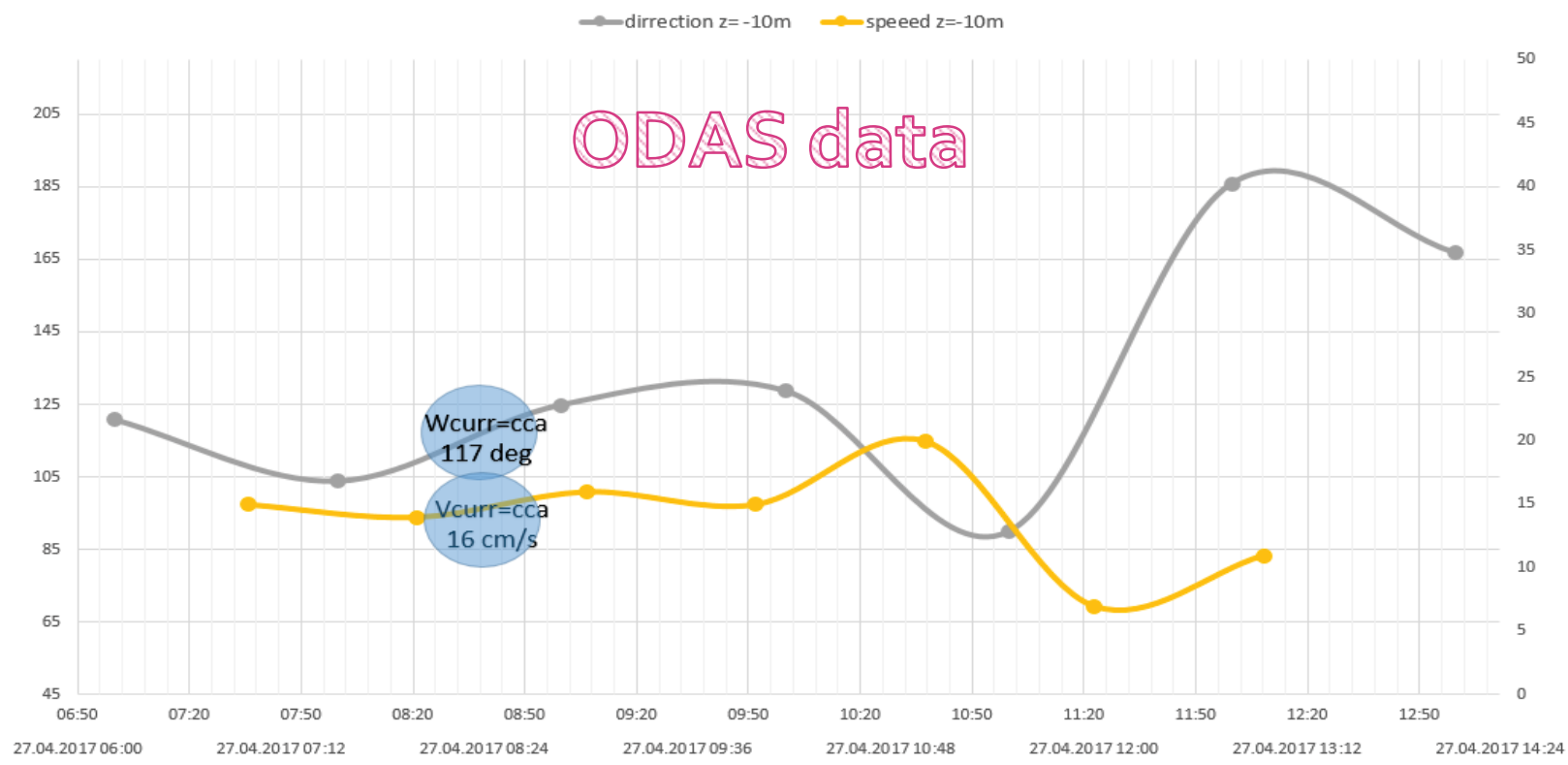
Experimental area; HF RADAR 3 ODAS stations and 4 anemometers

AIS, HF Radar & ODAS data



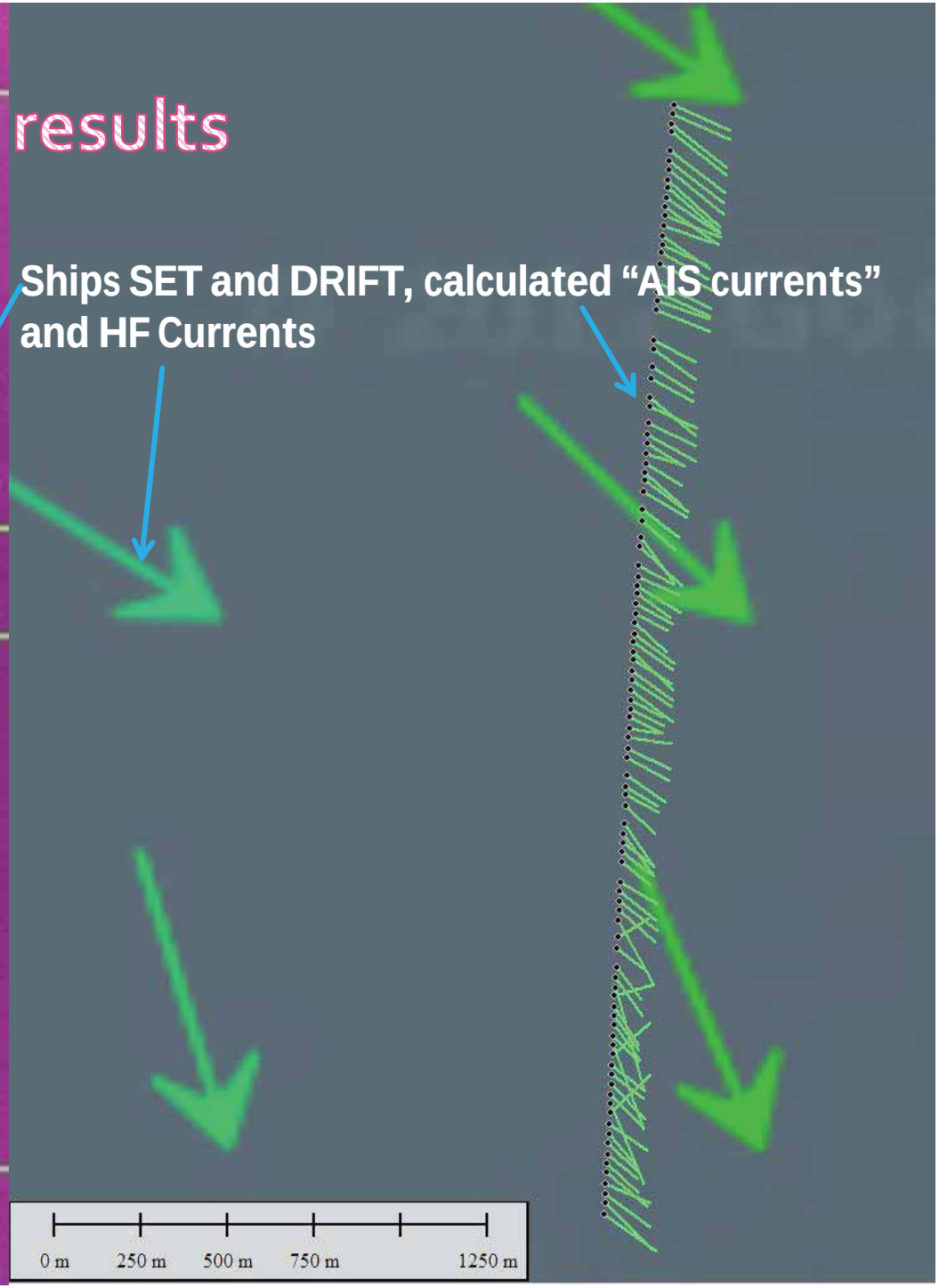
Experimental area; HF RADAR and 3 ODAS stations

ODAS data

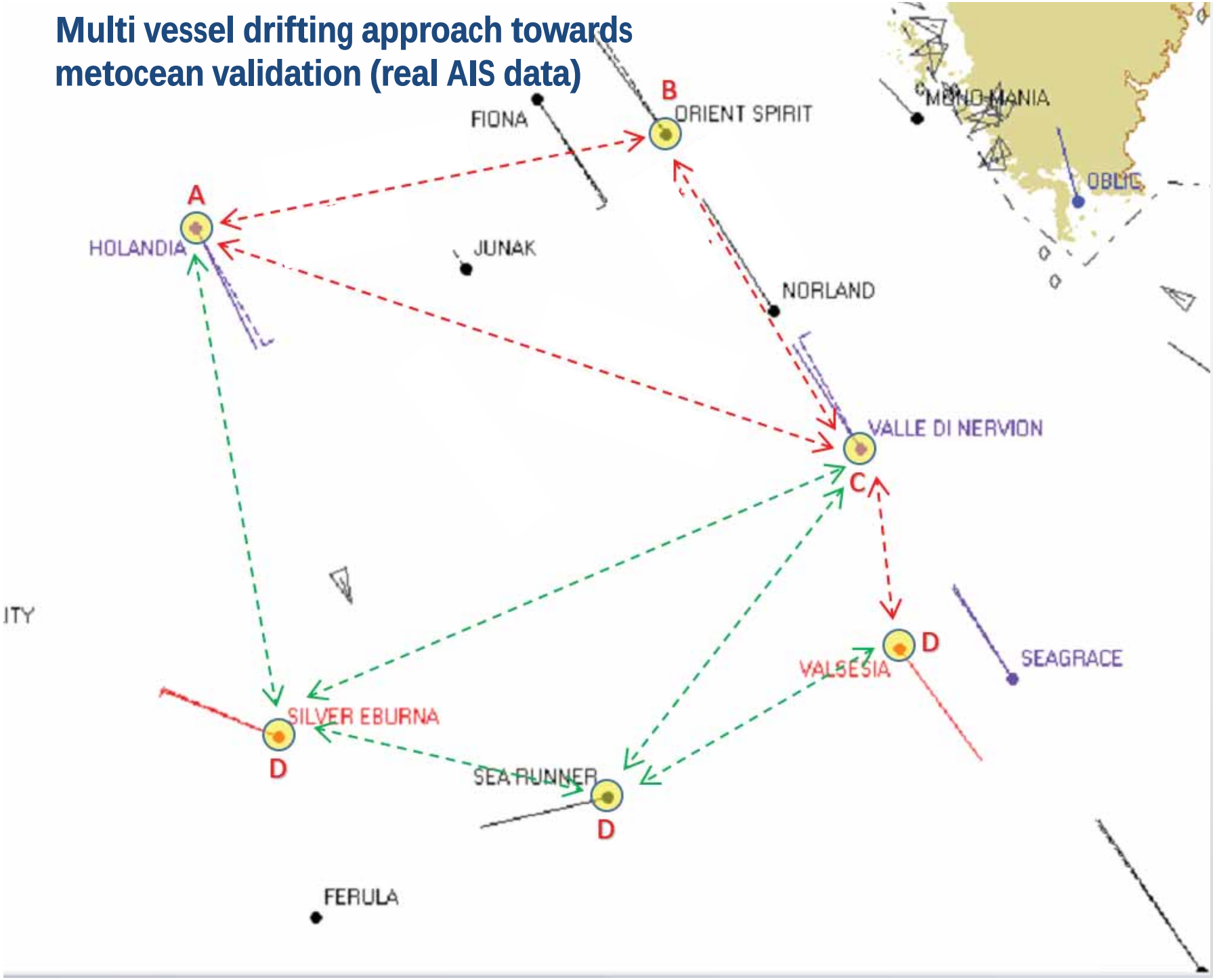

dirrection z= -10m
speeed z=-10m
205
185
165
145
125
105
85
65
45
50
45
40
35
30
25
20
15
10
5
0
06:50
07:20
07:50
08:20
08:50
09:20
09:50
10:20
10:50
11:20
11:50
12:20
12:50
27.04.2017 06:00
27.04.2017 07:12
27.04.2017 08:24
27.04.2017 09:36
27.04.2017 10:48
27.04.2017 12:00
27.04.2017 13:12
27.04.2017 14:24
Wcurr=cca
117 deg
Vcurr=cca
16 cm/s

180
170
160
150
140
130
120
110
100
90
Wind direction (from)
06:35:43
06:38:36
06:41:28
06:44:21
06:47:14
06:50:07
06:53:00
06:55:52
UTC time

First results

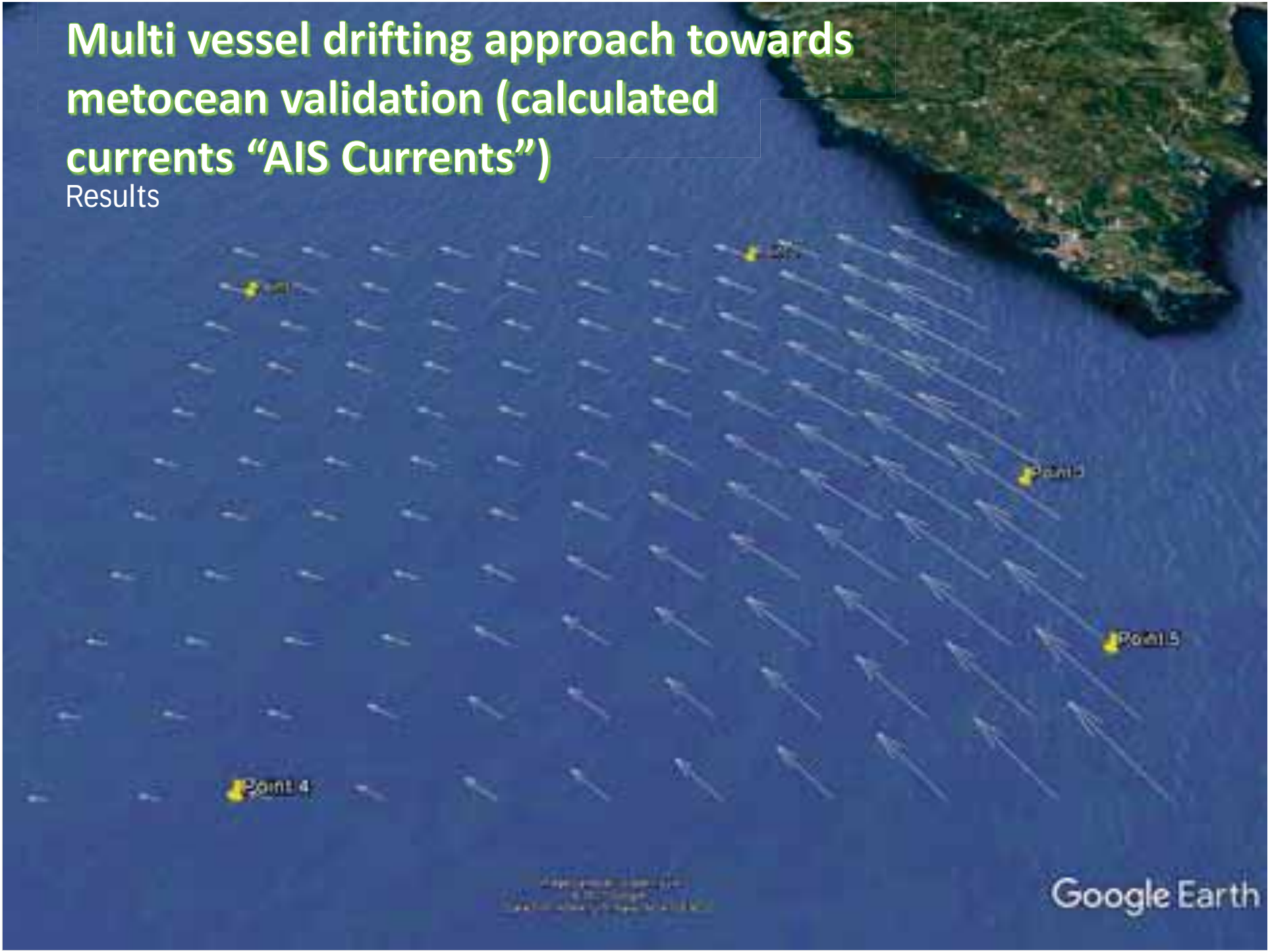


Multi vessel drifting approach towards metocean validation (real AIS data)



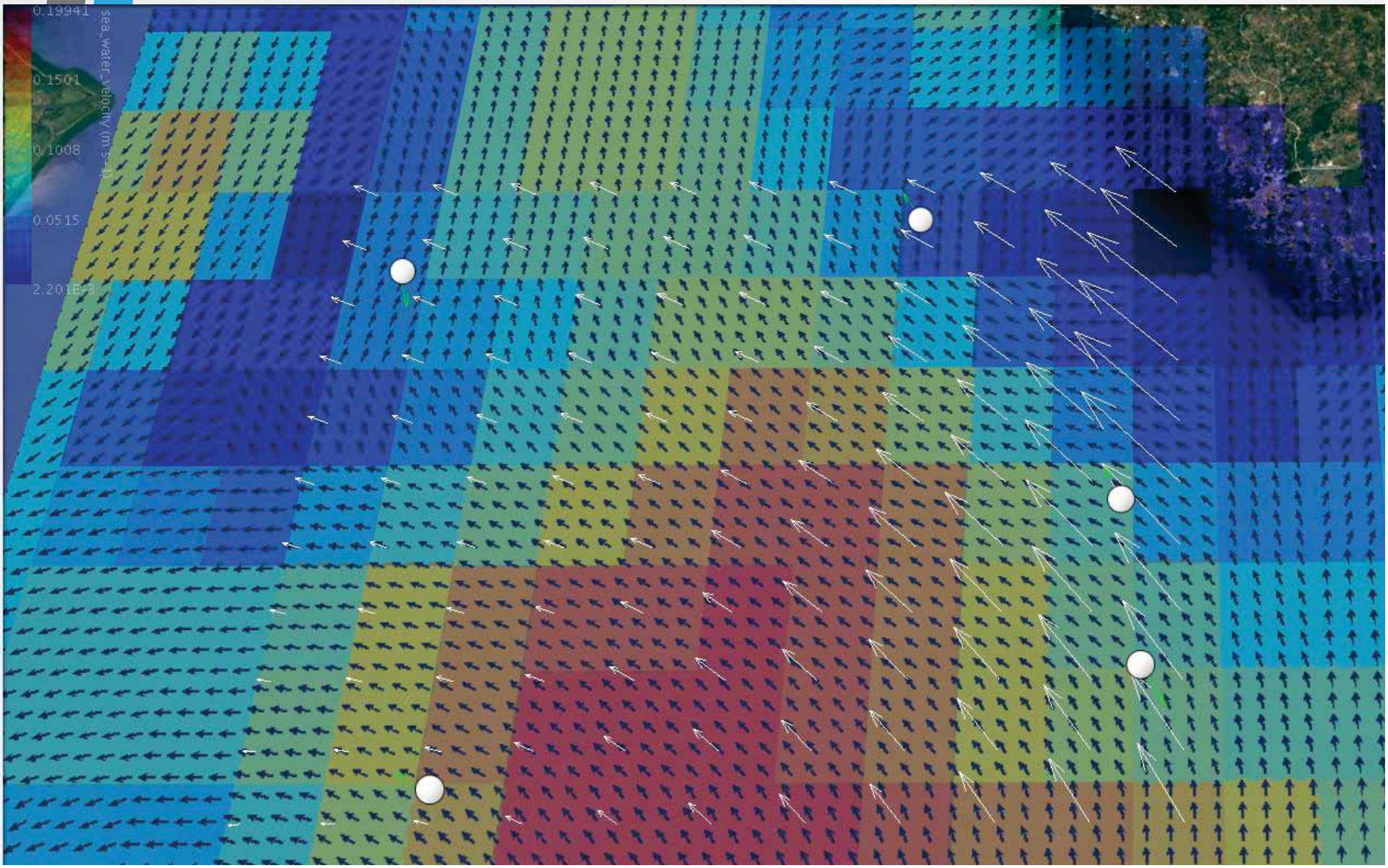
Multi vessel drifting approach towards metocean validation (calculated currents “AIS Currents”)

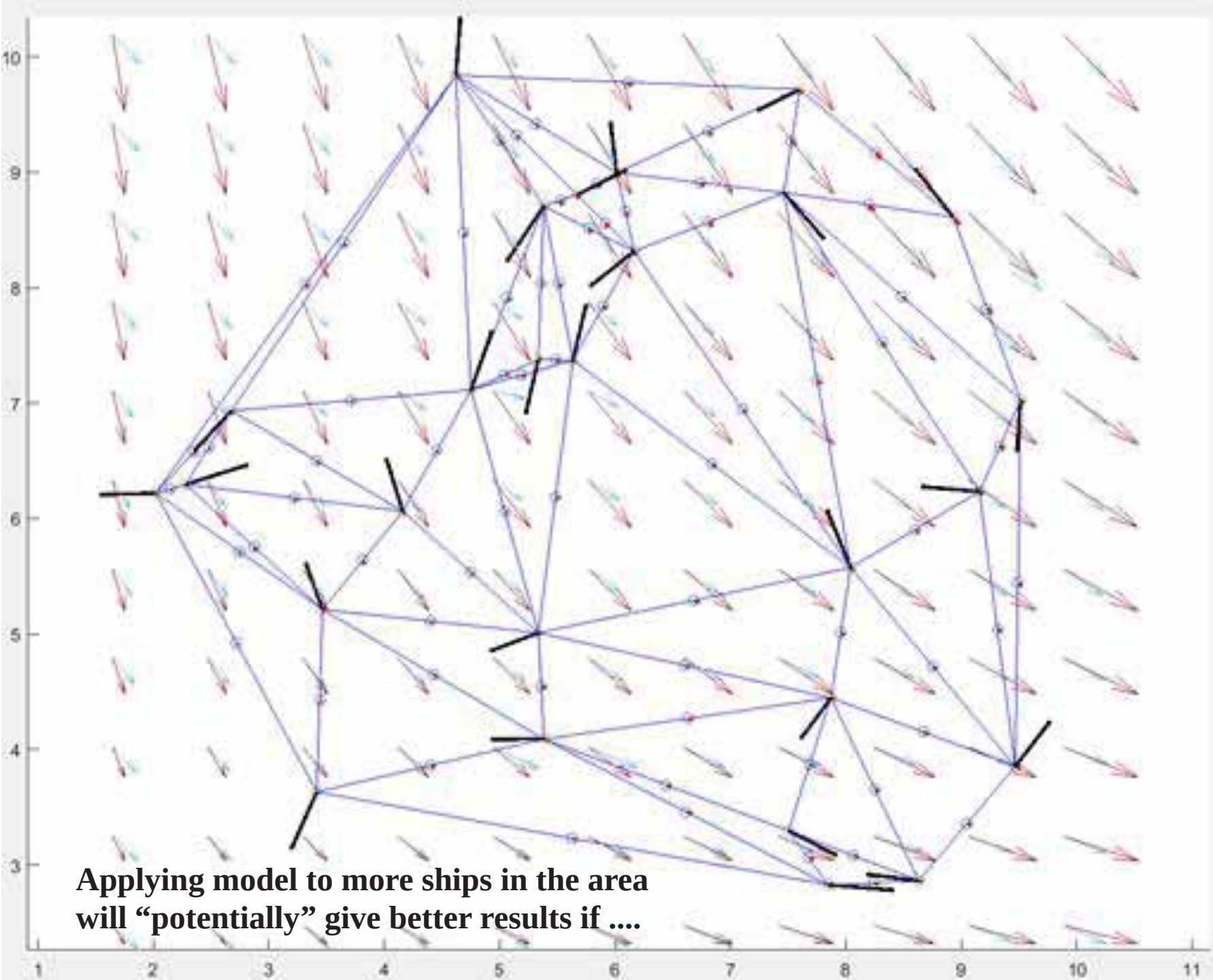
Results



Multi vessel drifting approach towards metocean validation

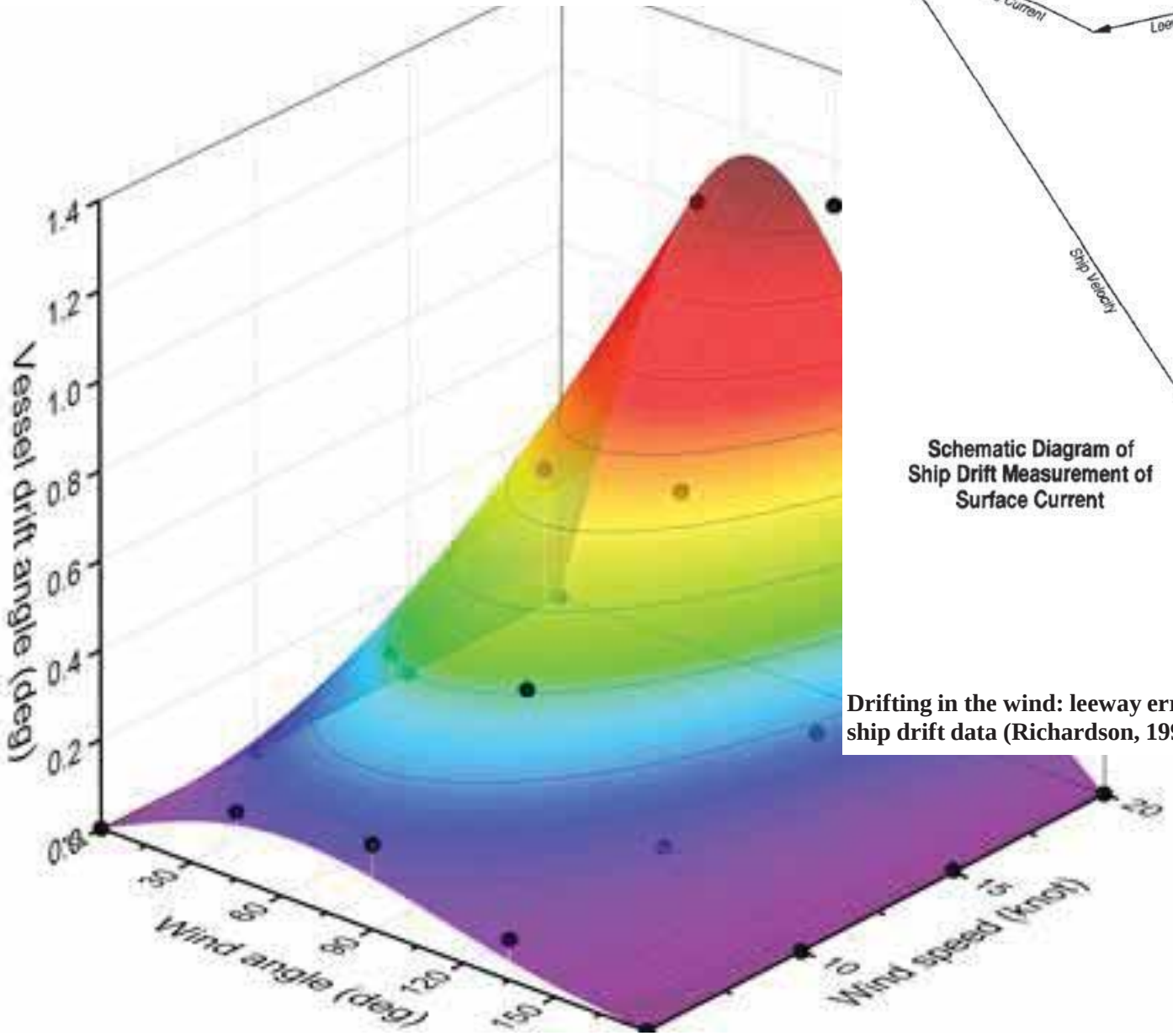
Surface currents model analysis data vs “AIS currents”

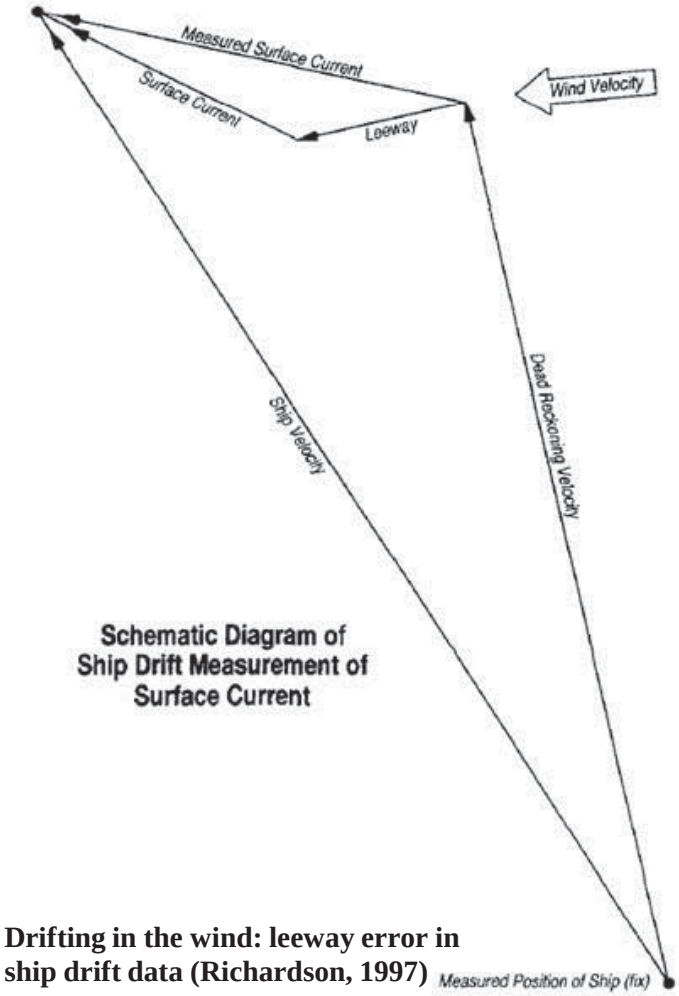




Applying model to more ships in the area will "potentially" give better results if ....

Leeway correction is implemented!!!



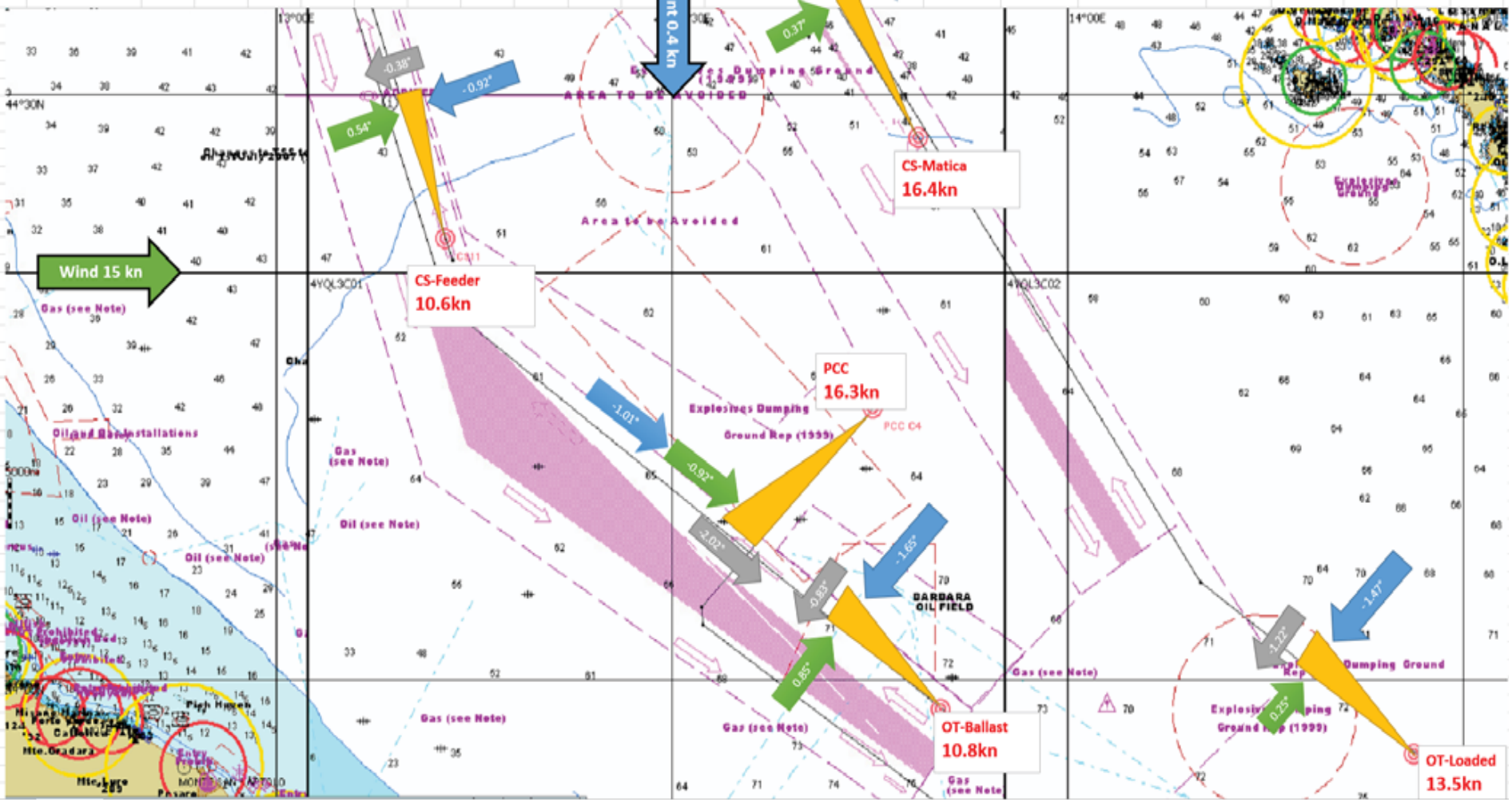


Drifting in the wind: leeway error in ship drift data (Richardson, 1997)

Leeway of large container carrier (mother ship) at slow steaming (11.5 kn)

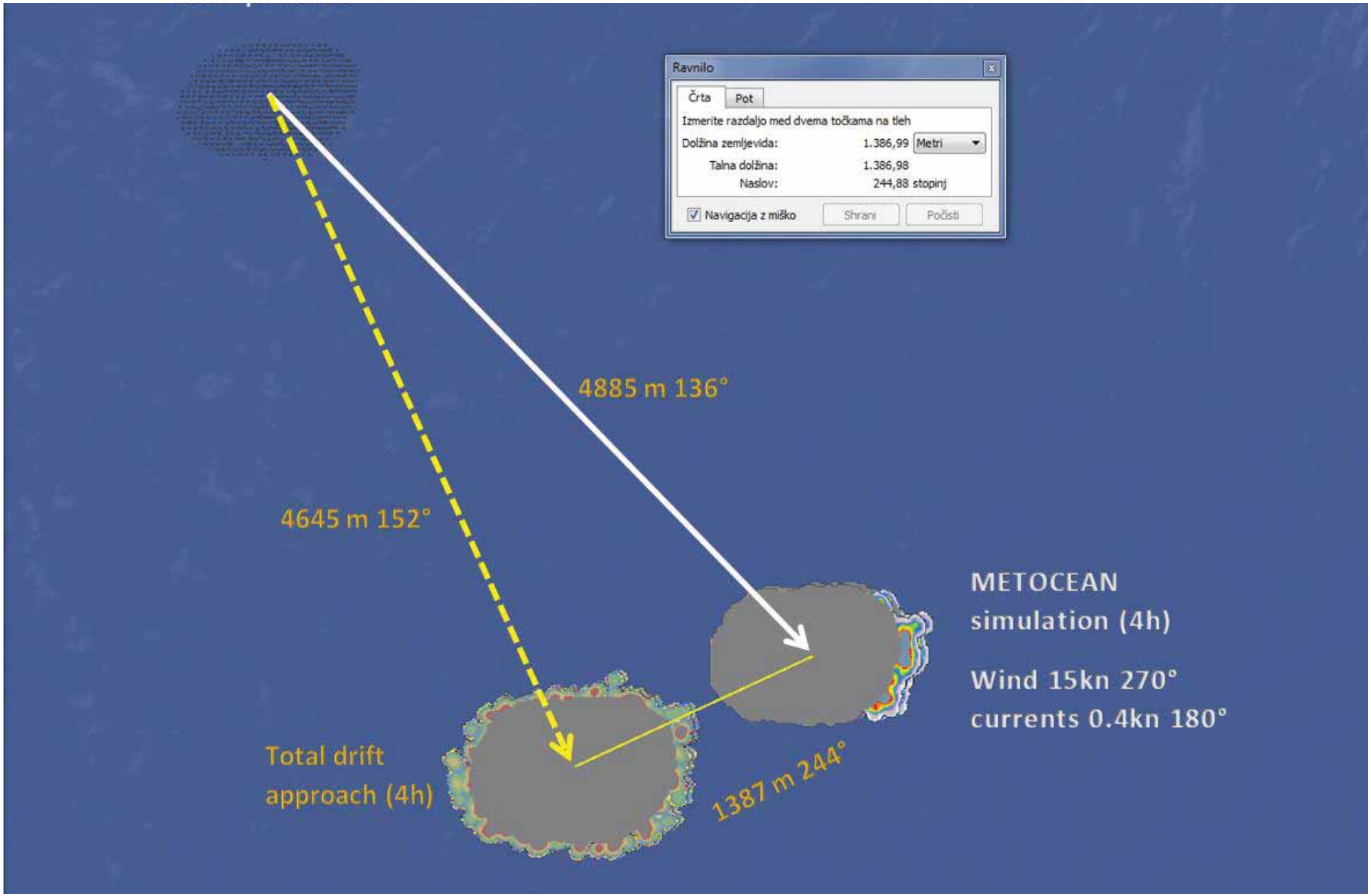
Example; hindcasting detected surfactants

MMSI	STATUS	ROT	SOG	LON	LAT	COG	HDG'	DRIFT (currents)
CS-Matica		0.00	16.41	13.81415	44.46047	327.60	328.34	-0.74
PCC		0.00	16.39	13.756	44.23263	220.99	222.09	-1.10
OT-Ballast	Average	0.00	10.84	13.8432	43.97258	306.90	308.55	-1.65
OT-Loaded		0.00	13.47	14.44189	43.93324	303.70	305.17	-1.47
CS-Feeder		0.00	10.62	13.21598	44.37434	343.37	344.29	-0.92



Total drift (AIS currents without leeway correction) vs. corrected drift approach

Example; Hindcasting detected surfactants



Total drift (AIS currents without leeway correction) vs corrected drift approach

Thank You

European Maritime Safety Agency

Celebrating 10 years CSN/ESA/EMSA

Break-out session 3:
The potential of RPAS

Moderators: Pedro Galache (EFCA) & Olaf Trieschmann(EMSA)

Room -01.13 Lisbon/ 15 Nov 2017

EMSA

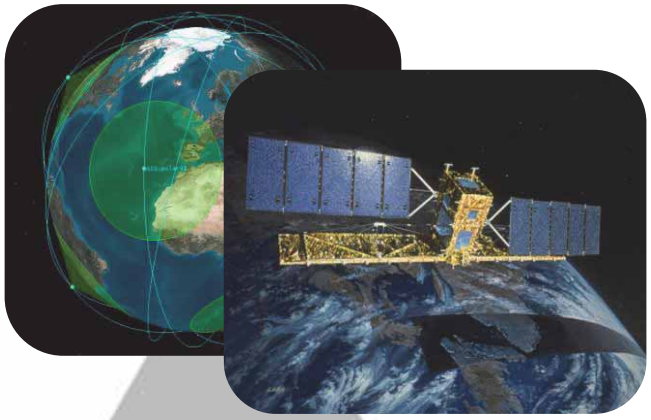
Seed Questions

- What are the existing gaps and visions? to be filled?

- What are the RPAS capabilities/unique advantages to complement maritime surveillance?
- How to integrate data from satellite, RPAS, in-situ to form a complete maritime picture?
- What are the issues still to be tackled to make RPAS complementing maritime surveillance?

Bridging the gap …

Remotely Piloted Aircraft Systems



How can RPAS complement maritime surveillance?

EMSA

Outcome of the breakout group “RPAS” - 1

- What are the existing gaps and visions to be filled?

  - Satellite, RPAS, manned aircraft and in-situ systems are complementary and not replacing each other!
  - LEO satellite with their orbits are not always available and cannot stay on location. RPAS can provide long term surveillance of a specific spot.
  - Rapid response is limited for LEO satellites (e.g. emergencies like SAR, pollutions response, natural catastrophes, …).
  - Unlike satellites, RPAS can fly below the cloud, which makes visible and IR observations available in cloudy atmospheres.
  - HAPS were seen to be the next steps for long endurance operations

Outcome of the breakout group “RPAS” - 2

- What are the RPAS capabilities/unique advantages to complement maritime surveillance?
  - Continuous monitoring of AOI (e.g. high-risk areas for fishing, hot spots for irregular migrants, or for duration of large SAR operations):
    - extreme endurance (which is not possible with manned aircraft) also in case of cross border operations and
    - large range to find and approach AOI
    - RPAS operation 24/7
  - RPAS could be operated in dangerous areas (e.g. over fires, radioactivity, HNS , anti-terrorism) – however a relevant set of sensors need to be defined Reconnaissance with RPAS (e.g. 3D analysis) of a ship could help in the decision making process and prepare response actions
  - OPAS (optionally Piloted Aircraft System) operations; Rapid deployment services where crew and ground equipment fly the aircraft to base location of RPAS operations and flexible operation based on need for unmanned missions

Outcome of the breakout group “RPAS” - 3

- How to integrate all data to form a complete maritime picture?
  - Integration of RPAS with the other data sources by value adding and fusing of information is requested
  - Real time data is essential to react immediately. But post-flight video was requested
  - Geo-projection of data/video on maps is requested for operational purposes
  - RPAS should be included in the
    - civil protection mechanisms
    - inspection regimes, e.g. THETIS
  - Common (open source) standards for dissemination and fusion of data are proposed: data should be exchanged by respecting the INSPIRE directive.

Outcome of the breakout group “RPAS” - 4

- What are the issues still to be tackled to make RPAS complementing maritime surveillance?
  - A standardized management and use segregated air space is necessary to make RPAS operations work seamlessly
  - Harmonized (EU) procedures required for permit-to-fly (incl. common risk analysis)
  - Operational procedures in MS how to use RPAS needs be addressed
  - EMSA was requested to focus larger RPAS with complex payload – and to operate them multinational; smaller RPAS could be operated on national level
  - Data link for real time data availability is essential (RLOS up to 100km, SatCOM beyond)
  - Use of software/sensors technology in order to fully autonomously detect, identify and classify substances. Sensor payload capable to identify substances have to be identified:
    - Unmanned vessels for in-situ observations?
    - Exchangeable sensor?
  - To be analyzed that RPAS are accepted to take evidence (e.g. taking samples) which would be very helpful for court cases – however this has to be tackled on national level

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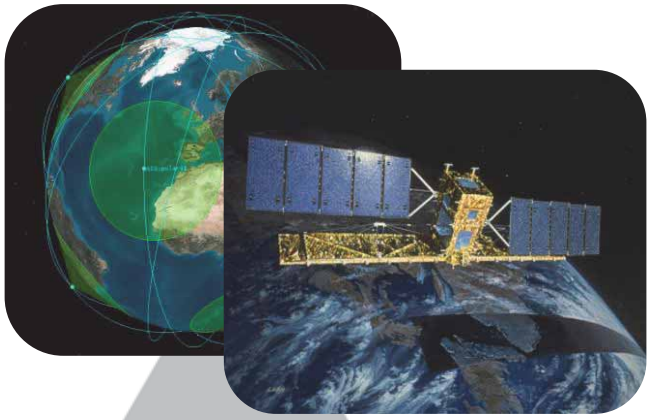
Integrating everything …



EO, SatAIS, LRIT

Observations
AIS, VDES

AIS

EMSA integrated maritime services

- Common interface
- Maritime picture
- Data fusion

- Ship registry
- Maps

Port state information

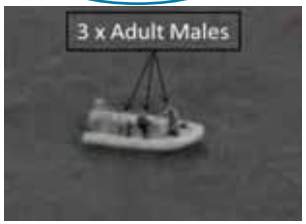
- Models
- Behaviour analysis

RPAS for maritime surveillance

Earth observation satellite

Distress
AIS

Radar, IR, optical



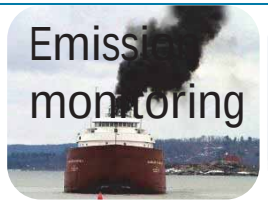
Common integrated services:

- in real time
- mapping of data
- alerting

Registries
Maps

In-situ data:
(Sat-)AIS, LRIT

User communities



European Maritime Safety Agency

Celebrating 10 years CSN/ESA/EMSA

Break-out session 4:
New Ideas and Technologies

Moderators: Pierre Potin (ESA) & Pedro Lourenço (EMSA)

Room 0.41 Lisbon/ 15 Nov 2017

Break out session 4: Operational needs

- Search and Rescue:
  - Ability to track satellite phones used by migrant ships
  - Ability to detect, track and characterize simultaneously a high number of migrant ships
  - Issues in terms of communications close migrant departure areas which affect SAR operations
- Oil spill monitoring
  - Ability to detect substance and volume of the spill
- Maritime Security
  - Ability to detect radar signatures of non/reporting vessels
- Maritime Safety
  - Need to have precise ice mapping for navigational purposes in specific areas of the Baltic (Gulf of Riga)
- Multipurpose
  - Persistent monitoring as a need for multiple use cases
  - Precise drift modelling requirement for search and rescue, oil spill monitoring, etc.
  - Accuracy of satellite detection of vessel speed, heading and length critical for operations

Break out session 4: Technologies / applications

- Electronics signal intelligence
  - Detection of satellite phones used on board migrant ships
  - Detection of ship radars of non/reporting vessels
- Combination of satellite information with other assets
  - Satellites used for the detection of vessels but characterization of targets requires other assets (RPAS, HAPS, etc.). Combination of assets is key.
- Oil spill monitoring
  - Hyperspectral sensors can be used to derive information about nature of the spill (Sentinel expansion mission?)
- Multipurpose
  - Persistent monitoring requires constellations, geostationary assets and/or a combination with non-space assets (RPAS, HAPS, etc.)
  - Tasking time and revisit time (as well as daily pass time) as critical variables
  - Quality of the derived information (in terms of accuracy of speed, heading, length), as well as detection reliability (false positives and false negatives(critical for multiple use cases.

Celebrating 10 years CleanSeaNet service Cooperation between ESA and EMSA

Conclusions

Leendert Bal / Head of Department
Department C: Operations

Lisbon / 15 November 2017

EMSA
European Maritime Safety Agency

Conclusions
Session 1: CleanSeaNet 10 years

- **Sustainable, mature EU wide harmonized service**
- **Strongly integrated in Coastal States pollution response chains**
- **Optimizes the uses of Coastal surveillance assets**
- **Enabled by strong cooperation with Industry**
- **Creates a clear long term deterrent effect for European waters**
- **Backbone of EMSA's Earth Observation Services (i.e. Copernicus Maritime Surveillance)**

Conclusions
Session 2: ESA EMSA cooperation

- **Strong synergies between EMSA and ESA: ESA's research and development activities and pre-operational demonstrations are taken to operations by EMSA**
  - ✓(i.e. ESA MARCOAST project and the SAT-AIS joint initiative)

- **Close partnership in Earth Observation for the maritime domain**
  - ✓ (bringing ENVISAT and SENTINEL-1 A/B into service, testing EDRS)

- **Cooperation has a lot of potential for the future:**
  - ✓RPAS and SAT-COM
  - ✓Satellite component of VDES, data processing, applications
  - ✓HAPS (High Altitude Pseudo Satellites)
  - ✓Vessel traffic management of unmanned vessels

Conclusions
Session 3: Defining the future

- **Break out sessions**
  - ✓Outcome will be summarised in the conference report
  - ✓Interesting ideas/inputs which will be explored further
  - ✓Positive outlook what new technologies and services can bring to the maritime domain

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