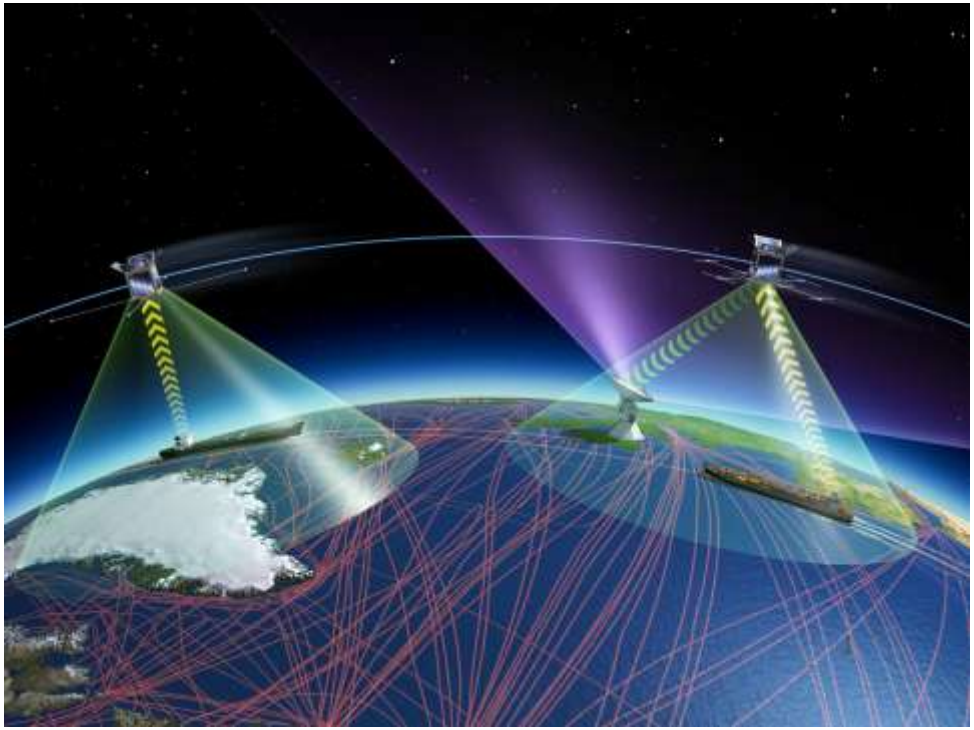
SAT-AIS DPC

DEMONSTRATOR OF A DATA PROCESSING CENTRE FOR SATELLITE BASED AIS SERVICES

Nuno Almeida

National Space Info Day

Lisbon, 28th October 2015



Credit: ESA

Elecnor Deimos *is a trademark which encompasses Elecnor Group companies that deal with Technology and Information Systems: Deimos Space S.L.U., Deimos Imaging S.L.U., Deimos Castilla La Mancha S.L., Deimos Engenharia S.A., Deimos Space UK Ltd., Deimos Space S.r.L. (Romania).*

© DEIMOS Engenharia S.A.

Project Presentation

- SAT-AIS DPC is a Demonstration Project from ARTES-20 IAP programme and is part of the Thematic Area "Transport & Logistics"
- Co-funded by ESA and EMSA
- The objective of the project is to specify, design, develop, integrate, validate and pre-operate of the DPC
- To demonstrate the scalability for satellite constellations that might result from on-going or future SAT-AIS initiatives
- EMSA is the main user of the services provided and DPC is an additional data stream of SAT-AIS data and services
- From September 2011 to March 2014
  - Including a pre-operations phase of 8 months

© DEIMOS Engenharia S.A.

Industrial Organisation

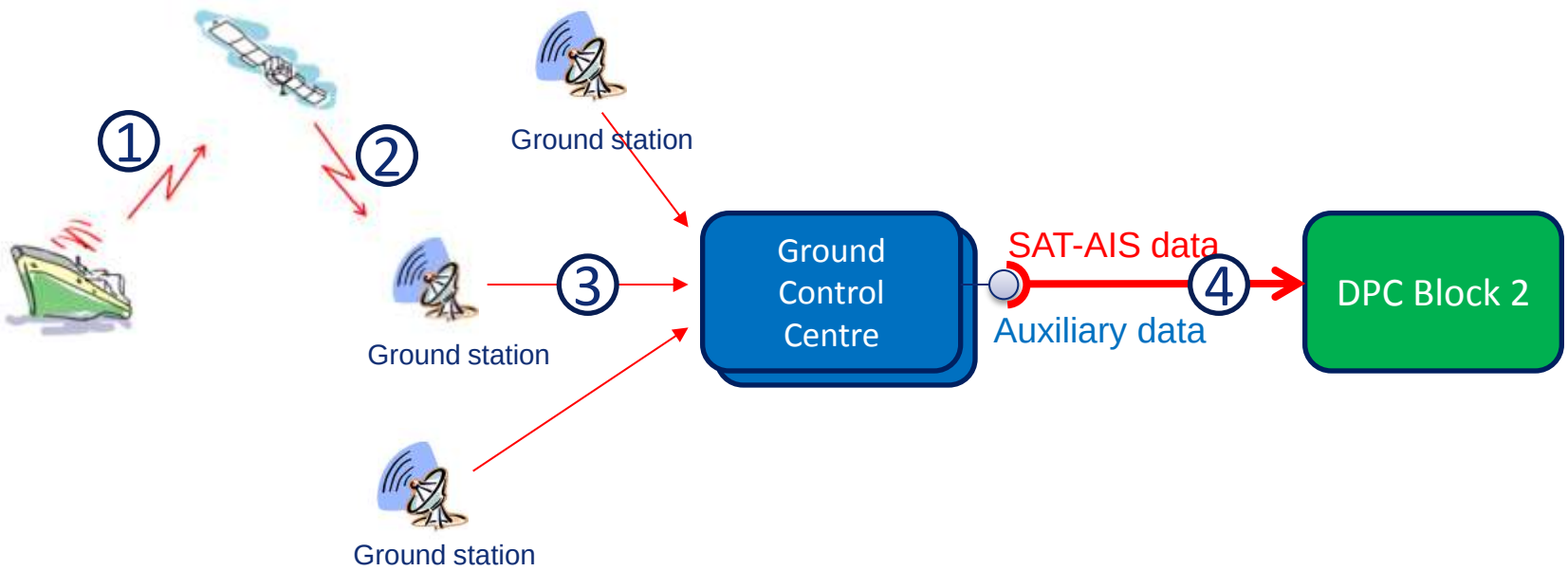
© DEIMOS Engenharia S.A.

Company Presentation

- **DEIMOS Engenharia** belongs to the ELECNOR DEIMOS group
- Located in **Lisbon, Portugal** since 2002
- Staff of 40 Engineers
- Areas of Expertise
  - Earth Observation Systems and Applications
  - Guidance Navigation and Control
  - **Ground Segment Systems***
  - Satellite Navigation

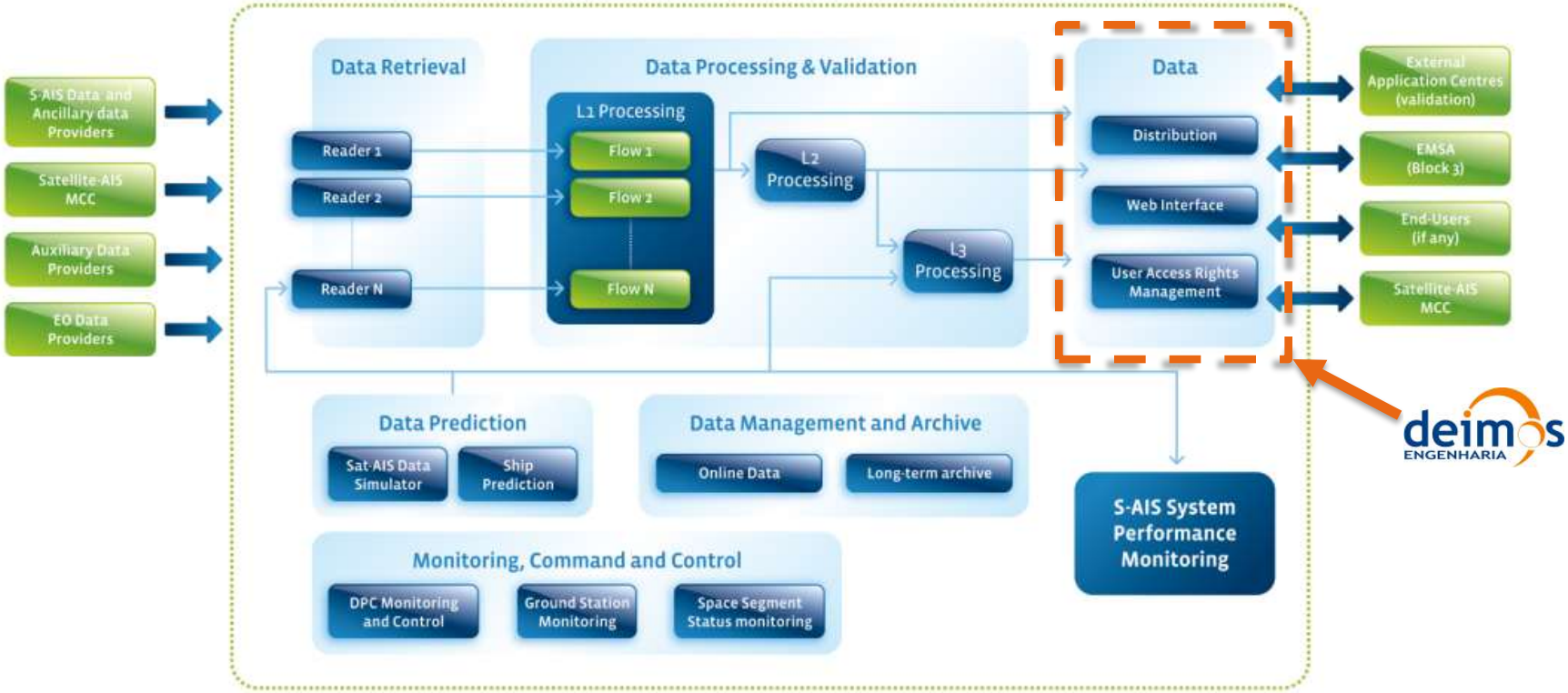
© DEIMOS Engenharia S.A.

System Presentation



© DEIMOS Engenharia S.A.

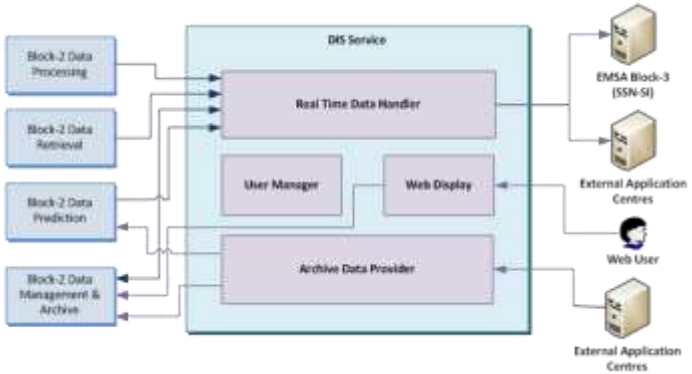
System Presentation

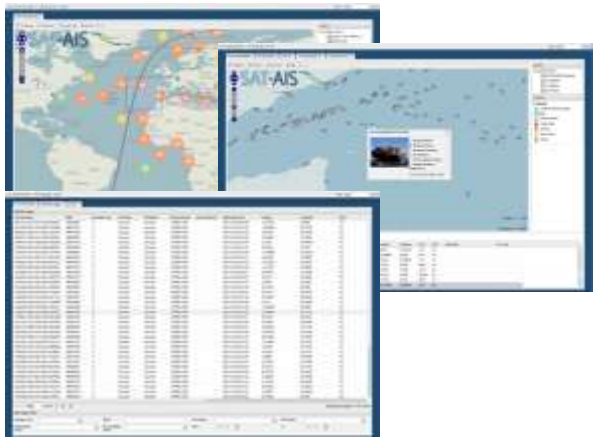


© DEIMOS Engenharia S.A.

DEIMOS Activities

- **To Support the SAT-AIS DPC High Level Definition**
  - High Level Requirements Definition and Design
- **To develop Data Distribution Subsystem**
  - Deliver data to authorized clients
  - Manage external queries
- **To develop a Web Display Interface**
  - GIS Support
  - Tabular Display
  - User Management
- **To Support System Validation**
  - To develop the DPC Validation Plan
  - To support on Overall Validation Activities





© DEIMOS Engenharia S.A.

DPC Services

Standard performance service

Service 1: Standard AIS messages provision

Advanced performance services

Service 2: Missing AIS messages

Service 3: Enhanced AIS messages provision

Service 4: Predicted AIS messages

Service 5: AIS messages with EO service

Service 6: SAT-AIS information

© DEIMOS Engenharia S.A.

Service 1: Standard AIS messages provision

Inconsistent positions detection:

- **CRC** validation
- AIS message **length** validation
- AIS message **content** validation (vs. bounded values)
- GPS position comparison with SAT-AIS satellite coverage area (vessel position inside satellite **footprint**),
- Consistent **velocity** test (average speed w.r.t. previous/next ship position)

Invalid AIS messages marked and distributed to EMSA

© DEIMOS Engenharia S.A.

Service 2: Missing AIS Messages

Service 2 produces « **Missing AIS messages** » report

- Alerts are generated **for a given vessel** when the number of AIS messages received at the DPC Block2 is below the expected.
- These alerts are computed using a specific simulator.
- The service produces and distributes alert reports in standard CAP format to EMSA
  - **Missing AIS messages alerts** when the vessel is not detected in a limited amount of time by one satellite
  - **Ship lost** alerts when all satellites of all providers cannot detect the vessel

© DEIMOS Engenharia S.A.

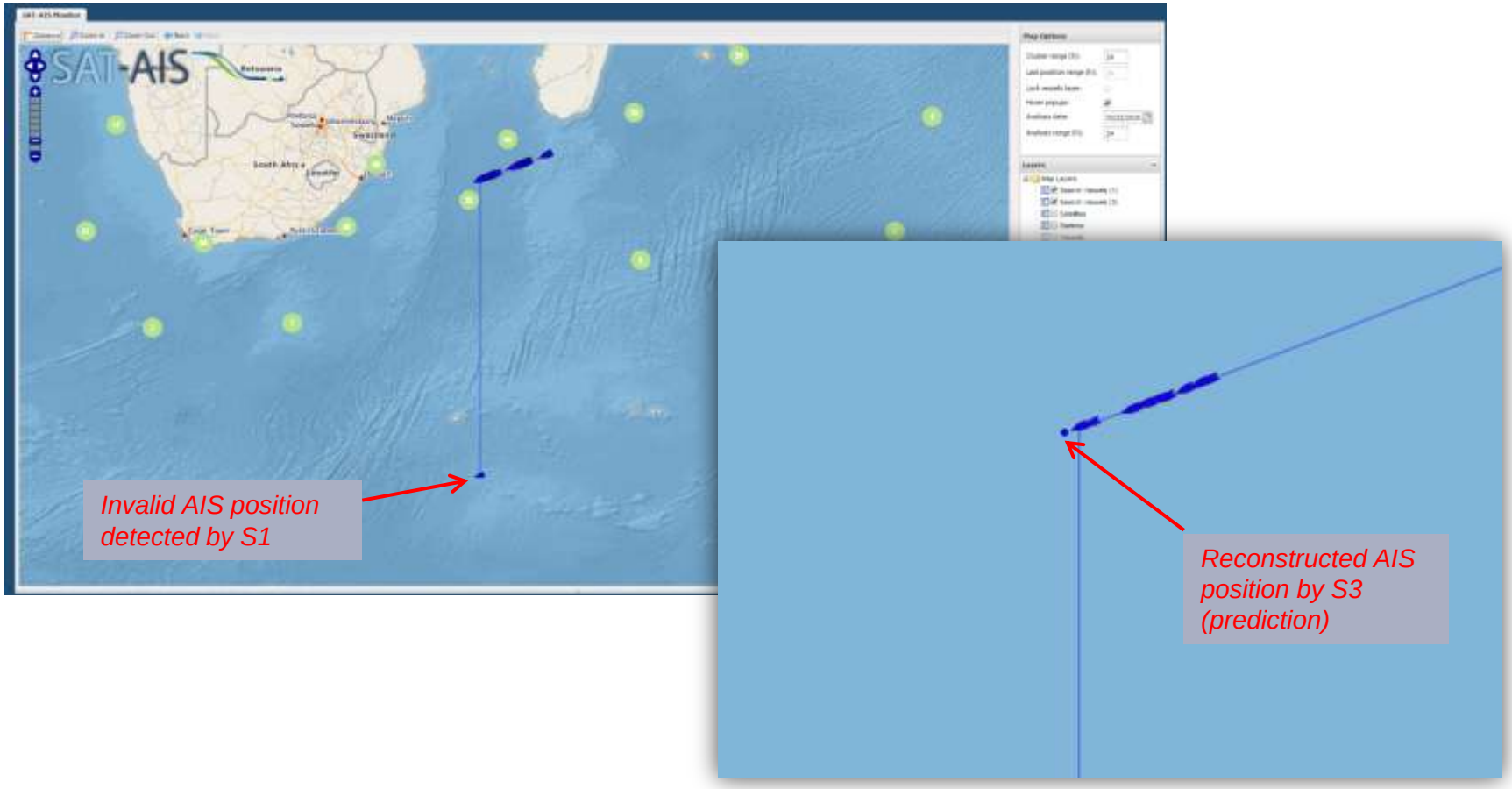
Service 3: Enhanced AIS messages provision

Service 3 enhances AIS messages with **value added** information

- With **valid** S1 AIS messages, S3 tries to correlate the GPS position with a Doppler-derived position.
  - This provides additional level of confidence for the validated position.
  - In case of Doppler invalidation an alert is raised
- With **invalid** S1 AIS messages, S3 tries a position reconstruction using several method:
  - Prediction reconstruction
  - Doppler reconstruction

© DEIMOS Engenharia S.A.

Service 3: Enhanced AIS messages provision

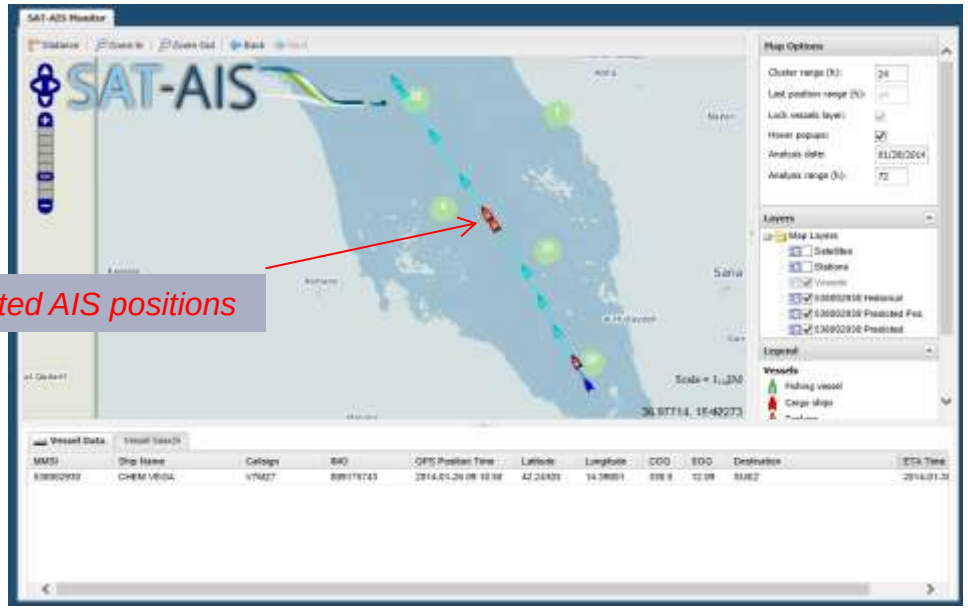


© DEIMOS Engenharia S.A.

Service 4: Predicted AIS messages

Service 4 offers Predicted AIS Messages

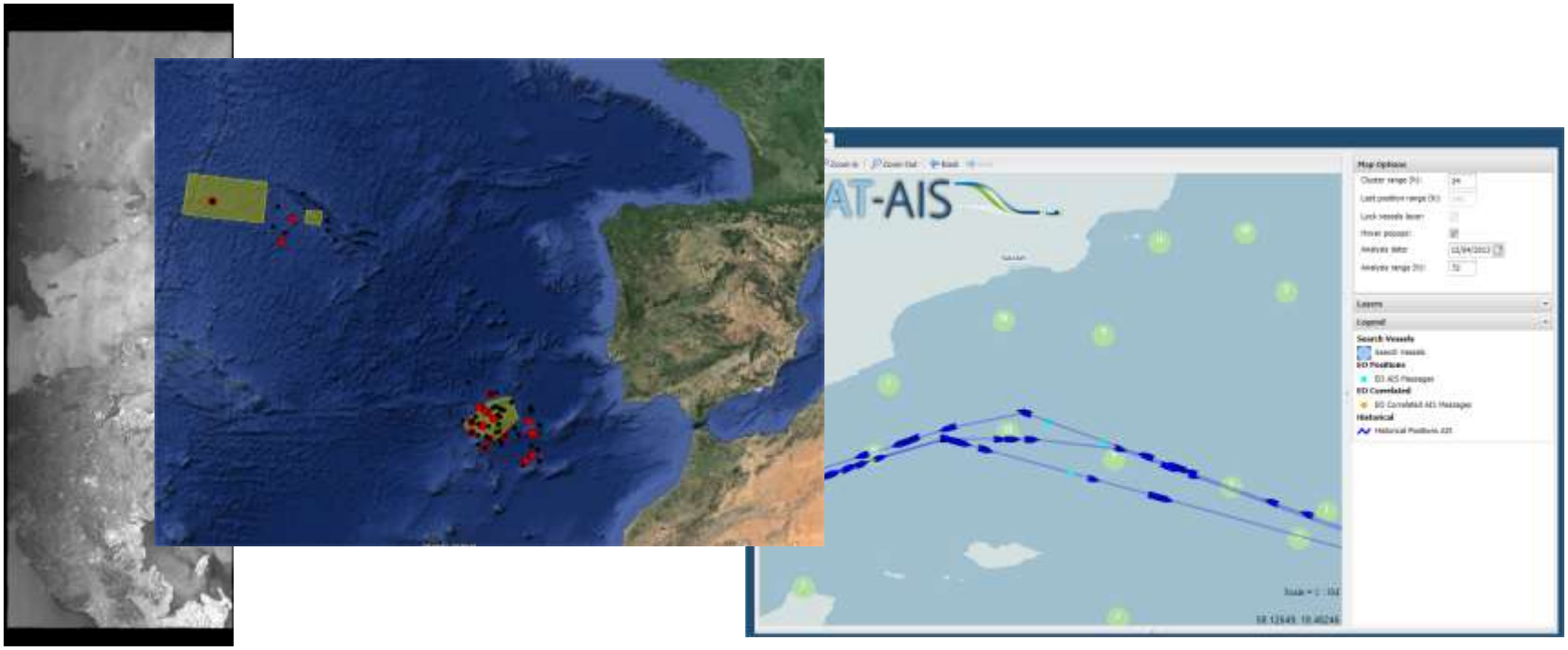
- Simulations are run on demand
- S4 inputs: Vessel's **port of call**, **speed** and **heading**.



© DEIMOS Engenharia S.A.

Service 5: AIS messages with EO service

Service 5 correlates Vessel positions reported by AIS and EO SAR Vessel data report



© DEIMOS Engenharia S.A.

Service 6: SAT-AIS information

Service 6 provides SAT-AIS information:

- SAT-AIS **orbital elements** (TLE or state vectors in J2000)
- **Satellites** and **ground stations** information
- Satellites and ground stations status and events (current or scheduled)
- **Downlink schedules** (downlink of satellites data to the ground stations)
- Processing / delivery delay for the ground stations

S6 provides a deeper knowledge of the space segment to the end user.

© DEIMOS Engenharia S.A.

Product Benefits

- To provide ship detection capabilities at distances from coastlines that cannot be covered by land-based AIS
- Validation of the positional information included in AIS messages providing an effective mean to identify and counteract illegal (maritime related) activities.
- SAT-AIS information will support European entities and institutions in:
  - law enforcement,
  - fisheries control campaigns,
  - maritime border control operations,
  - maritime safety and security issues including marine pollution response,
  - search and rescue
  - anti-piracy.

© DEIMOS Engenharia S.A.

Development Challenges

- Support high data volume (~5 millions AIS / day)
- Support peaks of data (SAIS data are distributed by flows)
- Provide high timeliness
- Provide high availability
- Handle ship prediction for lots of ships
- Simulate satellites / ships in real time
- Package an easily installable software

© DEIMOS Engenharia S.A.

Demonstration Campaign

8 months demonstration / 2 Areas of Interests:

- Atlantic Ocean + South Mediterranean sea
- Indian Ocean

Key performance indicators defined with ESA and EMSA

- Number of AIS messages **processed**
- Number of **distinct vessels** detected
- S1 related indicators (number of **invalid messages** detected / check)
- S3 related indicators (% of **reconstructed/validated** positions, Doppler positioning **accuracy**, **timeliness**)
- S5 indicators
- Ship prediction accuracy

Non-functional KPI:

- ICT related (**resources** usage monitoring: memory, CPU, disk IO)
- Uptime/downtime of the services, number of incidents

© DEIMOS Engenharia S.A.

Project Extension

- The scope of this Project Extension was to prepare the system to be deployed at EMSA premises (which was not foreseen in the beginning).
- Interfaces adaptation for data input and data distribution
- Data provider interface support
  - Data acquisition channel from ExactEarth proxy
- Migration from Posgresql to Oracle RAC database
  - Oracle spatial features
  - Partitioning of large tables (AIS messages, positions L1, positions L2)
- Tomcat migration
- Doppler engine calibration for ExactEarth data
- Monitoring and control
  - Specification and script monitoring samples
- From September 2014 to June 2015

© DEIMOS Engenharia S.A.

SAT-AIS capacity building in Portugal

This was the first system developed through the cooperation between ESA – EMSA.

- Granted DEIMOS key knowledge source for SAT-AIS systems in Portugal
  - Architect of Data Distribution Service on EMSA
  - Developer of High Performance SOA systems
- Created new partnership opportunities for future activities in SAT-AIS
- Case study of national technology developed by DEIMOS (QREN) entering into operation.

© DEIMOS Engenharia S.A.

Conclusions and opportunities

- Supporting SAT-AIS was a key decision by Portuguese Delegation
- SAT-AIS will become main oceanic security/safety asset in near future
  - The number AIS Satellites and operators is ramping up fast:
    - ORBCOMM will be launching 17 additional satellites, as part of its ORBCOMM Generation 2
- SAT-AIS is mandatory source of operational information for Portugal
  - when 97% of its territory will soon be ocean
- Opportunity for Portugal to become a source of innovative value-added services based on the know-how and capacity to exploit SAT-AIS
  - Data fusion with Copernicus products and Open Data
- Critical that Europe (and Portugal) continue supporting AIS through ARTES

© DEIMOS Engenharia S.A.

Thank you

Elecnor Deimos *is a trademark which encompasses Elecnor Group companies that deal with Technology and Information Systems: Deimos Space S.L.U., Deimos Imaging S.L.U., Deimos Castilla La Mancha S.L., Deimos Engenharia S.A., Deimos Space UK Ltd., Deimos Space S.r.L. (Romania).*

© DEIMOS Engenharia S.A.