SEASAR12 WORKSHOP, TROMSO, 06-12

NEREIDS: New concepts in maritime surveillance for consolidating operational developments

SEVENTH FRAMEWORK PROGRAMME

gmv® INNOVATING SOLUTIONS

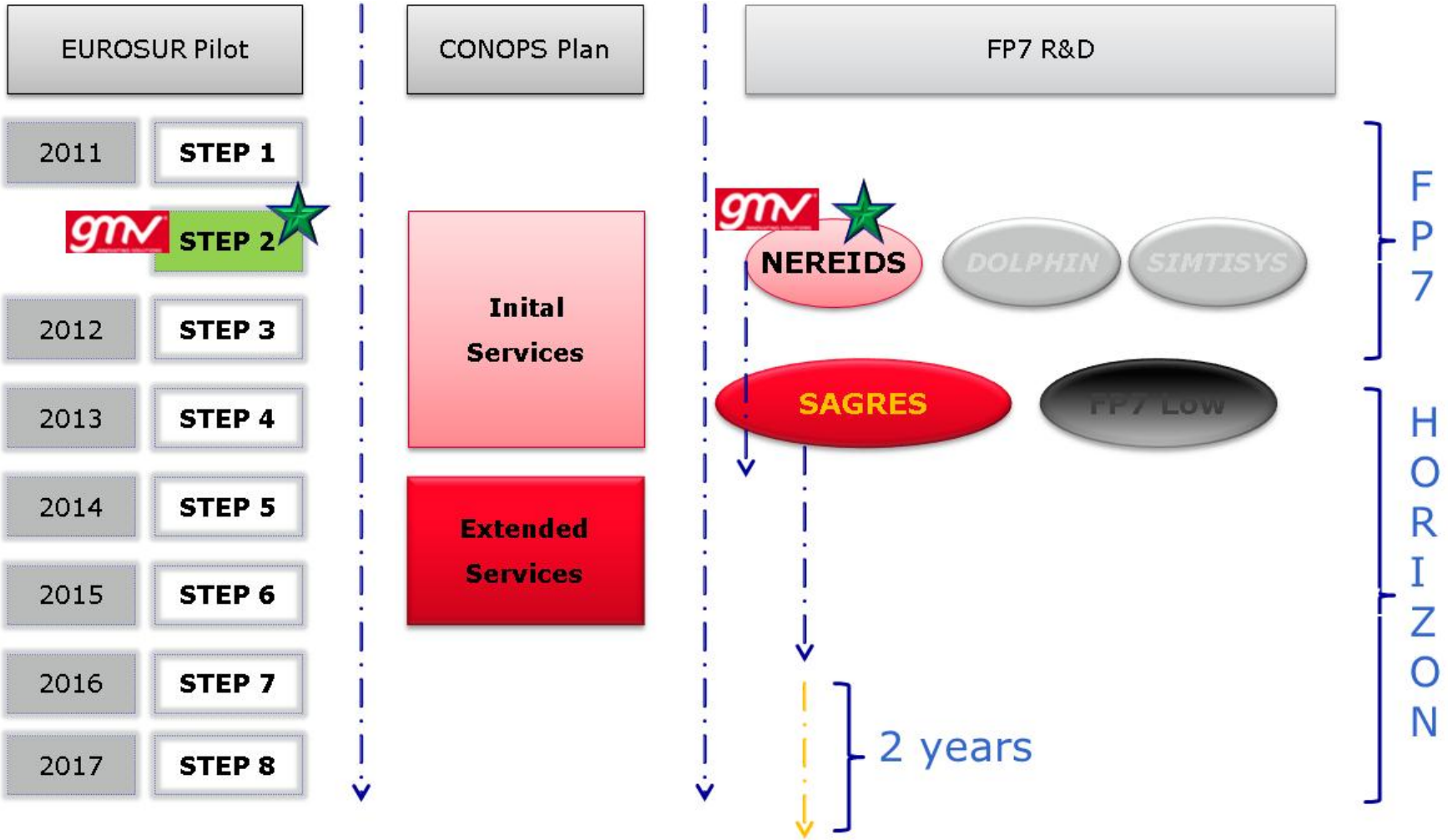
SUMMARY

- **NEREIDS PROJECT**
- NEREIDS CHALLENGES
- NEREIDS SYSTEM
- NEREIDS SCENARIOS

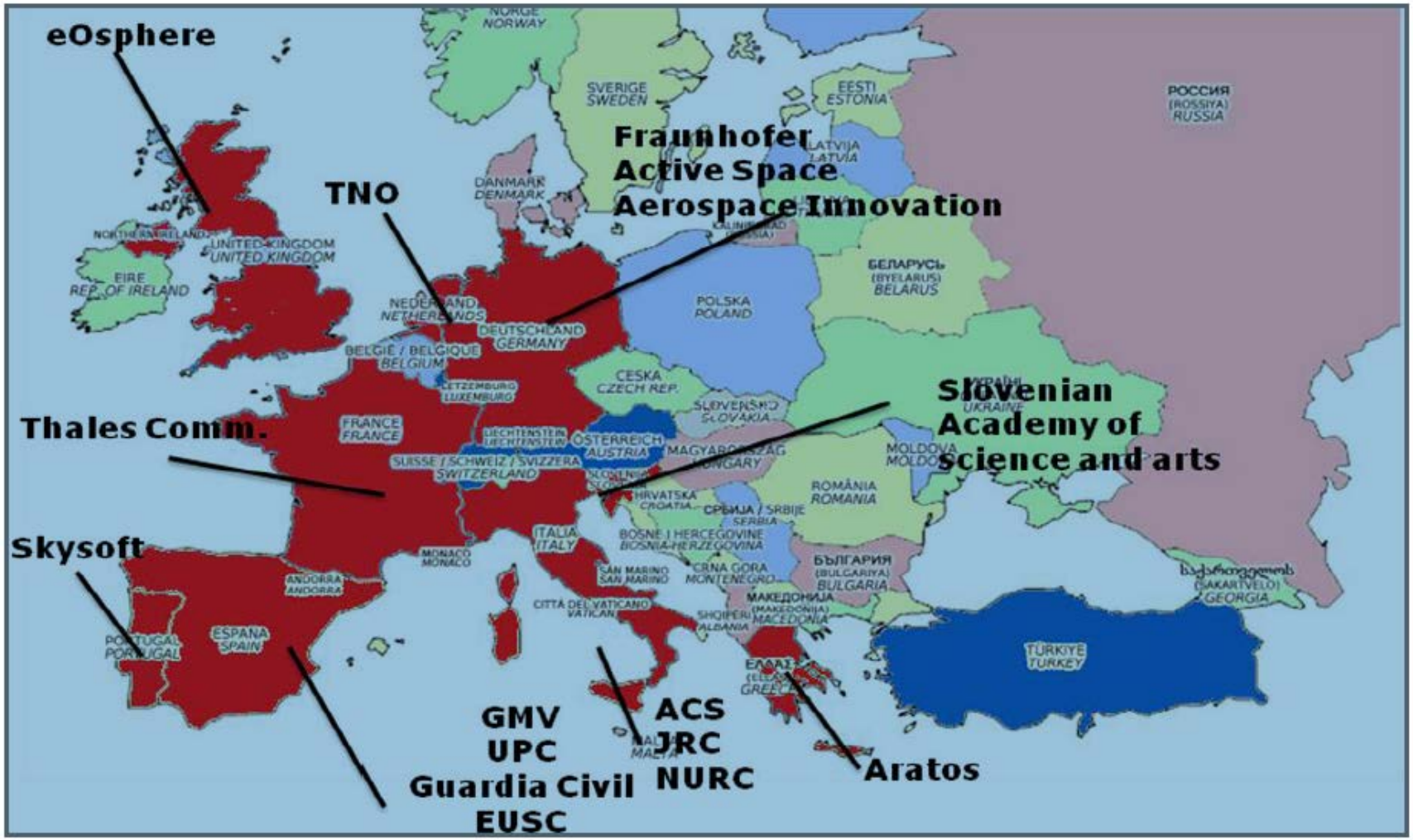
NEREIDS PROJECT: FIGURES

- CALL: 2010 Space Call,
  - SPA.2010.1.1-05 Contributing to the “S” in GMES – Developing pre-operational service capabilities for Maritime Surveillance.
- Customer: EC
- Duration: 36 months (01-06-2011 / 01-06-2014)
- Budget: ~6 M€.
- Requested Contribution: ~4 M€.
- Appointed effort: ~500 man/months
- Consortium of 16 partners with a proper distribution of R&D, SME, large companies and user segment.

NEREIDS PROJECT: FRAMEWORK



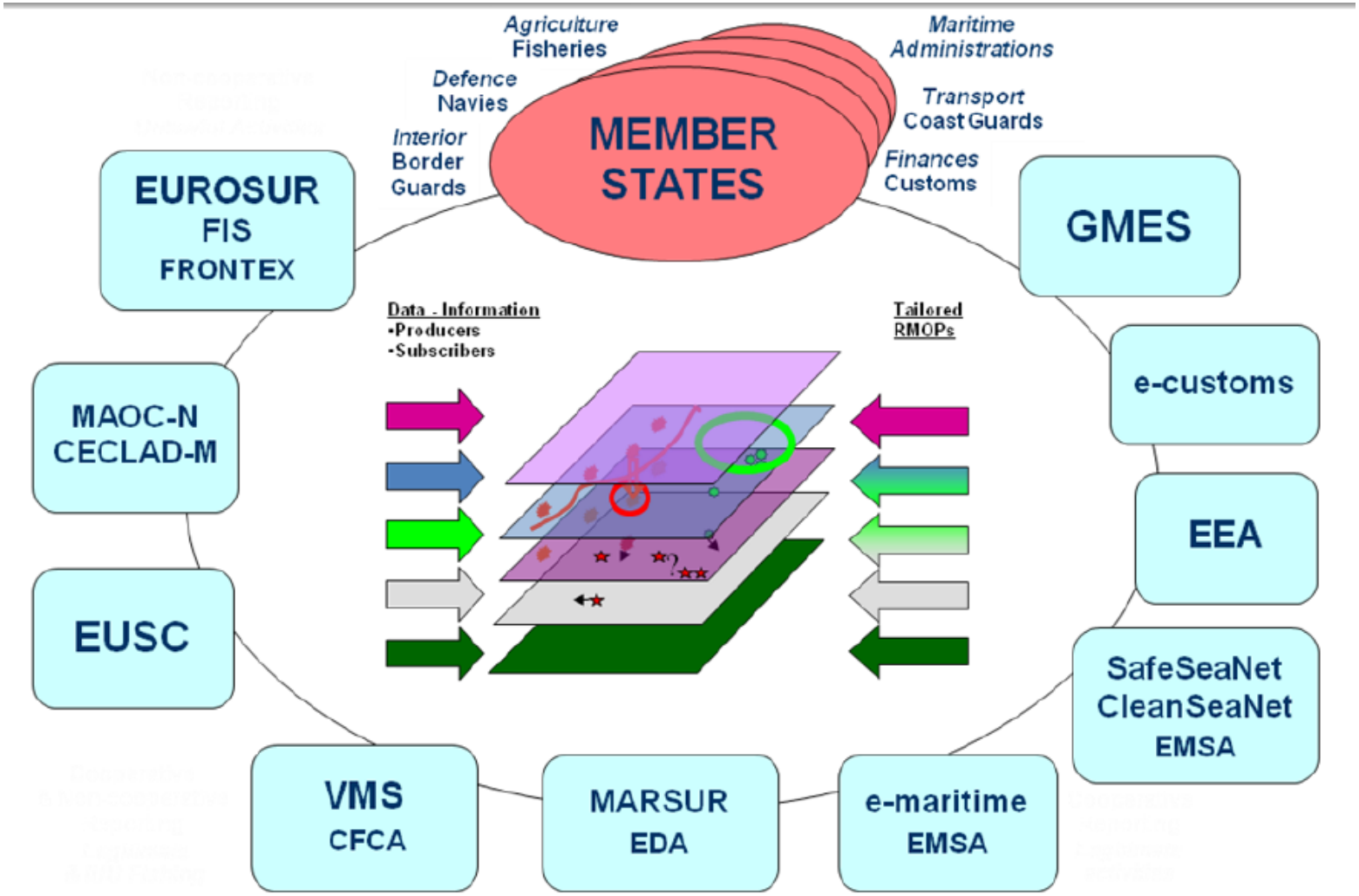
NEREIDS PROJECT : CONSORTIUM



NEREIDS PROJECT : OBJECTIVES (I)

- Test new technical and technological developments
  - The results shall be integrated, if possible, into EUROSUR and Space 2011 call projects.
  - Mostly devoted to enhance the detection capability in adverse conditions → Automatic Benchmark
- Integrated vision for maritime policy and surveillance
  - Take maritime policies and legal issues into account
  - Link user communities at regional, national and European level
  - Technological framework for interoperability (SOA, formats…)
  - Invest educational efforts to the user segment
    - User community is not homogenous and has a particular culture.
    - The proper explanation of new technologies is critical.

NEREIDS PROJECT : OBJECTIVES (II)



NEREIDS PROJECT : OBJECTIVES (III)

- GMES initiative merging
  - Best use of space assets → integrating what existing (AIS, SAR, Optic…).
  - Merge efforts among other GMES initiatives
  - Promotion of new satellite platform concepts.
  - Contribute to the definition of future maritime services within GMES.
  - Face technological challenges related to current user needs. Application areas
    - Open sea surveillance in a tactical way → NRT operations
    - Monitoring the coastal areas of third countries → non-NRT operations.
    - Integration with other platforms and sensors.

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NEREIDS CHALLENGES

- Technical challenges: *Target Detection*
- **SAR**
  - Ambiguity filtering:
    - Selective filtering → frequency domain nulling of ambiguities energy;
    - Matched filter → blind deconvolution;
    - Adaptive filtering → Selective filtering + Wiener filter;
    - Pixel level processing → analysis of gaps between real and ghost signal.
  - Land Masking:
    - Processing of shape files,
    - Wavelet-based approach → wavelet + Geodesic Active Contour (GAC).
  - Detection:
    - SUMO → K-distribution CFAR detector
    - EOSPHERE → CFAR detector + polarimetric analysis
    - Wavelet-based approach → Wavelet analysis.

NEREIDS CHALLENGES

- Technical challenges: *Target Detection*
- **SAR**
  - Autofocus (reduce the effects of blurring in images):
    - Multi Aperture Mapdrift → polynomial function model of the phase error build from the shifts among a set of non-overlapping sub-aperture.
    - Contrast-based Autofocus → considers a second-polynomial phase error function and find the coefficients which maximize the Image Contrast
    - Phase Gradient Autofocus → Fourier Transform properties to estimate the derivative of the phase error
  - Wake Detection:
    - Pre-processing → edge detectors, image segmentation
    - Transform → Radon, Radon+Wavelets, Hough
    - Detection → Wiener, Stochastic Matched, Dempster-Shafer
  - Target Categorization:
    - POLSAR →
    - POLInSAR →

NEREIDS CHALLENGES

- Technical challenges: *Target Detection*
- **OPTIC**
  - Object-based from VHR images. It accounts for four main steps
    - Coastline detection → image segmentation
    - Cloud removal → image segmentation
    - Target isolation → Feature-space thresholding, Region growing, Edge
    - Classification of candidates →Mathematical morphology.
  - Multiband satellite data for detecting small ship targets.
    - Reed-Xiaoli (RX) detector→ algorithm as the benchmark anomaly detection;
    - PCA → Principal components analysis (PCA).
    - Oriented Pyramids → Oriented or steerable pyramids are efficient tools to model the spatial structure of textured backgrounds.
    - Morphological filters → top-hat transforms or toggle contrast operator.

NEREIDS CHALLENGES

- Technical challenges: *Data Fusion*
- **Image Fusion**
  - Optical-optical fusion:
    - PCA (Principal Component Analysis)
    - IHS (Intensity-Hue-Saturation)
    - Brovey transformation
    - Multiplicative method
    - Image registration (more suited to work with ships).
  - Optical- SAR fusion:
    - PCS (Principal Component Substitution)
    - IHS (Intensity-Hue-Saturation)

NEREIDS CHALLENGES

- Technical challenges: *Data Fusion*
- **Report Fusion**
  - Plot (observations from EO)-to-track Fusion:
    - Association:
      - Global Nearest Neighbour (GNN) → single-hypothesis tracking
      - Joint Probabilistic Data Association (JPDA) →
    - Tracking:
      - Extended Kalman Filter →
      - α-β (alpha-beta) filter → Similar that before, but more focused to linear elements with two internal states: position and velocity.
  - Track-to-track Fusion:
    - Association:
      - Mahalanobis distance → distance between two Gaussian distributions
      - Bar-Shalom metric → Mahalanobis distance + cross-covariance matrix
    - Tracking:
      - Extended Kalman Filter →
      - α-β (alpha-beta) filter → Similar that before, but more focused to linear elements with two internal states: position and velocity.

NEREIDS CHALLENGES

- Technological challenges
  - To provide a benchmark for the automatic and easy integration of external modules.
    - Adopt standardized formats that permit the intra-module link and the link with external systems.
  - To provide an efficient visualization system that permits exploiting all the available information in the most convenient way.
    - Far from operational point of view
    - Accurate enough as to permit the generation of the study.
  - To fix the areas where EO can efficiently contribute to MSA.
  - To evaluate maritime anomalies and how EO can support decision making.
  - To evaluate new platforms and satellite configurations (equatorial orbits)

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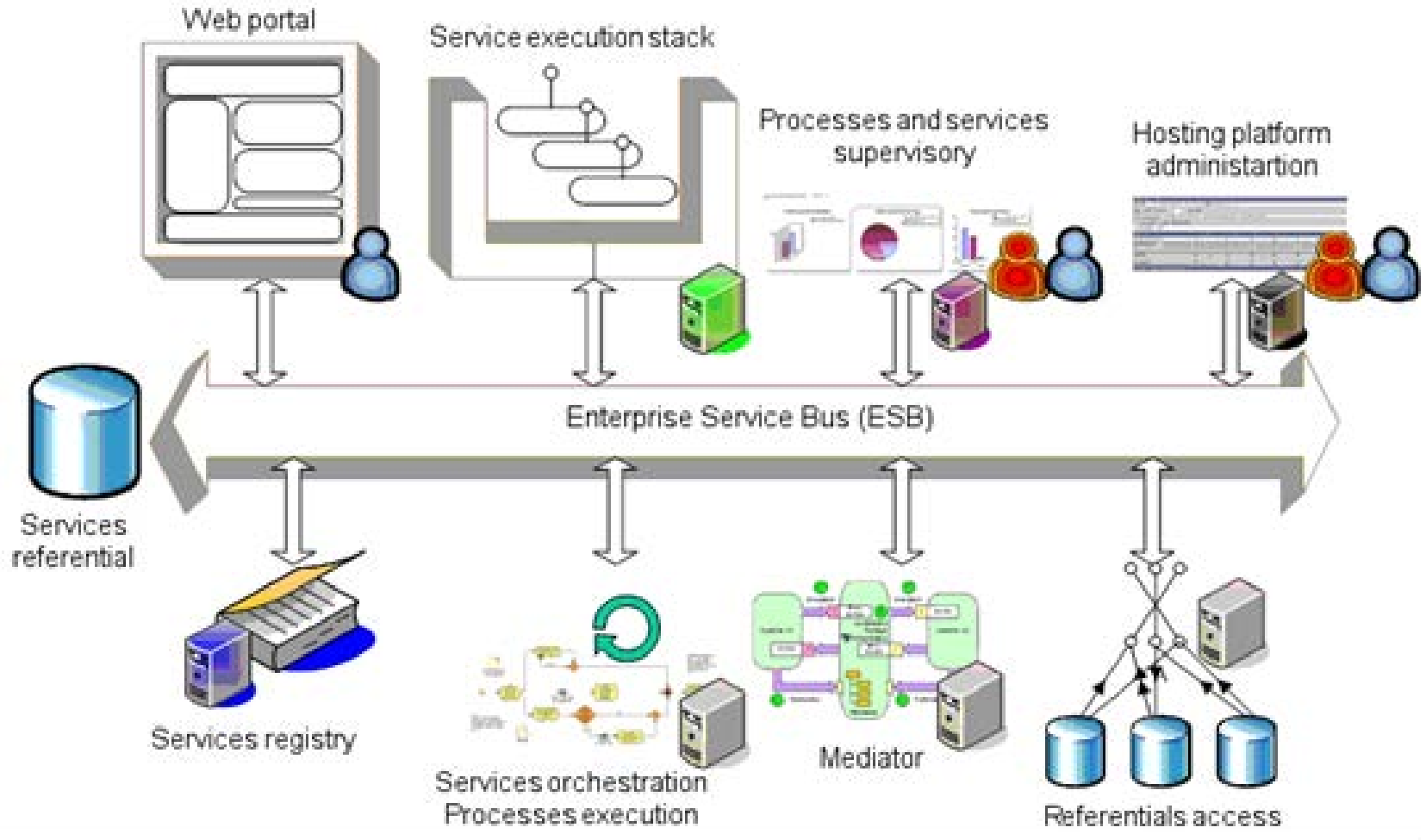
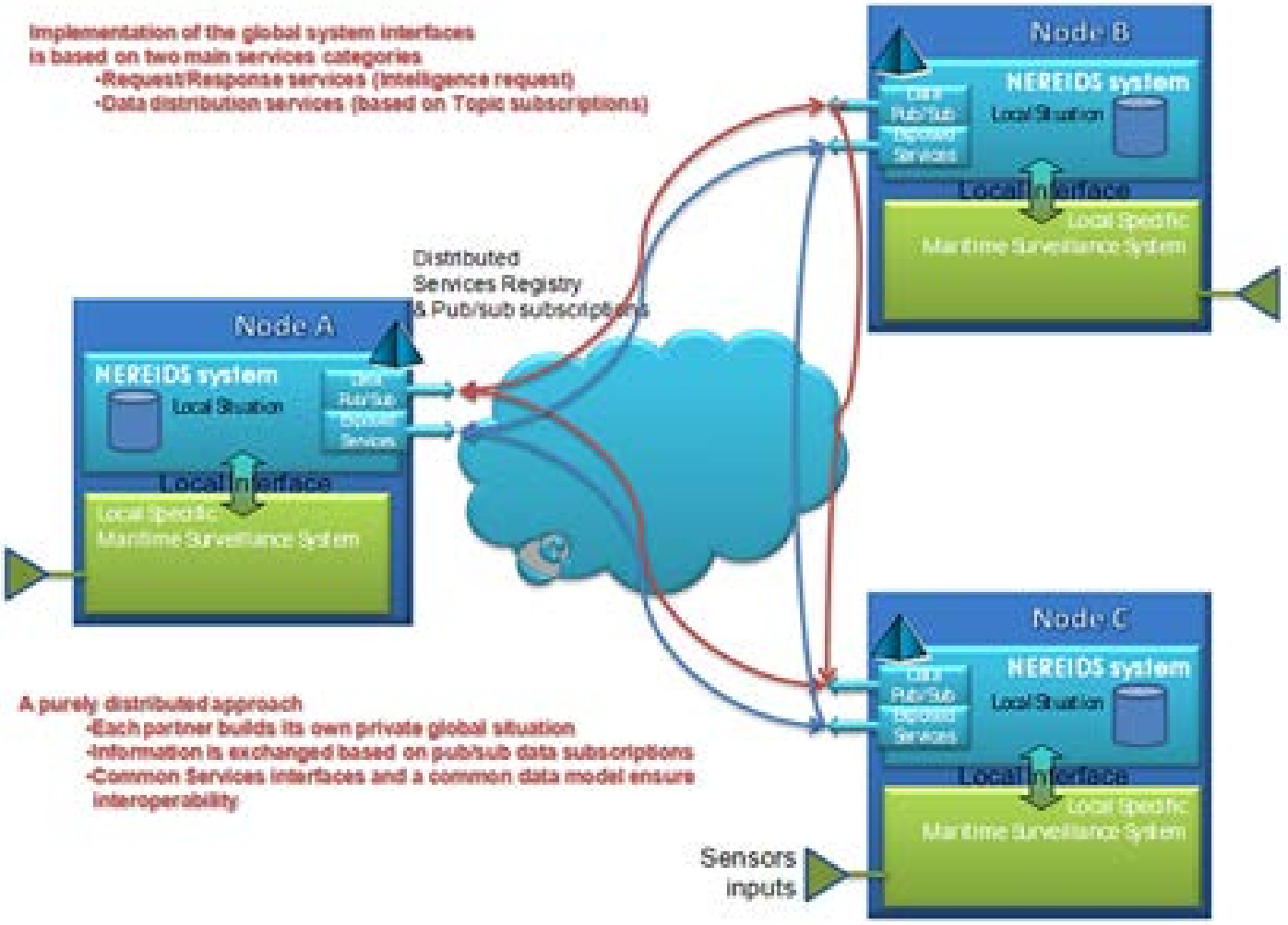
NEREIDS SYSTEM

- SOA architecture



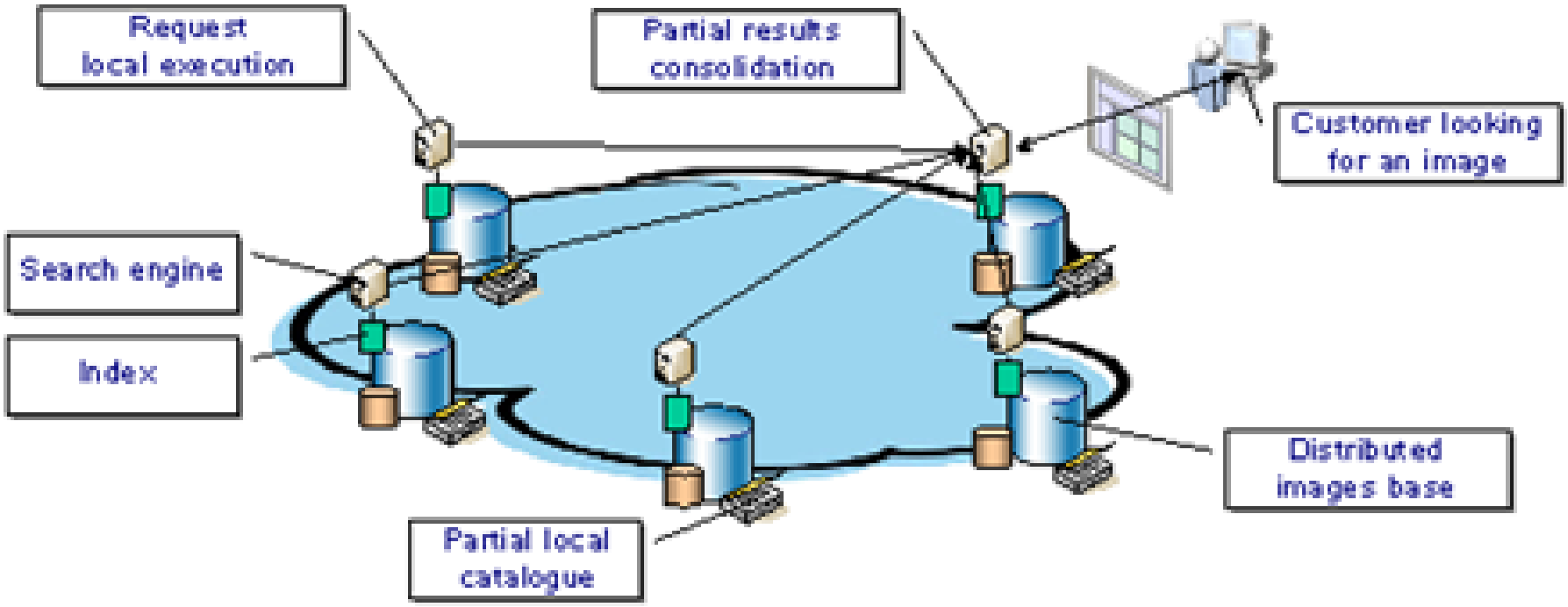
NEREIDS SYSTEM

- Logical view



NEREIDS SYSTEM

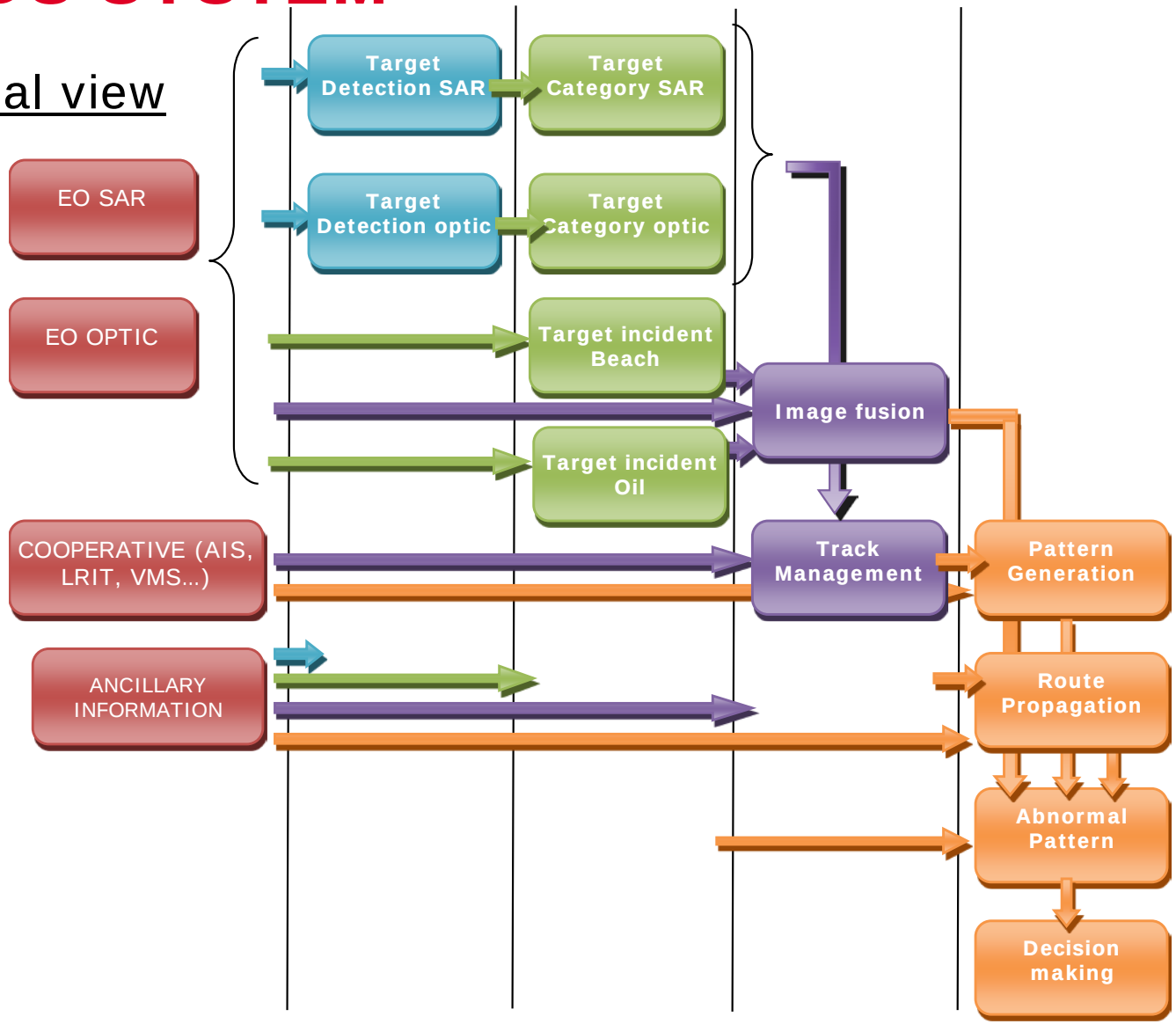
- Data view



Distributed searching on local catalogues

NEREIDS SYSTEM

- Functional view



NEREIDS SYSTEM

- Interfaces view (besides imagery exchange)

- Order: For triggering the execution of the different modules
  - Internal and developed for the purpose

- Target Reporting: For exchanging reporting streams
  - CSN, SSN for interoperability

- Target Detection: For exchanging detection reports
  - CSN, SSN for interoperability

- Incident Reporting: For exchanging incident reports, including anomaly detection
  - CSN, SSN for interoperability

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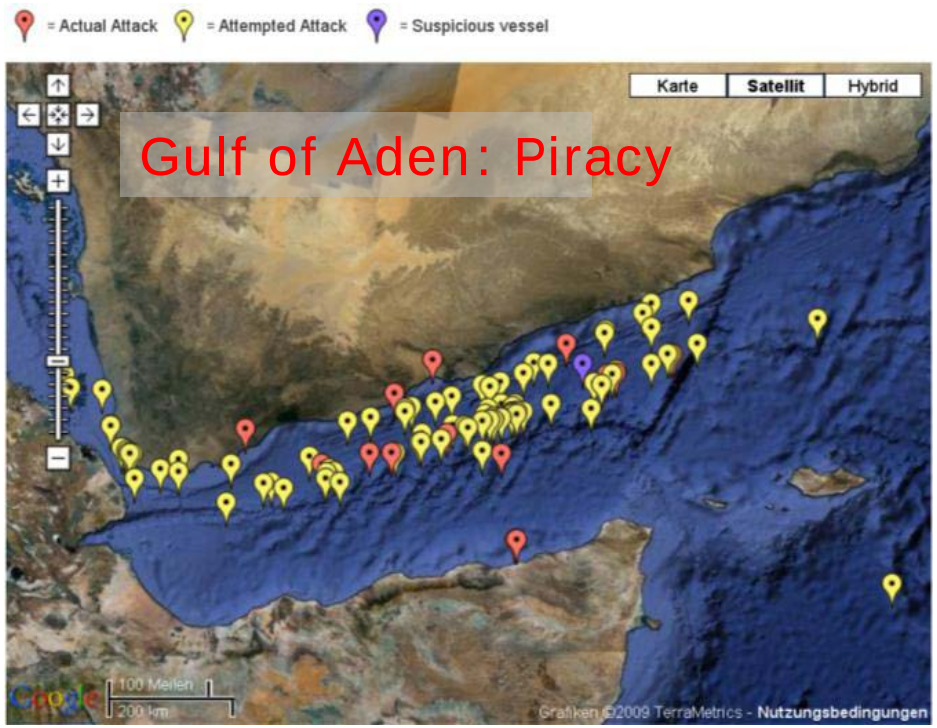
NEREIDS SCENARIOS: AOI(I)

- There are four main areas of interest. If the implementation calendar is met, West Africa will be tested this year.



NEREIDS SCENARIOS: AOI (II)

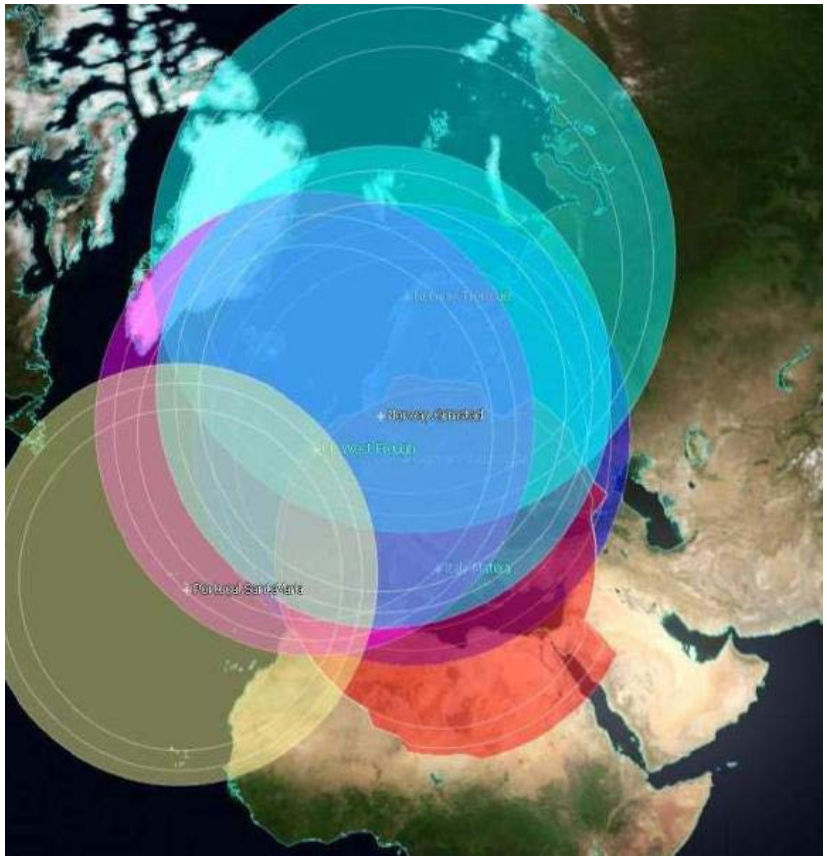
- There are four main areas of interest. If the implementation calendar is met, West Africa will be tested this year.

NEREIDS SCENARIOS: ASSETS (I)

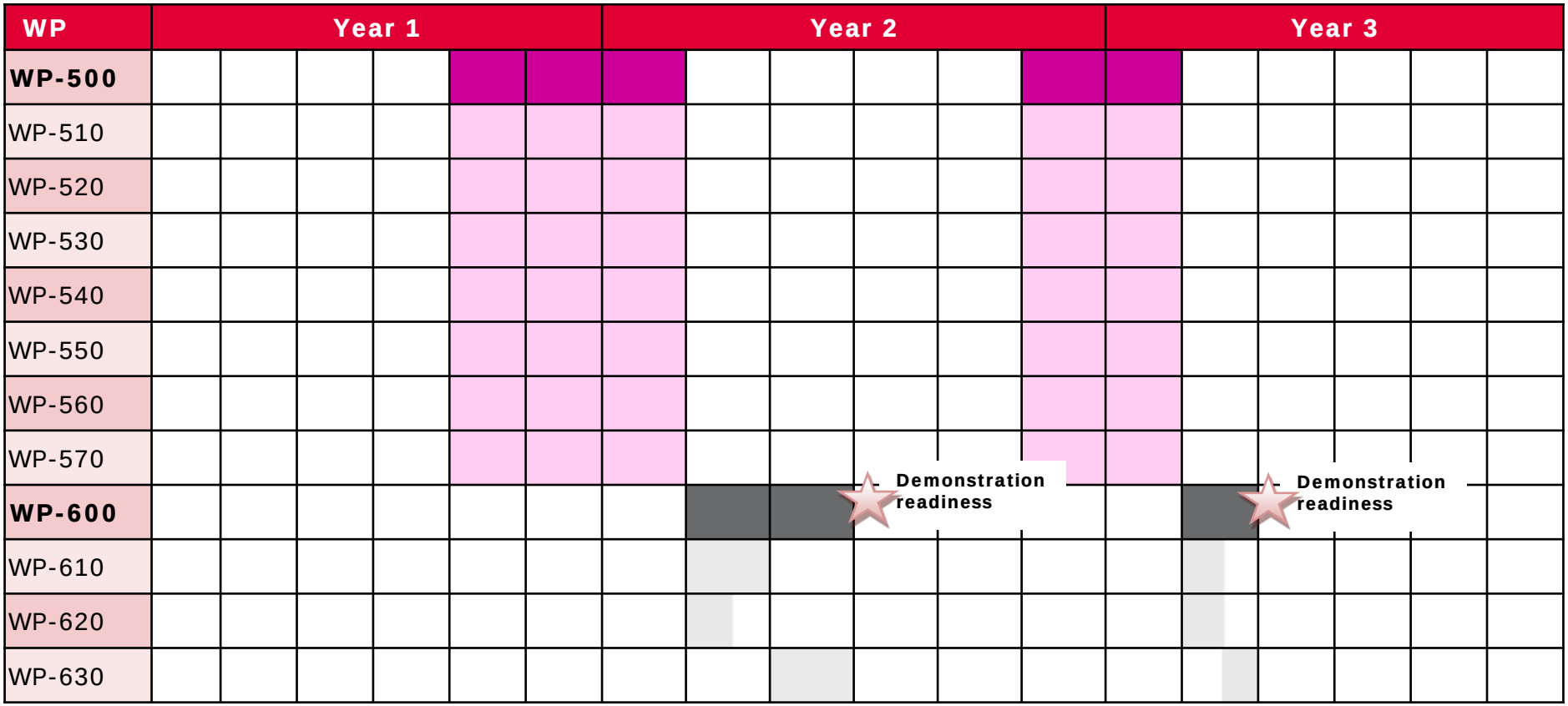
- Laboratory Testing
  - Test cases for assuring proper software functionality
- Assets.
  - In-situ sensors
  - Patrolling
  - Satellite collaborative
  - Satellite non-collaborative

NEREIDS SCENARIOS: ASSETS (I)

- Assets.
  - Ground-stations (non equatorial) for NRT experiments
  - Equatorial orbit satellites

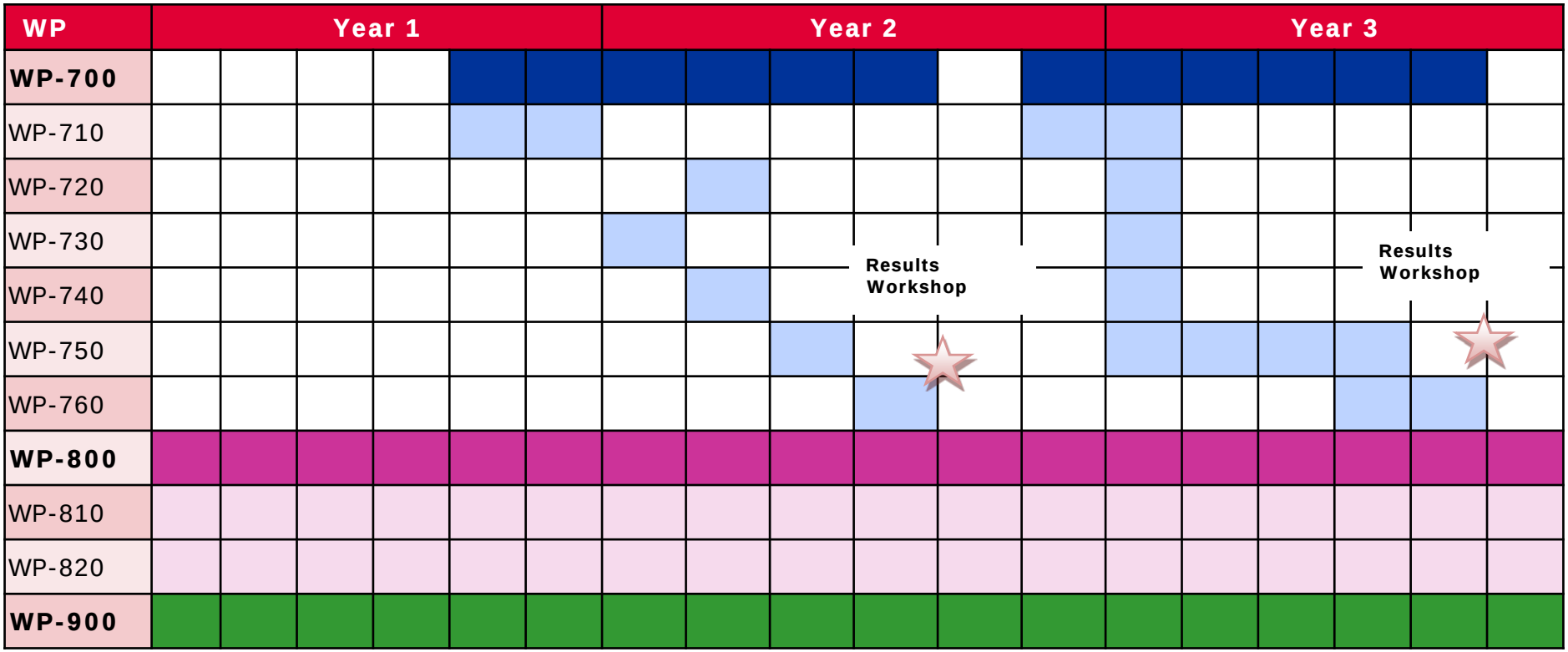


NEREIDS SCENARIOS: CALENDAR (I)



WP-500s will have two main deliverable versions in separated timestamps.

NEREIDS SCENARIOS: CALENDAR (II)



NEREIDS SCENARIOS: USERS

Name	Country
Ministry of Transport Slovenian Maritime Administration	Slovenia
Port of Madeira	Portugal
Community Fisheries Control Agency	Europe (located in Spain)
Italian Coast Guard	Italy
Environmental Agency of the Republic of Slovenia	Slovenia
Administration of the Republic of Slovenia for Civil Protection and Disaster Relief	Slovenia
France Fisheries Control Centre	France

NEREIDS SCENARIOS: DISSEMINATION

- Project web site http://www.nereids-fp7.eu
- 2 user workshops.
- Symposia, according to the topic.
- Scientific papers will be taken into account according to the casuistic of user structure.
- There is a specific sub-WP for generating promotional material
- A step forward: regular dissemination of projects achievements through European authorities and users.

Thank you

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