WP2, WP3, WP4 & WP6 Integrity Monitoring

Presentation of the Team

- GMV-NSL is the UK operating company of the GMV group
- Formed in late 2020 following the acquisition of NSL by GMV and the merger with GMV-UK

- 25 years experience in GNSS research and development
- Active in many areas related to GNSS integrity (UK-SBAS, SouthPAN, ARAIM)
- Responsible for user level integrity work packages 2, 3, 4 and 6

- WP Supported by GLA Research and Development (GRAD)

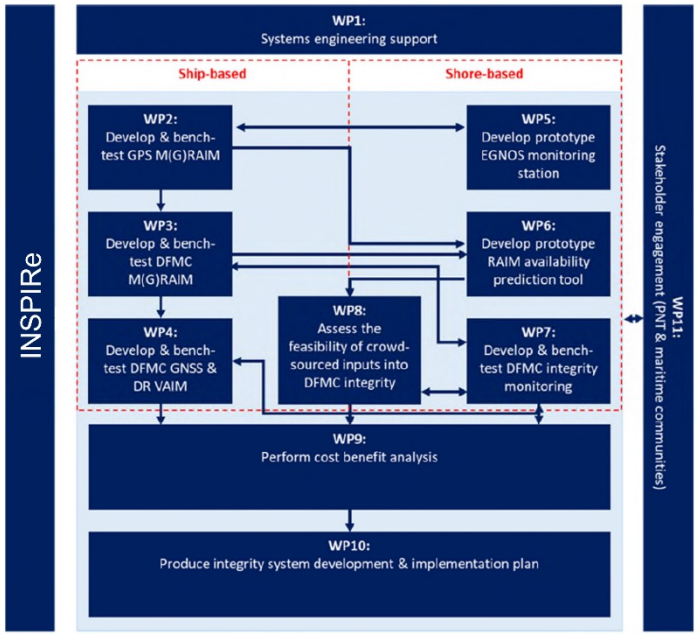
INSPIRe

To produce and validate algorithms for user-level integrity for PNT solutions at the following levels:

- WP2
  - A single frequency GNSS RAIM type solution, standalone in the user PNT processing system (Maritime GRAIM [MGRAIM]) or with EGNOS V2-aiding (Maritime RAIM [MRAIM]);
- WP3
  - A dual-frequency, multi-constellation GNSS RAIM type solution, standalone in the user PNT processing system (MGRAIM) or with aiding from a dual frequency, multi-constellation integrity monitoring system, conceptually aligned to a future EGNOS V3 (MRAIM);
- WP4
  - A vessel autonomous integrity monitoring (VAIM) type solution, loose coupling dual frequency, multi-constellation GNSS with onboard dead reckoning.

To define the UK system-level integrity monitoring and the alerting system needed to fulfil international obligations for aids to navigation (AtoN) services in the maritime sector. This will comprise of :

- WP6
  - a RAIM availability prediction capability, consistent with the three tiers of user-level integrity above, also developed and validated to prototype level;



Description of User Level Integrity Activities

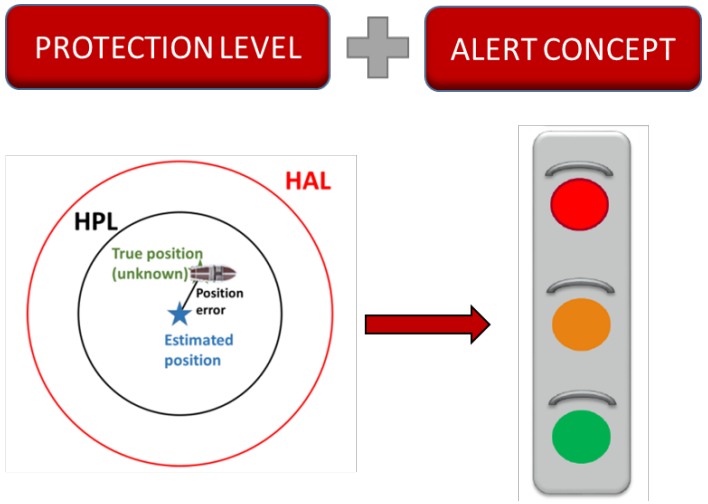
WP2 – Develop and test GPS M(G)RAIM Algorithms

- Purpose
  - Explore, develop and test algorithms to provide user-level integrity for single frequency GPS with and without system-level integrity information from EGNOS V2.
- Focus
  - Considering current equipment (GPS L1 receivers, with and without SBAS)
  - Aligning with current procedures (red, amber, green status)
  - Algorithms to improve current user-level integrity without major changes
    - Geometry, accuracy, fault detection
- Testing
  - Baseline clean GPS L1 data – with and without EGNOS
  - Introduction of different types of fault (ramps, jumps, ionosphere, multipath and non-LoS)
  - Assess performance
  - Provides framework for future testing regime

ALERT CONCEPT

WP3 – Develop and Test DFMC M(G)RAIM

- Purpose
  - Explore, develop and test algorithms to provide user-level integrity for dual frequency multi-constellation GNSS.
- Focus
  - Considering future equipment (GPS+GAL L1/L5 receivers, with and without DFMC SBAS)



- Aligning as far as possible with current procedures (red, amber, green status)
- Algorithms to improve user-level integrity and looking to future requirements
  - Geometry, accuracy, fault detection, Protection Levels

- Testing
  - Same baseline dataset and faults as WP2 – also including GPS, Galileo, L5/E5 and DFMC SBAS
  - Assess performance for WP2 algorithms
  - Assess performance with modified algorithms for possible future implementation

WP4 – Develop & test DFMC & DR VAIM

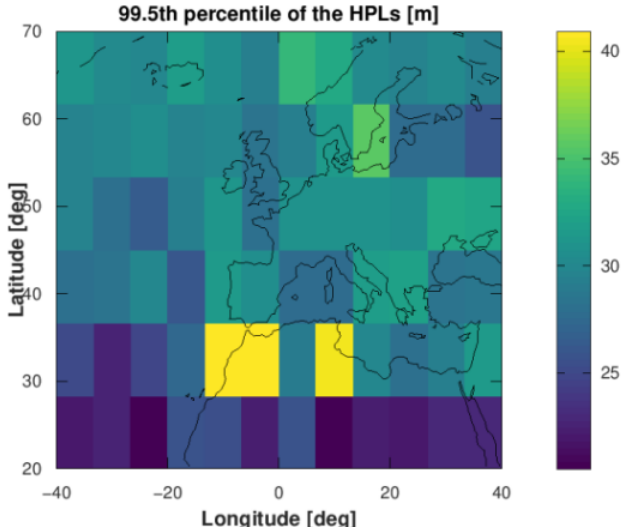
- Purpose
  - Explore, develop and test algorithms for the integration of DFMC GNSS and dead-reckoning to create a VAIM solution (analogous to aviation AAIM).

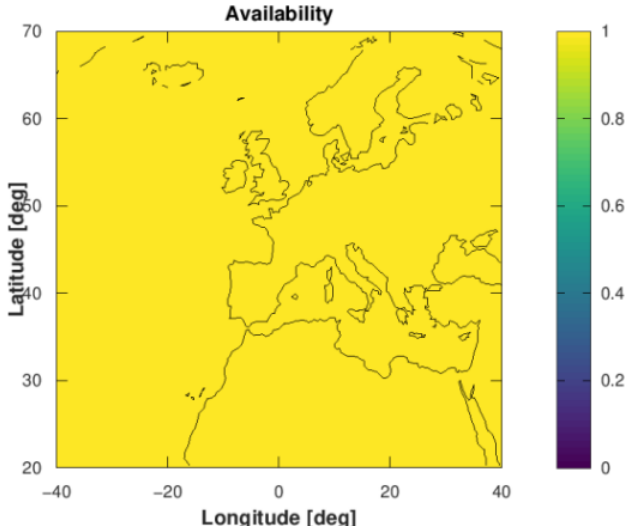
- Focus
  - Considering future equipment (GPS+GAL L1/L5 receivers)
  - Considering integration with other sensors (IMU, speed logs)
  - Algorithms to improve user-level integrity

- Testing
  - Reference clean datasets (real or simulated) with DFMC GNSS and other sensors
  - Introduction of different types of fault (ramps, jumps, ionosphere, multipath and non-LoS)
  - Assess performance

WP6 – Develop prototype RAIM availability prediction tool

- Purpose
  - Design, develop and produce the prototype RAIM availability prediction tool, similar to, but extended from, the EUROCONTROL AUGUR facility
- Focus
  - Modelling the availability of RAIM for combinations of GNSS frequencies and constellations considering the RAIM algorithms developed in WP2 and WP3
- Demonstration
  - The tool will predict RAIM availability acros the UK to the limits of the exclusive economic zones (EEZ) at various levels of integrity performance





Summary WP Outcomes

WP	Description
WP2	• Overall description of the chosen M(G)RAIM algorithms • Outcomes of testing of GPS M(G)RAIM algorithms • Description of the suitability and shortcomings of the algorithms for use in the maritime environment, highlighting any areas that need improvement • Assessment of the need for a maritime-specific EGNOS message to support MRAIM
WP3	• High-level description of the DFMC MRAIM and MGRAIM algorithms • Outcomes of their test and evaluation of the DFMC M(G)RAIM algorithms. • Description of the suitability and shortcomings of the algorithms for use in the maritime environment • Assessment of potential benefits of maritime specific EGNOS V3 message

Summary WP Outcomes

WP	Description
WP4	• Generation of a clear concept definition for VAIM • Assessment and trade-off analysis of different GNSS and dead reckoning loose coupling schemes • Definition of VAIM algorithms based on the preferred loose coupling scheme • Evaluation of the prototype algorithms • An assessment of the feasibility of a maritime VAIM solution
WP6	• The prototype RAIM prediction tool implemented in software (using a suitable application • A development and implementation plan for a UK RAIM prediction service • High-level estimated cost assessment

Thank You

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