AVIS Workshop 3

Automated Vessels on European Inland WaterwayS

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Agenda

Time	*Activity*	*Speaker*
10:00	Welcome and Introduction	EY, EC/EUSPA
10:05	AVIS Project & Context	GMV-SP
10:15	AVIS Technical Approach for EU Space Data Analysis	GMV-SP & Tresco
10:30	AVIS Pilots´ Plan & First results	GMV-SP & GMV-RO
10:55	AVIS Standardization	GMV-SP & WSV
11:05	AVIS: Further Activities	GMV-SP
11:10	Questions from the audience	EY
11:30	Closing remarks & AoB	EY

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Introduction

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Project Presentation

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Introduction

- **Main Objective:** to analyse how **EU Space Data** can be used for **Automated Vessels on European IWW**. In order to do this analysis, a prototype will be defined, design and implemented and will be used in pilots' demonstrations in different EU IWW important corridors.
- More **specifically**:
  - Define minimum requirements in technical, operational & regulatory terms to guarantee safe & secure navigation for automated vessels in different levels of automation on European IWW.
  - Demonstrate & validate the findings by means of several pilots, making use of EU Space data from Galileo, EGNOS & Copernicus.
- Those activities are expected to:
  - Contribute to the NAIADES III objectives for the development, demonstration and deployment of automated shipping concepts.
  - Contribute to EU Framework for IWW and Autonomous vessels.
  - Contribute to the standardisation work within relevant IWW standardisation bodies.

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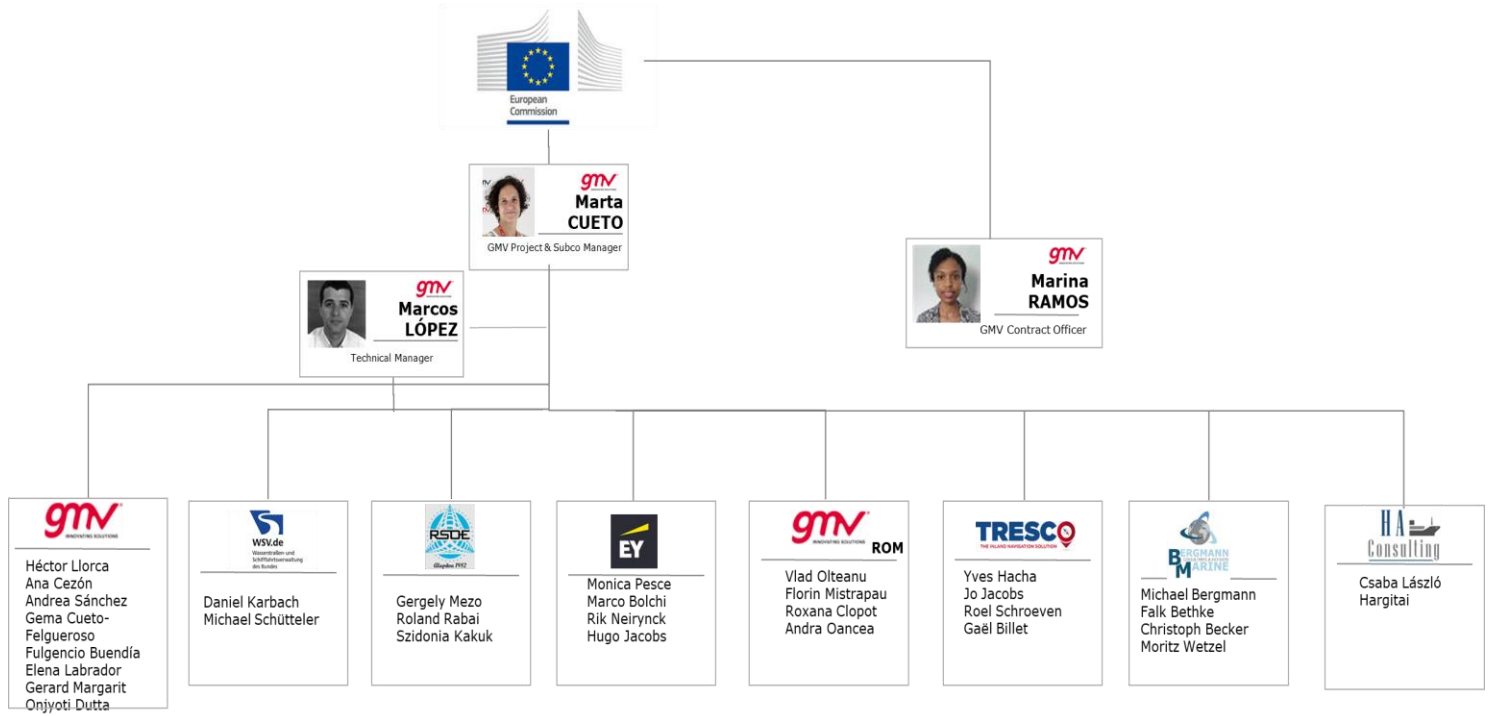
Project Team

- Project Manager:
  - Marta Cueto
- GMV's project team:
  - Technical Manager:
    - Marcos López
  - Project team including experts:
    - E-GNSS: Héctor Llorca, Fulgencio Buendía & Ana Cezón, Gema Cueto-Felgueroso & Andrea Sánchez
    - Copernicus: Gerard Margarit & Omjyoti Dutta
  - Support from GMV's Product Assurance section.
  - Contract Officer: Marina Ramos Delgado



- Consortium representatives led by:
  - WSV: Daniel Karbach / Michael Schütteler
  - RSOE: Gergely Mező
  - HAC: Csaba Hargitai
  - TRESCO: Yves Hacha
  - BM: Michael Bergmann
  - EY: Rik Neirynck
  - GMV-RO: Vlad Olteanu

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Wide Range of Activities:

AVIS project gathers a **diverse variety of activities**:

- Activities related to **operational aspects**, mainly identified in WP1000
- **Technical** activities, mainly related to WPs 2000-5000
- **Pilots**, mainly identified in WP6000
- **Awareness** activities, mainly identified in WP7000
- **Standardisation** activities, mainly identified in WP8000
- **Stakeholders' involvement**, mainly identified in WP7000 but also linked to other WPs

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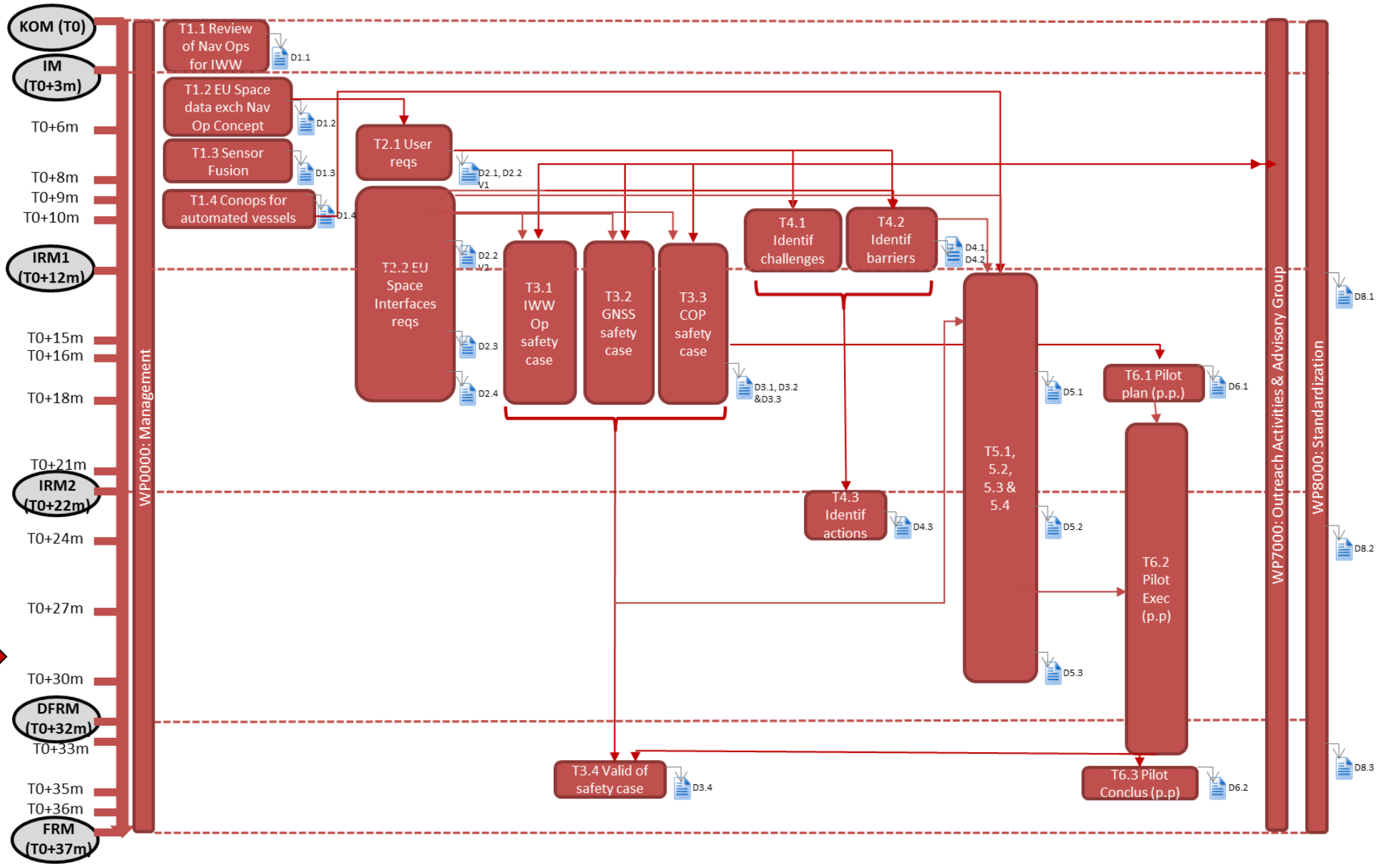
Overview of the Planning

- **Study Logic & Schedule:**



HERE WE ARE

p.p = per pilot

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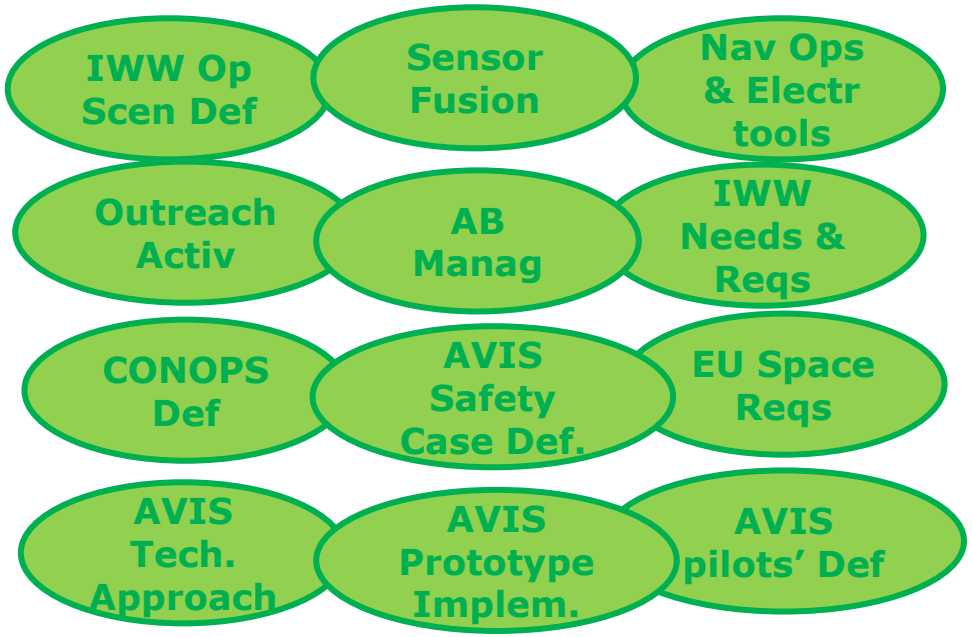
Summary of Developed & under-development Activities

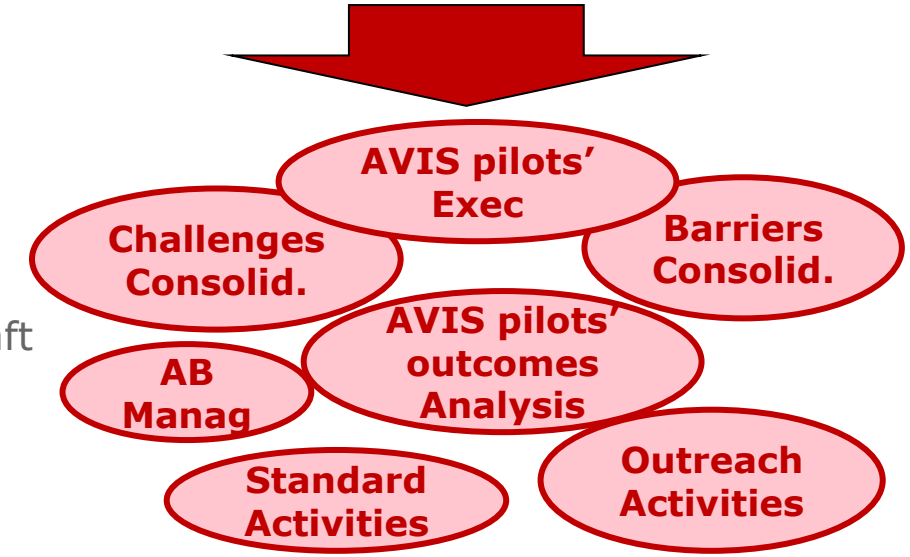
Main AVIS Activities already developed:

- Definition of IWW **Operational Scenarios**
- **Navigation operations** & electronic tools to support IWW operations
- Identification of potential **Sensor fusion**
- **IWW needs & User Requirements** for Automated Navigation
- EU Space **Interfaces Requirements**
- EU Space **CONOPS** and Interface definition
- **Safety Case** Definition
- **Pilots´ Plan** high level definition
- **AVIS Technical Approach**
- **AVIS prototype** implementation



Main AVIS Activities under development:

- **Pilots´ execution** & Outcomes **Analysis**
- Consolidation of **challenges** for Automated Navigation operations
- Consolidation of **Standardisation/regulation barriers**
- **Standardisation**: CESNI PNT & I-MSR WG involvement & Standard Draft Doc. for min requirements for automated vessels & EU Space Data
- **Outreach** Activities: Workshops, Consultations, webpage, LinkedIn…
- **AB management**



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AVIS Technical Approach for EU Space Data Analysis

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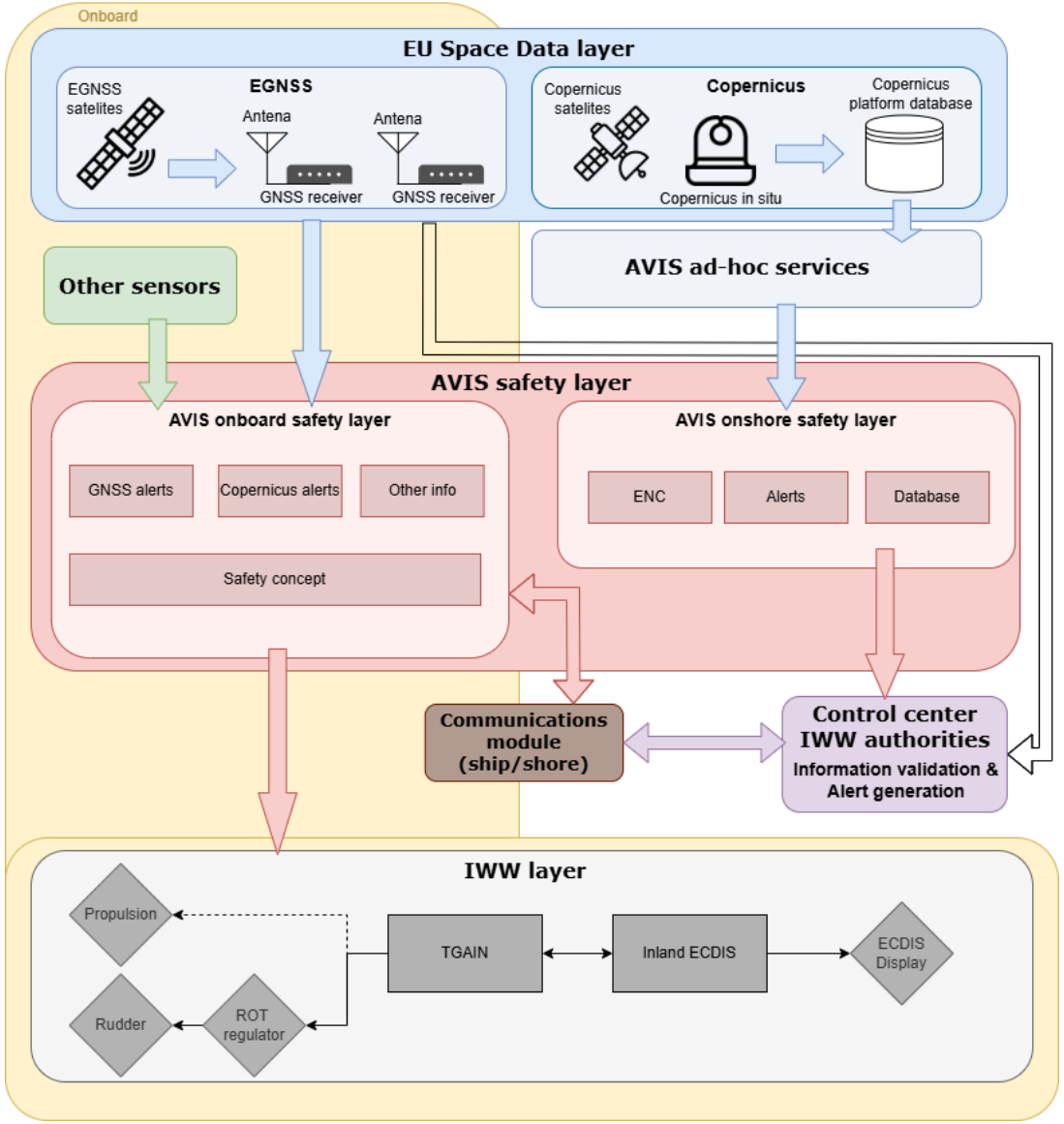
Architecture high level view



- **Objective of the prototype**: showcasing, with subsequent analysis, the added value of EU Space Data and services for automated vessels on European inland waterways
- **Approach:** record as much data as possible for **post-processing** and **analysis**
- **3 layers:**
  - **EU Space Data Layer**
    - Recompile all information from EGNSS + Copernicus services
  - **AVIS Safety Layer**
    - Process data and generate navigation outputs and alerts
  - **IWW Layer**
    - Provide calculated route for automated navigation using TGAIN
    - Display results on Inland ECDIS

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AVIS Prototype definition

EGNSS Prototype

- Provides accurate and reliable positioning data
- Provides protection levels that surround the vessel to indicate the uncertainty in the vessel's position
- Generates GNSS-related alerts

Copernicus Prototype

- Generates alerts regarding changes in river width and depth, as well as object detection.
- Generates an additional layer of information on the ECDIS.

IWW Prototype

- Capable of receiving input from other parts of the prototype.
- Display EU Space Data information on the ECDIS and perform navigation actions using TGAIN.

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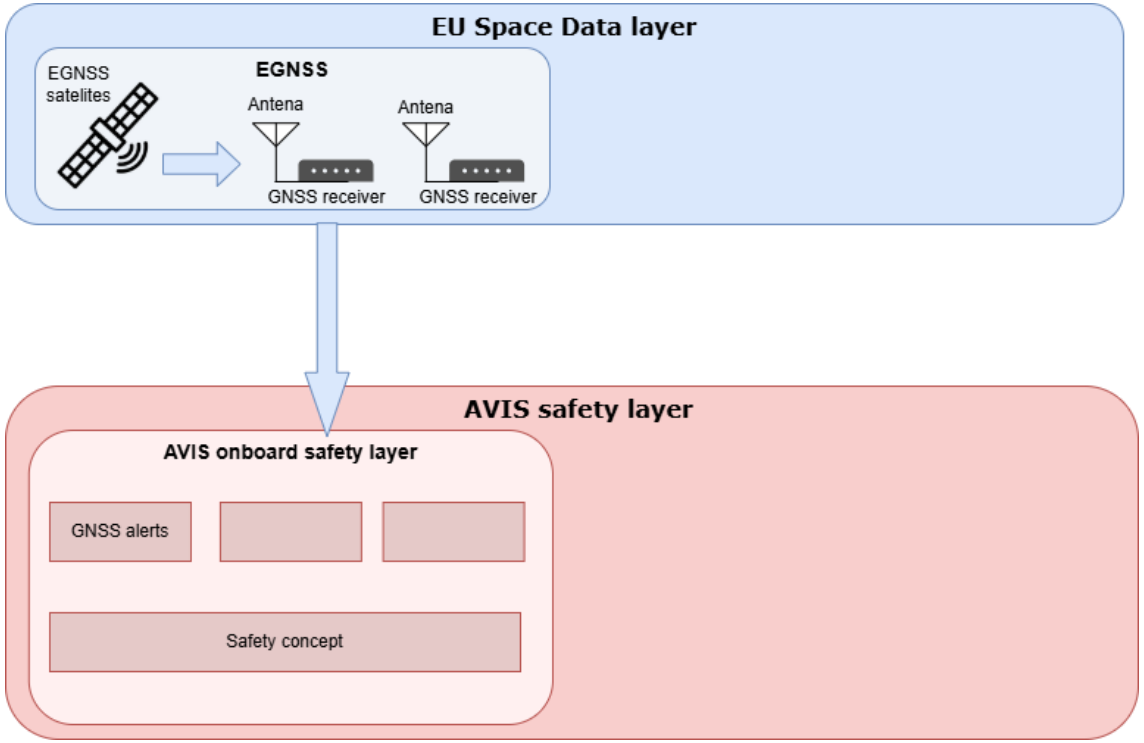
AVIS prototype: EGNSS Prototype

- The EGNSS prototype refers to any component of the prototype that is directly connected to EGNSS services.



- There are several elements that conform the EGNSS prototype:
  - GNSS antennas
  - GNSS receivers
  - GNSS antenna signal splitters

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AVIS prototype: EGNSS Prototype

- **GNSS antenna:** receives signals transmitted by GNSS satellites. These signals are electromagnetic waves in the L-band frequency range (1.2 to 1.6 GHz)

- There are different aspects to consider for the selection of antennas, including the installation location, the processed signals and the signal strength.

- The **EGNSS prototype has two GNSS antennas**. At least one antenna should be able to process the E6 band, since HAS services are provided through that band.

- Using two antennas allows the vessel's heading to be calculated by the EGNSS prototype. The greater the distance between the antennas, the higher the accuracy of the heading.

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AVIS prototype: EGNSS Prototype

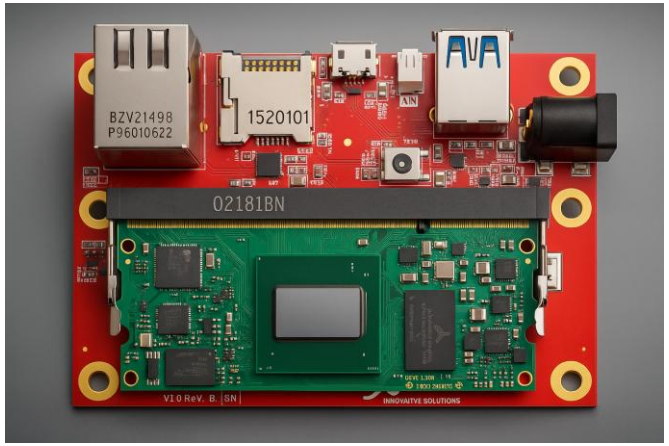
- **GNSS receiver:** a device that receives and processes signals from satellites to determine its location on Earth

- In the future, different receiver capabilities will be required onboard depending on the needs of operation and automation level target. The AVIS prototype is designed to analyse all these different capabilities with different receivers and their performances.

- For the **AVIS prototype**, **it is proposed to use two GNSS receivers**. This has the advantage of having greater redundancy in case of failure, being able to perform consistency checks, and even use different receivers to have a wider range of features.

- It is proposed to use auxiliary devices to save the observations in RINEX format to carry out a post-processing study.

- An SBAS receiver will be included in the prototype to receive and process EGNOS corrections.



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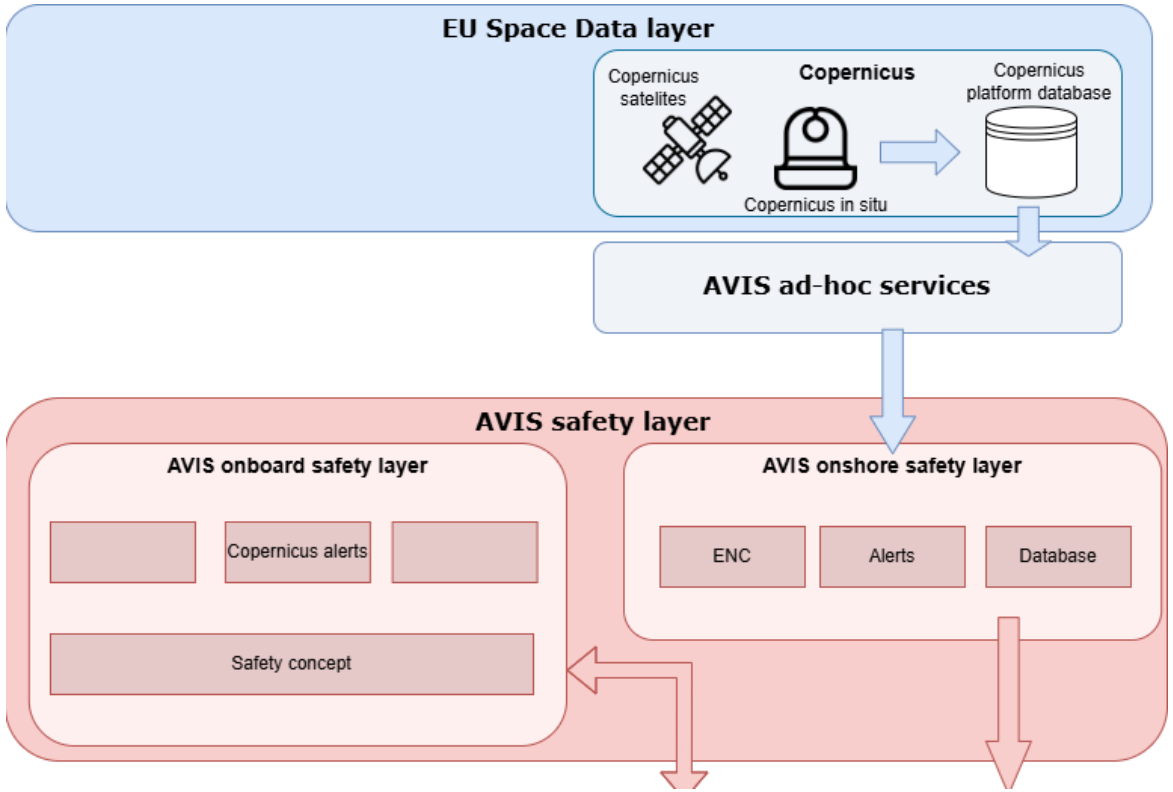
AVIS prototype: Copernicus Prototype

- The Copernicus prototype refers to any component of the prototype that is directly connected to Copernicus services.



- The prototype ad-hoc service consists of several modules:
  - Copernicus Interface
  - River Edge Module
  - River Depth Module
  - Object Detection Module
  - River Discharge Module
  - Turbidity Module
  - Geodatabase Module

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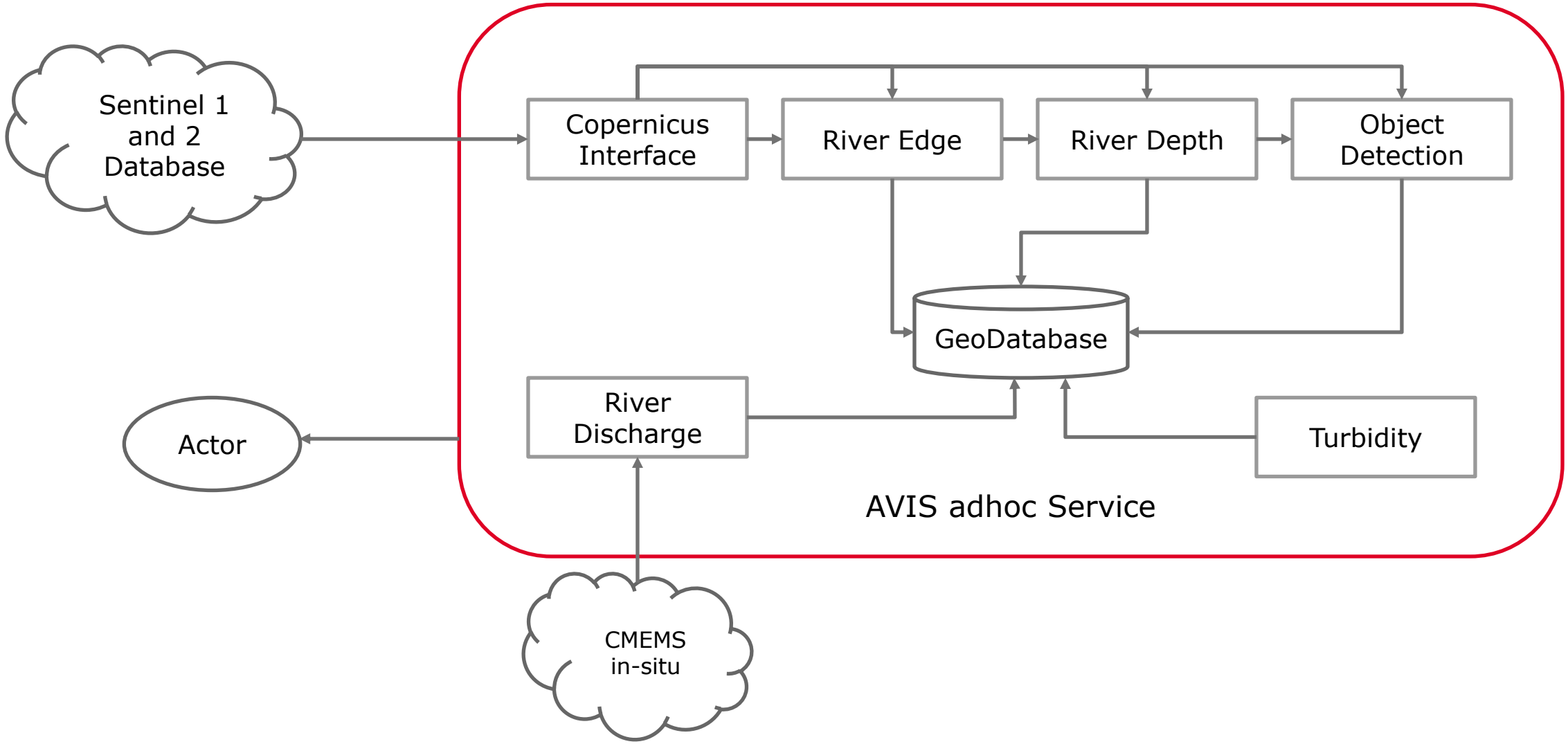
AVIS prototype: Copernicus Prototype

- The Copernicus prototype is defined as a modular design.



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AVIS prototype: Copernicus Prototype

- The geodatabase is created using GeoServer , an open-source server for sharing geospatial data, which implements OGC standards.

Workspace	Functionality
S12Image	Stores the satellite images available
RiverExtent	Stores raster files for River Edge ad-hoc services
RiverExtentAlert	Stores raster files generating alerts for River Edge ad-hoc services
RiverDischarge	Stores River Discharge data in shapefile format
ObjectDetection	Stores shapefiles for Object Detection ad-hoc services
Bathymetry	Stores raster files for River Depth proxy
Turbidity	Stores raster files for Turbidity proxy

The Geodatabase created will be running at GMV premises and a client code will be provided which can be used to access the data.

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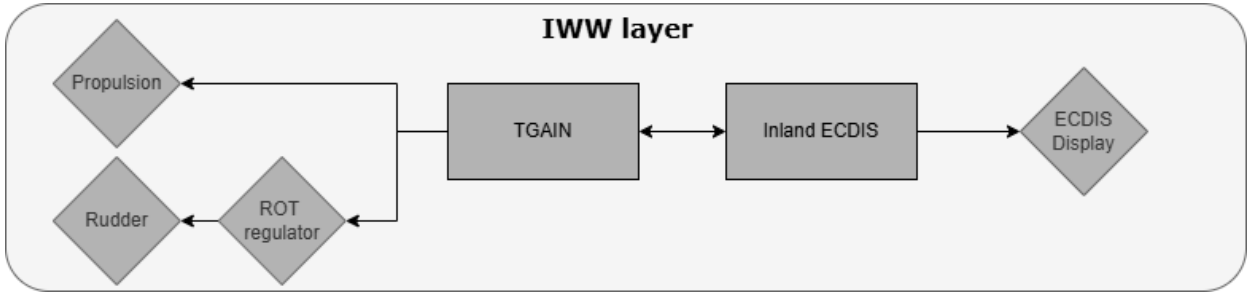
AVIS prototype: IWW Prototype

- The IWW prototype is defined as any part of the prototype that is directly related to IWW layer.



- Besides visualising ENCs to the boatmaster, the (inland) ECDIS has numerous other features:
  - Show all sensor info in a user interface
  - Communicate with external agents (info services like Copernicus)
  - Monitor/log TGAIN-path and -operation
  - Offer route planning options
  - Offer trip preparing options
  - Show overlaid information layers as showcasing Alerts and Maps extracted from EU Space data.
  - Log as much data as possible (sensor NMEA, pilot commands, …)

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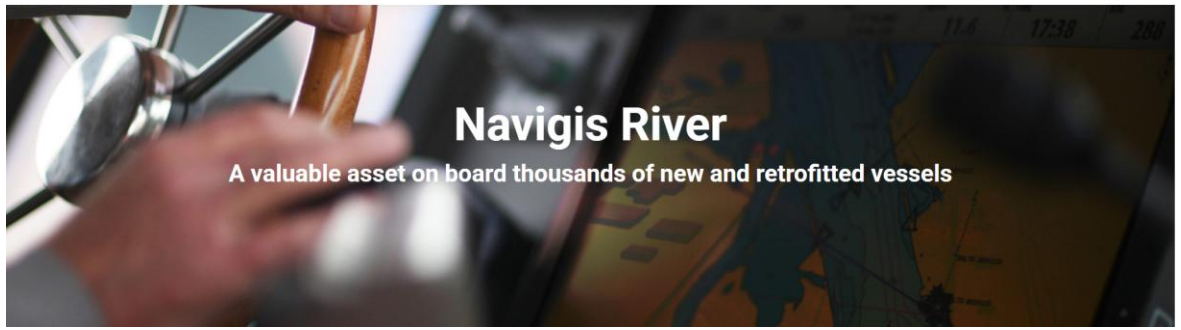
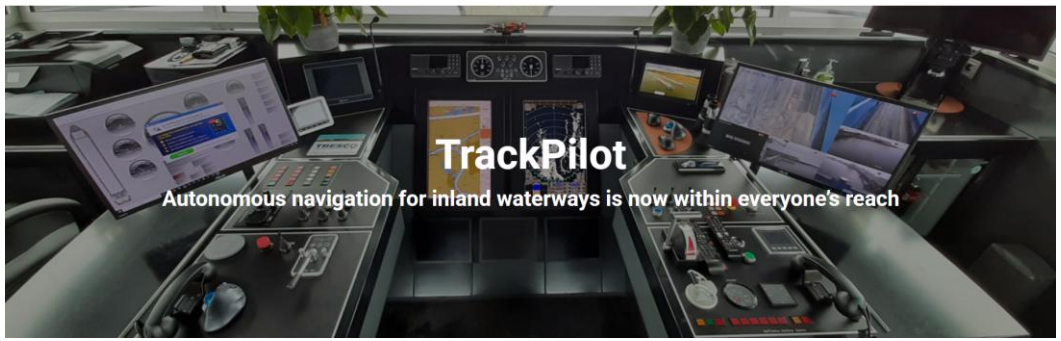
AVIS prototype: IWW Prototype

- Besides these internal features, an ECDIS also offers integration with other systems on the bridge.
- In our demonstrators we incorporate as much integration as is possible:
  - Integrate with EGNSS for more accurate PNT sensor data to also offer protection level info.
  - Integrate with Copernicus data for extra chart overlays and alerts.
  - Integrate with the ROT-regulator (auto pilot) to demonstrate TGAIN together with EGNSS and Copernicus
  - If possible, integrate with the onboard river radar to overlay the radar image on top of the chart.
- To have an optimal integration, our ECDIS PC will combine the ECDIS- and the TGAIN-functionality in a single process (Tresco Navigis license + Tresco TrackPilot license).





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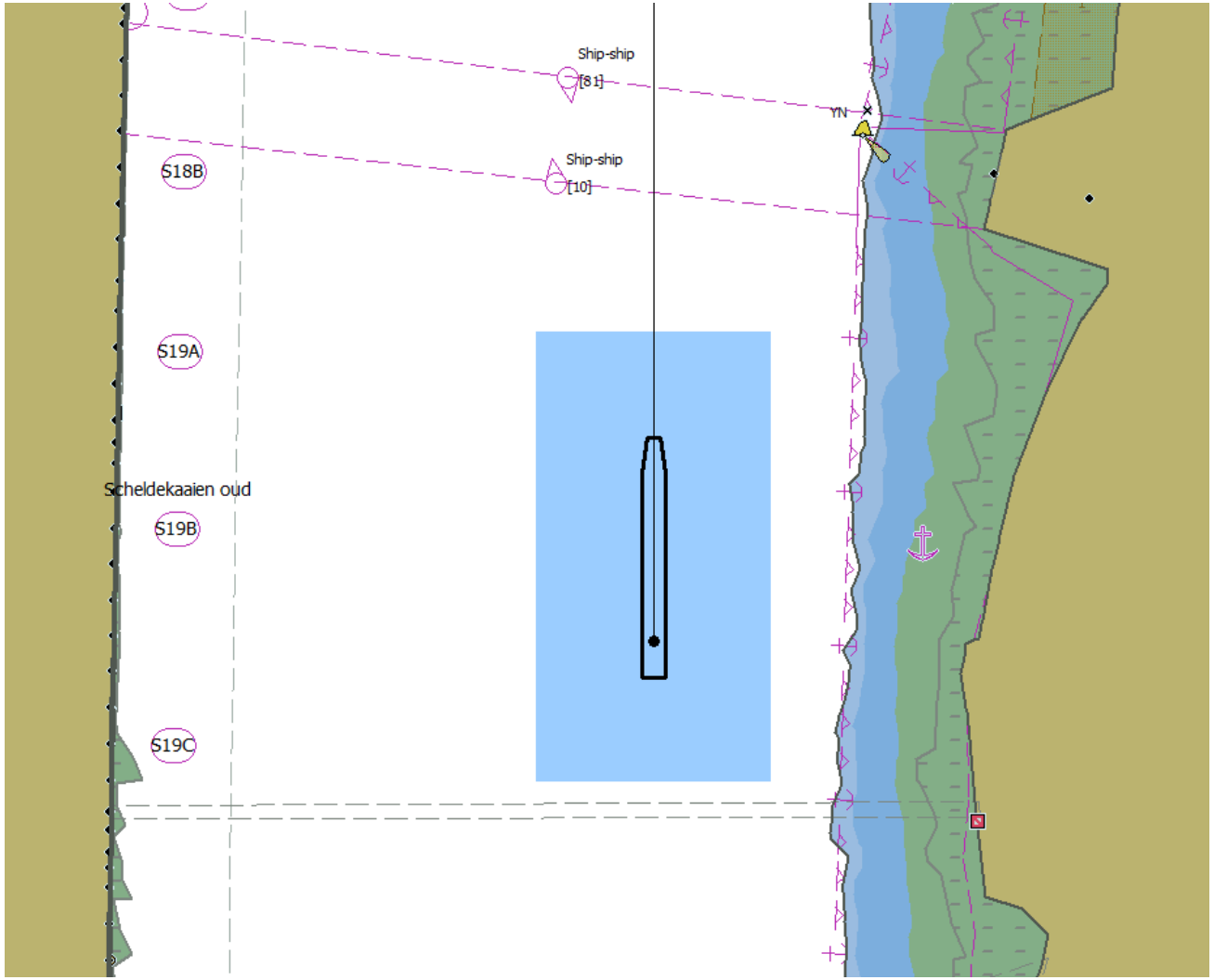
AVIS prototype: IWW Prototype

An example ECDIS-screenshot of the protection level visualization during sailing. The blue box varies dynamically. The vessel's true position lies inside this box. In the next two pilots, the box will be rounded to closer resemble the 2D-vessel outline and will change color during a protection level alarm.



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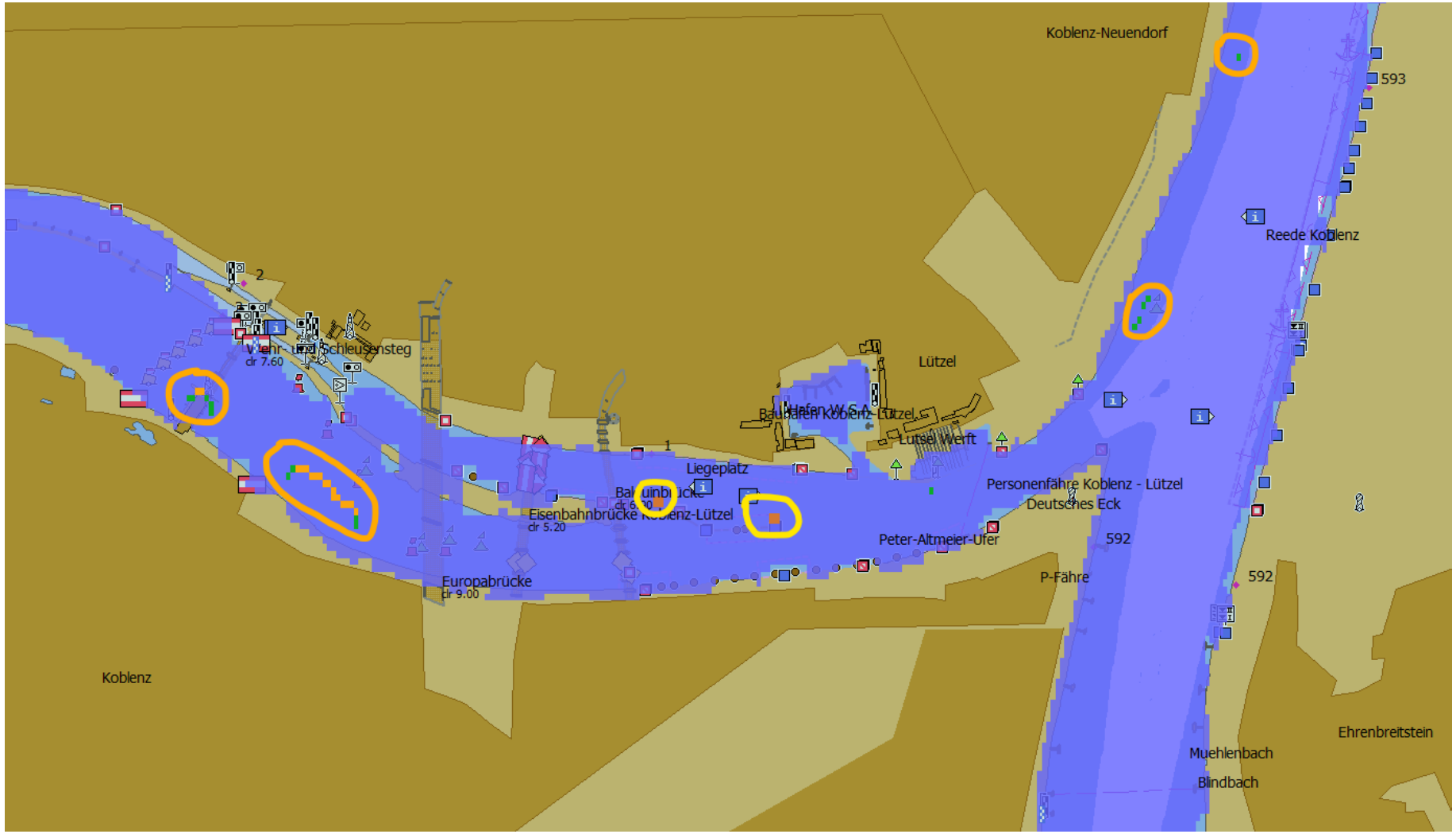
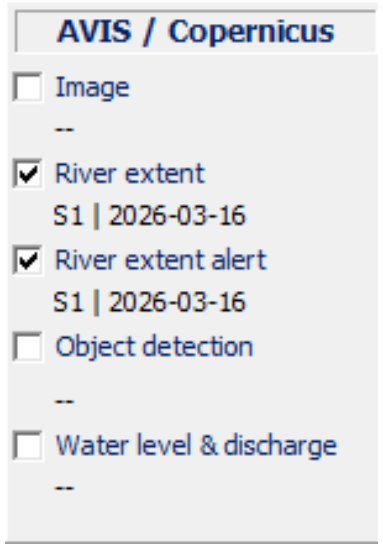
AVIS prototype: IWW Prototype

An example of Copernicus layer-visualization in the ECDIS

an overlaid, purple "*river extent*"-layer + the annotated "*river extent alert*"-layer:



the Copernicus layer configuration panel:



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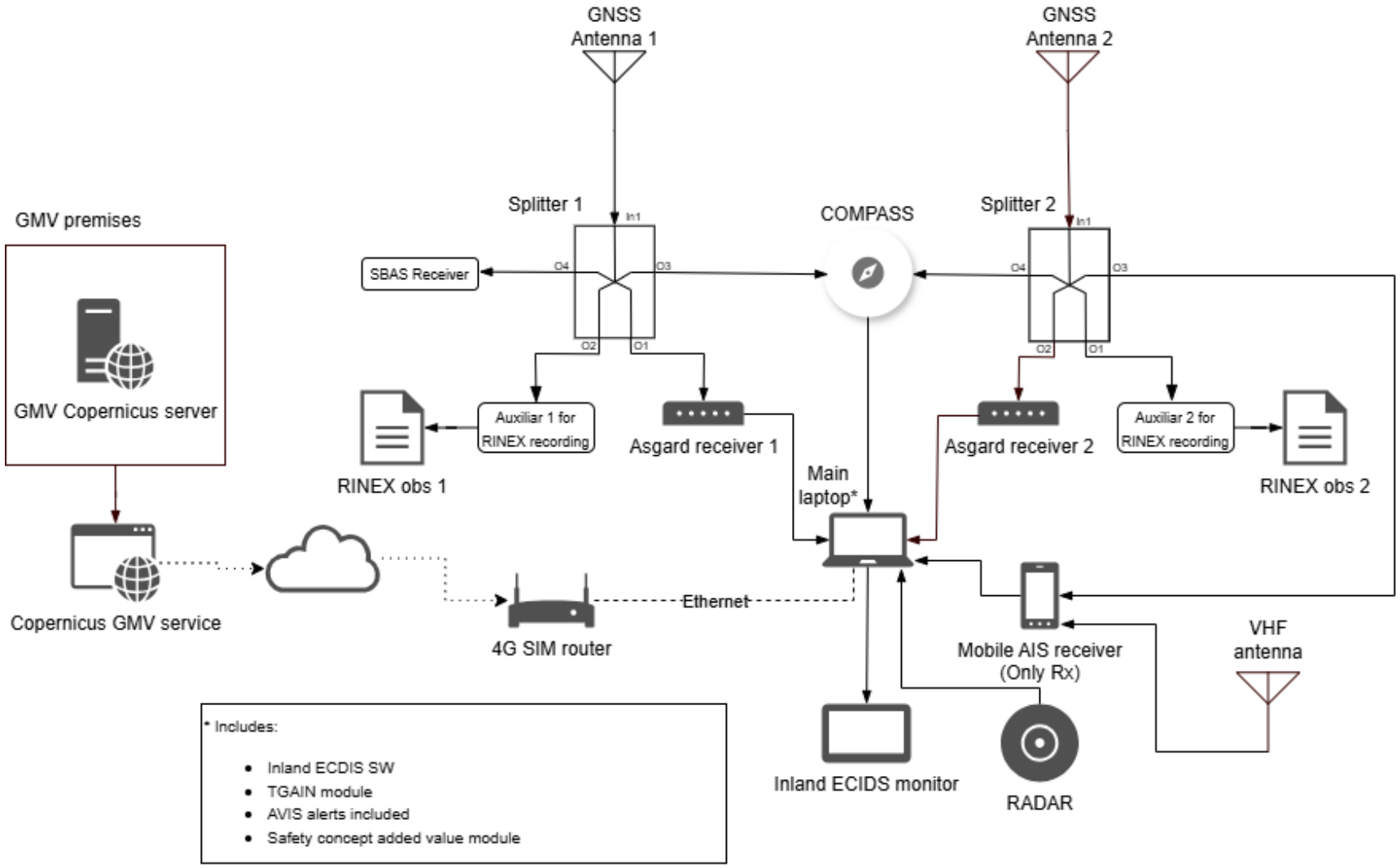
AVIS prototype: solution design

- The design of the prototype, which includes auxiliary equipment and sensors, is illustrated in the following figure:



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AVIS Pilots´ Plan & First results

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AVIS Pilots' plan

- **Pilot's plan for:**

Guadalquivir

Lower Danube

Rhine

Middle Danube

- **Objective of the pilots**: The main objective of the pilots is to obtain experimental data in a real-world setting to showcase, with subsequent analysis, the added value of EGNSS and Copernicus for automated vessels on European inland waterways.

- Pilots are being conducted throughout 2026.

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AVIS Pilot plan – Guadalquivir

- The area of interest is considered to be the entire navigable part of the river from the lock to the mouth of the river.
- The route along the Guadalquivir River runs under the Euroway E.60.02, and is approximately 90km long
- For the Guadalquivir pilot, the vessel Morfeo, belonging to TIMON DE TRIANA, S.L.U, has been identified.

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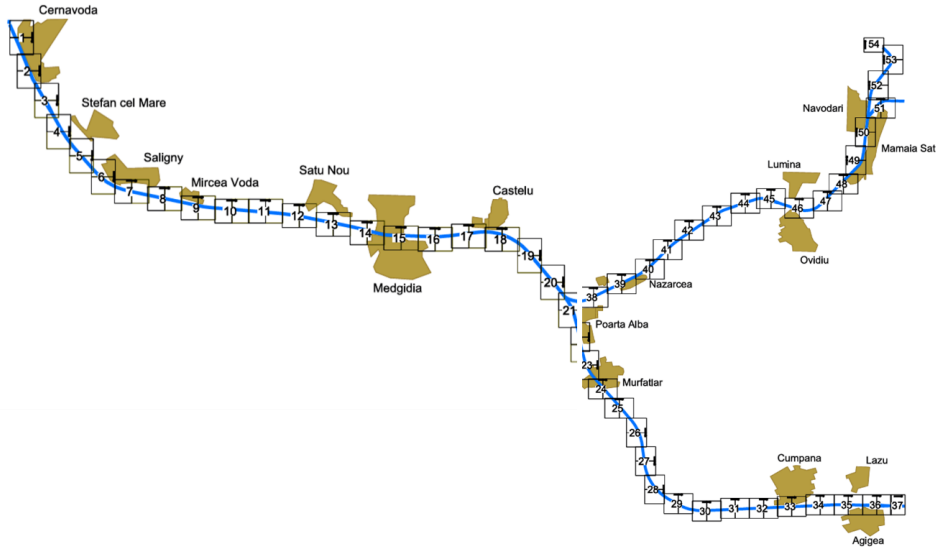
AVIS Pilot plan – Lower Danube

- In Romania, the Danube covers a distance of 1,075 km, representing the longest segment that lies within a single state.
- The primary route selected for the pilot covers the Danube–Black Sea Canal that goes from Agigea to Cernavoda.
- An optional extension is considered on the Poarta Alba–Midia–Navodari Canal, starting from the canal junction and ending near Midia Port.
- The identified vessel is the hydrographic launch OCEAN 2, operated by the Romanian Maritime Hydrographic Directorate



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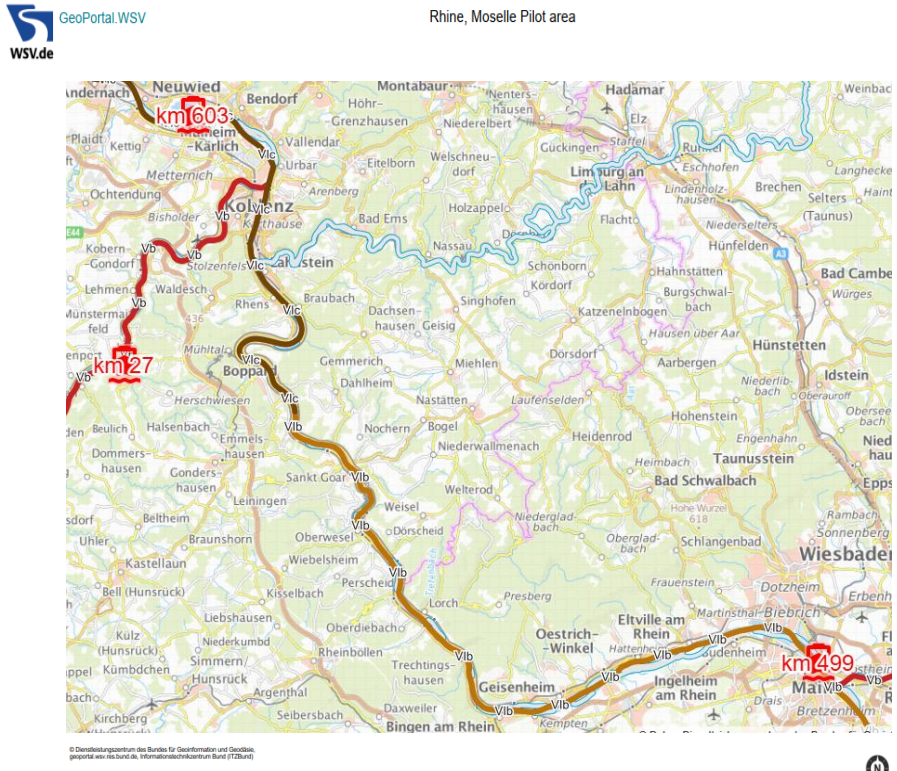
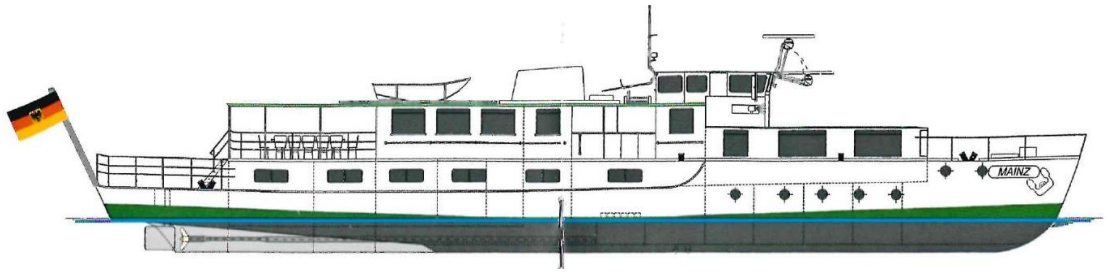
AVIS Pilots' plan - Rhine

- The pilot area in Germany is located around Koblenz, at the confluence of the Moselle and Rhine rivers. Consequently, it includes parts of both waterways.

- The area of interest is considered to be the following:
  - Rhine km: 499 – 603
  - Moselle km: 0 – 27

- The identified vessel is the MS Mainz, a ship operated by the Federal Waterways and Shipping Administration as a research vessel and is stationed in Koblenz.





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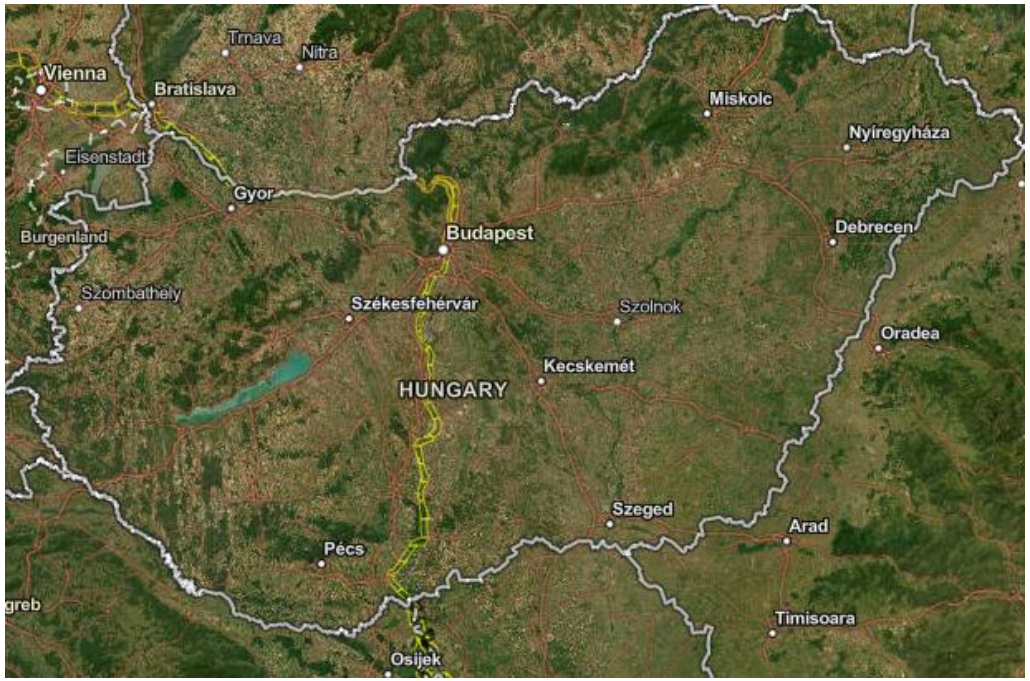
AVIS Pilot plan – Middle Danube

- The area of interest is Budapest, the capital of Hungary. The river is integrated part of the city life and besides this, is an important international inland navigation route for cargo and passenger vessels

- The Hungarian stretch of the Danube is 400 km long in the middle of the Trans-European Corridor VII. The inland waterway traffic in Budapest is the highest on the Hungarian Danube.

- The identified vessel is The ‘MS Luppa’ Marking Vessel. It is the waterway authority’s ship to maintain the Budapest stretch and nearby areas on the Danube.



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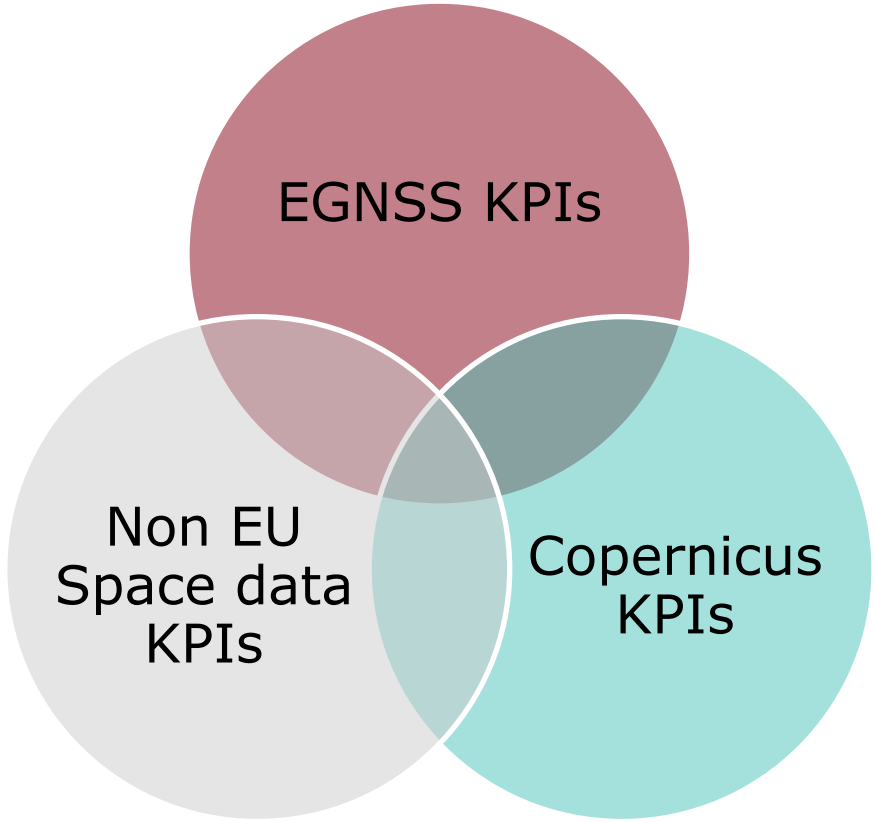
AVIS Pilot plan – KPI definition

- For assessing the results of the pilots, different Key Performance Indicators (KPI) have been defined.



- **EGNSS KPIs**
  - Accuracy, Integrity, Availability/Continuity, Security
- **Copernicus KPIs**
  - Statistical KPIs: mean absolute error, precision and recall for the different ad-hoc services
  - Non-statistical KPIs: meant to measure efficiency, responsiveness or reliability of Copernicus services
- **KPIs not related to EU Space Data**
  - KPIs related to TGAIN, navigation environment or other navigation parameters

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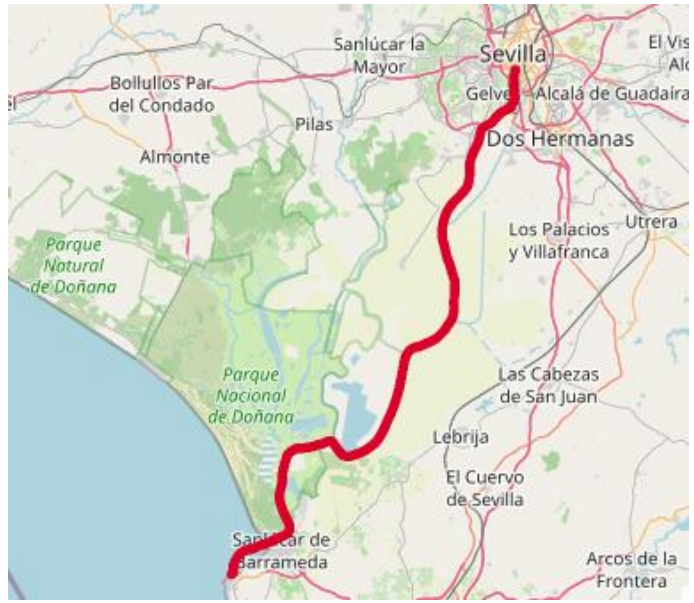
Guadalquivir preliminary results

- **General pilot information:**
  - Two days of navigation
    - Day 1: Data for roughly 5 hours
    - Day 2: Data for 6.5 hours
- **Setup:**
  - All the devices that made up the prototype worked correctly
  - All outputs were correctly logged
- **Services tested:**



Galileo OS, Galileo OSNMA, Galileo HAS, EGNOS	EGNSS Services
River Edge, Object Detection, River Discharge, Turbidity, Bathymetry Proxy	Copernicus Services

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Guadalquivir preliminary results

- **EGNSS results**
  - General IWW navigation: Accuracy obtained in real time comply with requirements up to AL3.
  - We were able to navigate more than 99.95% of the time with authenticated data with Authentication service (OSNMA).
  - Integrity Protection Levels below 25m - positioning uncertainty fits the requirements.

		Required Horizontal accuracy [m]	DFMC (including Galileo OS)		GAL + GPS (EGNOS)		Galileo HAS	
			Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Group 1	AL0-AL2	10	✓	✓	✓	✓	✓	✓
	AL3	5	✓	✓	✓	✓	✓	✓
Group 2	AL0-AL2	5 – 10	✓	✓	✓	✓	✓	✓
	AL3	1	×	×	×	✓	✓	✓
Group 3	AL0-AL2	1 – 3	~	×	~	✓	✓	✓
	AL3	0.1	×	×	×	×	×	×

Note: ✓ = requirement met; × = requirement not met; ~ = the value falls within the required range but does not meet the worst-case requirement.

Promising preliminary results.

For general IWW navigation (Group 1), the results show that current EGNSS services could meet key requirements defined. Potential use towards automation found.

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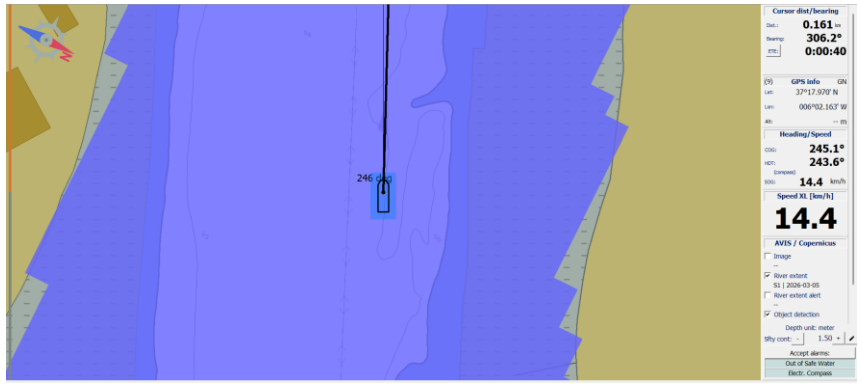
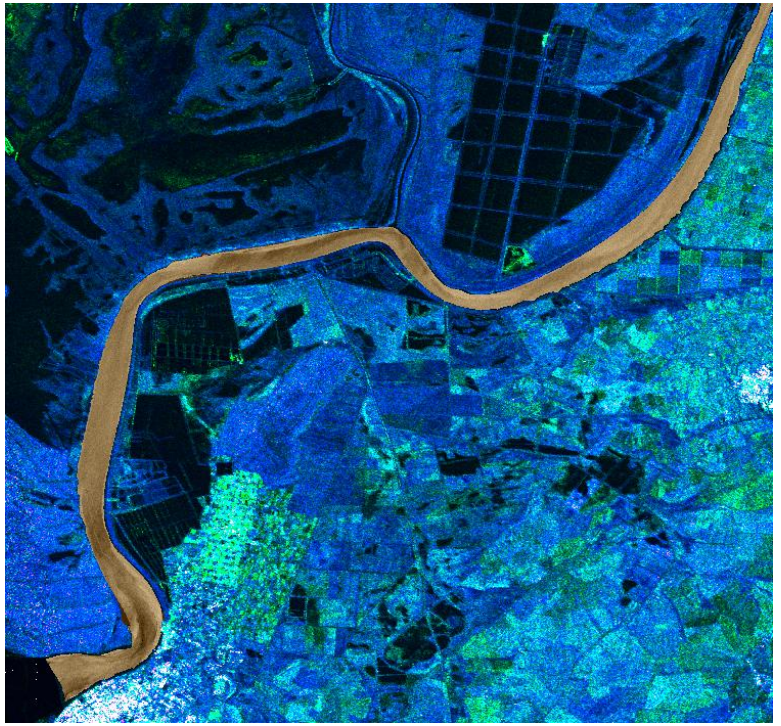
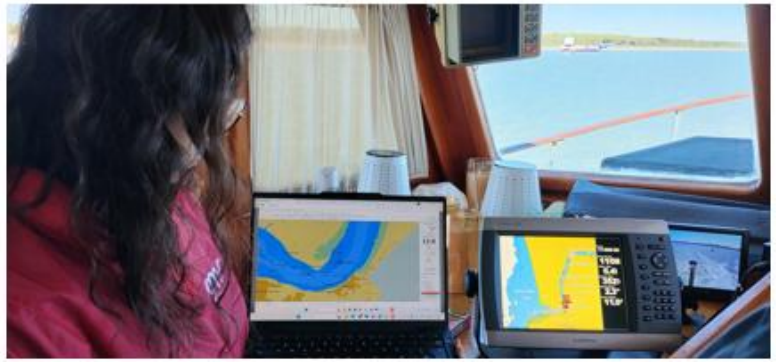
Guadalquivir preliminary results

- **Copernicus results**
  - Good communication with Copernicus server to load data in on-board ECDIS.
  - High-severity Copernicus alerts coincide with reported changes in the river by Authorities.







There is potential for using Copernicus services in planning activities as a backup and/or complementary system for issuing alerts.

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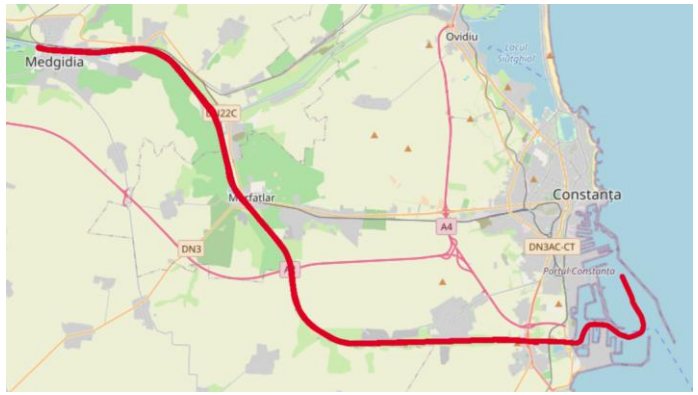
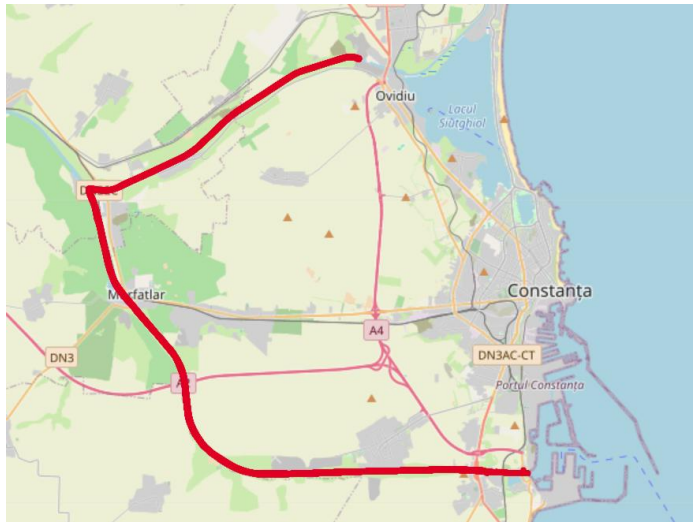
Lower Danube preliminary results

- **General pilot information:**
  - Two days of navigation
    - Day 1: Data for 5 hours of navigation
    - Day 2: Data for 5.5 hours of navigation
- **Setup:**
  - No equipment issues occurred during the trials
  - All expected data was logged
- **Services tested:**



Day 1



Day 2

Galileo OS | Galileo OSNMA | Galileo HAS | EGNOS — EGNSS Services

River Edge | Object Detection | River Discharge | Turbidity | Bathymetry Proxy — Copernicus Services

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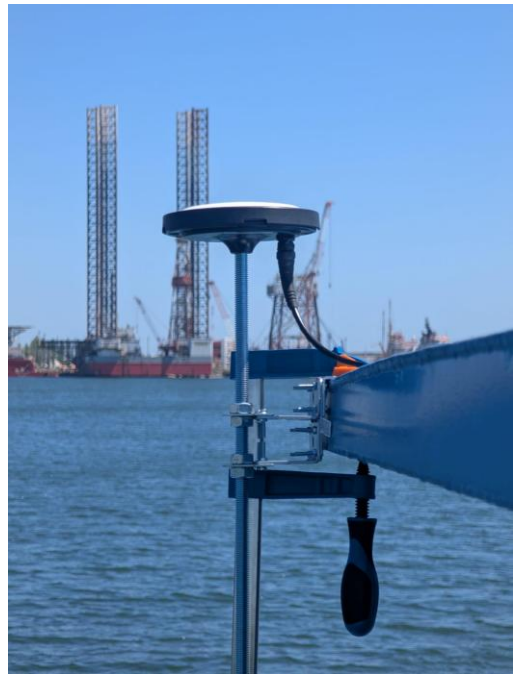
Lower Danube preliminary results

- **EGNSS results**
  - EGNSS performance is similar to that observed on the Guadalquivir River with some differences.
  - Navigating under bridges affects EGNSS services. It is possible to implement some features to reduce the effect of bridges in Galileo HAS.
  - Potential effect of interferences under assessment.
  - More than 99.9% of the time navigating with authenticated data with Authentication service



		Required Horizontal accuracy [m]	DFMC (with Galileo OS)		GAL + GPS (EGNOS)		Galileo HAS	
			Day 1	Day 2	Day 1	Day 2	Day 1	Day 2
Group 1	AL0-AL2	10	✓	✓	✓	✓	✓	✓
	AL3	5	✓	✓	✓	✓	✓	✓
Group 2	AL0-AL2	5 – 10	✓	✓	✓	✓	✓	✓
	AL3	1	×	×	×	×	×	×
Group 3	AL0-AL2	1 – 3	~	~	~	~	~	~
	AL3	0.1	×	×	×	×	×	×

Note: ✓ = requirement met; × = requirement not met; ~ = the value falls within the required range but does not meet the worst-case requirement.

The results of this pilot continue to look promising for the first steps toward automation.

There's a need for more pilots to further consolidate observations.

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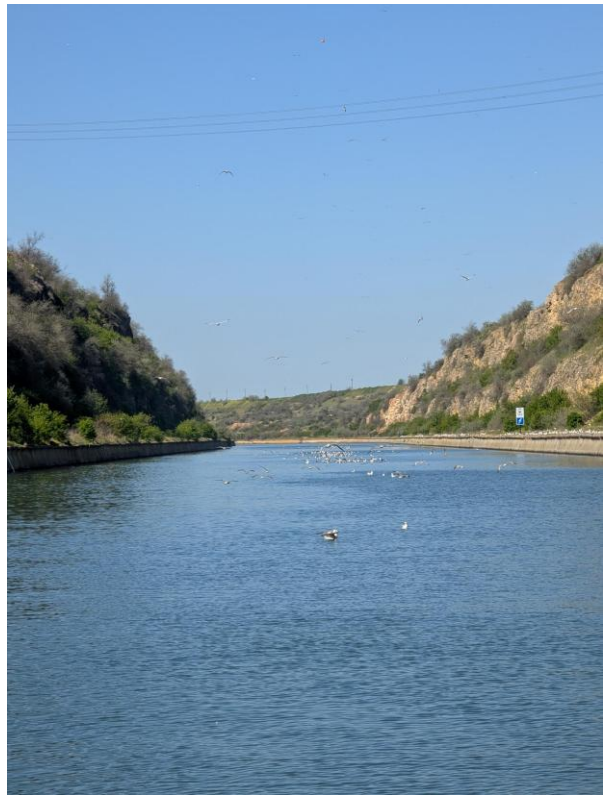
Lower Danube preliminary results

- **Copernicus results**
  - This stretch of the river is notably narrow, with a width that is less than the minimum width estimated to be necessary for Copernicus services.
  - It has been confirmed that Copernicus performs worse in these conditions.
  - Channeled sections reduce the areas where the river can change size. Lower likelihood of receiving Copernicus alerts.



Theoretical hypotheses regarding the limits of Copernicus have been confirmed.

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AVIS Standardisation Activities

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INNOVATING SOLUTIONS

AVIS Standardisation Activities

- **Standard Draft for minimum requirements for automated vessels & EU Space Data**
  - **Objective:** to draft a proposal for a new standard for minimum requirements for EU Space Data to guarantee safe automated vessel navigation on inland waterways in support of future regulatory initiatives.
  - The proposal for the standard shall cover the needs corresponding to the operational scenarios in inland navigation (AVIS Task 1) and user requirements (AVIS Task 2) for automated vessels on European inland waterways in the different levels of automation.
  - 3 versions to be prepared along AVIS project:
    - D8.1: ToC (excel format)
    - D8.2: 1st word version
    - D8.3: 2nd word version under preparation (by 12/26)

Column ID	Column Name	Description
A	**EU Space Data Standard Draft Section**	AVIS standard Section title
B	**Section Objective**	Description of the section purpose and information that section will contain
C	**Comments**	Additional details/comments on the proposed section objective(s) and scope
D	**Needed inputs**	**Identified nputs needed to properly complete the section**
E	**Reserved, Implemented by other regulation references (Impl by Ref) or To Be Developed?**	_ **Reserved:** not to be developed in AVIS _ **Impl by Ref:** Only the reference to the corresponding section of any other regulation where equivalent information is provided is included in sections marked as "Impl by Ref". _ **To Be Developed:** to be developed in the frame of AVIS
F	**Implementation date**	_ D8.2: to be implemented by 01/26 _ D8.3: to be implemented by 12/26 _ N/A: to be reserved & not implemented in AVIS
G-L	**AVIS partners´ participation in the development of each section**	Including leaders in orange, contributors & reviewers
M	**Section Status**	Current status of the standard´ section: _**Not started:** Section proposed to be prepared in AVIS, but not available for this version _**Drafted:** Section already drafted and but not ready for EC review _**On going:** Section being drafted in the context of AVIS _**Implemented:** Section already drafted in the context of AVIS and ready for EC _**Reviewed:** Section consolidated with EC _ **N/A:** Section not to be prepared in AVIS
N	**Need of research activities?**	Only marked as "Yes" when a specific engineering activity has been identified in a certain section.
O	**Feedback from EC**	Agreed/NotAgreed
P	**Feedback from EC: Comments**	Comments provided by EC/EUSPA for each proposed standard draft´s section

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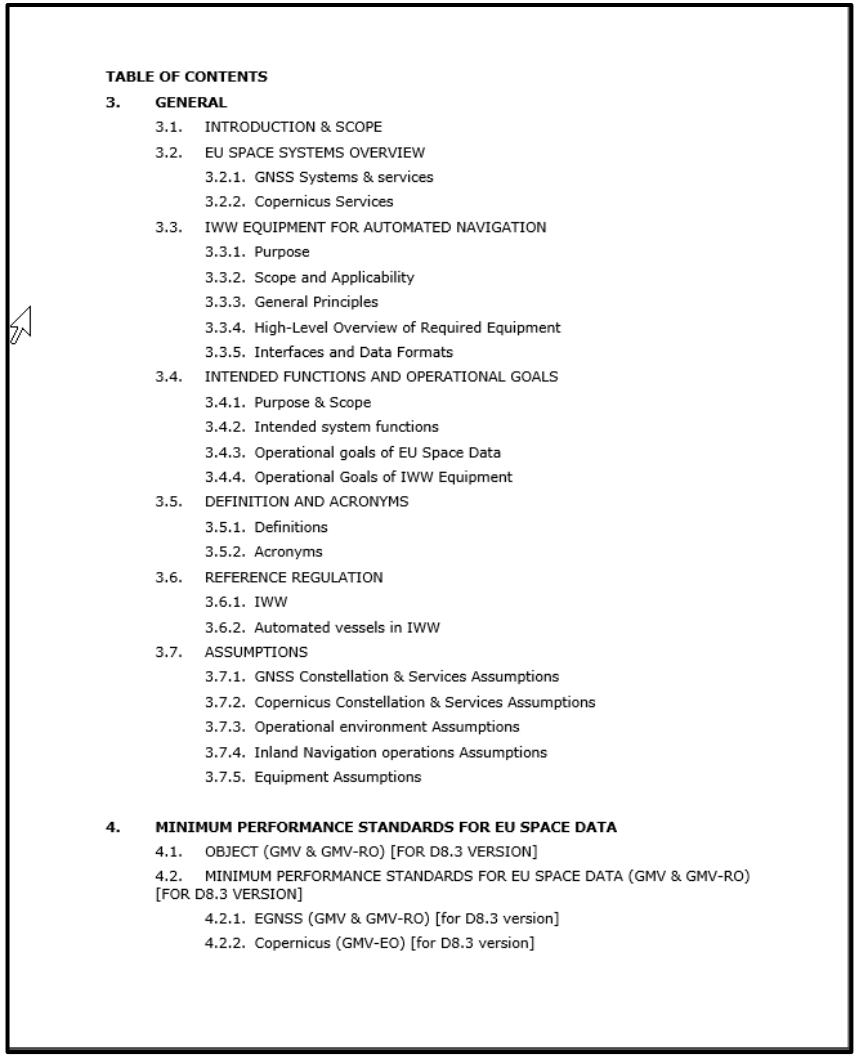
AVIS Standardisation Activities

- **Standard Draft Document for minimum requirements for automated vessels & EU Space Data**



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11. ANNEX 6: IDENTIFICATION OF POTENTIAL ADDITIONAL SENSORS FOR AUTOMATED NAVIGATION

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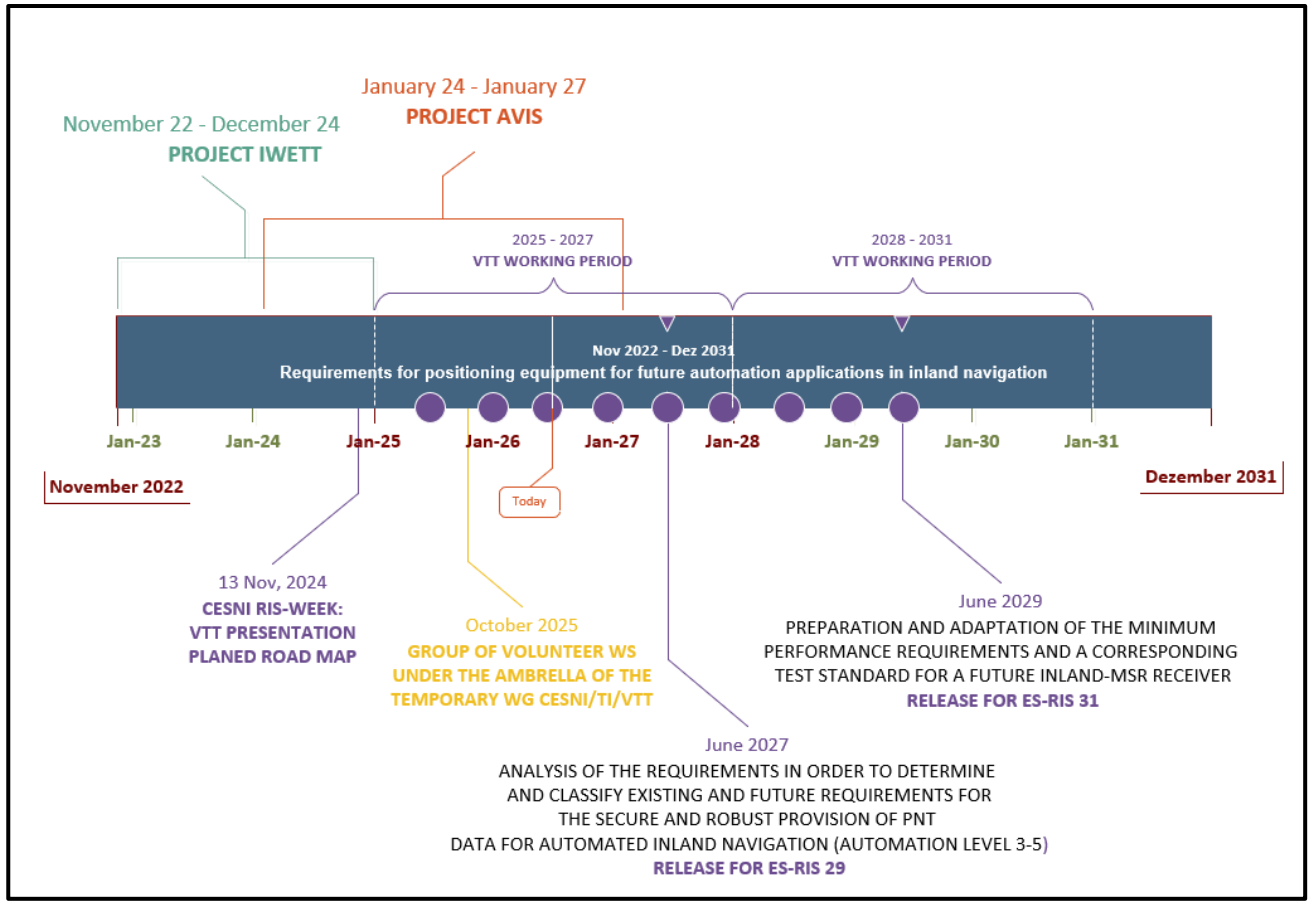
AVIS Standardisation Activities

- **CESNI Group of volunteer under the umbrella of the temporary working group CESNI/TI/VTT for task TI-14 (PNT & I-MSR)**
  - WG led by WSV, ensuring proper coordination with AVIS activities.
  - AVIS contribution: Meetings participation (when relevant) and contribution to the activities under development.
  - WG Schedule: See figure
- **WG Expected outputs:**
  - ES-RIS-29: Requirements for the secure & robust provision of PNT data for Automated Inland Navigation (Automation Level 3-5): to be prepared by June 2027
    - AVIS WP1000 and WP2000 outcomes are to be used as inputs for this document.
  - ES-RIS-31: Minimum Performance requirements and correspond test standard for a future Inland-MSR receiver: to be prepared by June 2029
    - AVIS WP8000 outcomes are to be used as inputs for this document.



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AVIS: Further Activities

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AVIS: Further Activities

- **AVIS Prototype Implementation: fine tunning**
  - Expected to end fine tunning by 07/26
- **AVIS Pilots**
  - To be performed along 2026
  - Preliminary dates for pending 2 pilots:
    - Rhine: 09/26
    - Middle Danube: 10/26
- **AVIS Standadization**
  - CESNI PNT & I-MSR WG participation
  - Preparation of final version of the Standard Draft Document for minimum requirements for automated vessels & EU Space Data
- **AVIS Outreach**
  - Presentation in events: IONGNSS, PLATINA4Action, DINA Commission Expert group meeting…
  - Final Event (during DISC Conference in Budapest: 2-3/12/26)

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Questions for the audience

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Slido questions

Have you experienced any case of spoofing during your operations?

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Slido questions

Do you think that Galileo OSNMA could support your operations?

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Slido questions

Have you experienced any unexpected (i.e., unnotified) changes in river width during your operations?

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Slido questions

Would you appreciate having a standard defining minimum requirements for automated vessels and EU space data?

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Questions from the audience

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Thank you!

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