Deliverable not yet approved by CINEA

Deliverable title:	Digital Solution requirements
Deliverable ID:	D5.2
Document version:	1.0
Partner responsible:	ENSM
Due date:	30 September 2025
Status:	Final

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement Project No: 101076633. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Document Control Sheet

Deliverable number	**D5.2**
Deliverable name	**Digital Solution requirements**
Dissemination Level	**PU**
Call	**HORIZON-CL5-2022-D6-01**
Topic	**HORIZON-CL5-2022-D6-01-08-Safer navigation and tackling containership fires**
Consortium Coordinator	**IMAT**
Partner responsible for the deliverable	**ENSM**
Edition	**1.0**

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ABSTRACT

Overheat relies on heterogeneous sources of information as IoT sensors and UAVs in addition of external information sources as cartography or weather. All this data needs to be “good enough” to take adapted responses. Data quality is usually defined as fit for the purpose of use. The main work of this task is to transform the identified end user requirements (Deliverable 5.1) into subsystem specifications. An important step in achieving this objective is ensuring data harmonization and compatibility between subsystems. Also, the integration of Overheat in the vessel architecture and other existing land systems is analysed in this task. This deliverable also proposes test specifications for the Digital Solution to be used in the evaluation of the developed prototype.

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ACRONYMS

AIS – Automatic Identification System
DS – Digital Solution
ECDIS – Electronic Chart Display and Information Systems
ECS – Electronic Chart Systems
ENC – Electronic Navigational Charts
EU – European Union
GI – Geospatial Information
GMDSS – Global Maritime Distress and Safety System
IALA – International Association of Marine Aids to Navigation and Lighthouse
IEC – International Electrotechnical Commission
IHO – International Hydrographic Organization
IMO – International Maritime Organization
ISO – International Organization for Standardization
NMEA – National Marine Electronics Association
SA – Situational Awareness
SMCP – Standard Marine Communication Phrases
SOLAS – International Convention for the Safety of Life at Sea
SMCP – Standard Marine Communication Phrases
SSA – Shared Situational Awareness
STCW - International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TRs – Technical Requirements
VTS - Vessel Traffic Service

INTRODUCTION

Task 5.2 aims to define the technical requirements and integration approach for the OVERHEAT Digital Solution (DS), building directly upon the user requirements identified in Task 5.1, which were defined through expert workshops, scenario analysis, and stakeholder interviews and consultation. While Task 5.1 is focused on gathering operational needs from primary end users such as ship crews, port authorities, and emergency responders, task 5.2 ensures that these needs are systematically transformed into precise and testable Technical Requirements (TRs) that guide the design and evaluation of the DS demonstrator.

The objective is to ensure that the DS is capable of supporting advanced fire detection, monitoring, and response coordination functionalities, while remaining compliant with maritime safety regulations such as IMO, SOLAS, IEC and aligned with standards including the IHO S-100 framework, ECDIS integration protocols, and modern cybersecurity practices. Key areas addressed include real-time data acquisition from onboard and aerial sensors, multi-stakeholder communication and Situational Awareness (SA), fire severity assessment, decision support systems, and secure data management. This task also accounts for system performance, usability, and interoperability, ensuring the DS can be deployed effectively in both vessel and port environments. This process ensures that the TRs are not abstract statements but concrete specifications that can be implemented and tested.

To support the validation phase, a test specification checklist has been developed, allowing systematic evaluation of each functional module under simulated or real-world operational conditions. This ensures that the demonstrator can be systematically evaluated under realistic operational conditions and lays the foundation for future deployment as a reliable, compliant, and user-driven maritime fire safety platform.

Overall, Task 5.2 plays a critical role in shaping the technical foundation of the OVERHEAT DS. By translating stakeholder needs into structured TRs and preparing the ground for validation, this task ensures that the DS is both user-driven and technically sound, capable of enhancing fire prevention, detection, and response in maritime operations.

1. Regulations and standards

The most widely used regulations, standards and good practices are being considered. These are:

I. International Maritime Organization (IMO)
   a. SOLAS Convention
   b. Global Maritime Distress and Safety System (GMDSS)
   c. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)
   d. Resolutions
II. International Hydrographic Organization (IHO)
III. International Electrotechnical Commission (IEC)
IV. National Marine Electronics Association (NMEA)
V. Wheelmark

1.1. International Maritime Organization (IMO)

The IMO is a UN specialized agency, which sets global standards for shipping safety, security, and environmental protection. Its core mission is to establish a fair, effective, and universally implemented regulatory framework for international shipping (IMO, Introduction to IMO, 2025). Among the key instruments and frameworks developed and overseen by the IMO are:

1.1.1. Solas Convention

The SOLAS Convention (Safety of Life at Sea), originally adopted in 1914, has been regarded as the most significant international treaty for the safety of merchant ships. Following its initial adoption, revisions were introduced in 1929, 1948, and 1960. The 1974 version, which remains in force today as SOLAS 1974, as amended, was adopted under the auspices of the International Maritime Organization (IMO, 2024). Under this convention, specific requirements for both fire safety systems and the mandatory carriage of Electronic Chart Display and Information Systems (ECDIS) have been established, thereby directly informing the DS requirements to be developed under this task (IMO, 2024).

The list of concerned SOLAS chapters is below:

i. Chapter V/Regulation 1 - Application
ii. Chapter V/Regulation 7 - Search and rescue services
iii. Chapter V/Regulation 8 - Life-saving signals
iv. Chapter V/Regulation 9 - Hydrographic services
v. Chapter V Regulation 18 - Approval, surveys and performance standards of navigational systems and equipment and voyage data recorder
vi. Chapter V/ Regulation 19 - Carriage requirements for shipborne navigational systems and equipment
vii. Chapter V/ Regulation 27 - Nautical charts and nautical publications
viii. Chapter II-2, Part C-G Regulations 7-10,12,14,15,17 and 22
ix. Chapter X/3

The S-100 standard, a crucial technology for ECDIS, becomes optional on January 1, 2026. It will be mandatory for all newly constructed ships equipped with ECDIS to incorporate the S-100 standard by January 1, 2029. For a comprehensive understanding, please refer to the

SOLAS convention for detailed information (https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx).

1.1.2. Global Maritime Distress and Safety System (GMDSS)

The Global Maritime Distress and Safety System (GMDSS) is a regulatory requirement under SOLAS (chapter IV), aimed at standardizing and improving distress and safety communications globally. Developed by the United Nations' IMO as part of the SOLAS Convention, GMDSS sets out the regulations, equipment, and protocols required to ensure that ships can send and receive distress alerts, enhancing global maritime safety. For comprehensive understanding, please refer to the GMDSS official webpage for detailed information https://gmdss.com/.

1.1.3. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)

The STCW Convention sets international standards for seafarer training, certification, and watchkeeping, ensuring global consistency in maritime competence. Its 1995 amendments introduced the mandatory STCW Code and enhanced compliance monitoring, while the 2010 Manila amendments further updated requirements for modern technology, safety, and security. This framework ensures qualified personnel for safer global shipping (STCW, 2025).

1.1.4. Resolutions

IMO Resolutions are official decisions issued by its Assembly, Council, and committees to amend or update existing international conventions. They provide a dynamic mechanism to adapt maritime regulations, such as SOLAS or STCW, to evolving industry practices and new global challenges like security. This process offers a more efficient alternative than creating entirely new conventions, ensuring continuous relevance and safety in shipping. The resolutions concerned are:

- IMO Res. MSC_36(63) -(1994 HSC Code)- as amended, 13
- IMO Res. MSC.97(73) -(2000 HSC Code)- as amended, 13
- IMO Res. A.694(17)
- IMO Res. MSC.191(79), MSC.232(82), MSC.302(87)
- IMO MSC. 1/Circ.1503.Rev.1

1.2. International Hydrographic Organization (IHO)

Standards, as advocated by the IHO (October 2023), are crucial for best practices, efficient production, quality optimization, and interoperability. IHO, established in 1921, plays a vital role in coordinating global hydrographic efforts, promoting uniformity in nautical charts, and issuing best practices, despite existing knowledge gaps concerning the seabed.

The IHO is the intergovernmental organization responsible for developing international standards related to hydrographic services as defined in SOLAS regulation V/9. Under its remit, and in support of the relevant performance standards for ECDIS adopted by the IMO, the IHO maintains the following set of standards related to ECDIS (IHO, Feb 2020):

- S-57 - Transfer Standard for Digital Hydrographic Data (including the Product Specification for ENC)

- S-52 - Chart Content and Display Aspects of ECDIS; S-52 Annex A - ECDIS Presentation Library (Preslib)
- S-64 - Test Data Sets for ECDIS
- S-58 - ENC Validation Checks
- S-61 - Product Specification for RNC
- S-62 - Data Producer Codes
- S-63 - Data Protection Scheme
- S-65 - ENCs: Production, Maintenance and Distribution Guidance
- S-11 Part A - Guidance for the Preparation and Maintenance of International (INT) Chart and ENC Schemes.

Of the standards developed by IHO, S-100 Universal Hydrographic Data Model is the most recent standard and is developed to address future demands for digital products and services. This comprehensive model is designed to support a wide range of applications in hydrography and beyond. S-100 serves as the foundation for next-generation ENCs and supports the integration of additional data layers, facilitating enhanced navigation, marine spatial planning, and environmental protection. OVERHEAT DS will be based on this standard.

Figure 1: S-100 Universal Hydrographic Data Model (IHO, October 2023)

1.2.1. S-100 Products

IHO proposes a set of standards for defining each type of product. This list is updated regularly with new versions and new information. The next Table shows the current S-1XX standards.

Table 1 – S-1XX standards

Product Code	Product Name	Scope
S-101	Electronic Navigational Chart (ENC)	Specifies content, structure, data encoding, metadata for S-101 ENC data; includes portrayal requirements for ECDIS. Supersedes S-57 ENC PS.
S-102	Bathymetric Surface	Provides bathymetric coverage layer based on Bathymetric Attributed Grid (BAG) for navigation and other purposes.
S-104	Water Level Information for Surface Navigation	Encapsulates tidal and water level data for use in ECDIS or dynamic tide applications. Critical for route planning and port entry.
S-111	Surface Currents	Provides surface current information to complement the S-101 ENC for navigation safety.
S-121	Maritime Limits and Boundaries	Encodes digital maritime boundary information, including maritime limits, zones, and boundaries as per UNCLOS.
S-122	Marine Protected Areas (MPAs)	Encodes information on Marine Protected Areas for use in ECDIS and other systems; MPAs are protected areas of seas, oceans, estuaries, or large lakes.
S-123	Marine Radio Services	Indicates location, availability, type of radio communications, frequencies, and content for navigational information and other maritime radio communications.
S-124	Navigational Warnings	Creates datasets for navigational warnings, primarily for ECDIS; contains urgent information relevant to safe navigation.
S-125	Marine Aids to Navigation (AtoN)	Describes navigational features including lights, marks, and local AIS messages; complements S-101 ENC.
S-126	Marine Physical Environment	Describes marine and terrestrial topography, currents, tides, weather, and other environmental conditions; complements S-101 ENC.
S-127	Marine Traffic Management	Covers vessel traffic services, pilotage, routeing systems, and ship reporting systems; complements S-101 ENC.
S-128	Catalogue of Nautical Products	Exchange of catalogues of printed and digital nautical products; assesses applications for navigation and e-Navigation services.
S-129	Under Keel Clearance Management (UKCM)	Provides digital data format for maritime safety and efficiency of marine traffic; enables exchange between Under Keel Clearance Management System and onboard navigation systems.
S-130	Polygonal Demarcations of Global Sea Areas	Supports digital coordinates for global sea area limits; uses unique numerical identifiers.
S-131	Marine Harbour Infrastructure	Describes layout of port facilities and availability of port services; facilitates berth-to-berth navigation and voyage planning.

S-164	IHO Test Data Sets for S-100 ECDIS	Provides test data sets for ECDIS testing requirements as outlined in IEC 61174 standard.

Other organizations as IALA propose complementary standards based on the S-100 family and named as S-2XX. Weather layers are placed as S-4XX.

- **IALA (S-201 to S-299):**
  - S-201 Aids to Navigation Information
  - S-210 Inter-VTS Exchange Format
  - S-211 Port Call Message Format
  - S-212 VTS Digital Service
  - S-230 Application Specific Messages
  - S-240 DGNSS Station Almanac
  - S-245 eLoran ASF Data
  - S-246 eLoran Station Almanac
  - S-247 Differential eLoran Reference Station Almanac
- WMO Service Commission (SERCOM) (S-411 to S420)
  - S-411 Dynamic Ice Information
  - S-412 Marine Weather Warnings
  - S-413 Marine Weather and Wave Conditions
  - S-414 Marine Weather and Wave Observations

For details and other standards, please refer to the website of IHO (https://iho.int/en/s-100-based-product-specifications).

1.3. International Electrotechnical Commission (IEC)

Founded in 1906, the IEC is the world's leading organization for the preparation and publication of international standards for all electrical, electronic and related technologies. The IEC publishes global standards for electrical and electronic technologies, including maritime navigation. Specifically, IEC 61174:2015 sets operational and performance requirements for Electronic Chart Display and Information Systems (ECDIS), aligning with IMO standards. This standard ensures ECDIS reliability, incorporating updates for radar/AIS display, new interfaces, and extended operational ranges. For comprehensive understanding, refer to the official IEC website at: https://www.iec.ch/homepage.

1.4. National Marine Electronics Association (NMEA)

The NMEA is a global trade organization dedicated to advancing marine electronics through installer training and interface standards, promoting professionalism and safety. It develops interface standards, provides installer training and certifications. The NMEA offers three key standards for marine electronics communication. NMEA 0183 is an older, widely adopted serial protocol, while NMEA 2000® provides a faster, bi-directional network based on CAN for robust data exchange. The newest, NMEA OneNet®, utilizes Ethernet and IPv6 for high-bandwidth applications like radar and video, designed to complement NMEA 2000. The concerned IEC regulations are:

- IEC 60945 (2002) + /Cor. 1 (2008)

- IEC 61162 series: IEC 61162-1 (2016) - IEC 61162-2 ed1.0 (1998-09)- IEC 61162-3 ed1.2 Consol. with am1 ed. 1.0 (2010-11) and am2 ed 1.0 (2014-07)- IEC 61162-450 (2018)
- IEC 61174 Ed. 4.0 (2015)
- IEC 62288 Ed. 3 0 (2021)
- IEC 62923-1 (2018)
- IEC 62923-2 (2018)

For comprehensive understanding, please refer to the official website of NMEA: https://www.nmea.org/.

1.5. Wheelmark

The Wheelmark is a mandatory European Union (EU) conformity mark for marine equipment placed on ships. It signifies that a product meets the safety-at-sea requirements of the Marine Equipment Directive (MED) and relevant international standards set by the IMO. Products bearing the Wheelmark have undergone rigorous testing and certification by a notified body ensuring their reliability and safety for use on board.

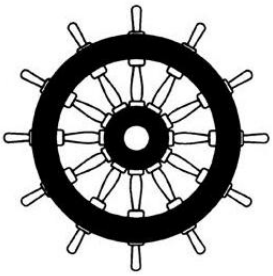

Figure 2 : Wheelmark , the European regulatory marking of all marine equipment

2. From Users to Technical Requirements

This section presents how the identified user requirements are translated into technical requirements. The purpose of defining TRs is to create a bridge between user expectations and technical implementation. To achieve this, a structured methodology was applied. First, user needs were identified and categorized according to the main functions of the DS, such as fire assessment and response, SA and response, S-100 integration and data management, technical enhancement and security, special considerations from port authorities and firefighters and non-functional requirements. Next, each user requirement was mapped to the functions that the DS must perform in order to address it. These functions were then translated into measurable TRs that describe exactly how the system should behave, perform, and integrate within the maritime environment. All TRs are based to ensure compliance with international standards and regulations such as SOLAS, IMO guidelines, IHO S-100 framework, and IEC/ISO standards for safety and cybersecurity. User requirements identified in D5.1 section 8 serves the basic input for the TRs with additional input from WP4. All TRs has been structured using the format table below.

Identifier	**REQ-OVERHEAT-D5.2-XXXX**
Requirement	*Requirement statement*
Status	<Defined> <Validated> <Modified> <Deleted>
Rationale	*Why requirement is stated*
Category	XXXX
Additional Comment	*If any*

The status of each requirement will be assessed using the following three checking criteria:

- Defined: The TR has been defined
- Validated: The TR has been validated in its initial form
- Modified: The TR has been validated with adaptations
- Deleted: The TR has been deleted because it has been declared irrelevant

The identified TRs are stated in next subsections.

2.1. Compliance with Regulations, Standards, and Good Practices

Identifier	**REQ-OVERHEAT-D5.2-0001**
Requirement	*The DS shall comply with SOLAS Chapter II-2 and V/18–19, ensuring conformity with fire protection and ECDIS carriage requirements (IMO, 2024).*
Status	<Defined>
Rationale	*This requirement allows to be compliant with current SOLAS regulations*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0002
Requirement	*The DS shall support the IHO S-100 framework, including integration with S-101 (ENC), to ensure interoperability with VTS and ECDIS-based navigation and support standardized data layers (IHO, 2023)*
Status	*<Defined>*
Rationale	*This requirement allows interoperability with existing navigation systems (VTS, ECDIS) and standardized use of hydrographic data*
Category	*Compliance with Regulations, Standards, and Good Practices*
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0003
Requirement	*The DS shall follow IEC 61162 and IEC 61174 interface standards to ensure safe and reliable electronic communication between bridge systems*
Status	<Defined>
Rationale	*This requirement allows safe and reliable electronic communication between bridge systems*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0004
Requirement	*Cybersecurity protocols aligned with IMO MSC-FAL.1/Circ.3 (IMO, GUIDELINES ON MARITIME CYBER RISK MANAGEMENT, 2025) shall be implemented, including authentication, encryption, and real-time intrusion detection for all data exchanges*
Status	<Defined>
Rationale	*This requirement allows for DS to be resilient against cyber risks*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0005
Requirement	*The DS shall conform to recognized firefighting procedures, such as those defined in the International Fire Safety Systems (FSS) Code, for alignment with operational safety protocols*
Status	<Defined>
Rationale	*This requirement allows alignment with internationally recognized firefighting procedures*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0006
Requirement	*The DS interface shall maintain offshore display clarity, avoiding information overload by placing fire-specific data in a separate, standardized overlay or window (For example: as per IMO ECDIS performance standards (MSC.232(82))*
Status	<Defined>
Rationale	*This requirement allows that fire-related information is clearly displayed without interfering with navigational functions, reducing the risk of information overload*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0007
Requirement	*The DS interface shall maintain onshore display clarity, avoiding information overload by placing fire-specific data in a separate, standardized overlay or window*
Status	<Defined>
Rationale	*This requirement allows that fire-related information is clearly displayed without interfering with VTS functions, reducing the risk of information overload*
Category	Compliance with Regulations, Standards, and Good Practices
Additional Comment	

2.2. Fire Assessment and Response

Identifier	REQ-OVERHEAT-D5.2-0008
Requirement	*The DS shall integrate IoT-based fire detection systems that provide real-time alerts integrated with existing systems*
Status	<Defined>
Rationale	*This requirement allows early fire detection and immediate crew awareness*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Detection & Monitoring*

Identifier	REQ-OVERHEAT-D5.2-0009
Requirement	*The DS shall support multiple sensor inputs, including smoke detectors using different detection technologies, gas sensors, temperature sensors, and Infrared (IR) cameras*
Status	<Defined>
Rationale	*This requirement allows comprehensive fire monitoring*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Detection & Monitoring*

Identifier	REQ-OVERHEAT-D5.2-0010
Requirement	*The DS shall enable UAV-assisted monitoring using dual vision (thermal + optical), with image processing capabilities for fire hot-spot detection and transmission*
Status	<Defined>
Rationale	*This requirement allows comprehensive detection and situational awareness*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Detection & Monitoring*

Identifier	REQ-OVERHEAT-D5.2-0011
Requirement	*The DS shall be capable of identifying fire location, combining spatial data from fixed sensors and real-time UAV video positioning*
Status	<Defined>
Rationale	*This requirement allows accurate fire localization by fusing data from multiple detection sources*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Location & Severity Assessment*

Identifier	REQ-OVERHEAT-D5.2-0012
Requirement	*The system shall provide real-time telemetry on temperatures*
Status	<Defined>
Rationale	*This requirement allows assessment of fire intensity*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Location & Severity Assessment*

Identifier	REQ-OVERHEAT-D5.2-0013
Requirement	*The system shall provide real-time telemetry on smoke/flame colour and density*
Status	<Defined>
Rationale	*This requirement allows assessment of fire type*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Fire Location & Severity Assessment*

Identifier	REQ-OVERHEAT-D5.2-0014
Requirement	*The DS user interface shall visualize automated fire severity classifications generated via the combination of data coming from IoT sensors telemetry and UAV-based analytical outputs*
Status	<Defined>
Rationale	*This requirement allows crew and responders to rapidly understand fire severity*
Category	Fire Assessment and Response

Additional Comment	*Sub-category: Fire Location & Severity Assessment*

Identifier	**REQ-OVERHEAT-D5.2-0015**
Requirement	*The DS shall include firefighting technique recommendations suggesting suppression methods per fire type (solid, gas, liquid, metal, etc)*
Status	<Defined>
Rationale	*This requirement allows standardized decision support*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Decision Support for Firefighting Strategy*

Identifier	**REQ-OVERHEAT-D5.2-0016**
Requirement	*When dangerous goods are involved, the DS shall trigger special handling alerts, including extinguishing agent restrictions*
Status	<Defined>
Rationale	*This requirement allows to prevent inappropriate firefighting actions*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Decision Support for Firefighting Strategy*

Identifier	**REQ-OVERHEAT-D5.2-0017**
Requirement	*The DS shall allow emergency response of fire incidents within 15 minutes*
Status	<Defined>
Rationale	*This requirement allows timely detection-to-action response*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Emergency Response Coordination*

Identifier	**REQ-OVERHEAT-D5.2-0018**
Requirement	*The DS shall be able to request external aid when high fire severity, explosion risks, or inadequate firefighting equipment is detected*
Status	<Defined>
Rationale	*This requirement allows escalation to external responders*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Emergency Response Coordination*

Identifier	**REQ-OVERHEAT-D5.2-0019**
Requirement	*The DS shall support predefined communication workflows, using GMDSS or S-124 protocols to contact relevant actors*
Status	<Defined>

Rationale	*This requirement allows standardized emergency communication with relevant actors*
Category	Fire Assessment and Response
Additional Comment	*Sub-category: Emergency Response Coordination*

2.3. Situational Awareness (SA) & Communication

Identifier	**REQ-OVERHEAT-D5.2-0020**
Requirement	*The DS shall stream real-time updates on fire location (geo-referenced), navigational hazards, weather, sensor outputs (temperature, smoke, gas), UAV video and thermal imaging*
Status	<Defined>
Rationale	*This requirement allows continuous and integrated monitoring of fire and navigation risks*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Real-Time Data Sharing & Visualization*

Identifier	**REQ-OVERHEAT-D5.2-0021**
Requirement	*The DS shall display fire related data, including UAV live feeds, and alerts in a dedicated window*
Status	<Defined>
Rationale	*This requirement allows clear separation and prioritization of fire data rapid situational awareness*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Real-Time Data Sharing & Visualization*

Identifier	**REQ-OVERHEAT-D5.2-0022**
Requirement	*The DS shall include a configurable data refresh interval between 10 to 30 minutes for sensor and visual updates, with an optional automation mode based on threat levels*
Status	<Defined>
Rationale	*This requirement allows performance with resource efficiency*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Real-Time Data Sharing & Visualization*

Identifier	**REQ-OVERHEAT-D5.2-0023**
Requirement	*The DS shall reduce reliance on manual voice communication (e.g., VHF/phone) by offering a primary digital coordination interface, accessible via ECDIS or VTS terminals*
Status	<Defined>
Rationale	*This requirement allows efficiency and reduces miscommunication risks during emergencies*
Category	Situational Awareness (SA) & Communication

Additional Comment	*Sub-category: Communication & Information Exchange*

Identifier	**REQ-OVERHEAT-D5.2-0024**
Requirement	*The DS shall enable ship crews, firefighting teams, ports, and authorities can access and share real-time situational data*
Status	<Defined>
Rationale	*This requirement allows shared situational awareness across all stakeholders involved*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Communication & Information Exchange*

Identifier	**REQ-OVERHEAT-D5.2-0025**
Requirement	*The DS shall support UAV image and video streaming, snapshot sharing of key frames, video clipping tools for transmitting critical segments and live-feed broadcasting*
Status	<Defined>
Rationale	*This requirement allows easy transmission of critical visual data for decision-making*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Communication & Information Exchange*

Identifier	**REQ-OVERHEAT-D5.2-0026**
Requirement	*The DS shall be complementary to a dedicated fire emergency display (ex: separate from the ECDIS main screen) to reduce navigation clutter*
Status	<Defined>
Rationale	*This requirement allows to prevent navigation interference*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Standardization & Usability*

Identifier	**REQ-OVERHEAT-D5.2-0027**
Requirement	*The DS shall allow for standardized overlays rather than fully customizable dashboards to maintain operational clarity*
Status	<Defined>
Rationale	*This requirement allows consistency and avoids confusion*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Standardization & Usability*

Identifier	**REQ-OVERHEAT-D5.2-0028**
Requirement	*The DS interface shall support English Language, including Standard fire response terminology*
Status	<Defined>

Rationale	*This requirement allows common understanding using recognized safety terminology*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Standardization & Usability*

Identifier	**REQ-OVERHEAT-D5.2-0029**
Requirement	*The UAV operators shall have a dedicated screen*
Status	<Defined>
Rationale	*This requirement allows UAV operators to independently manage UAV monitoring and control*
Category	Situational Awareness (SA) & Communication
Additional Comment	*Sub-category: Standardization & Usability*

2.4. S-100 Integration & Data Management

Identifier	**REQ-OVERHEAT-D5.2-0030**
Requirement	*The DS shall support the integration of the IHO S-100 product specifications as modular, selectable layers: S-101, S-102, S-111, S-127 and S-412*
Status	<Defined>
Rationale	*This requirement allows for availability of standardized cartographic data*
Category	S-100 Integration & Data Management
Additional Comment	*Sub-category: Incorporation of S-100 Layers*

Identifier	**REQ-OVERHEAT-D5.2-0031**
Requirement	*The DS shall enable external assistance vessels to access S-124 (Navigational Warnings) for situational risk awareness during fire response operations*
Status	<Defined>
Rationale	*This requirement allows responders to receive critical safety warnings*
Category	S-100 Integration & Data Management
Additional Comment	*Sub-category: Incorporation of S-100 Layers*

Identifier	**REQ-OVERHEAT-D5.2-0032**
Requirement	*All S-100 datasets shall be seamlessly retrievable from ECDIS and VTS (or auxiliary consoles), ensuring fire-related overlays are accessible and navigable*
Status	<Defined>
Rationale	*This requirement allows interoperability and usability of S-100 data across ship and shore systems*
Category	S-100 Integration & Data Management
Additional Comment	*Sub-category: Incorporation of S-100 Layers*

Identifier	REQ-OVERHEAT-D5.2-0033
Requirement	*The DS shall incorporate user-centered design features allowing the operators to clearly understand colour coded visual prioritization and reduce information overload*
Status	<Defined>
Rationale	*This requirement allows usability during emergencies by preventing cognitive overload for operators*
Category	S-100 Integration & Data Management
Additional Comment	*Sub-category: Mitigation of Adoption Challenges*

Identifier	REQ-OVERHEAT-D5.2-0034
Requirement	*The system shall include a training and onboarding module, user roles, and hands-on tutorials for Bridge officers, UAV operators, Port and Rescue Centres officials and Firefighters*
Status	<Defined>
Rationale	*This requirement allows smooth adoption of the system through tailored training*
Category	S-100 Integration & Data Management
Additional Comment	*Sub-category: Mitigation of Adoption Challenges*

2.5. Technical Enhancements & Security

Identifier	REQ-OVERHEAT-D5.2-0035
Requirement	*The DS shall extend ECDIS and VTS functionalities to overlay fire-related data using standardized S-100 symbology, without interfering with core navigational elements*
Status	<Defined>
Rationale	*This requirement allows fire data integration without disrupting navigational safety*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: DS & Digital Fire Management System*

Identifier	REQ-OVERHEAT-D5.2-0036
Requirement	*The DS shall support high-resolution display*
Status	<Defined>
Rationale	*This requirement allows enhanced spatial awareness*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: DS & Digital Fire Management System*

Identifier	REQ-OVERHEAT-D5.2-0037
Requirement	*The DS shall support real-time streaming of video and thermal imagery*

Status	<Defined>
Rationale	*This requirement allows better comprehension and enhanced decision-making*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: DS & Digital Fire Management System*

Identifier	**REQ-OVERHEAT-D5.2-0038**
Requirement	*The DS shall embed a predefined library of fire management procedures, tailored for vessel type, cargo class, and DG categorization. These shall be selectable through an interactive checklist*
Status	<Defined>
Rationale	*This requirement allows standardized firefighting response protocols across vessels and cargo types*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: DS & Digital Fire Management System*

Identifier	**REQ-OVERHEAT-D5.2-0039**
Requirement	*The DS shall ensure protection against data manipulation, data availability and unauthorized access*
Status	<Defined>
Rationale	*This requirement allows cyber resilience*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: Cybersecurity & Connectivity*

Identifier	**REQ-OVERHEAT-D5.2-0040**
Requirement	*The DS shall provide post-incident analysis*
Status	<Defined>
Rationale	*This requirement allows traceability for incident investigations*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: Cybersecurity & Connectivity*

Identifier	**REQ-OVERHEAT-D5.2-0041**
Requirement	*The DS shall enforce cybersecurity protocols*
Status	<Defined>
Rationale	*This requirement allows compliance with recognized maritime cybersecurity standards*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: Cybersecurity & Connectivity*

Identifier	REQ-OVERHEAT-D5.2-0042
Requirement	*The DS shall ensure secure maritime data exchange between shipboard systems, port operation centres, firefighting vessels and UAVs via secure maritime protocols*
Status	<Defined>
Rationale	*This requirement allows data integrity and confidentiality in cross-domain communication*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: Cybersecurity & Connectivity*

Identifier	REQ-OVERHEAT-D5.2-0043
Requirement	*The DS shall ensure real-time data synchronization with fallback mechanisms to prevent data loss or delay in the event of intermittent connectivity.*
Status	<Defined>
Rationale	*This requirement allows operational continuity even under unstable connectivity*
Category	Technical Enhancements & Security
Additional Comment	*Sub-category: Cybersecurity & Connectivity*

2.6. Special Considerations from Port Officials & Firefighters

Identifier	REQ-OVERHEAT-D5.2-0044
Requirement	*The DS shall calculate and display automated fire location estimations*
Status	<Defined>
Rationale	*This requirement allows SA even when precise data from container manifests is missing*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Port Coordination & Fire Response*

Identifier	REQ-OVERHEAT-D5.2-0045
Requirement	*The DS shall enable real-time data exchange between actors*
Status	<Defined>
Rationale	*This requirement allows seamless coordination between offshore and onshore team*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Port Coordination & Fire Response*

Identifier	REQ-OVERHEAT-D5.2-0046
Requirement	*The DS shall support automated notification systems to inform port authorities and rescue centres of fire incidents and cargo*

	details, eliminating the need for manual retrieval from ship manifests
Status	<Defined>
Rationale	*This requirement allows faster response times by automating alerting processes*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Port Coordination & Fire Response*

Identifier	**REQ-OVERHEAT-D5.2-0047**
Requirement	*The DS shall integrate UAV systems with image auto-stabilization and ship-relative locking mechanisms to maintain visual tracking in dynamic sea conditions*
Status	<Defined>
Rationale	*This requirement allows UAV feeds remain stable and usable during maritime operations*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Firefighter-Specific Requirements*

Identifier	**REQ-OVERHEAT-D5.2-0048**
Requirement	*The DS shall utilize container-level IoT sensors to deliver granular data, including fire presence/absence, temperature trends, fire type indicators*
Status	<Defined>
Rationale	*This requirement allows firefighters receive precise, container-level fire data*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Firefighter-Specific Requirements*

Identifier	**REQ-OVERHEAT-D5.2-0049**
Requirement	*The DS shall include a visual interface to allow firefighters to access video feeds, toggle between sensor data layers, and capture/share critical images in real time*
Status	<Defined>
Rationale	*This requirement allows the firefighters to interact with and share real-time situational data*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Firefighter-Specific Requirements*

Identifier	**REQ-OVERHEAT-D5.2-0050**
Requirement	*An embedded training module shall be included for firefighting teams, with terminology guidance, and standard operating procedures consistent across vessels and ports*
Status	<Defined>

Rationale	*This requirement allows consistency of response across ships and ports*
Category	Special Considerations from Port Officials & Firefighters
Additional Comment	*Sub-category: Firefighter-Specific Requirements*

2.7. Non-Functional Requirements

Identifier	**REQ-OVERHEAT-D5.2-0051**
Requirement	*The DS shall comply with applicable IMO, IHO, and IEC maritime safety standards*
Status	<Defined>
Rationale	*This requirement allows compliance with international maritime safety standards*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Regulatory Compliance & Standardization*

Identifier	**REQ-OVERHEAT-D5.2-0052**
Requirement	*The DS shall integrate with ECDIS and VTS without obstructing navigational workflows, preserving the core functions (route planning, radar overlays, AIS data).*
Status	<Defined>
Rationale	*This requirement allows smooth operational continuity and prevents*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Regulatory Compliance & Standardization*

Identifier	**REQ-OVERHEAT-D5.2-0053**
Requirement	*The DS shall include cybersecurity best practices, aligned with IMO MSC-FAL.1/Circ.3*
Status	<Defined>
Rationale	*This requirement allows alignment with international maritime cyber risk management guidelines*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Regulatory Compliance & Standardization*

Identifier	**REQ-OVERHEAT-D5.2-0054**
Requirement	*The DS shall process incoming sensor and UAV data with reduced latency time for internal systems, and for externally sourced data*
Status	<Defined>
Rationale	*This requirement allows timely situational awareness and response*
Category	Non-Functional Requirements

Additional Comment	*Sub-category: System Performance & Reliability*

Identifier	**REQ-OVERHEAT-D5.2-0055**
Requirement	*The DS hardware and enclosures shall comply with IP66 protection standards and be EMC-resistant, ensuring resilience in harsh maritime conditions (wind, saltwater, vibration)*
Status	<Defined>
Rationale	*This requirement allows the DS to operate reliably under marine environmental stressors*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: System Performance & Reliability*

Identifier	**REQ-OVERHEAT-D5.2-0056**
Requirement	*The DS shall include redundant data pathways and failover mechanisms to mitigate data loss during connectivity outages*
Status	<Defined>
Rationale	*This requirement allows continuous system operation despite connectivity failures*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: System Performance & Reliability*

Identifier	**REQ-OVERHEAT-D5.2-0057**
Requirement	*The DS interface shall follow human-centered design principles, using simplified navigation, iconography, and prioritized alerts to reduce user cognitive load in emergencies*
Status	<Defined>
Rationale	*This requirement allows reduced operator cognitive load and supports decision-making during emergencies*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Usability & Training*

Identifier	**REQ-OVERHEAT-D5.2-0058**
Requirement	*The DS shall allow end-users to choose between overlaying fire data directly on the ECDIS and VTS display or viewing fire data via a dedicated screen*
Status	<Defined>
Rationale	*This requirement provides operational flexibility to different user groups*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Usability & Training*

Identifier	REQ-OVERHEAT-D5.2-0059
Requirement	*An interactive training system shall be embedded or accessible remotely, offering tutorials, role-specific scenarios for crew members, firefighters, port and authority personnel*
Status	<Defined>
Rationale	*This requirement allows effective adoption and user readiness for emergencies*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Usability & Training*

Identifier	REQ-OVERHEAT-D5.2-0060
Requirement	*All communications and interface labels shall use standardized maritime fire response terminology, with multilingual support to ensure consistent understanding among international crews. Standard Marine Communication Phrases (SMCP) is an example for these communications*
Status	<Defined>
Rationale	*This requirement allows consistent understanding across multinational crews*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Usability & Training*

Identifier	REQ-OVERHEAT-D5.2-0061
Requirement	*The DS shall secure all fire-related data*
Status	<Defined>
Rationale	*This requirement allows confidentiality and protection of critical fire incident data*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Security & Data Protection*

Identifier	REQ-OVERHEAT-D5.2-0062
Requirement	*The DS shall apply real-time data validation logic to detect, and block spoofed or manipulated UAV/sensor inputs*
Status	<Defined>
Rationale	*This requirement allows data integrity and reliability during emergency operations*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Security & Data Protection*

Identifier	REQ-OVERHEAT-D5.2-0063
Requirement	*The DS shall comply with GDPR and maritime data privacy laws, including secure data storage, deletion protocols, and access logs*
Status	<Defined>
Rationale	*This requirement allows compliance with international privacy regulations*
Category	Non-Functional Requirements
Additional Comment	*Sub-category: Security & Data Protection*

2.8. Scalability & Future Integration

Identifier	REQ-OVERHEAT-D5.2-0064
Requirement	*The DS shall feature modular architecture supporting future upgrades such as new sensor types, and additional S-100 product specifications*
Status	<Defined>
Rationale	*This requirement allows scalability and future-proofing of the system*
Category	Scalability & Future Integration
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0065
Requirement	*The DS shall be interoperable with port fire control systems, emergency services dashboards and third-party maritime software*
Status	<Defined>
Rationale	*This requirement allows system extensibility and integration with broader maritime safety ecosystems*
Category	Non-Functional Requirements
Additional Comment	

Identifier	REQ-OVERHEAT-D5.2-0066
Requirement	*Interface is available in in the six official IMO languages (Arabic, Chinese, English, French, Russian and Spanish) and uses internationally recognized fire response (International Maritime Organization (IMO), 2024)*
Status	<Defined>
Rationale	*This requirement allows DS to be integrated globally*
Category	Non-Functional Requirements
Additional Comment	

3. Network requirements

The DS requires a robust, secure, and low-latency network architecture to ensure reliable fire detection, assessment, and response coordination across both vessel and port environments. To achieve this, the system must be capable of receiving real-time data from onboard IoT sensors, such as smoke, temperature, and gas detectors, and streaming live video and thermal imagery from UAVs deployed during fire incidents. This information must then be transmitted seamlessly to ground-based systems (Ground DS) for collaborative decision-making, SA, and emergency response coordination. Ensuring efficient data flow between shipboard components and shore-based authorities is essential for delivering synchronized and effective fire management capabilities across the maritime domain. This work has been introduced in WP4's deliverables and will be developed more in detail in WP6.

3.1. System Architecture

The DS is designed to enhance fire prevention, detection, and management on both vessels and port environments by integrating real-time data visualization, information management, and collaborative decision-making tools. The architecture consists of two primary components: Vessel DS - A local data integration and management system for onboard fire safety. Port DS or Ground DS - A port-based data hub that integrates environmental, traffic, and emergency response data. The two systems are designed to operate independently yet collaboratively, ensuring seamless fire response coordination between ship crews, harbor authorities, and rescue and assistance services.

3.1.1. Vessel DS

The Vessel DS serves as an onboard fire safety management system, leveraging the ship's existing local area data infrastructure. At its core, the ECDIS functions as the primary data integration hub, aggregating fire-related information from IoT sensors, onboard surveillance, and navigation systems. The system operates based on data collection and integration. The system will be designed to receive real-time fire data from temperature, smoke, and gas sensors. It will be integrated with UAV-assisted thermal imaging for enhanced fire detection. It connects with shipboard navigation systems for location-based risk assessment and utilizes the S-100 standard for structured data representation.

The vessel DS processes fire-related data to generate risk alerts and automated firefighting recommendations. It will ensure real-time synchronization with other onboard terminals (e.g., bridge, engine control room, crew interfaces). It can display fire alerts, affected cargo areas, and emergency routes through ECDIS. The vessel DS will facilitate real-time coordination with port-based responders via secure data channels. It also integrates inputs from tugs, pilot boats, rescue vessels, and incoming ships. RTSP (Real-Time Streaming Protocol) plays a key role in the transmission of UAV video and thermal imagery. RTSP is used to stream live videos from UAVs to the DS interface, allowing operators to monitor fire zones in real-time. As a result, the SA and SSA among onboard crew members will be enhanced. By integrating fire monitoring, risk assessment, and decision-support tools, the Vessel DS ensures that crew members can rapidly detect, assess, and respond to fire incidents.

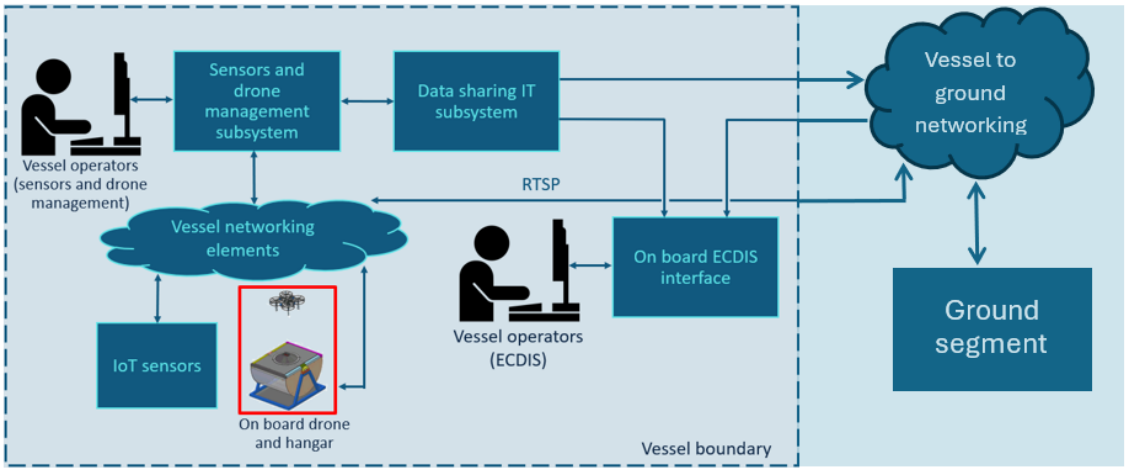

Figure 3: OVERHEAT's vessel segment with DS (ECDIS)

3.1.2. Port DS

The Port DS functions as a centralized maritime safety and coordination platform, aggregating data from sensors, vessels, and traffic monitoring systems to provide harbor authorities, pilots, rescue and assistance crew, with real-time SA. It will be available with VTS operation room. The system architecture includes data collection and integration. It will channel data from land-based and maritime sensors (e.g., weather conditions, tides, Automatic Identification System (AIS) traffic data). It will provide interfaces with the users, providing a real-time view of ongoing fire incidents. It can implement a data hub and web services model, allowing independent access for different users. It standardizes maritime safety data using S-100 and SOA based frameworks. It will be able to provide a COP for harbor masters, pilots, fire crews, and maritime traffic controllers. It will be able to prioritize selective information access e.g., the harbor master sees the overall sea traffic picture, while firefighting teams receive only vessel arrival times and fire status with UAV imagery. It will ensure secure data exchange between the ship and port, allowing continuous tracking of a rescue vessel's route, fire conditions, and response actions.

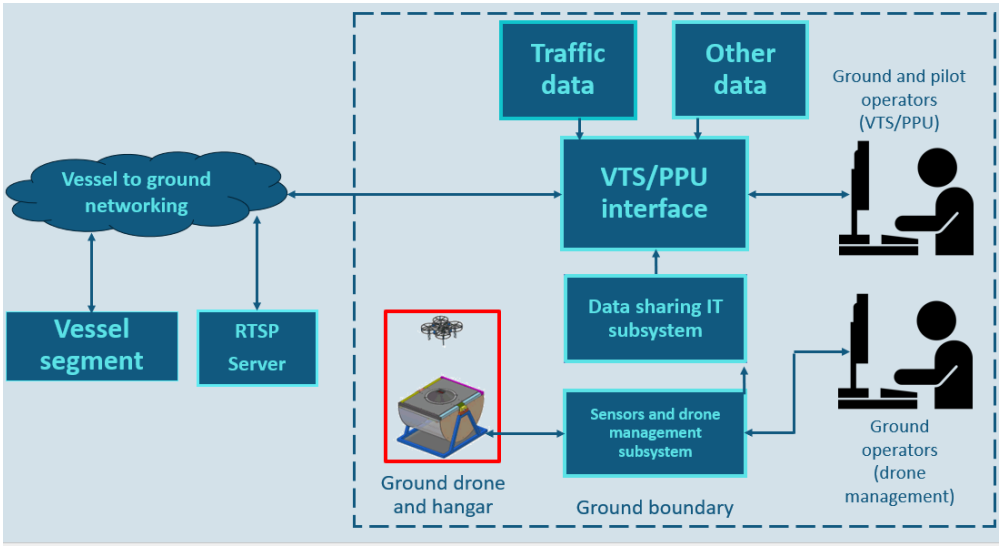

Figure 4: OVERHEAT's port segment with *DS* (VTS/PPU)

3.2. Systems Interconnections

The DS will be integrated with the other subsystems described in the project. For this, the DS needs to be compatible with the exchanged information with sensors and UAV. This work is addressed by WP4 and WP5 works and will be finalized in WP6. The Figure below shows an example of the shared information by the sensors to localize the fire detection.

Property	Data type	Description
deck_number	Integer	Number of the deck where the sensor is located
deck_name	String	Conventional deck name (if applicable)
deck_number_uncertainty	Integer	Uncertainty on the deck localization (± number of decks)
stern_distance	Integer	Estimated distance in meters from the stern of that deck (always positive)
stern_distance_uncertainty	Integer	Estimated uncertainty (± meters) on the stern_distance
centerline_distance	Integer	Estimated distance in meters from the centerline of the vessel (positive = port; negative = starboard)
centerline_distance_uncertainty	Integer	Estimated uncertainty (± meters) on the centerline_distance
stacking_level	Integer	Estimated position of the container in the stack (1 = floor)
stacking_level_uncertainty	Integer	Estimated uncertainty on the position of the container in the stack (± number of levels)

Figure 5 - Example of data description coming from the sensors for fire localisation

4. Technical Requirements Validation

To verify that the DS meets the defined technical requirements under simulated or real operational conditions, the following test specification is established. The fulfilment of each requirement will be assessed during both simulation and demonstration activities using the following three checking criteria:

- OK (Requirement Achieved): The requirement has been fully met and validated
- POK (Requirement Partially Achieved or Modified): The requirement has been partially met, or its original scope was modified during the testing process
- NOK (Requirement Not Achieved nor Validated): The requirement has not been met and could not be validated

4.1. Compliance with Regulations, Standards, and Good Practices

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-001	REQ-OVERHEAT-D5.2-0001, 0002, 0003,0057	DS aligns with SOLAS, IEC, and IMO standards	OK / POK / NOK	
VAL-OVERHEAT-D5.2-002		S-100 data layers are correctly displayed	OK / POK / NOK	Composed of next 4 check points
VAL-OVERHEAT-D5.2-002-A	REQ-OVERHEAT-D5.2-00030	S-101 (ENC)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-002-B	REQ-OVERHEAT-D5.2-00030	S-102 (high-resolution bathymetry)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-002-C	REQ-OVERHEAT-D5.2-00030	S-104 (water levels)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-002-D	REQ-OVERHEAT-D5.2-00030	S-111 (surface currents)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-003		Non S-100 data are correctly displayed	OK / POK / NOK	Composed of next 6 check points
VAL-OVERHEAT-D5.2-003-A	REQ-OVERHEAT-D5.2-0024	Waves	OK / POK / NOK	
VAL-OVERHEAT-D5.2-003-B	REQ-OVERHEAT-D5.2-0024	Wind	OK / POK / NOK	

VAL-OVERHEAT-D5.2-003-C	REQ-OVERHEAT-D5.2-0001,0024	AIS	OK / POK / NOK	
VAL-OVERHEAT-D5.2-003-D	REQ-OVERHEAT-D5.2-0001,0024	GPS	OK / POK / NOK	
VAL-OVERHEAT-D5.2-003-E	REQ-OVERHEAT-D5.2-0024	ETA	OK / POK / NOK	
VAL-OVERHEAT-D5.2-003-F	REQ-OVERHEAT-D5.2-0021,0024	UAV (position, route, pictures, video)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-004	REQ-OVERHEAT-D5.2-0006,0007,0029,0035	DS integration does not interfere with other operational functions	OK / POK / NOK	

4.2. Fire Assessment and Response

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-005	REQ-OVERHEAT-D5.2-0008,0014,0017	DS displays an alert in real time when sensors data exceeds threshold	OK / POK / NOK	
VAL-OVERHEAT-D5.2-006	REQ-OVERHEAT-D5.2-0011,0012,0021	Sensors displayed information is accurate	OK / POK / NOK	
VAL-OVERHEAT-D5.2-007	REQ-OVERHEAT-D5.2-0010,0013,0020,0021,0036,0037	IR/Thermal video feed from UAV is accessible in the DS interface	OK / POK / NOK	
VAL-OVERHEAT-D5.2-008	REQ-OVERHEAT-D5.2-0011	Check if manual container ID mapping is completed	OK / POK / NOK	

VAL-OVERHEAT-D5.2-009	REQ-OVERHEAT-D5.2-0011,0044	Fire related sensor location is accurately displayed	OK / POK / NOK	
VAL-OVERHEAT-D5.2-010	REQ-OVERHEAT-D5.2-0014,0018	DS provides a severity indication based on sensor and video inputs	OK / POK / NOK	
VAL-OVERHEAT-D5.2-011	REQ-OVERHEAT-D5.2-0018	DG influences the severity level	OK / POK / NOK	
VAL-OVERHEAT-D5.2-012	REQ-OVERHEAT-D5.2-0016	Special warnings appear for DG cargo fire	OK / POK / NOK	
VAL-OVERHEAT-D5.2-013	REQ-OVERHEAT-D5.2-0005,0015	Suggested firefighting methods/advices appear for each fire class	OK / POK / NOK	

4.3. SA and communication

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-014		Data is exchanged in real time	OK / POK / NOK	Composed of next 4 check points
VAL-OVERHEAT-D5.2-014A	REQ-OVERHEAT-D5.2-0008,0009,0012,0045	Sensor data is exchanged in real time	OK / POK / NOK	
VAL-OVERHEAT-D5.2-014B	REQ-OVERHEAT-D5.2-0009,0037,0045	UAV data is exchanged in real time	OK / POK / NOK	
VAL-OVERHEAT-D5.2-014C	REQ-OVERHEAT-D5.2-0020,0021,0022,0023,0045,0060	Digital communication (e.g., alerts, messages) is functional for coordination	OK / POK / NOK	

VAL-OVERHEAT-D5.2-014D	REQ-OVERHEAT-D5.2-0010,0013,0020,0025,0045	UAV photos and video are streamed, key frames captured, and video clips sent	OK / POK / NOK	
VAL-OVERHEAT-D5.2-015	REQ-OVERHEAT-D5.2-0026,0029,0045,0052	There is a dedicated fire screen (separate from navigation) for UAV operators	OK / POK / NOK	
VAL-OVERHEAT-D5.2-016	REQ-OVERHEAT-D5.2-0046	Automated aid requests are sent after critical event	OK / POK / NOK	
VAL-OVERHEAT-D5.2-017	REQ-OVERHEAT-D5.2-0045,0060	Communications reach actors such as VTS, and rescue vessels	OK / POK / NOK	
VAL-OVERHEAT-D5.2-018	REQ-OVERHEAT-D5.2-0019, 0031	DS correctly display or process a navigational warning (e.g., S-124) when it is received or created	OK / POK / NOK	
VAL-OVERHEAT-D5.2-019	REQ-OVERHEAT-D5.2-0014,0027,0033	Fire alerts appear in main interface	OK / POK / NOK	
VAL-OVERHEAT-D5.2-020	REQ-OVERHEAT-D5.2-0022,0036	Visual displays are refreshed regularly	OK / POK / NOK	
VAL-OVERHEAT-D5.2-021	REQ-OVERHEAT-D5.2-0047	UAV video is stable	OK / POK / NOK	
VAL-OVERHEAT-D5.2-022	REQ-OVERHEAT-D5.2-0028,0060	Interface is in English and uses correct fire/maritime terminology	OK / POK / NOK	
VAL-OVERHEAT-D5.2-023	REQ-OVERHEAT-D5.2-0026,0058	Fire dedicated display is separated from	OK / POK / NOK	

		ECDIS and VTS main screen		

4.4. Technical Enhancements & Security

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-024	REQ-OVERHEAT-D5.2-0004,0039,0041,0042,0051,0061,0063	Cybersecurity has been considered in DS development	OK / POK / NOK	
VAL-OVERHEAT-D5.2-025	REQ-OVERHEAT-D5.2-0004,0039,0041,0053,0063	Cybersecurity is considered in DS configuration	OK / POK / NOK	
VAL-OVERHEAT-D5.2-026	REQ-OVERHEAT-D5.2-0039,0062	DS blocks unauthorized access	OK / POK / NOK	
VAL-OVERHEAT-D5.2-0027	REQ-OVERHEAT-D5.2-0039,0041,0062	DS is resilient against cyberattacks of limited technical skills	OK / POK / NOK	
VAL-OVERHEAT-D5.2-0028	REQ-OVERHEAT-D5.2-0040	DS can be used in post-incident analysis	OK / POK / NOK	

4.5. Special Considerations from Port Officials & Firefighters

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-029	REQ-OVERHEAT-D5.2-0045,0048,0049	Fire data is shared correctly with other actors	OK / POK / NOK	
VAL-OVERHEAT-D5.2-030	REQ-OVERHEAT-D5.2-0047	UAV video is stabilized with moving ship deck	OK / POK / NOK	

VAL-OVERHEAT-D5.2-031	REQ-OVERHEAT-D5.2-0034,0038,0050,0059	Specific training modules are available for each potential user	OK / POK / NOK	

4.6. Non-Functional Requirements

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-031	REQ-OVERHEAT-D5.2-0054	DS recovers with minimum latency	OK / POK / NOK	
VAL-OVERHEAT-D5.2-032	REQ-OVERHEAT-D5.2-0043,0056	Confirm system recovers from lost connectivity without data loss	OK / POK / NOK	
VAL-OVERHEAT-D5.2-033	REQ-OVERHEAT-D5.2-0055	DS is resilient against problems coming from rough sea/weather conditions	OK / POK / NOK	

4.7. Scalability & Future Integration

Next TRs have been identified as optional for OVERHEAT's prototype, but they can be implemented for a final product.

Validation ID	Requirements ID	Description	OK/POK/NOK	Comments
VAL-OVERHEAT-D5.2-034	REQ-OVERHEAT-D5.2-0001,0002,0003,0004,0051,0057,0060	DS is certified (i.e. IMO ECDIS compliance (MSC.232(82)), SOLAS carriage, IEC 61174 approval, Wheelmark)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-035	REQ-OVERHEAT-D5.2-0060,0066	Interface is available in in the six official IMO languages (Arabic, Chinese, English, French, Russian and Spanish) and	OK / POK / NOK	

		uses internationally recognized fire response (International Maritime Organization (IMO), 2024)		
VAL-OVERHEAT-D5.2-036	REQ-OVERHEAT-D5.2-0019,0031	S-124 (navigation warnings) data is displayed	OK / POK / NOK	
VAL-OVERHEAT-D5.2-037	REQ-OVERHEAT-D5.2-0030	S-127 (Maritime Traffic Management) data is displayed	OK / POK / NOK	
VAL-OVERHEAT-D5.2-038	REQ-OVERHEAT-D5.2-0032	S-131 (Marine Harbour facilities) data is displayed	OK / POK / NOK	
VAL-OVERHEAT-D5.2-039	REQ-OVERHEAT-D5.2-0032	S-421 (Route Plan) data is displayed	OK / POK / NOK	
VAL-OVERHEAT-D5.2-040	REQ-OVERHEAT-D5.2-0064	DS modular design supports future upgrades (e.g., new sensor types, S-100 products)	OK / POK / NOK	
VAL-OVERHEAT-D5.2-041	REQ-OVERHEAT-D5.2-0065	DS interoperates with port fire control systems, emergency dashboards, and third-party maritime software.	OK / POK / NOK	
VAL-OVERHEAT-D5.2-042	REQ-OVERHEAT-D5.2-0011	The manual mapping of container is replaced by QR + OCR-based container ID mapping	OK / POK / NOK	

CONCLUSIONS

Task 5.2 focused on translating the user requirements defined in Task 5.1 into a structured set of technical specifications to guide the integration, implementation, and testing of the OVERHEAT DS. These technical requirements were developed with close attention to international maritime regulations (e.g., SOLAS, IMO, IEC, IHO and other standards), current industry best practices, and the operational needs of key end users such as ship crews, port authorities, and emergency response teams.

The defined requirements cover all critical components of the system, including fire detection and monitoring, decision support, SA, communication protocols, cybersecurity, S-100 data integration, and interoperability with ECDIS. Special consideration was given to ensuring scalability, usability, and real-time responsiveness across vessel and port environments.

A comprehensive test specification checklist was also developed to validate the implementation of each requirement in realistic operational scenarios, enabling systematic verification of the demonstrator’s functionalities. This task lays a solid foundation for the system's technical evaluation and ensures alignment with the project's objectives for improving maritime fire safety through a reliable, compliant, and user-oriented digital platform.

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Funded by
the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement Project No: 101076633. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.