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PROJECT DELIVERABLE REPORT

Introducing advanced ICT
and Mass Evacuation Vessel design
to ship evacuation and rescue systems

D2.6 PALAEMON Architecture

A holistic passenger ship evacuation and rescue ecosystem

MG-2-2-2018

Marine Accident Response

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Abbreviations

AE	Acoustic Emission
AIS	Automatic Identification System
Amazon S3	Amazon Simple Storage Service
AR	Augmented Reality
ASM	Application Specific Messages
BLE	Bluetooth Low Energy
BP	Blood Pressure
CCTV	Close Circuit Television
CM	Condition Monitoring
CPRI	Common Public Radio Interface
CRC	Cyclic Redundancy Check
CSV	Comma-Separated Values
DoA	Description of Action
DFB	Data Fusion Bus
DSS	Decision Support System
EC	Evacuation Coordinator
eCPRI	Evolved Common Public Radio Interface
EPC	Evolved Packet Core
eSIM	Embedded Subscriber Identity Module
FFE	Fire Fighting Equipment
GA	General Alarm
GCS	Ground Control Station
GDPR	General Data Protection Regulation
GPS	Global Positioning System
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
GUI	Graphical User Interface
Fps	Frames per second
HDFS	Hadoop Distributed File System
HMI	Human Machine Interface
HR	Heart Rate
HTTP	Hypertext Transfer Protocol

HTTPS	Hypertext Transfer Protocol Secure
HW	Hardware
ICT	Information and Communication Technology
IMO	International Maritime Organization
IoT	Internet of Things
ISM	International Safety Management
ISO/OSI	International Standard Organization / Open System Interconnection
IT	Information technology
JSON	JavaScript Object Notation
KPI	Key Performance Indicators
LAN	Local Area Network
LRS/LMS	Learning Record Store/ Learning Management System
LSA	Life Saving Appliance(s)
MEE	Maritime Emergency Evacuation
MEV	Massive Evacuation Vessel
MOB	Man Over Board
MQTT	MQ Telemetry Transport
NA	Not Applicable
NTSB	National Transportation Safety Board
OSI	Open System Interconnection
PaMEAS	Passengers Mustering and Evacuation Process Automation System
PEC	PALAEMON Evacuation Coordinator
PHP	PHP: Hypertext processor
PIMM	PALAEMON Incident Management module
RAN	Radio Access Network
RAO	Response Amplitude Operators
RFID	Radio Frequency Identification
ROPAX	Roll-on/Roll-off Passenger
Ro-Ro	Roll-on/Roll-off
RTLS	Real-Time Location System

S&R	Search and Rescue
SB	Smart Bracelet
SC	Smart Cameras
SEM	Smart Evacuation Management
SHM	Structural Health Monitoring
SMS	Safety Management System
SoC	System on Chip
SOLAS	Safety Of Life At Sea
SRAP	Smart Risk Assessment Platform
SSS	Smart Safety System
SST	Ship Stability Toolkit
TBC	To be confirmed
TBD	To be Determined
TCP/IP	Transmission Control Protocol/Internet Protocol
TRL	Technology Readiness Level
TX.Y	Task Y from WPX
TX/RX	Transmit and Receive
UAV	Unmanned Aerial Vehicle
VDES	VHF Data Exchange System
VHF	Very High Frequency
VR	Virtual Reality
WFT	Weather Forecast tool
WIFI	Wireless Fidelity
WP	Work Package
xAPI	Experience API

Executive Summary

Despite the breakthrough witnessed on Internet of Things devices and intelligent systems, the integration of state-of-the-art technologies on large vessels lags behind other mainstream domains (e.g., road transport). Traditionally, naval stakeholders have shown a “reluctant” behaviour when it comes to foster innovation to their day-to-day activities. It goes without saying that this generates a significant impact over ship evacuation procedures. Current methodologies leave the main responsibility to the ship’s staff, where most of the actions must be undertaken by people (i.e., Master, Bridge Command Team and crew members with specific tasks). This tight dependency on human-based reactions, together with the extreme conditions inherent to a maritime incident (e.g., extreme stress, panic, etc.) may lead to an underperforming evacuation management, thus driving to higher fatality risks.

To complement this, PALAEMON brings a number of innovative technologies and solutions that will help enhance the overall evacuation process. From the introduction of novel sensors that monitor the status/structural integrity of the structure, to the utilization of Unmanned Aerial Vehicles (UAVs) and smart cameras that run complex computer-vision mechanism, just to cite a few examples, we create a fully-fledged ecosystem of information that will be properly aggregated and processed, enriching enormously (in real-time) the knowledge of the current ship’s status. Furthermore, under the umbrella of the project, we also incorporate a disruptive reinterpretation of (intelligent) massive evacuation vessels and a state-of-the-art long-range data transceivers (i.e., VHF Data Exchange System), which come to improve or even relegate some of the legacy system we can find in traditional (and modern) vessels.

Shifting to the passenger side, the PALAEMON system incorporates a standalone 4G LTE/5G infrastructure, in combination with the utilization of smart bracelets and smartphones, returns an accurate real-time indoor positioning of the people on board. Beside this feature, the service will be also able to guide people, in emergency situations, to e.g. the safest muster station (from their current position).

On top of all this plethora of components, we build a smart evacuation management layer that, combines the information coming from all these components, yields support and recommendations to the Master/Bridge and the rest of the crew members throughout the evacuation process, since ato the moment the evacuation vessels are clearing out the ship.

This deliverable gathers a number of loose individual components and come up with a fully-fledged PALAEMON platform, whose main target is to drastically enhance the overall evacuation process, by bringing intelligence and innovation to the traditional procedures.

1 Introduction

This deliverable represents the first big milestone of Task 2.4 (*Architecture and Technical Specifications*), where we span the main breakthrough achieved during the first year of the project. The system will be developed in two successive versions, v1 (the one covered by this document) and v2. Hence, it is worth highlighting that this second and final release will come in M24 (May 2021), closing the loop of the PALAEMON Architecture definition, integrating the open issues we will pinpoint throughout the document (and gather in Section 6).

Under the extent of this task we will design the PALAEMON platform. For the sake of illustration, the main outcomes from this task can be enumerated as follows:

- Binding between the PALAEMON platform operation and the ship evacuation status, dynamically adapting the configuration according to the current evacuation phase
- Integration of Maritime Emergency Evacuation (MEE) process to an innovative ICT solution that combines timely IoT devices, state-of-the-art radio access communications and promising added-value services
- Compilation of the system requirements that will model the behaviour and operation of the various components, as well as the whole PALAEMON platform;
- Definition of the PALAEMON technical architecture
- Identification of the shipboard legacy systems that will be aggregated to the final PALAEMON workflow
- Introduction of the individual components/assets that will form the whole platform;
- Outline of the main interactions between the various components, which in some cases may combine themselves, leading to the creation of the Smart Evacuation Management (SEM) system

Technically speaking, the PALAEMON system needs to be easily scalable as it shall be installed in vessels with very different sizes and number of men on board, from cargos (a few persons) to large cruise ships (e.g. 5000/6000 persons).

It goes without saying that, alike any emergency system does, an essential aspect is to have the system running even if the vessel energy and communications have been broken down or strongly damaged because of the accident/event.

One of the main challenges addressed under the umbrella of this task (and, inherently, the whole Work Package) is the high heterogeneity of the pieces that shape the whole system and, hence, must be interconnected. Besides, due to the hybrid nature of PALAEMON, both in terms of consortium and knowledge domains (e.g., ICT vs Naval/Maritime), we had to carry out a thorough effort to make all these individual parts fit together in a seamless manner.

This deliverable aims to yield a holistic vision of a new evacuation process, where we leverage a handful of novel technologies that, at the end of the day, come (altogether) to support and enhance the overall passenger ship evacuation ecosystem.

This document is structured as follows: Section 2 maps the different phases that occur during an evacuation to how the platform works on each point in time. Section 3 encompasses all the system (functional and non-functional) requirements that will define the way the PALAEMON platform will work. Section 4 introduces all the individual components that compose the ecosystem, focusing on the further interaction with others. Section 5 deals with the interplay among all the components presented in the previous section and yields a holistic framework to enhance legacy ship passenger evacuation systems. Finally, Section 6 properly closes the

document and leaves the doors open to some future actions that will be addressed in the next iteration of the deliverable (i.e., D2.7 – PALAEMON Architecture v2).

Additionally, with the aim of complementing the content of the document, we have included three Annexes that cover the following material:

- Annex I presents a traceability matrix between PALAEMON components and system requirements.
- Annex II compiles the list of system requirements.
- Annex III gathers the technical specification of the main components.

1.1 WP2 relationship with other WPs

WP2 is the backbone of the PALAEMON Project, this Work Package sets the foundations for appropriate implementation of the project. As it can be seen in Figure 1, the outputs produced in WP2 are used in the core technical WPs (WP3-WP4-WP5-WP6), which in turn are the base material for WP7, in which the technology is integrated, and WP8, where the outputs are validated through the different pilots and trials. Also, WP2 is closely related to WP9 (i.e. *Raising Awareness Standardisation & Exploitation Roadmap*), since both Work Packages are intrinsically connected.

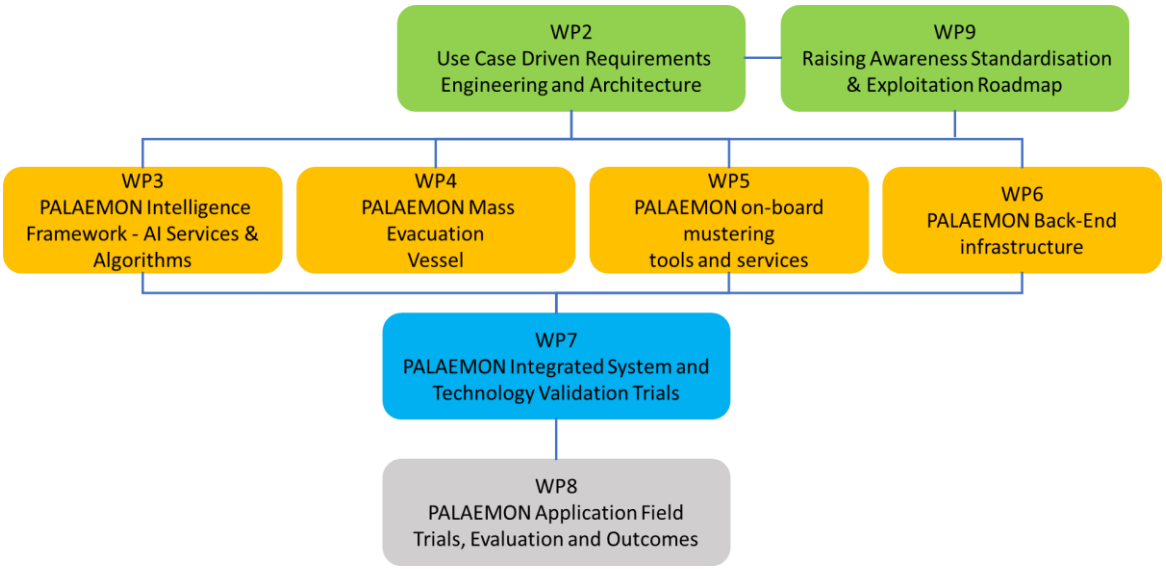

Figure 1. WP2 Dependencies with other WPs

WP2 was initiated with the deliverable D2.1 Report on the analysis of SoA, existing and past projects/ initiatives, as well as literature review and related projects in order to pave the way to D2.2 PALAEMON Requirement Capture Framework and D2.4 PALAEMON Use Cases Definition & Operational Requirements, which are deeply related with the current deliverable, due to the fact that both are inputs for D2.6.

2 Ship evacuation process

As will be mentioned throughout the document, the PALAEMON system presents tight bindings with the maritime emergency evacuation status. Namely, these means that the behaviour and operation of the whole platform (or individual components) may suffer drastic changes, always according to the point at the evacuation process the ship is undergoing at a particular time instant. Even though we have thoroughly addressed this in [1], [2], [10], we must overview the PALAEMON operation flow. Moreover, we must remark that this section presents a preliminary analysis of the dependency of the system with the evacuation status; we will duly complement and complete in the next version of the deliverable.

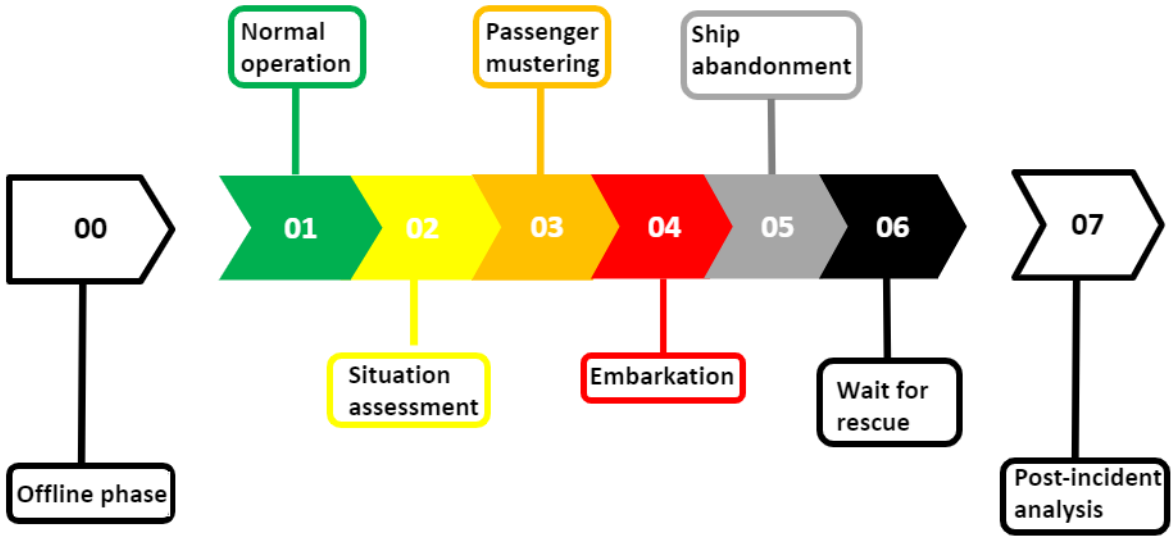

Figure 2. Maritime Emergency Evacuation status flow applied to PALAEMON

The PALAEMON operation flow is divided into 8 phases, as shown in Figure 2, two of which occur outside the ship's premises. The PALAEMON components can start or stop, or even change their operation mode depending on the phase that the ship is going through.

The first phase, **offline phase,** happens before the ship's departure and comprises the necessary processes in order to prepare for the emergency situations that can happen during the ship's trip. This phase mainly consists of the preparation of the document repository (SMS) for later instructions during evacuation and the training of the crew using the PALAEMON Academy app. Individual configuration of services and data sources is also performed at this stage for each of the components.

Once the ship sails, PALAEMON enters into the **Normal Operation phase**, where the ship is operating without any relevant alarm. In this phase, some of the PALAEMON components offer services complimentary to the evacuation process, which allow them to seamlessly integrate into the ship's everyday activities. These components range from the Ship Stability Toolkit, which allows the crew to monitor the status of stability of the ship and detect any anomaly, to the Structural Health Monitoring, that can detect any integral problems on the ship's structure. Additionally, the Smart Bracelets together with PaMEAS can provide information regarding the location of the occupants of the ship (both passengers and crew), in order to perform crowd control or planning for the different services of the ship. Meanwhile, the Smart Cameras can operate in this phase by counting the number of people that cross

certain corridors or common rooms and sending it to the PALAEMON platform for display in the Bridge.

In the unfortunate event that an incident occurs, the crew can sound the Bridge Alarm, which triggers the next phase, **Situation Assessment.** In this phase, most of the PALAEMON services are activated and start generating information that will help the crew and Master decide if the emergency is important enough to evacuate the ship. The crew and Master will receive information from the Decission Support System with recommendations regarding the incident nature and the evacuation process. At this point, the AR glasses for the crew can be used for analysis of the incident and the completion of the different tasks suggested by the SMS regarding the emergency assessment.

If, at the end of the Assessment process, the Master deems whether the evacuation is needed or not, he/she will sound the General Alarm, which will lead to the **Passenger Mustering phase**. In this phase, the crew will start directing the passengers to the Muster stations. These directions will be aided by the localization capabilities of the PaMEAS system and the possibility of displaying information on the Smart Bracelets. In addtion, in case of passengers jamming a corridor or some accident during mustering, the crew can be guided by the AR glasses to the conflict point to solve it. In this phase, the Smart Cameras will start sending their video feed so that the crew can better control the different localizations in the ship and report any blocked path or any other problem with the passengers.

If the Master gives the order to abandon the ship, the **MEV Boarding phase** is started. At this phase, all passengers are identified, and any passenger who has not arrived is searched for and rescued if needed. Two critical components for this phase are the Smart Bracelets along with PaMEAS, to provide with the localization of the missing passengers, and the AR glasses for the crew, which will allow them to safely navigate the ship in search of the missing passengers. During this phase, the UAV is activated to inspect the ship and look for any people that may have fallen into the water.

Once all passengers have been accounted for and they are securely positioned in the MEVs, the Evacuation Process will enter **Ship Abandonment phase**, where the MEVs are lowered to the water and the ship's engines are stopped. After all stopping procedures have been performed, the crew and Master board the remaining MEV and leave the ship.

The last phase during evacuation is the **Waiting for rescue phase**. In this phase, the MEVs get to a safe distance from the ship in order to avoid damaging the ship's hull and accidents with the MEVs. The MEVs should stay at a close distance from the ship to await rescue, but the immediate area around the ship is considered dangerous. In this phase the UAV will fly close to the MEVs so that localization of the passengers can be achieved by the maritime authorities.

Once the evacuation has been successful, the PALAEMON platform enters the last phase, **Post-incident analysis,** where the data stored during the evacuation phases is delivered to the maritime authorities in order to assess the appropriateness of the response from the crew and Master. The most important component during this phase is the SMS, which will address the recommended actions for the evacuation and how the crew performed them.

3 System requirements

This section describes the general specifications regarding the functional and non-functional requirements of the PALAEMON system. The work performed is based on the results of other deliverables, such as D2.2 [1] (i.e., stakeholders' requirements) and D2.4 [2] (i.e., scenarios and engineering process requirements).

We outline the fact that requirements described in this present document should not be considered the final list. During the next year, partners involved in WP2 will continue the work needed to ensure that the solution remains on track with the project vision and objectives and also providing feedback to the iterative development process. The results of this future work will be presented in the second version of the current document.

To easily keep track of each requirement, we have also mimicked the capture framework define in Section 3 of D2.2, which, at the same time, leant on the VOLERE methodology [3] to gather and subsequently display the most remarkable parts that define a requirement, as represented in and also the traceability matrix is provided in Annex I.

Different sets of requirements were identified during this research: functional and non-functional requirements. Besides, some aspects related to system's usability, security and privacy of data have been identified. Due to space restriction (and to keep a homogeneous balance throughout the document), we have decided to move the whole list of requirements to Annex II.

Table 1. Example of system requirement (template)

<table>
<tr><td>ID: Unique identification number</td><td>Functional / Non-functional</td><td>Priority: MUST/ MUST NOT/ SHOULD / SHOULD NOT/ COULD</td></tr>
<tr><td colspan="3">Description: A short statement describing the requirement.</td></tr>
<tr><td colspan="3">Rationale: A short description that justifies the necessity of the requirement and the goals achieved from its implementation.</td></tr>
<tr><td colspan="3">Stakeholders/Users: One (or more) in the following list: authorities, other ships, ship owners, Master, Bridge Command Team, Crew, Office, Passengers, Crew (UAV Controller), System Admin, IT team, PALAEMON Academy Team, PALAEMON Academy Trainee, Post-incident forensic, System developers, Technology providers.</td></tr>
<tr><td colspan="2">Category: One (or more) in the following list: Integration, performance, deployment, Interfaces / Data access, Interoperability, Security and Authentication, Visualization, Communications, Individual Component, Usability and Others</td><td>PALAEMON Components: List of individual (or all) components within the PALAEMON framework that are directly or indirectly affected by the requirement.</td></tr>
<tr><td colspan="2">Dependencies: List of requirements that directly or indirectly depend on the subject of analysis.</td><td>Conflicts: List of blocking/jeopardizing requirements that may be affected by the accomplishment of the current one.</td></tr>
</table>

4 PALAEMON Components Description

In order to give a brief overview of the whole PALAEMON platform, Figure 3 displays the different types of components that take part of the system, from the information generation (left part of the figure) until the moment a service is consumed in (at least) one of the outputs that will be used in the context of the project. Moreover, it is worth highlighting the wide spectrum of end-users/stakeholders that will play an important role throughout the different phases of the evacuation process, as illustrated at the right frame of the figure. In the next version of this deliverable, we will proceed to connect between services, outputs and stakeholders in order to give a complete standpoint of the usage/benefits of the PALAEMON platform.

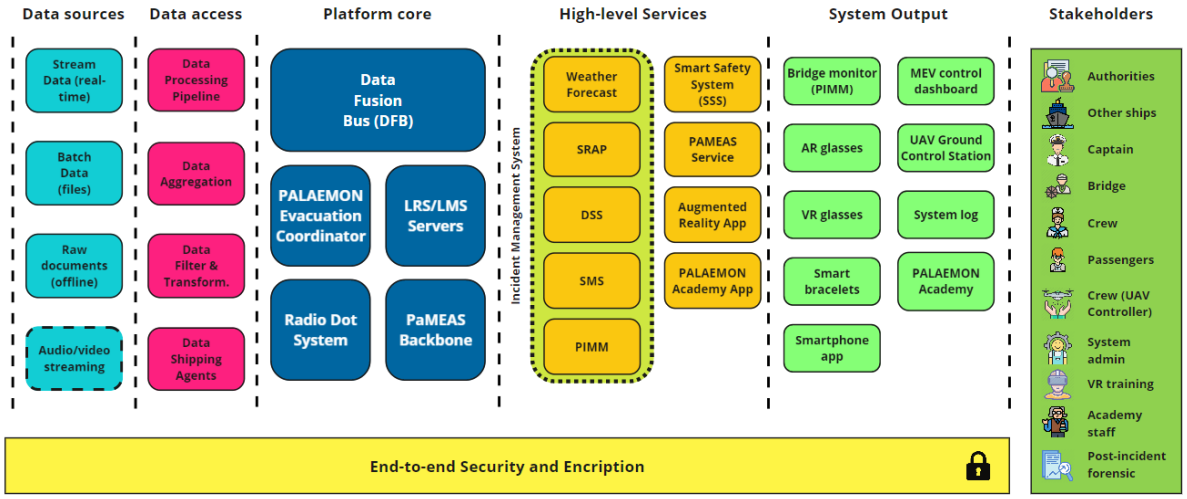

Figure 3. PALAEMON Architecture overall vision

Moreover, the platform will follow the privacy-by-design paradigm, where the communication among components will be encrypted (hence, protected) and all sensitive information will be 100% compliant with GDPR regulations [4]. As a matter of fact, this will be one of the main aspects to be covered in the second iteration of this deliverable.

It is worth stating at this point that Section 4 gathers the individual components presented here and yields a holistic vision of the whole PALAEMON platform.

This section presents and outlines the individual components that will shape the future PALAEMON Communication Platform, which will be described in detail in Section 5. For purposes of orderly presentation of the whole process, we have spanned the same left-to-right flow as we saw earlier in Figure 3, hinting the following (five) categories:

- **Data Sources**: Heterogeneous group that encompasses any element that may generate any kind of information that will be subsequently leveraged elsewhere in PALAEMON. We categorised between four types of sources: *streaming* (e.g., real-time information coming from sensors), *batch data* (e.g., components that process and aggregate information after a scheduled time), raw documents (e.g., PDF files that are stored before the ship leaves the shore) and, finally, *multimedia audio/video streaming*[1].

[1] Although we identify the sources that deal with this multimedia streaming, the PALAEMON system will not define the means to process and store this data until the next iteration of this deliverable.

- **Data Access**: Intermediate layer in charge of funnelling the information from the sources, leading to the platform core. At this level, the information may be filtered, transformed, aggregated, etc.
- **Platform Core**: Cornerstone of the PALAEMON platform, responsible for storing the raw data generated by the underlying data sources, thus offering it to high-level services.
- **Smart Evacuation Management (SEM) system**: Atop the core of the platform, PALAEMON will come up with a number of heterogeneous services that will help stakeholders (e.g., Master, Bridge, crew in general, passengers, etc.) improve their response when it comes to proceed to evacuate the ship.
- **System outputs**: At the very end of the workflow, added-value data and services outputs are represented/displayed in a format that brings about tangible benefits to the addressed stakeholders, leading to a notable (and innovative) evolution in the frame of the maritime emergency evacuation.

Last but not least, for the sake of simplicity (this is out of scope of this deliverable and will be addressed in future documents), we have intentionally left out the underlying communication technologies (mostly, radio access technologies) that are used to connect the different components to each other (mainly, at the both extremes of the picture, that is, how data sources inject data to the core and how the system outputs get the information).

4.1 Data sources

4.1.1 Shipboard legacy systems

During the last years, modern large ships tend to incorporate more and more ICT-related technologies as part of their vast catalogue of assets. On this matter, it is sensible to state that maritime domain actually lags behind other transport and mobility realms, even though it is also fair to say that shipping companies and shipyards are trying very hard to catch up [5].

In the meanwhile, in the scope of PALAEMON, ships that have been subject of study[2] (i.e., ANEK's Hellenic Spirit and OLSR's Orient Queen) do carry a number of built-in ICT technologies, in the form of sensors and actuators; besides, they also leverage "static" information sources that will be part of the overall system, like passenger and crew lists (properly anonymized in order to comply with GDPR regulations). Namely, the information catered by these will be subsequently exploited by the various high-level services (e.g., Passengers Mustering and Evacuation Process Automation System - PaMEAS, Decision Support System - DSS, etc.).

At the time of writing this deliverable and for the sake of illustration, we enumerate below a handful of information sources that ship owners/end users make available (this is not an exhaustive list):

- Passenger/crew lists (anonymized according to GDPR [4]);
- Fire Fighting Equipment (FFE) / Life Saving Appliances (LSA) drawings;
- Fire Detection/Fire Doors/Sprinkler Drawings;
- Ship & Decks Blueprints;
- Evacuation procedures/Contingency Plans;

[2] These vessels are property of partners within the PALAEMON consortium. Furthermore, one of them (i.e., Hellenic Spirit) will be utilized as real scenario for the deployment of the whole PALAEMON system and the subsequent evacuations use cases and scenarios assessment.

- Automatic Identification system (AIS) Navigation System; and
- Weather information & Weather forecast.

Moreover, apart from this raw data inputs, shipboard legacy systems may bring another class of benefits. For the sake of illustration, ships incorporate standalone radio access technologies (ship to shore, satellite, etc.) that might provide complementary communication capacity to the PALAEMON system. We will delve into the details of this radio links in the second version of the deliverable (D2.7).

However, it is worth highlighting that the access to all these assets and information sources may be restricted due to ship owners' security and privacy policies. In order to overcome these potential pitfalls, we can find alternatives directly brought by members of the consortium. For instance, a fully-fledged VDES system (see Section 4.1.7) will be deployed, thus enabling the possibility of retrieving (via AIS, ASM and VDE Data Channels, as will be explained in Section 4.1.7) getting the data formerly "blocked" by the shipboard legacy systems.

Besides, though it is out of the scope of this deliverable, the PALAEMON platform has been designed and conceived to work over the own hardware hosted by the ships. In the next iteration of this document (and others that are encompassed within WP7 – PALAEMON Integrated System and Technology Validation Trials – activities), we will deal with the limited or constrained capacities of these small/medium-scale systems.

4.1.2 Smart Bracelets

PALAEMON solution proposes a wearable (IoT) device for passengers and crew. A Smart Bracelet (SB) will be developed in order to support PaMEAS to identify (anonymously) and localize passengers and crew and establish adequate evacuation routes in the ship, as shown in Figure 4.

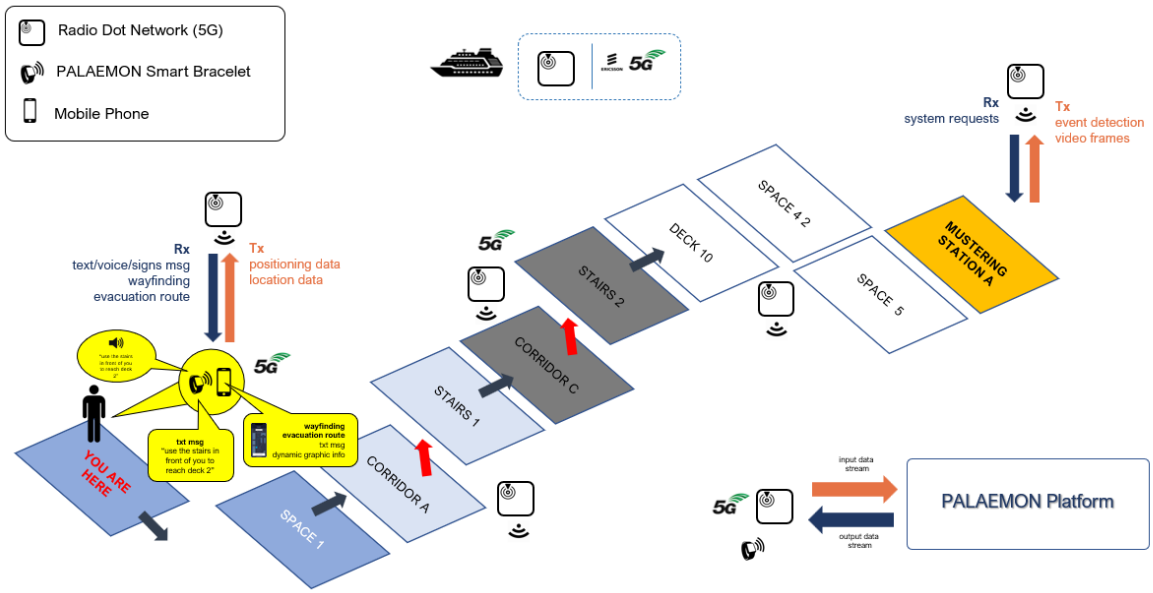

Figure 4. Smart Bracelet and PaMEAS vs PALAEMON platform

As a matter of fact, the main functionality of PaMEAS indoor location system will be described more thoroughly in Section 4.3.2. SB will consider both indoor and outdoor conditions operating as a beacon with bidirectional communication capabilities. Initially, the approach to be followed will be based on Ericsson 5G cellular technology (Radio Dot Network). The fusion

of different technologies, i.e., Bluetooth Low Energy (BLE), outdoor positioning such as Global Positioning System (GPS) and, potentially other technologies will be evaluated.

The SB will provide Bluetooth beaconing to assist PaMEAS in the localization of passengers and crew members, as well as showing relevant information regarding the evacuation on its screen (text or signs for routes). The SB will also feature an emergency button that passengers can use to actively inform the crew of problems during the evacuation.

Table 2. Smart Bracelet main features

Connectivity	▪ LTE/5G (via Radio Dot System) ▪ BLE ▪ GPS (to be confirmed) ▪ RFID (to be confirmed)
Measurement	Optional (to be confirmed at design & specific. phase) ▪ body sensor (HR) ▪ fall detection (accelerometer, gyroscope) ▪ GPS / Global Navigation Satellite System (GNSS)

4.1.3 Smart Cameras

PALAEMON proposes the use of smart cameras (SC) to monitor people in indoor areas. For the sake of illustration, during an emergency situation, the system will detect the people flow direction or whether a particular corridor is congested/overcrowded. Figure 5 shows the different elements that compose the overall SC solution (i.e., RGB-D camera and processing node[3]), the way the system is configured (via Graphical User Interface – GUI) and its connection to the core of the PALAEMON Communications Platform.

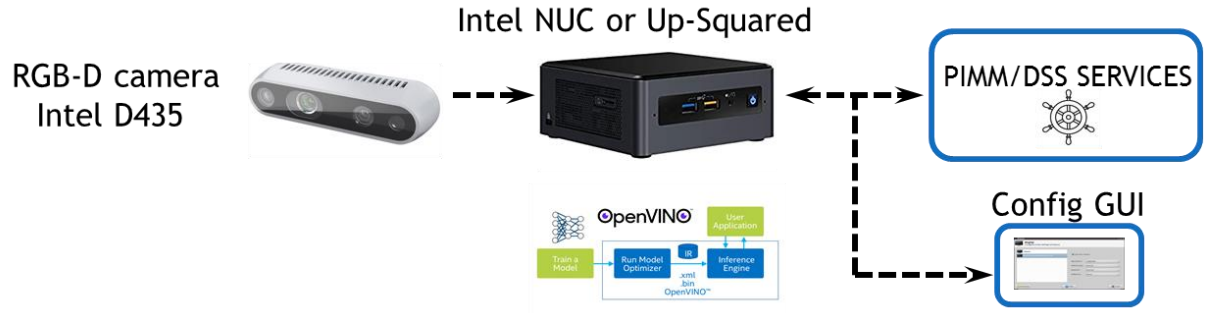

Figure 5. Smart Camera node: Basic structure and connections

This raw data (defined in Table 3) will be reported to the upper-layer services[4] (e.g., PaMEAS, PIMM, DSS) to use them adequately. SC will consider 3 different areas: long corridors, large open indoor areas and deck stairs. SC will execute at least 2 different modes, i.e., normal and evacuation, having different data rates, performance, and image analysis. Besides, the SC will inform about abnormal flow of people. The project embraces 2 different systems: new

[3] The final prototype may differ from the components presented here.
[4] The actual integration and usage of the information generated by the Smart Cameras will be addressed more specifically in the second version of this deliverable.

installation and legacy systems. The new installation of SCs will use RGB-D cameras, which not only include RGB images but also Depth information, which will be used in the developed algorithms to provide better results and performance. The algorithms will be based on Intel OpenVINO[5] libraries that can be executed on new SC nodes at the edge or standard processing computers placed in the Closed-Circuit Television (CCTV) room. To ease the installation of the system, the SC nodes will process the information each one separately, without overlapping images in the scene to provide fused results. At a later stage, the upper-layer services will interpret what the data from the static SC nodes mean. The SC will have a Graphical User Interface (GUI) required to configure the different parameters of the analysis, surveillance area, etc. The SC node could have 2 cameras and only one processing system if the performance is enough; this efficiency/saving will be evaluated.

Other considerations should be taken into account:

- The SC will be connected with the PALAEMON platform preferably with >1Gbps wired Ethernet, because it is a standard, cheap and has enough bandwidth to transmit video information (the reader must recall that all multimedia streaming will be integrated in the next iteration of this document).
- New nodes should be firmly installed as a ship infrastructure as it is required that the camera maintain the installed orientation.
- The SC node can be configured to send the video clip and data in the desired format, coding, size, and other parameters of data communication, considering the existence of standard libraries or code to be used in the Intel processor.

Table 3. Smart Camera main features

Connectivity	▪ Camera → Processing node: Ethernet ▪ Processing node → Core: Ethernet/WiFi (to be decided)
Measurement	Optional (to be confirmed at design & specific. phase) ▪ people count on the surveillance area ▪ occupancy ratio of the surveillance area ▪ people flow detection ▪ trapped people (if anyone)

4.1.4 Unmanned Aerial Vehicle (UAV)

The Unmanned Aerial Vehicle (UAV) module provides one (or multiple) rotary wings type vehicle, as well as its associated Ground Control Station (GCS). The GCS provides the tools to plan and monitor automated missions executed by the UAV. It also communicates information of interest with the PALAEMON system. It aims to facilitate the usability of the UAV in critical/stressed situations.

Its main goal is to assist the ship's crew in camera-oriented missions as search and rescue in Man Over Board (MOB) situations, damage assessment or scouting (i.e., help locate people in the sea). It is punctually used when a situation demands the use of the UAVs.

[5] Intel OpenVINO home page: https://software.intel.com/content/www/us/en/develop/tools/openvino-toolkit.html

The UAV will provide video/images and point of interest locations on demand to the ground station. It will also have the ability to measure its current GPS coordinates and velocity, its acceleration and attitude and the atmospheric pressure for height variation calculation.
It can be operated in **two modes**:

- **Automated navigation** via commands and missions provided by the GCS. The UAV will then navigate safely and autonomously around the ship in order to satisfy the specified mission.
- **Manually operated** via radio controller. If the situation requires to operate the UAV in a way that is not feasible via the GCS, the operator can use the controller to navigate manually.

Table 4. UAV main features

Connectivity	▪ UAV → GCS: Proprietary protocol (@2.4 GHz) ▪ GCS → Core: WiFi
Measurement	▪ Electro-optical sensor ▪ GPS / GLObal NAvigation Satellite System (GLONASS) ▪ Acceleration, attitude ▪ Pressure

4.1.5 Ship Stability Toolkit (SST)

The Ship Stability Toolkit (SST) consists of three individual components, the determination of the ship's intact stability based on its loading condition, the near-real-time description of the ship motions in the six degrees of freedom and the determination of damage stability. The three components are designed to build on each other and together give an overview of the ship's actual and future floating position and capability.

The calculation of **intact stability** is rather straightforward. It relies on the position of the center of all masses of the ship, the center of buoyancy and the ships shape. From this calculation the lever arm of righting moments at different angles of heel, the heeling angle of vanishing stability and the overall range of stability can be determined. These calculations are used as an input for the other components.

The calculations of **ship motions** are based on pre-calculated Response Amplitude Operators (RAOs) of the ship for different angles of incidence of the sea state. In combination with detailed weather forecasts these can be used to determine ship movements to be expected in the next few hours. This module is intended to serve as a decision-making aid for better route planning in order to increase passenger comfort and safety.

The determination of the ship's stability in case of hull damage (**damage stability**), in combination with the aforementioned modules, the watertight subdivision of the ship and the permeability of the individual compartments, determines the new floating position of the ship in case of damage. The influence of free liquid surfaces on the overall stability of the ship is also considered here.

After completion of the development of the individual modules, they will be part of the ship's DSS (Section 4.4.3). The development is done with the software MATLAB[6] and can be ported

[6] MATLAB homepage: https://www.mathworks.com/products/matlab.html

into another programming language later. A file format for data exchange has not yet been determined at this time.

Table 5. Ship stability toolkit main features

Connectivity	▪ Ethernet/WiFi (TBD)
Input parameters	▪ Hull parameters ▪ Weather forecast ▪ Status of ship
Output parameters	▪ Present floating position ▪ Expected future ship motions

4.1.6 Structural Health Monitoring (SHM)

The SHM (structural health monitoring) system, comprises of two sensor systems, i.e. the motion sensor system, accompanied by an application (i.e. within an independent processing node), and the AE (Acoustic Emission) system. The former one is used to measure the structural integrity and stability of the ship, while the AE system is used to identify local damages or events which can be produced by an accident or incident.

In this sense the motion sensor system is for monitoring the global structural health and stability of the ship, while the AE system is for local structural health. Both systems are real time CM (Condition Monitoring) systems and also have the capability to store data for post analysis.

The software which is being developed by ESI in the framework of the PALAEMON project will offer angles (stability) and structural health of the ship, real-time, as well as other calculations, such as rate of change of an angle or deflection, accelerations etc. in order to offer insight on possible deteriorating situation or other events after an accident or an incident.

Table 6. Structural Health Monitoring main features

Connectivity	▪ Sensors → Processing node: Ethernet ▪ Processing node → Core: Ethernet/WiFi
Input parameters	▪ Ship's stability angles ▪ Ship's motion ▪ Ship's heave (local hull displacement) ▪ Acoustic signals
Output parameters	▪ Roll and trim of ship ▪ Deflection of Ship (translated to bending moments and shear forces) ▪ Crack initiation ▪ Crack/defect formation and propagation ▪ Provide alarms when the aforementioned variables get over critical values

4.1.7 VDES as Data Source

VDES system (VHF Data Exchange System) is a communication system that operates between ships, coastal stations and satellites[7], by means of three different data channels

[7] The VDES satellite connection is out of the scope of the project and will not be implemented.

(services): i) Automatic Identification System (AIS); ii) Application Specific Messages (ASM); iii) VHF Data Exchange (VDE).

- AIS channels are used to transmit the position of each vessel to the whole maritime monitoring network (already operational);
- ASM channels will transmit messages, currently sent on the AIS frequencies, not related to the positions of the ships, lightening the traffic on the AIS frequencies; and
- VDE channels will enable the exchange of higher data volume, thanks to wider bandwidths w.r.t. AIS and ASM ones and consequently higher throughput.

In the receiver mode, VDES transceiver will be able to receive analogue signals at VHF frequency channels [6], convert them from analogue to digital, process them at different ISO/OSI levels, i.e., physical, data link, network and transport layers and pass them to PALAEMON application. At each ISO/OSI (International Standard Organization / Open System Interconnection) level the following operations are carried out: i) data synchronization by means of specific signals/indicators; ii) removal of layer overhead; iii) verification of data correctness by means of Cyclic Redundancy Check (CRC), if any; iv) data extrapolation. In the transmission mode the operations are dual of those listed for the receiver mode, i.e. data encapsulation, addition of CRC, addition of layer overhead and delivery to the bottom ISO/OSI layer.

VDES technology may be used to feed PALAEMON platform with data from coastal stations or other vessels, e.g. weather or environmental conditions, buoy position monitoring, berthing data. At the same time, VDES technology may be used in the opposite direction, by conveying messages from PALAEMON platform to coastal stations and vessels, actions that come to assist during the S&R operations. Some possible examples of data from PALAEMON platform to spread are the evacuation plan, passenger list, ship waypoints and/or route plan report.

Table 7. VDES main features

Connectivity	▪ VHF antennas with SMA connectors (TBC), Ethernet cable to PALAEMON platform.
Input parameters	▪ Weather station message ▪ Weather forecast ▪ Route information ▪ Tidal window ▪ Route suggestion ▪ Etc.
Output parameters	▪ Evacuation procedures and analysis (to be nailed down in D2.7)

4.1.8 Massive Evacuation Vessel (MEV)

The MEV is an essential component within the PALAEMON system. It is an evacuation vessel that is designed to carry a large number of persons (i.e., passengers and crew members). Its goal is to replace the current LSAs. The MEV's internal design will facilitate the boarding process of persons, including elderly people as well as disabled persons. Its launching mechanising will provide MEV the ability to be launched for large angles of trim and heel, at least as required by SOLAS Regulation III/23 [7].

To complement this introduction on the MEV and dig into the technical specifications of the MEV, the reader should refer to D4.1 – *Naval Architecture Studies, GA and lines of MEV-I* [8].

Moreover, the MEV will be customised as a function of the vessel type, architecture and size. For cruise ships hosting thousands of persons and for ferries/Ro-Ro that can also host hundreds of persons, there will be several MEVs on board. The transfer of the MEV from the vessel to the sea may also be different from vessel to vessel due to the storage locations, position of the MEV and vertical distance to reach the sea. However, this is out of scope of this deliverable and will be addressed as part of WP4 activities, which are more oriented to the naval/maritime domain.

The MEV will also be equipped with specific sensors to be connected with PALAEMON system giving it the ability and innovation to transit its operational condition during all phase of the evacuation process, manage the boarding process by counting the persons on board, operate the UAV following the abandonment of the ship and navigate in the best possible conditions. The components of the MEV are:

- the space for persons on board (the size will depend on the type of ship – number of persons on board, i.e. passengers and crew)
- the piloting cockpit including navigation tools and PALAEMON tools
- the main engine(s)
- the hull integrating all these components
- the additional floatability devices, i.e. the inflatables
- the various sensors that will be fitted to MEV

From an ICT standpoint, the PALAEMON system will be replicated in vessels and MEVs[8]. In normal situation, the system is partially active in the vessel. In case of critical alert, the system is activated both in the vessel and in the MEVs (both parts collaborating for the evacuation). When the ship is disabled/abandoned or sunk, the system is of course only active in the MEVs. The detailed behaviour and use cases related to the MEV during the evacuation process will be addressed in the second and final version of this deliverable.

4.1.9 Augmented Reality

Augmented Reality component will have a crucial role in supporting the implementation of the evacuation scenarios. During the simulations, Augmented Reality will support two critical features. In the first place, AR will be able to provide to crew members, real-time assistance and guidance during the bespoken scenarios, and secondly, it will be able to supply the users with vital information on ship status, changes or updates on the evacuation strategy but also passenger and environment information.

Furthermore, AR will enable crew members to maintain real-time communication during the scenarios, facilitating just in time information exchange between the participants. In order to sustain all the array of communication, the AR component will have to flawlessly connect and exchange data with the following systems: PaMEAS; SSS (Ship Stability toolkit) via PaMEAS; DSS (Decision Support System) via PaMEAS and SRAP (Smart Risk Assessment Platform) via PaMEAS. On the other hand, the AR technology will have to communicate with LRS/LMS servers for successful user ID functions and logging. At the same time, the AR glasses component is required to seamlessly integrate with the AR application itself (see Section 4.4.8).

[8] The MEV may deploy a reduced number of functionalities from the PALAEMON platform

Table 8. Augmented reality main features

Connectivity	▪ WiFi
Measurement	▪ Voice conversations from the crew (PALAEMON Architecture v2)

4.1.10 PALAEMON Academy-VR

The VR component of the PALAEMON Academy is based on three pillars of systems: Hardware; Drivers and Operating System.

Additionally, a group of systems complement the platform with various functions such as:

"Core systems" as a group of systems responsible for the unit testing, libraries, memory allocation, debug printing, etc.

A second component is the "Platform Independence Layer" which enables different actions such as platform detection and physics or graphics wrappers.

"Resources or Game Assets" is a component responsible with various resources utilised in the scenarios such as: Fonts, Game World, texture resources but also 3D Model resources.

"Human Interface" device is another system within the VR that will enable physical devices and lessons specific interface.

"Front end" system will interpret and render graphical items such as Video, Cinematics, GUI, Animations or Menu.

Another important sub system in the VR academy is the lesson specific subsystem that will trigger various learning mechanisms such as "next step" or "quiz". Although separate, "Gameplay foundations" and "visual effects" systems are closely connected as they both have interdependent elements. Other core systems of the VR academy are "collision and physics" and "low level render", systems that will involve visual interactions between bodies, or elements and their graphical behaviour in different conditions.

The PALAEMON Academy app will be used to mimic situations in which participants face everyday tasks. It will also be used in preparing the crew members to face the variety of challenges encountered in passenger ship evacuation scenarios.

Table 9. PALAEMON Academy main features

Connectivity	▪ WiFi
Measurement	▪ Measures the performance of crew members when facing challenges related to the evacuation process.

4.2 Data Access

Placed in between data sources and the core of the system, this intermediate layer is responsible for the preparation of the raw data, before persisting the information and making it available to all components, i.e., via Data Fusion Bus data interfaces (which will be described in detail in Section 4.3.1).Getting back to Figure 3 (page 17), and attending to the types of inputs that will enter this data exchange level (i.e., data streaming, batch, offline documents and multimedia), we have come up with a handful of dedicated and tailored components to

properly deliver the information to the core of the platform. But before starting, we must remind again that the last type of input (i.e., multimedia streaming) management has been left on hold until the next iteration of this deliverable.

4.2.1 Data Shipping Agent

In the context of PALAEMON, we can find some individual components that do not inject their data streams directly into the platform core (this will be explained at next point of this list of software modules). Instead, they dump the outputs as standalone "log-like" files as soon as they have a new piece of information to share. Traditionally, the legacy way to cope with this would be to tailor the data sources code to "manually" send the data across the defined interfaces (for instance, a typical RESTful API or a proprietary database library, just to cite a couple of examples). To this end and to enormously simplify the process, we can find open-source solutions that automatically handle this operation and, by keeping track of these files, every time something new is added to a document, they seamlessly proceed to forward these "new lines" to the adequate destination. To complement this with an illustrative example, if we think of a regular log file (.txt), all the different fields or attributes that are mapped there will be translated to a structured JSON document and will be immediately ported to the next stage in the workflow.

For instance, one of the most promising technologies or frameworks that are used nowadays on this matter are called "Beats Data Shippers"[9], able to forward data in a scalable manner from a number of different machines to Elasticsearch (which will be, as will be shown later, the main persistence system of the PALAEMON core platform).

4.2.2 Data Streaming Aggregator

One of the most challenging parts of ICT infrastructures has to do with the way real-time (or near real-time) data streams are processed and stored. In the context of PALAEMON, we count on a number of different devices and sensors (e.g., smart bracelets, cameras, ship stability toolkit sensors, UAVs, etc.) that will be continuously generating and delivering more and more information to the system. At this point, having a scalable tool that guarantees the correct forwarding of all this with the minimum latency is more than critical. In the context of PALAEMON, we have chosen Apache Kafka[10] (henceforth, simply Kafka) as the "glue" that will be used as streaming platform, attending to two broad classes of applications:

- Real-time streaming data pipelines that reliably get data between systems or applications.
- Real-time streaming applications that transform or react to the streams of data.

Therefore, in PALAEMON, Kafka will act as a messaging system, as a stream processing tool as well as a storage system.

In the scope of PALAEMON, Apache Kafka will play a twofold role: on the one hand, it will "funnel" the data (to the extent possible) that comes from data sources (e.g., shipboard legacy systems, field devices, etc.) and deliver it to the persistence plane (based on Elasticsearch in this case, as we will see in Section 4.3.1); on the other side, real-time communications among components will lean on the possibilities brought about by this powerful pipeline. Just to illustrate and complement this with an illustrative example, every time a message goes across this streaming platform, it will be *1)* stored as part of the Data Fusion Bus persistence system; *2)* broadcasted on a particular Kafka topic (a topic is a category that labels the

[9] Elastic Beats homepage: https://www.elastic.co/beats/
[10] Apache Kafka homepage: https://kafka.apache.org/

records/messages that are published) so that any component “subscribed” to it could receive the message with the minimum latency.

Moreover, Kafka will form the technical foundations behind the PALAEMON Evacuation Coordinator (Section 4.3.5), which will basically broadcast any evacuation-status switch to all components (i.e., subscribers).

4.2.3 Data Batch Aggregator

When we talk about offline documents (following the example we gave at the beginning of this section, a simple PDF or, going a step beyond, a CAD file containing a 3D modelling of a ship blueprint), we must deploy a component in charge of taking these files. In essence, the objective of this module is no other but taking all these documents and proceed to persist them in the PALAEMON core system. This way, all the useful information needed by high-level services will be on hand at a very same place, thus notably reducing the complexity when it comes to request and query information.

4.2.4 Data Processing Pipeline

Up to this point we have seen different ways to catch the information from their respective sources, regardless their underlying format or type, either streaming, batch or offline standalone documents. The subsequent action to carry in this case would be to centralize the access, parse the data, transform it[11] and send it to the next stage in the flow. Anyway, it is worth remarking here that not all data flows must go across this component, which will be used only under particular conditions (which is out of the scope of this version of the architecture and will be addressed in the final iteration). Sticking to the Elasticsearch stack that will be primarily used in the Data Fusion Bus, that is, the main component of the PALAEMON core, we also find Logstash[12] as a good candidate to undertake this operation, since it encompasses all the functionalities we are posed in a standalone software module.

4.2.5 Data Filtering & Transformation

As we have seen throughout Section 4.1, a number of heterogeneous components/data sources will generate different raw information models, whose output will be subsequently stored and transmitted to the high-level services. However, leaving this information as it is would not generate but chaos and a huge overhead to e.g. application developers, since they would have to deal with each of the formats/interfaces in an individual manner. To overcome this and from a holistic PALAEMON data modelling plane, we will add another component to this data access layer responsible for the filtering and transformation of the incoming data, yielding a common and homogeneous dataset.

We have decided not to dig into the details of this data models, since it will be covered as part of T7.3 (Uniform Data Exchange Modules – Interoperability Layer) and its subjacent deliverable D7.5 [9], due in M20 (March 2021). Moreover, it goes without saying that all the breakthrough and final design of the PALAEMON data models will be properly addressed in the final version of this deliverable.

[11] Even though it is possible to use this module to carry out the transformations, we have another standalone component dedicated to that end.
[12] Logstash home page: https://www.elastic.co/logstash

4.3 PALAEMON Core

4.3.1 Data Fusion Bus

In a nutshell, the Data Fusion Bus (DFB) will be the cornerstone of the PALAEMON platform. Basically, any kind of information either generated or consumed by data sources or high-level services (respectively) must go across this module. Technically speaking, the DFB is a component which provides a trustworthy way of transferring data between the connected elements and the persistent system. As a matter of fact, it is composed of a collection of open-source components which allows easy deployment and configuration as needed, thus following the global requirements (this can be also seen as a prerequisite here) defined along this task. Among the principal components that will compose the first version of the PALAEMON platform, we have (as shown in Figure 6):

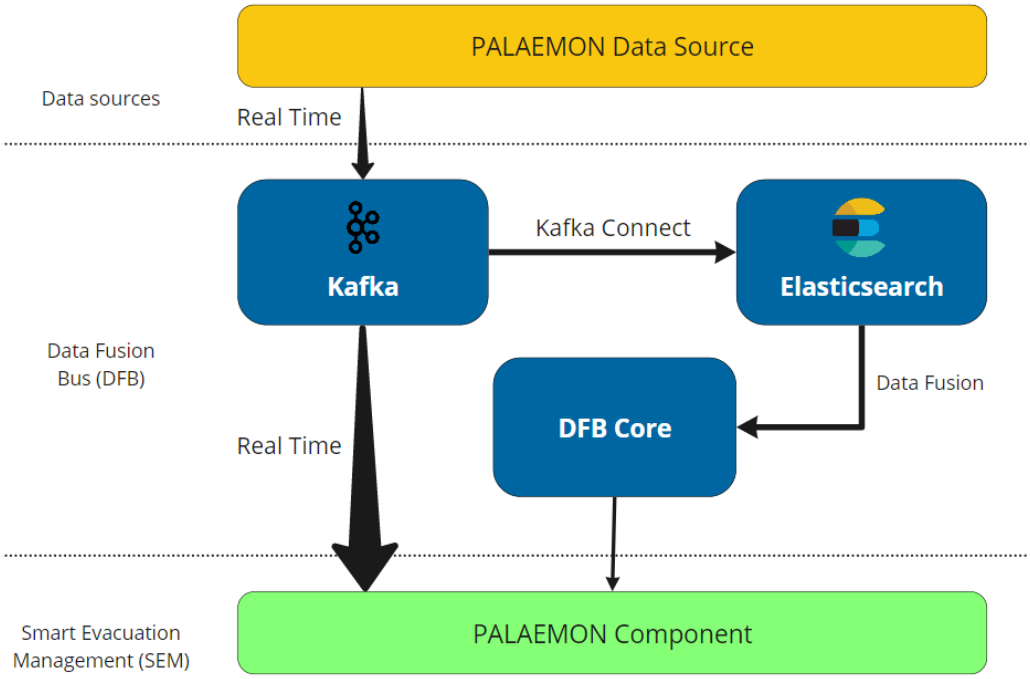

Figure 6. Data Fusion Bus overview and interplay with data sources and high-level services (SEM)

Elasticsearch[13] is a distributed RESTful search engine built for the cloud. It resembles a NoSQL database [10] being able to store data as JSON documents, but also works as a powerful search engine. Data is stored in the indices, which can be separated into shards and stored into a distributed system with replicas if needed. In contrast to traditional databases, the stored documents can have different format.

Within PALAEMON, data collected in the central Kafka broker is persisted in the Elasticsearch cluster.

DFB core provides a REST API for management and monitoring of the rest DFB components (Kafka and Elasticsearch clusters). The DFB UI provides a GUI that acts as a client to the DFB Core. The key features are:

- Health monitoring (Kafka broker status, ES cluster status, replication status)
- Kafka Performance metrics (e.g. broker status, messages in/out per topic, bytes in/out per topic, consumer lag)

[13] Elasticsearch home page: https://www.elastic.co/

- Elasticsearch Usage metrics
- Kafka Topic management (creation, configuration, persistence by Elasticsearch, client authorization & authentication)

Table 10. Data Fusion Bus main features

Input parameters	▪ Structured datasets: CSV files ▪ Semi-structured data: log files, JSON files ▪ Data streams (e.g. MQTT)
Output parameters	▪ SQL interface ▪ Data streams ▪ Web services (e.g., RESTUL API)

4.3.2 Passengers Mustering and Evacuation Process Automation System (PaMEAS) Backbone

PaMEAS is a multi-layer system that should provide accurate location positioning information to ship management for passengers and crew. PaMEAS consists of three main components, properly gathered in Figure 7:

a. A hybrid 4G LTE - 5G Cell Network organized around an Enterprise Core network component provided by Ericsson[14]; it will allow for standalone data connectivity provided in the form of a private network deployed for the needs of Work Package 8 Pilots (PALAEMON Ship 5G);
b. The PaMEAS Software Suite organized around a RTLS (Real Time Location System) software component; it will provide people location tracking, monitoring and indication of evacuation paths functionality;
c. The PaMEAS APIs which will define the interactions of the PaMEAS Software Suite with the other elements of the PALAEMON architecture and PALAEMON Services (it will mostly provide people location information to any other component that needs such functionality, within the constraints imposed by the EU privacy laws and by defining additional context-specific identity preservation safeguards.

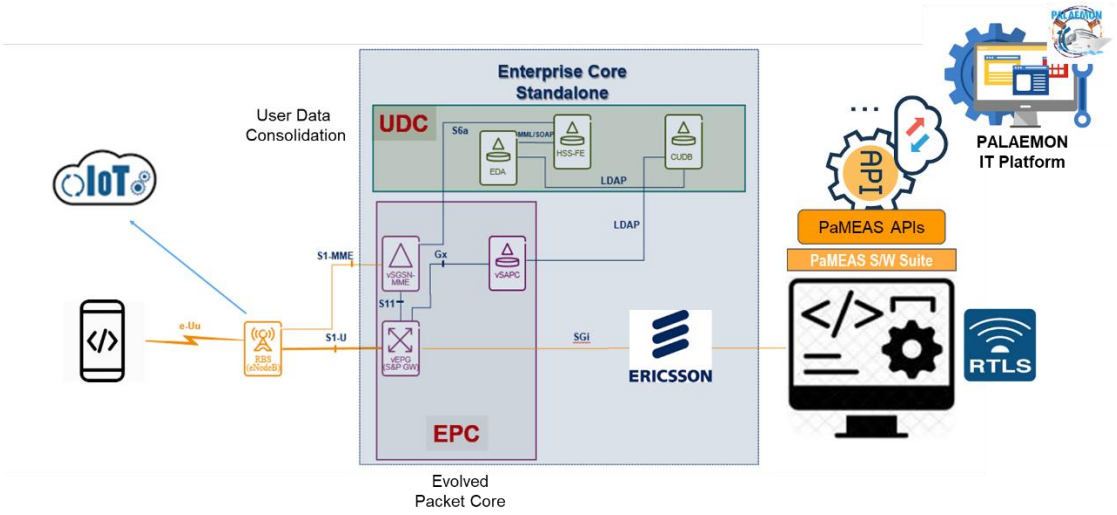

Figure 7. PaMEAS backbone infrastructure

[14] https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-packet-core/enterprise-core

PaMEAS connects with other components of the PALAEMON architecture and the rest of the components as follows:

- PaMEAS interconnects with User Devices (mobile phones, bracelets etc.) deployed for the needs of PALAEMON pilots and the PALAEMON AR glasses stack
- PaMEAS connects to Shipboard Legacy Systems to retrieve e.g., passengers' identity information (respecting the GDPR regulation).

Table 11. PaMEAS main features

Input parameters	▪ Smart Bracelets ▪ Smart Cameras ▪ Cellphones ▪ Passengers' list
Output parameters	▪ Passengers' location ▪ Smart route calculation ▪ AR location info

4.3.3 LTE/5G Radio Dot System

Radio Dot System is a small cell indoor mobile network aiming at exploring the benefits of LTE and 5G technologies to enable the provision of high-level mobile broadband coverage and smart services, for different kinds of users across small as well as large industrial buildings, business spaces and public venues. To meet the high requirements of network subscribers and tackle the challenges of digitally urbanizing environments, Ericsson's indoor small cell radios deliver high per-user capacity and rate coverage everywhere, with the potential to improve performance in the macro network by offloading the traffic generated in hotspots. Ericsson's Radio System creates a wireless environment where both indoor and outdoor networks perform perfectly and seamlessly, enabling the best end-user experience. This is made possible through a fully integrated Ericsson Radio System that secures performance across all radio network) for multiple bands and standards. The Radio Dot System is 5G and IoT ready and supports multi-operator and unlicensed deployments.

The Radio Access Network – RAN - (4G/5G) indoor coverage will be accommodated by Ericsson Radio Dot System (DOT). This is a high performance distributed active radio antenna system based on a centralized RAN architecture.

Radio DOT architecture optimized for medium to large scale indoor deployments.

Figure 8. Radio Dot 2243

The Radio Dot 2243 (Figure 8) is a single band indoor 2T2R antenna element that works in conjunction with an Indoor Radio Unit IRU 2242 to provide indoor connectivity to a wide range of building environments.

The Radio Dot System, with its distributed architecture, enables coverage and capacity throughout a variety of Indoor venues. Radio 2243 provides indoor connectivity through remotely powered active antenna elements using standard enterprise LAN cabling, while sharing centralized baseband and radio resources.

The deployed Radio Dot Network will be managed by Ericsson Enterprise Core network element, and the other PaMEAS components.

4.3.4 Learning Record Store (LRS) / Learning Management System (LMS)

In order to constantly update and exchange information, within PALAEMON Academy, AR and VR devices will have to communicate to an LMS/LRS server throughout the entire workflow of the scenario. To sustain the connectivity features and data flow, the LMS server will be comprised of four distinct systems: the scripting language (e.g. PHP); the webserver (e.g. Apache); the SQL Database and finally the operating system. From the OS perspective, the LMS server will run independently on Linux (Unix) operating software without any additional software packages. The LMS will handle the user management along with the user settings, and the LRS will record just the statements.

The LRS component is complementary to the LMS server. The LMS is capable to receive and process web requests for user management purposes but it is also responsible for receiving, storing and providing access to specific records. An LRS instance can work as standalone or can be integrated into an LMS server. However, there are some differences between the two approaches especially in terms of flexibility and scalability.

The data that is stored in an LRS can migrate to another LRS platform and this can be useful if one user or a group of users, move to another LRS. Moreover, the LRS has the ability to communicate with other systems, allowing thus to store or transfer data in different places.

Additionally, some LRSs have improved functionalities that help users view data in a graphical way (e.g. reports, dashboards, automated processes).

4.3.5 PALAEMON Evacuation Coordinator

For the correct and seamless operation of the PALAEMON platform, it is of utmost critical that all components are coordinated and fully aware of the status of the evacuation process. For this reason, the PALAEMON Evacuation Coordinator will be developed as an additional part of the system.

The PALAEMON Evacuation Coordinator will be in charge of listening for major events that occur regarding the evacuation process and then notifying all the components (both data sources and high-level services) of changes in the evacuation status phase, leading to changes in the operation modes or data generation rate of certain components, as illustrated in Figure 9..

The PALAEMON Evacuation Coordinator will work mainly with the output from the PIMM, as any command given by the Bridge Crew or the Master will be input through this component. Once a command has been received, the PALAEMON Evacuation Coordinator will update its status and broadcast a message via Data Streaming Aggregator to all the components that are subscribed to the Ship Evacuation Status topic. Additionally, the relevant information about

the current evacuation status will be available for on-demand querying by any component that needs it.

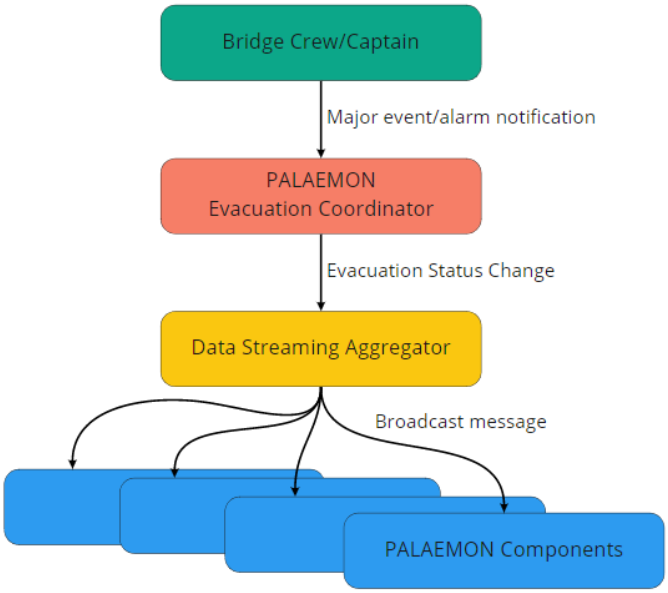

Figure 9. Evacuation coordinator overall concept

Table 12. PALAEMON Evacuation Coordinator main features

Input parameters	Evacuation commands
Output parameters	Evacuation process notifications

4.4 PALAEMON Smart Evacuation Management (SEM) system

4.4.1 Smart Safety System (SSS)

The main purpose of the Smart Safety System (SSS) is to assist the Master and Bridge Team during the evacuation process by graphically displaying the progress without the need of extended VHF/Radio communication between the members of the evacuation and the bridge teams.

The Smart Safety System (SSS) consists of three main components, as hinted in Figure 10: The **Logic Unit** is the base application that runs in the background on the main unit (e.g. Bridge Computer). It is responsible for the central data processing and validation of the user data inputs received from the HMI Units via the MQTT Broker.

The **MQTT Broker** could be installed together with the Logic Unit on the main unit or on a dedicated server. The Broker is responsible for the communication between the central Logic Unit and the various HMI Units. In addition, it will act as an interface to the PALAEMON Core, from where it will be able to receive additional data input like position information of crew and passengers distributed by the Smart Bracelets, but also provides information of the SSS like updated evacuation routes to the PALAEMON Core System.

The **HMI Units** are responsible for the graphical presentation of SSS information and for the manual input of evacuation related information. It will be installed on the main unit on the Bridge to support the Master and Bridge Team in the evacuation process and on mobile units like tablet computers for the on-scene crew.

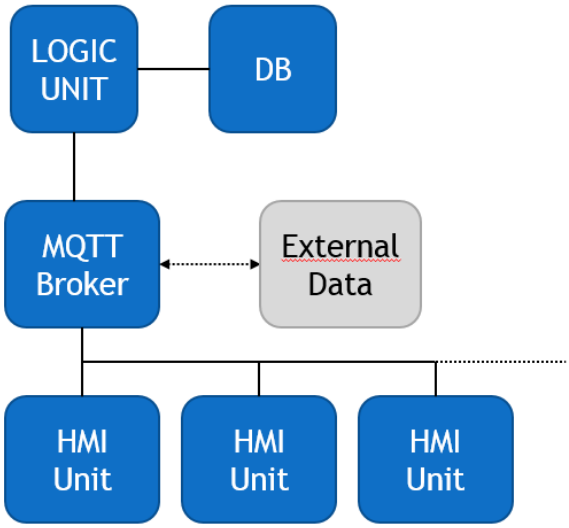

Figure 10 Smart Safety System Architecture

Table 13 summarizes the main features (in terms of input/output data) of the SSS module.

Table 13. Smart Safety System main features

Input parameters	▪ Position of incident on board ▪ Coordination info issued by Master
Output parameters	▪ Position/present situation of evacuation process

4.4.2 Smart Risk Assessment Platform (SRAP)

Smart Risk Assessment Platform (SRAP) is a real-time risk-based monitoring software component that will provide a colour coded risk level indication on the PALAEMON dashboard. Its purpose/goal is to assist the Master as well as the Bridge Command for:

1. the initial assessment of the situation, in order to take the decision of sounding the General Alarm (GA) or not.
2. the evaluation (monitoring) of the mustering process in order to take any additional actions (if necessary), following the GA; and
3. the final assessment of the situation, i.e. taking the decision to abandon the ship or not.

SRAP will implement basic risk assessment approaches to calculate the likelihood and the consequences severity of an incident/accident. To achieve that the data that will processed by SRAP will be distinguished in two main categories: Ship Condition and Passenger Data. It will take advantage and combine data taken from ship's legacy systems (i.e. smoke detectors, flooding sensors, etc.) and the main output of other PALAEMON components, indicatively some are shown below[15]:

- PaMEAS, for passenger localization and health monitoring data
- Stability Toolkit, for data regarding the evolution of ship's stability after the occurrence of an incident
- Structural Health Monitoring Toolkit, for data regarding ship's structure integrity;

[15] The interplay among components may vary in the future.

- Smart Safety System, for data regarding distance of passengers and crew members from threats/dangers (e.g. fire, smoke, congestion points, etc.)
- MEVs, for data regarding their availability, status, and persons on-board throughout the evacuation process

Table 14. Smart Risk Assessment Platform main features

Input parameters	▪ Passenger localization data ▪ Passenger health monitoring data ▪ Ship's stability data ▪ Passenger evacuation data ▪ Availability of MEVs ▪ Smoke/fire detectors ▪ Flooding sensors
Output parameters	▪ Risk level ▪ Risk level indication

4.4.3 Decision Support System (DSS)

PALAEMON DSS is an innovative system for assisting specific crew members (e.g., Master, Bridge Team, etc.) to deal with an emergency on-board incident. The main target of this component is the identification of the incident and, besides, the support to the user with suggestions of decisions and actions to be taken, in order to avoid any critical mistakes that will result in further damages to the ship (or even worse, putting people's lives at risk).

The DSS provides the following main functionalities:

- **Integration with other modules:** It will receive information from various modules such as the Smart Risk Assessment Platform, Safety Management System, Ship Structural Monitoring Ecosystem, Weather Forecast Toolkit, Data Fusion Bus, Incident Management Module etc. and combine this information to produce the most suitable suggestions according to the situation that takes place at the moment.
- **Graphical Interface**: It will have a dedicated dashboard (indeed, part of the PIMM layout, as will be described in Section 4.4.5) which will display the results from the analysis of the information that will be available either real time or offline.
- **Access to information:** Apart from the suggestions that will be made, data will be displayed on the DSS's dashboard that will be helpful for the bridge to have an overview of the ship's condition.

It will generate alerts when an incident occurs and also suggestions on decisions to be made towards mainly the Master and the Bridge Team. The DSS suggestions will be categorized and separated according to the individual incident and will be displayed on the dedicated dashboard provided by the PIMM.

Table 15. Decision Support systems main features

Input parameters	▪ Location of incident / Ship stability data (Ship Structural Monitoring Ecosystem) ▪ Weather forecast (WFT) ▪ Risk level (SRAP) ▪ Risk level indication (SRAP)
Output parameters	▪ Safety procedures (SMS) ▪ Recommendations to Master/Bridge/Crew

4.4.4 Safety Management System (SMS)

The Safety Management System (SMS) is an organized system planned and implemented by the shipping companies to ensure safety of the ship and marine environment. SMS is an important aspect of the International Safety Management (ISM) code and it details all the important policies, practices, and procedures that are to be followed in order to ensure safe functioning of ships at the sea [11]. All commercial vessels are required to establish safe ship management procedures so to comply with the mandatory safety rules and regulations, and follow the codes, guidelines, and standards recommended by the IMO, classification societies, and concerned maritime organizations[16]. Description of safety procedures are always company and vessel specific following global best practices. Every safety management policy consists of a set of functional requirements that ensure safety of every ship, therefore encompasses, among other requirements, procedures and guidelines to act in an emergency situation.

Safety procedures are documented in safety manuals and filed onboard in hardcopies to be easily accessible to crew for direct reference. Procedures are also dynamic in time while undergoing changes and revisions following upgrading of best practices or updating of policies and guidelines. PALAEMON will offer a document management tool where safety practices, policies and guidelines will be digitalized, stored and processed under a user-configured workflow engine. SMS tool will offer a form panel where checklist with standard safety procedures associated with any operation onboard will be designed, completed, manually or automatically, and circulated in between users with different level of authority for review, revision and approval.

SMS tool will have a two-fold application in PALAEMON ecosystem.

1. It will be integrated with the Decision Support System (DSS). DSS will advise the Master in decision making during an emergency event. Upon Master's decision or, in other words, following his confirmation over the derived DSS advice**,** SMS tool will populate and visualize through PIMM (working as Master interface), prescribed treatment or documented order of safety actions that are associated with the decision of the Master. Each digitized safety action will be linked with an action owner (crew member) to support effective flow of procedures for efficient respond against emergency. Dynamic electronic forms (checklists) will work as a digital advisor for crew and enhance reaction in emergency.

2. In post incident analysis (investigation of the event), SMS tool will assist in versioning update of documents to support any revision of safety procedures following change management and suggestions for improvements in company's safety policy. Embedded workflow engine will leverage document management flow between ship and shore and facilitate administration of reviewing and approving amendments.

Under the aforementioned scope of tool functionalities, PALAEMON SMS will be at the same time reactive and responsive to decision making in emergency as well as proactive following a *"plan-do-measure-act*" approach where safety procedures will be modified against lessons learnt from incidents on-board.

[16] https://www.marineinsight.com/marine-safety/what-is-safety-management-system-sms-on-ships/

Table 16. Safety Management System main features

Input parameters	▪ Electronic checklist ▪ Document Management
Output parameters	▪ Safety procedures (structured format – JSON)

4.4.5 PALAEMON Incident Management Module (PIMM)

The PALAEMON Incident Management module is a corner hub for managing (and displaying information) from different modules during an incident. Through its friendly Graphical User Interface, access is provided to critical PALAEMON components, to be used by the Master and the Bridge Team. For example, should an incident occur, the captain can use the PIMM to view the suggested plan of action proposed by the DSS. Following the same example, Master's decision (i.e., in the form of e.g., evacuation orders) will be visually caught through this service and will lead to the corresponding event generation at the Ship Evacuation Coordinator.

As a matter of fact, DSS and Weather Forecast Toolkit (WFT) will be directly integrated as part of the PIMM layout in this first version of the PALAEMON platform. Notwithstanding, in the future we may include more services as part of the holistic PIMM layout.

Through the use of hyperlinks, the PIMM can link to other modules' dashboards (e.g., PaMEAS). This way, a unified workflow can be achieved, and the Master/Bridge crew can navigate through all components/visuals in a seamless manner.

For the sake of illustration, Figure 11 display a preliminary layout that embraces the concepts to be shown on the PIMM at the time of writing this deliverable.

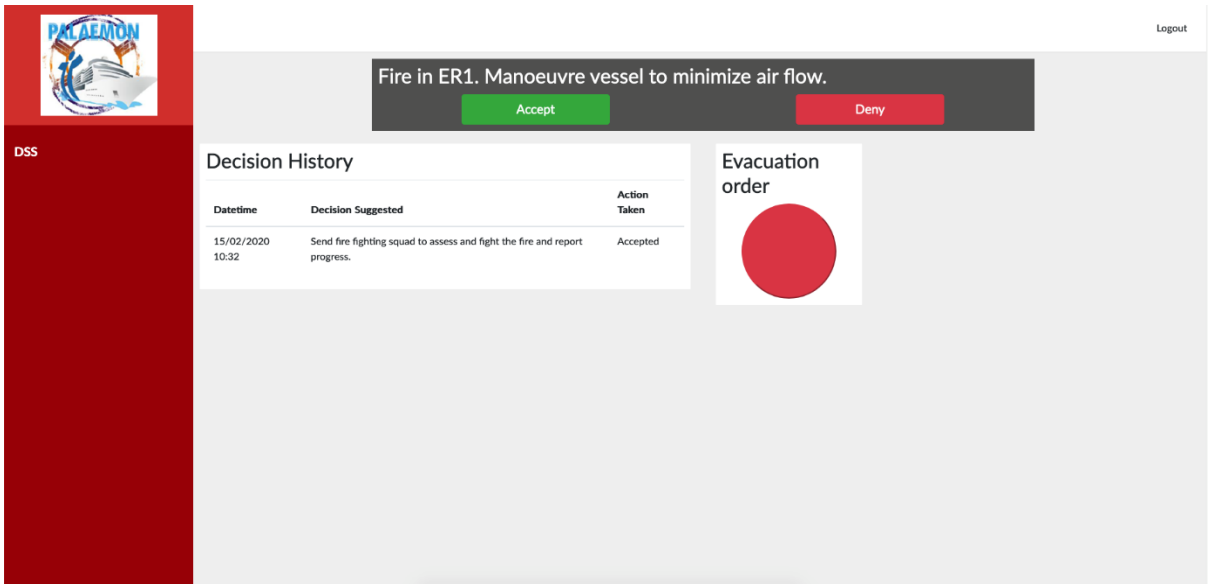

Figure 11. Sample screenshot of PIMM Proof of Concept (mockup)

Table 17. PIMM main features

Input parameters	▪ DSS ▪ WFT ▪ PALAEMON Evacuation Coordinator
Output parameters	▪ Graphical User Interface displayed on the bridge

4.4.6 Weather Forecast Toolkit (WFT)

Weather conditions are very important for the progress of the evacuation plan. An evacuation plan may not be effective without taking into consideration the weather conditions. For example, in case of a fire at an open deck the wind speed and direction play the more important role for the fire spreading.

The Weather Forecast Toolkit will correlate the weather conditions with the evacuation actions/plans. Evacuation actions that were successful in previous incidents will be more correlated with the weather conditions at the time of the incident. These actions will be displayed at the PIMM dashboard and will give a first insight for the actions that took place at the past for a successful evacuation. We define an evacuation as successful if there were no fatalities/casualties.

At the first place, unsupervised Machine Learning algorithms (i.e., clustering) will be used to group marine incidents that have similar evacuation plans (each incident is related to specific weather conditions and evacuation plans/actions). Then, we consider the center of each cluster as the representative type of the evacuation plan. Finally, we will find the k nearest evacuation plans (i.e., clusters) of the current incident considering only the current weather conditions and the weather conditions that correspond to the centers of each cluster [12].

This module will help the crew take quick actions during an incident in order not to waste valuable time. In many past incidents, delayed response has resulted in human losses[17]. Also, we will create a dataset based on the National Transportation Safety Board (NTSB) Database[18]. The attributes of this dataset are the weather conditions and the evacuation plans/actions during past incidents.

Table 18. Weather Forecast Tool main features

Input parameters	▪ Weather history of past accidents ▪ Weather station information ▪ Weather forecast ▪ DSS info
Output parameters	▪ Recommended procedures (to feed DSS)

4.4.7 PaMEAS - Service

PaMEAS will streamline and monitor the process of mustering and evacuation (and prepare for the use of MEV) by:

1. Identifying the location of passengers.
2. Monitoring in real-time the move of passengers towards muster stations.
3. Providing online instructions to passengers themselves, via smartphones and other users' IT devices, and guidance through IoT signaling for evacuation.
4. Recognizing the identity and assisting "passengers in danger" (e.g., moving slowly, locked in cabins, corridors, stairs, etc.)
5. Helping crew and S&R forces to locate passengers.
6. Continuously counting people reaching muster stations and evacuation facilities.

[17] H. Kim, S. Na, H. Kim, and W. Ha, Marine accident investigation and analysis with focus on human factors, *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (2010), Vol. 54, pp. 1440–1444.
[18] https://www.ntsb.gov/investigations/AccidentReports/Pages/marine.aspx

7. Providing precise information on evacuated passengers to the outside world (shipping company, maritime authorities, rescue teams etc.).

Table 19. PaMEAS Service main features

Functionality	Indoor positioning-based Evacuation Services to increase ship "evacuability" and help the rescue forces to operate more efficiently
Input parameters	Location data obtained from a 4G LTE – 5G private Network (PALAEMON Shio 5G)
Output parameters	Passenger Location Information bundled with PII Data (Personal Identity Information), People Flow Management in Ship Evacuation conditions

4.4.8 AR app

The AR application will be the supportive framework for the AR glasses hardware and will require to work seamlessly in between them but also with other standalone systems. In the same time, the AR app will support administrative functions, content authoring tools but also data transfer with external systems. The Application will be able to support a series of administrative functionalities, vital for initiating, running and concluding the scenarios. From the account oversight perspective, the AR app will allow crew members to set up their own accounts; login through encrypted channels but also to update, change or personalize their profiles. From an authoring tool perspective, the app will be able to add specific AR items and objects but also important content and information such as instructions or guidelines.

Another vital function of the app represents the ability to communicate through closed WiFi network with external systems such as: PaMEAS, DSS or SSS, among others. This will enable the AR glasses to exchange data but also receive input during the scenarios as crew members will be able to communicate and network information in real time.

Furthermore, the AR app will also be ready to load specific blueprints; view and display ship's passengers as markers or identify other's location on the ship's map. The AR app will be able to communicate all this data to an LRS/LMS platform for various improvement and analytics purposes. In case of any communication problems between the systems, the app should display such issues, informing the crew members.

Table 20. AR main features

Input parameters	▪ Ship blueprints ▪ DSS output ▪ Safety Procedures ▪ PaMEAS Indoor Positioning
Output parameters	▪ Visual interface for crew members (AR app) ▪ LRS/LMS logging info

4.4.9 PALAEMON Academy

PALAEMON Academy is intended and designed as a core architecture that sustains critical learning features and development tools. Its main goal of learning and improving skills is achieved through exploring various scenarios through simulations, covering specific learning

objectives and skill acquisition targets. Some of the main elements of the PALAEMON Academy are as follows:

The “Academy interface” is the gate that enables the user to access various features and functionalities such as: login and data storage or if needed log in to a user management system; customizable user interface based on specific preferences and roles.

In order to expand the diversity and applicability of the learning scenarios, a module “Level Designer” is available within the Academy. This tool available only to administrators, will enable to create simple scenarios using either isometric or first-person view, and publish them for all the other users.

Another important module within the PALAEMON Academy is the “Random Simulation”. This module will integrate AI systems that can generate random events based on environmental predefined modifiers and various types of incidents selected prior to starting the simulation.

This module will allow the users to jump within a specific simulation but also to track the progress in a given simulation.

“Learning” module in the PALAEMON Academy, contains lessons that allows step by step VR and 3D training for the users. Lessons will cover both legislation but also the head mounted devices. Data stored here will be used to customize bespoke AR interfaces for each user.

A similar module is the “Tutorial” section, which contains a set of lessons for both the legislation and the head mounted devices. Depending on the user role, different sets of legislation and interfaces will be unlocked covering either 3D, AR or VR devices.

PALAEMON Academy will include a wide array of scenarios ranging in complexity and mandatory level. Therefore, the “Evaluation” module within the Academy, will present a predefined set of levels that will measure user’s parameters and decisions ability but will also enable them to unlock further complex scenarios and expand skills base.

A final section within the PALAEMON Academy is the “Metrics” one. Closely connected to “Evaluation” section, the “Metrics” will have a skill tree that will allow the users to unlock certain widgets, views, badges and achievements as each scenario will have measurable KPI’s and customised feedback. The metric sections will also have several charts that will monitor the progress of a scenario, whilst communicating key data through a link with an external LRS via xApi (TinCan)[19].

Table 21. PALAEMON Academy main features

Input parameters	▪ Scenario descriptions
Output parameters	▪ Participants data log (e.g., training log, etc.)

[19] xAPI homepage: https://xapi.com/

5 PALAEMON Communication Platform

In the previous section we have individually fostered and introduced all the pieces that shape the whole puzzle, spanning from the sources of the data and to the point the information is shown/displayed to the various end users/stakeholders. To that end, we can observe in Figure 13 the overall PALAEMON architecture, going a step deeper from what we used to introduce and motivate the content of this deliverable (Figure 3 in page 17).

Again, repeating the same schema (from left to right), we see as the data sources (covered in Section 4.1) are now broken down into the actual list of components (instead of their data-generation category). One of the “new” things that appear here is the presence, in some of them, of intermediary nodes. For instance, we saw as the Smart Cameras (Section 4.1.3) do need an additional computing element to undergo the complex operations behind a computer-vision-based operation, since the cameras cannot make it by themselves. Likewise, the Structural Health Monitoring (Section 4.1.6) also lean on a processing node to aggregate (indeed, there will be more than one sensor), process and transform the information to be sent to the core. Aside from this, these companion nodes hint the possibility of transforming and aggregating the information before being forwarded to the next stage of the system.

Another circumstance that leads to the necessity of adaptation nodes lies on the legacy format the information is received. As illustrative example, messages received from VDES data channels (Section 4.1.7) come as raw octet streams[20] and must be parsed and translated before its introduction to the PALAEMON platform. Furthermore, the connection between the VDES transceiver (e.g., in charge of mainly the physical and link layers) and the rest of the system is something that requires a dedicated module. The same principles can be applied to shipboard legacy systems, which will be delivered in raw format (in this case, more details will be reflected in the next version of the deliverable).

Still at the same entry level, there are some modules that also rely on different elements to get connected to the platform. On the one hand, UAVs (Section 4.1.4) mainly communicate with their respective GCS through their proprietary transmission protocol (at the open band of 2.4 GHz). Nonetheless, the exchange of information with the rest of the platform is carried out across this node (which counts on more networking interfaces, like WiFi or Ethernet, to cite a few). On the other hand, safety procedures encompass all ship management procedures to comply the safety rules and regulations dictated by the ISM. However, we need to make this information available and accessible to the high-level services/SEM, but not as raw PDF documents. Instead, we have to transform the information there to the structured data (i.e., JSON, CSV, etc.) we manage at the core level. This way, these services (e.g., DSS) will be able to query for this data and directly integrate the response as part of the output of the module (for instance, to be displayed on the PIMM).

Shifting to the Data Access Layer, it is worth recalling again the importance of “uniformizing” the information, serving it with a homogeneous format (and interface) to the central part of the PALAEMON platform. At this level, the joint goal of all the components (i.e., Data Shipping Agent, Data Batch & Streaming Aggregators, Data Processing Pipelines and, Data Transformation & Filtering), is to properly prepare the raw information and to deliver it to the next level: the platform core.

[20] We can find some examples

The heart of the PALAEMON system (namely, the Data Fusion Bus) is responsible for a twofold role: on the one hand, it stores any kind of information generated by the other components; moreover, it enables a real-time messaging system to facilitate the communication among components. Furthermore, we must deploy at this core of the platform some service-specific modules, such as the PaMEAS backbone, foundation of the indoor location and individual route recommendation system, or the LRS/LMS server (which work atomically bound), keeping the information managed by the AR glasses and the PALAEMON Academy Suite (including the VR glasses). In addition, it is worth remarking the critical role of the PALAEMON Evacuation Coordinator, in charge of spreading any kind of modification in the ship evacuation status to all the components that may vary their intrinsic behaviour according to the phase of the evacuation process.

Going a step to the right we have the SEM, a number of different high-level services (presented in Section 4.4) that exploit the information accessible via PALAEMON DFB interfaces. In few words, their (common) target is to support ship stakeholders when it comes to deal with an evacuation process, bringing the process to the next level, (in terms of timing and safety, leading to, hopefully, a drastic reduction of casualties). For instance, PaMEAS service helps locate passengers within the ship in real-time and might be used in conjunction with AR glasses to allow crew members reduce the time spent in searching and reckoning people at muster stations. Moreover, the Smart Safety System comes to complement radio and legacy data communication with a visual layer that will offer critical information in a more intuitive manner.

Amongst the SEM components, we have identified a subset that interacts with each other and yields a joint “aggregated” service, so-called Incident Management System. In a nutshell (a complete description of the whole operation of this “combined” service will be addressed in the second version of this deliverable), some of the SEM components team up and give rise to a fully-fledged service. Starting from the initial assessment of the likelihood and severity of an incident, the IMS combines the information from past accidents (e.g., weather) and chooses the most adequate safety procedures to be displayed on e.g., the bridge, where the decisions to be taken by the Master (secondedby the Bridge Command Team) will be complemented/enriched by the output of this holistic ISM.

Last but not least, we must stop and take a look at the relationship between the outputs of the PALAEMON system and the corresponding stakeholders/users that will interact with them, as shown in Figure 12.

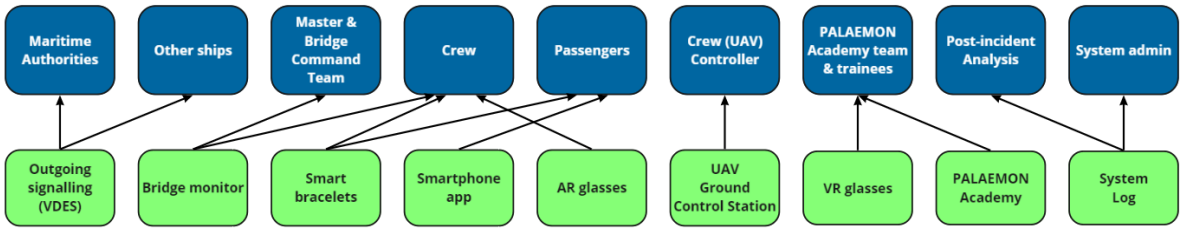

Figure 12. System output and stakeholder’s interactivity map

We can easily appreciate as every high-level service output has a direct connection with (at least) a dedicated end user; therefore, from the continuous feedback we will receive during the following months, we will proceed to streamline this last phase/layer defined in the PALAEMON stack.

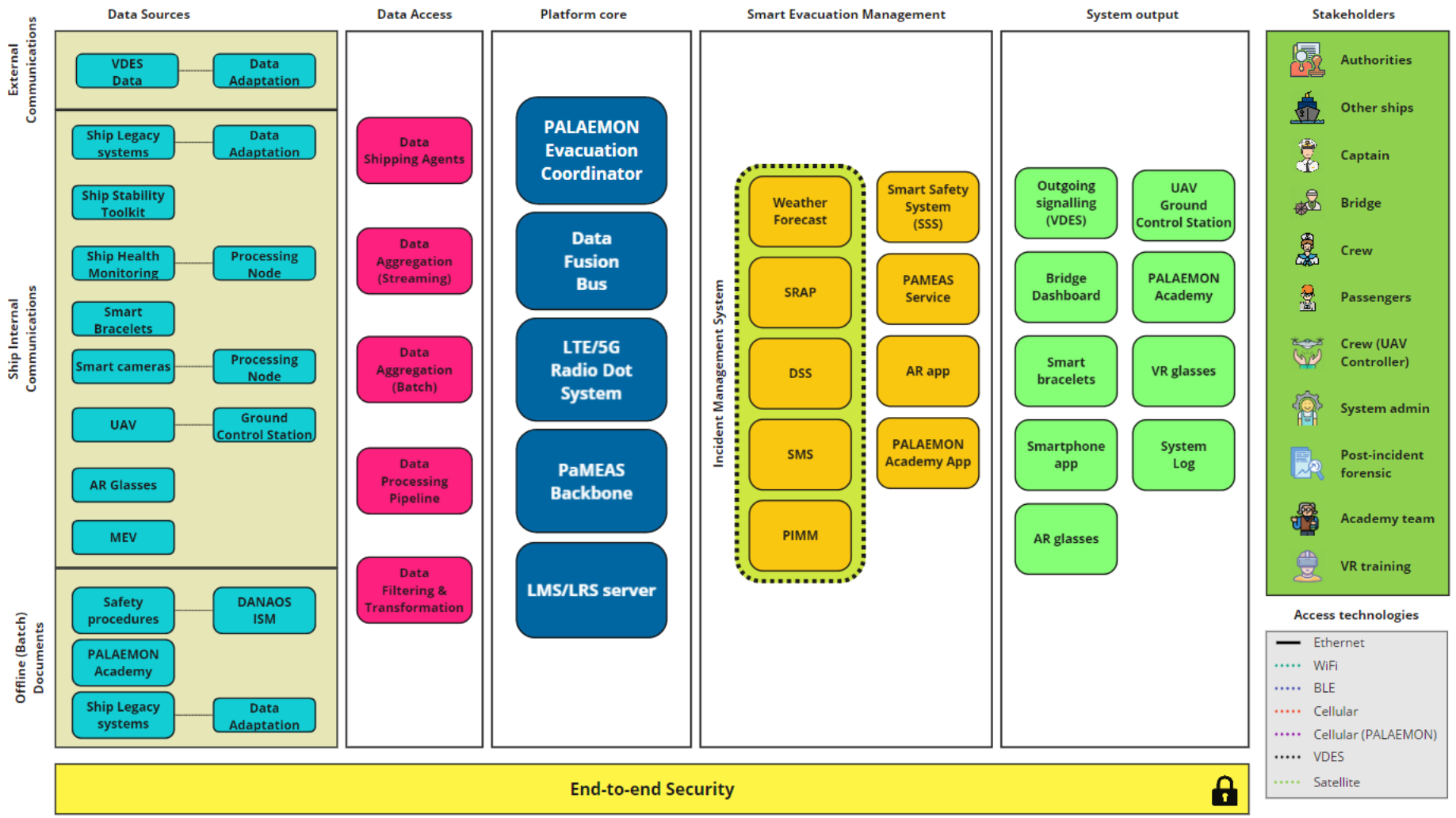

Figure 13. PALAEMON platform component map

The next points span a handful of examples (in the form of sequence diagrams) of the relationship among components to carry out different actions along the Ship Evacuation process (Section 2). To better understand the diagram, we recommend the reader refresh the state sequence during an evacuation in the context of PALAEMON (Figure 2in page 14). It is worth highlighting here that the final version of the deliverable will gather all the operations undertaken by the PALAEMON platform.

5.1 Example #1: Direct Data Source Ingestion to DFB (Smart Camera)

Figure 14 shows an example (focusing arbitrarily on Smart Cameras) of how the data is ingested into the PALAEMON platform. Namely, the Smart Cameras are pre-configured for operation in the Offline Phase. Once the ship sails and Normal Operation starts, the SCs provide assistance to the Crew by sending some data with a preconfigured rate to the PALAEMON platform. If an incident occurs, the system updates its Evacuation Status and the PALAEMON Evacuation Manager notifies the Smart Cameras of the change. This will lead to more data being sent by the SCs to the Data Streaming Aggregator at a different rate, also pre-configured at the Offline Phase. This data is stored into the Data Fusion for use of high-level services or post-incident analysis.

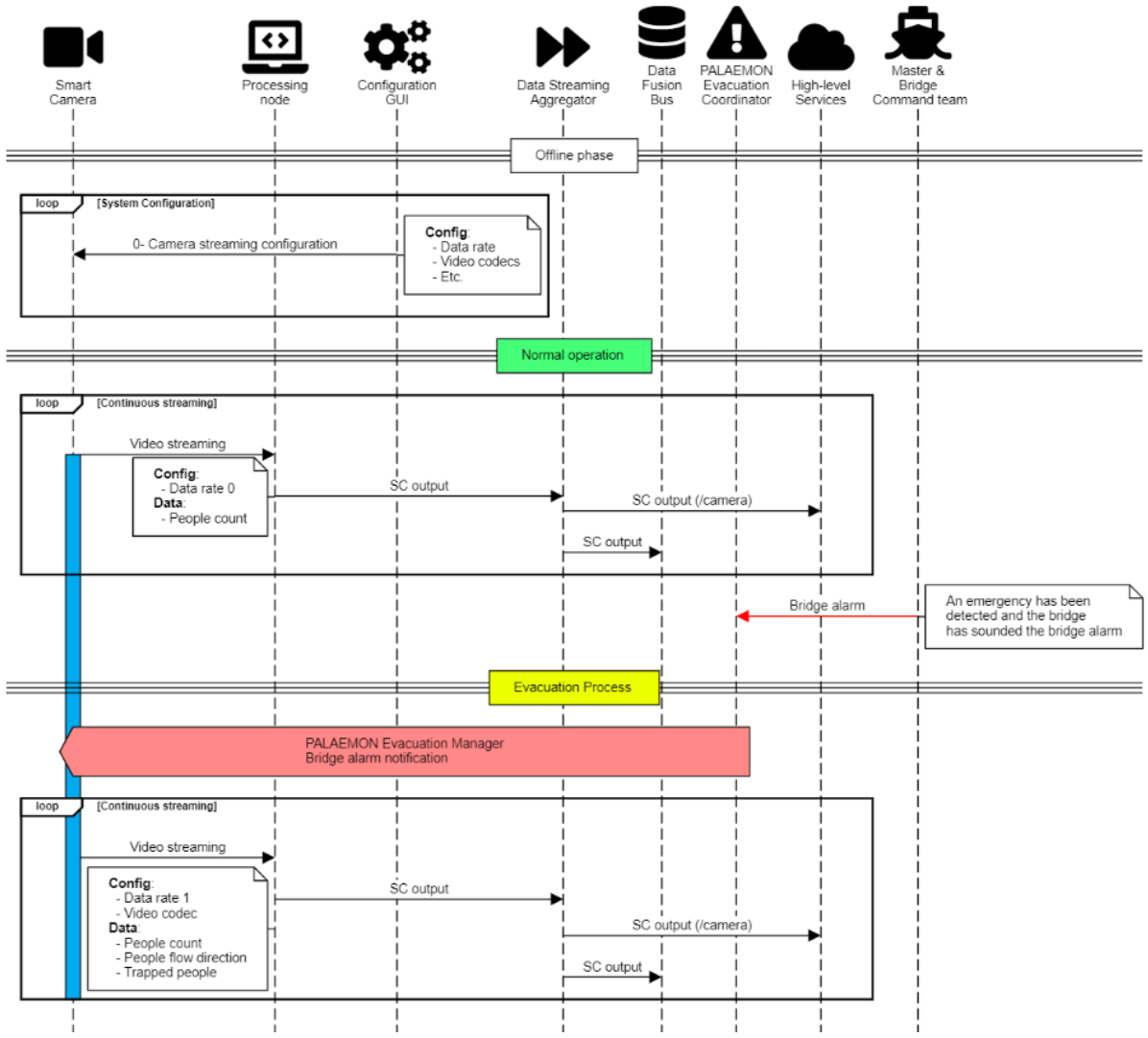

Figure 14. Direct Data Source Ingestion sequence diagram (Smart Camera)

5.2 Example #2: PALAEMON Evacuation Coordinator Status Change notification and subsequent actions

Figure 15 displays the Evacuation Process flow in the PALAEMON platform. Every time the Crew or the Master launch a command during an incident, the PALAEMON Evacuation Coordinator updates the Evacuation Status and notifies all the components in the system (Data Sources and High-level services), making them change their operation parameters in some way.

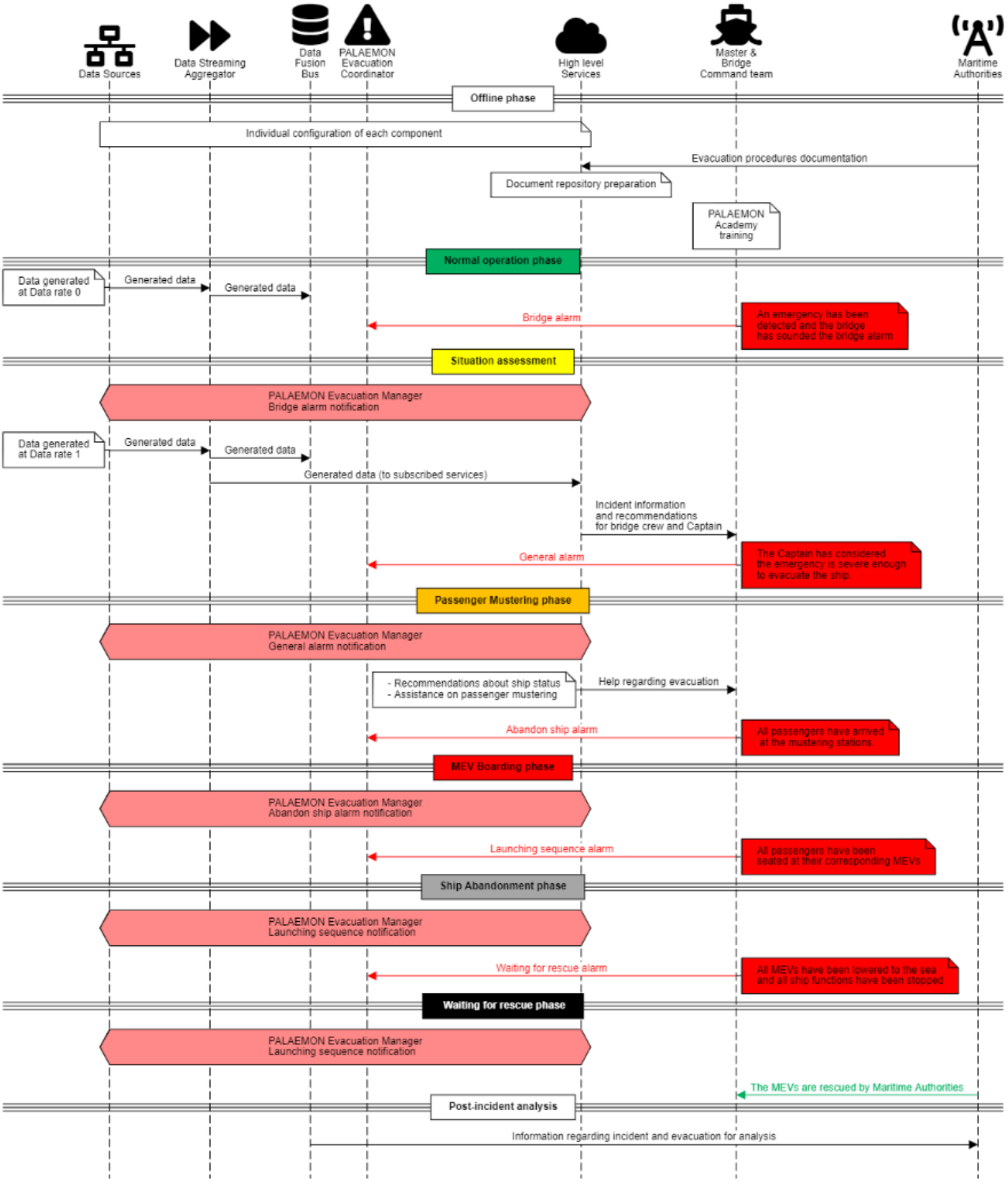

Figure 15. PALAEMON Evacuation Coordinator status change sequence diagram

5.3 Example #3: Incident Management System Master/Bridge Decision/Support

Figure 16 represents the exchange of messages/operations between the components that compose the so-called IMS. That is, SRAP, DSS, WFT, SMS and PIMM. On top of them, they strongly depend on the ship evacuation status; hence, Master's decisions, propagated by the PALAEMON Evacuation Coordinator, will trigger to behaviour changes in the whole system.

Taking a look at the figure, we can appreciate that the ISM is not active till the bridge alarm is triggered, moment from that the SRAP starts analyzing the environment and calculating the likelihood and severity of the current situation. After its "verdict", the DSS grasps additional sources of information and proceeds to ellaborate a list of recommendations to be shown on the bridge (via PIMM), including alternatives and safety procedures to be carried out.

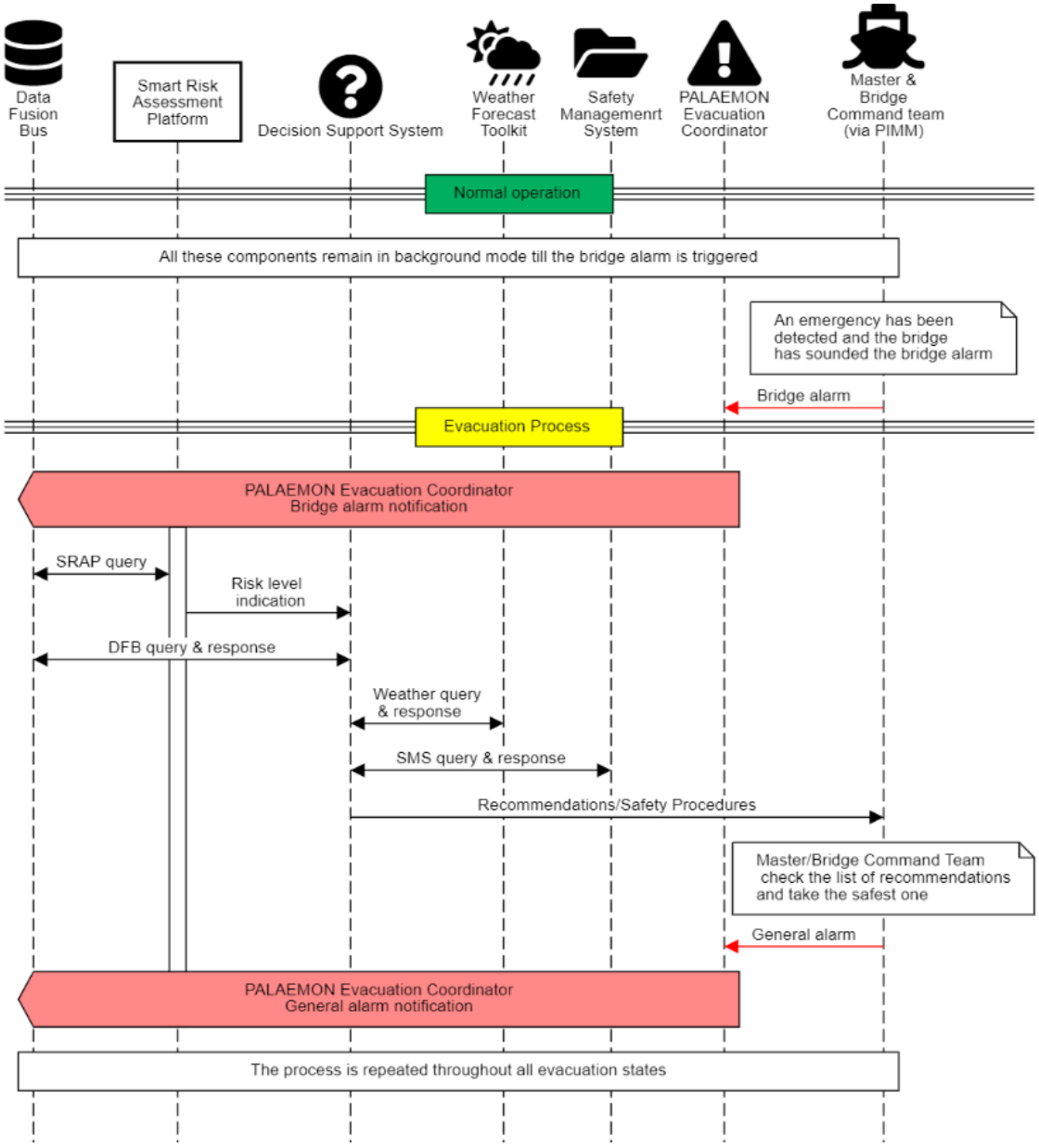

Figure 16. Incident Management System Master/Bridge Decision/Support sequence diagram

6 Conclusions

This document has been written in close conjunction with D2.2 [1] and D2.4 [2], where we, respectively: *1)* settled down the requirements capture from a stakeholders point of view; *2)* defined the use cases, scenarios and operational requirements where the PALAEMON system will come to redefine the concept of Maritime Emergency Evacuation.

In the context of this deliverable, we start from the main outcomes and lessons learnt from the aforementioned documents. Furthermore, we go a step beyond and define what we understand for the future PALAEMON platform. As we have seen throughout the document, this system encompasses a number of different and heterogeneous field devices, technologies and services that must coexist and interact with each other, in order to come up with a common and enhanced smart evacuation system. It is worth highlighting that, likely, the worthiest point behind this deliverable (and, inherently, T2.4) has been to find the binding and interactions among this plethora of assets, not only from a technical point of view, but also trying to keep the full evacuation frame across all the process.

At a first phase, we begun by defining the system requirements that nail down the behaviour and operation of every single piece within the PALAEMON platform, including the off-the-shelf assets that are already up-and-running in modern vessels (e.g., weather information, route recommendation, etc.). On top of them, we also focused on the elicitation of overall/integration requirements, from a holistic standpoint.

The next step was to introduce all these elements, remarking their main features and the way they will work as part of the whole PALAEMON system. We categorized up to 5 different classes of elements, following the flow that starts from the generation of information (e.g., sensors) to its final consumption by the system stakeholders (e.g., Master and Bridge Command Team): *1) Data Sources; 2) Data Access; 3) Platform Core; 4) Smart Evacuation Management system; 5) System Output*.

With all the elements on the table, the subsequent move was to gather all these pieces and come up with a first version of the so-called PALAEMON architecture. At this point, we are able to explain and understand the whole evacuation workflow that will be carried out in the scope of the project. In addition, we complemented the section with a handful of sequence diagrams that helped illustrate the component interaction that we had hinted until that point.

Last but not least, we did a mapping exercise between the Maritime Emergency Evacuation process and the way the system reacts between the succession of status during a ship evacuation process.

For the next version of the PALAEMON architecture, a complete integration of the system will be shown. All components will be connected throughout the next months and will be duly documented in the second iteration of this task's deliverable: D2.7 due in M24 (May 2021). Even though we have properly identified them along the text, it is worth remarking them before closing this document, thus settling down the future work to be addressed.

- Massive Evacuation Vessels (MEV). We have focused this initial phase on the project on their design from a naval/maritime perspective; we will dig into their digitalization as soon as the main structure is ready.
- Security/privacy. Due to a late starting date of its dedicated task (i.e., T7.2 Encryption and Authentication Mechanisms, which ramped up in M13 – June 2020), technical details will be provided in D2.7 when the devoted task will bring the outcomes.

- We have also mentioned the use of a common data model to represent all information going across the PALAEMON platform. This interoperability process goes tightly bound to T7.3 (Uniform Data Exchange Modules – Interoperability Layer), which, alike T7.2, has started in M13, one month before the delivery of this document.
- Besides, though we have glimpsed a connection between various high-level services (i.e., SRAP, DSS, WFT, SMS and PIMM), giving rise to the so-called IMS, it is true that we envisage to foster more, thus providing a larger added-value to the whole system. To this end, we basically foresee that PaMEAS and SSS will play a key role on that regard.
- Finally, we have also detected that there are a couple of data sources (i.e., Smart Cameras and AR glasses) that hint the utilization of multimedia audio/video streaming. However, the current version of the PALAEMON platform is not ready to natively host this kind of data and will have to wait until the second version for a proper handling and storage.

7 References

[1] PALAEMON Consortium, “PALAEMON D2.2- PALAEMON Requirements Capture Framework (v1),” 2020.

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Annex I Traceability matrix

Table 22 contains the mapping between the system requirements and the components to be developed in the PALAEMON project.

Table 22. PALAEMON Traceability matrix

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
PALAEMON-platform-001	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-002	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-003	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-004	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-005	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-006												x				x				x		x
PALAEMON-platform-007	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-008	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-009	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-010	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-011	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-012	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-013	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-014	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-015	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-016	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
PALAEMON-platform-017	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-018	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-019	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-020	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-platform-021	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PALAEMON-Evacuation-Coordinator-001															x							
PALAEMON-Evacuation-Coordinator-002															x							
PALAEMON-Evacuation-Coordinator-003															x							
PALAEMON-Evacuation-Coordinator-004															x				x			
PALAEMON-Evacuation-Coordinator-005															x				x			
AR-001									x													
AR-002									x													
AR-003																						
AR-004									x													
AR-005									x													
AR-006									x													
AR-007									x													
AR-008									x													

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
AR-009									x													
AR-010									x													
AR-011									x													
AR-012									x													
AR-013									x													
AR-014									x													
AR-015									x													
AR-016									x													
AR-017									x													
AR-018									x													
AR-019									x													
AR-020									x													
AR-021									x													
AR-022									x													
AR-023									x													
AR-024									x													
AR-025									x													
AR-026									x													
AR-027									x													
AR-028									x													

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
AR-029		x							x													
LMS/LRS-001														x								
VR-001										x												
VR-002										x												
VR-003										x												
VR-004										x												
VR-005										x												
VR-006										x												
VR-007										x												
VR-008										x												
VR-009										x												
VR-010										x				x								
VR-011										x												
VR-012										x												
VR-013										x												
VR-014										x												
VR-015										x												
VR-016										x												
VR-017										x												
VR-018										x												

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
VR-019										x				x								
WEATHER FORECAST TOOLKIT-001																					x	
WEATHER FORECAST TOOLKIT-002																					x	
WEATHER FORECAST TOOLKIT-003																					x	
WEATHER FORECAST TOOLKIT-004																					x	
WEATHER FORECAST TOOLKIT-005																					x	
WEATHER FORECAST TOOLKIT-006											x											
PALAEMON INCIDENT MANAGEMENT MODULE - 001																				x		
PALAEMON INCIDENT MANAGEMENT MODULE - 002																				x		
PALAEMON INCIDENT MANAGEMENT MODULE - 003																				x		
PALAEMON INCIDENT MANAGEMENT MODULE - 004																				x		
PALAEMON INCIDENT MANAGEMENT MODULE - 005																				x		

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
PALAEMON INCIDENT MANAGEMENT MODULE - 006																				x		
UAV-1				x																		
UAV-2				x																		
UAV-3				x																		
UAV-4				x																		
UAV-5				x																		
UAV-6				x																		
UAV-7				x																		
UAV-8				x																		
UAV-9				x																		
DFB-1											x											
DFB-2											x											
DFB-3											x											
DFB-4											x											
DFB-5											x											
DFB-6											x											
DFB-7											x											
Decision Support System - 001																				x		
Decision Support System - 002																		x				
Decision Support System - 003																		x				

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
Decision Support System - 004																		x				
Decision Support System - 005																		x				
JOAFG-1		x																				
JOAFG-2		x																				
JOAFG-3				x																		
JOAFG-4		x																				
JOAFG-5		x																				
JOAFG-6																		x				
JOAFG-7																		x				
JOAFG-8																		x				
JOAFG-9		x																				
SMART_CAMERAS_UAH-001			x																			
SMART_CAMERAS_UAH-002			x																			
SMART_CAMERAS_UAH-003			x																			
SMART_CAMERAS_UAH-004			x																			
SMART_CAMERAS_UAH-005			x																			
SMART_CAMERAS_UAH-006			x																			
SMART_CAMERAS_UAH-007			x																			
SMART_CAMERAS_UAH-008			x																			
SMART_CAMERAS_UAH-009			x																			

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
SMART_CAMERAS_UAH-010			x																			
SMART_CAMERAS_UAH-011			x																			
SMART_CAMERAS_JOAFG_01			x																			
SMART_BRACELET-001		x																				
SMART_BRACELET-002		x																				
SMART_BRACELET-003		x																				
SMART_BRACELET-004		x																				
SMART_BRACELET-005		x																				
SMART_BRACELET-006		x																				
SMART_BRACELET-007		x																				
SMART_BRACELET-008		x																				
SMART_BRACELET-009		x																				
SMART_BRACELET-010		x																				
SMART_BRACELET-011		x																				
SMART_BRACELET-012		x																				
SMART_BRACELET-013		x																				
SMART_BRACELET-014		x																				
SMART_BRACELET-015		x																				
SMART_BRACELET-016		x																				
SMART_BRACELET-017		x																				

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
SMART_BRACELET-018		x																				
SMART_BRACELET-019		x																				
SMART_BRACELET-020		x																				
SRAP-01																	x					
SRAP-02																	x					
SRAP-03																	x					
SRAP-04																	x					
SRAP-05																	x					
SRAP-06																	x					
SRAP-07																	x					
VDES_001							x															
VDES_002							x															
VDES_003							x															
VDES_004							x															
VDES_005							x															
VDES_006							x															
VDES_007							x															
VDES_008							x															
VDES_009							x															
VDES_010							x															

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
VDES_011							x															
SSS - 001																x						
SSS - 002																x						
SSS - 003																x						
SMS_01																			x			
SMS_02																			x			
SMS_03																			x			
SMS_04																			x			
SMS_05																			x			
PaMEAS_001												x	x									x
PaMEAS_002												x										x
PaMEAS_003												x										x
PaMEAS_004																						x
PaMEAS_005	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PaMEAS_006												x										x
PaMEAS_007												x	x									x
PaMEAS_008												x										x
PaMEAS_009												x										x
SHM_001	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SHM_002	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Requirement Unique ID / Component	Shipboard legacy systems	Smart Bracelets	Smart Cameras	UAV	SST	SHM	VDES	MEV	Augmented Reality	PALAEMON Academy-VR	Data Fusion Bus	PaMEAS Backbone	LTE/5G Radio Dot System	LRS/LMS	PALAEMON Evacuation	SSS	SRAP	DSS	SMS	PIMM	WFT	PaMEAS Service
SHM_003						x																
SHM_004						x																
SHM_005	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
SHM_006						x																
SHM_007						x																
SHM_008						x																
SHM_009						x																
SHM_010	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Annex II System requirements

II.1 Functional requirements

ID: AR-005	**Requirement:** Functional
Description: Authoring tool will be used to add AR descriptions or instructions to existing areas, objects, panels, switches.	
Category: AR Application	**PALAEMON component:** AR Glasses
Rationale: Authoring tool for configuring the AR dashboard and AR training application	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: AR-006	**Requirement:** Functional
Description: The tool will also allow the users to add AR 3D objects and instruments. The added resources will be used to create AR scenarios for training purposes.	
Category: AR Application	**PALAEMON component:** AR Glasses
Rationale: Authoring tool for configuring the AR dashboard and AR training application	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: AR-007	**Requirement:** Functional
Description:	

The app will allow the customisation of the user interfaces for the evacuation plan and team coordination	
Category: AR Application	**PALAEMON component:** AR Glasses
Rationale: Authoring tool for configuring the AR dashboard and AR training application	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: AR-013	**Requirement:** Functional
Description: Loading the 3D map of the vessel	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: The AR application needs to emulate and render, the close to physical environment of the ship. This includes obstacles and walls coordinates, rooms and hallways dimensions but also doors and windows positions	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Realistic representation of the vessel blueprint will dictate the accuracy of the information provided to each AR headset and system that rely on GPS coordinates or metering systems.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-014	**Requirement:** Functional
Description: Loading the procedure maps	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale:	

The AR application needs to emulate and render, the physical environment of the ship. This includes obstacles and walls coordinates, rooms and hallways dimensions but also doors and windows positions	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Realistic representation of the vessel blueprint will dictate the accuracy of the information provided to each AR headset and system that rely on GPS coordinates or metering systems.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-015	**Requirement:** Functional
Description: Loading the contextual help	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: The AR application needs to emulate and render, the physical environment of the ship. This includes obstacles and walls coordinates, rooms and hallways dimensions but also doors and windows positions	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Realistic representation of the vessel blueprint will dictate the accuracy of the information provided to each AR headset and system that rely on GPS coordinates or metering systems.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-016	**Requirement:** Functional
Description: Loading augmented reality temperature widget (that will appear on the user interface)	
Category: AR Glasses	**PALAEMON component:** AR Glasses

Rationale: Building a rich user interface that will provide all the information needed for the user, at any given time	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: Decision Support System - 001	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-017	**Requirement:** Functional
Description: Loading augmented reality alert messages widget (that will appear on the user interface)	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: Building a rich user interface that will provide all the information needed for the user, at any given time	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: PALAEMON INCIDENT MANAGEMENT MODULE - 001	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-018	**Requirement:** Functional
Description: Loading augmented reality AudioCall widget (that will appear on the user interface)	
Category: AR Glasses	**PALAEMON component:** AR Glasses

Rationale: Building a rich user interface that will provide all the information needed for the user, at any given time	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-019	**Requirement:** Functional
Description: Loading augmented reality Ship parameters widget (that will appear on the user interface)	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: Building a rich user interface that will provide all the information needed for the user, at any given time	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: SRAP-01, SRAP-03	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-020	**Requirement:** Functional
Description: Loading augmented reality Weather widget (that will appear on the user interface)	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: Building a rich user interface that will provide all the information needed for the user, at any given time	
Priority: MUST	**Originator:** SIMAVI

Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: Decision Support System - 005	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-021	**Requirement:** Functional
Description: AR Technology provides a “first-person” perspective and enables users to explore the physical environment with simultaneously over imposed digital content;	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: AR Glasses application assists and provide crewmembers with essential digital information regarding evacuation procedures throughout a realistic environment;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Optimal communication with other system components	**Conflicts:** AR devices cannot be worn over any type of glasses; however, the suppliers have partnered with Frames Direct to offer a Prescription Insert designed to work seamlessly with the given AR device.
Stakeholder(s) / Users: Crew	

ID: AR-023	**Requirement:** Functional
Description: The main goal of the AR application is to provide a visual guidance and instructions to the crewmembers to follow the evacuation plan	
Category: AR Glasses	**PALAEMON component:** AR Glasses
Rationale: The vital information that will help the intervention team will include evacuation tactics guidelines, environment details but also passenger’s condition	
Priority: MUST	**Originator:** SIMAVI

Dependencies: SMART_BRACELET-009 SRAP-03 PALAEMON INCIDENT MANAGEMENT MODULE - 003	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-024	**Requirement:** Functional
Description: The application will be able to provide real-time text communication between the crewmembers	
Category: AR Glasses/Communication	**PALAEMON component:** AR Glasses
Rationale: In order to better support and organise the evacuation procedures the crewmembers will be able to communicate with each other in real-time, therefore enhancing the coordination factor.	
Priority: MUST	**Originator:** SIMAVI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-025	**Requirement:** Functional
Description: The application will be able to provide real-time audio communication between the crewmembers	
Category: AR Glasses/Communication	**PALAEMON component:** AR Glasses
Rationale: In order to better support and organise the evacuation procedures the crewmembers will be able to communicate with each other in real-time, therefore enhancing the coordination factor.	
Priority: MUST	**Originator:** SIMAVI
Dependencies:	**Conflicts:** no conflict identified at this point

Stakeholder(s) / Users:
Crew

ID: AR-026	**Requirement:** Functional
Description: The application will be able to provide real-time video communication between the crewmembers	
Category: AR Glasses/Communication	**PALAEMON component:** AR Glasses
Rationale: In order to better support and organise the evacuation procedures the crewmembers will be able to communicate with each other in real-time, therefore enhancing the coordination factor.	
Priority: MUST	**Originator:** SIMAVI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-027	**Requirement:** Functional
Description: Each crew member will be able to visualise system information of the current evacuation plan, crewmembers or passenger's condition but also guidance messages from Decision Support System.	
Category: AR Glasses/Communication	**PALAEMON component:** AR Glasses
Rationale: This feature will enable crewmembers to better coordinate and synchronize actions and decisions.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Decision Support System - 005 SMART_BRACELET-007 SMART_BRACELET-009	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-028	**Requirement:** Functional
Description: The application will provide real-time information about the position of each crew member on the vessel's map;	
Category: AR Glasses/Communication/Localization	**PALAEMON component:** AR Glasses
Rationale: This functionality can be used for a better team management and staff deployment to certain areas on the vessel. For example, the Master can choose to send, recall or relocate staff based on their real-time location.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: SMART_BRACELET-007 SMART_BRACELET-009	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew; Master; Bridge Command Team	

ID: AR-029	**Requirement:** Functional
Description: The application will be able to provide real-time information regarding passenger's concentration on the vessel's map;	
Category: AR Glasses/Communication/Localization	**PALAEMON component:** AR Glasses/Bracelets
Rationale: This functionality will help to successfully assess location, volume and direction of groups or individuals, enabling for agile evacuation procedures.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: GPS coordinates of the passengers from the servi	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew; Master; Bridge Command Team	

ID: SMART_BRACELET-001	**Requirement:** Functional
Description: SB connectivity to PALAEMON system is supported by 5G/ Radio Dot Network	
Category: Communications	**PALAEMON component:** Smart Bracelet
Rationale: ship networking connection	
Priority: MUST	**Originator:** ADV
Dependencies:	**Conflicts:** pending assessment
Stakeholder(s) / Users: Passengers and Crew members	

ID: VDES_001	**Requirement:** Functional
Description: VDES transceiver shall not support the satellite link	
Category: Communications	**PALAEMON component:** VDES transceiver
Rationale: Satellite link is out of the scope of PALAEMON project.	
Priority: SHOULD NOT	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_002	**Requirement:** Functional
Description: VDES transceiver shall support VHF terrestrial communications	
Category: Communications	**PALAEMON component:** VDES transceiver
Rationale: Terrestrial link is the core of VDES activities within PALAEMON project.	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PALAEMON-platform-008	**Requirement:** Functional
Description: System redundancy	
Category: Deployment	**PALAEMON component:** ALL
Rationale: To prevent potential system outages, PALAEMON system should be replicated / have a redundant deployment that comes to the foreground in case of sudden system halt.	
Priority: MUST	**Originator:** Stakeholders (D2.2)
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: PALAEMON-platform-010	**Requirement:** Functional
Description: Component logging	
Category: Deployment	**PALAEMON component:** ALL
Rationale: All components should record all their underlying loggin, for the sake of, on the one hand, help spot potential misbehaviours; on the other hand, keep track of user(s) actions and shape a historical recording of their commands	
Priority: SHOULD	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team; system developers; technology providers;	

ID: PALAEMON-platform-011	**Requirement:** Functional
Description: Log (e.g., file, audio, video) all actions for post-incident analysis	
Category: Deployment	**PALAEMON component:** ALL
Rationale:	

Upon the emergency flag is hoisted, all multimedia streams from PALAEMON components (e.g., AR glasses, Smart Cameras, etc.) should record their activities.	
Priority: SHOULD	**Originator:** ATOS
Dependencies: PALAEMON-platform-010	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team; system developers; technology providers;	

ID: PALAEMON-Evacuation-Coordinator-001	**Requirement:** Functional
Description: Digitalization of the ship evacuation status (i.e., normal operation, situation awareness, alarm, mustering, embarking, evacuation)	
Category: Deployment	**PALAEMON component:** PEC
Rationale: The PALAEMON Evacuation Coordination has, as primary task, to map in real-time, the current evacuation status of the ship. Namely, this means that all master's commands generated at the bridge have to be translated and uipdated accordingly	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers	

ID: PaMEAS_001	**Requirement:** Functional
Description: Passenger accurate positioning output	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: The System will provide accurate location positioning information to ship management for passengers and crew	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Technology providers

ID: PaMEAS_002	**Requirement:** Functional
Description: Location positioning cost/accuracy enhancement	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: The System will improve the location positioning cost (Network Access Points coverage)/accuracy curve with the use of algorithmic functionality (e.g. machine learning etc.)	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PaMEAS_004	**Requirement:** Functional
Description: Indoor positioning full operation (evacuation status)	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: The system works in full operation mode in emergency situations and during ship evacuation to offer indoor real-time location positioning-on-demand”	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PaMEAS_006	**Requirement:** Functional
Description:	

PaMEAS service outputs	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: Based on the collected positioning information, the System: - Returns emergency navigation information to passengers (in the form of alerts, notifications and navigation instructions) - Manages a connected IoT signaling infrastructure for evacuation (such as emergency led indicators pointing to safe evacuation routes etc.)	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PaMEAS_007	**Requirement:** Functional
Description: PaMEAS privileged interaction extra features	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: The System establishes “privileged interaction” (through notifications) and direct high bandwidth video links with crew members and, eventually, with “passengers-in-danger” whenever this is possible	
Priority: SHOULD	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PaMEAS_008	**Requirement:** Functional
Description: PaMEAS flow management extra features	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS

Rationale: The System provides detailed “flow management” functionality for passengers, crew and rescue teams (i.e., use the location data of people to distinguish between people in a safe situation and persons-in-danger, by defining for each of them a level of risk...)	
Priority: SHOULD	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PaMEAS_009	**Requirement: Functional**
Description: PaMEAS aggregate visualization	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale: The System offers visualization at an aggregate level of evolution of an emergency plan in real time, as far as mustering and evacuation processes are regarded – including people counting	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_003	**Requirement:** Functional
Description: VDES shall operate in VHF band, following frequency plan specified in IALA G1139 document	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: In order to guarantee compliance to VDES standard frequency plan.	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Technology providers

ID: VDES_004	**Requirement:** Functional
Description: VDES transceiver shall transmit with a power within the range 1÷12.5 W, as specified in IALA G1139 document	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: In order to guarantee compliance to VDES standard transmit power.	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_005	**Requirement:** Functional
Description: VDES transceiver shall be able to receive an analogue signal at VHF frequencies, extract digital information and deliver digital data (bits) to PALAEMON platform	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: VDES transceiver output to PALAEMON platform	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_006	**Requirement:** Functional
Description:	

VDES transceiver shall be able to receive digital inputs (bits) from PALAEMON platform, encapsulate them in the VDES packet and transmit them at VHF frequencies.	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: VDES transceiver input from PALAEMON platform	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_007	**Requirement:** Functional
Description: VDES transceiver should be synchronized with UTC time.	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: UTC minute coincides with a VDES frame. The availability of UTC time in the VDES transceiver simplifies the SW waveform.	
Priority: SHOULD	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_008	**Requirement:** Functional
Description: VDES transceiver shall support AIS, ASM and VDE data channels.	
Category: Individual component (VDES)	**PALAEMON component:**
Rationale: In order to guarantee compliance to VDES standard data channels/services	
Priority: SHALL	**Originator:** WIS/TI

Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_007	**Requirement:** Functional
Description: Accoustic sensors output	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale: Acoustic Emission sensors will read signals from steel structure of ship and offer information on developing defects (cracks)	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_008	**Requirement:** Functional
Description: Motion sensors output	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale: SHM Motion sensors output: - List and trim angles of ship - Rate of change of ship angles - Deflection of ship (quasistatic and dynamic)	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_009	**Requirement:** Functional
Description: SHM asynchronous output	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale: SHM will offer alarms to PALAEMON core when critical values are exceeded	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SMART_CAMERAS_UAH-005	**Requirement:** Functional
Description: Each camera must have defined the surveillance area where people is counted (installation step).	
Category: Installation	**PALAEMON component:** Smart Cameras
Rationale: Installation requirement	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-006	**Requirement:** Functional
Description: To install the smart camera a developed GUI must be used to configure the video processing and control all the features	
Category: Installation	**PALAEMON component:** Smart Cameras
Rationale: Installation requirement	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point

Stakeholder(s) / Users:

ID: PALAEMON-platform-009	**Requirement:** Functional
Description: Subscription to PALAEMON Evacuation Coordinator Notifications	
Category: Integration	**PALAEMON component:** ALL
Rationale: All components (i.e., with behavioral dependency on the ship evacuation status) must be aware of the current ship state machine, managed by the PALAEMON Evacuation Coordinator	
Priority: MUST	**Originator:** ATOS
Dependencies: SMART_BRACELET-002	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: PALAEMON-Evacuation-Coordinator-003	**Requirement:** Functional
Description: Component situation awareness	
Category: Integration	**PALAEMON component:** PEC
Rationale: Communication between components should be carried out via Kafka topics. The PALAEMON Evacuation Coordinator will keep track of the main updates generated by the underlying components.	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: AR-001	**Requirement:** Functional
Description:	

The AR application will have an intuitive user interface that can be easily learned.	
Category: Integration	**PALAEMON component:** AR glasses
Rationale: The rationale for this requirement is that the application will be used by any crew member with varying capabilities	
Priority: SHOULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-002	**Requirement:** Functional
Description: The AR application will have a training tutorial embedded that will clearly explain each section of the interface and its functions.	
Category: Integration	**PALAEMON component:** AR glasses
Rationale: The rationale for this requirement is that the application will be used by any crew member	
Priority: SHOULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: Decision Support System - 002	**Requirement:** Functional
Description: The DSS will generate alerts and suggestions on action to be taken during an incident on dedicated dashboard.	
Category: Integration	**PALAEMON component:** DSS
Rationale:	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: Decision Support System - 003	**Requirement:** Functional
Description: The DSS will receive information from other modules and use that to produce a helpful output for decisions to be taken.	
Category: Integration	**PALAEMON component:** DSS
Rationale:	
Priority: MUST	**Originator:** KT
Dependencies: T3.3, T3.4, T3.5, T6.1, T6.2	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: SMART_CAMERAS_UAH-001	**Requirement:** Functional
Description: Communication system with enough bandwidth to transmit the information at the intended data rate	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Establish the type of communication	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-003	**Requirement:** Functional
Description: There will be only one service entry point (e.g. Kafka) to communicate results, information, images and videos	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Establish the type of communication	

Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-004	**Requirement:** Functional
Description: The format, coding, size, and other configurable parameters of the data communication must be done prior to operation in a previous configuration stage.	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Establish the type of communication	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-007	**Requirement:** Functional
Description: The server will have enough data capabilities to store the information sent without asking for retransmission.	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: HW requirements of other components	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-008	**Requirement:** Functional
Description: The processing platform will provide information periodically according to a given format and communication protocol	

Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Define the format of information to be send, where and when.	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-009	**Requirement:** Functional
Description: The processing platform will provide information by demand according to a given format and communication protocol	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Define the format of information to be send, where and when.	
Priority: COULD	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-010	**Requirement:** Functional
Description: The processing platform will send an alert when detecting anomalies in the people flow or coverage area of people in the surveillance area.	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: Define the format of information to be send, where and when.	
Priority: COULD	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_JOAFG_01	**Requirement:** Functional

Description: Automatic flow speed of people on the floor to estimate evacuation time	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_BRACELET-002	**Requirement:** Functional
Description: SB positioning info/data will be extracted from 5G/ Radio Dot Network connectivity and routing parmeters	
Category: Integration	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS input paremeters (SB connection/routing/tracking info) are generated by 5G/Radio Dot network	
Priority: MUST	**Originator:** ADV
Dependencies:	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

ID: SMART_BRACELET-003	**Requirement:** Functional
Description: SB positioning info/data will be extracted from 5G/ Radio Dot Network server	
Category: Integration	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS input paremeters (SB connection/routing/tracking info) are generated by 5G/Radio Dot network	
Priority: MUST	**Originator:** ADV
Dependencies:	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

ID: SMART_BRACELET-004	**Requirement:** Functional
Description: SB positioning info/data (5G/ Radio Dot Network connectivity and routing parmeters) will be processed by PaMEAS	
Category: Integration	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS input paremeters (SB connection/routing/tracking info) are generated by 5G/Radio Dot network	
Priority: MUST	**Originator:** ADV
Dependencies:	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

ID: SMART_BRACELET-005	**Requirement:** Functional
Description: SB localization/tracking info will be generated by PaMEAS	
Category: Integration	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS localization and evacuation services	
Priority: MUST	**Originator:** ADV
Dependencies: 5G/RadioDot Network operation server / PaMEAS logic (T5.4)	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

ID: SMART_BRACELET-006	**Requirement:** Functional
Description: data model/format must be defined to encapsule SB sensor readings	
Category: Integration	**PALAEMON component:** Smart Bracelet
Rationale: TBD	
Priority: MUST	**Originator:** ADV
Dependencies: PALAEMON data models /Kafka comp.	**Conflicts:** pending assessment

Stakeholder(s) / Users:

ID: SSS - 002	**Requirement:** Functional
Description: Evacuation information are shared between SSS units	
Category: Integration	**PALAEMON component:** SSS
Rationale: Gives an overview over the actual process and situation of the evacuation	
Priority: MUST	**Originator:** JU
Dependencies: Ships legacy system (network)	**Conflicts:** None
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: SSS - 003	**Requirement:** Functional
Description: SSS should share information with other PALAEMON systems	
Category: Integration	**PALAEMON component:** SSS
Rationale:	
Priority: COULD	**Originator:** JU
Dependencies: Conection with other PALAEMON Systems	**Conflicts:** None
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: SMS_01	**Requirement:** Functional
Description: SMS will populate order of predefined safety procedures against an emergeny and following master call for action	
Category: Integration	**PALAEMON component:** SMS
Rationale:	

Populates the order of associated safety actions crew should take to respond to an emergency on-board	
Priority: MUST	**Originator:** DANAOS
Dependencies: Conection with DSS and PIMM	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master, Crew	

ID: PALAEMON-Evacuation-Coordinator-002	**Requirement:** Functional
Description: Evacuation status switch notification	
Category: Interfaces	**PALAEMON component:** PEC
Rationale: Every transition between states will be notified (via Kafka streaming) to all subscribed components	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: DFB-5	**Requirement:** Functional
Description: Provision of common interface for data input in PALAEMON Core (Kafka subscribe/consumer, mqtt)	
Category: Interfaces	**PALAEMON component:** DFB
Rationale: Providing common interfaces for data input in the platform	
Priority: MUST	**Originator:** ITML
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: DFB-6	**Requirement:** Functional
Description: REST api: Provision of interface for retrieving historical data from PALAEMON Core and performing queries	
Category: Interfaces	**PALAEMON component:** DFB
Rationale: Providing common interface for data quering in the platform	
Priority: MUST	**Originator:** ITML
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SRAP-04	**Requirement:** Functional
Description: Risk level indication regarding the condition of the ship or part of the ship (e.g. vertical zones) and the progress of the mustering process that will trigger the DSS	
Category: Intergration/Operation	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: SRAP will provide a risk-based criterion that will signal the DSS to provide specific recommendations to the Master	
Priority: MUST	**Originator:** NTUA
Dependencies: DSS, PIMM	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: UAV-1	**Requirement:** Functional
Description: The UAV will provide automatic flight modes to ease safely navigating around the ship	
Category: Navigability	**PALAEMON component:** UAV
Rationale: Manually flying a drone around a ship in movement can be complicated for a human operator, especially considering parralax and distance appreciation.	

Priority: MUST	**Originator:** ADS
Dependencies: Ship's coordinates and attitude	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: UAV-3	**Requirement:** Functional
Description: The UAV will provide automatic search patterns and inspection	
Category: Navigability	**PALAEMON component:** UAV
Rationale: In case of MOB (Man Over Board) or rescue situation, the UAV needs to enter search mode and scan the most surface in the search area to provide extensive camera feedback	
Priority: MUST	**Originator:** ADS
Dependencies: Ship's coordinates and attitude	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: UAV-2	**Requirement:** Functional
Description: The UAV will automatically adapt its position/flight in order to obtain required camera angles	
Category: Observation	**PALAEMON component:** UAV
Rationale: The operator will need to inspect specific areas around the ship, so the system have be able to point a camera on them (e.g. Man Over Board situation, damage inspection)	
Priority: MUST	**Originator:** ADS
Dependencies: Ship's coordinates and attitude	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: UAV-4	**Requirement:** Functional
Description: The UAV system shall be able to approximately locate a place pointed by an operator from the camera stream	
Category: Observation	**PALAEMON component:** UAV
Rationale: In case of MOB, the ground station operator might locate the individual to rescue on the camera stream. The system shall then approximate location information necessary to send a MEV to the location.	
Priority: MUST	**Originator:** ADS
Dependencies: Ship's coordinates and attitude	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: PALAEMON-platform-007	**Requirement:** Functional
Description: The system must work even under extreme/adverse conditions	
Category: Operation	**PALAEMON component:** ALL
Rationale: Even though regular ICT infrastructures are not conceived to work under extreme conditions, the particularities of the scenario (i.e., ship) makes of utmost relevance to guarantee the correct operation of the system at any circumstance	
Priority: MUST	**Originator:** Stakeholders (D2.2)
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: SMART_BRACELET-007	**Requirement:** Functional
Description: SB will provide periodically readings from the body sensors attached (i.e., HR. BP, Temp)	
Category: operation	**PALAEMON component:** Smart Bracelet

Rationale: health/bio-sensors	
Priority: MUST	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-008	**Requirement:** Functional
Description: SB will receive evacuation instructions/ escape route information from PaMEAS in case of emergency (sequence of msg)	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS localization and evacuation services	
Priority: MUST	**Originator:** ADV
Dependencies: 5G/RadioDot Network operation server / PaMEAS logic (T5.4)	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-009	**Requirement:** Functional
Description: SB will provide periodically readings from the GPS module attached	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: only outdoor (deck/MOB)	
Priority: MUST	**Originator:** ADV
Dependencies: satellite	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-010	**Requirement:** Functional
Description: SB will detect falls based on accelerometer & gyroscope readings	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: fall detection	
Priority: MUST	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-011	**Requirement:** Functional
Description: SB will notify events (automated fall-detection)	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: alarm	
Priority: MUST	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-012	**Requirement:** Functional
Description: SB will notify events (user triggered alarm -emergency button-)	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: alarm	
Priority: MUST	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

passenger / crew

ID: SMART_BRACELET-013	**Requirement:** Functional
Description: evacuation route msg will be displayed by the SB (test/signs)	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS localization and evacuation services	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware + PaMEAS	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-014	**Requirement:** Functional
Description: evacuation route msg will be played by the SB (audio)	
Category: operation	**PALAEMON component:** Smart Bracelet
Rationale: PaMEAS localization and evacuation services	
Priority: COULD	**Originator:** ADV
Dependencies: SB HW & firmware + PaMEAS	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SRAP-01	**Requirement:** Functional
Description: Provide risk level indication regarding the condition of the ship or part of the ship (e.g. vertical zones) after an incident occurrence	

Category: Operation	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: To assist the Master to decide whether to start the mustering process during the initial assessment after an incident has occurred	
Priority: MUST	**Originator:** NTUA
Dependencies: Data input: Ship legacy systems, Structural Health Monitoring Toolkit, Stability Toolkit, Weather Toolkit, MEV. Data output: DSS	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: SRAP-02	**Requirement:** Functional
Description: Provide risk level indication regarding the progress of the mustering process to take any additional actions (if necessary)	
Category: Operation	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: To support the Master (and Bridge/Command Team) in monitoring the mustering process	
Priority: MUST	**Originator:** NTUA
Dependencies: Data input: Ship legacy systems, Structural Health Monitoring Toolkit, SSS, Stability Toolkit, PaMEAS, MEV.	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master/Bridge Command Team)	

ID: SRAP-03	**Requirement:** Functional
Description: Provide risk level indication regarding ship abandonment	
Category: Operation	**PALAEMON component:** Smart Risk Assessment Platform

Rationale: To assist the Master to decide whether to order the abandonment of the ship	
Priority: MUST	**Originator:** NTUA
Dependencies: Data input: Ship legacy systems, Structural Health Monitoring Toolkit, SSS, Stability Toolkit, PaMEAS, MEV.	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: VR-001	**Requirement:** Functional
Description: crew members will be able to create user accounts	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This is designed to ensure safety of: login; user information and data.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-002	**Requirement:** Functional
Description: crew members will need to login by using authentication interface	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This functionality will allow for safe and secure acces into the application.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Crew/Trainees

ID: VR-003	**Requirement:** Functional
Description: crew members will be able to customize their user profile	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: Each lerner profile is unique therefore users have the ability to customise them based on their specific characteristics: rank, role, responsibilites, tasks, etc.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-004	**Requirement:** Functional
Description: The application will include an authoring tool to create simple scenarios	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This feature will enable development of various scenarious that can cover a multitude of situations and risks.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-007	**Requirement:** Functional
Description: The application will allow the users to free roam within each part of the VR world	

Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This option will enhance the simulation factor but will also push the scenarios as close as possible to reality.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-008	**Requirement:** Functional
Description: User interface will display information similar to the one received by actual sensors or systems (information may change from one scenario to another)	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This functionality will be vital in launching the exercises as various scenarious will have different characteristics; conditions and data	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-009	**Requirement:** Functional
Description: The users will be able to receive all the information about the summary for a scenario before starting the simulation	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This requirement will provide the much needed briefing before the exercises.Much of the simulation success will be linked to this phase.	

Priority: SHOULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-011	**Requirement:** Functional
Description: The metrics will have a special section within the application to display all data collected through graphical reports	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: Data projection and dashboards would help asses the impact of various metrics and therefore will support potential adjustments.	
Priority: COULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-006	**Requirement:** Functional
Description: The application will allow download of virtual 3D environments depending on the scenario type	
Category: PALAEMON Academy/Communication	**PALAEMON component:** PALAEMON Academy
Rationale: 3D environments will be vital as they have the ability to replicate as much as possible complex ship environments.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-010	**Requirement:** Functional
Description: The application will send all relevant data (reports, progress, customizations) to LMS/LRS server	
Category: PALAEMON Academy & LRS/LMS	**PALAEMON component:** PALAEMON Academy
Rationale: This feature will enable collection of relevant data for the analysis; maintenance and improvement of the scenarious and exercises.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Communication with LMS/LRS server.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: DFB-3	**Requirement:** Functional
Description: Health Monitoring of PALAEMON Core infrustructure (Kafka, Elasticsearch, Shared FS)	
Category: Performance	**PALAEMON component:** DFB
Rationale: DFB must provide monitoring of its core infrastructure because of its criticality	
Priority: MUST	**Originator:** ITML
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: DFB-4	**Requirement:** Functional
Description: Monitoring of PALAEMON Core usage (load metrics, throughput per Kafka topic/consumer/producer, disk usage)	
Category: Performance	**PALAEMON component:** DFB
Rationale:	

DFB must provide monitoring of its core infrastructure because of its criticality	
Priority: MUST	**Originator:** ITML
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 002	**Requirement:** Functional
Description: The PIMM will have an interface for managing some of the modules of the PALAEMON ecosystem, and will be the first component issuing an evacuation order. Subsequent components will feature their own management interfaces.	
Category: PIMM Main Function	**PALAEMON component:** PIMM
Rationale: As it's an incident management module, this will be one of the main features.	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Captain/Bridge	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 003	**Requirement:** Functional
Description: The PIMM will integrate and provide a user interface for managing and monitoring the On-Board Decision Support System.	
Category: PIMM Main Function	**PALAEMON component:** PIMM
Rationale: As it's an incident management module, this will be one of the main features.	
Priority: MUST	**Originator:** KT
Dependencies: On-Board Decision Support System	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master/Bridge	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 004	**Requirement:** Functional
Description: The PIMM will integrat and provide a user interface for managing and monitoring the WFT (Weather Forecast Toolkit)	
Category: PIMM Main Function	**PALAEMON component:** PIMM
Rationale: As it's an incident management module, this will be one of the main features.	
Priority: MUST	**Originator:** KT
Dependencies: Weather Forecast Toolkit	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master/Bridge	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 005	**Requirement:** Functional
Description: The PIMM will integrate with the main PALAEMON Single Sign On (SSO) Service and the user will be authenticated by it.	
Category: PIMM Main Function	**PALAEMON component:** PIMM
Rationale: The PIMM should use the central authentication system and not require a separate user management system in place.	
Priority: MUST	**Originator:** KT
Dependencies: PALAEMON Single Sign On Service	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master/Bridge	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 006	**Requirement:** Functional
Description:	

The PIMM will integrate notifications from the DSS and the WFT.	
Category: PIMM Main Function	**PALAEMON component:** PIMM
Rationale: This feature will notify the captain and the bridge for various sub-incidents relating to the WFT and the DSS.	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master/Bridge	

ID: PALAEMON-platform-018	**Requirement:** Functional
Description: User-based role access	
Category: Security and Authentication	**PALAEMON component:** ALL
Rationale: Different stakeholders (e.g., system administrator, master, bridge crew members, passengers, etc.) must have different rights in the eyes of the PALAEMON system	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: AR-003	**Requirement:** Functional
Description: New members can create their own accounts and the user data will be validated to make sure there are no other users with the same credentials. Therefore, each user will be associated with a unique ID and user role	
Category: Security and Authentication	**PALAEMON component:** ALL
Rationale: The application can only be used by registered users	
Priority: MUST	**Originator:** SIMAVI

Dependencies: The user ID will be synchronized with the bracelets ID	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-004	**Requirement:** Functional
Description: Crewmembers will be logged into the AR application by using authentication interface, only authorized users will be allowed to use the application	
Category: Security and Authentication	**PALAEMON component:** ALL
Rationale: For safety and security purposes, the application can only be used by registered users	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Depends on the previous requirement (each user will need to have an account)	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: WEATHER FORECAST TOOLKIT-003	**Requirement:** Functional
Description: New members can create their own accounts and the user data will be validated to make sure there are no other users with the same credentials. Therefore, each user will be associated with a unique ID and user role	
Category: Security and Authentication	**PALAEMON component:** WFT
Rationale: The application can only be used by registered users.	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: WEATHER FORECAST TOOLKIT-004	**Requirement:** Functional
Description: Crewmembers will be logged into the WFT application by using authentication interface, only authorized users will be allowed to use the application.	
Category: Security and Authentication	**PALAEMON component:** WFT
Rationale: For safety and security purposes, the application can only be used by registered users.	
Priority: MUST	**Originator:** KT
Dependencies: Depends on the previous requirement (each user will need to have an account).	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Master	

ID: DFB-7	**Requirement:** Functional
Description: Authentication/authorisation for data input/output: Kafka ACLs per topic, client credentials management for REST service	
Category: Security and Authentication	**PALAEMON component:** DFB
Rationale: Providing PALAEMON Core security mechanisms	
Priority: MUST	**Originator:** ITML
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: Decision Support System - 004	**Requirement:** Functional
Description: Each memeber will have it's own user account according to the role they hold.	
Category: Security and Authentication	**PALAEMON component:** DSS
Rationale:	
Priority: SHOULD	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point

Stakeholder(s) / Users:
Bridge, Master, Crew

ID: Decision Support System - 005	**Requirement:** Functional
Description: Ship Stability Toolkit will recieve weather information and deliver to the DSS	
Category: Services	**PALAEMON component:** DSS
Rationale: Provides an overview of the actual floating condition of the ship.	
Priority: COULD	**Originator:** JU
Dependencies: Connection with other PALAEMON Systems	**Conflicts:** None
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: SMS_03	**Requirement:** Functional
Description: SMS will offer a workflow engine for document management	
Category: Services	**PALAEMON component:** SMS
Rationale: Circulate documents to users with different level of authority for review, revision and approval in case of amendments/updates	
Priority: SHOULD	**Originator:** DANAOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master, Crew, Office	

ID: SMS_04	**Requirement:** Functional
Description: SMS will offer an interface to user to create dynamic electronic checklists	

Category: Services	**PALAEMON component:** SMS
Rationale: Create order of safety actions and associate/group procedures with responsible crew member	
Priority: COULD	**Originator:** DANAOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master, Crew, Office	

ID: WEATHER FORECAST TOOLKIT-001	**Requirement:** Functional
Description: The WFT (WEATHER FORECAST TOOLKIT) application will have an intuitive user interface that can be easily learned. Moreover, the application comes with a tutorial that will clearly explain each section of the interface and its functions.	
Category: Usability	**PALAEMON component:** WFT
Rationale: The rationale for this requirement is that the application will be used by any crew member with varying capabilities.	
Priority: SHOULD	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Master	

ID: PALAEMON INCIDENT MANAGEMENT MODULE - 001	**Requirement:** Functional
Description: The PALAEMON Incident Management Module (PIMM) will have an intuitive user interface that can be easily learned. Moreover, the application comes with a tutorial that will clearly explain each section of the interface and its functions.	
Category: Usability	**PALAEMON component:** PIMM
Rationale: The rationale for this requirement is that the application will be used by any crew member with varying capabilities.	

Priority: SHOULD	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master/Bridge	

ID: AR-022	**Requirement:** Functional
Description: Each participant will be able to see on its user interface all the messages received from the connected system components;	
Category: Visualization	**PALAEMON component:** AR Glasses
Rationale: This functionality will be used for ensuring good tasks execution within the evacuation plan;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: PALAEMON INCIDENT MANAGEMENT MODULE - 003, Decision Support System - 005, WEATHER FORECAST TOOLKIT-006, PALAEMON-platform-009	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: UAV-5	**Requirement:** Functional
Description: The System should provide give the option to the crew to manually pilot the UAV	
Category: Visualization	**PALAEMON component:** UAV
Rationale: In emergency situation, the operator might need to operate the UAV beyond its flight planning capabilities, to the point where he might endanger the UAV.	
Priority: MUST	**Originator:** ADS
Dependencies: n/a	**Conflicts:** no conflict identified at this point

Stakeholder(s) / Users:
Crew

ID: UAV-6	**Requirement:** Functional
Description: The system will provide a GCS (Ground Control Station) to operate the UAV, make plan flights and monitor the flight	
Category: Visualization	**PALAEMON component:** UAV
Rationale: The operator needs an interface to set up flight plans for the UAV and monitor the mission.	
Priority: MUST	**Originator:** ADS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: Decision Support System - 001	**Requirement:** Functional
Description: The DSS will include a user interface that will display it's outcome that will be provided from the PIMM (PALAEMON Incident Management Module)	
Category: Visualization	**PALAEMON component:** PIMM
Rationale:	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: SSS - 001	**Requirement:** Functional
Description: SSS will include a graphic user interface, which will display information for evacuation	
Category: Visualization	**PALAEMON component:** SSS

Rationale: Reduce VHF communication by graphic presentation during evacuation	
Priority: MUST	**Originator:** JU
Dependencies: n/a	**Conflicts:** None
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: WEATHER FORECAST TOOLKIT-002	**Requirement:** Functional
Description: The WFT application will have a user interface that allows the users to identify the correlation between the weather conditions at the time of the incident and the evacuation plan/actions.	
Category: WFT Usability	**PALAEMON component:** WFT
Rationale: The rationale for this requirement is that the application will be used by any crew member with varying capabilities.	
Priority: MUST	**Originator:** KT
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Master	

ID: WEATHER FORECAST TOOLKIT-005	**Requirement:** Functional
Description: The WFT application will send to the DSS a correlation index during an incident among the weather conditions and the evacuation plan.	
Category: WFT Usability	**PALAEMON component:** WFT
Rationale: This usability will help the DSS to suggest actions. The correlation index takes values from 0-1, if this value is close to 1 this indicates very strong correlation among the weather conditions and the evacuation plan.	
Priority: MUST	**Originator:** KT

Dependencies: Depends on evacuation plans/protocols (e.g., ANEK).	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Master	

ID: WEATHER FORECAST TOOLKIT-006	**Requirement:** Functional
Description: The WFT application will send to the DFB weather data.	
Category: WFT Usability	**PALAEMON component:** DFB
Rationale: This usability will provide the PALAEMON's components with weather data.	
Priority: MUST	**Originator:** KT
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Master	

ID: SMS_02	**Requirement:** Funtional
Description: SMS will digitize and support control of documented safety procedures under company's safety management policy	
Category: Services	**PALAEMON component:** SMS
Rationale: Filing of manuals, safety checklists, policies etc. Allows document revision and versioning	
Priority: MUST	**Originator:** DANAOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master, Crew, Office	

II.2 Non-functional

ID: LMS/LRS-001	**Requirement:** Non-functional

Description: The application will be able to send to a designated LMS/LRS server, all the relevant information during the evacuation mission on the vessel;	
Category: AR & LRS/LMS	**PALAEMON component:** LRS/LMS
Rationale: Based on the findings of the first missions, future initiatives could be continuously improved in terms of project size, scenarios, applications, etc.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Communication with LMS/LRS server.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew; Master; Bridge Command Team	

ID: PALAEMON-platform-004	**Requirement:** Non-functional
Description: Communication infrastructure	
Category: Communications	**PALAEMON component:** ALL
Rationale: The ship (and intrinsically, the PALAEMON system) will offer all the communication interfaces (e.g., Ethernet, WiFi, LTE/5G, etc.) required by the different components of the platform.	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: PALAEMON-platform-006	**Requirement:** Non-functional
Description: Dedicated displays/monitors to show Graphical User Interfaces (GUIs) in the bridge	
Category: Deployment	**PALAEMON component:** PIMM, SSS, PAMEAS, etc.
Rationale:	

Apart from the legacy displays/monitors that can be seen in a real scenario (e.g. AIS, etc.), some of the PALAEMON components do require to (graphically) present their outputs in the bridge in order to support the Master's decision, centralize crew's acti	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master; Bridge Command Team	

ID: PALAEMON-platform-020	**Requirement:** Non-functional
Description: Micro-service oriented architecture	
Category: Deployment	**PALAEMON component:** ALL
Rationale: Follow a micro-service architecture (e.g., Docker-like images), together with a Platform Orchestrator (e.g., Kubernetes or similar) will lead to a common and widespread software development methodology	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team; system developers	

ID: PALAEMON-platform-021	**Requirement:** Non-functional
Description: Easy-to-deploy and scale the whole PALAEMON platform	
Category: Deployment	**PALAEMON component:** ALL
Rationale: Thanks to the way the architecture has been designed, the whole PALAEMON platform must be straightforwardly replicated and managed	
Priority: MUST NOT	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: DFB-2	**Requirement:** Non-functional
Description: DFB must provide redudancy mechanisms for stored data	
Category: Deployment	**PALAEMON component:** DFB
Rationale: DFB should have redundancy mechanisms for avoiding data loss in case of hardware failure	
Priority: SHOULD	**Originator:** ITML
Dependencies: Ship's infrastructure (multiple servers in cluster	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: JOAFG-1	**Requirement:** Non-functional
Description: Skinfriendly material of wristband	
Category: Individual component	**PALAEMON component:** Smart Bracelet
Rationale:	
Priority: MUST	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew; Passengers	

ID: JOAFG-2	**Requirement:** Non-functional
Description: Multiple usage needed to guarantee wearing	
Category: Individual component	**PALAEMON component:** Smart Bracelet
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Passengers

ID: JOAFG-3	**Requirement:** Non-functional
Description: Information about usage of drones needs to be provided to passengers	
Category: Individual component	**PALAEMON component:**
Rationale:	
Priority: MUST	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Passengers	

ID: JOAFG-4	**Requirement:** Non-functional
Description: GDPR conform data storage of movement patterns	
Category: Individual component	**PALAEMON component:** Smart Bracelet
Rationale:	
Priority: MUST	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Passengers	

ID: JOAFG-5	**Requirement:** Non-functional
Description: Clear and easy usage, no battery no maintainance	
Category: Individual component	**PALAEMON component:** Smart Bracelet
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Passengers

ID: JOAFG-6	**Requirement:** Non-functional
Description: Database on handicaps of passangers ready to allow better support during evacuation (mobility constraints)	
Category: Individual component	**PALAEMON component:** DSS
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: JOAFG-7	**Requirement:** Non-functional
Description: Adjust availability of evacuation support staff on deck according to mibility needs of passengers	
Category: Individual component	**PALAEMON component:** DSS
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Bridge, Master, Crew	

ID: PaMEAS_003	**Requirement:** Non-functional
Description: Indoor positioning partial operation (normal status)	
Category: Individual component (PaMEAS)	**PALAEMON component:** PaMEAS
Rationale:	

The system functions only partially in normal conditions and activates periodically for testing purposes (an activity that is constrained by PII data encryption requirements)	
Priority: MUST	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: JOAFG-8	**Requirement:** Non-functional
Description: Early warning for passengers to go to cabin and take necessities and utter most important belonglings like medication as precaution.	
Category: Individual component	**PALAEMON component:** DSS
Rationale:	
Priority: SHOULD	**Originator:** JOAFG
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: VDES_009	**Requirement:** Non-functional
Description: VDES transceiver should operate in accordance with the following priorities: Priority 1: (highest) AIS; Priority 2: ASM; Priority 3: VDE.	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: In order to guarantee compliance to VDES standard data services and their priorities.	
Priority: SHOULD	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_010	**Requirement:** Non-functional

Description: VDES transceiver shall transmit a maximum amount of data of 65 KB over VDE channels for single VDE session.	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: In order to select the most suitable applications within PALAEMON project to be transmitted over VDE channels.	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: VDES_011	**Requirement:** Non-functional
Description: VDES transceiver shall transmit a maximum amount of data of 1056 bits over ASM channels for single ASM session.	
Category: Individual component (VDES)	**PALAEMON component:** VDES transceiver
Rationale: In order to select the most suitable applications within PALAEMON project to be transmitted over ASM channels.	
Priority: SHALL	**Originator:** WIS/TI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_003	**Requirement:** Non-functional
Description: SHM configuration	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale:	

SHM will include a software with GUI for displaying for information	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_004	**Requirement:** Non-functional
Description: SHM to PALAEMON core communication	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale: SHM will connect with middleware through Kafka	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: SHM_006	**Requirement:** Non-functional
Description: SHM accousting sensor selective location	
Category: Individual components (SHM)	**PALAEMON component:** SHM
Rationale: SHM acoustic emission sensors will be placed on locations which are prone to cracking	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team, technology providers	

ID: PALAEMON-platform-001	**Requirement:** Non-functional
Description:	

The PALAEMON platform must work in a centralized manner (i.e., with all components physically hosted within the ship's premises)	
Category: Integration	**PALAEMON component:** ALL
Rationale: All the workload must be integrated in ship's premises, since we cannot rely on cloud-based solutions (e.g. latency, network breakdowns, etc.)	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: PALAEMON-platform-002	**Requirement:** Non-functional
Description: The integration and deployment of all components must work in the off-the-shelf hardware provided by the actual scenario(s)	
Category: Integration	**PALAEMON component:** ALL
Rationale: Legacy systems on a real ship might have limited computational capacity (e.g., storage, connectivity, memory, etc.). Nonetheless, the whole PALAEMON platform must fit and run smoothly regardless these limitations.	
Priority: MUST	**Originator:** ATOS / Stakeholders (D2.2)
Dependencies: PALAEMON-platform-001	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: PALAEMON-platform-003	**Requirement:** Non-functional
Description: Shipboard legacy systems complementarity	
Category: Integration	**PALAEMON component:** ALL
Rationale:	

PALAEMON System has not come to replace the legacy deployment and behavior of the ship operation; on the other hand, it has been designed to complement and support during the evacuation process. Besides, it introduces (and combines) new information source	
Priority: MUST	**Originator:** Stakeholders (D2.2)
Dependencies: PALAEMON-platform-016	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: PALAEMON-platform-017	**Requirement:** Non-functional
Description: Access to shipboard legacy systems	
Category: Integration	**PALAEMON component:** ALL
Rationale: Modern Ro-Ro and Ro-PAX vessels bring timely ICT-infrastructures, with sensors and actuators deployed throughout its decks. Besides, they manage additional static information (e.g., ship particulars, passengers and crew lists, ship blueprints, etc.) that	
Priority: SHOULD	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Ship owners; IT team; System developers	

ID: AR-008	**Requirement:** Non-functional
Description: The application must be able to flawlessly communicate with Ship Stability Toolkit (get data from Data Service bus), in order to assist and convey crewmembers the relevant information	
Category: Integration	**PALAEMON component:** ALL
Rationale: The other system components provide teams, information regarding on-going mustering; ship stability but also structural issues, thus, aiding them to safely guide all the passengers to the designated evacuation areas and MEVs;	
Priority: MUST	**Originator:** SIMAVI

Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: PALAEMON-platform-006, PALAEMON-platform-010	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-009	**Requirement:** Non-functional
Description: The application must be able to flawlessly communicate with Weather/forecast system (get data from Data Service bus), in order to assist and convey crewmembers the relevant information	
Category: Integration	**PALAEMON component:** ALL
Rationale: The other system components provide teams, information regarding on-going mustering; ship stability but also structural issues, thus, aiding them to safely guide all the passengers to the designated evacuation areas and MEVs;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: Decision Support System - 005	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-010	**Requirement:** Non-functional
Description: The application must be able to flawlessly communicate with Smart Bracelets (get data from Data Service bus), in order to assist and convey crewmembers the relevant information	
Category: Integration	**PALAEMON component:** ALL

Rationale: The other system components provide teams, information regarding on-going mustering; ship stability but also structural issues, thus, aiding them to safely guide all the passengers to the designated evacuation areas and MEVs;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: SMART_BRACELET-005, SMART_BRACELET-007, SMART_BRACELET-009	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-011	**Requirement:** Non-functional
Description: The application must be able to flawlessly communicate with Incident Management Module (get data from Data Service bus), in order to assist and convey crewmembers the relevant information	
Category: Integration	**PALAEMON component:** ALL
Rationale: The other system components provide teams, information regarding on-going mustering; ship stability but also structural issues, thus, aiding them to safely guide all the passengers to the designated evacuation areas and MEVs;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: SRAP-01, SRAP-03	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: AR-012	**Requirement:** Non-functional
Description: The application must be able to flawlessly communicate with Decision Support System (get data from Data Service bus), in order to assist and convey crewmembers the relevant information	
Category: Integration	**PALAEMON component:** ALL
Rationale: The other system components provide teams, information regarding on-going mustering; ship stability but also structural issues, thus, aiding them to safely guide all the passengers to the designated evacuation areas and MEVs;	
Priority: MUST	**Originator:** SIMAVI
Dependencies: To implement all the UI elements, several widgets will be developed. The widgets will get information from the Data service bus form the following components: PALAEMON INCIDENT MANAGEMENT MODULE - 002, PALAEMON-platform-009, PALAEMON-platform-017	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: SMART_CAMERAS_UAH-002	**Requirement:** Non-functional
Description: Installation as a ship infraestructure is required for the camera to maintain the orientation	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: The field of view of the camera must be maintaned and fixed correctly to the ship structure	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SMART_CAMERAS_UAH-011	**Requirement:** Non-functional

Description: Use of CCTV legacy systems if there is available a commercial gateway to feed-in the video streaming	
Category: Integration	**PALAEMON component:** Smart Cameras
Rationale: The developed SW can process the images from CCTV legacy systems already installed in the ship	
Priority: MUST	**Originator:** UAH
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: SRAP-07	**Requirement:** Non-functional
Description: Shall exploit the data generated by other PALAEMON components and ship legacy systems to calculate the risk level	
Category: Integration	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: This requirement will enable a fast evaluation of risk based on readily available (real-time) data	
Priority: MUST	**Originator:** NTUA
Dependencies: Data input: Ship legacy systems, Structural Health Monitoring Toolkit, Stability Toolkit, PaMEAS, MEV.	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: SHM_001	**Requirement:** Non-functional
Description: SHM sensors location	
Category: Integration	**PALAEMON component:** SHM
Rationale: SHM motion sensors located on the main deck of the ship	

Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team, technology providers	

ID: SHM_002	**Requirement:** Non-functional
Description: SHM sensor distribution throughout the ship	
Category: Integration	**PALAEMON component:** SHM
Rationale: Distance of placement of sensors depending on length of the ship	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team, technology providers	

ID: SHM_010	**Requirement:** Non-functional
Description: SHM physical infrastructure	
Category: Integration	**PALAEMON component:** SHM
Rationale: SHM sensors will be connected with wires (ethernet cable) but wireless connection is avialable and funcitonal	
Priority: MUST	**Originator:** ESI
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team, technology providers	

ID: PALAEMON-platform-014	**Requirement:** Non-functional
Description:	

Single access to database (e.g., DFB service)	
Category: Interfaces	**PALAEMON component:** ALL
Rationale: All the information generated in the scope of PALAEMON must be persisted into the same persistence system or component (i.e., Data Fusion Bus)	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: PALAEMON-platform-015	**Requirement:** Non-functional
Description: Single access point for field devices (e.g., Apache Kafka)	
Category: Interfaces	**PALAEMON component:** ALL
Rationale: All data sources will go across the same data streaming aggregator (i.e., Apache Kafka) in order to persist their respective information	
Priority: MUST	**Originator:** ATOS
Dependencies: 0	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: PALAEMON-Evacuation-Coordinator-005	**Requirement:** Non-functional
Description: PEC graphical management via PIMM	
Category: Interfaces	**PALAEMON component:** PEC, PIMM
Rationale: The main operation of the PEC must be accessible via PIMM	
Priority: MUST	**Originator:** ATOS
Dependencies: PALAEMON-platform-015	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Master; Bridge Command Team; Technology providers

ID: DFB-1	**Requirement:** Non-functional
Description: DFB must be able to support all input/output requests from other components	
Category: Interfaces	**PALAEMON component:** DFB
Rationale: DFB must be robust enough to withstand spikes of data troughput without loss of informaiton	
Priority: MUST	**Originator:** ITML
Dependencies: Ship's infrastructure (multiple servers in cluster	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

ID: PaMEAS_005	**Requirement:** Non-functional
Description: PaMEAS communications with other high-level services	
Category: Interfaces	**PALAEMON component:** PaMEAS
Rationale: The System operates on information received from the Incidence Management System (Module) and the DSS	
Priority: SHOULD	**Originator:** UAEG
Dependencies:	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers; technology providers	

ID: SHM_005	**Requirement:** Non-functional
Description: SHM usage in high-level services / Smart Evacuation Management system	
Category: Interfaces	**PALAEMON component:** SHM
Rationale:	

SHM will inteface with the DSS system and the middleware	
Priority: MUST	**Originator:** ESI
Dependencies: SMART_BRACELET-013	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Technology providers	

ID: PALAEMON-platform-016	**Requirement:** Non-functional
Description: Homogeneous data model (e.g., NGSI-LD)	
Category: Interoperability	**PALAEMON component:** ALL
Rationale: For the sake of interoperability, a common and unique interface and data models will be defined.	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: System developers	

ID: SRAP-06	**Requirement:** Non-functional
Description: Should operate continuously after an incident has occurred with a specific sampling and output rate	
Category: Operation	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: This requirement will enable real-time, risk-based monitoring of the evacuation	
Priority: MUST	**Originator:** NTUA
Dependencies: Depends on the sampling rates of the data inputs	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: VR-013	**Requirement:** Non-functional
Description: User interface should be clean and compatible with VR glasses;	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: Incompatibility between VR glasses and user interface would seriously impede the scenario flow.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-014	**Requirement:** Non-functional
Description: Users can access the tutorial at any moment;	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This functionality will enhance the flexibility of learning.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-017	**Requirement:** Non-functional
Description: The application should be capable to load the 3D objects defined in the scenarios;	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale:	

3D objects of the ones commonly found on the ship will increase the "close to reality" factor, therefore enhancing simulation overall effect.	
Priority: SHOULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-018	**Requirement:** Non-functional
Description: The application should to able to allow the users to personalize their interface with elements like (fonts, widgets, colours and language..	
Category: PALAEMON Academy	**PALAEMON component:** PALAEMON Academy
Rationale: This functionality will enhance the user friendly and customisation factor.	
Priority: COULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-005	**Requirement:** Non-functional
Description: The application will communicate with a web server to upload or download scenarios	
Category: PALAEMON Academy/Communication	**PALAEMON component:** PALAEMON Academy
Rationale: This functionality will allow import or export of different scenarious frameworks that can be either used as such or edited for more accurate exercises.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-015	**Requirement:** Non-functional
Description: The application should be able to connect to internet for uploading/downloading scenarios;	
Category: PALAEMON Academy/Communication	**PALAEMON component:** PALAEMON Academy
Rationale: Data transfer between application and web is vital for expanding the scenarios portfolio but also updating and maintaining the existing scenarios.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-016	**Requirement:** Non-functional
Description: The application should be capable to load 3D environments	
Category: PALAEMON Academy/Communication	**PALAEMON component:** PALAEMON Academy
Rationale: 3D environments have the ability to enhance the simulation through accurate replication of ship's environment.	
Priority: SHOULD	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: VR-019	**Requirement:** Non-functional
Description: The LMS/LRS server should capable to store all the relevant data from all participants.	
Category: PALAEMON Academy & LRS/LMS	**PALAEMON component:** PALAEMON Academy

Rationale: This function will allow to keep data and records for analytics and improvement options.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: Communication with LMS/LRS server.	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: PALAEMON-platform-019	**Requirement:** Non-functional
Description: Data latency (Near-real time data availability)	
Category: Performance	**PALAEMON component:** ALL
Rationale: The interval between a message is generated at its source and is made available to other components must not exceed 5 seconds	
Priority: MUST NOT	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team	

ID: UAV-9	**Requirement:** Non-functional
Description: The UAV shall imply high availability rate/low preparation time	
Category: Performance	**PALAEMON component:** UAV
Rationale: In emergency situation, the UAV should be ready to fly as soon as possible, in most situations.	
Priority: SHOULD	**Originator:** ADS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: SMART_BRACELET-015	**Requirement:** Non-functional
Description: IP67 waterproof housing	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale: ship/pool/water	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB housing	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-016	**Requirement:** Non-functional
Description: rechargeable battery	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale:	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-017	**Requirement:** Non-functional
Description: BLE	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale: TBD	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users:	

passenger / crew

ID: SMART_BRACELET-018	**Requirement:** Non-functional
Description: alarm button	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale: user enabled alarm	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-019	**Requirement:** Non-functional
Description: dimension 43(L)*23(W)*13(H) mm	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale: wristband/bracelet	
Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: SMART_BRACELET-020	**Requirement:** Non-functional
Description: weight <100g	
Category: physical characteristics	**PALAEMON component:** Smart Bracelet
Rationale: estimated	

Priority: SHOULD	**Originator:** ADV
Dependencies: SB HW & firmware	**Conflicts:** pending assessment
Stakeholder(s) / Users: passenger / crew	

ID: PALAEMON-platform-013	**Requirement:** Non-functional
Description: GDPR disclosure upon emergency status hoist	
Category: Security and Privacy	**PALAEMON component:** ALL
Rationale: Once the evacuation alarm has been triggered, and according to GDPR's Recital 46, "Some types of processing may serve both important grounds of public interest and the vital interests of the data subject as for instance when processing is necessary for hu	
Priority: MUST	**Originator:** ATOS
Dependencies: SMART_BRACELET-020	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Authorities; system developers; technology providers	

ID: PALAEMON-platform-012	**Requirement:** Non-functional
Description: GDPR-compliance system	
Category: Security and Provacy	**PALAEMON component:** ALL
Rationale: All the personal/sensitive information introduced in the PALAEMON platform must respect and be 100% with GDPR regulation	
Priority: MUST	**Originator:** ATOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: IT team; system developers	

ID: SMS_05	**Requirement:** Non-functional
Description: SMS should support agility and change management	
Category: Services	**PALAEMON component:** SMS
Rationale: Following post-incident root cause analysis should be able to trigger an alert for revision of safety policy	
Priority: SHOULD	**Originator:** DANAOS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master, Crew, Office	

ID: PALAEMON-platform-005	**Requirement:** Non-functional
Description: PALAEMON system handling overhead for crew members/management stakeholders	
Category: Usability	**PALAEMON component:** ALL
Rationale: The controlling and manipulation of the PALAEMON system should not generate a significant overhead on the crew workload	
Priority: SHOULD NOT	**Originator:** Stakeholders (D2.2)
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master; Bridge; Bridge Command team	

ID: SRAP-05	**Requirement:** Non-functional
Description: Risk level indication shall be colour coded and shown on the PALAEMON dashboard	
Category: Usability	**PALAEMON component:** Smart Risk Assessment Platform
Rationale: The information provided by SRAP should be easily understandable and clear	
Priority: MUST	**Originator:** NTUA

Dependencies: PIMM	**Conflicts:** None
Stakeholder(s) / Users: Crew (Master)	

ID: PALAEMON-Evacuation-Coordinator-004	**Requirement:** Non-functional
Description: PEC Visualization	
Category: Visualization	**PALAEMON component:** PEC, PIMM
Rationale: For the sake of usability, the PEC will be part of the PIMM, which will be displayed in the bridge; this way, master and crew members will be able to directly map status transitions	
Priority: MUST	**Originator:** ATOS
Dependencies: 0	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Master; Bridge Command Team; Technology providers; system developers	

ID: UAV-7	**Requirement:** Non-functional
Description: The GCS shall be simplified to the point it can be easily used in stressed situations	
Category: Visualization	**PALAEMON component:** UAV
Rationale: In stressed situation the operator could take confused decisions or hardly read. The GCS shall then be as simple graphic as possible without compromising the mission safety	
Priority: SHOULD	**Originator:** ADS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: UAV-8	**Requirement:** Non-functional
Description:	

The GCS should be portable	
Category: Visualization	**PALAEMON component:** UAV
Rationale: The operator might need to move to the MEV while continuing to operate the UAV. In this case a portable GCS would be suited.	
Priority: SHOULD	**Originator:** ADS
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew	

ID: VR-012	**Requirement:** Non-functional
Description: The application will run on VR glasses	
Category: VR Glasses	**PALAEMON component:** PALAEMON Academy
Rationale: VR glases have the ability to run and display the scenario and the complexity of its 3D graphical environments.	
Priority: MUST	**Originator:** SIMAVI
Dependencies: n/a	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users: Crew/Trainees	

ID: JOAFG-9	**Requirement:** Non-functional
Description: Emergency alarm for people that fell during the evacuation and need help. this feature should be available during the full cruise.	
Category: Wristband	**PALAEMON component:** Smart Bracelets
Rationale: Establish inner ship communication for sending a call for help to the crew.	
Priority: SHOULD	**Originator:** JOAFG

Dependencies: SMART_BRACELET-011 SMART_BRACELET-012	**Conflicts:** no conflict identified at this point
Stakeholder(s) / Users:	

Annex III PALAEMON Components specs

III.1 Smart Bracelets

Device/Gateway/Infrastructure Description and Functionality	
Name	Smart Bracelet
Short Description	wearable device operating as a beacon with bi-directional communication capabilities, used to support PALAEMON indoor positioning (IP) mustering and evacuation system (PaMEAS)
Measurement	Optional (to be confirmed at design & specific. phase) ▪ body sensor (HR) ▪ fall detection (accelerometer, gyroscope) ▪ GPS/GSNN
Digital/Analog Signals	Radio signals (routing parameters)
Functionality	▪ beaconing (tracking/localization support) ▪ information display (text/signs) ▪ emergency button
Physical Characteristics	
Dimensions	**TBD** (Approx.) Length 130-210 mm; Height 42-48 mm; Width 12-15 mm
Weight	**TBD** (< 100 gr.)
Material	**TBD** (Silicone – TPU – PC -IP67 - IP68)
Mounting	MEMS - PCB integrated
Operational Characteristics	
Measurement Range	depends on radio dot network infrastructure
Measurement Resolution	sensor dependent
Accuracy	sensor dependent
Zero Error	sensor dependent
Humidity	indoor/outdoor conditions (-15 ºC~ +45ºC)
Pressure	indoor/outdoor conditions (-15 ºC~ +45ºC)
Lifetime	depends on battery type/size – expect. 50 days
Hardware Requirements	
Power Requirements	**TBC** - ~Lithium polymer battery 3.7V 100mAH
Data Connections	▪ Primary: Cellular (hybrid 4G/5G support) ▪ Secondary: BLE, RFID
Data Format	JSON – to be defined during technical specific. phase
Data Rate	▪ Synchronous transmission: biometric sensors, GPS info - to be defined during technical specific. phase ▪ Asynchronous transmission: alarms notification (fall detection, user-triggered)
Data Availability	Acquisition (SB sensors) ▪ Biometric sensor (min. range) ▪ GPS (second range) ▪ TX/RX (cellular network)

	▪ 4G/5G cellular network server – sensor data + routing info + alarms/notifications
Transmission Frequency	Cellular network (hybrid 4G/5G) – Freq. to be determined by network provider (ERICSSON)
Software Requirements (e.g. API creation)	
Software Required	yes
Software Details	dedicated firmware (system, data and management)
Note	N/A

III.2 Smart Cameras

Device/Gateway/Infrastructure Description and Functionality	
Name	**Smart Cameras**
Short Description	▪ RGB-D camera connected to a processing HW platform with high-level communication capabilities, used by PALAEMON components
Measurement	▪ Optional (to be confirmed at design & specific. phase) ▪ people count on the surveillance area ▪ occupancy ratio of the surveillance area ▪ people flow detection
Digital/Analog Signals	▪ Ethernet / WiFi / RF communication with enough Bandwidth to stream video images.
Functionality	▪ Remote control (Headless system) via OpenSSH and ad-hoc GUI
Physical Characteristics	
Dimensions	**TBD** (Approx.) Length 200-300 mm; Height 200-300 mm; Width 200-300 mm;
Weight	**TBD** (Approx.) 1.5 kg
Material	**TBD** (Silicone – TPU – PC -IP67 - IP68)
Mounting	Infrastructure installation (in piloting demos with posts and supports)
Operational Characteristics	
Measurement Range	depends on camera field of view balance among occlusions and counter accuracy
Measurement Resolution	platform dependent (min images 400 x 300 pix)
Accuracy	platform dependent
Zero Error	platform dependent
Humidity	platform dependent
Pressure	platform dependent
Lifetime	platform dependent (lifetime of products)
Hardware Requirements	
Power Requirements	**TBC** - Power cord supply requirement (platform is non-battery operated).
Data Connections	▪ Primary: wired ethernet

	▪ Secondary: WiFi/4G/5G
Data Format	To be defined during technical specific phase
Data Rate	▪ Synchronous transmission: people detection, people flow, occupancy ratio of the surveillance area ▪ Asynchronous transmission: alarms notification (e.g. abnormal flow detection), on-demand video clip
Data Availability	**TBD** – PaMEAS (Kafka producer) interface specific
Transmission Frequency	**TBD** – PaMEAS (Kafka producer) interface specific
Software Requirements (e.g. API creation)	
Software Required	Yes
Software Details	Linux SO + Computer Vision Libraries + GUI
Note	N/A

III.3 UAV

Device/Gateway/Infrastructure Description and Functionality	
Name	UAV camera
Short Description	Camera embedded on the UAV that is used for observation, point of interest localization and situation assessment.
Measurement	Electro-optical sensor TBD
Digital/Analog Signals	Analog input Radio transmitted to ground station
Functionality	Provides video/images, point of interest locations on demand to the ground station. Once processed, data of interest are extracted and used on the bridge.
Physical Characteristics	
Dimensions	<L x W x H in mm> UAV: 200 x 100 x100 (TBC)
Weight	UAV: 800g
Material	NA
Mounting	Gimbal
Operational Characteristics	
Measurement Range	/
Measurement Resolution	TBC 12.35MP local recording: 4096x2160p@24fps Radio transmitted: 1280x720p@30fps
Accuracy	NA
Zero Error	/
Humidity	NA
Pressure	NA
Temperature	0 – 40°C
Lifetime	NA
Hardware Requirements	
Power Requirements	UAV embedded battery

Data Connections	Proprietary radio link (2.4-2.483GHz)
Data Format	H264
Data Rate	30fps
Data Availability	On demand
Transmission Frequency	TBC 2.4-2.483GHz (max 100mW)
Software Requirements (e.g. API creation)	
Software Required	yes
Software Details	UAV control software: Commands the UAV in real-time and execute the mission Ground control station: Plan the mission, process sensor data, act as a relay to the rest of the system
Note	
Device/Gateway/Infrastructure Description and Functionality	
Name	UAV GPS
Short Description	GPS used by the UAV for its own global positioning
Measurement	GPS/GLONASS Measures GPS position, velocity
Digital/Analog Signals	Radio, GPS/GLONASS
Functionality	Measures current GPS and velocity of the UAV for navigation purposes and point of interest location. It is also fused with other sensor information such as barometer/accelerometer to enhance actual precision.
Physical Characteristics	
Dimensions	<L x W x H in mm> UAV: 200 x 100 x100 (TBC)
Weight	UAV: 800g
Material	NA
Mounting	MEMS
Operational Characteristics	
Measurement Range	/
Measurement Resolution	10cm
Accuracy	+/-10m
Zero Error	/
Humidity	NA
Pressure	NA
Temperature	0 – 40°C
Lifetime	NA
Hardware Requirements	
Power Requirements	UAV embedded battery
Data Connections	Proprietary radio link (2.4-2.483GHz)
Data Format	Lat/Lng/Alt
Data Rate	20Hz
Data Availability	Always, when signal available
Transmission Frequency	TBC 2.4-2.483GHz (max 100mW)
Software Requirements (e.g. API creation)	

Software Required	yes
Software Details	UAV control software: Commands the UAV in real-time and execute the mission Ground control station: Plan the mission, process sensor data, act as a relay to the rest of the system
Note	
Device/Gateway/Infrastructure Description and Functionality	
Name	UAVIMU
Short Description	Embedded IMU on UAV used for navigation and localization
Measurement	Acceleration, attitude
Digital/Analog Signals	Analog
Functionality	Measures acceleration and attitude. This information is used for UAV navigation and point of interest localization.
Physical Characteristics	
Dimensions	<L x W x H in mm> UAV: 200 x 100 x100 (TBC)
Weight	UAV: 800g
Material	NA
Mounting	MEMS
Operational Characteristics	
Measurement Range	/
Measurement Resolution	NA
Accuracy	NA
Zero Error	/
Humidity	NA
Pressure	NA
Temperature	0 – 40°C
Lifetime	NA
Hardware Requirements	
Power Requirements	UAV embedded battery
Data Connections	Proprietary radio link (2.4-2.483GHz)
Data Format	Acceleration in m/s, orientation in radians
Data Rate	20Hz
Data Availability	Always
Transmission Frequency	TBC 2.4-2.483GHz (max 100mW)
Software Requirements (e.g. API creation)	
Software Required	yes
Software Details	UAV control software: Commands the UAV in real-time and execute the mission Ground control station: Plan the mission, process sensor data, act as a relay to the rest of the system
Note	
Device/Gateway/Infrastructure Description and Functionality	
Name	UAV GPS
Short Description	GPS used by the UAV for its own global positioning
Measurement	GPS/GLONASS

	Measures GPS position, velocity
Digital/Analog Signals	Radio, GPS/GLONASS
Functionality	Measures current GPS and velocity of the UAV for navigation purposes and point of interest location. It is also fused with other sensor information such as barometer/accelerometer to enhance actual precision.
Physical Characteristics	
Dimensions	<L x W x H in mm> UAV: 200 x 100 x100 (TBC)
Weight	UAV: 800g
Material	NA
Mounting	MEMS
Operational Characteristics	
Measurement Range	/
Measurement Resolution	10cm
Accuracy	+/-10m
Zero Error	/
Humidity	NA
Pressure	NA
Temperature	0 – 40°C
Lifetime	NA
Hardware Requirements	
Power Requirements	UAV embedded battery
Data Connections	Proprietary radio link (2.4-2.483GHz)
Data Format	Lat/Lng/Alt
Data Rate	20Hz
Data Availability	Always, when signal available
Transmission Frequency	TBC 2.4-2.483GHz (max 100mW)
Software Requirements (e.g. API creation)	
Software Required	yes
Software Details	UAV control software: Commands the UAV in real-time and execute the mission Ground control station: Plan the mission, process sensor data, act as a relay to the rest of the system
Note	
Device/Gateway/Infrastructure Description and Functionality	
Name	Barometer
Short Description	Combined with GPS information for better altitude precision.
Measurement	Measures pressure to calculate height variations.
Digital/Analog Signals	Analog
Functionality	Measures pressure for height variation calculation. This information is used for UAV navigation and point of interest localization.
Physical Characteristics	
Dimensions	<L x W x H in mm> UAV: 200 x 100 x100 (TBC)

Weight	UAV: 800g
Material	NA
Mounting	MEMS
Operational Characteristics	
Measurement Range	/
Measurement Resolution	NA
Accuracy	NA
Zero Error	/
Humidity	NA
Pressure	NA
Temperature	0 – 40°C
Lifetime	NA
Hardware Requirements	
Power Requirements	UAV embedded battery
Data Connections	Proprietary radio link (2.4-2.483GHz)
Data Format	Meters
Data Rate	20Hz
Data Availability	Always
Transmission Frequency	TBC 2.4-2.483GHz (max 100mW)
Software Requirements (e.g. API creation)	
Software Required	yes
Software Details	UAV control software: Commands the UAV in real-time and execute the mission Ground control station: Plan the mission, process sensor data, act as a relay to the rest of the system
Note	

III.4 Ship Stability Toolkit

Device/Gateway/Infrastructure Description and Functionality					
Name of New Component/Service:	Stability Toolkit				
Type:	Component / Software				
Functionality:	This module gives an overview of the ships future stability data and motions based on weather forecast data and the actual state of the ship, e.g. whether or not compartments are flooded. It will present the data to master and crew via a graphical interface.				
Input Connections & Interfaces: From which components it receives input	The device will receive input from weather forecast data about the expected sea conditions and from sensors within the hull.				
Output Connections & Interfaces: To which components it sends the results	Mainly to DSS Interface (Graphic interface)				
Functional Requirements	N/A				
Non-Functional Requirements	N/A				
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***

Hull parameters	Main dimensions, Hullform, mass distribution	Int / CAD	tbd		OELS / Anek
Weather forecast	Wind: Speed/ Direction Swell: Direction/ Hs / Period Sea: Direction/ Hs/ Period	Int	tbd	tbd	Weather Information Service / KT
State of ship	Intact/Damaged/ Location	tbd	tbd	On call	tbd
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Present swimming position	Heel / Trim	Int / String	tbd	On call	DSS
Expected future ship motions	surge/sway/ heave/ roll/ pitch/ yaw	Table	tbd	Depending on weather reports	DSS
Software Requirements/Development Language			MATLAB		
Hardware Requirements			N/A		
Communications			To be decided		
Status of the development of the component			To be developed from scratch		

III.5 VDES as Data Source

Device/Gateway/Infrastructure Description and Functionality	
Name	VDES transceiver
Short Description	VDES transceiver prototype shall allow data transfer to/from PALAEMON platform via VHF frequencies. VDES transceiver shall allow long distance communications.
Measurement	TBD
Digital/Analog Signals	VDES transceiver has an analogue section, interfacing with VHF spectrum and a digital section, able to transmit/receive bits to/from PALAEMON platform.
Functionality	VDES transceiver is a gateway for long distance communications (dozens of kms)
Physical Characteristics	
Dimensions	*TBD*
Weight	*TBD*
Material	*TBD*
Mounting	*TBD*

Operational Characteristics	
Measurement Range	N/A
Measurement Resolution	N/A
Accuracy	N/A
Zero Error	N/A
Humidity	N/A
Pressure	N/A
Lifetime	N/A
Hardware Requirements	
Power Requirements	To Be updated after HW selection
Data Connections	VHF antennas with SMA connectors (TBC), SW interface to PALAEMON platform (e.g. Socket IP)
Data Format	Character strings are presented left to right most significant bit first. All unused characters should be represented by the @ symbol, and they should be placed at the end of the string. When data is output on the VHF data link it should be grouped in bytes of 8 bits from top to bottom of the table associated with each message in accordance with ISO/IEC 13239:2002. Each byte should be output with least significant bit first.
Data Rate	AIS: 9.6 kbit/s ASM: 9.6 kbit/s VDE: TER-MCS-1.25 19.2 kbit/s TER-MCS-5.100 230.4 kbit/s
Data Availability	VDES transmission are periodic or on-demand, not continuous.
Transmission ~~Frequency~~ power	VDES standard specified that transmit power shall fits within 1÷12.5 W.
Software Requirements (e.g. API creation)	
Software Required	Yes. VDES transceiver will be based on Software Defined Radio approach. Algorithms for transmitting and receiving VDES signal will be implemented in software.
Software Details	VDES transceiver waveform will be developed in C++ with multi-threading approach.
Note	None.

III.6 Augmented Reality Glasses

Device/Gateway/Infrastructure Description and Functionality	
Name	AR Glasses microphone
Short Description	Directional microphones used to capture the ambient sound and crewmember voice.
Measurement	Ambient sound and crew members conversations
Digital/Analog Signals	

Functionality	Allows crewmembers to communicate in an emergency situation and records their conversations for further analysis.
Physical Characteristics	
Dimensions	TBD
Weight	TBD
Material	TBD
Mounting	TBD
Operational Characteristics	
Measurement Range	▪ 0.1-100 mb/30min ▪ -40 - 100 Degrees
Measurement Resolution	N/A
Accuracy	N/A
Zero Error	N/A
Humidity	N/A
Pressure	N/A
Lifetime	N/A
Hardware Requirements	
Power Requirements	N/A
Data Connections	Wired, infrared, wireless, Bluetooth
Data Format	Audiostream, XML, JSON, Custom
Data Rate	▪ Bandwidth 1600kbps ▪ Media type mp3 ▪ Payload type 127 ▪ Encoding Mp3 ▪ Sampling Rate 8khz ▪ Bits per sample 1.65 ▪ Packet time 20ms
Data Availability	1ms refresh frequency
Transmission ~~Frequency~~ Frequency	Depending on crewmembers
Software Requirements (e.g. API creation)	
Software Required	
Software Details	
Note	Visual representation: 

III.7 PALAEMON Academy VR

Name of New Component/Service:	Tool for training
Type:	Component / Software
Functionality:	Development of an application designed for VR glasses which helps the crewmembers train for different ship evacuation scenarios. The application is intended for learning purposes. It allows

	actual practicing and development of new skills for the crew members.
Input Connections & Interfaces: From which components it receives input	Login to LRS/LMS server. Users must be enrolled first to get an account. With the account, they are given access to use the VR Application.
Output Connections & Interfaces: To which components it sends the results	Send to LRS/LMS server: user ID, actions, times, scenario progress.

Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
- Json file that represent a created already scenario	The application will load the available scenarios from the list provided in WP2.2	String	JSON	-	Web server or local

Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Json format with all the relevant data from all participants;	The application will send data to LMS/LRS server for all the participants.	String	JSON	-	LMS/LRS server

Software Requirements/Development Language	Unity 3D, C#
Hardware Requirements	▪ VR headsets that provide virtual reality for the users; ▪ LRS/ LMS server.
Communications	Internet connection via a Wireless Network
Status of the development of the component	Currently developing the authoring tool that will be used for scenarios creation.

Device Description and Functionality	
Name	VR Glasses
Short Description	VR Glasses are an all-in-one gaming system for virtual reality The headsets provide 6DOF with positional tracked controllers. No PC is required.
Measurement	Measures the performance of crew members when facing challenges related to the evacuation process.
Digital/Analog Signals	N/A
Functionality	Will be used to mimic situations in which participants face everyday tasks. It will

	also be used in preparing the crew members to face the variety of challenges encountered in passenger ship evacuation scenarios.
Physical Characteristics	
Dimensions	Width: 142 mm or less; Height: 50 mm or less.
Weight	571 grams
Material	The outer material is fabric, with a plastic shell on the front and a padded section for the face.
Mounting	Head mounted
Operational Characteristics	
Measurement Range	N/A
Measurement Resolution	N/A
Accuracy	N/A
Zero Error	N/A
Humidity	Do not expose them to high humidity
Pressure	Do not expose them to high and low pressure
Lifetime	The battery life is around 2–3 hours.
Hardware Requirements	
Power Requirements	3648 mAh rechargeable lithium ion battery pack
Data Connections	WiFi
Data Format	JSON
Data Rate	Read/logged
Data Availability	Periodic
Transmission Frequency	Depends on the frequency of the wireless network.
Software Requirements (e.g. API creation)	
Software Required	Yes
Software Details	Android
Note	N/A

III.8 Safety Management System

Name of New Component/Service:			Safety Management System tool		
Type:			Component, Software		
Functionality:			Dynamic electronic checklist, Document management workflow engine, Form panel for storing and managing Vessel Safety documents		
Input Connections & Interfaces: From which components it receives input			Company safety document legacy		
Output Connections & Interfaces: To which components it sends the results			Integrates with DSS/PIMM		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***

Electronic checklist	User to create and fill in checklists with the order of safety actions on-board	string	text	N/A	N/A
Document Management	Manage safety documents (versioning, revision, workflow engine)	Will be defined at later stage	Will be defined at later stage	Will be defined at later stage	Will be defined at later stage
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)
Software Requirements/Development Language			C#.Net , VueJS		
Hardware Requirements			N/A		
Communications			Rest API (Preliminary statement, should be defined)		
Status of the development of the component			Ongoing		

III.9 Data Fusion Bus

Name of New Component/Service:	Data Fusion Bus (DFB)
Type:	Component
Functionality:	The ITML Data Fusion Bus (DFB) is a customizable product for data fusion for multiple modality data streams. It is using a modality processing pipeline transforming heterogeneous data in real time by reducing the granularity from the signal/raw level to a semantic level. The DFB includes autonomous fusion agents that are activated during the execution of the modality processing. It will be customised to aggregate multiple streams both for R&D as well as deployment to LEAs, thereby allowing seamless service of data to the network analysis and visualization. DFB relies on Kafka and Elasticsearch. It provides a web interface (and API) for importing data , performing ML , manipulating datasets and datastreams.
Input Connections & Interfaces: From which components it receives input	Data sources, Data streams

Output Connections & Interfaces: To which components it sends the results			Web services, Data streams		
Input Data					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
Structured datasets: CSV files Semi-structured data: log files Datastreams (e.g. MQTT)	Data inputs depends on data sources	TBD	CSV, JSON	Can support high throughputs	Sensors, Any type of logging mechanism
Output					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
SQL interface Data streams Web service		Complex (objects,, Arrays of objects,)	SQL, JSON	Can support high throughputs	DSS or any other component
Software Requirements/Development Language					
Hardware Requirements			Minimum COMPUTE RESOURCSES • CPUs: 6 Cores: • RAM: minimum 16G • Disk space: Depends on use cases • To support redundancy, it is preferable to provide a cluster of nodes (at least two) with the aforementioned specs		
Communications			TBD (depends on the actual ship infrastructure)		
Status of the development of the component			Currently available in low TRL, it will be increase within the project and can be further customized		

III.10 PALAEMON Evacuation Coordinator

Name of New Component/Service:	PALAEMON Evacuation Coordinator
Type:	Component
Functionality:	The PALAEMON Evacuation Coordinator takes charge of digitalizing the Bridge Crew and Captain commands and notifying all the components in the PALAEMON system of any changes regarding the Evacuation process.
Input Connections & Interfaces: From which components it receives input	PIMM
Output Connections & Interfaces: To which components it sends the results	Data Streaming Aggregator

			All components that are subscribed to the Evacuation Coordinator topic		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
Evacuation Commands	Orders launched by the Bridge Crew and Captain regarding evacuation	object	JSON	Async	PIMM/Bridge command control
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Evacuation process notifications	Notifications about the Evacuation Status	object	JSON	Async	Data Streaming Aggregator/ all components
Software Requirements/Development Language			Python		
Hardware Requirements			Linux server with Python and Docker installed.		
Communications			Internet connection to the PALAEMON platform		
Status of the development of the component			Developed from scratch		

III.11 LRS/LMS Servers (SIMAVI)

Name of New Component/Service:	LMS/LRS
Type:	Component / Software
Functionality:	Deployment of an LMS and LRS server to assure the user management (via LMS) and the logging of records (via the learning record store). The application designed for VR glasses will connect to the LMS and log to the system. After they successfully log in they will receive a passphrase that will be used for signing xApi statements. The application is intended for learning purposes. It allows the users to check their progress. This allows them to identify where are the areas they can improve and where are very good.
Input Connections & Interfaces: From which components it receives input	The system will need the VR application to perform the Login process. If they won't have a username, they can create a new one. The login is verified with the LMS and only the enrolled users are given access to use the VR Application.

Output Connections & Interfaces: To which components it sends the results			Send to LRS/LMS server: user ID, user passphrase, actions, times, scenario progress.		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
- Username and password for logging to the LMS. Statements for the LRS	The	String	JSON	-	Web server or local
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Json format with all the relevant data from each participant;	The application will request data from the LRS server for each of the participants.	String	JSON	-	LMS/LRS server
Software Requirements/Development Language			Unity 3D, C#		
Hardware Requirements			- NGINX Linux server for the LMS and LRS		
Communications			Internet connection via a Wireless Network		
Status of the development of the component			We have deployed the LRM/LRS. We are currently working on the Webservices for Signup, and login via the LMS and statement validation via the LRS		

Device/Gateway/Infrastructure Description and Functionality	
Name	NGINX Server
Short Description	The NGINX Server will be needed to deploy the LMS and LRS.
Measurement	N/A
Digital/Analog Signals	N/A
Functionality	The server will need to have access to the same Wireless Network as the Headsets (VR and AR) to be able to communicate with them.
Physical Characteristics	
Dimensions	Standard dimensions for ATX Case
Weight	1-5kg.
Material	Standard ATX Case (Steel + Plastic)
Mounting	No special mounting is needed
Operational Characteristics	
Measurement Range	N/A

Measurement Resolution	N/A
Accuracy	N/A
Zero Error	N/A
Humidity	Do not expose them to high humidity
Pressure	Do not expose them to high and low pressure
Lifetime	min 5 years.
Hardware Requirements	
Power Requirements	3400-600W power supply
Data Connections	WiFi
Data Format	JSON
Data Rate	Read/logged
Data Availability	Periodic
Transmission Frequency	Depends on the frequency of the wireless network.
Software Requirements (e.g. API creation)	
Software Required	Yes
Software Details	NGINX, Combu, Apache, MySQL
Note	N/A

III.12 Smart Safety System

Name of New Component/Service:	(SSS) Smart Safety System
Type:	Component /Software
Functionality:	This module gives an overview of evacuation condition and actual status of evacuation progress. Also provide interface to connect between Master and evacuation team. The information will provide as gadget in the (DSS) decision support system.
Input Connections & Interfaces: From which components it receives input	Mainly officers and crew team provide Information (V1). Can rely on sensors (bracelets for example) and also through communication devices (for example tablet or Bluetooth receiver)V2
Output Connections & Interfaces: To which components it sends the results	Mainly to DSS Interface (Graphic interface)

Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
Position of incident on board Coordination info. Issued by Master	Coordination /Status Status / plans	Int / String Graphic object	MQTT TBA	First Transmission on activation On activation	Crew on Board/Sensors/ Master or Evacuation coordinator
Output Parameters					
Attribute / Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Position / present situation of	NA >	Int, String and	MQTT	On call	DSS

evacuation process		Graphic Object			
Software Requirements/Development Language			MATLAB, Python, MQTT Broker		
Hardware Requirements			NA		
Communications			MQTT		
Status of the development of the component			to be developed from scratch based on DSS available system		

III.13 SRAP

Name of New Component/Service:	Smart Risk Assessment Platform (SRAP)
Type:	Software
Functionality:	SRAP is a real-time risk-based monitoring software component that will provide a colour coded risk level indication on the PALAEMON dashboard. Its purpose/goal is to assist the Master as well as the Bridge Command for: 1. the initial assessment of the situation, in order to take the decision of sounding the General Alarm (GA) or not. 2. the evaluation (monitoring) of the mustering process in order to take any additional actions (if necessary), following the GA; and 3. the final assessment of the situation, i.e. taking the decision to abandon the ship or not.
Input Connections & Interfaces: From which components it receives input	▪ Smart Safety System ▪ Stability Toolkit ▪ PaMEAS ▪ Structural Health Monitoring Toolkit ▪ MEVs ▪ Ship Legacy Systems ▪ Weather Forecast Toolkit (TBD, depends on component output) ▪ Smart Cameras (TBD, depends on component output)
Output Connections & Interfaces: To which components it sends the results	DSS PALAEMON Dashboard (PIMM)

Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
Passenger localisation data	The position of each passenger during the	TBD double or	TBD (XML or JSON)	TBD (15 s – 1 min.)	PaMEAS

	evacuation process	complex (list)			
Passenger health monitoring data	Data that represent the health condition of each passenger	TBD double or complex (list)	TBD (XML or JSON)	TBD (30 s – 5 min.)	PaMEAS
ship's stability data	Data for the evolution of the ship's stability (e.g. angle of heel, trim, GZ curve, etc.)	TBD double or complex (list)	TBD (XML or JSON)	TBD (30 s – 5 min.)	Stability Toolkit
Passenger evacuation data	Data regarding the distance of passengers and crew members from threats/dangers (e.g. fire, smoke, congestion points, etc.)	TBD double or complex (list)	TBD (XML or JSON)	TBD (15 s – 1 min.)	Smart Safety System
Availability of MEVs	Data regarding MEVs availability, status, and persons on-board	TBD double or complex (list)	TBD (XML or JSON)	TBD (30 s – 5 min.)	MEV
Smoke/Fire detectors	Signal of detectors	ON - OFF	TBD	TBD (15 s – 1 min.)	Ship Legacy Systems
Flooding sensors	Signal of sensors	ON - OFF	TBD	TBD (15 s – 1 min.)	Ship Legacy Systems
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Risk level	Provide the risk level for the 3 phases (i.e., initial assessment, monitoring evacuation process, final assessment)	TBD	TBD	TBD (30 s – 1 min.)	DSS
Risk level indication	Colour coded risk level indication	TBD	TBD	4 coloured scale (green, yellow, orange, red) (30 s – 2 min.)	PALAEMON dashboard (PIMM)

Software Requirements/Development Language	High level Programming Language (Python)
Hardware Requirements	TBD
Communications	N/A
Status of the development of the component	To be developed from scratch

III.14 Decision Support System

Name of New Component/Service:			DSS (Decision Support System)		
Type:			Software		
Functionality:			It will provide passengers and crew of the ship with suggestions on evacuation		
Input Connections & Interfaces: From which components it receives input			Evacuation methodologies Safety Procedures Ship Structural Monitoring Ecosystem Risk management Stability tool kit Smart Safety System Weather forecast tool kit Data fusion bus		
Output Connections & Interfaces: To which components it sends the results			DSS Interface		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
TBD	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
TBD	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*
Software Requirements/Development Language			Python		
Hardware Requirements			N/A		
Communications			To be decided		
Status of the development of the component			Components analysis		

III.15 SMS

Name of New Component/Service:			Safety Management System tool		
Type:			Component, Software		
Functionality:			Dynamic electronic checklist, Document management workflow engine, Form panel for storing and managing Vessel Safety documents		
Input Connections & Interfaces: From which components it receives input			Company safety document legacy		
Output Connections & Interfaces: To which components it sends the results			Integrates with DSS/PIMM		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***

Electronic checklist	User to create and fill in checklists with the order of safety actions on-board	string	text	N/A	N/A
Document Management	Manage safety documents (versioning, revision, workflow engine)	Will be defined at later stage	Will be defined at later stage	Will be defined at later stage	Will be defined at later stage
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)	TBD (to be defined)
Software Requirements/Development Language			C#.Net , VueJS		
Hardware Requirements			N/A		
Communications			Rest API (Preliminary statement, should be defined)		
Status of the development of the component			Ongoing		

III.16 PIMM

Name of New Component/Service:	PALAEMON Incident Management Module (PIMM)
Type:	Software component
Functionality:	Provides a user- friendly GUI for managing the incident. Integrates with various other modules (DSS, WFT). Links to other dashboards (e.g. PaMEAS).
Input Connections & Interfaces: From which components it receives input Thou	DSS: Through DFB's API/Directly through ES WFT: Through DFB's API/Directly through ES Ship Evacuation Manager (SEM): Through DFB's API/Directly through ES
Output Connections & Interfaces: To which components it sends the results	DSS: Through DFB's API/Directly through ES WFT: Through DFB's API/Directly through ES Ship Evacuation Manager (SEM): Through DFB's API/Directly through ES

Software Requirements/Development Language	Python (Django), JavaScript (Vue), PostgreSQL
Hardware Requirements	Low-Mid Range PC or Low Range Server
Communications	
Status of the development of the component	Partially Developed

III.17 Weather Forecast Toolkit

Name of New Component/Service:			Weather Forecast Toolkit		
Type:			Component/Software		
Functionality:			This module's purpose is to give the correlation between the weather conditions and the evacuation plan/actions.		
Input Connections & Interfaces: From which components it receives input			Shipboard legacy systems and VDES ASM data channels.		
Output Connections & Interfaces: To which components it sends the results			Decision Support System (DSS) and PALAEMON Incident Management Module (PIMM).		
Functional Requirements			-		
Non-Functional Requirements			-		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
windspeed (knots) windDir (Degrees) currentSpeed (knots) currentDir (Degrees) waves height (m) temp (℃) swellDir (Degrees) swellPeriod (Time) wavesPeriod (Time)	Weather Weather Weather Weather Weather Weather Weather	Interval Interval Interval Interval Interval Interval Interval Interval Interval	CSV CSV CSV CSV CSV CSV CSV CSV CSV	[1,71] [0,360] [1,71] [0,360] (-89,58) [0,100] [0,360]	Shipboard legacy systems and VDES ASM data channels.
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
Actions list	A short list of actions based on the weather conditions	String	JSON	On call	Decision Support System (DSS) and PALAEMON Incident Management Module (PIMM).
Software Requirements/Development Language			Python		
Hardware Requirements			No specified		
Communications			REST API		
Status of the development of the component			To be developed from scratch		

III.18 PaMEAS Service

Name of New Component/Service:			PaMEAS (Passengers Mustering and Evacuation process Automation System)		
Type:			Software Suite		
Functionality:			Streamline and monitor the process of mustering and evacuation (and prepare for the use of MEV)		
Input Connections & Interfaces: From which components it receives input			• PALAEMON 4G LTE – 5G cell Network • DSS • PALAEMON Incidence Management System • Ship Identity Management System • PALAEMON Identity Management		
Output Connections & Interfaces: To which components it sends the results			• Generic API with privacy safeguards to be used by other components and services • User Devices (smartphones, bracelets etc.) • IoT Signalling for evacuation • Crew/AR Glasses		
Input Parameters					
Attribute/ Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Received From***
TBD	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*
Output Parameters					
Attribute/Parameter	***Short Description***	***Data Type***	***Data Format***	***Value Range & Frequency***	***Data Sent To***
TBD	*TBD*	*TBD*	*TBD*	*TBD*	*TBD*
Software Requirements/Development Language			Enterprise Software / Java		
Hardware Requirements			2-3 servers deployed within the ship that will host PALAEMON pilots		
Communications			REST APIs (in general)		
Status of the development of the component			“To be developed from scratch” but based on existing available libraries, interfaces and components		

III.19 AR app

Covered in Section III.6

III.20 PALAEMON Academy

Covered in Section III.7