



PROJECT DELIVERABLE REPORT



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

D5.14 PaMEAS Software Suite: Deployment (V2)

A holistic passenger ship evacuation and rescue ecosystem

MG-2-2-2018

Marine Accident Response

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Abbreviations

2FA	Two-Factor Authentication
3GPP	3rd Generation Partnership Project
4G	Fourth generation mobile communication network
5G	Fifth generation mobile communication network
5GC	5G core
ALE	Analytics Location Engine
AoA	Angle-of-Arrival
AoD	Angle-of-Departure
AP	Access Point
API	Application Program Interface
BRMS	Business Rules Management System
BLE	Bluetooth Low Energy
CN	Core Network
CRM	Customer Relationship Management
DFB	Data Fusion Bus
DIDs	Disposable Ids
DSS	Decision Support Systems
DVI	Digital Visual Interface
ECs	Evacuation Coordinators
EP	Evacuation Plan
EPC	Evolved Packet
EPG	Evolved Packet Gateway
GA	Grant Agreement
HTTP	Hypertext Transfer Protocol
IAP	Instant Access Point
IMEI	International Mobile Equipment Identity
IMSI	International mobile subscriber identity
IoT	Internet of Things
IT	Information Technology
JVM	Java Virtual Machine
LAN	Local Area Network
LTE	Long Term Evolution
MAC	Media Access Control
MEE	Marine Emergency Evacuation
MEV	Massive Evacuation Vessel
MME	Mobility Management Entity
MSISDN	Mobile Station International Subscriber Directory Number
MSRP	Message Session Relay Protocol
NMS	Network Management System
NFV	Network Functions Virtualization
NFVI	Network Functions Virtualization Infrastructure
NR	New Radio
OIDC	OpenID Connect
PaMEAS	Passengers Clustering and Evacuation Process Automation System
PII	Personally Identifiable Information
PIMM	PALAEMON Incident Management Module
RAN	Radio Access Network
PMS	People Management System
RF	Radio Frequency
RO	Resource Orchestrator
RSSI	Received Signal Strength Indicator
RTLS	Real-Time Locating Systems
RTP	Real-time Transport Protocol
SAML	Security Assertion Markup Language
SEM	Smart Evacuation Management
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SNR	Signal-to-noise ratio



VCs	Verifiable Credentials
VNF	Virtual Network Functions
UE	User Equipment
webRTC	Web Real-Time Communication
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network
WP	Work Package
XMPP	Extensible Messaging and Presence Protocol

Executive Summary

Ship evacuation is directly related to the safety of passengers during accidents. During the last years, many methods for avoiding and reducing casualties in accidents have been proposed and investigated by the research community of maritime safety. However, the digitization and automation of the evacuation proves remains a challenge.

Passengers Mustering and Evacuation Process Automation System (PaMEAS), in the context of the PALAEMON project, is oriented towards the development of a technology-assisted evacuation management approach and the actual demonstration of its capacity to the real environment. The purpose of this deliverable is to provide a detailed description of the technical development, which follows the design approach outlined in D5.9 and D5.10. The developments presented here aim at demonstrating a smart evacuation procedure, exploiting cutting edge technologies such as the indoor localization techniques, the integration of the location of the passenger with their identity (under privacy constraints), the guidance of the passengers in real-time through personalised notifications, and the use of a 5G Standalone network, specifically deployed for the needs of the project, to deliver such notifications and alerts with low latency.

This document describes, in technical details, the PALAEMON Smart Evacuation Management approach, follows up on the design reported in D5.13 PaMEAS Software Suite: Deployment v1) and presents the final development of the PaMEAS Suite (v2). The Software PaMEAS Suite Architecture and Components (v2) are explained thoroughly, an overview of their functionalities and current, on-board a passenger ship. deployment conditions are provided, while a demonstrator is included to show effective integration and correct functioning of the current deployment.

1 Introduction

The present document is the Deliverable D5.14 “PaMEAS Software Suite: Deployment v2”. The deliverable D5.14 is a part of the WP5 of PALAEMON project which is entitled “PALAEMON on-board mustering tools and services”. More specifically, D5.14 reports on the results of Task 5.4 “PaMEAS - Passengers Mustering and Evacuation Process Automation System” (led by the University of the Aegean; Ericsson Hellas, Athonet and DNV GL Hellas complete the group of project partners participating in this Task).

PaMEAS software suite is a multi-layered system of applications and network functionality, using both open source and commercial components, which supports the ship evacuation process with “ICT intelligence”, and a certain degree of automation. Essentially, the system includes three components:

- PaMEAS-W (Wireless): Indoor positioning system that collects and exports to the upper software layers, passenger and crew location data.
- PaMEAS-Cell: A 5G Standalone network infrastructure that forwards alerts and notifications to the mobile devices of passengers and crew.
- PaMEAS-A (Applications): Microservices application architecture that processes the location data collected from PaMEAS-W and produces personalised emergency alerts and notifications (based on rules that depend on the specific stage the evacuation has reached, and a context-specific messaging policy).

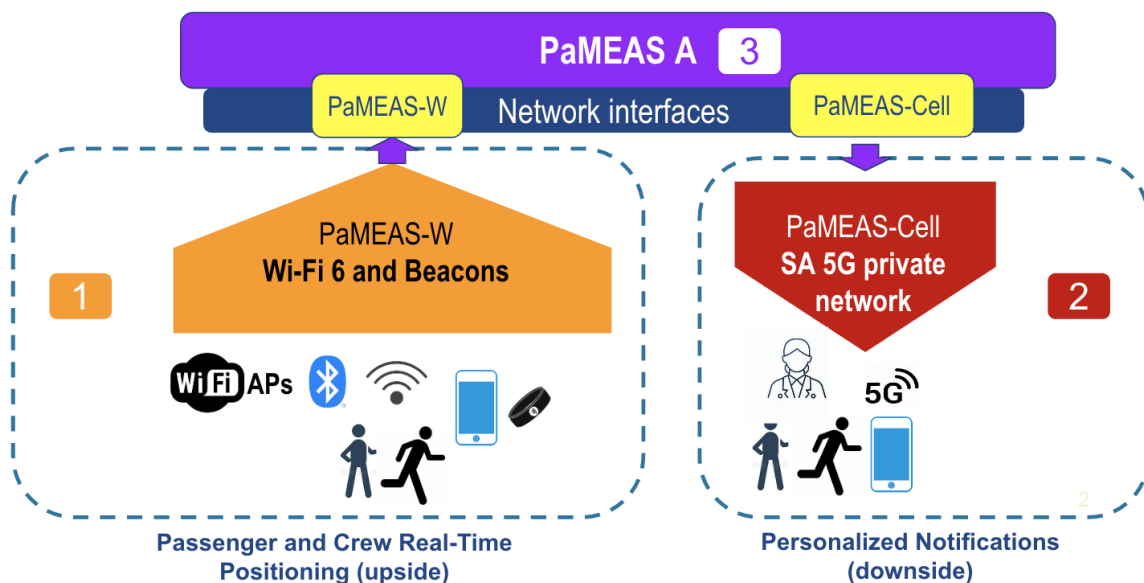


Figure 1: PaMEAS Core Components

The first version of the PaMEAS architecture in a real environment has been deployed earlier on the life of the project (M6-M18), at a building provided by the Municipality of Piraeus (where a reduced version of the Wireless LAN component of PaMEAS, i.e., PaMEAS-W, has been installed) and on the cloud. The implementation details and the progress made at this point of time, in terms of integration of the different PaMEAS

components, based on clean interfaces, has been reported in Deliverable D5.13 “PaMEAS Software Suite: Deployment v1”, delivered in May 2021 [1]).

Compared with version (v1), the second version of the PaMEAS architecture has further extended and improved the functionality of the PaMEAS system, during M18-M44, and deployed the final system configuration onboard a ship, in close interaction with WP8 “PALAEMON Application Field Trials, Evaluation and Outcomes” (M20-M44). PaMEAS is the core engine of the Smart Evacuation Management platform (SEM) that has been deployed on-board a ship provided by ANEK (ELYROS F/b) in WP8 to support the pilot application of the PALAEMON technology-assisted evacuation process -- described in Deliverable 8.4-5 “PALAEMON application trial SEM (Greece)” [2].

The validation of PaMEAS v2 has conducted in two phases, as part of the overall validation of the SEM platform:

- a) TRL¹ 4 validation (in laboratory conditions): Included all core components and system functionality (PaMEA-A) but
 - i) the Wireless Network (PaMEAS-W) has been simulated through a passenger location simulator which takes in consideration the specificities of the ship's structure, decks, staircases etc.
 - ii) the Communications functionality (PaMEAS-Cell) was delivered by a typical 4G telecom connection
- b) TRL 5 validation (in a relevant environment - industrially relevant environment): PaMEAS-W and PaMEAS-Cell implemented on-board (in the context of the parallel development of WP5 and WP8)

This Deliverable follows the design principles and specifications described in Deliverables D5.9 and D5.10, delivered at M18 and M44, respectively [3,4]. It implements the Technical Architecture described in D5.9 and D5.10 documents, The PaMEAS Software Suite follows the design principles of PALAEMON Reference Architecture v1, described in D2.6 [5]. Of course, PaMEAS is part of the broader PALAEMON ICT ecosystem, as shown in the following figure.

¹ Technology Readiness Level

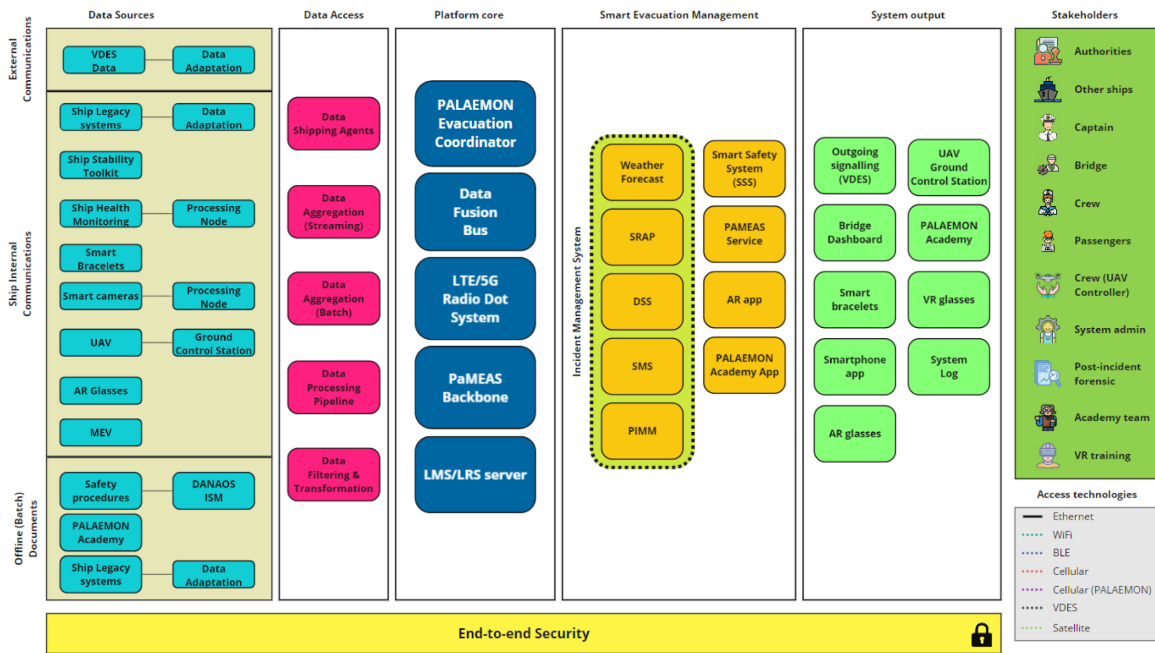


Figure 2: PALAEMON ICT Ecosystem: Architecture and Components

The Deliverable document is structured in the following sections, besides the Introduction section:

Section 2 outlines the PaMEAS functionality and the implementation approach adopted in the development of PaMEAS Software Suite v2.

Sections 3 describes, in detail, the PaMEAS Software Suite v2 implemented system architecture and catalogue the key components of the system highlighting their functionalities.

Section 4 describes the deployment details of the PaMEAS Software Suite v2 (demonstrator) under TRL 4 status, as part of the overall SEM platform (TRL 4) - TRL 5 status (reached after successful TRL 4 validation) is described in D8.6 “PALAEMON Consolidated Pilots Evaluation” [6].

2 PaMEAS functionality and implementation approach

PaMEAS is a key component of the PALAEMON Smart Evacuation Management approach. It incorporates IT technology, human factors, safety processes, and regulated operating procedures to improve ship “evacuability”. The SEM platform enhances the evacuation experience, and helps ensure efficient evacuations, by providing the Bridge the tools to sense/monitor the ship's state, track resources and passengers, guide crew and passengers during an evacuation, manage incidents (real-time monitored operation).

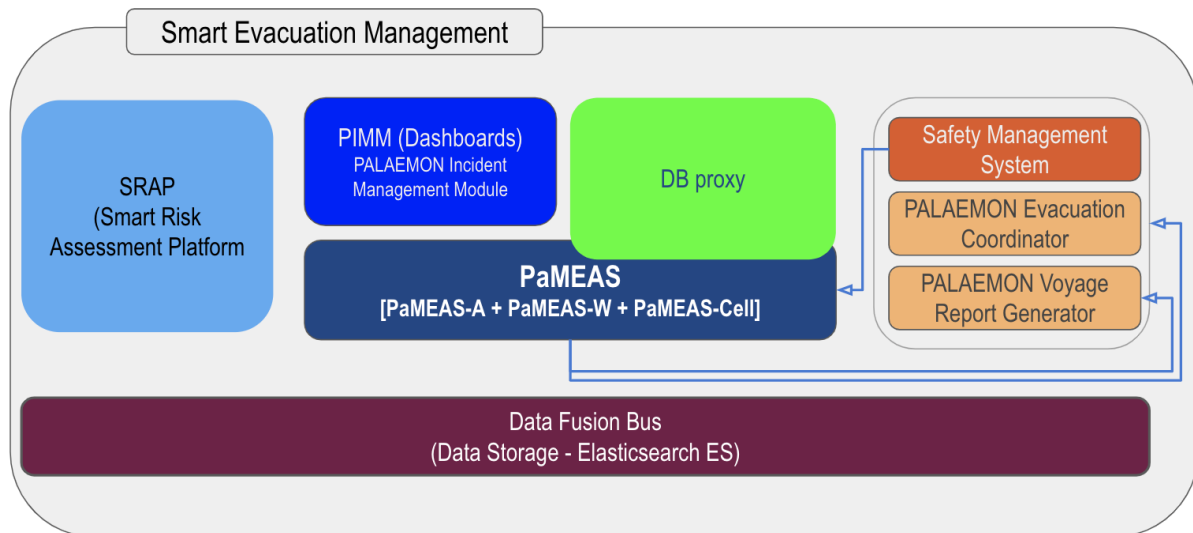


Figure 3: PaMEAS within Smart Evacuation Management architecture

Specifically, PaMEAS enables the following capabilities:

PaMEAS Core Functionality

1. Allows for real-time tracking and monitoring of passengers and crew members on all areas/decks of the ship
2. Automatically initiates a pre-established evacuation messaging policy that is communicated to passengers' mobile devices via multimedia messages
3. Builds instant communication channels between the bridge, the crew members and the passengers
4. Manages the handling of passenger issues such as injuries optimising the allocation of crew resources needed for their management

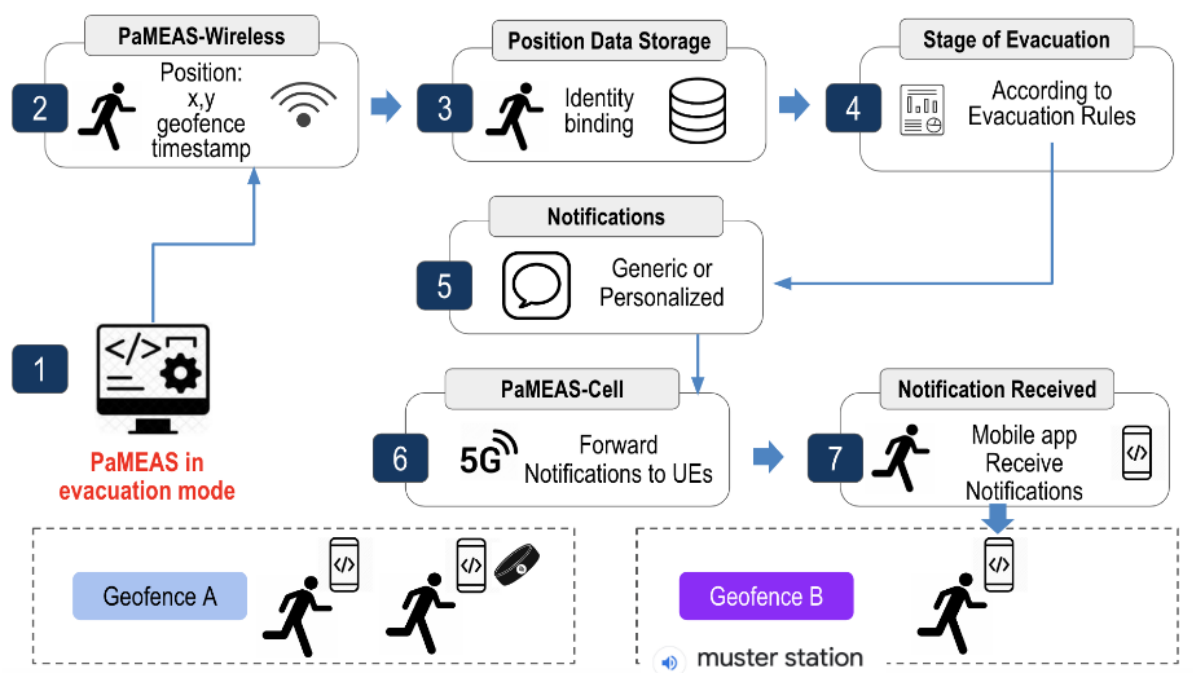
The PaMEAS Software Suite provides the aforementioned functionality in the way that is shown below:

PaMEAS Software Suite v2 Core Implementation Approach

1. Passengers and crew members have been registered with PaMEAS People Management System (PMS)
 - Passengers complete the registration by downloading and initialising the PALAEMON Passenger app
 - Crew members have downloaded the PALAEMON crew app
2. PaMEAS has transitioned out of the normal mode in which passengers' location is regularly retrieved but under passengers' consent²

² which can be withdrawn by the passenger at any time

3. PaMEAS is triggered by the Evacuation Signal (received via the PALAEMON Communication Platform³): all passengers' locations become visible to the system (obviously, GDPR restrictions can not apply when people's lives are in danger).
4. The mobile apps of the passengers and crew members uses the signals received by the PaMEAS-W (PaMEAS Wireless) network to calculate the location of the users and make them available to PaMEAS RTLS system (Real Time Location System)
5. The PaMEAS-A (Application) retrieves all passengers' position data and effectively stores them updating the profiles of the passenger and crew members with their latest known location (timestamped)
6. The PaMEAS-A (Application) applies the evacuation plan and selects the appropriate reference "stage of evacuation" -- based also on the information received from PALAEMON Communications Platform (note: an evacuation plan consists of several distinct stages: Situation Assessment, Activation of Evacuation Protocol, Alert Passengers, Mustering and Embarkation).
7. The PaMEAS-A (Application) composes the appropriate Alert or Notification Messages (generic and personalised) that should be sent to passengers based on:
 - The reference Evacuation Stage
 - PaMEAS Messaging Policy Model
 - Passenger location position information (geofence)
 - Passenger specific profile (Personal Information Profile, Network Access Profile, Location Profile)
8. PaMEAS-A forwards the previously composed output Alert or Notification Messages to PaMEAS-Cell (5G SA Network)
9. PaMEAS-Cell reaches the UEs of the passengers and delivers them via the appropriate channel on their mobile apps (MCPTT or Websocket)
10. PaMEAS registers eventual passengers' position change -- based on the notification received (until the arrival of the passengers at the MEVs).



³ PALAEMON Data Fusion Bus, "evacuation-coordinator" Kafka topic.

Figure 4: PaMEAS Software Suite V2 implementation approach

3 PaMEAS architecture and components

The PaMEAS Software Suite consists, at first, of a set of microservice which coordinate to offer specific functionalities (organised into high level components), i.e., **PaMEAS-A**. It comprises the following major groups of components which are mostly integrated through Application Program Interfaces (APIs):

Processing Components:

1. People Management System (PMS) - C1
2. PALAEMON Mobile Apps - C2
3. PaMEAS Evacuation Enabler - C4
4. PALAEMON Emergency Messaging Service - C5
5. PaMEAS Incident Manager - C6

Integration Components:

6. PaMEAS Access Manager - C3
7. PaMEAS-SRAP Integrator - C7
8. PaMEAS Passenger Location Simulator - C8

PaMEAS-A, at second, integrates with the underlying network layers, **PaMEAS-W** and **PaMEAS-Cell**, via the following network interface components: RTLS and Emergency messaging Service (Mumble/Tactilon Servers), as explained in the following figure.

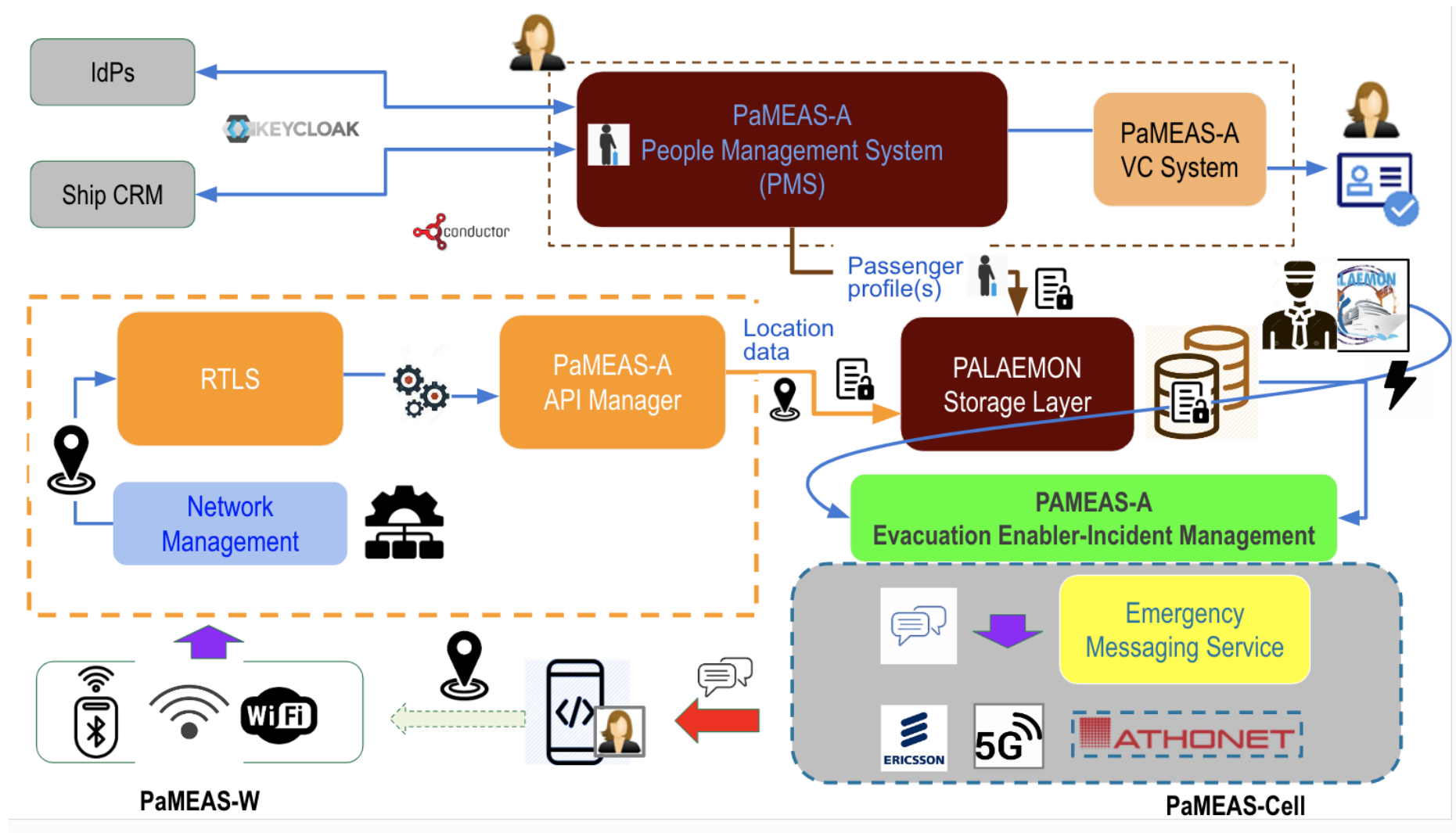


Figure 5: PaMEAS Software Suite V2 architecture, components and flows

Table 1: PaMEAS-A architecture: List of components

no.	High Level Component	MicroServices - Implementing High Level Component	Description
Processing Components			
C1	People Management System (PMS)		
		Embarkation Registration Service	Passenger (and Crew) Registration Service
		PaMEAS VC System: - PaMEAS VC (Verifiable Credentials) Issuer - PaMEAS VC Verifier	Backend service of the PMS generating and managing the lifecycle of the PALAEMON Service card
		Trusted Registry	Revocation Registry for PALAEMON Service Cards
C2	PALAEMON Mobile Apps		
		PALAEMON Passenger App	
		PALAEMON Crew App (Agnat Work)	
C4	PaMEAS Evacuation Enabler		
		Real time Location Service (RTLS)	Over cloud or “on premises”
		RTLS API Manager	Location monitoring and pushing to persistence
		RTLS-Load Balancer	Load balancing (nginx)
		Netflix Conductor & Postgre	Microservices Orchestration Engine
		PaMEAS-A Orchestrator	Orchestrator implementing PaMEAS-A flows using Netflix Conductor
		Rules Engine	Rules Engine to support message generation and passenger routing selection



C5	PALAEMON Emergency Messaging Service		
		Core Messaging Service Module Mumble Server Tactilon Agnet Work	Messaging functionality over Websocket and external services (Airbus Tactilon Agnet)
C6	PaMEAS Incident Manager		
		Constraint Solver (OptaPlanner)	AI constraint solver to assist with Passenger issues
		Pathfinder	Utility service that helps calculate distances on board the decks
		Rules Engine (Drools, API over Drools)	AI Rules Engine to support message generation and passenger routing selection
Integrating (Peripheral) Components			
C3	PaMEAS Access Manager (*) WP5 - WP6 collaboration		
		PaMEAS OAuth 2.0 server Keycloak	OAuth 2.0 Authorization & User Identification
		PaMEAS DBProxy Service	Persistence API
		PaMEAS DBProxy Load Balancer	Load balancing (nginx)
C7	PaMEAS-SRAP Integrator		
		PaMEAS DBProxy Service	
		Orchestrator (Conductor)	
C8	PaMEAS Passenger Location Simulator		
		PaMEAS Passenger Location Simulator	Simulates movements of passengers from random location to muster stations



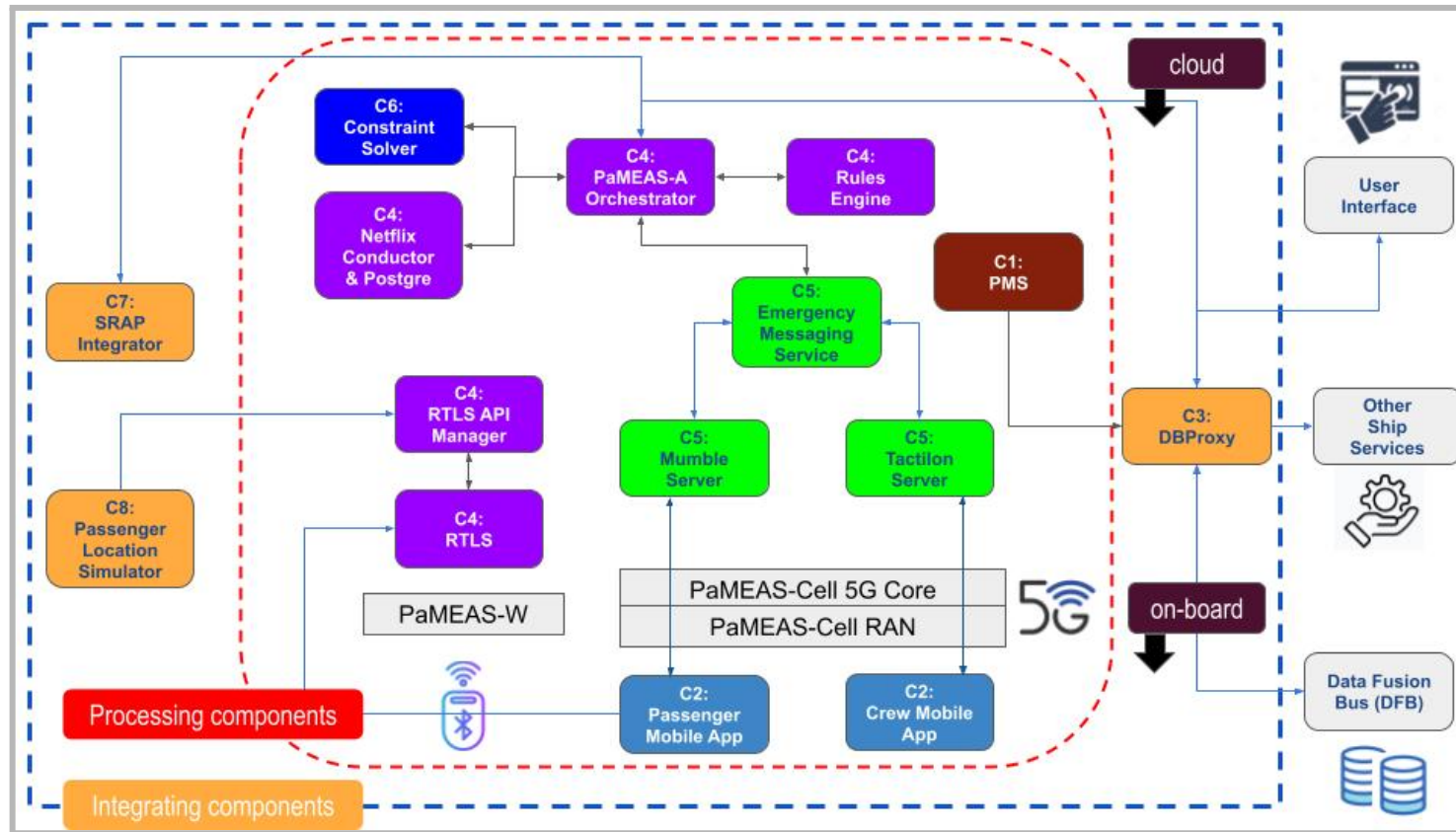


Figure 6: PaMEAS architecture and components

3.1 C1: People Management System (PMS)

This component is responsible for the registration of the passengers (and crew members) to the system generating their full profile. This profile is used by the PaMEAS to target the instructions and alerts to the specific needs/capacities of the passengers and assign appropriate tasks to the crew members. It is implemented via the following microservices:

- **Embarkation Registration Service:** Web interface that the passengers interact with (primarily via their mobile phones) to register to the system. This service enables the users to authenticate (using an Identity Provider built specifically for the purposes of the project), and register with the PaMEAS.
 - Reference presentations:
 - https://docs.google.com/presentation/d/1MwXEf7tc2a9sANBsxOAwitxY7Gbb4oov/edit#slide=id.g11059583ad3_1_7
 - https://docs.google.com/presentation/d/16W8H_h-qz2HTbRwcXpGJ9RnrYqZxCAZ8/edit#slide=id.g109536bd6dd_2_24
 - github:
 - <https://github.com/uaegean-i4mLab/palaemon-registration-embarkation>
- **PaMEAS VC System:** Backend service of the Embarkation Registration Service generating and managing the lifecycle of the PALAEMON Service card (a verifiable credential⁴ issued to the passengers of the system, enabling them to manage access to their location data- when not in emergency situations-). Consists of the following modules:
 - **PaMEAS VC Issuer:** this module implements a W3C compliant verifiable credential issuer (utilising the Jolocom stack⁵) which is responsible for the creation of the passengers verifiable credentials (VCs) attesting to their identity and personal attributes, allowing them to gain access to specific services on board.
 - github:
 - <https://github.com/uaegean-i4mLab/palaemon-registration-embarkation>
 - **PaMEAS VC Verifier:** Implements an OIDC⁶ Provider which consumes the aforementioned VCs verified them according to the W3C specifications and uses them to enable access to specific on board services
 - github:
 - <https://github.com/uaegean-i4mLab/palaemon-registration-embarkation>
 - **Trusted Registry:** Registry on a permissioned blockchain which enables to maintain the revocation status of issues VCs by the system as well as a list of trusted issuers.

⁴ W3C verifiable credentials are a standard for digital credentials that can be cryptographically verified and used to prove different kinds of information about different subjects. <https://www.w3.org/TR/vc-data-model/>

⁵ <https://jolocom.io/>

⁶ OpenID Connect (OIDC) is an authentication protocol that verifies a user's identity when a user tries to access a protected HTTPS endpoint, using an ID token that is issued by an OpenID provider



3.2 C2: PALAEMON Mobile Apps

PaMEAS offers two mobile apps (one for passengers and one exclusively for crew members). These enable the instant communication between the bridge, the crew members and the passengers. Additionally, the Passenger apps generate and transmit to the system the location of the users.

- **Passenger Mobile app:** Mobile app provided to the passengers enabling them to register their device to their profile. Furthermore, it enables users to A) receive emergency alerts and notifications (e.g. mustering instructions) B) initiate VoIP communications with the bridge C) publish the location data of the users to the system (binding them to their profile) D) provide Wayfinding capabilities to the users. Both the messaging and VoIP communications take place on a dedicated server which acts as the backend of the system.
 - Reference document: <https://docs.google.com/document/d/1RNmEbCnGu-0ELdQQpQkQ3aPBznm4-MvINh-ncl6tpkU/edit?usp=sharing>
 - Accessed via: <https://cloud.kgiannakis.me/s/z8XJt7SNnowT2Db>
- **Crew Mobile app:** Mobile app operated by the crew members and the bridge. This app (together with its backend system) enables the crew to A) receive and transmit messages to the bridge B) Initiate Push2Talk channels as well as C) Streaming sessions between the bridge and the crew members. This app is a proprietary Mission Critical Push to Talk (MCPTT) solution provided for the needs of the project by Airbus (Tactilon Agnet)⁷ [12].
 - Accessed via: <https://play.google.com/store/apps/details?id=com.airbus.agnet.work.producti on>

3.3 C3: PaMEAS Access Manager

Service providing security via access control policies with respect to the data offered by the PaMEAS ecosystem. Specifically, this service implements ABAC providing fine grained control over which microservice can gain access to which passenger data.

- Reference presentation:
- https://docs.google.com/presentation/d/16W8H_h-qz2HTbRwcXpGJ9RnrYqZxCAZ8/edit#slide=id.g109536bd6dd_2_24

It consists of the following modules:

- **PaMEAS DBProxy Service:** This service handles the encryption of the user's personal identification information and acts as a gateway to the overall generated user data providing access only to authorised microservices (acting as a OAuth2.0 protected resource). Finally, this module connects to the persistence and message queues of PALAEMON (ElasticSearch and Kafka respectively)
 - github: <https://github.com/uaegean-i4mLab/palaemon-db-proxy>
- **PaMEAS OAuth 2.0 server (Keycloak).** OAuth 2.0 resource server defining the policy about and issuing the access control tokens to the platform's microservices

⁷ <https://www.securelandcommunications.com/agnet>



- **PaMEAS DBProxy Load Balancer:** Load balancer using “round-robin”, distributing the load between several instances of the PaMEAS DBProxy Service to ensure better availability.

3.4 C4: PaMEAS Evacuation Enabler

This component provides core functionality of the system: (a) fetching and publishing the location of the passengers and crew members to the system (b) implements the core evacuation flows (alert passengers via personalised, location-based, notifications, provide guidance to the passengers on how to reach a muster station, detect passenger issues and address incidents during evacuation). Specifically, it consists of the following modules:

- **Real time Location Service (RTLS):** An indoor Real Time Location Service (RTLS) is a system that provides indoor location coordinates and services for people or assets inside a building⁸. An RTLS system can be implemented by a plethora of technologies such as WiFi, Bluetooth and so on, to determine and communicate the location of the targeted person or asset. Essentially, it can be seen as a GPS for indoor locations. In the context of PALAEMON various “on premises” and cloud RTLS systems were evaluated with respect to their capacity to offer accurate real time location of passengers and crew members inside the premises of the ship. PaMEAS abstracts the actual implementation of the RTLS system via the RTLS API Manager module. In this way the RTLS system becomes a plug-and-play feature of PaMEAS enabling the best suited system to be used depending on the specifics of each vessel, and furthermore enabling the deployment of the RTLS service either on the cloud or on-premises of the ship.

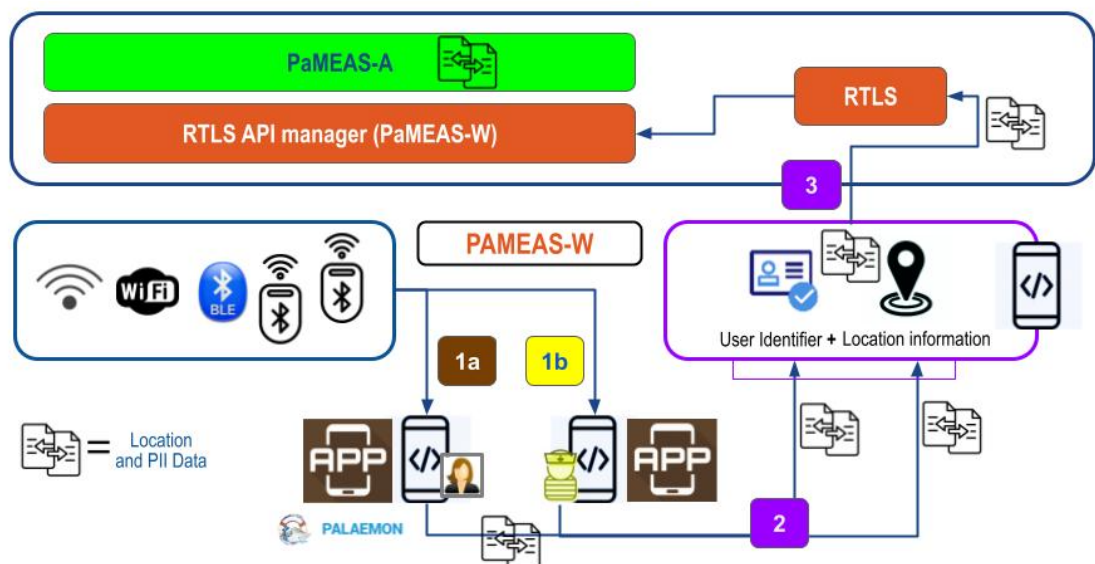


Figure 7: RTLS integration on PaMEAS

- **RTLS API Manager:** This module abstracts the specifics of the RTLS system employed enabling the integration of different such solutions to PaMEAS with

⁸ <https://www.gartner.com/reviews/market/indoor-location-services>

minimal integration effort and ensuring the changes do not cascade into the rest of the microservices implementing the platform. Specifically, the RTLS API Manager:

- Handles in real time the retrieval of the location information of the passengers and crew members from the RTLS system
- Transforms the RTLS data into a PaMEAS specific data model ensuring uniformity regardless of the solution used (see figure below)
- Ensures passenger location data are retrieved only if consent is provided or if the emergency evacuation procedure is active
- Exposes certain location based functionalities, like the calculation of a geofence based on provided coordinates
- Enables the definition of various PaMEAS specific configuration parameters (e.g. location update intervals)



Figure 8: PaMEAS Location Data Model

- **github:**
<https://github.com/uaegean-i4mLab/rtls-api-manager>

- **RTLS-Load Balancer:** Load balancer to ensure the system can handle hundreds of simultaneous location update requests and queries.
- **Netflix Conductor & Postgre:** Netflix conductor⁹ is an open-source platform created by Netflix to orchestrate workflows that span across microservices. It supports creating workflows using JSON and code in multiple languages. In the context of PaMEAS an instance of Netflix Conductor (with persistence provided by a Postgre db) is used to define and execute the flows¹⁰ created by combining the tasks implemented by the PaMEAS-A Orchestrator module. As a result PaMEAS uses microservice orchestration to coordinate the interactions between the various microservices, ensuring that they work together seamlessly to provide a smooth and efficient user experience. This allows the platform to be highly scalable and adaptable.
 - github:
<https://github.com/Netflix/conductor>
- **PaMEAS-A Orchestrator:** This module creates the tasks required to define and execute flows implementing the PaMEAS business logic. Specifically, it defines the necessary tasks for alerting passengers to emergencies, sending mustering instructions, detecting and resolving passenger incidents and so on.
 - Flows: Design Document/Notes
<https://docs.google.com/document/d/1ljmMZdKulWhcCmA4jlquAxP8VplmNn1SXZUCWVLKp2o/edit?usp=sharing>
 - github:
<https://github.com/uaegean-i4mLab/palaemon-conductor>
- **Rules Engine:** A rules engine is a software tool that is used to define and enforce rules within a system. The rules engine used in the context of PaMEAS is based on the Drools framework, which provides a powerful and flexible set of tools for defining, managing, and executing rules within a system. The rules engine module is used to:
 - Define the rules that govern the generation of text messages that are sent to passengers in the case of an emergency. Using the rules engine, PaMEAS is able to define the conditions under which messages should be sent to passengers, as well as the specific content of those messages. For example, the rules engine is used to specify that passengers should be alerted if there is an emergency on board the ship, and that the messages sent to passengers should contain instructions on how to evacuate or muster in a safe location.
 - Determine the optimal mustering path that passengers should follow based on their latest location, following the ships evacuation plan and the real-time condition of the segments of the paths (blocked, congested, open). This allows the PaMEAS to provide passengers with the most efficient and safe mustering route, ensuring that they can reach their designated muster point quickly and easily in the event of an emergency.
 - Determine the capacity of a crew member to assist a with a specific passenger issue based on their training

⁹ <https://conductor.netflix.com/>

¹⁰ passengers requesting help via their mobile apps, passengers needing help due to pre-existing health issues, passengers not following the evacuation plan, passengers leaving the muster stations and so on



- implements the required REST endpoints to enable querying of the Rules engine by other services.
- github:
<https://github.com/uaegean-i4mLab/palaemon-rules-engine>

3.5 C5: PALAEMON Emergency Messaging Service

The PALAEMON Emergency Messaging Service implements all the required software functionalities to support the instant communication between the bridge, passengers and crew. Specifically, the Emergency Messaging Service implements the following core features:

- a. With respect to **Passengers**:
 - i. **Text, Multimedia Messages**: Passengers receive alerts and evacuation instructions from PaMEAS-A
 - ii. **Emergency buttons** (standard assistance functionality such as: SOS - CallMe - I feel sick - My family is at risk - Report an Accident - Text the Bridge): Passengers send Emergency Feedback Messages directly to the Bridge to request assistance
 - iii. **PushToTalk**, enabling the passenger to directly send and receive audio messages to/from the bridge
 - b. With respect to **Crew Members**:
 - i. **Text Messages** and **Text2Speech**: Crew receive assignment requests sent from PaMEAS-A
 - ii. **Mission Critical PushToTalk (MCPTT)**: Crew receive orders and acknowledge assignment requests
 - iii. **Streaming and information forwarding**: Crew stream video to the Bridge,
 - c. With respect to **Storage**
 - i. Storage for all text messages sent to Passengers and Crew Members
 - ii. Storage for all messages received from Passengers
 - d. With respect to **Interfaces**
 - i. View all messages sent to Passengers and Crew
 - ii. View all messages sent to a specific Passenger/Crew Member - search
 - iii. View all Emergency Feedback Messages received by the Passengers
- Reference document:
https://docs.google.com/document/d/14ds9-FdW9yl_IIxppFHMxRhMwfnB4X_q39MY3uhRdEQ/edit?usp=sharing
 - github:
<https://github.com/uaegean-i4mLab/pameas-message-service>

To implement this functionality the **Emergency Messaging Service** is implemented by the **Core Messaging Service Module** which abstracts the specifics of the messaging protocols/systems used by exposing a REST API to the rest of the PaMEAS-A suite. This is achieved by integrating the following:

- **Tactilon Agnet Work**: Airbus Tactilon Agnet is a professional communication solution that provides voice, video, multimedia services for mission-critical users. It



allows secure and reliable transmission of data to all relevant parties. It is used by public safety, fire brigade, airport and industrial users¹¹.

- **Mumble Server:** The PaMEAS Mumble Server is an instance of Mumble¹² deployed for the needs of communicating with the passengers. Mumble is a free, open source, low latency, high quality voice chat application and protocol.

]The usage of the Emergency Messaging Service in the broader context of PaMEAS is presented below:

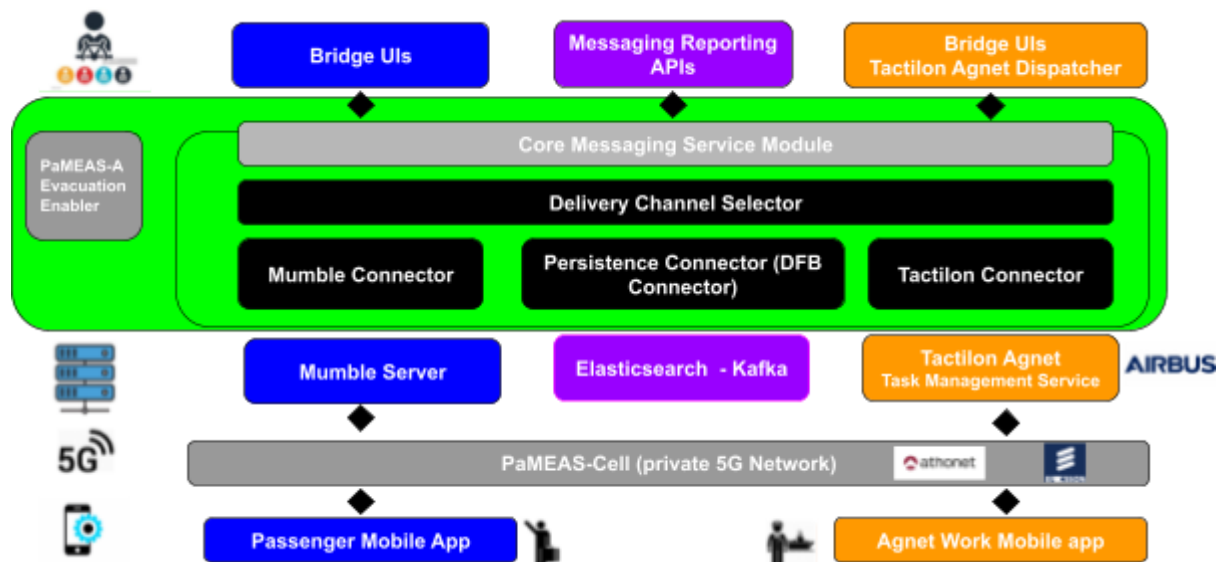


Figure 9: Emergency Messaging Service integration

Furthermore, the Emergency Messaging platform is used to initiate PaMEAS flows based on the messages received by the passengers (requesting help) as presented in the figure below:

¹¹ <https://www.securelandcommunications.com/agnet>
<https://www.timesaerospace.aero/news/airports/india-public-safety-users-to-receive-airbus-tactilon-agnet-solution>

¹² <https://www.mumble.info/>

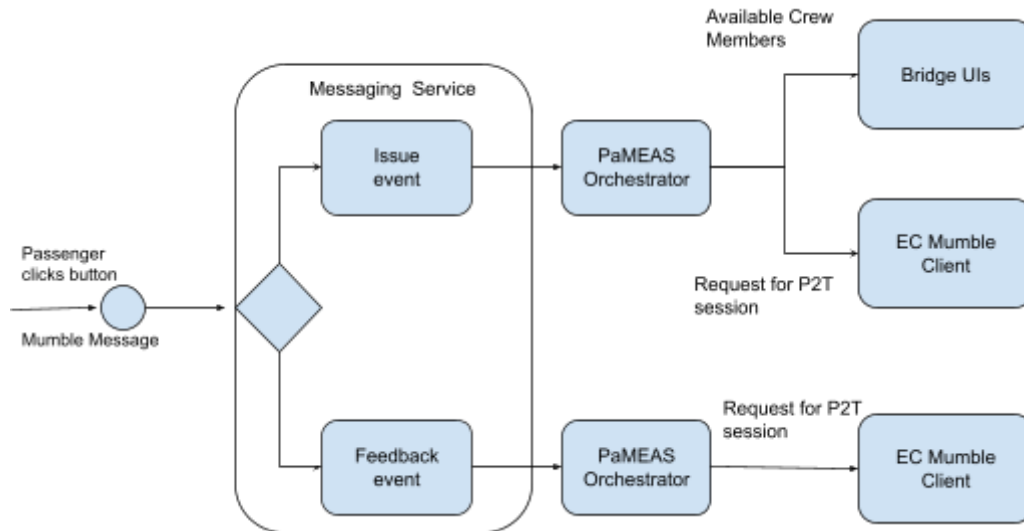


Figure 10: Passenger messages triggering flow execution

3.6 C6: PaMEAS Incident Manager

The PaMEAS Incident Manager component encapsulates the business logic required for detecting and handling passenger incidents (specifically with respect to optimising crew member assignments in an effort to minimise task execution times). Its functionalities are implemented using the following microservices:

- **Constraint Solver:** A constraint solver is a type of optimization algorithm implementation that can be used to find solutions to complex problems with multiple constraints. In PaMEAS Optaplanner¹³ is used to build the Constraint Solver microservice that suggests to the bridge the optimal assignment of crew member teams to passenger issues. OptaPlanner is an open source constraint solver that optimises planning problems with hard and soft constraints. It is highly configurable and can support various construction heuristics such as Tabu Search¹⁴, Simulated Annealing¹⁵ and Late Acceptance¹⁶, to find feasible and optimal solutions. Specifically, The PaMEAS Constraint solver leverages Optaplanner and takes into account factors such as the skills and expertise of individual crew members, the type of each passenger issue, the availability of crew members, and uses this information to find the optimal assignment of crew members to passenger issues.
 - github: <https://github.com/uaegean-i4mLab/palaemon-constraint-solver>
- **Pathfinder:** This module implements a service for calculating the distances between the various points of interest (crew members, passengers, muster stations etc.) taking into consideration the specifics of the ships layout, exposing endpoints to query it
 - github: <https://github.com/uaegean-i4mLab/location-simulator>
- **Rules Engine:** described as part of C4

¹³ <https://www.optaplanner.org/>

¹⁴ https://www.researchgate.net/publication/242527226_Tabu_Search_A_Tutorial

¹⁵ https://www.researchgate.net/publication/226778564_Simulated_Annealing

¹⁶ <https://www.sciencedirect.com/science/article/abs/pii/S0377221716305495>



3.7 C7: PaMEAS-SRAP Integrator

This component is responsible for handling the outputs of the Smart Risk Assessment Platform (SRAP) module [7]. SRAP is a PALAEMON module that calculates risks for various aspects of the emergency evacuation management, including risks with respect to passengers health as those are recorded by the SmartBracelets¹⁷ of the passengers (e.g. biometrics of a passenger fall below acceptable thresholds, movement speed reduced when everyone else around them is moving)¹⁸. This component processes the outputs of SRAP and depending on the results triggered PaMEAS specific flows (e.g. handling of a passenger incident).

The functionality of this component is implemented via the following two microservices described above:

- PaMEAS DBProxy Service: described as part of C3
- Orchestrator (Conductor): described as part of C4

3.8 C8: PaMEAS Passenger Location Simulator

The PaMEAS Passenger Location Simulator is a component/microservice built for the purposes of testing the overall functionality of the PaMEAS-A. The Location Simulator enables the “mocking” of the network/”sensing” dependent facilities of PaMEAS-W when that is not available (in pre-production conditions), for example in the context of a lab deployment” (TRL 4).

Specifically, this microservice supports the simulation of passengers moving onboard the vessel heading towards the Muster Stations and is predominantly used as a stub for the RTLS service (mimicking the generation of compatible RTLS location data for “virtual” passengers).

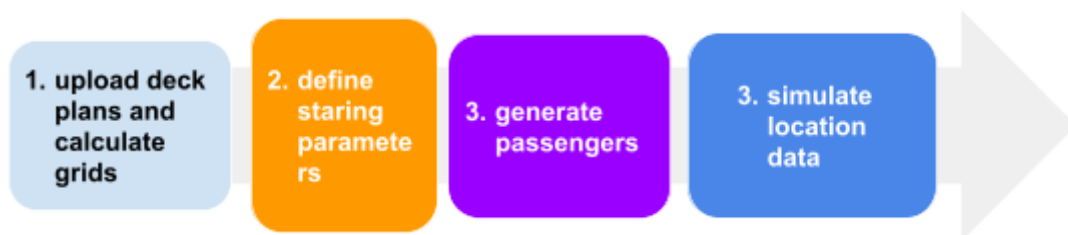


Figure 11. Passenger Simulator Execution Flow

The Simulator works as follows: the ships layout is used as a grid via which the Simulator generates passengers at random locations and then uses the A*-algorithm¹⁹ to guide them to the Mustering Stations using predefined paths. Additionally, the software enables the random assignment of movement speeds to the passengers and allows for the specification of the percentage of passengers who require evacuation assistance or will display health issues. The steps of the simulation execution flows are presented in the following table.

¹⁷ For an overview of the capacities of the SmartBracelets please refer to D7.7[7]

¹⁸ For a comprehensive overview of the capacities of SRAP please refer to D7.7 [7]

¹⁹ The A* algorithm is a popular pathfinding algorithm commonly used in computer science and game development to find the shortest path between two points on a grid

Table 2: Simulation Stages

Simulation Input	Simulation Execution	Simulation Finish
<ul style="list-style-type: none"> • Vessels floor plan • Initialization parameters (percentage of passengers to exhibit health issues) 	<ul style="list-style-type: none"> • Virtual Passenger Generation • Path Assignment • Speed Assignment • Movement Simulation • Tester triggers events (e.g. mustering instructions) 	<ul style="list-style-type: none"> • Virtual Passengers gathered at MS

- github:
<https://github.com/uaegean-i4mLab/location-simulator>

3.9 PaMEAS-A summary table

The following table summarises the location of the online references for the web location of the different components of PaMEAS-A.

Table 3: PaMEAS -A Summary Online Location Table

PaMEAS-A Components name	References
C1: People Management System (PMS) Embarkation Registration Service	github reference: <ul style="list-style-type: none"> https://github.com/uaegean-i4mLab/palaemon-registration-embarkation
	online material: <ol style="list-style-type: none"> https://docs.google.com/presentation/d/1MwXEf7tc2a9sANBsxOAwitxY7Gbb4oov/edit#slide=id.g11059583ad3_1_7 https://docs.google.com/presentation/d/16W8H_h-qz2HTbRwcXpGJ9RnrYqZxCAZ8/edit#slide=id.g109536bd6dd_2_24
C1: People Management System (PMS) PaMEAS VC Issuer	github reference: https://github.com/uaegean-i4mLab/palaemon-registration-embarkation
C1: People Management System (PMS) PaMEAS VC Verifier	github reference: <ul style="list-style-type: none"> https://github.com/uaegean-i4mLab/palaemon-registration-embarkation
C2: PALAEMON Mobile Apps Passenger Mobile app	github reference: <ul style="list-style-type: none"> https://github.com/kerk12/flutter-wayfinding
	online material: <ol style="list-style-type: none"> https://docs.google.com/document/d/1RNmEbCnGu-0ELdQQpqkQ3aPBznm4-MvINh-ncL6tpkU/edit?usp=sharing
	accessed via: <ul style="list-style-type: none"> https://cloud.kgiannakis.me/s/z8XJt7SNnowT2Db
C2: PALAEMON Mobile Apps Crew Mobile app	accessed via: <ul style="list-style-type: none"> https://play.google.com/store/apps/details?id=com.airbus.agnet.work.production



C3: PaMEAS Access Manager PaMEAS DBProxy Service	online material: 1. https://docs.google.com/document/d/1RNmEbCnGu-0ELdQQpgkQ3aPBznm4-MvINh-ncL6tpkU/edit?usp=sharing
	github reference: • https://github.com/uaegean-i4mLab/palaemon-db-proxy
C4: PaMEAS Evacuation Enabler RTLS API Manager	github reference: • https://github.com/uaegean-i4mLab/rtls-api-manager
C4: PaMEAS Evacuation Enabler Netflix Conductor	github reference: • https://github.com/Netflix/conductor
C4: PaMEAS Evacuation Enabler PaMEAS-A Orchestrator	github reference: • https://github.com/uaegean-i4mLab/palaemon-conductor
	online material: 1. https://docs.google.com/document/d/1IjmMZdKuIWhcCmA4jIquAxP8VplmNn1SXZUCWVLKp2o/edit?usp=sharing
C4: PaMEAS Evacuation Enabler Rules Engine	github reference: • https://github.com/uaegean-i4mLab/palaemon-rules-engine
C5: PALAEMON Emergency Messaging Service PALAEMON Emergency Messaging Service	github reference: • https://github.com/uaegean-i4mLab/pameas-message-service
	online material: 1. https://docs.google.com/document/d/14ds9-FdW9yI_IIXppFHMxRhMwfnB4X_q39MY3uhRdEQ/edit?usp=sharing
C6: PaMEAS Incident Manager Constraint Solver	github reference: • https://github.com/uaegean-i4mLab/palaemon-constraint-solver



C8: PaMEAS Passenger Location Simulator PaMEAS Passenger Location Simulator	github reference: <ul style="list-style-type: none">• https://github.com/uaegean-i4mLab/location-simulator
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4 PaMEAS Software Suite v2 Demonstrator

The above system architecture and components (PaMEAS-A, PaMEAS-W and PaMEAS-Cell) have been implemented in two different environments:

Table 4: PaMEAS Demonstrators

Lab environment: In-Lab Demonstrator	TRL 4
On-board a Ship (industrial environment): On-board Demonstrator	TRL 5

The PaMEAS Software suite demonstrator consists of the configuration and deployment of the components presented in the following two figures (Figure 9 and 10), which produce an operational instance of the PaMEAS system.

Figure number 9 presents the onboard deployment of the microservice architecture of PaMEAS, including the connectors to the underlying network infrastructures, PaMEAS-W and PaMEAS-Cell/5G Standalone (via RTLS and Mumble/Tactilon Servers, respectively) | **On-board Demonstrator - TRL 5.**

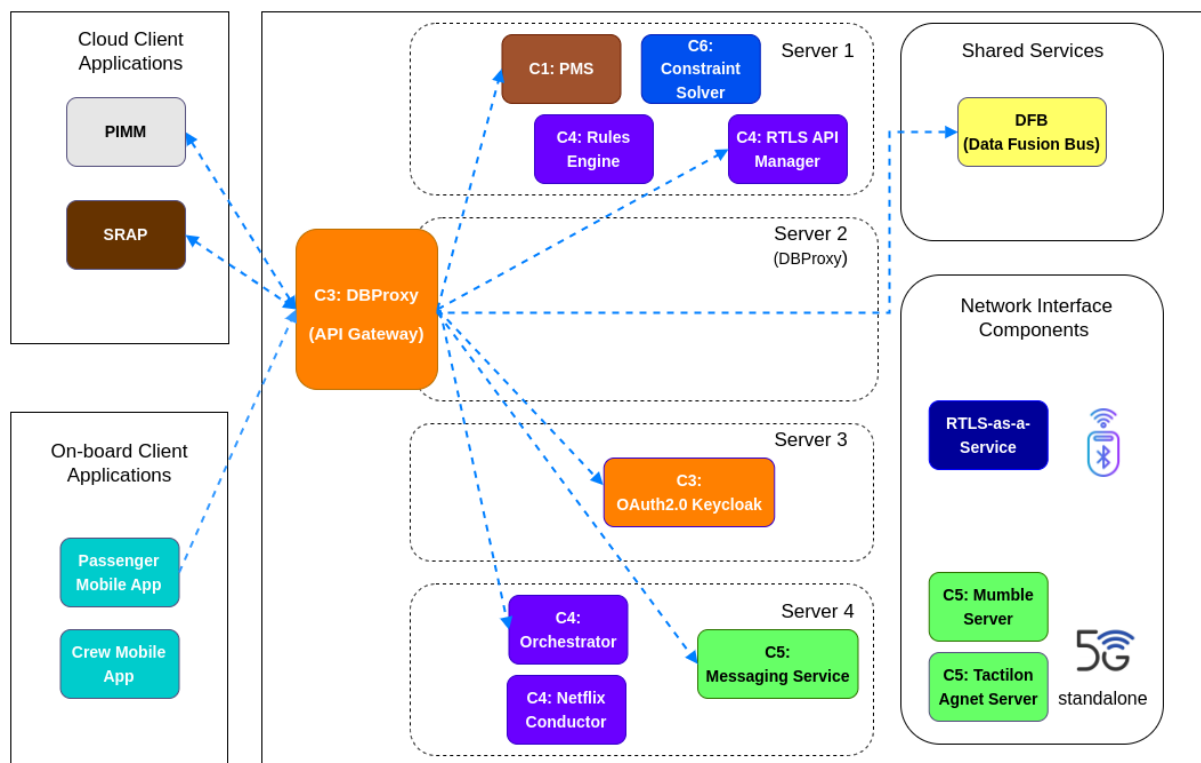


Figure 12: On-board Demonstrator - TRL 5

Figure number 10 presents the microservice architecture of PaMEAS as deployed in the Lab. In this implementation, the functionality of the Wireless, while a typical public 4G connection was used in the place of a 5G network infrastructure | **In-Lab Demonstrator - TRL 4.**

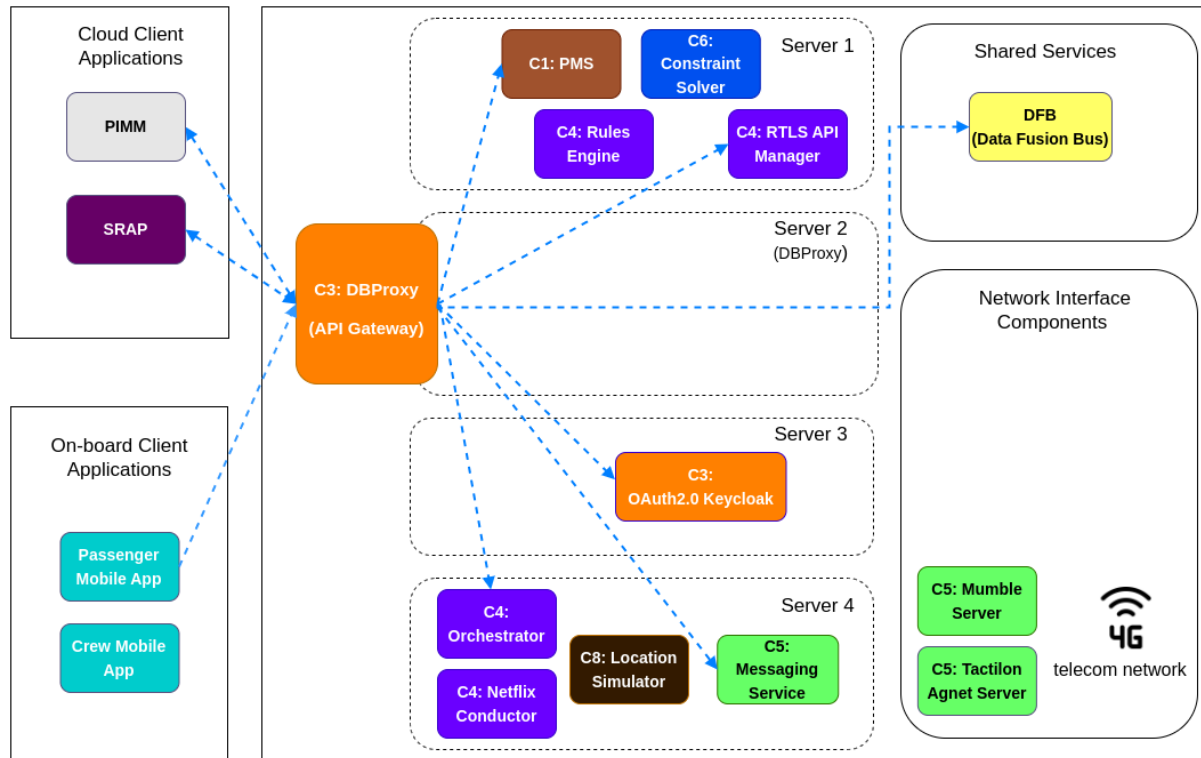


Figure 13: In-Lab Demonstrator - TRL 4

The demonstrator can be accessed and operated via a UI which is the PIMM²⁰, an important PALAEMON ICT Ecosystem component and core component of the Smart Evacuation Management platform. The deployment details of PaMEAS Software Suite v2 are presented in the following table:

Table 5: PaMEAS Deployment (Demonstrator)

Deployed on Cloud : In-Lab and On-Board Demonstrators (TRL4 & TRL5)		
Server	Owner	Modules
Server 1 195.251.134.246	UAegean	C1: PMS C3: PaMEAS DBProxy Load Balancer C4: Rules Engine C4: RTLS-Load Balancer C4: RTLS API Manager C5: PaMEAS Messaging Service: Mumble Server C6: Constraint Solver
Server 2 195.251.134.105	UAegean NTUA	C3: 5x PaMEAS DBProxy Service SRAP component
Server 3 195.251.134.199	UAegean	C3: PaMEAS OAuth 2.0 server Keycloak

²⁰ PIMM is the PALAEMON Incident Management Module, produced within WP6, which serves as the User Interface for PaMEAS-A.

Server 4 195.251.134.91	UAegean	C4: Netflix Conductor & Postgre C4: PaMEAS-A Orchestrator C5: PaMEAS Messaging Service: Emergency Core Messaging Service Module C8: 3x PaMEAS Passenger Location Simulator instances
https://dispatcher-1.ea-1.eu-west-1.agnet.com/	UAegean	C5: Tactilon Agnet Service
https://dashboard.situm.com/api/v1	UAegean	C4: RTLS as-a-Service
https://dfb.palaemon.itml.gr/	ITML	DFB (Data Fusion Bus)
https://pimm.konnekt-able.com/	Konnektable	PIMM (as User Interface)
Deployed On Premises (On-board a Ship): Included in the On-board Demonstrator (TRL5)		
Type	Owner	Component
WiFi 6 Access Points	UAegean	PaMEAS-W APs
BLE (Beacons)	UAegean	PaMEAS-W BLE Beacons
5G Core Server	UAegean Athonet	PaMEAS-Cell: 5G core (Athonet 5G Core)
5G Radio Dots	UAegean Ericsson	PaMEAS-Cell: RadioDots (Ericsson Radio Dots 4479)
Connected Mobile App		
Type	Owner	Component
Mobile app	UAegean	PALAEMON Passenger App (Android)
Mobile app	Airbus (ADS)	Agnet Work Crew Mobile App - MCPTT (Android)

The following Table presents the specific features of the PaMEAS Demonstrator:

Table 6: PaMEAS two-fold Demonstrator - Features

Description	Demo video	Status
In-Lab Demonstrator (*)		
<ul style="list-style-type: none"> All applicable PaMEAS modules operating with full functionality PIMM as UI Passenger and Crew location simulated (number of passengers and crew > 500) 	https://youtu.be/J7uQ0Pfl8pk	Reported in Annex 1

<ul style="list-style-type: none"> • Connectivity over 4G public network • Execution using a specific scenario (*) <ul style="list-style-type: none"> ◦ split into verifiable steps • Validation in the laboratory <ul style="list-style-type: none"> ◦ alpha testing ("white box testing") executed by a team of in-house developers ◦ additional "black box tests" were executed as part of the TRL4 validation where the developers acted as the end users of the system (Master, crew members and passengers) interacting with the system as necessary (e.g. participating in push to talk calls, requesting assistance via mobile app etc.). 		
On-board Demonstrator (**)		
<ul style="list-style-type: none"> • All PaMEAS modules operating with full functionality • PIMM as UI • Passenger and crew location via RTLS connected to a APs/Beacons network (PaMEAS-W) • Connectivity over 5G Standalone network - private 5G (PaMEAS-Cell) • Execution using several scenarios/exercises • Validation on ELYROS F/B with real users <ul style="list-style-type: none"> ◦ "closed" beta testing, in "production environment" ◦ Students acting as passengers and crew ◦ ELYROS crew members par of the demonstration/pilot team 	https://youtu.be/HooVWFkStqM	Reported in WP8 Deliverables

(*) In-Lab Demonstration Scenario

Preparatory Actions: Passenger and Crew Registration via PALAEMON People Management System (PMS)
1. Emergency Situation Assessment (two acts) Act 1.1: Emergency Inspection Episode 1.1.1 - Triggering of the smoke alarm and its display on PIMM Episode 1.1.2 - Order for emergency Inspection Act 1.2: Emergency Reconnaissance Episode 1.2.1 - Crew team arrives on the Incident location Crew reports back Situation is evaluated
2. Activation of evacuation protocol - Alerting passengers (one act) Act 2.1: Activation of evacuation protocol - Alerting passengers Episode 2.1.1 - Evacuation protocol activated Crew notification about evacuation launch Alerting passengers

<p>3. Mustering (three acts)</p> <p>Act 3.1: Mustering in progress</p> <p>Episode 3.1.1 - All systems in mustering mode Passengers notifications</p> <p>Episode 3.1.2 - Passengers mustering instructions</p> <p>Episode 3.1.3 - Identification of passengers in distress</p> <p>Act 3.2: Mustering update - Closing of Muster station D</p> <p>Episode 3.2.1 - Mustering instructions update</p> <p>Act 3.3: Incident Management</p> <p>Episode 3.3.1 - Identification of trapped passenger</p> <p>Episode 3.3.2 - Passenger requests help</p>
<p>4. Embarkation (two acts)</p> <p>Act 4.1: Mustering Completed and reporting from the fire team</p> <p>Episode 4.1.1 - Decision to abandon the ship</p> <p>Episode 4.1.2 - Passengers embarkation to LSAs</p> <p>Act 4.2: Organization of evacuees in groups</p> <p>Episode 4.2.1 Group formation and notification for evacuation</p>

(**) Onboard Demonstration Scenario: See WP8 Deliverables

5 PaMEAS Software Suite v2 Demonstrator: design requirements validated

The purpose of PaMEAS Software Suite was to establish the necessary tracking, data processing and notification functionality for a technology-assisted evacuation management approach. The PaMEAS Demonstrator V2 provides, in fact, the system features that are described in the design requirements. In summary, the following design requirements are satisfied:

Table 7: PaMEAS Requirements Validated

PaMEAS Requirements Validated
Track passengers and crew members, in real time (indoor positioning via people location coordinates and geofence proximity), under strong privacy safeguards
Inform and alert passengers via personalized, location-based, notification messages
<p>Provide guidance on how to reach a muster station via personalized multimedia messages (adhering to the ship primary evacuation plan)</p> <ul style="list-style-type: none"> generated based on the passengers location at the moment the mustering instruction is given updated in case parts of these paths (geofences) become unavailable (due to evolution of the emergency incident, e.g. fire spreading, heavy smoke in areas etc)
Support the detection of passenger issues and address incidents during evacuation (automatically detect an issue, request assistance), assist the Evacuation Coordinator with the allocation of available resources (via automated crew assignment recommendations), and furthermore assist with the coordination of the crew efforts (via MCPTT)
Enable instant communication channels between the Evacuation Coordinator and passengers, and between the Evacuation Coordinator and crew members

Optimize coordination and real-time monitoring of the mustering and evacuation processes (from the early pre-evacuation stages, i.e. the reconnaissance of an accident, to the embarkation of passengers and crew to LSAs) - during both real emergencies and regular safety drills

6 References

- [1]. PALAEMON D5.13 "PaMEAS Software Suite: Deployment v1
- [2]. PALAEMON D8.4-5 "PALAEMON application trial SEM (Greece)
- [3]. PALAEMON D5.9 "PaMEAS design principles and Technical Architecture (V1)"
- [4]. PALAEMON D5.10 "PaMEAS design principles and Technical Architecture (V2)"
- [5]. PALAEMON D2.6: "PALAEMON Architecture v1"
- [6]. PALAEMON D8.6: "PALAEMON Consolidated Pilots Evaluation"
- [7]. SRAP overview, available at:
https://docs.google.com/presentation/d/12AsYrkm9dgQ01ewpfXWIVqx-5YO8dfyl/edit?usp=share_link&ouid=101096721707031783382&rtpof=true&sd=true



ANNEX 1

Validation Scenario

TRL4 Verification of the PaMEAS Software Suite (together with the necessary SEM component UIs) took place using a complex scenario designed to cover all aspects of managing an emergency, demonstrating the capabilities of PaMEAS in enhancing and improving existing procedures.

The scenario presented in this ANNEX was executed in a lab environment mimicking the conditions of the ship (with some physical component interactions being stubbed as is to be expected - e.g. ship fire sensors). Specifically, this scenario is designed to demonstrate and validate how PaMEAS enhances existing practices with respect to:

- The detection and investigation of a Fire Incident on board the ship (**Emergency Situation Assessment**) and the assignment of tasks to crew
- The decision the bridge makes to initiate the mustering, the initial steps the crew must take and the alerting of the passengers about the emergency (**Activation of evacuation protocol - Alerting passengers**)
- The direction of the passengers to the muster stations via personalised messages, the assistance of passengers with mobility hindering issues, the handling of un-expected passenger issues and incidents (injuries etc.), and finally the on-the-fly update of the mustering instructions due to the progression of the fire (**Mustering - three acts**)
- The decision to abandon ship and the monitoring of the embarkation processes (**Embarkation**)

In detail, this pilot scenario starts with the detection of a fire on deck 5. This results in alarms being set off on the main PALAEMON UI (PIMM - component) which is monitored by the bridge. Next, the bridge using the PALAEMON MCPTT integrated system (PaMEAS/Tactilon - Agnet Works) orders the investigation of the incident. The teams are assumed to arrive on site but are unable to contain the fire. Taking into account the recommendations generated by PALAEMON'S decision support and risk assessment modules (DSS and SRAP respectively) which are displayed on the main UI (PIMM) the bridge decides to proceed to the alerting of the passengers²¹ and their mustering (in two Muster Stations - MSB and MSD). During mustering some of the passengers' health becomes critical (with the appropriate data being mocked). PALAEMON detects this and automatically proposes crew members (trained for the type of incident and in the closest proximity to the passenger) to assist (recommendations displayed on PIMM). Next, the bridge authorises these assignments, crew members are notified (via MCPTT) and eventually the passenger issues are resolved. Additionally, as the fire progresses MSD becomes inaccessible (due to smoke being detected in the area). The bridge decides to close this muster station (via PIMM UI) and PALAEMON updates the instructions sent to the passengers (assigning new muster station and sending the appropriate directions) and additionally informs the crew members of the deviation from the original mustering plan. Finally, as the situation deteriorates further, PALAEMON (via the SRAP component) recommends to the bridge the abandonment of the ship (displayed on PIMM). The bridge evaluates the situation, verifies that the mustering is

²¹ Passengers profiles and locations were simulated in real-time using the PaMEAS-Simulator component, specifically built for this purpose.



completed (via PIMM and MCPTT) and decides to proceed with the embarkation of the passengers to the LSA. PALAEMON notifies the passengers on how to proceed complementing the instructions of the crew members on site.

Validation Scenario Artificialities (Profiles and Location Data)

The aforementioned scenario was executed in the lab. The goal of this scenario execution was to verify that the functionality of the SEM platform is operational in accordance with a Technical Readiness Level (TRL) of 4 (see next section for an overview of TRL4 testing and its goals).

Passengers were generated at random starting locations on the ships decks 7,8,9 (with their respective profiles added to the system) and their movement to the master stations was simulated using software specifically built for this purpose (PaMEAS-Simulator component). Specifically, for this pilot scenario execution **200 passengers** were simulated. Furthermore, from these passengers, **three** (3) were registered as having **mobility impairing issues** ("unable_to_walk"). This attribute in the passengers profile ensures that once the mustering instructions are sent by PALAEMON these passengers will be instructed to remain in their positions and additionally PALAEMON will automatically recommend to the bridge the assignment of suitably trained crew members to assist the passengers reach the muster station.

Finally, **5 crew members** profiles were created. These profiles were generated in such a way that ensured all necessary scenario requirements would be met (e.g. crew members belonging to the fire fighting teams and so on).

PaMEAS implements its location tracing capabilities using a state-of-the art Indoor Positioning System (RTLS) in a plug and play manner. The RTLS system leverages both network capacities and advanced AI enhanced algorithms to improve the accuracy of the perceived passenger and crew member location (during times of emergencies). To enable this functionality passengers and crew members are equipped with a specially built app (PALAEMON passenger and crew mobile **app**).

	Number	Characterising Attributes	Location Data Simulated	Real Location Data (Lab)
Passengers	200	3 with mobility issues	200	0
Crew	5	2 firefighting team, 2 mustering unit, 1 medical team	5	0

Validation Execution: TRL 4

TRL4 Definition



This pilot scenario was executed at Technology Readiness Level (TRL) 4. **TRL4** is defined as: “Technology validated in lab”²². Specifically, under TRL4 the system is validated in a laboratory environment (while at the same time scaling the system to a more realistic representation of an industrial application as opposed to lower TRL tests).

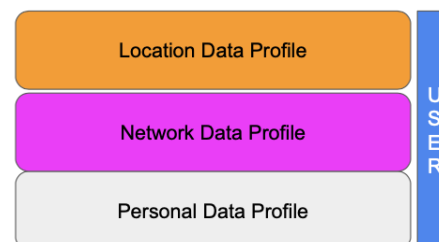
The main goal of a TRL4 test is to confirm the systems basic formulation²³ (i.e. that the core functionality of the system is implemented). TRL4 tests are validated through designed investigations (testing scenarios like the one described in this document). The results of a TRL4 test provide evidence that the system requirements are attainable and constitute **Alpha**²⁴ “**White-Box**” tests executed by a set of inhouse developers/testers.

Finally, with respect to the complexity of the system under TRL4 typically we are interested in proving that the system under testing has achieved sufficient component integration to the extent that it can provide a representation of a system that can be used to demonstrate feasibility and to provide technical data.

Preparatory Actions: Passenger Registration

Overview: A passenger registers to the PALAEMON People Management System (PMS). Passenger’s registration enables three personal data profiles: a) a Personal Data Profile, b) a Network Data profile and c) a Location Data Profile.

- ▶ Person Registration enables **Three Data Profiles**:
 - ▶ **Personal Profile**: Personal Identification Information
 - ▶ Generated during the **Pre-embarkation Registration Service**
 - ▶ **Network Profile**: Network Access and Messaging Specific Device Information
 - ▶ Generated during the **embarkation Registration Service**
 - ▶ **Location Profile**: Current Location Data
 - ▶ Generated from the **RTLS System**
- ▶ Note: Additional Palaemon Services are built on top of these three profiles



The Personal Data Profile contains the details about the:

- Identity of the user (as retrieved from the eID system integrated to Palaemon)
- Health Specific Data (that might hinder their capability to efficiently muster/evacuate in case of an emergency)
- Voyage Specific Data (such as embarkation, disembarkation ports, emergency contact persons and so on).

The Network Data Profile of the passenger contains the details of the devices that are in possession of. This allows the proper identification of the users location as well as enables

²²

https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

²³ <https://yukti.mic.gov.in/assets/assetsYukti/img/Developement-Stages-TRL-MRL-IRL.pdf>

²⁴ An Alpha software version can be defined as still having potentially lots of bugs, might not have all functionality but the core of the system is implemented and can be tested extensively.

the evacuation procedures to instantly communicate with them. The attributes captured in this profile are the following: `macAddress`, `imsi`, `msisdn`, `imei`, `messagingAppClientId`²⁵.

Finally, the Location Data Profile of the user contains data about their location (current and previous locations within the vessel). However, capturing of this data starts always after the user embarks the vessel (and in cases of non-emergencies their gathering can be prohibited by the user). As a result during registration the location profile of the user is not filled in.

After the generation of these profiles, the passenger opts in to issue a Verifiable Credential²⁶ (called the PALAEMON service card) that can be used to prove their identity on the ship and control (and preserve) the privacy of their data.

Presentation material:

- PALAEMON Passenger and Crew Registration
[PALAEMON Passenger and Crew Registration v7.pptx - Google Slides](#)
- PALAEMON People Management System
[PALAEMON People Management System DEMO v1.1.pptx - Google Slides](#)

Assumptions:

- (1) The passenger is registered at the “PALAEMON Local Identity Provider”. This is an IdP built especially for the purpose of testing the PALAEMON system and mimics an eIDAS eID identity provider (or potentially some other form of national eID identification scheme). This IdP is used for testing because the available test users were not in possession of an eIDAS eID and its usage is inline with the scope of TRL4 testing (TRL5 as well).
- (2) Passenger has downloaded, and configured an eID Wallet application ([Jolocom](#)) that is used to store a Verifiable Credential proving their identity profile onboard if requested.

Registration Flow:

- The passengers access the PALAEMON Embarkation Registration Service [[PMS Service Landing page](#)] via their mobile phones. [[prep 1](#)]
- The passengers authenticate using their provided credentials (username/password) mimicking an eIDAS 2.0 eID authentication. Test credentials used are the following, user: phil, password²⁷
- Passengers' details are fetched from the IdP (personal data) and confirmed by the passenger (name: Phil, surname: Claude, etc...) [[prep 2](#)]
- For testing purposes the passengers' health/mobility and pregnancy data (parts of Personal Data profile) are predefined and returned via this IdP (to ensure testing users cover all necessary mobility hindering cases). The user fills in their additional

²⁵ **MacAddress** is a unique identifier embedded in any network interface controller. **IMSI** stands for the international mobile subscriber identity, it is a number that uniquely identifies every user of a cellular network. **MSISDN** is a number uniquely identifying a subscription in a Global System for Mobile communications. **IMEI** is a numeric identifier, usually unique, for 3GPP and iDEN mobile phones. **MessagingAppClientId** is the identifier generated by the users PALAEMON messaging app and can be used to send messages to the user's device.

²⁶ Verifiable Credentials are tamper resistant, secure data sets containing claims made by the issuer (PMS) attesting information about a subject (Passenger). <https://www.w3.org/TR/vc-data-model/>

²⁷ In case you desire this password please contact the UAegean team directly.



data (country of residence, preferred communication language, emergency contact person) [[prep 3](#)]

- The passenger taps the Deep Link presented to connect their Wallet app (Jolocom Smart Wallet app) [[prep 4](#)]
- The passenger authorises, via their Wallet, the sharing of data
- On the PALAEMON Embarkation Registration Service UI the passenger requests to generate their 'PALAEMON Service Card' Verifiable Credential [[prep 5](#)]
- The passenger, via their Wallet, accepts the incoming offer
- On their Wallet the passenger receives their Verifiable Credential [not available due to security policy of app]
- On the PALAEMON Embarkation Registration Service UI the passenger receives a 'registration completed' message [[prep 6](#)]

Results:

1. Passengers PALAEMON Service Card (VC)
2. Passenger Registered in PMS. Passenger's full Personal and Network Data profiles are generated and stored in the systems persistence layer (Elasticsearch), with name, surname, person identifier encrypted. The passengers' Location Data profile is empty at this stage since this is filled in once the passenger steps into the ship.

Personal Data Profile

```
"personalInfo" : {
  "name" : "kDAvEhu5jTRrcs71W0k4vSEOKDwOp0rGwQ+bPDG8+UKAUlwbTVQlYHOX92LxWHzZIRfs4E/LuH/hxIf35
/ke7W9hvtXl3gdFIH5XVG7do5dIwSvTHKpPbAju+QDgw6i6LJ3vAMiDk3kL8ceuCktpAJX8jHSwHvTL/hvhfzz55M3uC01M60gp
+cvaNrIFB7DXjfFibBOzhWgpR6lQNiS0bo3jhB/tmzAlUIWczZjiuG3PuL/gdYdHYPhmzwBiZvBUL17ehLn1UrcmhV1e
/Oq9RIJQcknE35k7eFLP7AGd6vNBbanZ6phQjbnwTZElaJz/7XQbxj3RFEiP0brHtdhHQ==",
  "surname" : "UyrvDbyQyfrBBXnZBecbBL3/bdmASjBBYVSRc0Lu0T81EFaC35Y53GDGunnDcXQ7jmxJUNCF0GvGJn/V6T
/pN2q1QJqwGSwkMw7ffG7r9nSKK673ox7iSqvdkHxUA7kNYLASSVvjE12RbvQRaaSDgzUjB280U6z0y1eBQWnPIkATEBHVoJZbT5xiW
+0PB+zXjvBzxVrBMA2frErvdPxrfL86o9P48M0jYML0BnGh7n5X4kZ5vGdCvf6nAFchzDaLq7KlB3
+qRLnqhTU26ixeVQri3QJidORJ3g9Cy1890tfXgouUgGKpHLV9GLwoLo+joT7D3RrLI54WipXypWfg==",
  "dateOfBirth" : "28",
  "gender" : "male",
  "personalId" : "sEZAqFXRDWKPmd8nJX8qZJ8xjyBX0sFgDh7l1fC6X93jIEJCYWFWAMM1XNCeK0D2SErNwIo81IV8tVsuqZKDPoWfwg
S2Ykb/IcEJLXaeZiEwTchZrCjBwPiIksRAfrC1/aHNV56dEa+RoiKa4AFjrGnnwNjiAQwIBcUJ0cuagWTmrzIrDtpxUTLH
/NTGU9yrsNsEWIEh3mn4B7
+tBkZ3M22IcsM9RTD9jbKvrIG9i1dBgwondK9xyWLOjHa0XA3EzCoLJnAMu9a3y1wCrmIC0cssGbp0G0QwXBikxYD0u2Vb3drFWDx3P2
NdKjZ0Yv788NaEL4FSxJv37zhxlb6wQ==",
  "ticketNumber" : "456",
  "ticketInfo" : [ ],
  "crew" : false,
  "embarkationPort" : "PIRAEUS",
  "disembarkationPort" : "CHANIA",
  "email" : "test14@test.gr",
  "emergencyContact" : "306943808730",
  "countryOfResidence" : "GR",
  "medicalCondition" : "equip_required",
  "mobilityIssues" : "",
  "pregnencyData" : "",
  "role" : "passenger",
  "emergencyDuty" : "",
  "preferredLanguage" : [
    "EN"
  ],
  "inPosition" : false,
  "assignedMusterStation" : "7BG6",
  "oxygenSaturation" : "99",
  "heartBeat" : "102"
},
```

Network Data Profile




```

"networkInfo" : {
  "deviceInfoList" : [
    {
      "macAddress" : "58:37:8B:DE:42:B3",
      "hashedMacAddress" : "9d0f789d80c23b632998be457d9830f47e1a445740efe5b842d7e665246e582d",
      "imsi" : "502130123456789",
      "imei" : "919825098250"
    }
  ],
  "messagingAppClientId" : "kat",
  "braceletId" : "580002"
}

```

Crew is handled differently from the passengers, since as it is well known, crew members have a much more persistent relationship with a vessel and a shipping company in general. For this reason while crew members are also registered in the system's database (implemented via Elasticsearch in this case) using the same three profiles (Personal, Network and Location), presented in the previous section, the generation of these profiles is assumed to be handled directly by the Shipping company IT systems (as it is necessary for security reasons). However, for testing purposes only, special endpoints have been built to generate the crew member populations that are necessary to complete the various flows described in this document.

Evacuation Phase 1: Emergency Situation Assessment

Short Description: This sub-process covers the detection, inspection and further investigation of the status fire accident which will become later the reason for launching the ship evacuation process. It includes two stages: Emergency Inspection & Emergency Reconnaissance. We demonstrate the functionality of these two stages through two specific acts: Act 1.1: Emergency inspection (in 3 episodes) and Act 1.2: Emergency reconnaissance (1 episode)

- **Start event:** PIMM displays a triggered alarm notification (the alarm event is a JSON message)
- **End event:** Preparation to launch the Evacuation Procedures (the Evacuation Coordinator, under the instructions of the Captain, presses the "Activation of the Evacuation Procedure" Button on PIMM); or the assessment of the situation goes until more information is available and eventually stops if the accident appears under control (return to "Normal Operation" mode)

Act 1.1: Emergency inspection

Overview: This Act covers the detection of an emergency (specifically fire and smoke) by the ships fire detection systems and the actions that the Bridge undertakes to investigate the situation.

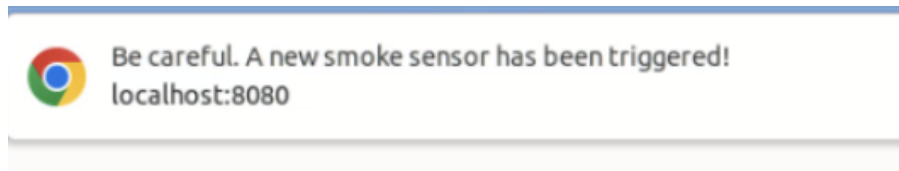
Assumptions:



- (1) The Bridge receives a fire/smoke alarm through the ship's fire detection system
- (2) The alarm is received by the Smart Safety System (SSS)

Episode 1.1.1 - Triggering of the smoke alarm and its display on PIMM

- PIMM displays the triggered smoke alarm [[act1.1_1](#), [act1.1_2](#)]
 - JSON message received: type=Fire, timestamp=2022act1.1_-10-17 13:12:59, deck=5, positionX=13.72, positionY=5.47
 - Alarm on PIMM



- Via PIMM the Evacuation Coordinator (under Captain's instructions) changes the state from 'Normal' to '**Situation Assessment**' [[act1.1_3](#)]
- PIMM displays standard actions to be taken by the crew in the case of a triggered smoke alarm and the muster list which shows the duties assigned to the different crew members [[act1.1_4](#)] [[act1.1_4.1.png](#)]

Episode 1.1.2 - Order for emergency inspection

- PIMM, via the button "Team Dispatcher", enables the EC to reach directly the **Tactilon Agnet Dispatcher UI** where they can initiate a Push to Talk session (PTT) with the members of the Firefighting unit²⁸ [[act1.1_5](#), [act1.1_6](#)]
- The emergency response team is ordered to move and investigate the area of the emergency. Specifically, using the PTT Tactilon Dispatcher UI the EC initiates a push to talk session with the members of the Firefighting unit and instructs to move to the location of the triggered fire alarm (Deck 5) [[act1.1_7](#), [act1.1_8](#), [act1.1_9](#)]
- The response team verifies the receipt of the order via PTT [direct audio communication]

Act 1.2: Emergency reconnaissance

Overview: The emergency response team is dispatched to make a visual assessment of the situation and report back to the Bridge.

Episode 1.2.1 - Crew team arrives on the Incident location | Crew reports back | Situation is evaluated





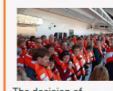
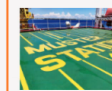
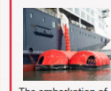
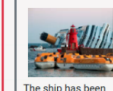
- Bridge Command Team monitors the position of the crew members via PIMM [[act1.2_1](#)]
- The Master assesses the situation with all the available information shown on the PIMM and feedback from the direct communication with the Firefighting unit and decides to proceed with Mustering [[act1.2_2](#)]

²⁸ The Fire fighting unit team consisting for the purposes of this test of a crew member equipped with the Tactilon Agnet mobile app which enables the direct communication to the Bridge

Acts 1.1 and 1.2 results

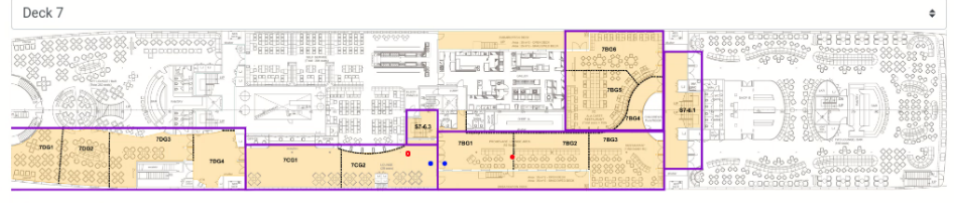
1. PALAEMON Status changed process states (from “Normal” to ‘Situation Assessment’)
2. Bridge monitors the location of the crew members
3. Initiation of “Push2Talk’ session with Fire Fighting team to investigate the incident

Evacuation Manager:
(Click the following buttons to change the EM's Operational Level)

Normal Operation  No incident has occurred and all of the ship's functions run smoothly.	Situation Assessment Active  Team Dispatcher An alarm has been raised and the related incident is being investigated in correlation with the ship's condition.	Activation of Evacuation Protocol  The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.	Alert Passengers  The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.	Passenger Mustering  The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.	Mustering Completed  The Mustering phase has been confirmed and the embarkation of all passengers has started.	Embarkation  The embarkation of people into the MEV's is taking place.	Ship Abandonment  The ship has been successfully evacuated.
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Deck Maps

Deck 7



● Passenger ● Crew Member

Push-To-Talk conversation
Press once to talk

GROUP CONVERSATION > BROADCAST PUSH-TO-TALK CANCEL

BROADCAST CALL CONFERENCE CALL SHARE SCREEN BROADCAST VIDEO

Katerina Ksystra Broadcast video - Google Chrome

dispatcher-1.ea-1.eu-west-1.agnet.com/video-streaming/index/msidsn/306971111...

Live 00:04

Emergency Response Team

Emergency Response Team

2 contacts out of 2 are connected to the Emergency Response Team Talk group

Nikos Triantafyllou Katerina Ksystra



SEM Evacuation Phase 2: Activation of evacuation protocol - Alerting passengers

Short Description: This sub-process includes the actions the EC takes to evaluate the situation, instruct the crew members to assume their emergency posts and finally alert the passengers of the incident. It consists of the following actions: Instruct passengers to emergency posts, Crew Positioning Verification, Launch of the core Evacuation Procedure (EC presses the “Alert Passengers” button). We demonstrate the functionality of these stages through a single act: Act 2.1: Activation of evacuation protocol (in 1 episode)

- **Start event:** End of phase “Situation Assessment” phase (“Activation of the Evacuation Procedure” Button on PIMM pressed by EC)
- **Intermediate event:** EC presses the “Alert Passengers” button on PIMM
- **End event:** All Alert Messages delivered to the Passengers and Crew successfully

Act 2.1 Activation of evacuation protocol - Alerting passengers

Overview: During this act the bridge first instructs the crew members to assume their emergency posts. Next, monitors their position and confirms it (if needed via Tactilon Agnet). Finally, the bridge makes the decision to sound the GA resulting in the passengers receiving alert messages about the emergency. Specifically, under this Act the following actions take place:

- The Master evaluates the severity of the incident (with the information provided by the PALAEMON system) and decides to initiate the Evacuation Protocol (“Activation of the Evacuation Procedure”)
- The crew is instructed to move to their predesignated posts
- The evacuation protocol for summoning passengers at the muster stations is activated (sounding of the GA)
- Passengers receive warnings about the situation

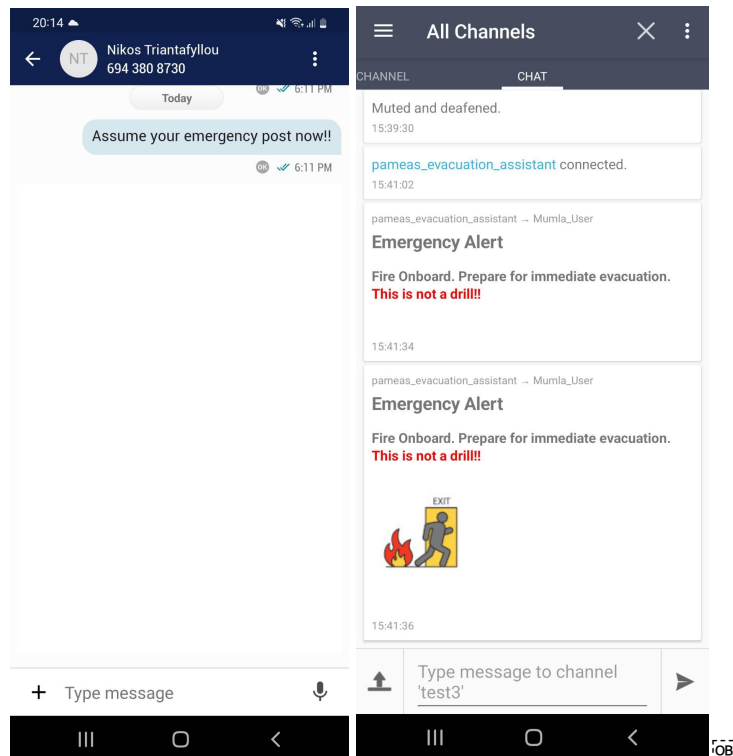
Episode 2.1.1 - Evacuation protocol activated | Crew notification about evacuation launch | Alerting passengers

- Via PIMM the Evacuation Coordinator changes the state from “Situation Assessment” to “Activate Evacuation Protocol”. [\[act2.1_1\]](#)
- Crew teams are informed to move to their predesignated emergency posts [\[act2.1_2\]](#):
 - Message Text: Assume your emergency post now!!
- Bridge Command Team monitors the position of the crew via PIMM [\[act2.1_3\]](#)
- Via PIMM the Evacuation Coordinator changes the state to “Alert Passengers” [\[act2.1_4\]](#).
- GA is sounded from the public address system of the ship
- Passengers receive alert messages of the emergency [\[act2.1_5\]](#):
 - 2xMessage Text: Fire Onboard. Prepare for immediate evacuation. This is not a drill!!

Results:



1. Crew are informed to move to their posts
2. Passengers receive alerts informing them about the emergency in parallel to the GA



SEM Evacuation Phase 3: Mustering

Short Description: This sub-process includes the actions the bridge takes to transmit personalised (based on the latest location of the passenger) mustering instructions, adhering to the ships evacuation plan. The actions required for the monitoring of the overall mustering process and for the verification of the completion of the mustering. Furthermore, this sub-process includes the actions taken to handle escalations of the fire event that leads to the bridge instructing the closing of Muster Station C (denoted by the geofence 7DG4) and the subsequent update of the evacuation plan including its communication to the passengers and crew. Finally, this sub-process includes the actions taken to handle passenger issues and incidents (manually declared by the passenger or automatically detected by PALAEMON)

This phase consists of the following actions: Launch the Mustering process (“Mustering” button), Crew and Passenger Location Monitoring, Close Muster Station, Handle Passenger Incidents. We demonstrate the functionality of these stages through three separate acts: Act 3.1 (with 4 episodes), Act 3.2 (with a single episode) and Act 3.3 (with two episodes).

- **Start event:** EC presses the “Start Mustering” button on PIMM
- **End event:** EC confirms that all passengers are gathered at the muster stations (EC presses the “Mustering End” Button on PIMM)



Act 3.1 Mustering in progress

Overview: Under this Act the PALAEMON system is triggered to initiate the interactions with the passengers. Specifically, under this task the following actions take place:

- Passengers receive notifications and mustering instructions
- Passengers in need of assistance are identified by the system and are notified on the actions they need to take (wait for assistance)

Episode 3.1.1 - All systems in mustering mode | Passengers Notifications

- EC presses the “Start Mustering” button on PIMM [[act3.1_0](#)]
- Passengers receive warnings on how to prepare for evacuation [[act3.1_1](#)]
 - Message Text: Remain calm and stay where you are!! You will receive instructions on your phone in a few seconds!

Episode 3.1.2 - Passengers mustering Instructions

- Passengers receive notifications with instructions on how to reach the muster station based on their current location [[act3.1_2](#)]
 - Message text: Access to Muster Station Muster Station D is via the following path: PathDescription
 - Message file: Path image
- Passengers receive notifications on what to do in case of becoming lost and were to get life jackets [[act3.1_3](#)]
 - Message text: If you get lost follow this sign to Muster Station B. Lifejackets are there.

Episode 3.1.3 - Identification of passengers in distress

- Passengers in distress are identified. The system proposes to the Bridge the closest available Response Team trained to handle those passengers. [[act3.1_4](#), [act3.1_5](#), [act2_9](#)]
 - a. Enabling the EC to review the profile of the passenger in distress [[act3.1_6](#)]
- The EC authorizes the dispatch of the aforementioned Response Team [[act3.1_7](#)]
- The Response Team is ordered to proceed to the location of the passengers that are in distress
 - Message text: Proceed to Cabin 8206. Passenger speaking French, with Complicated Pregnancy, needs assistance to evacuate [[act3.1_8](#)].
- Passengers in distress are instructed to stay to their current location:
 - Message text: Please stay where you are and do not make any attempt to move. Assistance is on the wayA crew member is on its way to escort you to the Muster Station and will arrive shortly [[act3.1_9](#)]

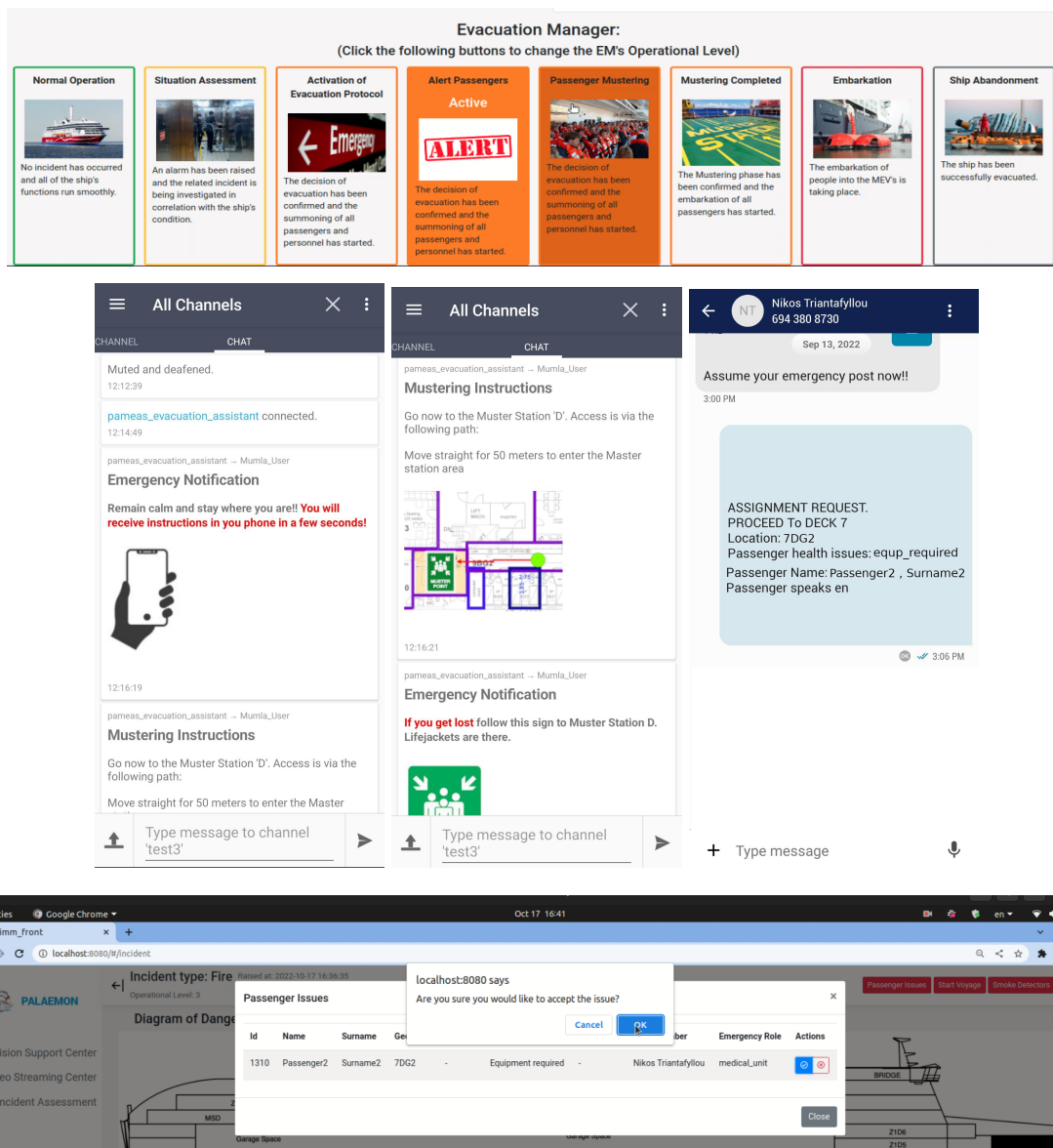
Episode 3.1.4 - Medium congestions are detected.

- From the movement of the passengers it is detected that medium congestions are noticed on the area Z2D8, Z1D8, Z4D9 of Deck 8 and this information is displayed on PIMM [[act3.1_10](#)]

Results:



1. Passengers receive notification and mustering instructions
2. Passengers requiring assistance to evacuate are identified and crew members are assigned to assist them



Act 3.2. Mustering update - Closing of Muster station D

Overview: Under this Act the incident progresses and PALAEMON responds by adjusting the mustering process to unforeseen circumstances in order to ensure that all passengers are safely gathered.

Assumptions:

- (1) Due to heavy smoke and rapid increase of temperature, Muster station D in Deck 7 is becoming dangerous.
- (2) The Master decides that Muster Station D must be closed.

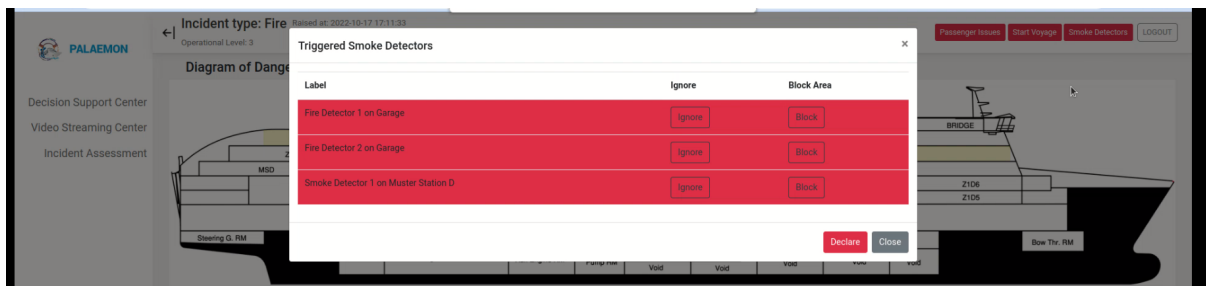
Episode 3.2.1 - Mustering instructions update

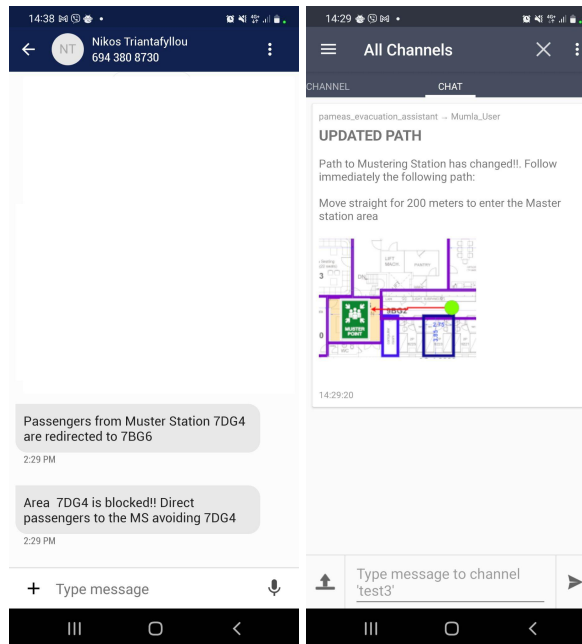


- SRAP detects via propagating smoke alarms that the fire has spread. [\[act3.2_1\]](#)
- Master decides to close Muster Station D and move the passengers gathered to the adjacent MusterStation C. [\[act3.2_2\]](#)
- SRAP recalculates risks of delays based on the closing of MS D [\[ac3.2_3\]](#)
- Passengers receive updated mustering routes [\[act3.2_4\]](#):
 - Message text: Path to Mustering Station has changed!! Follow immediately the following path....
 - Message File: Path image
- Crew receive updated mustering notifications[\[act3.2_5\]](#):
 - Informing them about the blocked path. Message text: Area 7DG4 is blocked!! Direct passengers avoiding 7DG4
 - And because this is a muster station informing them about the redistribution of the passengers. Message text: Passengers from Muster Station 7DG4 are redirected to 7BG6

Results:

1. Bridge is alerted about additional smoke alarms and closes MSD
2. Passengers and crew members are notified about the change in the evacuation routes





Act 3.3 Incident Management

Overview: Under this Act the handling of passenger incidents is demonstrated. Specifically, PALAEMON automatically detects passengers that need help and provides them immediate assistance. Additionally, PALAEMON enables passengers to actively request for assistance using their PALAEMON mobile apps. Specifically, under this Act the following actions take place:

- PALAEMON notifies the Bridge which crew members are trained to handle this passenger issue/incident (based on the medical/mobility profile of the passenger) and also based on the proximity of the crew member to the passenger (based on the latest passenger location indicator)
- The Bridge authorizes the crew assignment (or ignores the recommendation and initiates a manual crew allocation processes via Tactilon Agnet)
- The passengers are notified that help is on the way

Assumptions:

- One of the passengers from Deck 9 biometrics (speed, heart rate, oxygen saturation levels) drop below the acceptable threshold which results in SRAP to initiate a passenger incident
- One of the passengers from Deck 8 requests immediate help using their mobile app
- One of the passengers from Deck 7 presses their smart bracelet button to request assistance

Episode 3.3.1 - Identification of a passenger issue based on biometrics

- One of the passengers biometrics (speed, heart rate, oxygen saturation levels) drop below the acceptable threshold
- PIMM displays a notification requesting authorization from the Bridge to dispatch a crew member team to the identified from PaMEAS incident [\[act3.3.1_1\]](#)



- The selected crew members are instructed to move to the location of the passenger by receiving the following message on their mobile phones [\[act3.3.1 2\]](#):
 - Message text: Assignment Request...
- The passenger in need is notified that help is on his way [\[act3.3.1 3\]](#):
 - Message text: Please stay where you are and do not make any attempt to move. Assistance is on its way and will arrive shortly.
- The crew members assist the passenger to reach his assigned Muster Station and reports that the passenger is safe [\[act3.3.1 4\]](#)

Episode 3.3.2 - Passenger requests help via mobile app

- One passenger requests immediate help using his mobile app [\[act3.3.2 1\]](#)
- PIMM displays a notification requesting authorization from the Bridge to dispatch a crew member team to the identified from PaMEAS incident []
- EC initiates a push to talk session with the passenger to verify the situation [\[act3.3.2 2\]](#)
- The selected crew members are instructed to move to the location of the passenger by receiving the following message on their mobile phones [\[act3.3.2 2\]](#):
 - Message text: Assignment Request...
- The crew members assist the passenger to reach his assigned Muster Station and reports that the passenger is safe [\[act3.3.2 4\]](#)

Episode 3.3.3 - Passenger requests help via bracelet

- One passenger requests immediate help by doing a prolonged pressing of their bracelet button
- PIMM displays a notification requesting authorization from the Bridge to dispatch a crew member team to the identified from PaMEAS incident
- The rest of the steps are omitted as they are identical to the previous episodes.

Results:

1. Passengers declare issues (via app, bracelets) or are automatically detected by SRAP
2. Bridge is notified about the passenger incidents via PIMM and crew member assignment is proposed
3. EC initiates a P2T session with the passenger to verify the situation.
4. Crew members are dispatched to assist.



The top screenshot shows a chat interface with a message from 'pameas_evacuation_assistant' to 'Mumla_User' at 13:46:45. The message says 'okay'. Below it, another message from 'pameas_evacuation_assistant' to 'Mumla_User' at 13:46:47 says 'Please stay where you are and do not make any attempt to move. Assistance is on its way and will arrive shortly.' The bottom screenshot shows a 'Passenger Issues' table with columns: Id, Name, Surname, Geofence, Mobility, Health, Pregnancy, Crew Member, Emergency Role, and Actions. The table contains one row for 'Passenger3' with 'Surname3' and '9BG1' geofence, 'assisted_gait' mobility, and 'Equipment required' health. The background shows a ship's bridge interface with buttons like 'Start Voyage', 'Smoke Detectors', and 'LOGOUT'.

Id	Name	Surname	Geofence	Mobility	Health	Pregnancy	Crew Member	Emergency Role	Actions
86	Passenger3	Surname3	9BG1	assisted_gait	Equipment required	-	Nikos Triantafyllou	medical_unit	

The bottom screenshot shows a mobile app interface with a list of channels: 'Root', 'pameas_evacuation_assistant', 'private channel', 'Assist Passenger', 'ec', and 'Mumla_User'. A chat window is open showing an 'ASSIGNMENT REQUEST. PROCEED To DECK 9' with location '9BG1' and passenger health issues 'assisted_gait'. The chat also shows 'Passenger Name: Passenger3, Surname3. Passenger speaks en' and a timestamp '4:51 PM'.

SEM Evacuation Phase 4: Embarkation

Short Description: This sub-process includes the actions the bridge takes to decide upon abandoning the ship and to initiate the Embarkation flows (transmitting personalised embarkation instructions to the passengers about their embarkation groups).

This phase consists of the following actions: Mustering Completed and reporting from the fire teams, and Launch of the Embarkation process (“Embarkation” button). We demonstrate the functionality of these stages through three separate acts: Act 4.1 (with 2 episodes), and Act 4.2 (with a single episode)



- **Start event:** EC terminates the Mustering process (EC presses the “Mustering Completed” Button on PIMM)
- **End event:** Embarkation operation ended (EC presses the “Ship Abandonment” Button on PIMM)

Act 4.1 Mustering Completed and reporting from the fire team

Overview: Under this task the completion of the mustering process is executed and the decision to abandon the ship is taken

Assumptions:

- (1) Muster stations report the completion of passengers’ mustering and counting
- (2) The fire squad leader reports that the fire is out of control and that the boundary cooling of the fire is not possible anymore
- (3) Master decides to abandon the ship

Episode 4.1.1 - Decision to abandon the ship

- PIMM displays the completion of passengers’ mustering [[act4.1_0](#), [act4.1_1](#)]
- The Master assesses the situation with all the available information shown on the PIMM (including SRAPs recommendation to abandon ship) and decides to abandon the ship [[act4.1_2](#), [act4.1_3](#)]

Results:

1. EC reviews the mustering list
2. The Bridge assess the situation and decides to proceed to abandon ship



Decision Support Center
Video Streaming Center
Incident Assessment

Incident type: None Raised at: Operational Level: 0

Passenger Issues Start Voyage Smoke Detectors LOGOUT

Diagram of Danger in Ship

PaMEAS Map of Decks Crew Member List

Muster station D

Total: 0

Passengers currently in MS D : 0

Passengers not in MS D : 0

Close

Muster station C Closed

Total: 0

Passengers currently in MS C : 0

Passengers not in MS C : 0

Muster station B Mustered

Total: 248

Passengers currently in MS B : 248

Passengers not in MS B : 0

Close

Mustered Passengers

ID	Name	Surname	Gender	Age	Embarkation Port	Disembarkation Port
7DC4	Jonathan	Krajcik	male	19	Piraeus	Chania
7BG6	Jo	Klein	female	26	Piraeus	Chania
	Ernestine	Bayer	female	62	Piraeus	Chania
	Kyra	Farnell	female	20	Piraeus	Chania
	Patience	Carroll	female	59	Piraeus	Chania
	Abel	Wolff	male	46	Piraeus	Chania

(Click the following buttons to change the EM's Operational Level)

Operation Situation Assessment Activation of Evacuation Protocol Alert Passengers Passenger Mustering Mustering Completed

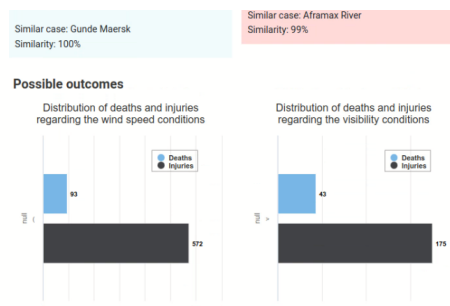
Situation Assessment Recommendation

Sound GA: Abandon: Abandon

Decision Support System

Go Back

- After the fire signal, check through CCTV and send the patrol sailor for verification (USE OF PORTABLES UHF / VHF).
- Determine the existence of fire or smoke.
- Call of the master, first mate, and engine room.
- Immediate termination of all oil and ballast works, if it is possible.
- Stop mechanical ventilation. Close all fire doors, openings, and electricity.
- Condition assessment for use of DRENCHER and fire crew.



Evacuation Manager:

(Click the following buttons to change the EM's Operational Level)

Normal Operation

No incident has occurred and all of the ship's functions run smoothly.

Situation Assessment

An alarm has been raised and the related incident is being investigated in correlation with the ship's condition.

Activation of Evacuation Protocol

The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Alert Passengers

The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Passenger Mustering

The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Mustering Completed

The Mustering phase has been confirmed and the embarkation of all passengers has started.

Embarkation Active

The embarkation of people into the MEV's is taking place.

Ship Abandonment

The ship has been successfully evacuated.



Act 4.2 Launch of the Embarkation process

Overview: Under this task the passengers are safely moved to the embarkation stations.

Assumptions:

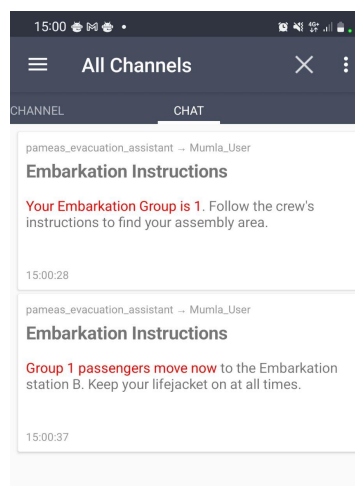
- (1) Passengers have completed Mustering and are all located in MSB
- (2) Master decides to abandon the ship

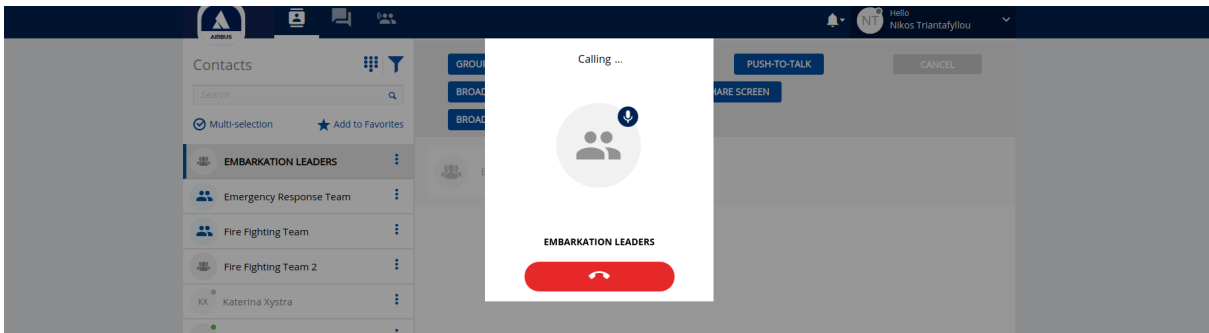
Episode 4.2.1 - Passengers embarkation to LSAs

- Passengers receive notifications about their assigned embarkation groups [\[act4.2_1\]](#)
 - Message text: Your Embarkation Group is 1. Follow the crew's instructions to find your assembly area.
- Passengers receive notification to proceed to embarkation [\[act4.2_1\]](#)
 - Message: Group 1 passengers move now to the Embarkation station B. Keep your lifejacket on at all times.
- The Bridge initiates a Push to Talk session (PTT) with the members of the Embarkation Teams to verify that all passengers are embarked safely [\[act4.2_2\]](#)
- EC changes the status "Ship abandonment" denoting the end of the process (and generating in the backend a report that is sent to the shipping company's records) [\[act4.2_3\]](#)

Results:


1. Passenger receive Embarkation Instructions
2. The Bridge verifies all passengers are embarked on the LSA
3. The Bridge denotes the abandonment of the ship





Evacuation Manager:
(Click the following buttons to change the EM's Operational Level)

Normal Operation




No incident has occurred and all of the ship's functions run smoothly.

Situation Assessment




An alarm has been raised and the related incident is being investigated in correlation with the ship's condition.

Activation of Evacuation Protocol




The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Alert Passengers




The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Passenger Mustering




The decision of evacuation has been confirmed and the summoning of all passengers and personnel has started.

Mustering Completed




The Mustering phase has been confirmed and the embarkation of all passengers has started.

Embarkation



The embarkation of people into the MEV's is taking place.

Ship Abandonment Active



The ship has been successfully evacuated.

