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Technical Report

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Feasibility Study on Maritime Communication Services
over 3GPP system;
Stage 1
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Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

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Introduction

Distinguished from the previous generations, a new movement is happening for 5G in 3GPP, i.e. vertical domains started to join 3GPP and requirements from vertical domains have been provided to 3GPP so that 3GPP takes into account requirements from vertical domains as well as requirements from legacy ICT domain to standardize 5G System in 3GPP.

Maritime domain, one of 5G vertical domains in 3GPP, started to be considered since 2016 to enable 3GPP systems to play the role of mobile communication platform necessary for the digitalization and mobilization of the maritime domain that bring about the Fourth Industrial Revolution of the maritime businesses as well as maritime safety.

Compared to other vertical domains, the maritime domain has the radio communication environment that 3GPP hasn't considered in detail, which means that maritime related issues and features were not in the scope of 3GPP standardization and some of existing 3GPP enabling technologies or solutions are not able to fully support the optimized performances required by the maritime domain in a way that has been guaranteed for on-land communication. In addition, on-board mobile users in a vessel would like to experience the same rich mobile communication services as they enjoy on land.

Furthermore, it is of the view that the capacity and rate for data transmission based on legacy maritime radio communication technologies are indeed not enough for e-Navigation described in IMO Strategy Implementation Plan (SIP) or Maritime Autonomous Surface Ships (MASS), which the International Maritime Organization (IMO), a United Nations specialized agency, have been working to provide to ship.

Considering that the maritime domain is one of 5G vertical domains that 3GPP take into account in order for 5G to be able to provide enhanced mobile broadband services or massive machine-type communication services etc. everywhere anytime in the world, it is desirable to study use cases and requirements for maritime communication services over 3GPP system so that 3GPP system can be a good candidate of innovative tools to help address the information gap between users on land and users at sea as well as the maritime safety and vessel traffic management etc. that IMO intends to achieve especially in 5G era.

1 Scope

The present document aims to support the maritime communication services between users ashore and at sea or between vessels at sea over 3GPP system that are targeted to improve maritime safety, protect the maritime environment and promote the efficiency of shipping by reducing maritime casualty caused by human error, in particular, involving small ships and fishing vessels. In addition, the outcome of the technical report is expected to narrow the information gap between mobile users on land and shipboard users on vessels at sea by making it possible to provide the mobile broadband services.

The document describes use cases and potential requirements for services between shore-based users such as authorities and shipboard users in the maritime radio communication environment over 3GPP system. In addition, it deals with use cases to support Mission Critical Services between authorities on land and authorities at sea (e.g. maritime police) as well as use cases to support the interworking between 3GPP system and the existing/future maritime radio communication system for the seamless service of voice communication and data communication between users ashore and at sea or between vessels at sea.

Analysis is also made on which legacy services and requirements from the existing 3GPP system need to be included and which potential requirements need additional work for new functions to support maritime communication services over 3GPP system.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] IMO NCSR 1/15/1: "Consideration of operational and technical coordination provisions of maritime safety information (MSI) services, including the development and review of related documents", 28 March 2014.
- [3] IMO NCSR 1-28: "Report to the Maritime Safety Committee" 16 July 2014.
- [4] IMO NCSR 4/29: "Report to the Maritime Safety Committee", 24 March 2017.
- [5] IMO NCSR/WP.4: "Report of the Navigation Working Group", 9 March 2017.
- [6] IMO NCSR 4/16/1: "IALA Guideline No. 1117 on VHF Data Exchange System (VDES) Overview", 16 December 2016.
- [7] 3GPP TS 22.261: "Service requirements for next generation new services and markets".
- [8] 3GPP TS 22.268: "Public Warning System (PWS) requirements".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

SOLAS vessel: Any vessel applied by the International Convention for the Safety of Life at Sea 1974 that is a passenger ship engaged on an international voyage or a non-passenger ship (i.e. cargo ship) of 500 tons gross tonnage or more engaged on an international voyage

Non-SOLAS vessel: Any vessel that is not a SOLAS vessel.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

| | |
|-------|---|
| HGDM | Harmonisation Group on Data Modelling |
| IALA | International Association of Marine Aids to Navigation and Lighthouse Authorities |
| IHO | International Hydrographic Organisation |
| IMO | International Maritime Organisation |
| MSP | Maritime Service Portfolio |
| NCSR | Sub-Committee on Navigation, Communications and Search and Rescue |
| SOLAS | Safety of Life at Sea |
| VDES | VHF Data Exchange System |

4 Overview

This Technical Report introduces use cases and potential requirements to support maritime communication services in maritime communication environment that hasn't been considered in details in 3GPP for the purpose of maritime commercial businesses as well as maritime safety and maritime traffic management over 3GPP system.

Clause 5 and clause 6 describe use cases for mobile broadband services and for machine type communication services, respectively to satisfy demands for maritime commercial businesses. Clause 7 describes use cases for maritime safety as well as IMO MSPs to satisfy demands for authorities in maritime domain and clause 8 provides the description of the interworking with satellite access component and VDES.

In addition, some considerations are taken in clause 9 in order to enable 3GPP enabling technologies supporting legacy (i.e. pre Rel-16) mobile services to be applicable to maritime areas and to enable 3GPP enabling technologies supporting machine type communication such as eMTC and NB-IoT features that were specified from 3GPP Release 13 onwards and are expected to be specified in 3GPP Release 16 to be applicable to maritime areas.

Clause 10 consolidates potential requirements developed in clause 5 to clause 9 and the conclusion and recommendations are described in clause 11.

5 Use Cases for Mobile Broadband Services for Users at Sea

5.1 Use case on video streaming service in the cabin or on the deck

5.1.1 Description

This use case describes a scenario where users experience video streaming service in the cabin or on the deck of the vessel.

5.1.2 Pre-conditions

Because most of vessels are made of the steel material, UEs on the vessel (especially in the cabin of the vessel) access 3GPP network via the indirect network connection provided by another UE that plays a role as a relay UE for other UEs on the vessel and is deployed at the top of the vessel.

NOTE: Depending on the vessel capacity and the number of users on the vessel, the relay UE might be incapable of supporting the indirect network connection for all UEs on the vessel. In this use case, it is assumed that the size of a vessel and the number of users on the vessel are reasonable to have 3GPP network access via the relay UE.

UEs on the deck are capable of accessing 3GPP networks via direct network connection or via indirect network connection depending on the UE constraint related to the uplink transmission capability.

UEs on the vessel are subscribed and connected to a 3GPP network.

5.1.3 Service Flows

Bob is now on his yacht that is far away from the shore (e.g. 100 km distance from the shore) for his holidays.

He turns on the device that is positioned at the top of the yacht and is the relay UE that connects to 3GPP network.

The device automatically establishes the indirect network connection to provide 3GPP network access to UEs on the yacht.

Bob moves into the steel cabin of the yacht and enjoys the video streaming service from his tablet via the indirect network connection.

He wants to watch it on the deck of the yacht because the weather suddenly turns to be clear so moves out of the steel cabin with his table while keeping watching the video streaming service.

5.1.4 Post-conditions

Bob enjoyed the video streaming service on the deck as well as in the steel cabin of the vessel.

5.1.5 Potential Impacts or Interactions with Existing Services/Features

None identified

5.1.6 Potential Requirements

[PR-5.1.6-1] 3GPP system shall support the extreme long range coverage at sea (up to 100 km).

[PR-5.1.6-2] 3GPP system shall provide a mechanism to establish and keep a 3GPP network connection for UEs on the vessel when UEs are to be connected to 3GPP system via an indirect network connection or when there is any UE constraint on the uplink transmission capability at sea.

[PR-5.1.6-3] Downlink video streaming service shall be accessible by the direct network connection or the indirect network connection for users at sea.

[PR-5.1.6-4] The 3GPP system shall support service continuity between direct network connection and indirect network connection at sea or in a vessel.

5.2 Use case on transition from IOPS mode to on-network mode

5.2.1 Description

Local services in a vessel can be supported in IOPS mode when a vessel moves away from 3GPP network coverage. When that vessel approaches to the area in 3GPP network coverage, mobile devices of on-board passengers can switch back to the on-land network connection.

This use case describes a scenario where the network reselection is requested to be connected to on-land network when a vessel is approaching back to a maritime region that is in 3GPP network coverage.

5.2.2 Pre-conditions

A local 3GPP network operating in IOPS mode is installed in a vessel to provide local services (e.g. online gaming, video streaming, online duty free shopping).

The local 3GPP network operating in IOPS mode turns on when the vessel moves away from 3GPP network coverage and turns off when the vessel is approaching back to a maritime region that is in 3GPP network coverage.

5.2.3 Service Flows

1. A cruise stays in a Incheon harbour and UEs of shipboard users in the cruise are connected to 3GPP system by the direct network connection mode.
2. The cruise leaves for Kaohsiung harbour and is away from 3GPP network coverage.
3. UEs of shipboard users are utilizing the 3GPP network operating in IOPS mode on board of the vessel to access local services during the cruise.
4. The cruise is approaching Kaohsiung harbour and is about to enter 3GPP network coverage.
5. As soon as the cruise is in 3GPP network coverage in Kaohsiung harbour, the 3GPP network operating in IOPS mode on board of the vessel switches off and network reselection is performed by UEs of shipboard users in the cruise.

5.2.4 Post-conditions

Shipboard users enjoyed local mobile communication services with their mobile devices during the cruise and their UEs are successfully attached to the on-land network by the network reselection procedure.

5.2.5 Potential Impacts or Interactions with Existing Services/Features

None

5.2.6 Potential Requirements

[PR-5.2.6-1] Based on home operator policy, a UE shall be able to perform the network reselection when on-land networks are available.

[PR-5.2.6-2] A UE shall be able to access local services that are accessible via a 3GPP network operating in IOPS mode on board of a vessel.

5.3 Use case on next positioning technologies

5.3.1 Description

The study item FS_HYPOS is under standardization to study positioning use cases for diverse vertical domains including maritime domain.

Requirements as the outcome of 5G_HYPOS shall be supported for positioning services inside a vessel over 5G system.

5.3.2 Potential Requirements

Editor's NOTE: Requirements for positioning services inside a vessel are to be added later from the outcome of 5G_HYPOS work.

5.4 Use case on 5G LAN-type services over 5G system in a vessel

5.4.1 Description

5GLAN work is under standardization to support 5G LAN-type services over 5G system.

Maritime environment inside a vessel is similar to residential environment, enterprise environment or industrial automation environment depending on the type of vessels.

Requirements are covered by the outcome of 5GLAN work.

6 Use Cases for Machine Type Communication Services inside a Vessel, between Vessels and between UEs at Sea

6.1 Use case on communication between wearable IoT devices and maritime rescue coordination centre for saving a life

6.1.1 Description

This use case describes a scenario where a passenger saves a life by wearing IoT devices (e.g. air jacket, smart band) and its monitoring system.



Figure 6.1.1-1: Wearable IoT device

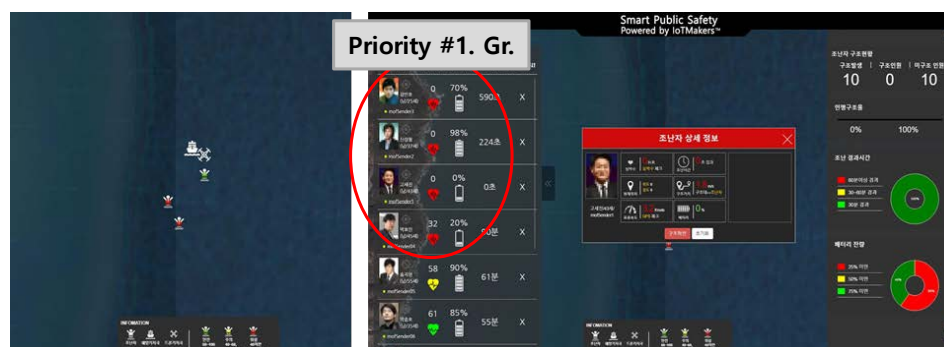


Figure 6.1.1-2: Maritime rescue coordination centre monitoring screen

6.1.2 Pre-conditions

A passenger buys a boarding ticket at ticket booth. Ticket counter employee activate UE (e.g. air jacket, smart band) which could be replaced boarding ticket and register UE device to maritime rescue coordination centre.

UE has the capability of transmitting the data (e.g. location information, heartbeat information) under the seawater to maritime rescue coordination centre.

Maritime rescue coordination centre has the capability of ordering and monitoring rescue based on passenger's location and health information.

Moving UE (e.g. drone) subscribes to 3GPP system and has the capability of relay as an UE.

Patrol craft connects to the core network of 3GPP system on land and has moving UE station which services battery charge and control.

6.1.3 Service Flows

1. Maritime collision/accident happens.

2. A shipboard user (e.g. crew or passenger) pressed a button on his/her jacket to send a rescue request to maritime rescue coordination centre and a user at sea who is adrift (e.g. castaway) also presses a button on his/her air jacket to send a rescue request including the information of the location and heartbeat to maritime rescue coordination centre.

3. The maritime rescue coordination centre receives their rescue requests including the information of their locations and heartbeats. The maritime rescue coordination centre lets a patrol craft where there are moving UE for rescue them.

Maritime rescue coordination centre indicates all passengers' current location and health status and classifies emergency patient who need to rescue right away.

A user who is adrift is moving along with the flow of the wind and the tide and now is out of the coverage of 3GPP network when the patrol craft arrives at the accident place.

4. Moving UE is flying from the patrol craft and moving around while extending the coverage of 3GPP network to find out a user who is adrift.

5. A rescue request is repeatedly transmitted from an air jacket of a user who is adrift once a user pressed the button and moving UE receives his/her rescue request so his/her location is identified.



Fig. 6.1.3-1 LTE maritime Service Scenario

6.1.4 Post-conditions

All shipboard users who faced the accident at sea are saved.

6.1.5 Potential Impacts or Interactions with Existing Services/Features

NOTE: Maritime emergency requests can be transmitted by other means such as GOSPASS/SARSAT and AIS so maritime rescue coordination centre need to identify whether maritime emergency requests from several sources are from a same user and figure out whether such maritime emergency requests are true or false alarms. It is out of 3GPP scope.

6.1.6 Requirements

[PR-6.1.6-1] 3GPP network shall transmit wake up message to UE for activating

[PR-6.1.6-2] UE shall transmit automatic maritime emergency request with location information and heartbeat information of the UE at the sea to maritime rescue coordination centre. The 3GPP system shall support to transmit manual maritime emergency request to maritime rescue coordination centre.

[PR-6.1.6-3] The network shall support the maritime emergency agency to transmit the list of users who need to be rescued with the vital information (e.g. heartbeat, user's location) to a MCX UE in the patrol craft.

[PR-6.1.6-4] The 3GPP system shall support moving UE (e.g. drone) to operate in relay mode for UEs that are out of 3GPP network coverage.

6.2 Use case on off-mode of mobility management for group of UEs in a vessel

6.2.1 Description

IoT devices (e.g. location tracking sensors) are attached to containers and products inside containers to help logistics system keep tracking the status of them during the transportation on land and at sea. 3GPP systems support different mobility management depending on UE's movements that are, for example,

- stationary during their entire usable life,
- stationary during active periods, but nomadic between activations,
- mobile within a constrained and well-defined space, and
- fully mobile

This use case describes mobility management for IoT devices attached to containers and products inside containers that can be regarded as stationary in a vessel once they are on board though a vessel continues to move during the voyage in order to make a representative UE of all IoT devices attached to containers and products inside containers carry out necessary procedures for the mobility management during the voyage and make IoT devices except for a representative UE skip required procedures that need to be carried out according to the mobility management procedure specified in 3GPP system because it does not seem to be efficient to make all IoT devices on board enforced to carry out mobility management procedure in a vessel especially when such IoT devices are connected to the 3GPP system via the indirect network connection.

6.2.2 Pre-conditions

Diverse mobility procedures that satisfy requirements specified in the section 6.2 of 3GPP TS 22.261 [x] are supported by 3GPP system.

Legacy mobility management procedures for IoT devices specified in 3GPP technical specifications are carried out until IoT devices are on board.

Shipping routes of a vessel are in the coverage of 3GPP system.

IoT devices are attached to products that are packed into containers.

IoT devices are attached to containers that are delivered by a vessel.

IoT devices are subscribed to 3GPP system.

6.2.3 Service Flows

1. IoT devices of containers are connected to 3GPP system.
2. Those containers are completed to be loaded onto a vessel and the vessel is ready for a voyage to deliver containers from Busan harbour to Mokpo harbour.
3. Containers are connected to 3GPP system via the indirect network connection in the vessel after on board.
4. The vessel is on voyage where the mobility management procedure is carried out whenever 3GPP access networks are changed along to the shipping routes.
5. Information (e.g. current location, estimated port arrival time) required by shipping companies that need to keep tracking their products packed into containers in the vessel is periodically transmitted to their shipping systems over 3GPP system.

6.2.4 Post-conditions

Shipping companies took proper actions on time for the land transportation of products packed into containers after the vessel is arrived at the port.

6.2.5 Potential Impacts or Interactions with Existing Services/Features

None

6.2.6 Potential Requirements

[PR-6.2.6-1] 3GPP system shall provide a means of mapping a representative UE (e.g. a UE whose identity is related to vessel identity or one of UEs attached to containers) with all UEs attached to containers and products packed into containers to enable a representative UE to carry out the mobility management procedure instead of all of those UEs.

NOTE: A representative UE can be selected by the network based on the strength of the radio signal transmitted by all of UEs attached to containers.

[PR-6.2.6-2] 3GPP system shall provide a mechanism of making the mobility management of UEs attached to containers and products packed into containers off during the voyage once they are loaded to the vessel and they are connected to 3GPP system via indirect network connection.

6.3 Use case on Push to Location service among vessels

6.3.1 Description

When any accident happens in a vessel at sea, neighbouring vessels used to be faster to go to help shipboard users in the vessel in danger than coastal guards depending on where they are. Considering different rescue environment at sea from on land, it is necessary to make it possible for a vessel to send the location information to neighbouring vessels in a multicast or broadcast way and for vessels to communicate each other directly.

This use case describes Push to Location service from a vessel to all neighbouring vessels.

6.3.2 Pre-conditions

MCX Services off the network are supported for vessel to vessel communication.

3GPP system provides the solution to satisfy the requirement [R-7.8-001] specified in the clause 7.8 of 3GPP TS 22.280 and the requirement [R-10-001] specified in the clause 10 of 3GPP TS 22.280.

Each vessel has a device that is connected to 3GPP system and whose identity is mapped into the identity of the vessel itself.

6.3.3 Service Flows

1. Vessels are under night fishing and a single shipboard user is on board in each vessel.
2. All vessels are connected in off the network mode so shipboard users communicate each other through MCX Services off the network.
3. A shipboard user of the vessel A suddenly feels the pain and needs the help from someone else. However, shipboard users from other vessels cannot see what is happening to the shipboard user of the vessel A because it is so dark.
4. The shipboard user of the vessel A push the button to send the location information of the vessel A that is transmitted to all neighbouring vessels that are connected together in off the network mode.
5. Neighbouring vessels receive the location information of the vessel A and shipboard users of neighbouring vessels move to the vessel A based on the received location information to check if the shipboard user of the vessel A is OK.

6.3.4 Post-conditions

Shipboard user of the vessel A was found and given proper emergency measures until the coastal guards come to the vessel A and move the shipboard user of the vessel A to the hospital on land.

6.3.5 Potential Impacts or Interactions with Existing Services/Features

None

6.3.6 Potential Requirements

[PR-6.3.6-1] For maritime usage, off-network use of MCX Services shall be supported.

[PR-6.3.6-2] The communication range between vessels for the push of the location information is [15 km] in case of non-SOLAS vessels.

NOTE 1: The KPI of the communication range between vessels for the push of the location information will be further analysed and can be revised during the normative work.

NOTE 2: The KPI of the communication range between vessels for the voice call or group call can be smaller than for the push of the location information.

NOTE 3: As an example, Korean coastal guards have the requirement that the communication coverage between a large vessel (e.g. a carrier ship) and a speedboat shall be supported by 7.5 km as a minimum value.

NOTE 4: Location information can be provided based on next positioning technologies that are outcomes of 5G_HYPOS work.

6.4 Use case on small cells deployed in each cabin of a vessel

6.4.1 Description

Provision of wireless environment over 3GPP access or non-3GPP access in a vessel is quite challenging because each cabin in a vessel is separated by barriers made of steels that make wireless signal too weakened to go through the barrier and be delivered to neighbouring cabins. In addition, it is also very challenging to keep tracking the movement of cabin crews in a vessel that could be one of essential requirements required for the safety of cabin crews especially in case of a huge vessel where there are only a few cabin crews who may be exposed to any unexpected risk in an enclosed place of the vessel.

The deployment of small cells in each cabin can be one of possible solutions to provide wireless environment over 3GPP system in a vessel.

This use case describes the deployment scenario of small cells in each cabin of a vessel and also the scenario where the movement of cabin crew can be traceable with the help of the IoT device as well as the location information of a cabin crew reported to the small cell.

6.4.2 Pre-conditions

Wireless backhaul is supported to connect small cells deployed in a vessel with core networks deployed on land.

Small cells operate in licensed spectrums or unlicensed spectrum to provide wireless services in a vessel.

Legacy procedures on small cells specified in 3GPP technical specification are carried out in a vessel.

Isolated networks are built so that wireless services over 3GPP system inside a vessel can be supported during the voyage regardless of whether the connection to the core network is kept or lost.

IoT devices used by cabin crews are subscribed to 3GPP system and direct device connection among IoT devices is supported.

6.4.3 Service Flows

1. A cargo ship where small cells are deployed in each cabin and on the deck, are on voyage to transport dangerous substance.

2. A few cabin crews are on board to navigate a cargo ship, manage facilities during the voyage and periodically go around in a cargo ship alone to check if everything is OK.
3. A cabin crew has an IoT device on his wrist that is connected to a small cell of a cabin and sends the information (e.g. the current location of the user of IoT device) to the bridge of the cargo ship only if there is no movement from a user of the IoT device during the given time in order to prevent cabin crews from being exposed to any risk alone while going around in a cargo ship.
4. A cabin crew starts to go around in a cargo ship alone and enters into cabin A where small cell A is deployed and his IoT device is attached to small cell A as soon as he enters cabin A.
5. He moves to cabin B and his IoT device is attached to small cell B that is deployed in the cabin B. Unfortunately, something wrong happens so he collapsed there.
6. After the given time is passed, he is lying unconscious on the floor of the cabin B so his IoT device transmits the information (e.g. the current location of the user based on the information of the registered small cell B as well as other information on his health status) to the devices of other cabin crews as well as the bridge of the cargo ship.
7. In addition, his IoT device also transmits the request that will trigger the activation of all IoT devices (e.g. CCTV cameras, sensors detecting a dangerous substance) deployed in the cabin B to check if there is any identifiable risk (e.g. any leak of dangerous substance) by the direct device connection among IoT devices in the cabin B.
8. Real time video streaming captured from CCTV cameras in the cabin B is transmitted to the bridge and a captain who is at the bridge of a cargo ship notices what is happening to the cabin crew collapsed in the cabin B and based on the information transmitted from IoT device of the cabin crew in the cabin B (e.g. information on his health status) as well as from other IoT devices that detect any leak of dangerous substance, the captain identifies that fortunately there is no leak of dangerous substance.
9. Another cabin crew in other cabin nearby cabin B gets informed of the emergency occurrence to the cabin crew in the cabin B because his device shows such emergency event with detailed information transmitted from IoT device of the collapsed cabin crew in the cabin B. So, he runs into the cabin B to help the cabin crew in the cabin B

6.4.4 Post-conditions

Cabin crew collapsed in the cabin B could be recovered soon with the help of his colleague who were in other cabin nearby cabin B and ran into the cabin B.

6.4.5 Potential Impacts or Interactions with Existing Services/Features

None

6.4.6 Potential Requirements

[PR-6.4.6-1] 3GPP system shall provide a means of mapping the location information of each cabin in a vessel with the location information of a corresponding small cell deployed in each cabin so that the location information of devices that is in a cabin is identifiable based on the location information of a small cell deployed in that cabin.

[PR-6.4.6-2] 3GPP system shall provide a mechanism of multicasting or broadcasting the information received from IoT device via a small cell to devices of shipboard users via only small cells deployed in cabins where there are shipboard users.

7 Use Cases for Maritime Communication Services between Authorities and Users at Sea

7.1 Vessel Shore Reporting

7.1.1 Description

The description on IMO MSP 8 (vessel shore reporting) is provided in IMO NCSR 1-28 [3] as follows.

The aim of vessel shore reporting is to safeguard traffic at sea, ensure personnel safety and security, ensure environmental protection and increase the efficiency of maritime operations.

Maritime single window is one of the most important solutions to reduce the mariners workload (amount of time spent on preparing and submitting reports to shore-based authorities). To achieve this, reports should be automatically generated as much as possible from onboard systems. Some other important possibilities for vessel shore reporting system may include:

- *single-entry of reportable information in single-window solution;*
- *automated collection of internal ship data for reporting;*
- *all national reporting requirements to apply standardized digital reporting formats based on IMO FAL forms; and*
- *automated or semi-automated digital distribution/communication of required reportable information.*

End-users of vessel shore reporting identified as IMO MSP 8 could be shore-based users such as national competent authorities, ship owners or operator and shipboard users such as a ship master who has the access right to vessel shore reporting.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.2 Use case on communication for search and rescue

7.2.1 Description

This use case describes a scenario where a user saves the life by receiving the immediate emergency treatment by the tele-medical service accessible between the patrol boat of coast guards at sea and the health organization on land after the maritime emergency request is transmitted to the maritime rescue co-ordination centre that transmits the maritime notification message informing the emergency event to patrol boats of coast guards at sea.

7.2.2 Pre-conditions

The patrol boat of the coast guard is equipped with the tele-medical treatment machine that is connected to national health organization or dedicated health organization such as a hospital for the tele-medical service over 3GPP system.

In addition, the patrol boat is in the coverage of 3GPP system at sea and mission critical services such as MCVideo and MCDATA are supported for the communication between the coast guard in the patrol boat and a doctor in health organizations in order to provide tele-medical services.

Because most of yacht are made of the steel material, UEs on the yacht (especially in the steel cabin of the yacht) access 3GPP network via the indirect network connection provided by another UE that plays a role as a relay UE and is deployed at the top of the yacht.

7.2.3 Service Flows

When Jiho and her friends are spending their summer vacation on the yacht at sea, Jiho suddenly collapses in the steel cabin of the yacht so one of her friends sends a maritime emergency request to the maritime rescue co-ordination centre using her mobile device through the indirect network connection provided by the relay UE.

The maritime rescue co-ordination centre transmits the maritime notification message about the emergency event and the location of the yacht to all patrol boats of coast guards around the yacht at sea.

One of patrol boats is fortunately very close to the yacht so sends the reply message back to the maritime rescue co-ordination centre in order to indicate that they will move to Jiho's yacht.

Jiho needs the immediate medical treatment when the coast guards arrive at the yacht so they move her to the patrol boat to take her to the hospital on land.

The coast guard requests the maritime rescue co-ordination centre to call for the ambulance that takes her to the hospital as soon as the patrol boat arrives at the port while the tele-medical service is provided to her through tele-medical treatment machine in the patrol boat.

The doctor examines her health status based on the video information transmitted from the tele-medical treatment machine over the relay UE that is connected to 3GPP system.

7.2.4 Post-conditions

Coast guard took the proper medical action for Jiho according to the instruction of the doctor thanks to the tele-medical service in the patrol boat before arriving at the port so they saved her life.

7.2.5 Potential Impacts or Interactions with Existing Services/Features

None identified

7.2.6 Potential Requirements

[PR-7.2.6-1] A UE shall transmit the maritime emergency request with the location information of the UE at sea to the mission critical organisation (e.g. maritime rescue co-ordination centre) when the UE transmits the maritime emergency request via the indirect network connection.

[PR-7.2.6-2] The 3GPP network shall transmit the maritime notification message including the user's location information extracted from the maritime emergency request and optionally emergency event information to inform.

[PR-7.2.6-3] An MCX UE shall receive the maritime notification message transmitted from the mission critical organisation over 3GPP system and an MCX UE may receive the maritime notification message transmitted from the mission critical organisation via the indirect network connection provided by the relay UE connecting to 3GPP system.

[PR-7.2.6-4] A UE at sea may receive the maritime notification message transmitted from the mission critical organisation over 3GPP system.

[PR-7.2.6-5] The MCX UE shall transmit the maritime response message including the location information of the authority (e.g. the location of the patrol boat of the coast guard) at sea to the mission critical organization over 3GPP system.

[PR-7.2.6-6] 3GPP system shall support the capability of transmitting vessel's location information used in the legacy maritime communication in case there is any equipment providing such location information inside the vessel.

[PR-7.2.6-7] A remote MCX UE shall be capable of accessing MCVideo service and MCDData service via the relay UE (i.e., a UE that is a vessel, itself) for the communication between the coast guard of the patrol boat and a doctor in a health organisation to support the tele-medical service.

7.3 Coastal and local warning service

7.3.1 Description

Maritime safety information service provides navigational warning, meteorological information and other urgent safety-related information.

Navigational warnings are messages containing urgent information relevant to safe navigation that are broadcast to ships in accordance with the provisions of the International Convention for the Safety of Life at Sea, 1974, as amended. There are four types of navigational warnings, i.e. NAVAREA warnings, Sub-Area warnings, coastal warnings and local warnings. The first two warnings are broadcast by NAVTEX or SafetyNET and the second two warnings could be broadcast by other means (e.g. 3GPP system) than NAVTEX or SafetyNET according to IMO NCSR 1/15/1 [2].

Coastal warnings disseminate the information which is necessary for safe navigation within areas seaward of the fairway buoy or pilot station, and should not be restricted to main shipping lanes.

Local warnings disseminate the information which covers inshore waters, often within the limits of jurisdiction of a harbour or port authority. They are disseminated by other means than NAVTEX or SafetyNET, and supplement to coastal warnings by giving detailed information within inshore waters.

This use case describes a scenario where coastal and local warnings disseminate the information relevant to safe navigation over 3GPP system and vessels automatically monitor disseminated information and display information which is relevant to their navigation.

7.3.2 Pre-conditions

Coastal and local warning service is available to all vessels that are subscribed to 3GPP system.

Electronic Navigation Chart (ENC) service is available to an authority in charge of coastal and local warnings and to a vessel and shipboard users (e.g. mariner or shipmaster) of that vessel

Vessels are in the coverage of 3GPP system.

7.3.3 Service Flows

1. When a vessel is approaching the port, a shipboard user (e.g. a mariner or a shipmaster) requests a maritime safety information from an authority (e.g. national administrator of the national coordinator) in charge of coastal and local warnings.
2. The authority in charge of coastal and local warnings provides the coastal and local warnings.

NOTE 1: An authority can provide either coastal warning or local warning or both depending on marine traffic information and marine environmental situation near a vessel requesting a maritime safety information.

NOTE 2: According to IMO NCSR 1/15/1 [2], a message that is sent to notify coastal and local warnings consists of three parts, i.e. preamble, warning and postscript. The identifier of that message (i.e. message series identifier followed by the consecutive number) is always included in the preamble of that message. As a minimum information of coastal and local warnings, the information about a key subject and a geographical position is included in that message and the example of key subjects are as follows.

- Casualties to lights, fog signals, buoys and other aids to navigation affecting main shipping lanes;
- The presence of dangerous wrecks in or near main shipping lanes and, if relevant, their marking;
- Establishment of major new aids to navigation or significant changes to existing ones, when such establishment or change might be misleading to shipping;
- The presence of large unwieldy tows in congested waters;
- Drifting hazards (including derelict ships, ice, mines, containers, other large items over 6 metres in length, etc.);

- Areas where search and rescue (SAR) and anti-pollution operations are being carried out (for avoidance of such areas);
- The presence of newly discovered rocks, shoals, reefs and wrecks likely to constitute a danger to shipping, and, if relevant, their marking;
- Unexpected alteration or suspension of established routes;
- Cable or pipe-laying activities, seismic surveys, the towing of large submerged objects for research or exploration purposes, the employment of manned or unmanned submersibles, or other underwater operations constituting potential dangers in or near shipping lanes;
- The establishment of research or scientific instruments in or near shipping lanes;
- The establishment of offshore structures in or near shipping lanes;
- Significant malfunctioning of radio-navigation services and shore-based maritime safety information radio or satellite services;
- Information concerning events which might affect the safety of shipping, sometimes over wide areas, e.g. naval exercises, missile firings, space missions, nuclear tests, ordnance dumping zones, etc;
- Operating anomalies identified within ECDIS including ENC issues;
- Acts of piracy and armed robbery against ships;
- Tsunamis and other natural phenomena, such as abnormal changes to sea level;
- World Health Organization (WHO) health advisory information; and
- Security-related requirements in accordance with the requirements of the ISPS (International Ship and Port Facility Security) only.

3. The authority provides another message to the vessel requesting maritime safety information in order to provide enough extra data for shipboard users of that vessel to be able to recognize the hazard and assess its effect upon their navigation.

4. The authority periodically broadcasts coastal and local warnings at a scheduled notification time as well to all vessels in the coverage of 3GPP system.

NOTE 1: Same coastal and local warnings can be disseminated at a scheduled notification time if they are valid.

NOTE 2: Cancellation details are included in a message notified in order to inform that coastal and local warnings related to that message is cancelled and not valid any more.

NOTE 3: A message indicating no warnings can be periodically disseminated at a scheduled notification time though there are no coastal and local warnings to be notified.

5. Source data relating to coastal and local warnings that are notified are recorded with coastal and local warning messages including message series identifier according to the requirement of the national administration.

6. The shipboard user receives messages notified by the authority in charge of coastal and local warnings and identifies some important information included in that message on the ENC in the vessel.

7.3.4 Post-conditions

The vessel safely entered to the port by avoiding potential risks that were notified by coastal and local warning service.

7.3.5 Potential Impacts or Interactions with Existing Services/Features

None

7.3.6 Potential Requirements

[PR-7.3.6-1] 3GPP system shall provide a mechanism of correlating a UE identity with a vessel identity (e.g. a national vessel identification number managed by a national authority or an IMO number that is a unique international vessel identification number consisting of 7-digit number).

[PR-7.3.6-2] The information related to a vessel-dedicated UE's actual position where the vessel is located and is expected to be located along with a navigational route shall be included in a message sent from a UE in order to request a maritime safety information.

NOTE: The example of the information related to a vessel-dedicated UE's actual position is current position, heading and speed of a vessel and scheduled navigational routes, heading and speed of a vessel.

[PR-7.3.6-3] 3GPP system shall provide a mechanism of notifying a message on coastal and local warnings to a sea area that includes the position, heading and speed of other UEs in the area.

[PR-7.3.6-4] 3GPP system shall provide a mechanism of enabling only the UE that requested a maritime safety information to identify a message notified from an authority in charge of coastal and local warnings.

[PR-7.3.6-5] 3GPP system shall provide a mechanism of enabling all UEs of vessels that are in the coverage of 3GPP system to identify a message broadcast from an authority in charge of coastal and local warnings.

7.4 Pilotage service

7.4.1 Description

This use case describes the pilotage service that provides shipboard users such as a pilot or a shipmaster and shore-based users such as pilot authorities, pilot organization or bridge personnel the exact information necessary to manoeuvre vessels through pilotage areas such as dangerous or congested waters and harbours or to anchor vessels in a harbour in order to safeguard traffic at sea and protect the environment.

7.4.2 Pre-conditions

Shipboard users such as a pilot who has a pilotage certificate or licensing or a shipmaster who has a pilotage exemption certificate are subscribed to pilotage service.

Vessels are subscribed to pilotage service and to 3GPP system so that the information about their neighbouring situations including other vessels that are operating in a pilotage area is able to be timely provided over 3GPP system to make vessels successfully pass through a pilotage area.

Vessels are subscribed to electronic navigation chart (ENC) service so the ENC is updated as the latest version when a vessel is in a pilotage area.

NOTE: A shipboard user can identify the latest information about a port or sea area such as the depth of water, buoys, navigational route, berth information from the ENC.

Pilotage service is accessible to ENC service.

Vessels are subscribed to coastal and local warning service so the maritime safety information including the meteorological information is updated as the latest version when a vessel is in a pilotage area.

A drone with a 3D-LiDAR sensor that is operated by a pilot authority or pilot organisation is subscribed to pilotage service and to 3GPP system.

A pilotage area is in the coverage of 3GPP system.

7.4.3 Service Flows

1. A shipboard user (e.g. mariner or shipmaster) on a vessel A sends an online request on pilotage service to a pilot authority or pilot organisation such as a (local) pilot office when the vessel A is approaching a pilotage area.

NOTE: A ship company or an agent in charge of the vessel A can request a pilot assignment to a pilot authority or pilot organisation instead of a shipboard user on the vessel A in advance before the vessel A's entry or departure.

2. A shipmaster on a vessel B who has the pilotage exemption certificate also sends a request on pilotage service to a pilot authority or pilot organization when the vessel B is approaching the same pilotage area. He informs a pilot authority or pilot organization of his pilotage exemption certificate in order to manoeuvre his vessel by himself and pass a pilotage area.

3. The pilot authority or pilot organization accept requests on pilotage service for the vessel A and the vessel B. In addition, they inform the vessel A of the assignment of a pilot after assigning a pilot to provide pilotage service for the vessel A and permit the shipmaster on the vessel B to access the pilotage service that is available to a pilot.

4. The pilot embarks on the vessel A and logs in the pilotage service. Then, the pilotage service authenticates the pilot on the vessel A and authorises the pilot to the pilotage service that is available to a pilot.

NOTE: A pilot can log in the pilotage service using a device that is one of communication equipments inside the vessel A or using a device that is brought by a pilot and is connected to an equipment of the vessel A.

5. The pilotage service provides the shipboard user (i.e. a pilot or a shipmaster with the pilotage exemption certificate) with the latest information such as a port guideline of a pilotage area that helps the shipboard user understand the characteristics of sea area corresponding to a pilotage area and the standard piloting method in advance.

6. The shipboard user (i.e. a pilot or a shipmaster with the pilotage exemption certificate) identifies the marine traffic information about all vessels in a pilotage area from the pilotage service. The example of the marine traffic information is as follows.

- static information about vessels such as IMO number as a vessel identification number consisting of 7-digit number and vessel particulars)

NOTE: Vessel particulars include vessel name, call sign, IMO number, MMSI number, type, flag/port of registry, gross tonnage/net tonnage, dead weight, LOA (Length Over All), width, depth etc..

- dynamic information about the movement of vessels such as direction, speed, rate of turn (ROT) expressed in degrees per second of heading change that vessels make, and position of vessels
- navigational information (e.g. cargo, estimated time of arrival (ETA), and destination of a vessel)

7. A drone with a 3D-LiDAR sensor that is operated by a pilot authority or a pilot organisation is flying above the vessel A and the information captured from the 3D-LiDAR sensor is transmitted in real time to the vessel A, a pilot authority or a pilot organisation and a bridge personnel until the shipboard user (i.e. a pilot or a shipmaster with the pilotage exemption certificate) completes his mission on the pilotage.

NOTE: Information that is captured by a 3D-LiDAR and is transmitted to the vessel A, a pilot authority or a pilot organisation and a bridge personnel can be displayed in the ENC if the ENC supports 3D data.

8. The pilotage service provides the prediction of vessels' movement in a pilotage area based on the information of the current vessels' movement that is obtained from AIS, radar sensor of vessels or 3D-LiDAR sensor of a drone. In addition, the pilotage service provides a piloting route automatically proposed by the pilotage service or manually planned by the shipboard user (i.e. a pilot or a shipmaster with the pilotage exemption certificate).

9. In order to avoid any collision between vessel A and vessel B in a pilotage area, the information relevant to safe navigation is exchanged between vessel A and vessel B directly. Such information is also transmitted to a pilot authority, a pilot organization or a bridge personnel who are involved in supporting the pilotage service for the vessel A and vessel B

10. A bridge personnel transmits a local warning that in advance informs vessel A and vessel B of any potential risk (e.g. a collision between two vessels or a collision between a vessel and any obstacle) if it is anticipated by the pilotage service.

10. The shipboard user (i.e. a pilot or a shipmaster with the pilotage exemption certificate) manoeuvres his vessel and passes a pilotage area with the help of several useful information provided by pilotage service.

11. The pilotage service records vessel routes passed in real time.

7.4.4 Post-conditions

Vessel A and vessel B are safely anchored to the port without any collision or accident.

7.4.5 Potential Impacts or Interactions with Existing Services/Features

None

7.4.6 Potential Requirements

[PR-7.4.6-1] 3GPP system shall provide a mechanism of authenticating a UE transmitting an online request on pilotage service and authorising such a UE to access the pilotage service.

[PR-7.4.6-2] 3GPP system shall provide a mechanism of correlating a UE identity with a vessel identity (e.g. IMO number that is a unique international vessel identification number consisting of 7-digit number).

[PR-7.4.6-3] 3GPP system shall support to transmit the information about the movement of vessels obtained from diverse sensors (e.g. 3D-LiDAR, radar, GPS) in real time.

[PR-7.4.6-4] 3GPP system shall provide a mechanism of synchronising the information used by shipboard users (i.e. a pilot or a shipmaster with pilotage exemption certificate) and shore-based users (e.g. a pilot authority or a pilot organisation and a bridge personnel).

[PR-7.4.6-5] 3GPP system shall support the data rate and the latency that enable a shipboard user not to recognise any gap between the real vessel movement and the vessel movement shown through the pilotage service.

NOTE: Depending on the size and weight of a vessel, it may cause a large movement of a vessel within a very short time that is difficult to restore to the original status. Very short latency is also as important as the high data rate when transmitting information obtained from sensors such as 3D-LiDAR.

[PR-7.4.6-6] 3GPP system shall support real-time data streaming service.

7.5 Tugs service

7.5.1 Description

A tug is a boat or ship that manoeuvres vessels by pushing or towing them. Tugs move vessels that either should not move by themselves (e.g. vessels passing in a narrow canal, berthing and unberthing operations) or those that cannot move by themselves (e.g. barges, disabled ships, oil platforms).

This use case describes the tugs service that are for ship assistance (e.g. mooring), towage (in harbour/ocean), or escort operations to safeguard traffic at sea and protect the environment.

7.5.2 Pre-conditions

Shipmasters of tug boats are subscribed to tugs service and pilotage service.

Tug boats as well as a vessel that is moved by tug boats are subscribed to tugs service, to pilotage service and to 3GPP system.

Tug boats are subscribed to an Electronic Navigation Chart (ENC) service. The ENC is updated as the latest version before tug boats start their mission of moving a vessel.

NOTE: A shipboard user can identify the latest information about a port or sea area such as the depth of water, buoys, navigational route, berth information from the ENC.

Tugs service is accessible to ENC service.

Tug boats are subscribed to coastal and local warning service so the maritime safety information including the meteorological information is updated as the latest version when tug boats are in a tug area.

A drone with a 3D-LiDAR sensor that is operated by a port tug organisation is subscribed to tugs service and to 3GPP system.

A tug area is in the coverage of 3GPP system.

Pilotage service is available in a tug area.

7.5.3 Service Flows

1. A shipboard user (e.g. mariner or shipmaster) on a vessel sends an online request on tugs service to a port tug organisation when a vessel is approaching a waiting point of a tug area.

NOTE: A ship company or an agent in charge of a vessel can request the assignment of tug boats to a port tug organisation instead of a shipboard user on a vessel in advance before a vessel's entry or departure.

2. The port tug organisation accepts the request on tugs service for the vessel, assign four tug boats to move that vessel and inform the vessel requesting tugs service of the assignment of tug boats.

NOTE: The number of tug boats assigned by a port tug organisation may be decided depending on the size of a vessel that tug boats move.

3. Tug boats approach the vessel and are attached to that vessel with tugboat ropes. In addition, tug boats and the vessel are connected together through indirect network connection between tug boats and the vessel via a drone with a 3D-LiDAR sensor or through direct network connection between them over 3GPP system in order to directly exchange the information necessary for tugs service depending on the capability of the vessel.

4. Shipmasters of four tug boats receive the marine traffic information about all vessels in a tug area from the pilotage service. In addition, they share information about tug boats and the vessel that tug boats move with bridge personnel or pilots manoeuvring other vessels in a tug area through pilotage service in real-time.

NOTE: The shipmasters of the four tug boats receive all information from the pilotage service that is available to a pilot in a tug area. They may receive the information about the vessel that tug boats move either via the indirect network connection through the drone or via the direct network connection between tug boats and the vessel that tug boats move.

5. A drone with a 3D-LiDAR sensor that is operated by a port tug organisation is flying above tug boats and the vessel and the information captured from the 3D-LiDAR sensor is transmitted in real time to tug boats, the vessel, a port tug organisation and a bridge personnel until shipmasters of tug boats complete their mission on the tugs service.

NOTE: Information that is captured by a 3D-LiDAR and is transmitted to tug boats, the vessel, a port tug organisation and a bridge personnel can be displayed in the ENC if the ENC service supports 3D data.

6. A bridge personnel transmits a local warning that informs shipmasters of tug boats of any potential risk (e.g. a collision between tug boats and other vessels).

7. Tugs service provides the prediction of the movement of tug boats.

8. Tugs service records information applied to control four tug boats (e.g. strength of pulling tugboat ropes in each tug boat as well as its environmental circumstance around them) and routes passed by tug boats and the vessel in real time.

9. Shipmasters of tug boats manoeuvre tug boats by exquisitely coordinating tug boats based on all available information about marine traffic situations and make the vessel pass in a tug area.

7.5.4 Post-conditions

Tug boats safely completed their mission of moving the vessel to the destination.

7.5.5 Potential Impacts or Interactions with Existing Services/Features

None.

7.5.6 Potential Requirements

[PR-7.5.6-1] 3GPP system shall provide a mechanism for tugs service to authenticate and authorise a UE to access the tugs service.

[PR-7.5.6-2] 3GPP system shall support handling of an online request for tugs service from an authorised UE.

[PR-7.5.6-3] 3GPP system shall provide a mechanism of correlating a UE identity with a vessel identity (e.g. IMO number that is a unique international vessel identification number consisting of 7-digit number).

[PR-7.5.6-4] 3GPP system shall provide a mechanism of registering the UEs that are dedicated to tug boats and a vessel moved by tug boats as a group of UEs.

[PR-7.5.6-5] Group communication among a group of UEs that are dedicated to tug boats and a vessel moved by tug boats shall be supported via the direct network connection or via indirect network connection.

NOTE 1: The example of a relay UE providing the indirect network connection mode is a drone that is regarded as one of UEs or a UE deployed in the highest place of a vessel or one of tug boats where the group communication among a group of UEs is available.

NOTE 2: Group communication specified by off-network MC services can be used to support the group communication among a group of UEs dedicated to tug boats and a vessel moved by tug boats.

NOTE3: Existing ProSe enabling technologies can be suitable to vessel to vessel communication in spite of the limitation of the communication range between vessels that is a few hundred meters to less than 2 kilometers in case of SOLAS vessels.

[PR-7.5.6-6] 3GPP system shall support the data rate and the latency that enable shipboard users (e.g. shipmasters of tug boats) to exquisitely coordinate tug boats based on all information available to them (e.g. the information captured from the 3D-LiDAR sensor in real-time during tugs service) while manoeuvring tug boats to move a vessel to the destination.

NOTE: Depending on the size and weight of a vessel, it may cause a large movement of a vessel within a very short time that is difficult to restore to the original status. Very short latency is also as important as the high data rate when transmitting information obtained from sensors such as 3D-LiDAR.

7.6 Dissemination of PWS message for shipboard users

7.6.1 Description

This use case describes a scenario where PWS notification is delivered to shipboard users by the direct network connection or by the indirect network connection. Language-independent content is also included in a PWS message delivered to them.

7.6.2 Pre-conditions

A fishing boat is in the coverage of 3GPP system.

A relay UE and remote UEs are subscribed to operator's 3GPP network.

The relay UE is placed at the top of a fishing boat and is connected to the 3GPP network.

The remote UEs are connected to the 3GPP network over direct network connection or indirect network connection.

The relay UE monitors the 3GPP network for public warning alarms.

7.6.3 Service Flows

1. A fishing boat where three crews are foreigners is now in the coastal waters of Pohang to catch the squid at night.

2. A UE of a shipmaster who is Korean is placed in the cabin of the fishing boat and UEs of crews who are foreigners are in their pockets while they are working to catch the squid.

3. An earthquake happens in waters off Japanese Shimane prefecture and PWS messages, a Korean-text based PWS message and a language-independent content (e.g. pictogram or symbol representing the earthquake) based PWS message, are broadcast to notify the occurrence of the earthquake to shipboard users at the fishing boat.

4. The relay UE placed at the top of the fishing boat receives the PWS messages and forwards them to UEs of the shipmaster and three crews.

5. The shipmaster fails to notice the reception of the PWS messages due to the loud noise of the fishing boat engine but the three crews receive PWS messages and understand the occurrence of the earthquake with the help of the language-independent content based PWS message.

7.6.4 Post-conditions

Crews informed the shipmaster of the occurrence of the earthquake and the shipmaster could take the proper action.

7.6.5 Potential Impacts or Interactions with Existing Services/Features

None

7.6.6 Potential Requirements

Potential requirements for this use case are already covered in 3GPP TS 22.268 [8].

7.7 Urgent alarm service

7.7.1 Description

This use case describes a scenario where ships avoid accident using warning message.

7.7.2 Pre-conditions

All ships register an auto identification system (AIS).

Maritime platform calculates collision probability based on speed on ground (SOG) and course on ground (COG).

7.7.3 Service Flows

1. Maritime platform (Figure 7.7.3-1) calculates collision probability based on speed on ground (SOG) and course on ground (COG).



Figure 7.7.3-1 Example of maritime platform

2. Maritime platform transmits warning message to ships through 3GPP network. (Figure 7.7.3-2)

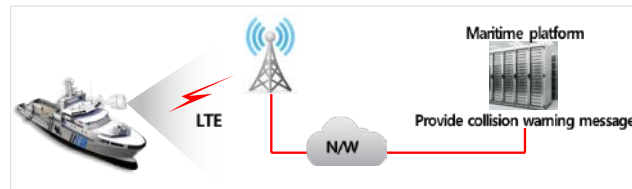


Figure 7.7.3-2 Urgent alarm service network

7.7.4 Post-conditions

Maritime accident avoided.

7.7.5 Potential Impacts or Interactions with Existing Services/Features

None identified.

7.7.6 Potential Requirements

[PR-7.7.6-1] 3GPP network shall transmit warning message received from maritime authorities to neighbouring ships.

7.8 VTS Information Service

7.8.1 Description

The description on IMO MSP 1 (VTS Information Service) is provided in IMO NCSR 1-28 [3] as follows.

Vessel traffic service (VTS) is a shore-side system which range from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.

Generally, ships entering a VTS area report to the authorities, usually by radio, and may be tracked by the VTS control centre. Ships must keep watching on a specific frequency for navigational or other warnings, while they may be contacted directly by the VTS operator if there is risk of an incident or, in areas where traffic flow is regulated, to be given advice on when to proceed.

Regulation 12 on vessel traffic services that is described in the SOLAS (International Convention for the Safety of Life at Sea) Chapter V states:

1. *VTS contribute to safety of life at sea, safety and efficiency of navigation and protection of the marine environment, adjacent shore areas, work sites and offshore installations from possible adverse effects of maritime traffic.*
2. *Contracting Governments undertake to arrange for the establishment of VTS where, in their opinion, the volume of traffic or the degree of risk justifies such services.*
3. *Contracting Governments planning and implementing VTS shall, wherever possible, follow the guidelines developed by the Organization. The use of VTS may only be made mandatory in sea areas within the territorial seas of a coastal State.*
4. *Contracting Governments shall endeavour to secure the participation in, and compliance with, the provisions of vessel traffic services by ships entitled to fly their flag.*
5. *Nothing in this regulation or the guidelines adopted by the Organization shall prejudice the rights and duties of Governments under international law or the legal regimes of straits used for international navigation and archipelagic sea lanes.*

End-users of VTS Information Service (IS) identified as MSP1 could be shore-based users such as VTS authority and shipboard users such as a ship master or crew who has the access right to VTS IS.

The VTS IS is defined as a service to ensure that essential information becomes available in time for onboard navigational decision making.

Relevant information is broadcasted at fixed times and intervals or provided when deemed necessary by the VTS or at the request of a vessel.

A VTS IS involves maintaining a traffic image and allows interaction with traffic and response to developing traffic situations. A VTS IS should provide essential and timely information to assist the onboard decision-making process, which may include but is not limited to:

- *the position, identity, intention and destination of vessels;*
- *amendments and changes in promulgated information concerning the VTS area such as boundaries, procedures, radio frequencies, reporting points;*
- *the mandatory reporting of vessel traffic movements;*
- *meteorological and hydrological conditions, notices to mariners, status of aids to navigation;*
- *manoeuvrability limitations of vessels in the VTS area that may impose restrictions on the navigation of other vessels, or any other potential hindrances; or*
- *any information concerning the safe navigation of the vessel.*

The VTS IS is designed to improve the safety and efficiency of vessel traffic and to protect the environment. Among others, such services include catalogue such as: routing, channel info, security level, berthing, anchorage, time slot, traffic monitoring and assessment, waterway conditions, weather, navigational hazards, any other factors that may influence the vessel's transit, reports on the position, identity and intentions of other traffic.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.9 Navigational Assistance Service

7.9.1 Description

The description on IMO MSP 2 (navigational assistance service (NAS)) is provided in IMO NCSR 1-28 [3] as follows.

The NAS is defined as "a service to assist onboard navigational decision-making and to monitor its effects".

NAS may be provided on request by a vessel in circumstances such as equipment failure or navigational unfamiliarity.

Specific examples of developing situations where NAS may be provided by the VTS include:

- *risk of grounding;*
- *vessel deviating from the recommended track or sailing plan;*
- *vessel unsure of its position or unable to determine its position;*
- *vessel unsure of the route to its destination;*
- *assistance to a vessel to an anchoring position;*
- *vessel navigational or manoeuvring equipment casualty;*
- *inclement conditions (e.g. low visibility, high winds);*
- *potential collision between vessels;*
- *potential collision with a fixed object or hazard; and*

- *assistance to a vessel to support the unexpected incapacity of a key member of the bridge team, on the request of the master.*

End-users of navigational assistance service (NAS) identified as MSP 2 could be shore-based users such as national competent VTS authorities and coastal or port authorities and shipboard users such as a ship master or crew who has the access right to NAS.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.10 Traffic Organisation Service

7.10.1 Description

The description on IMO MSP 3 (traffic organisation service (TOS)) is provided in IMO NCSR 1-28 [3] as follows.

The TOS is defined as "a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area".

The purpose of the TOS is to prevent hazardous situations from developing and to ensure safe and efficient navigation through the VTS area.

TOS should be provided when the VTS is authorized to provide services, such as when:

- *vessel movements need to be planned or prioritized to prevent congestion or dangerous situations;*
- *special transports or vessels with hazardous or polluting cargo may affect the flow of other traffic and need to be organized;*
- *an operating system of traffic clearances or sailing plans, or both, has been established;*
- *the allocation of space needs to be organized;*
- *mandatory reporting of movements in the VTS area has been established;*
- *special routes should be followed;*
- *speed limits should be observed;*
- *the VTS observes a developing situation and deems it necessary to interact and coordinate vessel traffic; and*
- *nautical activities (e.g. sailing regattas) or marine works in-progress (such as dredging or submarine cable-laying) may interfere with the flow of vessel movement.*

End-users of traffic organization service (TOS) identified as MSP 3 could be shore-based users such as national competent VTS authorities and coastal or port authorities and shipboard users such as a ship master or crew who has the access right to TOS.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.11 Local Port Service

7.11.1 Description

The description on IMO MSP 4 (local port service (LPS)) is provided in IMO NCSR 1-28 [3] as follows.

LPS is applicable to those ports where it has been assessed that a VTS, as described above, is excessive or inappropriate.

The main difference arising from the provision of LPS is that it does not interact with traffic, nor is it required to have the ability and/or the resources to respond to developing traffic situations and there is no requirement for a vessel traffic image to be maintained.

Provision of LPS is designed to improve port safety and co-ordination of port services within the port community by dissemination of port information to vessels and berth or terminal operators. It is mainly concerned with the management of the port, by the supply of information on berth and port conditions. Provision of LPS can also act as a medium for liaison between vessels and allied services, as well as providing a basis for implementing port emergency plans. Examples of LPS may include:

- *berthing information;*
- *availability of port services;*
- *shipping schedules; and*
- *meteorological and hydrological data.*

A number of web-based LPS services are being developed. An example is AVANTI, an initiative of the International Harbour Masters Association (IHMA).

End-users of local port service (LPS) identified as MSP 4 could be shore-based users such as local port/harbour operators and shipboard users such as a ship master who has the access right to LPS.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.12 Telemedical Assistance Service

7.12.1 Description

The description on IMO MSP 9 (telemedical assistance service (TMAS)) is provided in IMO NCSR 1-28 [3] as follows.

TMAS centres should provide medical advice for seafarers 24 h/day, 365 days/year. TMAS should be permanently staffed by physicians qualified in conducting remote consultations and who are well versed in the particular nature of treatment on board ship.

Within the maritime medicine the prevailing view has for a long time been that a standardization of the TMAS services is both necessary and wanted. This would firstly enhance the quality of the medical practice, and secondly, a standardization of reporting and registering of medical events will make a much better basis for advancement.

End-users of telemedical assistance service (TMAS) identified as MSP9 could be shore-based users such as national health organization or dedicated health organization and shipboard users who need medical treatment.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it

is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.13 Maritime Assistance Service

7.13.1 Description

The description on IMO MSP 10 (maritime assistance service (MAS)) is provided in IMO NCSR 1-28 [3] as follows.

The primary mission of MAS is to handle communication between the coastal state, ship's officers requiring assistance and other players in maritime community. These can be fleet owners, salvage companies, port authorities, brokers, etc.

The MAS is on 24-hour alert to deploy rapid assistance and professional support for ships in connection with combating pollution, fire and explosions on board, collision, grounding, maritime security, terror mitigation, etc.

The ship security alert system (SSAS) enables a vessel to send a distress call if it is attacked by pirates, etc. On receiving such a call, the MAS is responsible for alerting the relevant authorities responsible for a response.

The MAS is responsible only for receiving and transmitting communications and monitoring the situation. It serves as a point of contact between the master and the coastal state concerned if the ship's situation requires exchanges of information between the ship and the coastal State.

Situations where the MAS apply are as follows:

- *ship involved in an incident (loss of cargo, accidental discharge of oil, etc.) that does impair its seakeeping ability but nevertheless has to be reported;*
- *ship in need of assistance according to the master's assessment, but not in distress situation that requires the rescue of personnel on board; and*
- *ship in distress situation and those on board have already been rescued, with the possible exception of those who have remained aboard or have been placed on board to attempt to deal with the ship's situation.*

The MAS entails the implementation of procedures and instructions enabling the forward of any given information to the competent organization and requiring the organizations concerned to go through the MAS in order to make contact with the ship.

End-users of maritime assistance service (MAS) identified as MSP 10 could be shore-based users such as coastal or port authorities/organizations and shipboard users who has the access right to MAS.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.14 Nautical Chart Service

7.14.1 Description

The description on IMO MSP 11 (nautical chart service) is provided in IMO NCSR 1-28 [3] as follows.

The aim of the nautical chart service is to safeguard navigation at sea by providing information such as nature and form of the coast, water depth, tides table, obstructions and other dangers to navigation, location and type of aids to navigation.

The nautical chart service also ensures the distribution, update and licensing of electronic chart to vessels and other maritime parties.

End-users of nautical chart service identified as MSP 11 could be shore-based users such as national hydrographic authority/organization and shipboard users such as a ship master who has the access right to nautical chart service.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.15 Nautical Publications Service

7.15.1 Description

The description on IMO MSP 12 (nautical publications service) is provided in IMO NCSR 1-28 [3] as follows.

The aim of the nautical publication service is to promote navigation awareness and safe navigation of ships. The nature of waterways described by any given nautical publication changes regularly, and a mariner navigating by use of an old or uncorrected publication is courting disaster. Nautical publications include:

- *tidal currents, aids to navigation system, buoys and fog signals, radio aids to marine navigation, chart symbols, terms and abbreviations, sailing directions; and*
- *a chart and publication correction record card system can be used to ensure that every publication is properly corrected prior use by mariners.*

End-users of nautical publications service identified as MSP 12 could be shore-based users such as national hydrographic authority/organization and shipboard users such as a ship master who has the access right to nautical publications service.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.16 Ice Navigation Service

7.16.1 Description

The description on IMO MSP 13 (ice navigation service) is provided in IMO NCSR 1-28 [3] as follows.

The ice navigation service is critical to safeguard the ship navigation in ice-infested waters, given how quickly the ice maps become outdated in the rapid changing conditions of the ice-covered navigational regions. Such services include:

- *ice condition information and operational recommendations/advice;*
- *ice condition around a vessel;*
- *vessel routing;*
- *vessel escort and ice breaking;*
- *ice drift load and momentum; and*
- *ice patrol.*

End-users of ice navigation service identified as MSP 13 could be shore-based users such as national competent authority/organization and shipboard users such as a ship master or crew who has the access right to ice navigation service.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.17 Meteorological Information Service

7.17.1 Description

The description on IMO MSP 14 (meteorological information service) is provided in IMO NCSR 1-28 [3] as follows.

The meteorological service is essential to safeguard the traffic at sea by providing weather, climate digital forecasts and related information to mariners who will use these types of information to support their decision making. Such information includes:

- *weather routing, solar radiation and precipitation;*
- *cold/hot durations and warnings;*
- *air temperature, wind speed and direction; and*
- *cloud cover and barometric pressure.*

End-users of meteorological information service identified as MSP 14 could be shore-based users such as national meteorological authorities/WMO/public institutions and shipboard users such as a ship master or crew who has the access right to meteorological information service.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

7.18 Real-time Hydrographic and Environmental Information Service

7.18.1 Description

The description on IMO MSP 15 (real-time hydrographic and environmental information service) is provided in IMO NCSR 1-28 [3] as follows.

The real-time hydrographic and environmental information service is essential to safeguard navigation at sea and protect the environment. The services provided are such as:

- *current speed and direction;*
- *wave height;*
- *marine habitat and bathymetry;*
- *sailing directions (or pilots): detailed descriptions of areas of the sea, shipping routes, harbours, aids to navigation, regulations, etc.;*
- *lists of lights: descriptions of lighthouses and lightbuoys;*
- *tide surge prediction tables and tidal stream atlases;*
- *ephemerides and nautical almanacs for celestial navigation; and*

- *notice to mariners: periodical (often weekly) updates and corrections for nautical charts and publications.*

End-users of real-time hydrographic and environmental information service identified as MSP 15 could be shore-based users such as national hydrographic and meteorological authorities and shipboard users such as a ship master or crew who has the access right to real-time hydrographic and environmental information service.

IMO/IHO HGDM group is under the development of the guideline on IMO MSP till September 2018 and the guideline on IMO MSP developed by IMO/IHO HGDM group is planned to be reported to IMO NCSR#6 that is supposed to be held in March 2019. Then, IMO MSC#101 that is supposed to be held in June 2019 is planned to make a decision on the guideline of IMO MSP based on the report from IMO NCSR#6. Considering the status of IMO standardisation [4][5], it is not possible to receive the detailed guidance on this IMO MSP before the standardisation of this Technical Report is completed. So, the use case on this IMO MSP is not introduced in this Technical Report.

8 Use Cases for Interworking and Harmonization

8.1 Use case on satellite access to support maritime communication services over 5G system

8.1.1 Description

TS 22.261 (Service requirements for next generation new services and markets) requires that the 5G system shall be able to provide services using satellite access. It further specifies that the 5G system shall support service continuity between land based 5G access and satellite based access networks owned by the same operator or by an agreement between operators.

Accordingly, 3GPP RAN and 3GPP SA1 are under study on the usage of satellite access from radio access and service aspects, respectively by standardizing 3GPP Technical Reports as follows.

- 3GPP TR 22.822 Study on using Satellite Access in 5G
- 3GPP TR 38.811 Study on NR to support non-terrestrial networks

Satellite access is one of conventional access networks used in maritime domain to support maritime communication services especially in the ocean where terrestrial access networks are not available.

Potential requirements are covered by the outcome of 5GSAT work.

8.2 Use case on interworking with VHF Data Exchange System

8.2.1 Description

VHF Data Exchange System (VDES) is under standardisation in IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) as well as in ITU-R and there is an issue related to VDES satellite component to be able to be solved after the decision made in WRC-19.

Therefore, the use case on the interworking between VDES and 3GPP system is not introduced in this Technical Report.

9 Considerations

9.1 Considerations on legacy mobile services supported by 3GPP system

9.1.1 Description

Diverse mobile services are accessible over 3GPP systems as follows.

- mobile internet access,
- real time audio and video streaming,
- TV broadcast and multicast services
- SMS, MMS
- voice call and video call, etc.

Those legacy mobile services should be accessible at sea as long as the coverage of 3GPP systems is supported at sea with the help of diverse solutions such as satellite backhaul or moving networks utilizing drones or flying balloons though marine environment may not be identical to land environment that has been assumed by 3GPP systems so far.

9.1.2 Potential requirements

[PR-9.1.2-1] Existing requirements for legacy (i.e. pre Rel-16) mobile services accessible by mobile users over 3GPP systems shall be supported for maritime areas.

9.2 Considerations on machine type communication services supported by 3GPP system

9.2.1 Description

eMTC and NB-IoT features have been specified in 3GPP Technical Specifications from 3GPP Release 13 onwards. In addition, additional features are also expected to be specified in 3GPP Release 16 for 5G systems.

Those features for IoT devices shall be applicable for maritime use cases though some functions may need to be enhanced to provide optimised solution dedicated to maritime environments as well as the environment inside a vessel.

9.2.2 Potential requirements

[PR-9.2.2-1] Requirements for machine type communication such as eMTC and NB-IoT features over 3GPP systems shall be supported for maritime use cases.

10 Potential Requirements

10.1 General

This technical report has described use cases and potential requirements for maritime communication services to be supported over 3GPP system. Proposed potential requirements are consolidated as follows.

- Consolidated potential requirements met by existing 3GPP enabling technologies
- Consolidated potential requirements applicable for the general maritime usage
- Consolidated potential requirements dedicated to authority-related usage on maritime safety and traffic management

10.2 Consolidation of potential requirements

10.2.1 Potential requirements met by existing 3GPP enabling technologies

This section consolidates potential requirements that are able to be satisfied by existing 3GPP enabling technologies to support maritime communication services over 3GPP system.

[PR-10.2.1-1] 3GPP systems shall be able to support existing requirements for legacy mobile services accessible by on-land mobile users for maritime communication services at sea or in a vessel.

NOTE1: Example of legacy mobile services are mobile internet access, real time audio and video streaming for transmission and reception, TV broadcast and multicast services, SMS, MMS, voice call and video call etc.

NOTE2: Some of existing 3GPP enabling technologies that satisfy these requirements may not be able to fully support the optimised performances required by the maritime domain in a way that has been guaranteed for on-land communication.

[PR-10.2.1-2] 3GPP systems shall be able to support requirements for machine type communication such as eMTC and NB-IoT features for maritime communication services at sea or in a vessel.

NOTE1: Features for machine type communication are what has been specified in 3GPP specifications including 5G from 3GPP Release 13 onwards.

NOTE2: Some of existing 3GPP enabling technologies that satisfy these requirements may not be able to fully support the optimised performances required by the maritime domain in a way that has been guaranteed for on-land communication.

[PR-10.2.1-3] Requirements specified in 3GPP TS 22.268 [8] shall be supported for PWS-UEs or ePWS-UEs that provide maritime communication services.

Editor's NOTE: Requirements for positioning services inside a vessel are to be added later from the outcome of 5G_HYPOS work.

[PR-10.2.1-4] Requirements for 5GSAT work and 5GLAN work also shall be supported to make satellite access component applicable to maritime communication services at sea and to make 5G LAN-type services applicable to maritime communication inside a vessel, respectively.

[PR-10.2.1-5] Requirements specified in 3GPP specifications for MCX Services also shall be supported for the maritime commercial usage as well as authority-related usage on maritime safety and traffic management.

[PR-10.2.1-6] General 5G requirements specified in 3GPP TS 22.261 [7] (e.g., requirement on the extreme long range coverage at sea (up to 100 km)) also shall be supported for maritime communication services over 5G system.

10.2.2 Potential requirements applicable for the general maritime usage

This section consolidates potential requirements that are common requirements for the general maritime usage applicable for commercial maritime usage as well as authority-related usage for the purpose of maritime safety and traffic management over 3GPP system. 3GPP enabling technologies that meet requirements described in this section are expected to be fundamental enabling technologies applicable for most maritime usage.

[PR-10.2.2-1] 3GPP system shall provide a mechanism to establish and keep a 3GPP network connection for UEs on the vessel when UEs are to be connected to 3GPP system via an indirect network connection or when there is any UE constraint on the uplink transmission capability at sea.

[PR-10.2.2-2] Downlink video streaming service shall be accessible by the direct network connection or the indirect network connection for users at sea.

[PR-10.2.2-3] The 3GPP system shall support service continuity between direct network connection and indirect network connection at sea or in a vessel.

[PR-10.2.2-4] Based on home operator policy, a UE shall be able to perform the network reselection when on-land networks are available.

[PR-10.2.2-5] A UE shall be able to access local services that are accessible via a 3GPP network operating in IOPS mode on board of a vessel.

[PR-10.2.2-6] 3GPP network shall transmit wake up message to UE for activating

[PR-10.2.2-7] The 3GPP system shall support moving UE (e.g. drone) to be operated as a relay UE for UEs that are out of 3GPP network coverage.

[PR-10.2.2-8] 3GPP system shall provide a means of mapping a representative UE (e.g. a UE whose identity is related to vessel identity or one of UEs attached to containers) with all UEs that can be regarded as stationary UEs (e.g. all UEs attached to containers and products packed into containers) to enable a representative UE to carry out the mobility management procedure instead of all of those UEs.

NOTE: A representative UE can be selected by the network based on the strength of the radio signal transmitted by all of UEs attached to containers.

[PR-10.2.2-9] 3GPP system shall provide a mechanism of switching off the mobility management of UEs (e.g. UEs attached to containers and products packed into containers) during the voyage once they are loaded to the vessel and they are connected to 3GPP system via indirect network connection.

[PR-10.2.2-10] The communication range between vessels for the push of the location information shall be [15 km] as minimum in case of non-SOLAS vessels.

NOTE 1: The KPI of the communication range between vessels for the push of the location information will be further analysed and can be revised during the normative work.

NOTE 2: The KPI of the communication range between vessels for the voice call or group call can be smaller than for the push of the location information.

NOTE 3: As an example, Korean coastal guards require that the minimum communication range between a large vessel (e.g. a carrier ship) and a speedboat is larger than 7.5 km.

NOTE 4: Location information can be provided based on positioning technologies that are outcomes of HYPOS work.

[PR-10.2.2-11] 3GPP system shall provide a means of mapping the location information of each cabin in a vessel with the location information of a corresponding small cell deployed in each cabin so that the location information of devices that is in a cabin is identifiable based on the location information of a small cell deployed in that cabin.

[PR-10.2.2-12] 3GPP system shall provide a mechanism of multicasting or broadcasting the information received from IoT device via a small cell to devices of shipboard users via only small cells deployed in cabins where there are shipboard users.

[PR-10.2.2-13] 3GPP system shall support the capability of transmitting vessel's location information used in the legacy maritime communication in case there is any equipment providing such location information inside the vessel.

[PR-10.2.2-14] 3GPP system shall provide a mechanism of correlating a UE identity with a vessel identity (e.g. a national vessel identification number managed by a national authority or an IMO number that is a unique international vessel identification number consisting of 7-digit number).

[PR-10.2.2-15] The information related to a vessel-dedicated UE's actual position where the vessel is located and is expected to be located along with a navigational route shall be included in a message sent from a UE in order to request a maritime safety information.

NOTE: The example of the information related to a vessel-dedicated UE's actual position is current position, heading and speed of a vessel and scheduled navigational routes, heading and speed of a vessel.

[PR-10.2.2-16] 3GPP system shall provide a mechanism of correlating a UE identity with a vessel identity (e.g. IMO number that is a unique international vessel identification number consisting of 7-digit number).

[PR-10.2.2-17] 3GPP system shall support to transmit the information about the movement of vessels obtained from diverse sensors (e.g. 3D-LiDAR, radar, GPS) in real time.

[PR-10.2.2-18] 3GPP system shall provide a mechanism of synchronising the information used by shipboard users (i.e. a pilot or a shipmaster with pilotage exemption certificate) and shore-based users (e.g. a pilot authority or a pilot organisation and a bridge personnel).

10.2.3 Potential requirements dedicated to authority-related usage on maritime safety and traffic management

This section consolidates potential requirements dedicated to authority-related usage for the purpose of maritime safety and traffic management (e.g. IMO MSPs) over 3GPP system.

[PR-10.2.3-1] UE shall transmit automatic maritime emergency request with location information and heartbeat information of the UE at the sea to maritime rescue coordination centre. The 3GPP system shall support to transmit manual maritime emergency request to maritime rescue coordination centre.

[PR-10.2.3-2] The network shall support the maritime emergency agency to transmit the list of users who need to be rescued with the vital information (e.g. heartbeat, user's location) to a MCX UE in the patrol craft.

[PR-10.2.3-3] A UE shall transmit the maritime emergency request with the location information of the UE at sea to the mission critical organisation (e.g. maritime rescue co-ordination centre) when the UE transmits the maritime emergency request via the indirect network connection.

[PR-10.2.3-4] The 3GPP network shall transmit the maritime notification message including the user's location information extracted from the maritime emergency request and optionally emergency event information to inform.

[PR-10.2.3-5] An MCX UE shall receive the maritime notification message transmitted from the mission critical organisation over 3GPP system and an MCX UE may receive the maritime notification message transmitted from the mission critical organisation via the indirect network connection provided by the relay UE connecting to 3GPP system.

[PR-10.2.3-6] A UE at sea may receive the maritime notification message transmitted from the mission critical organisation over 3GPP system.

[PR-10.2.3-7] The MCX UE shall transmit the maritime response message including the location information of the authority (e.g. the location of the patrol boat of the coast guard) at sea to the mission critical organization over 3GPP system.

[PR-10.2.3-8] A remote MCX UE shall be capable of accessing MCVideo service and MCDATA service via the relay UE (i.e., a UE that is a vessel, itself) for the communication between the coast guard of the patrol boat and a doctor in a health organisation to support the tele-medical service.

[PR-10.2.3-9] 3GPP system shall provide a mechanism of notifying a message on coastal and local warnings to a sea area that includes the position, heading and speed of other UEs in the area.

[PR-10.2.3-10] 3GPP system shall provide a mechanism of enabling only the UE that requested a maritime safety information to identify a message notified from an authority in charge of coastal and local warnings.

[PR-10.2.3-11] 3GPP system shall provide a mechanism of enabling all UEs of vessels that are in the coverage of 3GPP system to identify a message broadcast from an authority in charge of coastal and local warnings.

[PR-10.2.3-12] 3GPP system shall provide a mechanism of authenticating a UE transmitting an online request on pilotage service and authorising such a UE to access the pilotage service.

[PR-10.2.3-13] 3GPP system shall support the data rate and the latency that enable a shipboard user not to recognise any gap between the real vessel movement and the vessel movement shown through the pilotage service.

NOTE: Depending on the size and weight of a vessel, it may cause a large movement of a vessel within a very short time that is difficult to restore to the original status. Very short latency is also as important as the high data rate when transmitting information obtained from sensors such as 3D-LiDAR.

[PR-10.2.3-14] 3GPP system shall provide a mechanism for tugs service to authenticate and authorise a UE to access the tugs service.

[PR-10.2.3-15] 3GPP system shall support handling of an online request for tugs service from an authorised UE.

[PR-10.2.3-16] 3GPP system shall provide a mechanism of registering the UEs that are dedicated to tug boats and a vessel moved by tug boats as a group of UEs.

[PR-10.2.3-17] Group communication among a group of UEs that are dedicated to tug boats and a vessel moved by tug boats shall be supported via the direct network connection or via indirect network connection.

NOTE 1: The example of a relay UE providing the indirect network connection mode is a drone that is regarded as one of UEs or a UE deployed in the highest place of a vessel or one of tug boats where the group communication among a group of UEs is available.

NOTE 2: Group communication specified by off-network MC can be used to support the group communication among a group of UEs dedicated to tug boats and a vessel moved by tug boats.

NOTE 3: Existing ProSe enabling technologies can be suitable to vessel to vessel communication in spite of the limitation of the communication range between vessels that is a few hundred meters to less than 2 kilometers in case of SOLAS vessels.

[PR-10.2.3-18] 3GPP system shall support the data rate and the latency that enable shipboard users (e.g. shipmasters of tug boats) to exquisitely coordinate tug boats based on all information available to them (e.g. the information captured from the 3D-LiDAR sensor in real-time during tugs service) while manoeuvring tug boats to move a vessel to the destination.

NOTE: Depending on the size and weight of a vessel, it may cause a large movement of a vessel within a very short time that is difficult to restore to the original status. Very short latency is also as important as the high data rate when transmitting information obtained from sensors such as 3D-LiDAR.

[PR-10.2.3-19] 3GPP network shall transmit warning message received from maritime authorities to neighbouring ships.

11 Conclusion and Recommendations

11.1 Conclusion

This Technical Report studied use cases and potential requirements for the support of maritime communication services over 3GPP system so that 3GPP system can be a good candidate of innovative tools to help address the information gap between users on land and users at sea as well as the maritime safety and vessel traffic management etc. that IMO intends to achieve especially in 5G era.

Consolidated potential requirements are specified in the section 10.2.1 to enable existing 3GPP enabling technologies to be applicable for the support of maritime communication services over 3GPP system. Example of existing features are as follows.

- Mobile services such as mobile internet access, real time audio and video streaming for transmission and reception, TV broadcast and multicast services, SMS, MSM, voice call and video call etc.
- Machine type communication such as eMTC and NB-IoT feature
- Public warning service for PWS-UEs and ePWS-UEs
- Mission Critical Services on-network and off-network
- General 5G services developed by SMARTER work
- Enabling technologies developed by 5GSAT work and 5GLAN work
- Indoor positioning services developed by 5G_HYPOS

Consolidated potential requirements dedicated to maritime usage are described in the section 10.2.2 and 10.2.3.

- In the section 10.2.2, consolidated potential requirements that are common requirements for the general maritime usage applicable for commercial maritime usage as well as authority-related usage for the purpose of maritime safety and traffic management over 3GPP system.
- In the section 10.2.3, consolidated potential requirements dedicated to authority-related usage on maritime safety and traffic management over 3GPP system.

11.2 Recommendations

It is recommended to start the normative work on consolidated potential requirements described in the clause 10.

Work is ongoing in the maritime domain for the digitalisation and mobilisation of maritime related businesses as well as maritime safety and traffic management. New movement towards the 4th Industrial Revolution of maritime domain is getting to recognise that mobile communication tools such as 3GPP system need to be taken into account for the realization of maritime autonomous ship, maritime smart shipping or smart port that requires the performance incapable of being satisfied by legacy maritime communication systems or evolved ones.

Therefore, it is also recommended to continue to study new maritime use cases that 3GPP need to take into account so that 3GPP system can be a good candidate of innovative tools as mobile communication platform necessary for the digitalization and mobilization of the maritime domain that bring about the Fourth Industrial Revolution of the maritime businesses as well as maritime safety and traffic management.

Annex <X>: Change history

| Change history | | | | | | | |
|----------------|---------|------------|----|-----|-----|--|-------------|
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2016-08 | SA1#75 | S1-162523 | | | | TR Skeleton | 0.0.0 |
| 2016-11 | SA1#76 | S1-163234 | | | | Addition of the scope | 0.1.0 |
| 2016-11 | SA1#76 | S1-163235 | | | | Addition of the annex A : IMO Maritime Service Portfolios | 0.1.0 |
| 2016-11 | SA1#76 | S1-163236 | | | | Addition of the use case of maritime single window | 0.1.0 |
| 2017-02 | SA1#77 | S1-171452 | | | | Revised WID for Study on Maritime Communication Services over 3GPP system | 0.2.0 |
| 2017-02 | SA1#77 | S1-171453 | | | | FS_MARCOM TR content update | 0.2.0 |
| 2017-02 | SA1#77 | S1-171454 | | | | Use case on video streaming service in the cabin or on the deck | 0.2.0 |
| 2017-02 | SA1#77 | S1-171455 | | | | Use case on communication for search and rescue | 0.2.0 |
| 2017-08 | SA1#79 | S1-173494 | | | | Use case on communication between wearable IoT devices and maritime rescue coordination centre for saving a life | 0.3.0 |
| 2017-08 | SA1#79 | S1-173222 | | | | Addition of Editor's Note in section 7.1 | 0.3.0 |
| 2017-08 | SA1#79 | S1-173495 | | | | Coastal and local warning service for maritime safety information | 0.3.0 |
| 2017-08 | SA1#79 | S1-173409 | | | | Pilotage service | 0.3.0 |
| 2017-08 | SA1#79 | S1-173536 | | | | Tugs service | 0.3.0 |
| 2017-08 | SA1#79 | S1-173411 | | | | Dissemination of PWS message for shipboard users | 0.3.0 |
| 2017-11 | SA1#80 | S1-174496 | | | | Off-mode of mobility management for group of UEs in the vessel | 0.4.0 |
| 2017-11 | SA1#80 | S1-174597 | | | | Push to Location - Off-network mode | 0.4.0 |
| 2017-11 | SA1#80 | S1-174598 | | | | Small cells deployed in each cabin of a vessel | 0.4.0 |
| 2017-11 | SA1#80 | S1-174599 | | | | Support of legacy mobile broadband services at sea | 0.4.0 |
| 2017-11 | SA1#80 | S1-174500 | | | | Support of legacy machine type communication services at sea | 0.4.0 |
| 2018-02 | SA1#81 | S1-180407 | | | | Urgent alarm service | 0.5.0 |
| 2018-02 | SA1#81 | S1-180415 | | | | Deletion of the section 7.1 Maritime single window service | 0.5.0 |
| 2018-02 | SA1#81 | S1-180416 | | | | Other IMO MSPs | 0.5.0 |
| 2018-05 | SA1#82 | S1-181489 | | | | Introduction and Overview | 0.6.0 |
| 2018-05 | SA1#82 | S1-181490 | | | | Editor's NOTE in the clause 5.1 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181491 | | | | Editor's NOTE in the clause 6.2 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181492 | | | | Editor's NOTE in the clause 6.3 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181498 | | | | Editor's NOTE in the clause 7.2 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181689 | | | | Editor's NOTE in the clause 7.5 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181500 | | | | Update of requirements in the clause 7.6 | 0.6.0 |
| 2018-05 | SA1#82 | S1-181501 | | | | Network reselection in case of the transition from IOPS mode to on-network mode | 0.6.0 |
| 2018-05 | SA1#82 | S1-181593 | | | | Next positioning technologies | 0.6.0 |
| 2018-05 | SA1#82 | S1-181594 | | | | 5G LAN-type services over 5G system in a vessel | 0.6.0 |
| 2018-05 | SA1#82 | S1-181595 | | | | Satellite access to support maritime communication services over 5G system | 0.6.0 |
| 2018-05 | SA1#82 | S1-181115 | | | | Interworking with VHF Data Exchange System | 0.6.0 |
| 2018-05 | SA1#82 | S1-1811690 | | | | Consolidated potential requirements | 0.6.0 |
| 2018-05 | SA1#82 | S1-181597 | | | | Conclusion and Recommendations | 0.6.0 |