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| IALA Guideline |

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IALA GUideline on integration and use of International Mobile Telecommunications (IMT) technologies by aton authorities

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# Introduction

The developments of mobile telecommunication technology is integrated into day-to-day life, with the development of 3G, 4G and now 5G. The International Telecommunication Union (ITU) has termed these developments ‘International Mobile Telecommunication’ or IMT. The fifth generation of mobile telecommunication technology (‘5G’) is called ‘IMT for 2020 and beyond‘ by ITU and can be abbreviated to read ‘IMT-2020.’

While 5G is the common designation, this is also used as a marketing term. It is important to clearly identify the generic use of IMT-2020 and the common use of 5G. Industry developed 5G technology candidates need to meet the requirements of IMT-2020.

Note that IMT-2020 comprises essential features of IMT-Advanced, better known as ‘LTE-Advanced’ or ‘4G’ (and its derivatives). The summary term for all stages of the development up to IMT-2020 at ITU is known as ‘IMT-Systems.’

ITU has published documents dealing with different facets of the various IMT-Systems, including IMT-2020 and their interdependencies. From a strategic, operational and overview perspective, the key high-level documents include:

* **ITU-R M.2083** together with **ITU-R M.2441** - provide the IMT-2020 use cases and the requirement base in an overview manner, i.e. the ‘promises’ of IMT-2020;
* **ITU-R M.2373** focusses on the audio-visual capabilities;
* **ITU-R M.2440** focusses on the use of IMT-2020 for Machine Type Communications (MTC);
* **ITU-R M.2370** provides IMT-systems traffic estimates 2020-2030;
* **ITU-R M.2320** introduces the radio communication technologies supporting IMT-2020 in an overview manner;
* **ITU-R M.2375** presents the technical architecture and topology

## IMT and 3GPP

International Mobile Telecommunications includes the 3rd Generation Partnership Project (3GPP). 3GPP unites seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as [“Organizational Partners”](https://www.3gpp.org/Partners) and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

The project covers mobile telecommunications technologies, including radio access, core network and service capabilities, which provide a complete system description for mobile telecommunications.

The 3GPP specifications also provide hooks for non-radio access to the core network, and for interworking with non-3GPP networks.

3GPP specifications and studies are contribution-driven by member companies.

There are three [Technical Specification Groups](https://www.3gpp.org/specifications-groups) (TSG) in 3GPP with a number of working groups.

1. Radio Access Networks ([RAN](https://www.3gpp.org/RAN)),
2. Services & Systems Aspects ([SA](https://www.3gpp.org/SA)),
3. [](https://www.3gpp.org/specifications-groups)Core Network & Terminals ([CT](https://www.3gpp.org/rubrique34))
4. 3GPP Structure

3GPP networks are primarily public networks established by commercial companies for profit. Many mission critical services are now taking advantage of the availability of these networks to enable the rapid dissemination of alerts and dangers, as well as the establishment of mission critical networks such as first responder and train control services in the network coverage area.

The maritime domain is using 3GPP networks for ship to shore and shore to ship communications along coastlines and within port domains including Republic of Korea and China. 3GPP networks also enable the interconnection of distributed shore side Maritime Information System (MIS) services such as connecting AIS base stations to the national network (Australia).

# Background

3GPP Technical Specification Group RAN, like other TSGs, ensures that systems based on 3GPP specifications are capable of rapid development and deployment with the provision of global roaming of equipment.

When considering the evolution of the 3G system towards LTE, the 3GPP community decided to use IP (Internet Protocol) as the key protocol to transport all services.

This decision had consequences on the way that the services were provided. Traditional use of circuits to carry voice and short messages needed to be replaced by IP-based solutions in the long term.

The 3GPP scope to include the production of Technical Specifications and Technical Reports for a 3G Mobile System based on evolved GSM core networks and the radio access technologies that they support. The 3GPP scope also includes the maintenance and development of the Global System for Mobile communication (GSM) Technical Specifications and Technical Reports including evolved radio access technologies.

The increasing bandwidth, reducing latency, reducing cost and increasing global coverage along coastlines and in ports may provide AtoN authorities with a platform on which to deliver a range of services using commercially available infrastructure or private networks. The bandwidth, latency and coverage of 3GPP networks have enabled some maritime authorities such as Republic of Korea, Australia and China to use 3GPP networks as part of their current communication channels for delivering services in support of maritime operations.

# Aims and Objectives

The aim of this guideline is to provide guidance to IALA members who may be considering, or who are currently in the process of, integrating IMT, such as 3GPP networks to deliver services to both shore and ship sides.

# Overview of IMT in the maritime domain

IMO's [Strategic Plan](http://www.imo.org/en/About/strategy/Pages/default.aspx) (2018-2023) Resolution A.1110(30) includes Strategic Direction 2 (SD2) "Integrate new and advancing technologies in the regulatory framework".

The IMO E-Navigation Strategy Implementation Plan (MSC.1/Circ.1595) includes solution 4 – integration and presentation of available information in graphical displays received via communications equipment; and solution 5 – improved communication of VTS Service Portfolio (not limited to VTS stations). Task 15 (T15) is to ‘identify and draft guidelines on seamless integration of all currently available communications infrastructure and how they can used (e.g. range, bandwidth, etc) …’ and ‘The task should look at short range systems such as VHF, 4G and 5G …’ Solution 4, sub-solution 4.1.4 “available communications systems need to be identified, including how they can be used, based on range, bandwidth, etc. and what systems are currently being developed and will be in use when e-navigation is fully implemented. The task should look into short-range systems such as VHF, 4G and 5G”

This involves:

* balancing the benefits derived from new and advancing technologies against safety and security concerns,
* assessing the impact on the environment and on international trade facilitation,
* identifying the potential costs to the industry, and
* assessing the impact on personnel, both on board and ashore.

The primary benefits of IMT to IALA members include:

1. High bandwidth (>10Mb/s with LTE and >1Gb/s with 5G)
2. Low latency (<50ms with LTE and 5G and a 5G network radio interface latency goal of <1ms)
3. Coverage (>150 countries have 3GPP GSM network installed and operational with coverage limited to Line Of Sight (LOS) which in some cases has been tested to 100Km (Republic of Korea))
4. Affordable
5. High availability (goal of network reliability of 99.999%)
6. Easily interfaced to existing and new Information Technology systems (uses Internet Protocol (IP))
7. Relatively secure radio channel (security of 5G is improved over LTE)

# IMT and Maritime Services

IMT, provide high bandwidth, low latency, radio based, Wide Area Network (WAN) that offers the ability to connect ship and shore and distributed shore side systems. 3GPP

It is important to be aware of the following when evaluating the use cases provided in 3GPP use cases, as provided in 3GPP TR 22.819 (V16.2.0):

1. Most IMT networks are commercially operated, and the use of a commercial network normally requires that the user pays
2. IMT Mission Critical Services are offered in some countries and to access these services, the maritime domain including IALA members will need to be recognised as a Mission Critical Service within the IMT specifications
3. Access to IMT Mission Critical Services may include additional service and terminal unit costs
4. The bandwidth of the IMT data channel is inversely proportional to the distance to the base station
5. Although the IMT network have significant reliability due to the commercial imperative.
6. The user of IMT is dependent on the commercial operators to maintain access to the network.
7. While the large number of users may result in large coverage and reduces costs due to economies of scale, this may not be realised in the maritime environment, noting the limited number of maritime users of IMT.

## Use of IMT to support Marine Aids to Navgation Provision

Typical uses for IMT, to support the provision of marine AtoN, including VTS, include the following:

1. Monitoring of Aids to Navigation: IMT provides a communications channel for remote Internet of Things (IoT) devices allowing the shore authority to monitor a wide range of peripheral AtoN and their supporting subsystems including batteries, solar panels and electricity generating systems.
2. Collection and dissemination of meteorological and hydrographic sensor data: The connection of remote sensors using IMT enables the placing of meteorological and hydrographic sensors in ideal locations to gather the required data and ensure that this is available in real time to share with ship and shore services using AIS, ASM, VDE and IMT as the ship to shore communication channel.
3. Connection of multiple, remote, high bandwidth, low latency sensors: IMT can be used to connect remote CCTV cameras, VHF voice base stations and AIS base stations to Vessel Traffic Services (VTS) and maritime information systems allowing the sharing of maritime information. Processing at the edge (at the device) can limit the amount of data that is to be transferred.
4. Dissemination of [IHO] S-100 Series of services.

It is noted that many ship operators are currently using IMT systems to provide services to crew, monitor containers, collect data on emissions and monitor vessel systems using existing coastal and port IMT systems.

As technology capabilities increase, it is anticipated that the use cases for digital data exchange will also increase.

# Development of IMT

Over the years IMT systems have developed from the initial 1G technology available in the 1980’s to the subsequent generational systems (up to 5G today) that provide capabilities and services that were not even imaginable then.

1. Major system milestones for IMT (3GPP) technology

| **Generation** | **Major Systems Milestones** |
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| 1G | Analogue technology, from the 1980s onwards. Various technologies were deployed, Nationally or Regionally, including:   1. NMT (Nordic Mobile Telephone), 2. AMPS (Advanced Mobile Phone System), 3. TACS (Total Access Communications System), 4. A-Netz to E-Netz, 5. Radiocom 2000, 6. RTMI (Radio Telefono Mobile Integrato), 7. JTACS (Japan Total Access Communications System) and 8. TZ-80n (Source:[wikipedia](http://en.wikipedia.org/wiki/1G)) |
| 2G | First digital systems, deployed in the 1990s introducing voice, SMS and data services. The Primary 2G technologies are:   1. GSM/GPRS & EDGE, 2. CDMAOne, 3. PDC, 4. iDEN, 5. IS-136 or D-AMPS. |
| 3G  IMT 2000 | The 3G system from 3GPP is based on evolved Global System for Mobile communication (GSM) core networks and the radio access technologies that they support.  This has allowed for the maintenance and development of GSM, with the evolution of General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE), as well as further developments with the Universal Mobile Telecommunications System (UMTS) and High-Speed Packet data Access (HSPA).  3G brought a global vision to the evolution of mobile networks, with the creation of the ITU's family of IMT-2000 systems which included EDGE, CDMA2000 1X/EVDO and UMTS-HSPA+ radio access technologies. |
| 3G/4G  IMT Advanced | LTE and LTE-Advanced have crossed the “generational boundary” offering the next generation(s) of capabilities. With their capacity for high-speed data, significant spectral efficiencies and adoption of advanced radio techniques, their emergence has been the basis for all new mobile systems from Release 8 onwards.  It should be noted that LTE-Advanced (From Release 10) is 3GPP's ITU-R IMT-Advanced radio interface. LTE-Advanced is the first true 4G technology to be specified by 3GPP.  LTE-Advanced Pro is the name that helps the industry describe what has been achieved with the completion of Release 13. LTE Pro is set to be used by other sectors, beyond telecoms, including Critical Communications (blue light services & other Mission Critical systems), the machine-to-machine or Internet of Things (IoT) sector, Transport (Rail, ITS, etc), Education and many other areas. LTE-Advanced Pro is 3GPP's steppingstone to 5G systems. |
| 5G  IMT2020 | 5G brings another major technology step, with the creation of a 'New Radio' (NR).  Unlike with 4G, where 3GPP hesitated to join the generational march onwards beyond 3G, 3GPP have embraced the alignment of the industry on NR and on LTE-Advanced Pro to provide 5G – from 3GPP Release 15 onwards. |

# Definitions

The definitions of terms used in this IALA Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at <http://www.iala-aism.org/wiki/dictionary> and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

# Acronyms

AIS Automatic Identification System

ARIB Association of Radio Industries and Businesses

ASM ASM as part of the VHF Data Exchange System

ASM Application Specific Message

ATIS Alliance for Telecommunications Industry Solutions, USA

CCSA China Communications Standards Association

CT Core Network & Terminals (A Technical Specification Groups (TSG) in 3GPP)

ESTI The European Telecommunications Standards Institute

IMO International Maritime Organization (Acronym style)

MIS Maritime Information System

MASS Maritime Autonomous Surface Ships

eMBB enhanced Mobile Broadband

IMT International Mobile Telecommunications

IMT-Advanced International Mobile Telecommunications-4G standard

IMT-2000 International Mobile Telecommunications-3G standard

IMT-2020 International Mobile Telecommunications-5G standard

IoT Internet of Things

LTE Long-Term Evolution

mMTC Massive Machine-Type Communications

NB-IoT Narrowband Internet of Things

RAN Radio Access Networks (A Technical Specification Groups (TSG) in 3GPP)

SA Services & Systems Aspects (A Technical Specification Groups (TSG) in 3GPP)

TSDSI Telecommunications Standards Development Society, India

TTA Telecommunications Technology Association, Korea

TTC Telecommunication Technology Committee, Japan

VDES VHF Data Exchange System

VTS Vessel Traffic Services

3GPP 3rd Generation Partnership Project

# References

<https://www.3gpp.org/about-3gpp/about-3gpp>

IALA ENAV23-9.4 ‘LTE-Maritime as an e-Navigation communication infrastructure’(Republic of Korea)

IALA ENAV24-6.1.21 ‘Summary of LTE Private Network for the Yangtze River Estuary e-Navigation Construction Project’(China)

[e-Navigation Underway 2020 programme book](https://e-navap.org/attach/%5bENUW%20AP%202020%5d%20Programme%20Book.pdf), ‘LTE-Maritime: the beginning of Digital Maritime Communication infrastructure for e-Navigation era’, Session 2, 8th September, 2020, Republic of Korea.

[there could be opportunity to add in annexes, with use case examples from Republic of Korea and China – this may also be a suitable place for a summary of the technology review matrix]