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| IALA Guideline |

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IALA GUideline on integration and use of 3GPP technologies by aton authorities

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Document date

Revisions to this IALA Document are to be noted in the table prior to the issue of a revised document.

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# Introduction

The 3rd Generation Partnership Project (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))

Figure 1- 3GPP structure

The maritime domain is using 3GPP networks for ship to shore and shore to ship communications along coastlines and within port domains. 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, support VTS operations.

# 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. It was therefore agreed that the Evolved Packet Core (EPC) would not have a circuit-switched domain but that the EPC should be an evolution of the packet-switched architecture used in GPRS/UMTS.

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 includes 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 infrastructure that has the goal of being both backward and forward compatible. The bandwidth, latency and coverage of 3GPP networks have enabled some maritime authorities such as South 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 3GPP networks to deliver services to both shore and ship sides.

# Overview of 3gpp in the maritime domain

IMO's [Strategic Plan](http://www.imo.org/en/About/strategy/Pages/default.aspx) (2018-2023) has a key Strategic Direction to "Integrate new and advancing technologies in the regulatory framework", and, a task to look into “available communications systems…and 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 live is fully implemented…[and] should look into short-range systems such as VHF, 4G and 5G (IMO SIP Task S4.1.4).

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 the 3GPP environments 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 (South Korea))
4. Low cost (industrial LTE modems are available for less than $500)
5. High availability (goal of network reliability of 99.999%)
6. Easily interfaced to existing and new systems (uses Internet Protocol (IP))
7. Relatively secure radio channel (security of 5G is improved over LTE)

# 3GPP and Maritime Services

The 3GPP services, primarily LTE and 5G, 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.

It is important to be aware of the following when evaluating 3GPP use cases:

1. Most 3GPP networks are commercially operated, and the use of a commercial network normally requires that the user pays
2. 3GPP 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
3. Access to 3GPP Mission Critical Services may include additional service and terminal unit costs
4. The bandwidth of the 3GPP data channel is inversely proportional to the distance to the GSM base station
5. Although the GSM network have significant reliability due to the commercial imperative, the user is dependent on the commercial operators to maintain access to the network

## Use cases

Typical use cases for 3GPP services to support the provision of AtoN, including VTS, include the following:

1. Monitoring of Aids to Navigation: 3GPP 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 3GPP 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 and 3GPP as the ship to shore communication channel.
3. Connection of multiple, remote, high bandwidth, low latency sensors: 3GPP 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 (MIS). Processing at the edge (at the device) can limit the amount of data that is to be transferred.

It is noted that many ship operators are currently using 3GPP systems to provide services to crew, monitor containers, collect data on emissions and monitor vessel systems using existing coastal and port 3GPP systems.

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

# Development of 3GPP

Over the years 3GPP 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.

| **Generation** | **Major Systems Milestones** |
| --- | --- |
| 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 | 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 | 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 | 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. |

Table 1- 3GPP technology

Most of us have personally experienced these advance in 3GPP and their beneficiary through the use of our mobile phones and tablets. Now the opportunity exist the leverage this and the next generations of 3GPP technology to support the many missions and needs of IALA members.

# 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.

[Need to consider adding definitions to support 3GPP as appropriate]

# Acronyms

IMO International Maritime Organization (Acronym style)

MIS Maritime Information System

MASS Maritime Autonomous Surface Ships

AIS Automatic Identification System

ASM ASM as part of the VHF Data Exchange System

ASM Application Specific Message

IoT Internet of Things

LTE Long-Term Evolution

VDES VHF Data Exchange System

VTS Vessel Traffic Services

3GPP 3rd Generation Partnership Project

# References

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

South Korean LTE paper

South Korea presentation to IALA

China presentation to IALA

ENAV WG2 Technology Review matrix

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