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IALA GUIDELINE

G1179
AN INTRODUCTION TO THE INTERNET OF THINGS (IOT) FROM AN IALA PERSPECTIVE

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CONTENTS

List of Figures

1. INTRODUCTION

The Internet of Things (IoT) describes the network of physical objects ("things") that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

IoT has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.

1.1. BACKGROUND

The monitoring of Marine Aids to Navigation (AtoN) and associated systems has been achieved using a variety of methods that include the use of defined AIS messages.

The advantage of real time monitoring includes:

1. Preventative maintenance can be scheduled to be pre-emptive based on the AtoN system status.
2. The real time status of the monitored systems and associated availability can be shared with stakeholders.

The rapid development of IoT systems allows the connection of many different sensors in the maritime AtoN environment including meteorological and hydrographic sensors, allowing data to be collected, processed, and shared.

2. AIMS AND OBJECTIVES

The aim of this Guideline is to provide guidance those who may be undertaking testing, trials and/or deployment of IoT systems. This Guideline also provides guidance for organizations implementing technical solutions to support the introduction of IoT.

3. OVERVIEW OF IOT

A literature review shows that between three (3) to seven (7) layers for IoT is used. For the purpose of this Guideline three layers (Figure 1) are identified.

1. The application layer is responsible for delivering application specific services to the user.
2. The transportation layer is responsible for connecting to other smart things, network devices, and servers.
3. The perception layer is the physical layer, which has sensors for sensing and gathering information about the environment.

Messaging protocols are used to transmit device telemetry (or messages) to and from devices.

The messaging protocol and the transportation layer have an impact on the design and deployment of IoT systems and the integration, as well as the processing and display of information derived from the IoT system.

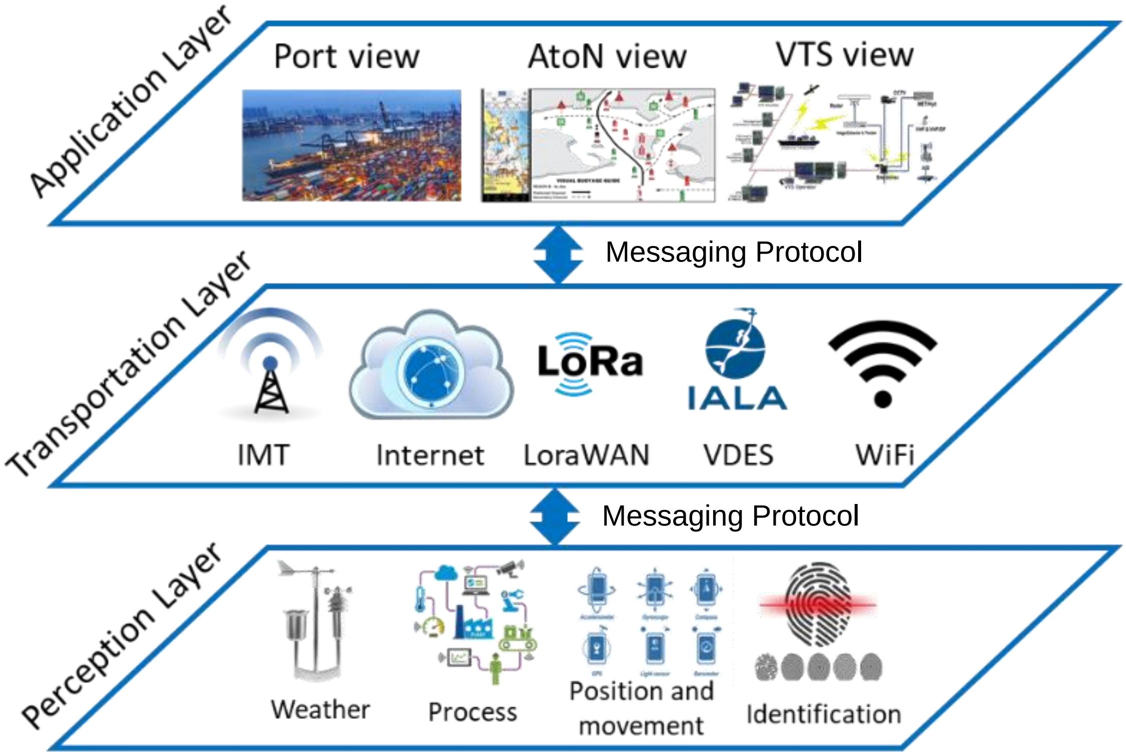

Figure 1 IoT Layers (3 layer model with messaging protocol)

3.1. APPLICATION LAYER

The application layer manages the application processes based on information obtained from the sensors and provided through the transportation layer.

3.2. TRANSPORTATION LAYER

The transportation layer transfers the data from the perception layer (the sensors) to the application layer. It makes use of networks such as International Maritime Telecommunication (IMT), WiFi, Very High Frecuency Data Exchange System (VDES), etc. The transportation layer must be robust and reliable within the maritime domain.

The transportation layer has various characteristics that impacts on IoT and its application in the maritime domain including:

- data rate (How much data can be sent through the transportation layer in a specific period?);
- latency (How long does it take from when the message is ready to be sent until the time it arrives at the receiving application layer?);
- error detection/correction (How many errors are received by the application layer and how many of these can be corrected?);
- reliability (How many of the messages that are sent from the IoT device arrive at the application layer?);
- availability (Is the transportation layer available when a message is scheduled to be sent?);
- transparency (Can I send the message I have using the protocol that I am using, or does it need to be translated?);

- capacity (How many remote IoT units can be connected to the system in any one area?), and;
- security (How are the IoT sensors and application layers protected from Cyber Attack?).

There are further considerations in respect of the transportation layer technologies that includes:

- licensing (What licenses are required to use the spectrum, what is the cost and what protection does this afford the system?); and
- range (What is the reliable range that can be achieved under the transportation layer Radio Frequency (RF) licensing conditions and considering the local morphology?).

3.3. PERCEPTION LAYER

The perception layer includes sensors for sensing and gathering information. There are many different types of sensors in this layer which need to be able to be identified within the system.

This layer is a driver for IoT, with many different sensors used for a diverse array of IoT applications. Within the maritime domain, these sensors could include:

- Meteorological sensors
- Hydrographic sensors
- AtoN position
- AtoN movement

3.4. MESSAGING PROTOCOL

The primary IoT messaging protocols include:

- MQTT (Message Queue Telemetry Transport). The MQTT, or Message Queue Telemetry Transport, protocol is a lightweight, publish/subscribe network protocol for transporting telemetry messages between IoT devices. It can operate on top of other networking protocols so long as they provide ordered, lossless, bi-directional connections.
- AMQP (Advanced Message Queue Protocol). AMQP, or Advanced Message Queue Protocol, is an open standard application layer protocol. It is not specifically built for IoT solutions, but it works very well for message communications which include many IoT scenarios.
- DDS (Data Distributed Service). The DDS protocol is designed to address the unique needs of application scenarios such as aerospace, defence, air-traffic control, autonomous vehicles, medical devices, robotics, power generation, transportation systems, and other real-time data exchange systems.
- XMPP (Extensible Messaging and Presence Protocol). XMPP, or Extensible Messaging and Presence Protocol, is a communications protocol based on XML (Extensible Markup Language). It is designed to provide near real-time exchange of structured XML data between two or more devices.
- CoAP (Constrained Application Protocol). The CoAP, or Constrained Application Protocol, is a specialized application protocol designed for constrained devices. It is designed to require low power and work across lossy networks.
- IEC 61162-1(NMEA 0183) is used by GPS as well the AIS, ASM and VDE Presentation Interface. It is a message-based protocol that, in the case of AIS is an efficient binary encoded protocol.

3.5. OTHER CONSIDERATIONS

The use of IoT in the maritime AtoN domain should consider additional factors that includes:

- Cost of IoT sensors and local transport layer interface
- Battery life/power consumption
- Cost of communications
- Physical size/form factor of the integrated IoT device
- Installation complexity
- Accessibility for installation and ongoing maintenance
- Installation licenses and need for approval
- Application Layer processing and data storage requirements
- Cyber Security

4. DEFINITIONS

The definitions of terms used in this IALA Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA 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.

5. ABBREVIATIONS

AIS	Automatic Identification System
AMQP	Advanced Message Queue Protocol
ASM	ASM as part of the VHF Data Exchange System
ASM	Application Specific Message
AtoN	Marine Aid(s) to Navigation
CoAP	Constrained Application Protocol
DDS	Data Distributed Service
IoT	Internet of Things
MQTT	Message Queue Telemetry Transport
VDES	VHF Data Exchange System
VTS	Vessel Traffic Services
XMPP	Extensible Messaging and Presence Protocol

6. FURTHER READING

[1] https://www.meritalk.com/articles/darpa-floats-a-proposal-for-the-ocean-of-things/.

[2] https://www.securityinfowatch.com/video-surveillance/video-transmission-equipment/article/10840006/innovative-wireless-network-connects-new-york-waterways-ferries-for-safety-security-roi-and-more.

[3] https://mondaynote.com/internet-of-things-the-basket-of-remotes-problem-f80922a91a0f.