



IALA RECOMMENDATION

R0124 (A-124)

THE AIS SERVICE

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

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| December 2002 | 1 st issue | |
| December 2004 | | Initial revision |
| September 2005 | Addition of FATDMA Configuration of Physical AIS Shore Stations Guidance on configuration of FATDMA is now available. | Full revision of A-124 to occur after publication of IEC AIS non-ship-based testing standard 62320-1. |
| January 2007 | Section F Editorial changes in Section F | (number of reserved slots) |
| December 2008 Edition 1.3 | Document | Removal of portions now covered by IEC documents. Addition of Appendices for DGPS correction broadcasts and for FATDMA planning. |
| December 2011 Edition 2.0 | Whole document | Complete revision of the document, including its structure. Major additions: Appendix 4 Interaction and Dataflow model Appendix 5 AIS service interfacing model Appendix 17 Channel Management Appendix 18 VDL Management Appendix 19 Satellite AIS |
| December 2012 Edition 2.1 | | New Appendices and consequential updates of the main document |
| September 2020 Edition 2.2 | Editorial Corrections | |



THE IALA COUNCIL

RECALLING the function of IALA with respect to Safety of Navigation, the efficiency of maritime transport and the protection of the environment;

RECOGNISING that IMO has concluded that AIS will improve the safety of navigation and the protection of the environment;

RECOGNISING FURTHER that the Association has recommended that National Members:

- providing aids to navigation services, including VTS, consider the introduction of AIS facilities in their shore infrastructure (IALA Recommendation R0123 (A-123));
- using AIS in marine aids to navigation consider IALA Recommendation R0126 (A-126);

NOTING that National Members intending to introduce AIS facilities in their shore infrastructure need information on the operational, technical and life cycle management aspects of such facilities;

NOTING ALSO that IALA has contributed substantially to the development of AIS through collaboration with IMO, ITU and IEC;

CONSIDERING that there is an urgent need for shore based AIS infrastructure to facilitate the interchange of data with shipping;

CONSIDERING ALSO that:

- IMO recently has defined the e-Navigation concept;
- the shore based AIS infrastructure of National Members have an important role in that concept;

CONSIDERING FURTHER that the Association has recommended that National Members consider the:

- e-Navigation architecture – the shore perspective;
- IALA Common Shore-based System Architecture (CSSA);
- shore based AIS infrastructure of National Members should be under-stood as an AIS Service within the framework of the CSSA;
- generic engineering service model template;
- IALA Universal Maritime Data Model (IALA UMDM);
- IALA Maritime Data Exchange Format (IALA MDEF);

ADOPTS the Recommendation on the AIS Service in the Annex of this recommendation; and,

RECOMMENDS that National Members and other appropriate Authorities, introducing an AIS Service into their shore infrastructure, take into account the Annex to this Recommendation.



ANNEX

TO

IALA RECOMMENDATION R0124 (A-124)

ON

THE AIS SERVICE



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Appendix 0 References, Glossary of terms and Abbreviations

Deliverables of the AIS Service to the shore-based clients:

Appendix 1 Basic AIS Services, Data model & AIS Service specific MDEF sentences

Appendix 2 **Intentionally blank**

Architecture of the AIS Service:

Appendix 3 Distribution model

Appendix 4 Interaction and data flow model

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Appendix 6 Internal Time Latency model **Not developed**

Appendix 7 Internal Reliability model **Not developed**

Appendix 8 Test model **Not developed**

Functional components of AIS Service:

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Appendix 13 Recommendation regarding efficient operation and maintenance **Not developed**

Runtime configuration management of the VDL:

Appendix 14 FATDMA planning and operation

Appendix 15 Assigned mode operation **Not developed**

Appendix 16 DGNSS broadcast via the AIS Service

Appendix 17 Channel management

Appendix 18 VDL loading management

Appendix 19 Satellite AIS considerations

The AIS Service

Note: For the purpose of this generic engineering service model, the term ‘technical e-Navigation service’ is abbreviated to ‘service’. Once a specific service is addressed, it is capitalized, e.g. in ‘Basic Service’ or ‘AIS Service’.

1 AIS SERVICE AS DESCRIBED BY OTHER IALA RECOMMENDATIONS

IALA Recommendation R0123 (A-123) on ‘The Provision of Shore Based Automatic Identification Systems (AIS)’ encourages administrations to provide ‘an AIS shore infrastructure so that the full benefit of the system can be realised in terms of navigation safety and protection of the environment’.

The same Recommendation identifies AIS as a maritime, safety-related information service as follows:

‘From a VTS or, more generally speaking, from the point of view of a competent authority the AIS provides an information service for shore-based VTS, traffic management schemes, ship reporting systems and other shore-based safety-related services. This service consists of information delivery between ships and shore and vice versa. Thus the service of information exchange between ships and maritime, safety-related shore services, such as VTS, is one important part for the AIS. Consequently, approaching the AIS from any shore-based application’s point of view, there will be an *AIS Service* delivered at a functional interface.’

The same Recommendation eventually identifies the place of the AIS Service within a hierarchy of other shore-based services.

IALA Recommendation R0126 (A-126) on ‘The Use of the Automatic Identification System (AIS) in Marine Aids to Navigation’, while not expressly requiring a shore-based AIS Service for use of AIS in marine Aids to Navigation, implies the existence of a shore-based AIS Service for some of the applications described therein.

2 SERVICE MODEL OF THE SHORE-BASED AIS SERVICE

2.1 INTRODUCTION TO THE SHORE-BASED AIS SERVICE

The purpose of the shore-based AIS Service is to allow its clients to interface with the different AIS stations that can be used by mariners or maritime administrations on the VHF Data Link (VDL). The VDL is defined as the media used by AIS stations to exchange information. Figure 1 below represents the relation between the shore-based AIS, its clients, the different AIS stations and the VDL.

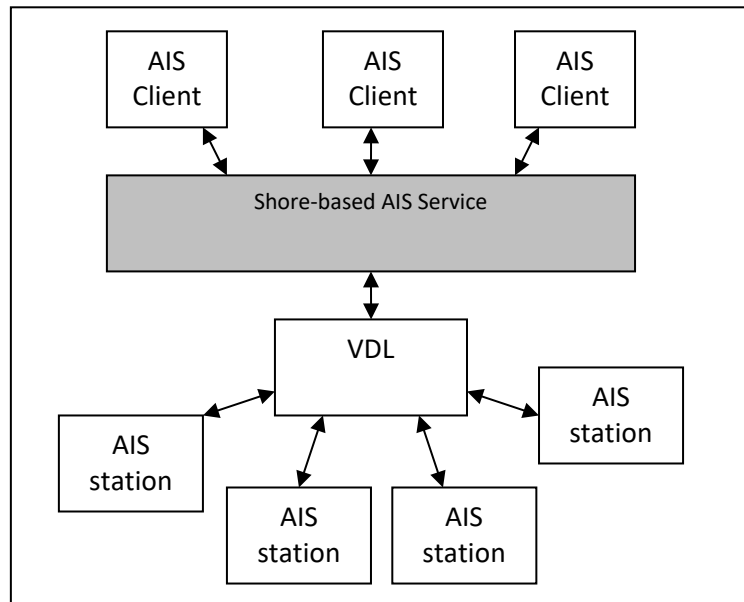


Figure 1 *Overview of the shore-based AIS Service*

Clients to the shore-based AIS Service can be:

- Other systems of the maritime administration which operates the shore-based AIS Service, such as viewing clients;
- Systems of other entities external to the maritime administration, e.g. other departments of government or other governments;
- Other shore-based services as described in the Common Shore Based Architecture.

The different AIS stations that a shore-based AIS Service can interface with include but are not limited to:

- AIS base stations of other competent authority;
- Limited AIS base stations of other competent entities;
- AIS repeater stations;
- Class A mobile AIS stations;
- Class B mobile AIS stations;
- SAR AIS stations;
- AtoN AIS stations;
- AIS-SART stations.

In order to allow its clients to interface with AIS stations, the shore-based AIS Service offers a series of services called Basic AIS Services (BAS). There are external BAS and internal BAS. External BAS are available for the clients of the AIS. Internal BAS are used for management of the AIS and the VDL. All BAS are introduced further into this document and detailed in Appendix 1.

This service centric approach has many benefits such as allowing the operator of the shore-based AIS Service to manage which BAS can be used by which client. The service centric approach used for the shore-based AIS Service is derived from the IALA Common Shore Based System Architecture (CSSA), refer to appropriate recommendations. The shore-based AIS Service hence becomes a technical service, called the 'AIS Service'.

2.2 DESCRIPTION OF THE STRUCTURE OF THE AIS SERVICE - OVERVIEW AND APPENDICES

The AIS Service is designed, operated and maintained as described in the generic Service Engineering Model of the CSSA. This section applies the generic engineering model template to the AIS Service in order to define the different engineering aspects that need to be discussed in the rest of the document and its appendices.

Table 1 *AIS service engineering aspects and related appendices*

| Appendix ID | Title | Description | Section of this document where high level description may be located |
|---|--|--|--|
| 0 | <i>Glossary of terms:</i> | <i>Nomenclature is defined</i> | |
| Appendices related to the Deliverables of the AIS Service to the shore-based clients | | | |
| 1 | <i>Basic AIS Services, Data model & AIS Service specific MDEF sentences.</i> | <i>Capabilities of the AIS Service and functional interface statements. Introduces abstract descriptions of the data provided by the AIS Service to its shore-clients, i.e. defines data types and data objects of the AIS Service and also AIS specific MDEF sentences.</i> | 2.3 & 2.7.3 |
| 2 | <i>Currently not allocated</i> | | |
| Appendices related to the Architecture of the AIS Service | | | |
| 3 | <i>Distribution model</i> | <i>Deals with issues arising from geographically distributed AIS Service layouts and with coverage planning as one major factor</i> | 2.6 & 2.12.3 |
| 4 | <i>Interaction and data flow model</i> | <i>Introduces the dynamics of the interaction of individual components of the AIS Service and deals with associated data flow issues.</i> | 2.7 |
| 5 | <i>Interfacing model</i> | <i>Deals with data encoding for interfacing and with interface protocols proper between components of the AIS Service</i> | 2.8 |
| 6 | <i>Internal time latency model</i> | Currently not to be developed <i>Introduces absolute (real) time considerations, even quantitatively</i> | 2.9 |
| 7 | <i>Internal Reliability model</i> | Currently not to be developed <i>Provides an analytical framework for reliability considerations of the AIS Service</i> | 2.10 |
| 8 | <i>Test model</i> | Currently not to be developed <i>Provides a test strategy on service level</i> | 2.11 |
| Appendices related to Functional components of AIS Service | | | |

| Appendix ID | Title | Description | Section of this document where high level description may be located |
|---|--|--|--|
| 9 | <i>Functional description of the AIS Logical Shore Station (AIS-LSS)</i> | <i>Functional description of the AIS Logical Shore Station (AIS-LSS)</i> | 2.12.3, 2.12.5 |
| 10.1 | <i>Physical Layer consideration</i> | <i>Physical Layer consideration</i> | |
| 10.2 | <i>Functional description of the AIS PSS Controlling Unit (AIS-PCU)</i> | <i>Functional description of the AIS PSS Controlling Unit (AIS-PCU)</i> | |
| 11 | <i>Functional description of the AIS Service Management (AIS-SM)</i> | <i>Functional description of the AIS Service Management (AIS-SM)</i> | 2.12.5 |
| Appendices related to Installation and life-cycle management issues of the AIS Service | | | |
| 12 | <i>Co-location issues at Physical Shore Stations (PSS) and on-site infrastructure considerations</i> | <i>Co-location issues at Physical Shore Stations (PSS) and on-site infrastructure considerations</i> | |
| 13 | <i>Recommendation regarding efficient operation and maintenance</i> | Currently not to be developed <i>Recommendation regarding efficient operation and maintenance</i> | |
| Appendices related to Runtime configuration management of the VDL | | | |
| 14 | <i>FATDMA planning and operation</i> | <i>FATDMA planning and operation</i> | 2.14.2 |
| 15 | <i>Assigned mode operation</i> | Currently not to be developed <i>Assigned mode operation</i> | 2.14.2 |
| 16 | <i>DGNSS broadcast via the AIS Service</i> | <i>DGNSS broadcast via the AIS Service</i> | 2.14.3 |
| 17 | <i>Channel management</i> | <i>Channel management</i> | 2.14.5 |
| 18 | <i>VDL loading management</i> | <i>VDL loading management</i> | 2.14.6 |

Figure 2 represents all these different aspects of the structure of the AIS service and their relation to each other. It is a detailed conceptual diagram of Figure 1.

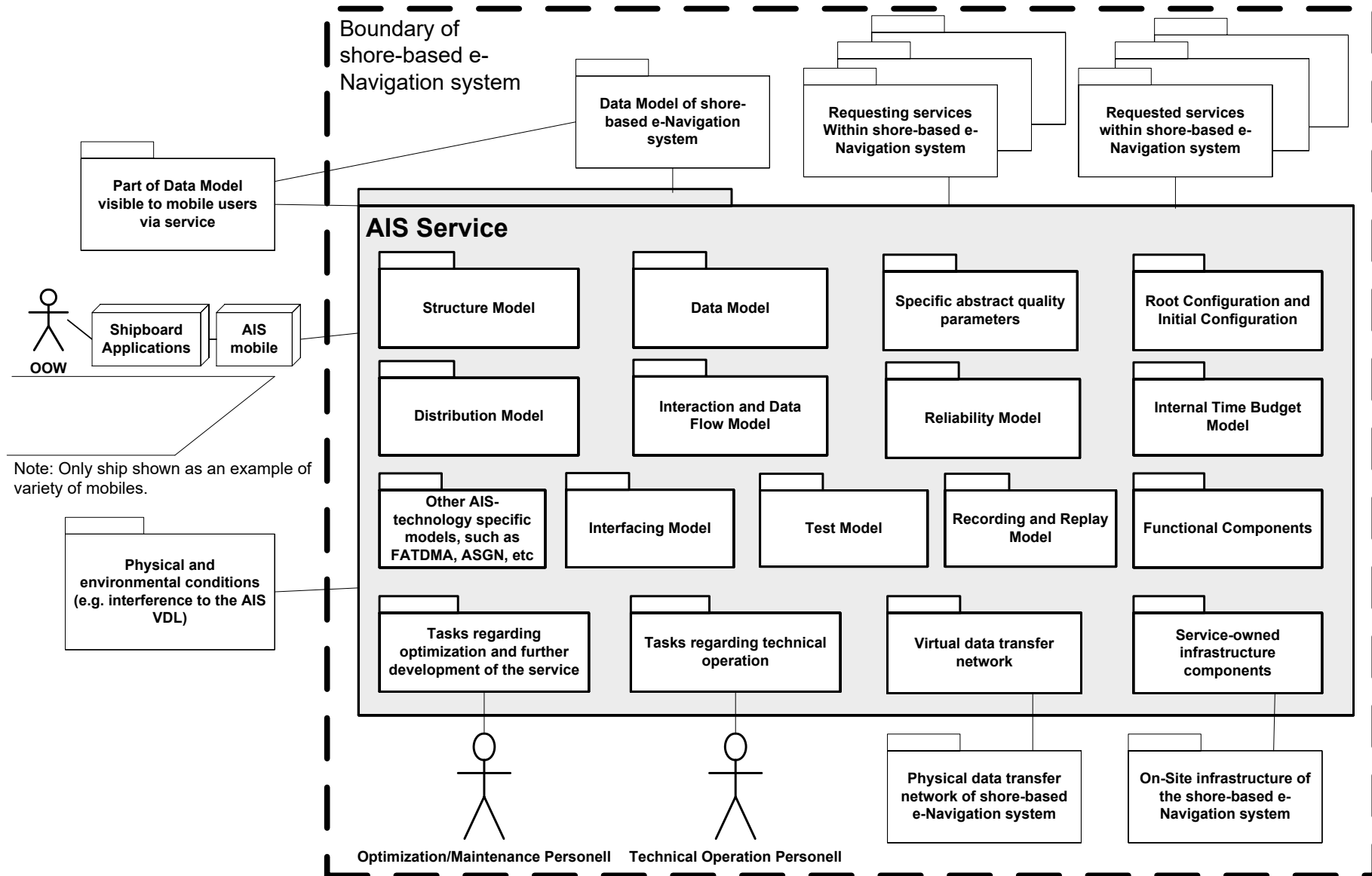


Figure 2 *AIS Service model*

2.3 CAPABILITIES OF THE AIS SERVICE

2.3.1 Introduction

As previously mentioned, the AIS Service is offering different services to its clients, called external Basic AIS Services (BAS). All external BAS are justified by at least one interaction with a 'requesting service', i.e. client of the AIS Service.¹ The set of predefined BAS represent the overall knowledge the clients may gain about traffic objects (mainly ships) from the AIS Service.

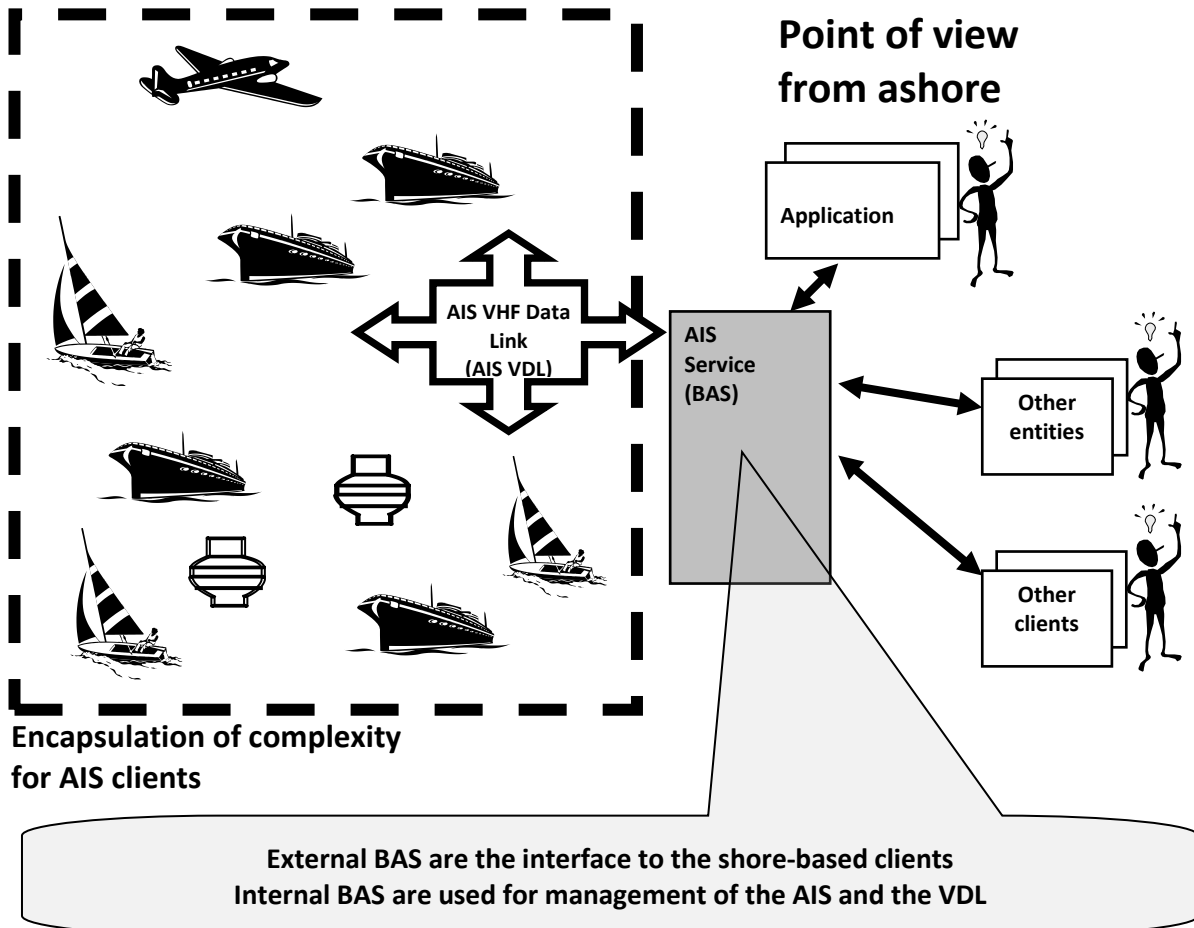


Figure 3 AIS Service relations with shore-based clients and the VDL

2.3.2 Table of external Basic AIS Services

Table 2 presents the external Basic AIS Services. The first column indicates the abbreviated name of the BAS, the second column indicates whether the BAS is a receive (Rx) or a transmit (Tx) BAS from the shore-based client point of view and the last column gives a brief description of the BAS. It should be noted that some BAS are available both in reception and in transmission. These BAS should then be considered as 2 distinct BAS since it should be possible to allow a client to receive only or transmit only. More detailed information is available on external BAS in Appendix 1.

¹ For further details in particular on the mechanisms refer to Appendix 5

Table 2 External Basic AIS Services (BAS)

| Service name | Tx/Rx | Description |
|--------------|---------|--|
| A_DYN | Rx | Receive dynamic ship data from Class A shipborne mobile AIS stations |
| A_STAT | Rx | Receive static ship data from Class A shipborne mobile AIS stations |
| A_VOY | Rx | Receive voyage related ship data from Class A shipborne mobile AIS stations |
| B_DAT | Rx | Receive Ship data from Class B shipborne mobile AIS stations |
| SAR_DAT | Rx | Receive data from SAR airborne AIS stations |
| SART_DAT | Rx | Receive data from AIS-SART mobile AIS stations |
| ATON_DAT | Tx & Rx | Send or receive AtoN AIS stations data |
| ASC_AD | Tx & Rx | Addressed application specific messages |
| ASC_BR | Tx & Rx | Broadcasted application specific messages |
| SAFE_AD | Tx & Rx | Safety related addressed message |
| SAFE_BR | Tx & Rx | Safety related broadcasted message |
| DGNS_COR | Tx | DGNSS corrections sent through AIS |
| INT_TDMA | Tx | Interrogation via AIS VDL |
| ASGN_RATE | Tx | Assignment of report rate and slot to specific mobile unit |
| ASGN_GROUP | Tx | Assignment of transmission parameters to group of mobile |
| AIS_MON | Rx | Monitoring of AIS Service and VDL to provide status to AIS clients |
| STA_PROFILE | Rx | Monitoring of specific AIS stations external to the own AIS Service to provide status to AIS clients |

2.3.3 Table of internal Basic AIS Services

Table 3 presents the internal Basic AIS Services. The first column indicates the abbreviated name of the BAS and the second column gives a brief description of the BAS. More detailed information is available on internal BAS in Appendix 1.

Table 3 Internal Basic AIS Services (BAS)

| Service name | Description |
|--------------|---|
| INIT_AIS | Initiate, restart and reset AIS service |
| TERM_AIS | Terminate AIS service |
| BASE_DAT | Base station data |
| FATDMA | Base station FATDMA reservations |
| CH_MGMT | Channel management of VDL |
| LSS_MGMT | Management and configuration of AIS-LSS |
| PCU_MGMT | Management and configuration of AIS-PCU |
| STA_MGMT | Management and configuration of AIS Fixed Station |
| AIS_MON | Monitoring of AIS Service and VDL |

It should be noted that the AIS Service may include some type of logging and/or archiving capabilities. Logged or archived data may be accessed by appropriate replay functionalities. As an alternative to internal logging and/or archiving capabilities within the AIS Service, permanent AIS data storage may be left to higher level applications within the CSSA. Due to the encapsulation principle, internal logging and/or archiving will contain a more comprehensive set of AIS data than external logging and/or archiving, especially with regards to the data related to the internal BAS.

2.4 DATA MODEL OF THE AIS SERVICE

2.4.1 Introduction

This section introduces the AIS Service Data Model, which will be described in Appendix 1. It is meant to describe what data is used, received and transmitted by the AIS Service. It is important to understand that the data objects used by the AIS Service are derived from an over-arching data model called the IALA Universal Maritime Data Model (UMDM).

The above Basic AIS Services define the functionality provided by the AIS Service. They are operations performed on certain data objects. To provide a complete picture of what the AIS Service can deliver its clients, it is necessary to consider those data objects and their structure and mutual relationship. Eventually, it is the data, which is only relevant for the clients.

2.4.2 Usage of the IALA UMDM by the AIS Service

The IALA UMDM is an abstract representation of the maritime domain. This domain but does not represent processes. The purpose of a data model is to give system engineers a common understanding of the entities and their relationships.

The Data Model of the AIS Service is an application of the IALA UMDM. It provides the well-structured and abstract (functional) description of the data that the AIS Service exchanges with requesting services of its clients. In the IALA UMDM all data objects are expressively described in one place together, with data attributes based on an appropriate data type definition.

Also, the Data Model represents the data usage of the individual BAS. Hence, the Data Model shows the overall use of the AIS Service of the IALA UMDM. The reference to the IALA UMDM is made by using the Universal Data Object Identifiers (U.DOI) of the data objects

The Data Model provides the engineers of requesting services and / or applications precise information on what data the AIS Service may provide (receive) or expect (transmit), without the need to know, for example, the encoding details of the VDL. Hence the data model helps to encapsulate the 'science of the AIS' and confine it to the AIS Service on behalf of the shore-based system(s) as a whole.

Although, the Data Model does not contain encoding information, encoding is required on the application level. The Data Model of the AIS Service is given in Appendix 1. Additional information on encoding is given in Appendix 5, The Interfacing Model.

2.5 STRUCTURE MODEL - THE LAYERED STRUCTURE OF THE AIS SERVICE

2.5.1 Introduction

This section aims to give a brief introduction of the different functional components of an AIS Service. The functional components are presented in a very important layered structure. This introduction to the AIS Service functional components will allow for the association between the component and the functions it performs to provide the different BAS presented earlier.

A more detailed introduction to the AIS functional components is available in section 2.12 of this document.

2.5.2 Definition of the layered structure of the AIS Service

The AIS Service consists of three main functional layers as follows (refer to Figure 4 on the following page):

- Service Management Layer (AIS Service Management or AIS-SM);
- Logical Layer (AIS Logical Shore Station or AIS-LSS);
- Physical Layer (AIS Physical Shore Stations or AIS-PSS).



The Physical Layer directly interacts with the AIS VDL. The AIS VDL as such does not belong to the AIS Service, although the AIS Service may influence it by its usage and/or management. (The AIS VDL is also outside the shore-based system.)

For the description of the AIS Physical Shore Stations (AIS-PSS), the Physical Layer can be further subdivided into three layers as follows:

- 1 AIS PSS Controlling Unit (PCU) Layer.
- 2 AIS Fixed Stations Layer.
- 3 AIS RF Components Layer.

The layers described above include all components necessary to implement and operate the AIS Service. Each layer comprises of:

- The service component itself, which provides the required functionality in terms of AIS-specific data processing;
- The supporting components and resources, which are exclusively used by the AIS Service, such as computers and local networking devices, i.e. the so called service-owned infrastructure;
- The Human Machine Interfaces (HMI) to allow for (remote) access to Technical Operation Personnel.

It is also important to note that each layer is supported by on-site infrastructure, such as energy supply, which may be shared with other on-site technical services.

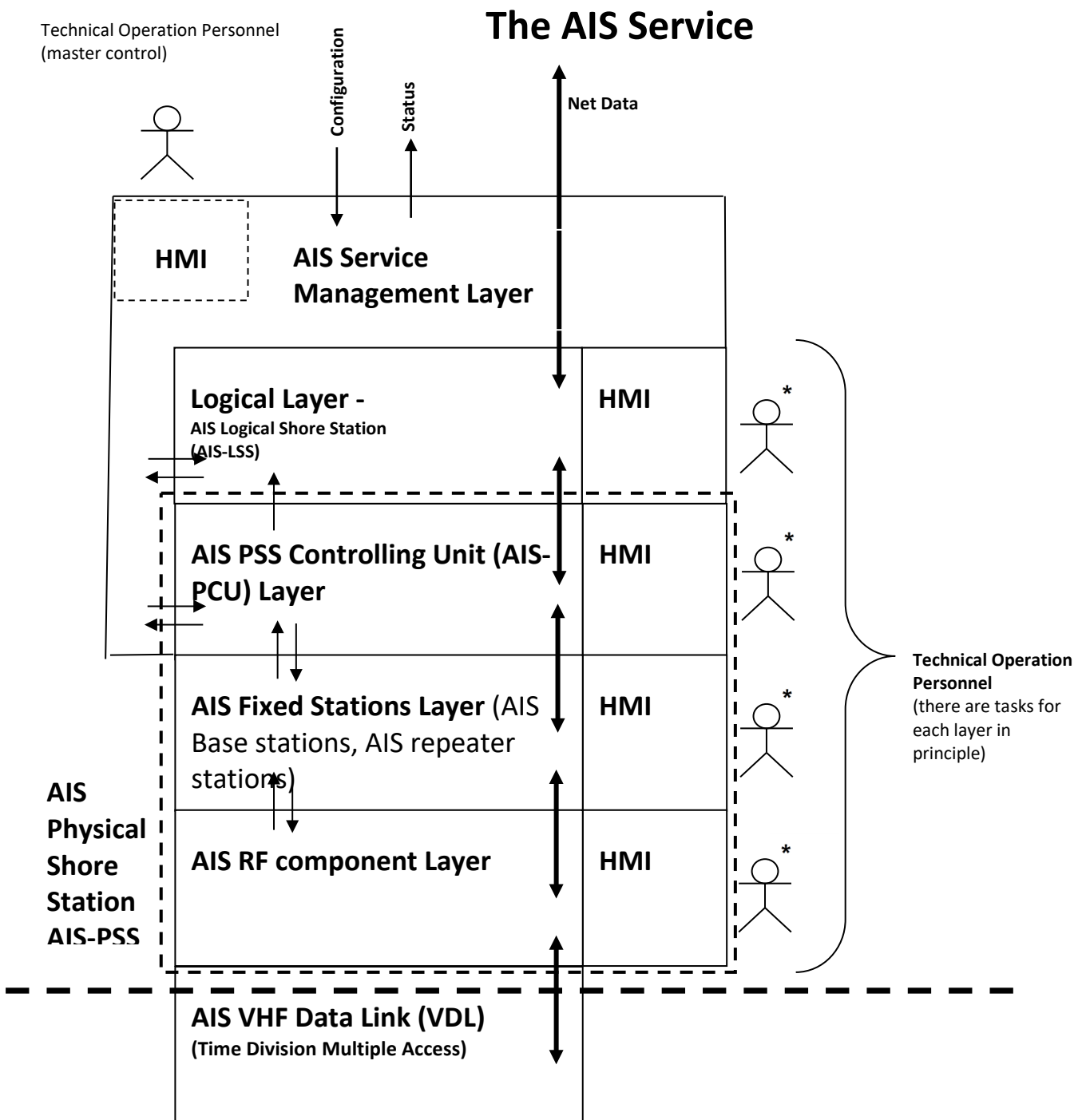


Figure 4 *Layered structure of AIS Service – Structure model of the AIS Service*

* Note: This symbolic representation should not be taken as an inference of the amount of personnel required for the technical operation of the AIS service. This symbolic representation aims at indicating that human interaction with the largely automated AIS Service is required as the last resort - and in some cases possibly on a regular basis - on all layers of the AIS Service.

2.5.3 Mapping of the BAS to component functionalities and component requirements

To arrive at the required functionalities of the components internal to the AIS Service it is necessary to map the Basic AIS Services (both External and Internal) to the relevant individual components. In accordance with Figure 4 and the above section there are the three main service components, namely AIS Logical Shore Station (AIS-LSS), AIS PSS Controlling Unit (AIS-PCU), and AIS Service Management (AIS-SM) to be considered for the mapping. The AIS Base Stations, the AIS antennae, and also the AIS VDL are omitted from the consideration at this point since they are transparent in regard to the net information flow. They will re-appear when considering secondary issues of the AIS Service, such as component management or loading of the AIS VDL.

The mapping of the Basic AIS Services to functional components is described in Appendix 1.

The resulting component functionalities are collected in Appendices 9, 10 and 11, which deal with the functional descriptions of the respective components.

2.6 DISTRIBUTION MODEL FOR THE AIS SERVICE

So far, the BAS and the internal structure of the AIS Service have been introduced. The Distribution Model considers the influence of the geographical topology on the design of the AIS Service. It deals with subjects such as the type of AIS Service recommended for different topologies, coverage planning and considerations for the location of different AIS functional components.

The distribution model of the AIS Service is defined in accordance with the generic rules set out for Data Collection and Data Transfer Services in the IALA CSSA description. The influence of the geographical topology on the AIS technology is given in Appendix 3.

2.7 INTERACTION AND DATA FLOW MODEL OF THE AIS SERVICE

2.7.1 Introduction

Previous sections considered the static aspects of the AIS Service. It is now necessary to introduce the mechanics of the internal working of the AIS Service.

This section introduces the Interaction and Data Flow model which will be described in Appendix 4. The objectives of Appendix 4 are to:

- 1 Identify and describe the dynamic interactions between the various components of the AIS Service, due to their geographical distribution;
- 2 Provide a description of the roles of the various components of the AIS Service regarding the data flow;
- 3 Provide guidance to a competent authority on the operation of the components of the AIS Service.

2.7.2 The dynamic interactions between components of the AIS Service

The Interaction and Data Flow Model of the AIS Service shows the interaction between its relevant components. The Interaction and Data Flow model combines the Basic AIS Service descriptions, the Structure Model and the Distribution Model and addresses issues associated with the data flow mechanism in a distributed AIS Service setup. Hence, the Interaction and Data Flow model of the AIS Service weaves together the different strands that have been introduced so far.

2.7.3 The description of the roles of the components of the AIS Service

The Interaction and Data Flow Model of the AIS Service deals with the roles of the components of the AIS Service. It is relevant in particular due to the geographical distribution of the components. It deals with aspects such as:

- Networking aspects of the data flow between the AIS Service and its clients;
- Handling of MDEF sentences by the different AIS functional components;
- Mechanisms of data exchange between the different AIS functional components.

The Interaction and Data Flow Model provides a description of the roles of the components of the AIS Service, namely of the AIS PSS Controlling Unit (AIS-PCU), the AIS Logical Shore Station (AIS-LSS), and the AIS Service Management (AIS-SM). The roles of these components with respect to the BAS are addressed in Appendix 1 regarding their static behaviour. Appendix 4 looks at the roles of these components in maintaining and ensuring the data flow through the AIS Service, i.e. their dynamic behaviour. It also considers these roles with respect to the geographical topology of these components, as discussed in the Distribution Model.

This functionality description described in Appendix 4 would allow for an eventual type approval applied to the AIS-PCU, the AIS-LSS, and the AIS-SM software module, as far as the AIS-specific functionality is concerned.

The functionality of these functional components would consist of the sum of all functions needed to support all interaction and data flow scenarios identified within the Interaction and Data Flow Model of the AIS Service. Due to the complexity of the AIS Service many different interaction scenarios need to be considered. To reduce the number of interaction scenarios to be considered and thus reduce complexity, an appropriate methodology is introduced in Appendix 4.

2.7.4 Guidance on the operation of an AIS Service

Concerns have been expressed regarding the powerful functionality of AIS Base Stations and regarding their improper operation which may consume too much of the AIS VHF data link capacity. Therefore, guidance is required for competent authorities setting up and operating an AIS Service on two aspects:

- 1 How to deploy and set up the powerful functionality provided for competent authorities by Recommendation ITU-R M.1371 in a responsible manner.
- 2 How to manage and configure during run-time the operation of their AIS Service and of the AIS VHF data link in a responsible manner.

This is particularly true when considering the configuration and control of the two fundamental modes of AIS Base Stations, i.e. Dependent Mode operation and Independent Mode operation, by the AIS PSS Controlling Unit (AIS-PCU).

The Interaction and data Flow Model provides the comprehensive functional framework both for:

- proper deployment and functional set-up of shore-based AIS capabilities by a competent authority; and
- responsible run-time configuration of an AIS Service by a competent authority.

The details of proper deployment and run-time configuration aspects of an AIS Service will be further developed in several Appendices. Specifically, Appendix 18 'VDL Usage by AIS Service and VDL Management' expands on the use of the above Interaction and Data Flow Model to provide guidance to competent authorities operating an AIS Service, and also to effectively answer the above concerns.

2.8 INTERFACING MODEL OF THE AIS SERVICE

The Interfacing model of the AIS Service describes the:

- 1 relationship of the AIS Service within the shore-based systems.
- 2 interfaces of the AIS Service to other shore-based systems, and
- 3 interfaces between the components of the AIS Service.

Items 2 and 3 take into account the following aspects:

- The application encoding methods - a portfolio of encoding techniques is recommended to suit the data objects exchanged;
- The protocol stacks recommended for internal and external data transfer of the AIS Service.

All application encoding methods and protocol stacks recommended are in keeping with the open system philosophy of the CSSA. The Interfacing Model of the AIS Service is described in Appendix 5.

2.9 INTERNAL TIME LATENCY MODEL OF THE AIS SERVICE

The Internal Time Latency Model of the AIS Service describes the time latency limits regarding the BAS (by external and internal BAS Category). The actual latencies are strongly dependent on the design and characteristics of the system components and the transmission used. External systems interfacing with the AIS service need to consider AIS service delays and address them.

In particular the resulting permissible latency of AIS data delivery of the AIS Service operating within the CSSA must be considered, for example, when correlating AIS data with radar target data within the Value Added Processing Services of the CSSA.

From the BAS level, concrete timing requirements for components of the AIS Service and their mutual interconnection can be derived. The Internal Time Latency Model must also take loading scenarios of the AIS VDL into account.

Appendix 6 of this Recommendation is not developed.

2.10 INTERNAL RELIABILITY MODEL OF THE AIS SERVICE

The Internal Reliability Model of the AIS Service analyzes the internal reliability aspects of the AIS Service. The AIS Service is built on components and transmission services whose reliability is well known and documented. Reliability of the AIS Service can be calculated using standard engineering methods. It may also be necessary to consider the reliability of the VDL, which is discussed in Appendix 18.

Appendix 7 of this Recommendation is not developed.

2.11 TEST MODEL FOR THE AIS SERVICE

A general Test Model for the AIS Service has not been developed. Individual components are vendor-dependent and it is difficult to come up with a "standard" test model for these. Individual components may have their own tests according to manufacturer specifications or certifications. The specific implementation of an AIS service will necessitate development of requirements for that implementation; these will be the basis for any needed testing model. Furthermore, relevant, systematic experience from test models for the AIS Service is missing, and no specific recommendations can be given.

Appendix 8 of this Recommendation is not developed.

2.12 FUNCTIONAL COMPONENTS OF THE AIS SERVICE

This section introduces the functional components of the AIS Service.

2.12.1 Typical AIS Service physical setup

Figure 5 shows a typical AIS Service with clients and providers of AIS Data. It is one possible translation of the more abstract layered structure depiction of the AIS Service in Figure 4 (see above). This example describes an AIS Service, which includes PSS Controlling Units (AIS-PCU), AIS Logical Shore Stations (AIS-LSS) and an AIS Service Management (AIS-SM) entity. Several AIS-PCUs are assigned to at least one AIS-LSS, which combines the data from these AIS-PCUs in order to cover a certain area. In this example the AIS Service includes several AIS-LSS. Clients will receive data from the AIS-LSS distributing the data of interest to that particular client. The management of the AIS Service is done by the AIS-SM. This entity controls the data flow in the system and configures the different components in order to fulfil the given requirements.

The following should be noted about Figure 5:

- 1 The AIS-LSS are specified as being instances or processes. This means that all AIS-LSS can be executed on the same physical infrastructure or on separate physical infra-structures depending on the requirements for the AIS Service.
- 2 Each client is assigned an individual AIS-LSS configured especially for its own requirements. Although this is the recommended way to manage clients and AIS-LSS, it should be possible to have clients connect to different and multiple existing AIS-LSS if their requirements are the same. Alternatively, it should be considered to set up a portal for different users with the same set of requirements as part of a dedicated Gateway Service as a separate technical service not being part of the AIS Service (refer to CSSA system layout recommendation).
- 3 It may be possible to interconnect AIS-LSS processes in order to accommodate different network topologies that may not offer complete, i.e. meshed, connectivity to all AIS-PSS or that may have other network constraints, e.g. bandwidth or latency.

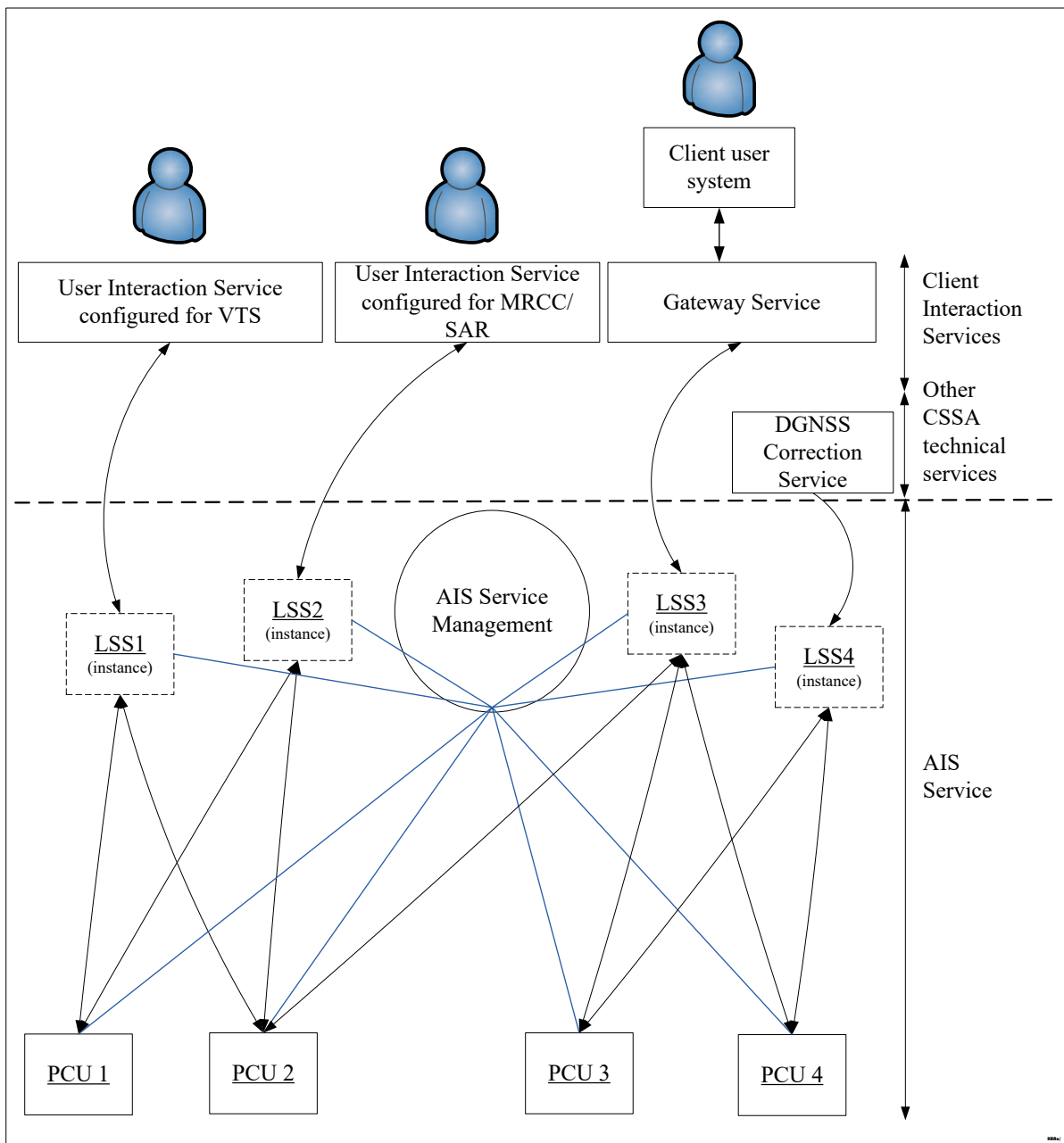


Figure 5 *Typical AIS Service setup*

2.12.2 Overview of tasks of the functional components of the AIS Service

While Figure 5 describes one example of a workable AIS Service setup, it should be noted, that the available features and the available options in setting up an AIS Service can only precisely be captured by the more abstract descriptions provided in this Recommendation. Hence the following sections will continue the description of the AIS Service on a more abstract level, but will continue to give similar examples regarding the possible configurations.

The functional components are defined by their individual set of tasks. Figure 6 shows the different tasks of the different functional components of the AIS Service.

Please note that:

- 1 The different *task orientation* of functional components, i.e. the:
 - a orientation of the Logical Layer towards the requesting / requested services of the shore-based technical system(s) and their requirements.
 - b orientation of the Physical Layer towards the AIS VDL and its requirements.
 - c configuration and control capabilities of the AIS-SM.
- 2 The *instances* are now implied, namely that the:
 - a Physical Layer consists of all AIS Physical Shore Stations (AIS-PSS) of the individual AIS Service of an individual administration.
 - b Logical Layer consists of all AIS Logical Shore Stations (AIS-LSS) set up as individual software processes of the individual AIS Service of an individual administration.
- 3 There are necessary functionalities, which are *invisible* to the net AIS data flow between the AIS VDL and the requesting services, and vice versa. These functionalities are supported by infrastructure components owned by the AIS Service (so called service owned infrastructure), namely by distributed databases, local area networking, etc.

To specify concrete features and attributes of those functional components, such as data processing capabilities, interaction capabilities, interfacing requirements, timing constraints, and reliability figures, the appropriate service models need to be considered as introduced in the previous sections.

These models have discussed the AIS Service on the class level. In order to set up an AIS Service by an individual administration, it is necessary to eventually arrive at concrete components that materialize at concrete sites, i.e. at the instance level. This is where the Distribution model fits in.

All these different aspects need to be merged within the description of the functional components. This will be done in the appropriate Appendices, describing the particular functional component. In the following sections, a short introduction is provided.

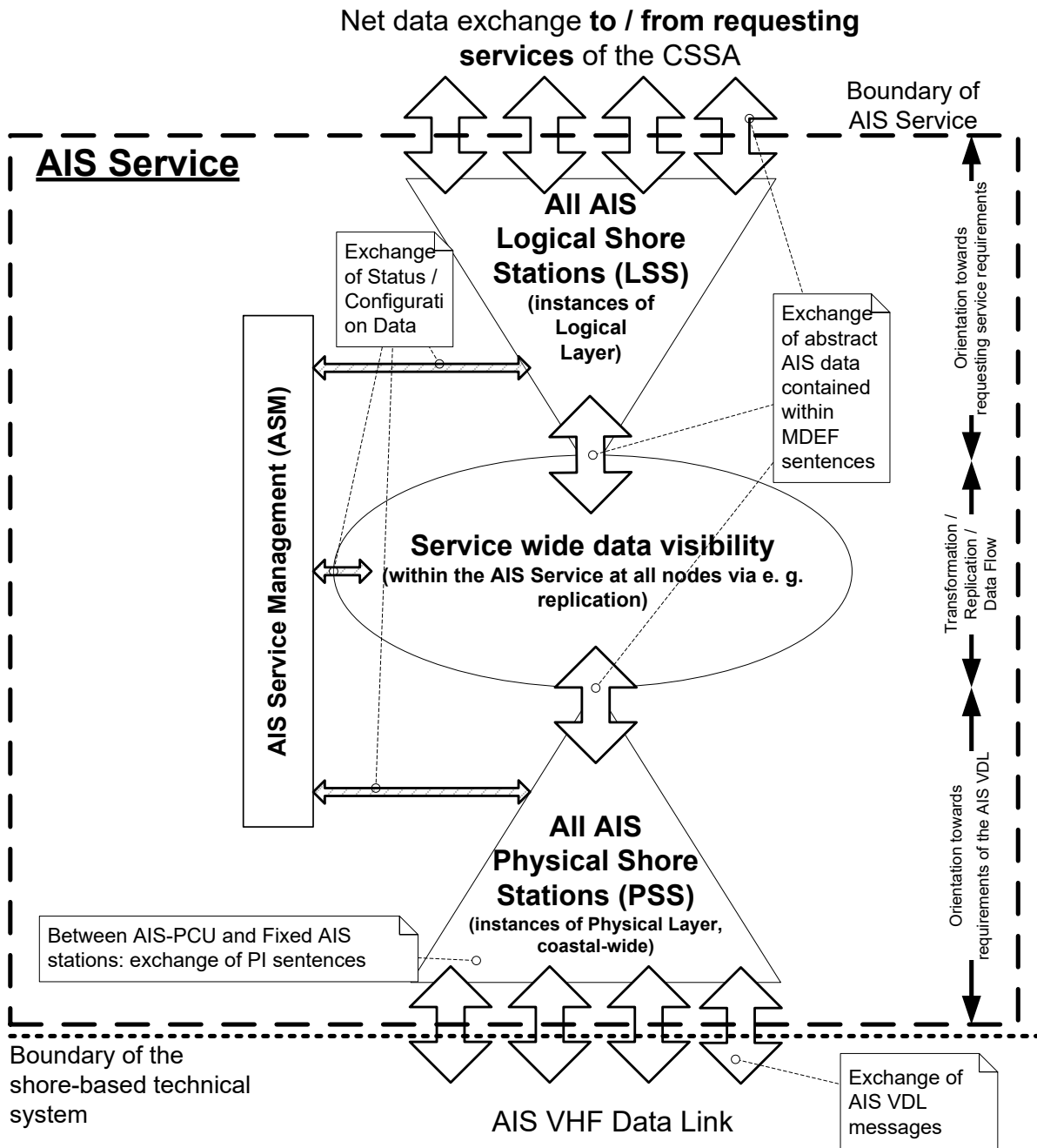


Figure 6 *Overview of the tasks of the functional components of the AIS Service*

Figure 6 is used and explained in several Appendices that elaborate certain aspects of this figure.

2.12.3 AIS Logical Shore Station (AIS-LSS)

The AIS Logical Shore Station purpose is to facilitate interaction with the AIS Service. For the clients' systems, the AIS-LSS represents a single point of interface to the AIS Service. It merges the different data streams from all relevant AIS-PSS. In a sense, the AIS-LSS hides all the complexity of the AIS Service from its clients.

Hence, the AIS-LSS has three major data processing functions:

- 1 AIS data filtering.
- 2 AIS data flow control.
- 3 AIS data transformation.

The software process of an AIS-LSS can run on any appropriate computer at any appropriate place. The options for selecting an appropriate configuration for setting up the instances of the AIS-LSS, and its consequences, are discussed in the Distribution Model of the AIS Service (see Appendix 3).

An individual software process of an AIS-LSS running in an individual computer is called instance of an AIS-LSS. Hence, an instance of an AIS-LSS is a software process, which filters, controls and transforms the AIS data flow(s) from one or more AIS Physical Shore Station(s) in order to create a single AIS-related data flow associated with one (1) requesting service. Please note that the AIS-LSS will also do the opposite, i.e. filter, control and transform the AIS data flow from one requesting service into different AIS data flows associated with one or more AIS Physical Shore Station(s). The run-time configuration of any instance of AIS-LSS is managed by the AIS-SM.

For each requesting service, the AIS Service sets up at least one instance of an AIS-LSS. An instance of AIS-LSS of the AIS Service communicates with one instance of a logical interface of the requesting service in a 1:1 relationship. The protocols recommended for the exchange of AIS data between the AIS-LSS and the systems of the AIS Service's clients are introduced in Appendix 5, the Interfacing Model.

It is required that there are reliable functional connections between any instance of AIS-LSS and all associated AIS Physical Shore Stations.

Details of the AIS-LSS are described in Appendix 9.

2.12.4 AIS Physical Shore Station (AIS-PSS)

The AIS-PSS is an abstract concept that encompasses multiple real physical elements of a shore-based AIS Service. Typically, all elements of an AIS-PSS would be located together in the same location, but notable exceptions exist where different elements of a AIS-PSS are located in different locations because of different external factors.

The AIS-PSS is the most basic AIS-related entity that can exist on its own in a real physical environment, as opposed to the AIS PSS Controlling Unit (AIS-PCU) or an AIS fixed station.

An AIS-PSS consists of at least the following components:

- one AIS PSS Controlling Unit (AIS-PCU) in charge of controlling one or more AIS fixed station;
- one AIS fixed station (base station, limited base station or repeater station) providing the interface to the VDL;
- an agent of the AIS Service Management providing configuration and monitoring capabilities for the AIS-PCU(s) and AIS fixed station(s);
- AIS RF components (maybe shared with other services on-site);
- Supportive infrastructure (Service owned or shared).

Thus, an AIS-PSS does not necessarily need to be considered large physically.

In the list of components above, the supported infrastructure refers to physical and functional elements as required by the AIS service design, such as shelter, power source, local network, data storage, cables, etc. It is worth highlighting that some of these components may be shared with other co-located technical services or dedicated to the AIS Service, in which case they are referred to as AIS Service owned.

An AIS-PSS generally has a UTC source of its own. This UTC source may be internal to the AIS fixed station such as a GNSS receiver, or external to the AIS fixed station (being a part of the on-site infrastructure), such as a solid-state (crystal oscillator) clock, providing timing for the AIS fixed station(s) by an appropriate timing interface (such as IRIG / IEEE 1344). There may also be cases where the AIS fixed station is set up using only the synchronisation provided by the AIS VDL itself, i.e. UTC indirect or even slot synchronisation.

Figure 7 illustrates, as an example, the AIS-PSS aspects explained above. It shows two different locations (pink boxes) representing a remote site facility and another facility (Node, Control Centre or other location). The outside dotted box outlines the boundary of the AIS-PSS object. It includes all components of the AIS-PSS described above, i.e.:

- functional components of one AIS-PCU located at the other facility;
- two AIS base stations located on site;
- part of the functional components of the AIS-SM in charge of monitoring and configuring the AIS-PCU;
- the required infrastructure for the PSS (GPS, RF equipment, UPS, network, etc.).

The required infrastructure is also highlighted by a box including the RF equipment, the GPS antenna, cables, the UPS, the local area network, the local router, the wide area network, the AIS-PCU hardware and part of the AIS-SM hardware.

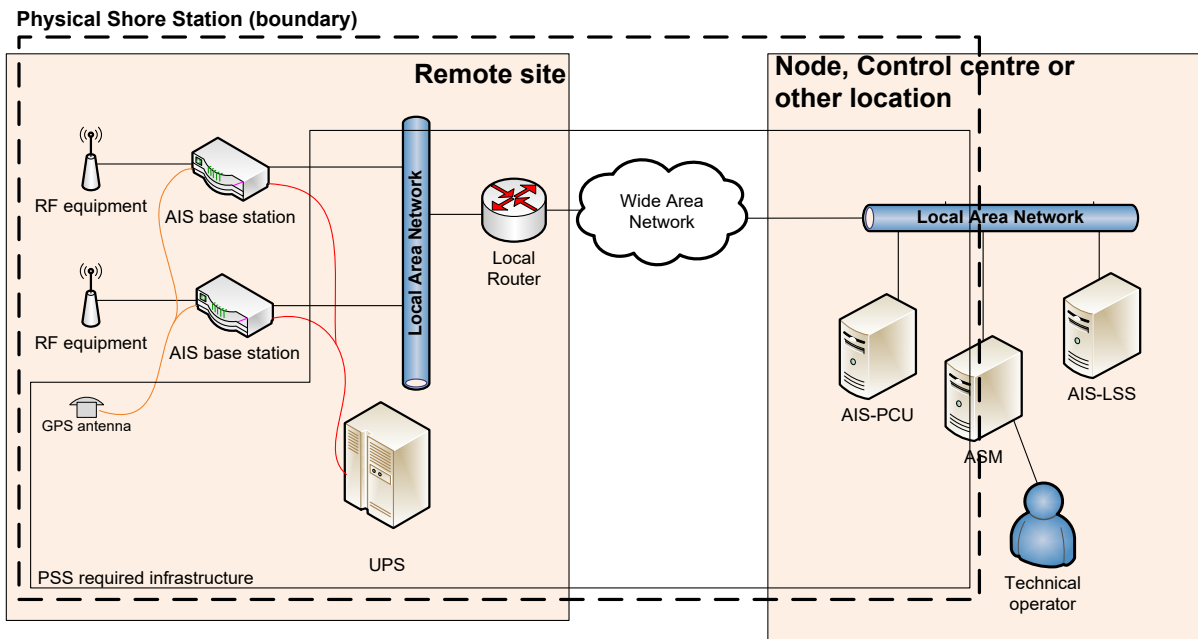


Figure 7 Example of AIS Physical Shore Station of the AIS Service

Cautionary note: Figure 7 should not be construed as normative or the only recommended way to set up an AIS Physical Shore Station of the AIS Service. Figure 7 does claim however, to be correct and consistent with the normative statements in this Recommendation with regard to what it shows. For example, the AIS-PCU hardware and software and/or the PSS functional components of the AIS could very well be located at the remote site and they must be located at the remote site when using dependant mode base station (see section 2.12.4.3).

Considerations for establishing the optimized location of all AIS-PSS components are addressed in Appendix 3. Appendix 10 provides more details on AIS Physical Shore Stations (AIS-PSS) and Appendix 12 addresses technical aspects of AIS-PSS co-location with other technical services operating at the same Remote Site.

2.12.4.1 AIS PSS Controlling Unit (AIS-PCU)

The AIS PSS Controlling Unit (AIS-PCU) performs the following main tasks:

- pre-processing of AIS data in one or both directions (receive and/or transmit), depending on configuration;
- control of the AIS fixed stations of the AIS-PSS depending on the configuration established by using the AIS Service Management.

The AIS-PCU is essentially a software process running as either an application on a computer, the physical entity, or as an integral firmware of a dedicated unit. It is responsible for the AIS fixed Station(s) configuration, transmission scheduling, and processing of received information. The Presentation Interface (PI) sentences defined by IEC 62320-1 are used by the AIS-PCU to interface with the AIS fixed station(s). More details on the AIS-PCU are described in Appendix 10.

2.12.4.2 AIS Fixed Stations

The AIS Fixed Stations are the most basic AIS-related entity of any AIS shore infrastructure. Conceptually, they are a 'bare bone' black-box like device defined by the functional description and interface definitions. The AIS Fixed Stations transform the presentation interface sentences, as received from the AIS-PCU, into actual AIS VDL message in RF for transmission via the AIS RF components. This process is also performed in reverse order for reception of AIS VDL messages.

There are different kinds of AIS Fixed Stations, such as the AIS Base Station, the limited AIS Base Station, and the AIS Repeater Station. The differences between each type of AIS fixed stations are explained below:

- 1 The AIS base station is compatible with all BAS and is typically deployed and operated by competent authorities.
- 2 The Limited Base Station (LBS) is only compatible with a sub-set of all the BAS and is intended for competent authorities that require some AIS functionality without being able to manage the VDL. They are typically deployed by port authorities, ferry terminals or other such types of localised organizations.
- 3 The AIS Repeater Station is a store and forward repeater for AIS VDL messages aimed at increasing AIS coverage of a competent authority without requiring a complete AIS base station installation. It can also be used to autonomously retransmit AIS VDL messages to improve AIS station to AIS station communications.

Considerations about choosing to install an AIS repeater station instead of an AIS base station are addressed in Appendix 3.

Technical details for the AIS Fixed Stations are described in the appropriate IEC Standards (see references).

2.12.4.3 AIS Base Stations Dependent / Independent Mode

The AIS Base Station was designed for dependent operation or independent operation. Both are under some control of an AIS PSS Controlling Unit (AIS-PCU).

- a dependent mode AIS base station can only access the AIS VHF data link (VDL) using the Presentation Interface (PI) sentences provided by the AIS-PCU;
A dependent mode AIS base station operates in full dependency of the AIS-PCU, hence the name.
- an independent mode AIS base station accesses the VDL using the PI sentences provided by the AIS-PCU or by using internal control.

When operated as an independent mode AIS Base Station the unit will be delegated certain autonomous functionality under the supervisory control of the AIS-PCU.

As previously mentioned, the AIS-PCU is responsible for AIS Base Station configuration, transmission scheduling, and processing of received information. PI sentences are used by the AIS-PCU to configure the AIS Base Station, schedule message transmissions and output information. The AIS Base Station may also be used to monitor and improve the integrity of the AIS VDL.

Further details are available in IALA Guidelines 1059 on the Comparison of AIS stations and in IEC Standard 62320-1.

2.12.4.4 Limited Base Station (LBS)

The AIS Service in a littoral or port state is operated by the competent authority for the whole of the coverage area. This competent authority has the need to control the AIS Service and the AIS VDL, by employing means like channel management, protected slot allocations and assigned mode. The AIS Base Station allows for the full control of the AIS VDL.

However, there are other local competent entities responsible for local operations such as individual harbours, locks, marinas, off-shore structures. These regularly have an interest in monitoring the vessel traffic in their

locally confined area of competence and exchange general operational information with ships with respect to their area of competence, e.g. docking scheduling and tug operations.

The Competent Authority is in charge of the full AIS Service functionality, including the control mechanisms. However, to allow local competent entities to participate in and benefit from the AIS Service, there are two possible options for them to:

- connect to the competent authority AIS Service via a shore-based communication link;
- establish a locally owned and confined shore-based AIS infrastructure with limited capacities.

Should the local competent entity be in need of tactical information on local ship movements or in situations where the competent authority AIS Service does not provide coverage of that area, then the local competent entity could coordinate with the competent authority to set up a Limited Base Station (LBS).

These Limited Base Stations have no means of controlling the AIS Service, of controlling the AIS VDL or of broadcasting any navigational signals. There is a requirement, though, that the operation of a LBS is co-ordinated with the competent authority AIS Service in any case. In addition, national regulations may apply.

General overview on the capabilities and limitations of the LBS:

- the LBS is capable of receiving all AIS messages within its radio range. In the case of addressed AIS messages the LBS only receives messages addressed to it;
- the LBS may transmit interrogation messages, application specific messages and safety related messages. The LBS may also transmit acknowledgements to addressed messages;
- if the optional Aids-to-Navigation functionality is added then the LBS may also transmit AtoN-reports, in which case this station is called AIS AtoN Controller ;
- the maximum permissible link utilization of an LBS is 20 slots per frame for all above messages except acknowledgements;
- the LBS is prohibited to transmit any controlling or navigational messages such as as-signed mode commands, DGNSs broadcasts and to perform data link management and channel management.

The LBS also does not provide secondary synchronisation support, i.e. it cannot be acting as a semaphore.

- LBS are subject to the channel management messages of the national AIS Service. Therefore, the LBS reacts like a mobile station when receiving AIS Channel Management commands.

Further details are available in IALA Guidelines 1059 on the Comparison of AIS stations and in IEC Standard 62320-4 under development.

2.12.5 The AIS Service Management

The AIS Service Management of a competent authority performs the following tasks:

- it acts as a management entity for the whole of the AIS Service (which will in most cases comprise more than one AIS-LSS, AIS-PCU, and AIS Fixed Station (refer to the Distribution model described in Appendix 3));
- it manages the internal BAS, including the management of the AIS VDL; and
- it is the last resort regarding faulty behaviour (other than the Technical Operation Personnel).

Specifically, the AIS-SM:

- invokes, initialises, configures and terminates all the instances of AIS-LSS and AIS-PCU at run-time;
- determines the functional connections between AIS-PCU and their associated AIS-LSS for them to use during run-time;

- determines the functional connections between the AIS-LSS and the clients requesting services' logical interface associated with them, i.e. this top level acts as a 'switch-board' for the data exchange relationships between the different processes;
- provides the Human Machine Interface for the Technical Operation Personnel to monitor the current status of the VDL and configure it accordingly by means of VDL management;
- Due to the distributed nature of the AIS Service (see Distribution Model of the AIS Service), the AIS-SM may consist of several distributed agents and of one master functionality, all of which are generally software processes. The master functionality is often located at a centralized location.

Details on the AIS-SM are described in Appendix 11.

2.12.6 Type approval considerations for AIS-PCU, AIS-LSS, and AIS-SM software modules

When introducing the Interaction Model of the AIS Service above, the provision for type approval of the AIS-PCU, AIS-LSS and AIS-SM software modules was given as a rationale. This section elaborates on that type approval aspect using the above introduction of the functionality descriptions for the AIS-PCU, the AIS-LSS, and the AIS-SM.

Regarding type approval, the following notions should be taken into account:

- 1 Type approval for software modules should only apply to the AIS specific functionalities of the AIS-PCU, AIS-LSS, and AIS-SM software modules. Ideally these AIS specific functionalities would be *software modules*. Type approval would not address or include infra-structure components owned by the AIS Service, such as computers, LAN components etc.
- 2 The description of the AIS specific functionalities of AIS-PCU, AIS-LSS, and AIS-SM, which are covered in Appendix 9-10-11, would be precise in terms of functionality while not being prescriptive regarding implementation method by a manufacturer. Thus, the functional components AIS-PCU, AIS-LSS, and AIS-SM would be modelled as 'black boxes', rendering open interface definitions.
- 3 The following aspects and the associated degree of impact should guide the selection of AIS specific functionality of these functional components subject to type approval:

Table 4 *Type approval aspects and impacts*

| Aspect | Degree of impact | |
|---|--|----------------|
| | HIGHER | LOWER |
| Local impact of AIS VDL related run-time configurations | AIS-PCU (for both modes of AIS Base stations) | AIS-SM |
| Coastal-wide impact of AIS VDL related run-time configuration | AIS-SM (in particular AIS-SM-Master functionality) | AIS-PCU |
| Quality of data delivery to/from shore-based clients | AIS-LSS + AIS-PCU | AIS-SM |

2.13 IMPLEMENTATION, INSTALLATION AND MAINTENANCE

Implementation and maintenance issues of the AIS Service are mainly concerned with the protection and best use of the VDL, and are dealt with in Appendices 14, 16, 17 and 18. Standard engineering methods apply to the AIS infrastructure and its maintenance.

Appendix 13 of this Recommendation is not developed.

2.14 VDL USAGE BY AIS SERVICE AND VDL MANAGEMENT

As previously mentioned, the AIS service of a competent authority interfaces with the VDL using AIS Fixed Stations. The VDL being a shared medium, careful planning is required in order to ensure that the VDL remains accessible by all AIS stations and does not overload.

In resolution MSC.140 (76) the IMO recognizes a compelling need to ensure the integrity of the AIS VDL and recommends that administrations take the necessary steps to do so. It is therefore strongly recommended that a national competent authority is appointed with the responsibility of managing the AIS VDL.

Co-ordination between competent authorities sharing a common border is also required.

The following sections introduce the different aspects of managing the VDL for a competent authority. More details will be available in the respective appendices.

2.14.1 Introduction to the VHF Data Link (VDL)

The VDL uses 2 default VHF frequencies in the maritime mobile band. Channel 87B (161.975 Mhz) and 88B (162.025 Mhz) have been reserved internationally for AIS use.

The VDL is based on a Time Division Multiple Access (TDMA) scheme. Each minute, on each channel, is divided in 2250 time slots for a total of 4500 available time slots per minute.

There are the following aspects of VDL usage by the AIS Service:

- FATDMA planning;
- Assigned mode operation;
- DGNSS broadcast via AIS;
- Channel management of the AIS Service;
- Channel loading management of the AIS Service.

2.14.2 FATDMA planning and operation of an AIS Service

As mentioned in IALA Guideline 1059, the AIS fixed station(s) of a competent authority use the Fixed Allocation Time Division Multiple Access scheme (FATDMA) on the VDL. The FATDMA requires careful planning in order to optimize the use of the VDL for all AIS participants.

Details on planning and operating an AIS service using FATDMA are described in Appendix 14.

2.14.3 Assigned mode operation of an AIS Service

Assigned mode operation allows for limited control of transmissions of position reports from mobile stations by transmitting Msg 16 or Msg 23 from an AIS base station by a competent authority.

Msg 16 (Assigned mode command) can be transmitted from a base station to simultaneously control the reporting interval of one or two specific ships identified by their MMSI.

Msg 23 (Group assignment command) can be transmitted from a base station to control the operating parameters of mobile stations in a specified area and selected by “ship and cargo type” or “station type.”

Operating parameters are:

- transmit/receive mode;
- reporting interval;
- duration of a quiet period.

The reporting interval of Class A mobile stations can only be decreased (as compared to their autonomous reporting interval). Class A mobile station transmits a Msg 2 Position report when in assigned mode. Class A mobile stations cannot be assigned to “receive only” mode.

Assignment commands are only valid for a limited time period and must be repeated to maintain the requested reporting behaviour. Continuous assignments are not recommended.

The use of assigned mode is presently very limited and there is not enough experience with using assigned mode to make specific recommendations. Assigned mode commands strongly influence the VDL and should be used with caution. Its use and the messages are described in ITU-R M. 1371.

Appendix 15 of this Recommendation is not developed.

2.14.4 DGNSS broadcast via an AIS Service

The AIS Service does not contain a source for DGNSS correction data to be broadcast. Rather it acts as a ‘modem’ to the DGNSS Correction Service of the shore-based system architecture, hence ‘DGNSS broadcast via an AIS Service’. The AIS Service transmits DGNSS corrections received from the shore-based DGNSS Correction Service, while wrapping it in an AIS VDL message and also taking into account the specifics of the AIS VDL and also the relationship to other aspects of the AIS VDL operation such as FATDMA configuration and Channel management. Hence, the AIS Service encapsulates these specifics and thus alleviates the DGNSS Correction Service of any such AIS-specific consideration.

In Appendix 16 the support of the AIS Service to the DGNSS Correction Service of the shore-based system architecture is described. Also the guidelines for DGNSS corrections broadcast via an AIS Service are discussed.

2.14.5 Channel management by an AIS Service

Appendix 17 provides an introduction to channel management and its fundamental definitions and concepts. Channel management requires very careful planning and the appendix provides general recommendations on how to implement channel management together with issues where caution is recommended.

2.14.6 VDL loading management by an AIS Service

Appendix 18 describes basic definitions and the impact of VDL loading. It also describes consideration for monitoring VDL loading, and potential mitigation measures to reduce the risk of overloading.

2.14.7 Satellite AIS considerations

In Appendix 19 the fundamental concepts related to Satellite detection of AIS are introduced, together with considerations of data quality and integration and use cases where satellite AIS may be beneficial.