Appendix Revisions

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**IALA Recommendation**

**ENAV-[###] - Appendix 4**

**Interaction and Data Storage Model**

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**Initial Version**

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

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IALA Recommendation ENAV-[####]

Appendix 4 - Interaction and Data Storage Model

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Appendix 4 -

**Interaction and Data Storage Model**

# Introduction to the Interaction and Data Storage Model

The Interaction and Data Storage Model addresses issues associated with the *distributed data storage entities* *within the components of a service* under consideration and the *associated data flow mechanisms within that service* between the different data storage entities, taking into account the distributed geographical topology.

Thereby the Interaction and Data Storage Model combine the concept of the Basic Services, the Structure Model and the Distribution Model. The two models, i.e. the Interaction Model and the Data Storage Model, can be introduced and described most efficiently together, i.e. in this Annex, although they represent two different angles of perspective on the service under consideration.

## Dynamic interactions within the service and the role of the functional components therein – the Interaction Model

So far, static aspects of the service have been considered. It is now necessary to introduce the mechanics of the internal working of the service. The *Interaction Model* addresses issues associated with the *data flow mechanism in a distributed service* setup.

There are three main reasons for introducing an Interaction Model:

* identify and generically describe the *complex dynamic interactions* between the various components of a service, taking into account their geographical distribution;
* provide a *framework for the functionality description of the main functional components of the service*, namely of the Physical Shore Station (PSS), the Logical Shore Station (LSS), and the Service Management (SM), *in terms of requirements stemming from their context amongst other components of the service*;
* provide *guidance to a competent authority for proper and responsible operation* of the components of the service at run-time, in particular when they have powerful features to control their Physical Links.

The functionality of the above service components would consist of the sum of *all* functions needed *to support all interaction scenarios* identified within the Interaction Model of the service, which in turn would be *derived from the Basic Services of the service*. Due to the variety of *Basic Service Categories*, different interaction scenarios need to be considered, one for each Basic Service Category.

To *reduce complexity further* regarding this variety an appropriate methodology is introduced below, which requires only some few additional common conceptional elements which are used throughout.

Specifically, on the level of Basic Services and service component use cases derived from those Basic Services, i.e. on application level and therefore not on protocol level of Machine-to-Machine interfaces,[[1]](#footnote-1) the Interaction Model deals with aspects like:

* generic mapping of different data flow mechanism to the topology of the relevant components of the service;
* generic data flow push/pull considerations between relevant components of the service;
* generic data flow acknowledgement mechanics between relevant components of the service;
* generic networking of data storage entities within the service – here is the close link to the Data Storage Model;
* generic identification of functional connections within the service.

## The Data Storage Model of the service

It is now necessary to consider the related aspects of internal data storage within the service.

The *Data Storage Model of the service* deals with storage entities of the service on an abstract level. It is relevant in particular due to the geographical distribution of its components. It deals with aspects like

* visibility of data objects on application level,
* age of data objects on application level,
* abstract rule bases for data processing in the service on application level (i.e. on Basic Service level), and
* replication of data objects due to geographical distribution of node sites within the Multiple-Node Service Distribution Configuration.

# The Interaction Model developed

The Interaction Model has been introduced in general in the above chapter. Here it is developed in a generic way.

## Interaction within the service under consideration – an Overview

Regarding the interaction of functional components of the service the most important functional components, i.e. service components, are:

* Logical Shore Station (LSS)
* Physical Shore Station (PSS)
* Physical Link Terminal Equipment (PLTE) as arranged in sectors
* Service Management (SM)

Reference is made to the description of the layered structure of the AIS service within the main document (compare in particular appropriate Figure in the Main Body of this Recommendation). A functional description of the LSS, PSS and ASM is given in **Annexes 9, 10 and 11** respectively.

Those are the relevant service components for the Interaction Model. Other relevant components of the service, besides the above service components, will be recognized in due course when addressing data storage issues.

Figure A4.1 shows *an example* of the resulting interactions in overview fashion, taking also in account the requesting service(s) of the shore-based e-Navigation system, and also the directly supported users. It should be noted, that Figure A4.1 for the purpose of an example highlights the multiple interactions between *instances* of the above service components. This reflects a practical situation because it is the instances of the service components which actually materialize the desired functionality.

Figure A4.1 also gives an impression of the emerging *multitude of diverse functional links required*. This in turn requires a supporting (both functional/virtual and physical) data transfer network with a *large degree of connectivity*, i.e. the capability to connect flexible, seamlessly and cost efficiently to a large number of components, such as could be achieved by employing internet technology (Internet Protocol (IP)-based technology; compare Annex 5 in this regard).



**Figure A4.1: Pictorial example of interactions within own service and with other services**

Within this Annex a method is developed which simplifies the mesh of functional links. This mesh is shown as an example of the interactions which arise as soon as the functional components are instantiated.

## General identification of interactions

This section describes the interactions within the service in general verbal terms. The interactions identified and explained in this section are already indicated tentatively by the arrows between the different layers of the service in the Structure Model (compare Figure 7 in main body of this Recommendation).

A specific individual service of the common shore-based e-Navigation system architecture will only have those interactions as required by the Basic Service Categories it uses.

Regarding the encoding of the data objects to be transferred by these interactions as well as for the protocol level for the Machine-to-Machine interfaces refer to Interfacing Model in Annex 5 for complete discussion.

### Interactions between Remote Shore Stations and Logical Shore Stations

The following interactions between the Remote Shore Stations (RSS) and the Logical Shore Stations (LSS) of the service under consideration have been identified:

* *From RSS to LSS:*
* The RSS receives signals or messages encoded in the format of the appropriate Physical Link from the appropriate Physical Link, processes them and sends the resulting data contents of the received signals or messages to the LSS as data sentences.
* The RSS may also generate data sentences carrying status data of various kinds and sends these data sentences to the LSS.
* *From LSS to RSS:* The RSS receives data sentences from the LSS for conversion into signals or messages encoded in the format of the appropriate Physical Link for transmission on the Physical Link.

### Interactions between Remote Shore Stations and the Service Management

The following interactions between the Remote Shore Stations (RSS) and the Service Management (SM) of the service under consideration have been identified:

* *From RSS to SM:*
* The RSS generates data sentences carrying alarm, warning and other data objects describing the status of the RSS itself, and sends these to the SM directly.
* There may also be some technical operation/management of the RSS from the SM which are not executed via data sentences to the RSS itself, but rather to the service-owned infrastructure components which carry the RSS (for example remote desktop, re-boot of servers, temperature control, etc.). The operation of the RSS is affected indirectly by these interactions.
* *From SM to RSS:*
* The RSS receives sentences generated by the SM for configuration, control and management of the RSS itself. These sentences are received directly from the SM.
* The RSS receives sentences generated by the SM, for conversion into appropriate signals or messages encoded in the format of the appropriate Physical Link, and for ultimate transmission on the appropriate Physical Link, e.g. for the purpose of the management of the features of the Physical Link. These sentences are received directly from the SM.

### Interactions between Logical Shore Stations and the Service Management

The following interactions between the Logical Shore Stations (LSS) and the Service Management (SM) of the service under consideration have been identified:

* *Actions initiated by the SM*, generally in response to input from the Technical Operation Personnel:
* Configuration of individual LSS instances
* Management of individual LSS instances
* Termination of individual LSS instances
* *Actions initiated automatically by the LSS instances:*
* Sending of status data sentences from LSS instances to SM
* Sending of warning/alarm data sentences from LSS instances to SM

### Interaction between LSS and LSS (instances)

There is ***no*** interaction between individual instances of LSS. All LSS instances access a common data storage section, however, the Internal Service-wide Data Storage (IDS).[[2]](#footnote-2)

### Resulting fundamental technical prerequisites

From the above considerations the following fundamental technical prerequisites can be deduced, which need to be fulfilled by proper planning (see the appropriate chapters and further Annexes):

* Each of the layers of the service requires a certain ***amount of processing capacity*** to ensure proper and timely interactions of the components involved. The competent authority should provide the needed processing capacity.
* The layered structure of the service does not expressively state transportation of data locally or over distances. ***Between each layer a transportation process is required, which is called “functional link”***.As introduced in the Distribution Model (**Annex 3**) there are the following functional links defined: LAN (local), WAN feeder link (remote), WAN backbone link (remote). In the following chapters, the ***term “remote” indicates, that either a WAN feeder link or a WAN backbone functional link*** will be required. ***Whenever the term “local” appears, the LAN functional link would suffice.***   
    
  The distances and capacity requirements of these functional links are totally dependent on local conditions. It is assumed, that the transportation processes, i.e. the functional links, do not constitute a bottleneck which determine the overall functionality. This can be achieved by standard modern technology even with high capacity needs.
* Between each layer there are ***functional interfaces***, which can be defined precisely. Regarding the encoding of the ***data sentences*** identified above, refer to Interfacing Model of the service in **Annex 5** for complete discussion.

# The Data Storage Model developed

## Data Storage Sections as a fulfilment of user requirements

The Data Storage Model is an important feature of a technical e-Navigation service. Its exclusive element is the definition and description of so-called *Data Storage Sections*, i.e. the Data Storage Model is exclusively build by using different Data Storage Sections. Data Storage Sections are entities in the abstract data object domain. They exist both as a class and as instances, each.

Like the Basic Services and the Data Model, the Data Storage Model with its Data Storage Sections can be *considered an engineering answer to the general request for a* *user-requirement driven system design*: It is the Data Storage Model with its Data Storage Sections which reflects the user-requirements regarding parameters associated with data storage, such as *age of data objects* and *data delivery latency*, in a *implementation independent* manner.

Data Storage Sections should *not* be confused with *data storage entities*, i.e. components which contain data storage that may contain a Data Storage Section in part or in total: If a data storage entity only contains a part of a Data Storage Section, the complete Data Storage Section can only be represented by the contributions of all relevant data storage entities.

## The Definition of the Data Storage Sections

### The context of the Data Storage Sections within the shore-based e-Navigation system architecture

Figure A4.2 shows the Data Storage Section concept tied to the top-down requirement analysis process of the shore-based e-Navigation system. Also, the relative visibilities of the resulting Data Storage Sections are highlighted.

  
**Figure A4.2: Relationship between the Data Storage Sections of the service and the top-down requirement analysis of the shore-based e-Navigation system**

In Figure A4.2 the following Data Storage Sections are defined:

* the *System-wide Data Storage (SDS)*
* the *Internal Service-wide Data Storage (IDS)*
* the *Centralized Data Storage (CDS)*
* the *Remote Data Storage (RDS)*
* the *Local Data Storage (LDS).*

The following Figure A4.3 shows the tree-diagram of the above Data Storage Sections, thus also giving the appropriate discriminators. The following sections will provide descriptions of these Data Storage Sections.



**Figure A4.3: Inheritance relationship between Data Storage Sections**

### Benefits of the Data Storage Section definition

The definition of these Data Storage Sections has the following benefits:

* *incorporation of data storage issues in service description* and *without need to consider technological details* of data storage technologies at this point – provides this description an *independency from the steady technology change* regarding data storage technologies;
* by the same token, description stays on *algorithmic or functional level* and stays clear off implementation issues;
* provides *easy-to-use terminology*, which *encapsulates the data storage technology* involved in an individual implementation;
* supports the *seamless derivation of functionality requirements for components* of the service under consideration from the top-down requirement analysis;
* incorporation of *functional links (LAN, WAN feeder link, WAN backbone link;* compare Distribution Model in **Annex 3**), though encapsulated in abstract terms.

### The context of the Data Storage Sections to the tasks of functional components of the service

The following Figure A4.4 highlights the data storage aspects of the service. It is consistent with the Figure 10 of the Main Body of this Recommendation in what it says, but goes into more detail.



**Figure A4.4: Data Storage Sections in their context within the service (derived from Figure 10 of Main Body of this Recommendation)**

### Common features of the Data Storage Sections

The following Figure A4.5 shows the common features of a Data Storage Section in use case terminology. Any Data Storage Section performs the following two main tasks:

* *acquisition and storage of data objects*
* *retrieve data objects from the data storage*

The Data Storage Section does ***not*** *change the stored data in any way*, neither in terms of content nor in terms of format.

It should be noted, that the entities “data source”, “data processing”, and “data sink” are different entities than the data storage: They perform specific operations in relationship to the data storage section as indicated in the Figure A4.5.



**Figure A4.5: Data source, data processing entity, and data sink in relationship to Data Storage Section**

It should be noted, that this abstract modelling is compatible with the (abstract) data modelling introduced in **Annex 2** on one hand, and thereby with the UMDM/UDOI concept, and allows for an abstract treatment of dynamic interface issues in the context of the interaction modelling, which will be finally resolved in **Annex 5**.

### Data Storage Sections at Node sites

Since the Node sites are the main features of any Service Distribution Configuration (compare Distribution Model, **Annex 3**), the Data Storage Sections are ***defined*** ***from a Node site’s perspective***. This section describes Data Storage Sections which reside in some appropriate IT component at the Node site(s).

#### The System-wide Data Storage (SDS) section

The System-wide Data Storage (SDS) is a Data Storage Section, which comprises ***any and all data storage entities of the common shore-based e-Navigation system architecture, which are directly accessible, hence “visible”, for any other technical e-Navigation service.***

While the SDS therefore is not a part of a single service alone, strictly speaking, every service of the shore-based e-Navigation system contributes to the SDS and benefits from the contributions of other services in turn. Hence, ***the SDS section describes the data exchange between the services of the shore-based e-Navigation system in abstract and data storage terms*** (compare Figure A4.6).



**Figure A4.6: The System-wide Data Storage (SDS) as the means for interaction of “own service” with the shore-based e-Navigation system**

By the same token, the SDS section is the ***only*** Data Storage Section “visible” to other services, in keeping with the encapsulation principle.

From the own service perspective, there are only two functional components which interact with other services, *i.e.* which interact with the SDS section: the Logical Shore Station (LSS) regarding net data and the Service Management (SM), the SM-Node agent (SM-Node) to be precise, regarding configuration and status of the own service as relevant for other requesting and requested services.

#### The Internal Service-wide Data Storage (IDS)

The Internal Service-wide Data Storage (IDS) section is accessible internally to the own service, hence ***“internal”***. This means, that the IDS cannot be accessed by other services.

The IDS is ***accessible*** by functional components of the own service ***from*** all sites where own service is present, hence ***“service-wide”***. Since the IDS is residing ***at*** the Node site(s) only, there are the following implications:

* The IDS is of particular importance for the Multiple-Node Service Distribution: “Service-wide” therefore means that the data stored in the IDS section is ***identically*** available at all Note sites of the own service ***simultaneously***. In order to achieve this, the IDS section contains some ***automated replication functionality***. This replication functionality is achieved ***transparently***, *i.e.* without any involvement of the functional components LSS and PSS. This replication functionality can be achieved by a dedicated functional component called ***“replicator”****.* In IT terms the “replicator” may be an intelligent switch or a computer with a distributed data base programmed accordingly.
* The functional sites other than the Node sites need to access the IDS ***via a WAN feeder link*** (Remote sites on different premise as Node site; regular case for Multiple-Node Service Configuration), or by a ***LAN*** (Remote site on same premise as Node site).

Figure A4.7 illustrates the IDS section within the context of an example Multiple-Node Service Configuration.



Note: The contribution of the SM-Node of the own service to the SDS not shown for simplicity’s sake.

**Figure A4.7: Example configuration of the IDS, the replication process and the interaction of the IDS with the SDS via the Logical Shore Station (LSS)**

The benefits of the abstract concept of the IDS section are:

* *conceptional separation of tasks:* functional data processing done in LSS and PSS separated conceptually from the task to overcome difficulties introduced by geographically distributed Nodes;
* *functional network greatly simplified:* The else required mesh of “direct” functional connections between every (!) LSS instance and every (!) RSS relevant to that LSS instance is now transformed into a simple multiple-star, backbone-supported functional link topology. This can be administered easily by both Service Management and the Technical Operation Personnel.
* *potentially data transfer capacity requirements reduced:* This holds true for the same reasons: The IDS “bundles” the functional links, thus beneficially employing the trade-off between WAN feeder link data transfer capacity and the capacity of the WAN backbone links.

It should be noted, that

* the IDS section also *efficiently supports the Service Management (SM) data distribution and data acquisition* by the transparent and automated replication functionality. This is particularly helpful for data objects issued by the SM and intended to be accessed “service-wide”, *i.e.* for the “hormones” of the own service.
* *the replication introduces a small amount of time latency for each replication hop*, depending on the actual IT used. This is rarely critical because replicated IDS data at “further off” Node sites will be used for strategic purposes (as opposed to tactical usage).
* *the LSS transform net data from the IDS section to the SDS section:* That is one important function of the LSS.
* *the IDS section conceptually does also exist for the two others Service Distribution configurations “Single-Node” and “One-Spot”*: In these cases the IDS section is reduced to one data storage entity (as opposed to a compound of replicators).

#### The Centralized Data Storage (CDS) section

The Centralized Data Storage (CDS) section stores data objects, which must or should ***only be stored at one Node site***. Those are data objects, *which must always be up-to-date* ***and*** *the integrity of which must not be potentially compromised by distributed storage sites.*

Examples are:

* master configuration and master status data objects which may be even highly critical;
* “hormones” issued to all functional components of the service via the IDS;
* tokens, which determine, that a certain functionality is only done at a given point in time by one functional entity;
* routing data objects for selecting the appropriate RSS for addressed transmission (in cases of services with Physical Layer and addressed interaction with mobiles).

The CDS section co-exists with and complements the IDS section.

Figure A4.8 illustrates the CDS in context by an example, where the CDS section is contained in the functional component of the SM-Master.



Note: This example shows the Concentrated Data Storage section regarding data relevant for the management of the own service, i.e. this example shows the CDS within the SM. The CDS can as well exchange data with the IDS within the LSS (not shown for simplicity’s sake).

**Figure 8: Example configuration of the CDS and its interaction with the IDS and RDS within the own service**

### Data Storage Sections at the Remote Shore Station (RSS) site(s)

Since the Data Storage Sections are ***defined*** ***from a Node site’s perspective***, this section describes Data Storage Sections which reside in some appropriate Information Technology (IT) ***at Remote sites***.

Figure A4.9 provides an overview by example (to be explained below).



**Figure A4.9: Local Data Storage (LDS) (lower part) and Remote Data Storage (RDS) (upper part) in relationship to Node site**

#### The Remote Data Storage (RDS) section

A Remote Data Storage (RDS) section is a Data Storage Section which resides at either a Remote Site (RS), a Technical Operation Personnel (TOP) site, and a Technical Development Personnel (TDP) site, which is truly *remote to a Node site, i.e. which is on a different premise than the Node site.*

Hence, data transfer from the RDS to the any other Data Storage Section within the own service (IDS, CDS) requires a WAN feeder link. Thus, *whenever RDS appears* in the following Interaction and Data Storage Model, *the issues associated with WAN feeder links need to be taken into account.*

A RDS does never directly connect to the SDS section because this would violate the encapsulation principle.

#### The Local Data Storage (LDS) section

The Local Data Storage (LDS) section is an RDS, which *“happens” to be on the same premise as the Node site because the Remote site happens to be co-located with the Node site*. This is a special case for the Multiple-Node and the One-Node Service Distribution configurations, but a feature of the One-Spot Service Distribution configuration by definition.

The LDS section *implies the use of (uncritical) LAN functional links* for data transfer, only.

## The combination of Interaction and Data Storage Model

In principle, the interaction and the data storage aspects of the service could be described separately. This approach would soon render a certain amount of *editorial* similarities which would give rise to the question to combine the two descriptions to achieve an even more efficient description.

In the following chapter, the Interaction and Data Storage Model is composed in accordance with the following rules:

* The BS Categories are used for efficient description – regularly only one description per BS Category.
* The interaction and the data storage is introduced in a top-down manner in three steps for each of the BS Category under consideration:

1. high level description of the Data Storage Sections and their interactions required (figure);
2. data flow between functional components introducing the time sequence of actions by the functional components (figure + table);
3. merging of results of steps 1 and 2 into one composite figure showing the data flow between Data Storage Sections (from step 1) which now have been assigned to individual functional components (from step 2).

# Interaction and Data Storage Considerations for External Basic Services

## Interaction and Data Storage Considerations BS Category E-1

### Data Storage Sections used

Received signals or messages from Physical Link(s) get into RDS respectively LDS. From there the net data are transferred via the IDS and SDS to the requesting service.



Figure A4.10: Data Storage sections used by the operation of BS Category E-1 (without ACK)

### Processing of received signals and broadcast messages

Cause: reception of signals or messages

Effect: single effect: net data is extracted from Physical link(s) and forwarded to requesting service



Figure A4.11: Processing of received signals or broadcast messages of BS Category E-1

**Essential data exchange steps between functional components involved**

|  |  |
| --- | --- |
| LSS | (1.1.1) reception of net data from PSS  (1.1.1.1) transfer of net data to requesting service |

|  |  |
| --- | --- |
| PSS | (1.1) reception of net data from the Physical Link Terminal Equipment  (1.1.1) transfer of net data to the LSS  (1.1.2) transfer of routing data to the SM (where needed) |

|  |  |
| --- | --- |
| PLTE | (1) reception of a message from the Physical Link(s)  (1.1) transfer of net data to the PSS |

|  |  |
| --- | --- |
| SM | (1.1.1) reception of routing data from the PSS |

### Distribution of Data Storage sections used in a Multi-Node site environment by BS Category E-1

Following Figure shows the distribution configuration of service components and Data Storage Sections to the different premises of the service and the interaction between the different Data Storage Sections.



Figure A4.12: Distribution of Data Storage Sections used in a Multiple Node Service Configuration for BS Category E-1

## Interaction and Data Storage Considerations BS Category E-2

### Data Storage Sections used by BS Category E-2

BS Category E-2 transfer data from the requesting service via the service under consideration to the Physical Link(s).



Figure A4.13: Data Storage Sections used by BS Category E-2

### Processing of signal(s) or message(s) of BS Category E-2

Cause: reception of data from requesting service to be sent to the Physical Link(s)

Effect: single effect: requesting service -> Physical Link(s)



Figure A4.14: Processing of BS Category E-2

**Essential data exchange steps between functional components involved**

|  |  |
| --- | --- |
| LSS | (1.) reception of net data from requesting service  (1.1.1) request for routing data to SM  (1.1.3) reception of routing data from SM  (1.2) transfer of net data to PSS |

|  |  |
| --- | --- |
| PSS | (1.2) reception of net data from LSS instance  (1.2.2) transfer of PLTE sentences from PSS to PLTE |

|  |  |
| --- | --- |
| PLTE | (1.2.2) reception PLTE sentences from PSS  (1.2.2.1) send net data to the Physical Link(s) |

|  |  |
| --- | --- |
| SM | (1.1.1) reception of request for routing data from LSS instance  (1.1.3) transfer of routing data to LSS instance |

### Distribution of Data Storage Sections used in a Multi-Node Site Environment by BS Category E-2

Following Figure shows the Distribution Configuration of service components and Data Storage Sections to the different premises of the service and the interaction between the different Data Storage Sections.



Figure A4.15: Data Storage Sections used in a Multiple Node Service Configuration for BS Category E-2

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## Interaction and Data Storage Considerations for E-BS Cat. E-3

Two subtypes:

--- ATON-Dat => without Token-handling (no CDS required)

--- ASGN\_x => with Token-Handling (CDS involved)

### Data Storage sections used by the operation of BAS Category E-3 ATON\_DAT

#### Data Storage sections used by the operation of BAS Category E-3 ATON\_DAT

The following figure shows the data exchange and Data Storage sections used by the operation of BAS Category E-3 ATON\_DAT.



Figure 24: Data Storage sections used by the operation of BAS Category E-3 ATON\_DAT

#### Processing of BAS Category E-3 ATON\_DAT initiated by a requesting e-Navigation service



Figure 25: Processing of BAS Category E-3 ATON\_DAT

**Component related description of essential operation sequences:**

|  |  |
| --- | --- |
| LSS | 1.) reception of net data from requesting e-Navigation service  (1.1) transfer of acknowledgement of receipt to requesting service  (1.1.1) request for routing data to ASM  (1.1.2) reception of acknowledgement of receipt from ASM  (1.1.3) reception of routing data from ASM  (1.1.4) transfer of acknowledgement of receipt to ASM  *repeat in time interval tLSS1:*  (2) transfer of net data to PSS  (2.1) reception of acknowledgement of receipt from PSS  *repeat in time interval tPSS2:*  (4) reception of status report from PSS  (4.1) transfer of acknowledgement of receipt to PSS  *repeat in time interval tLSS2:*  (5) reception of status report to requesting e-Navigation service  (5.1) reception of acknowledgement of receipt from requesting e-Navigation service |

|  |  |
| --- | --- |
| PSS | *repeat in time interval tLSS1:*  (2) reception of net data from LSS instance  (2.1) ) transfer of acknowledgement of receipt to LSS instance  *repeat in time interval tPSS1:*  (3) transfer of TSA and VDM sentences 21 to AIS Base station  (3.1.1) reception of TFR and VDO sentences 21 from AIS Base station  *repeat in time interval tPSS2:*  (4) transfer of status report to LSS instance  (4.1) reception of acknowledgement of receipt from LSS instance |

|  |  |
| --- | --- |
| AIS Base station | *repeat in time interval tPSS1:*  (3) receive of TSA and VDM sentences 21 from PSS  (3.1) transmit VDL message 21 on VDL  (3.1.1) transfer of TFR and VDO sentences 21 to PSS |

|  |  |
| --- | --- |
| ASM | (1.1.1) reception of request for routing data from LSS instance  (1.1.2) transfer of acknowledgement of receipt to LSS instance  (1.1.3) transfer of routing data to LSS instance  (1.1.4) reception of acknowledgement of receipt from LSS instance |

|  |  |  |
| --- | --- | --- |
| **Name of BAS** | **VDL message (net data)** | **Acknowledgement**  **VDL -> AIS Base Station** |
| ATON\_DAT  (transmit) | 21 | - |

### Data Storage sections used by the operation of BAS Category E-3 ASGN\_RATE / ASGN\_SLOT

The data exchange for BAS Category E-3 ASGN\_RATE / ASGN\_SLOT is:

Initiation, token request and token assignment, acknowledgement of receipt and status report.

During the autonomous and continuous operation of the BAS status reports and acknowledgements are transferred between the Data Storage sections of the service components concerned as well as to the requesting e-Navigation service.

#### Data Storage sections used by the operation of BAS Category E-3 ASGN\_RTE / ASGN\_SLOT

The following figure shows the data exchange and Data Storage sections used by the operation of BAS Category E-3 ASGN\_RTE / ASGN\_SLOT



Figure 26: Data Storage sections used by the operation of BAS Category E-3 ASGN\_RATE / ASGN\_SLOT

#### Processing of BAS Category E-3 ASGN\_RATE and ASGN\_SLOT



Figure 27: Processing of BAS Category E-3 ASGN\_RATE and ASGN\_SLOT

**Component related description of essential operation sequences:**

|  |  |
| --- | --- |
| LSS | (1) reception of net data from requesting e-Navigation service  (1.1) transfer of acknowledgement of receipt to requesting service  (1.2) request for token to ASM  (1.2.1) reception of acknowledgement of receipt from ASM  (1.2.2) reception of token from ASM  (1.2.2.1) transfer authorisation (received token) to requesting e-Navigation service  (1.3) request for routing data to ASM  (1.3.1) reception of acknowledgement of receipt from ASM  (1.3.2) reception of routing data from ASM  (1.3.3) transfer of acknowledgement of receipt to ASM  *repeat in time interval tLSS1:*  (2) transfer of net data to PSS  (2.1) reception of acknowledgement of receipt from PSS  *repeat in time interval tPSS2:*  (5) reception of status report from PSS  (5.1) transfer of acknowledgement of receipt to PSS  *repeat in time interval tLSS2:*  (6) reception of status report to requesting e-Navigation service  (6.1) reception of acknowledgement of receipt from requesting e-Navigation service |

|  |  |
| --- | --- |
| PSS | *repeat in time interval tLSS1:*  (2) reception of net data from LSS instance  (2.1) ) transfer of acknowledgement of receipt to LSS instance  *repeat in time interval tPSS1:*  (3) transfer of TSA and VDM sentences 16 to AIS Base Station  (3.1.1) reception of TFR and VDO sentences 16 from AIS Base station  *repeat in time interval tMG1:*  (4.1) reception of VDM sentences 2 from AIS Base station  *repeat in time interval tPSS2:*  (5) transfer of status report to LSS instance  (5.1) reception of acknowledgement of receipt from LSS instance |

|  |  |
| --- | --- |
| AIS Base station | *repeat in time interval tPSS1:*  (3) receive of TSA and VDM sentences 16 from PSS  (3.1) transmit VDL message 16 on VDL  (3.1.1) transfer of TFR and VDO sentences 16 to PSS  *repeat in time interval tMG1:*  (4) reception of VDL message 2 from to VDL  (4.1) transfer of VDO sentences 2 to PSS |

|  |  |
| --- | --- |
| ASM | (1.2) reception of request for token from LSS instance  (1.2.1) transfer of acknowledgement of receipt to LSS instance  (1.2.2) transfer of token to LSS instance  (1.3) reception of request for routing data from LSS instance  (1.3.1) transfer of acknowledgement of receipt to LSS instance  (1.3.2) transfer of routing data to LSS instance  (1.3.3) reception of acknowledgement of receipt to LSS instance |
|  |  |

|  |  |  |
| --- | --- | --- |
| **Name of BAS** | **VDL message (net data)** | **Acknowledgement**  **VDL -> AIS Base Station PSS** |
| ASGN\_SLOT  (transmit) | 16 | VDM sentence 2 |
| ASGN\_RATE  (transmit) | 16 | VDM sentence 2 |

### Distribution of Data Storage sections used in a multi node site environment by the operation of BAS Category E-3

Following Figure shows the distribution configuration of service components and data storage sections to the different premises of the AIS Service and the interaction between the different data storage sections



Figure 28: Distribution of Data Storage sections used in a Multiple Node AIS Service Configuration by the operation of BAS Category E-3

## Interaction and Data Storage Considerations for E-BS Cat. E-4

### Data Storage sections used by the operation of BAS Category E-4

The data exchange for BAS Category E-4 is basically a request for data at the concentrated data storage (CDS). The net data are transferred via the LDS and SDS to the requesting e-Navigation service. Acknowledgements take place.



Figure 30 Data Storage sections used by the operation of BAS Category E-4

### Processing of BAS Category E-4 CH\_MON (primary) initiated by a requesting e-Navigation service

Cause: initiation by requesting e-Navigation service

Effect: autonomous and continuous operation

Information flow LSS -> requesting e-Navigation service

The BAS CH\_MON monitors the AIS VDL and provides the CH\_MON status report to the requesting e-Navigation service.



Figure 31: Processing of BAS Category E-4 CH\_MON

**Component related description of essential operation sequences:**

|  |  |
| --- | --- |
| LSS | (1) reception of initiation of CH\_MON from requesting e-Navigation service  (1.1) transfer of acknowledgement of receipt to requesting service  (1.2) request of CH\_MON status data to ASM  (1.2.1) reception of acknowledgement of receipt from ASM  *repeat in time interval tASM1:*  (1.2.2) reception of CH\_MON status data from ASM  (1.2.2.1) transfer of acknowledgement of receipt to ASM  *repeat in time interval tLSS1:*  (1.3) transfer CH\_MON status information to requesting e-Navigation service  (1.3.1) reception of acknowledgement of receipt from requesting service |

|  |  |
| --- | --- |
| PSS | - |

|  |  |
| --- | --- |
| AIS Base Station | *-* |

|  |  |
| --- | --- |
| ASM | (1.2) reception of request for CH\_MON status from LSS instance  (1.2.1) transfer of acknowledgement of receipt to LSS instance  *repeat in time interval tASM1:*  (1.2.2) transfer of CH\_MON status information to LSS instance  (1.2.2.1) reception of acknowledgement of receipt from LSS |

### Processing of BAS Category E-4 MOB\_PROFILE (primary)

Cause: reception of request for profile data from requesting e-Navigation service

Effect: Information flow single occurrence LSS -> requesting e-Navigation service

The BAS MOB\_PROFILE ascertains a profile of characteristics and features of AIS mobile stations and connected board equipment and provides the profile to the requesting e-Navigation service.



Figure 32: Processing of BAS Category E-4 MOB\_PROFILE

**Component related description of essential operation sequences:**

|  |  |
| --- | --- |
| LSS | (1) reception of request for MOB\_PROFILE data from requesting e-Navigation service  (1.1) transfer of acknowledgement of receipt to requesting service  (1.2) transfer request MOB\_PROFILE date to ASM  (1.2.1) reception of acknowledgement of receipt from ASM  (1.2.2) receive MOB\_PROFILE date from ASM  (1.2.2.1) reception of acknowledgement of receipt to ASM  (1.3) transfer request MOB\_PROFILE date to requesting e-Navigation service  (1.3.1) reception of acknowledgement of receipt from requesting e-Navigation service |

|  |  |
| --- | --- |
| PSS | - |

|  |  |
| --- | --- |
| AIS Base Station | *-* |

|  |  |
| --- | --- |
| ASM | (1.2) reception of request for MOB\_PROFILE data from LSS instance  (1.2.1) transfer of acknowledgement of receipt to LSS instance  (1.2.2) transfer request MOB\_PROFILE date to LLS instance  (1.2.2.1) reception of acknowledgement of receipt from LSS instance |

### Distribution of Data Storage sections used in a multi node site environment by the operation of BAS Category E-4

Following Figure shows the distribution configuration of service components and data storage sections to the different premises of the AIS Service and the interaction between the different data storage sections



Note: two different premises configuration shown in this example.

**Figure 33: Distribution of Data Storage sections used in a multi node site environment by the operation of BAS Category E-4**

# Interaction and Data Storage Considerations for Internal Basic Services

--- in accordance with I-BS-Categories E-1 to E-7

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-1

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-2

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-3

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-4

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-5

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-6

--- take materials from A-124, Annex 4, and generalize it

## Interaction and Data Storage Considerations for I-BS Cat. I-7

--- take materials from A-124, Annex 4, and generalize it

1. For a discussion of the protocol level refer to the Interfacing Model (**Annex 5**). [↑](#footnote-ref-1)
2. The Internal Service-wide Data Storage (IDS) will be explained in the following Data Storage Model description. The IDS is in operation to exchange data within the Logical Layer *service-wide*. Hence the name. The IDS is part of the Logical Layer to which also the LSS instances belong. The IDS is *transparent* to the net data flow, though. It serves to *replicate the relevant data throughout a coastal-wide distributed topology transparently*. Therefore, it can be neglected for the purpose of this overview. [↑](#footnote-ref-2)