Appendix Revisions

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**IALA Recommendation**

**ENAV-[###] - Appendix 3**

**Service Distribution Model**

**[Working Towards] Edition 1**

**[2015]**

**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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| **Date** | **Page / Section Revised** | **Requirement for Revision** |
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Appendix 3 -

**Service Distribution Model**

# Functional building blocks for the distribution configurations

When modeling the distribution of a service, the following *functional* building blocks for any distribution configuration are used. They are *useful definitions* on a functional level, hence *are abstracted from the concrete physical instances*.

Their *big advantage* is, that only on this level of abstraction *the massive load of technical detail,* that the service-specific technology and the “sciences” of infrastructure and data transfer technologies tend to provide, *can be avoided* (which otherwise would clutter up the consideration unnecessarily). Only on this level the *more advanced life cycle management concepts* for services and components can be *tied in* *without cluttering the picture*. Also, the functional site definitions proved useful when making *management decisions* and when assessing their potential results.

These functional site definitions comply with object orientation and the service oriented architecture of the shore-based e-Navigation system.

Note: When explaining the functional site definitions it is useful to forward point to the appropriate Service distribution model definitions by means of example although they will only consecutively be defined.

## Functional site definitions

When modeling a service under consideration regarding its distribution aspects, it proved useful to distinguish between the following *functional* sites:

### Remote Site

* Remote Sites are *only* populated by services with a Physical Layer.
* The Remote Site is where a *Remote Shore Station (RSS) of* ***any*** *of the services of the shore-based system* is set up physically.
* *At* the Remote Site the *instances of the Physical Layer of the service under consideration* are materialized, *together* *with the agents of the Service Management to the Remote Shore Station*.
* As the name implies, the Remote Site is close to the waterway or even sitting in the waterway in order to receive / transmit the signals-in-air or to perform sensory data acquisition. (Note: The Remote Site may not be such “remote” in the case of the One-Spot Service configuration or in some cases of even the Multi-Node Service configuration; see below.)
* Therefore, the required on-site infrastructure is determined mainly by the potentially rough environmental conditions on one hand and by the site’s characteristic as a radio or sensor site with data pre-processing capabilities on the other hand. Also energy supply and protection against various physical and human influences are required. In some cases, a fixed time normal may be required for timing/synchronisation purposes.
* At Remote Sites, the on-site infrastructure is often shared with co-located Remote Shore Stations of other services with a Physical Layer.

### Node or Node Site

* All services of the common shore-based system architecture populate at least one Node Site.
* The Node Site is where the instances of the *Logical Shore Stations* are set up, together with components of the *Service Management* and other supportive components and/or functionalities of the service-owned infrastructure (such as data storage, data replication).
* The idea of a Node is to bundle all functionality (and thereby also the physical components carrying that functionality) in a *minimum number of Nodes* of one administration’s deployment of the service under consideration. This is a strong requirement *from a shore-based system management perspective (operation and maintenance costs!)*.
* All functionality which is *not* rigidly necessary at the Remote Site from a *topology* point of view *may* be concentrated at the Node. There is the option not to bundle all of this kind of functionality, if good reasons are opposed to it. But from a system optimization point of view, the *default is concentration of geographically volatile functionality* *at the Node.*
* Hence, by its very definition the Logical Layer of a service is represented at Nodes, *only*.
* By the same token, the Physical Layer of any service is not represented at Nodes from a functional point of view, *never*.
* Data transfer between the service under consideration and other services of the shore-based e-Navigation system takes place at the Node, and at a Node *only* (service encapsulation principle of the shore-based e-Navigation system architecture applies). This has the following consequences:
* At the Nodes, the required Basic Services of the service under consideration are provided to other services of the shore-based e-Navigation system as a data transfer between one instance of a Logical Shore Station (LSS) of the service under consideration and one appropriate logical interface of the other service *at the same Node*.
* Therefore, the data transfer between other services and the service under consideration is *always* local, i.e. is done using local functional connections between the components involved. Physically, the data transfer uses Local Area Network (LAN) technology.
* *Note 1:* A Remote Site may be co-located at the same premises or within the same physical shelter or physical housing where there is a Node. However, conceptually-wise Remote Site and Node Site remain two distinct functional sites.
* *Note 2:* There is an option for an alternative functionality-to-functional site allocation regarding the Physical Shore Station (PSS)–not the whole Physical Layer, though–, if certain conditions are met. This option will be elaborated in some more detail below.

### Technical Operation Personnel Site – TOP Sites

* This is where Human Machine Interfaces (HMI) are provided by the service under consideration to the Technical Operation Personnel *at their workplaces* as defined by the management of the organization. (The criterion of a defined workplace (even mobile) is important, because there may be Human Machine Interfaces at other functional sites provided by machines to the Technical Operation Personnel for only short-time/quick interaction with the machines.)
* The Technical Operation Personnel keeps the service components running, does their run-time configuration and repairs defective on-site components. It hasn’t got the license to change structure and / or functionality of the service, though.
* The Human Machine Interfaces (HMI) provided by the service at the Technical Operation Personnel Site(s) support(s) these tasks in accordance with role profiles.
* There are local technical operation tasks and coastal-wide technical operation tasks, in particular the tasks which are associated with the so-called master functionality of the Service Management.
* There are functional connections between TOP Sites and Remote Sites and between TOP Sites and Node Sites.

### Technical Development Personnel site – TDP site

* Similar to TOP Sites, but the Technical Development Personnel has the license to change structure and / or functionality of the service under consideration.
* Hence, the TDP site is where Human Machine Interfaces (HMI) is provided by the service to the Technical Development Personnel, which would allow them to perform their tasks. One important task is e. g. to download new software releases.
* Again, there is the distinction between different roles/tasks of different levels of Technical Development Personnel Sites.
* There may be a *Master Technical Development Personnel Site* for a coastal-wide distributed service. In fact, from a shore-based system management point of view, this would be the default.
* Also, at the Master Technical Development Personnel Site, a reference system for the service under consideration could be provided, which would allow extensive testing before a new software version release is introduced, or which would allow investigation into enhanced capabilities of the service.

### User Sites

There is a further functional site definition within the generic shore-based e-Navigation distribution model, *i.e.* the “**User Site”**.

* This is where the data between the shore-based e-Navigation system, of which the service under consideration is a part, and the operational end user is presented by means of a Human Machine Interface (HMI).
* VTS Centres are examples of (sometimes sophisticated) User Sites.
* Within the common shore-based e-Navigation system framework, it is *only* the User Interaction Service (UIA), which populates the User Sites with its Human Machine Interfaces (HMI).
* User Sites are often co-located with Node Sites.

### Distribution of Service Management components

The *Service Management* is – by its very nature – represented at all functional sites where the service under consideration is present, but special management functionality of the Service Management resides in the Node Site(s), too. For example the so-called *Service Management Master (SM-Master)* functionality resides in one Node Site out of many (at the Multi-Node Service configuration), only.

## Shore-based data transfer network considerations

### Functional and physical shore-based data transfer network considerations

There are two levels of data transfer network considerations:

* *Functional shore-based data transfer connection between functional sites:* abstracted from physical detail; shows functional data transfer attributes only, i.e. data volume, transfer bandwidth requirements, security attributes etc. How these capabilities are achieved (i.e. by what data transfer technology) is only relevant as far as the actual data transfer technology impacts certain functional data transfer attributes.
* *physical shore-based data transfer means of whatever kind:* here the functional shore-based data transfer connections are translated into concrete technological designs.

Obviously, the functional shore-based data transfer connections between the above sites are the relevant level of consideration when defining the Distribution Model of the service under consideration. Only on this level of abstraction the massive load of technical detail, the physical shore-based data transfer means tend to provide, can be avoided (which otherwise would clutter up the consideration unnecessarily). Also, only on this level of abstraction can there be achieved a solution which is more stable over a long period of time when there is a high succession rate of different physical data transfer technologies involved.

### Wide-area data transfer network (WAN) considerations

When data is to be exchanged between two different functional sites, which are *geographically distinctly separated*, wide-area data transfer network considerations are necessary. This is always the case in the One-Node or the Multiple-Node Service Configurations, never in the One-Spot Service Configuration.

On the functional level, there can be discerned to functionally distinct data transfer connections:

* *Wide Area Network (WAN) feeder links:*
* between a Remote Site and a Node Site
* between a Technical Operation Personnel Site and a Node Site
* between a Technical Development Personnel Site and a Node Site
* between a User Site and a Node Site
* *Coastal WAN-Backbone links:* between Node Sites exclusively.

These functional shore-based data transfer connections between functional sites should be construed as the topology-dependent requirements for the *Shore-Based Wide Area Network Service (SBN)* of the common shore-based e-Navigation system, which fulfils these requirements by providing physical connections.

### Local-area data transfer network (LAN) considerations

Data transfer within components of the same functional site *or* between different functional sites *on the same premise* (i.e. different co-located functional sites) is done by local area data transfer network(s) (LAN). LAN(s) is/are treated as part of the infrastructure “owned” by the service under consideration at the site (so called service-owned infrastructure as opposed to on-site infrastructure, which may be shared with other co-located services).

## Resulting distribution configurations for the common shore-based e-Navigation system

By correlation of the various services defined in the system layout of the common shore-based e-Navigation system layout (IALA Recommendation e-NAV 201 refers; [0.2]) with the above definitions of the functional sites, there can be derived a generic description of geographical topology influence on a service for all groups of services (compare following figure).Note: The Technical Development Personnel Site(s) are not shown for simplicity’s sake. They are introduced in a similar way to the Technical Operation Personnel Site(s). Also, only sample functional connections between Technical Operation Personnel Sites and other sites are shown.

**Figure A3.1: Generic geographic distribution setup of a shore-based e-Nav system using the functional site definitions**

# Generic Service Distribution Configurations

Using the above functional site definitions, several Service Distribution Configurations can be defined:

* the Multiple-Node Service Distribution Configuration
* the One-Node Service Distribution Configuration
* the One-Spot Service Distribution Configuration

They are described in the following sections.

Note: There are *no* other possible Service Distribution Configurations. Hence, the above list is exhaustive.

## Multiple-Node Service Distribution Configuration

The Multiple-Node Service Distribution Configuration is characterized topologically by at least two Node sites and – in the case of a service with a Physical Layer - some Remote Sites. All Remote Shore Stations (RSS) of the service under consideration residing at the Remote Sites are connected to the Node Sites populated by the service under consideration by using WAN feeder links (multiple star configuration). In addition *all* Node Sites populated by the service under consideration are connected by WAN backbone links. This is necessary e. g. for master control of the service under consideration and for data replication. It is recommended that all Node Sites populated by the service under consideration are connected with all other Nodes Sites populated by the service.

Typically, even in geographically large Multiple-Node Service Distribution Configurations there are only two or three Node Sites populated or required. The following figure shows one typical configuration with three Node Sites populated by the service under consideration.

**Figure A3.2: Multiple-Node Service Distribution Configuration**

Features of the Multiple-Node Service Distribution Configuration are:

* *Coverage Area:* The Multiple-Node Service Distribution Configuration supports a *large* number of RSS providing a *very large* coverage area of the service. Also, physical link-specific redundancy and mitigation of unwanted effects become possible for services with Physical Layer due to dual or multiple coverage.
* *Integration aspects:* Simplest integration into shore-based e-Navigation system architectures: just one connection between service under consideration and other e-Navigation services required, which may reside at the very same Node.
* *Receive- and Transmit-Configuration Setup:* receive/transmit functionalities distribution to different Remote Shore Stations possible
* *Site-infrastructure requirements:* several Node site and several Remote Sites need to be equipped and maintained.
* *Bearing on data transfer requirements:* The data transfer network consists of Local Area Network(s) (LAN) at each of the sites populated and several functional connection (WAN feeder link) networks generally with star-configurations; there may be priority and fallback-arrangements regarding the Node site, to which a Remote Shore Station (RSS) is assigned on a primary and on a secondary level; in addition a network of functional connections between Node sites (WAN backbone links) is required.
* *Node geographical redundancy:* Node site redundancy provided functionality and capacity design has taken into account a run-time switch-over of functionality between Node sites: Hence, the Multiple-Node Service Distribution Configuration mitigates the risk of complete failure of the service under consideration, if and when the premises where the Node site resides should be completely unavailable, e.g. by a major catastrophic event. Thereby, the Multiple-Node Service Distribution Configuration also provides a better starting point for any recovery after disaster hitting one Node than any of the other Service Distribution Configurations.
* *Organizational aspects:* Multiple Nodes in multiple regions may support regional organizational structures of an administration; this may be particularly relevant when the administration already has existing distributed Technical Operation Personnel sites in place.

The Multiple-Node Service Distribution Configuration would best serve administrations,

* whose area of responsibility and/or interest is *geographical large* and/or
* where *a concave coastal topology would require more than one Node anyway*, in particular when considering costs associated to the WAN feeder links as opposed to the costs associated with WAN backbone links – this is particularly relevant for a service with a Physical Layer –, and/or
* where *centralization of all geographically volatile functionality into one Node is not desirable* due to redundancy reasons, regardless of the additional costs associated with this redundancy.

Cautionary note:

* For redundancy reasons, in the Multiple-Node distribution model there is the option to duplicate the *Service Management Master functionality* to two (or even more) Nodes. In this case, however, only one SM Master functionality must be active at any point in time.

## One-Node Service Distribution Configuration

The One-Node Service Distribution Configuration is characterized topologically by one Node site and at least one Remote Site, generally more than one Remote Sites. All Remote Shore Stations (RSS) of the service under consideration residing at the Remote Sites are connected to the one Node by WAN feeder links (star configuration).

The following figure shows this configuration.

**Figure A3.3: One-Node Service Distribution Configuration**

Features of the One-Node Service Distribution Configuration are:

* *Coverage area:* The One-Node Service Distribution Configuration supports a *limited* number of RSS. Physical link-specific redundancy and mitigation of unwanted effects become possible for services with Physical Layer due to dual or multiple coverage.
* *Integration aspects:* Simplest integration into shore-based e-Navigation system architectures: just one connection between service under consideration and other e-Navigation services required, which also resides at the same Node.
* *Receive- and Transmit-Configuration Setup:* receive/transmit functionalities distribution to different Remote Shore Stations possible (relevant for services with Physical Layer only)
* *Site-infrastructure requirements:* one Node site and several Remote Sites need to be equipped and maintained.
* *Bearing on data transfer requirements:* The data transfer network consists of Local Area Network(s) (LAN) at each of the sites populated and a functional connection (WAN feeder link) network with a star-configuration.
* *Node geographical redundancy:* to have only one Node site constitutes a risk for the operation of the whole of the service under consideration if and when the premises where the Node site resides should be completely unavailable, e.g. by a major catastrophic event. This missing geographical redundancy is the most important argument to prefer a Multiple-Node Service Distribution Configuration (see above).
* *Organizational aspects:* one Node may support centralized organizational structures of an administration; this may be particularly relevant when the administration already has existing centralized Technical Operation Personnel sites in place.

The One-Node Service Distribution Configuration would best serve administrations,

* whose area of responsibility and/or interest is *confined to a limited geographical area* or
* where *a convex coastal topology renders the One-Node Service Distribution the most economically feasible solution*, in particular when considering costs related to the WAN feeder links – this is particularly relevant for a service with a Physical Layer –, or
* where *centralization of all geographically volatile functionality into one Node is desired* for whatever reason regardless of the coastal topology.

## One-Spot Service Distribution Configuration

The One-Spot Service Distribution Configuration is the simplest service “distribution” configuration: The Remote Shore Station (for a service with Physical Layer), the functionalities of the Logical Layer and the functionalities of the Service Management are co-located on just *one* premise. Hence, also all technical operation, maintenance and further development would be done at this one premise.

The following figure shows this configuration.



**Figure A3.4: One-Spot Service Distribution Configuration**

Features of the One-Spot Service Distribution Configuration are:

* *Site-infrastructure requirements:* one site needs to be equipped and maintained.
* *Bearing on data transfer requirements:* The data transfer network is exclusively local.
* Minimum of components needed, i.e. it is possible to run software functionalities of the PSS (in case of a service with Physical Layer), LSS, and the SM in the same computer.
* *Integration aspects:* The whole shore-based e-Navigation system resides on the very same one spot. Just one local connection between service under consideration and other e-Navigation services required, which also resides at the same spot. Hence, “integration” is achieved by default.
* *Coverage area:* Limited coverage area depending on the physical properties of the on-site Remote Shore Station (RSS), in the case of a service with a Physical Layer;
* Limited technology-specific *redundancy* (no dual coverage possible by definition)
* *Receive- and Transmit-Configuration Setup (for service with Physical Layer):* receive/transmit functionalities done on same site, which may impose limitations

The One-Spot Service Distribution Configuration would best serve administrations, whose area of responsibility and/or interest is *confined to one geographical premise*, only. As a further development potential, the same administration could set up *several* independent services of the *same* kind with One-Spot Service Distribution Configurations *each*, at *several* distinct premises of interest *with considerable geographical separation*. Hence, the One-Spot Service Distribution Configuration may serve administrations in geographically large countries with only one or few geographically distinctly separated ports, which do not require coastal-wide coverage.

This renders two principal cases of application for One-Spot Service Distribution Configuration:

* *case 1:* *national* competent authority interested in individually confined geographical coverage area(s) within a vast geographical topology, only.
* *case 2:* *localized* competent authority operating under the regulation of a national competent authority.

## Selecting an appropriate Service Distribution Configuration

Three different Service Distributions Configurations were introduced in the previous sections. This section summarizes these sections by *introducing criteria-based recommendation for proper selecting the appropriate Service Distribution Configuration*.

***Cautionary note:*** The following criteria-based recommendations were created as guidance in particular for those management situations where there is still margin to freely choose the number of Node sites and their locations. ***Since the determination of the number and the location of the Node sites is a powerful management tool for higher management of a competent authority in the context of the shore-based e-Navigation system architecture,*** the ***Node site configuration may have been pre-determined*** ***by a higher management decision***, from the overall management perspective regarding the shore-based e-Navigation system of that competent authority. In that case the following table *indicates the potential consequences* of that higher management decision for the Distribution Configuration of the service under consideration of that competent authority.

Hence, for the above and for additional reasons as explained below, the Table on the following page can be read in different directions, all of which render useful data. Regarding the criteria given in the Table the following *explanations* should be considered:

* ***Node site redundancy requirement:*** This criterion is independent of any other of the criteria given, and has an overruling effect. Should this criterion be fulfilled, the One-Spot and the One-Node Service Distribution Configurations are *not* feasible any more, and the table content for the Multi-Node Service Distribution Configuration is relevant, only. This criterion is relevant for *all* services *with or without* Physical Layers.
* ***Resulting Number of Remote Shore Stations:***This criterion is only relevant for a service with a Physical Layer. In this case this column provides an entry point into the Table for those competent authorities, where the planning for Remote Shore Station (RSS) locations has been finalized already. The Table would allow for double-checking the results of that RSS planning in terms of the consequences for the service under consideration. Also the Table provides guidance when the Node site arrangement has not yet been finalized.
* ***Potential for cellular concepts and their associated advantages:***At least one cell is formed around one RSS. The advantages of cellular concepts are in particular
* (1) the localization of interaction with the Physical Link while serving a (much) larger nominal coverage area and
* (2) the dual insight into the same local coverage area from different RSS of the service under consideration with different geometrical angles of perspective. The advantages of (2) are, amongst others:
  + coverage redundancy,
  + garbling mitigation,
  + separation of receive/transmit RSS,
  + dynamic re-allocation of receive/transmit RSS,
  + capability for signal in space pooling from different RSS of the service under consideration.

The importance of the capability for cellular concepts is technology-specific, of course.

**Table A3.1: Criteria and Recommendation for selecting an appropriate Service Distribution Contribution**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Recommen-**  **dation** | **Criteria related to** | | | | |
| **Coverage area characteristics (\*)** | | **Potential for cellular concepts and their associated advantages (\*)** | **Recommended for resulting No of RSS (\*); (1)** | **Site diversity required for Node site**  **(Node site redundancy)** |
| **Total size**  (in relationship to coverage area of individual RSS) | **Distinct and separate sea areas to be covered** |
| **Multiple-Node** Service Distribution Configuration | Very large (e.g. large countries) | Most likely / recommended | Capable / possible | *many* *more* than a dozen (12) Remote Shore Stations (RSS) | Possible |
| **One-Node** Service Distribution Configuration | Intermediate to large (e.g. “small” countries) | Possible / recommended only for smaller countries | Capable / possible | *Up to* ca. a dozen (12) Remote Shore Stations (RSS) | *Not possible* |
| **One-Spot** Service Distribution Configuration | Small  (e.g. port area) | *Not possible* | *Not possible* | *One (1)* Remote Shore Station (RSS) | *Not possible* |

***Note (\*):*** relevant for service with Physical Layer which interacts with a Physical Link external to the shore-based e-Navigation system.

***Note 1:*** The figure “dozen (12)” indicates that this figure is meant to indicate the order of the number of RSS. Hence, the range of e.g. 10-15 would be equally appropriate.

# Coverage Area Definitions

## Introduction

The previous chapter has introduced different Service Distribution Configurations. Also, certain criteria were given for which Service Distribution Contribution would suit which competent authority. For a service under consideration with a Physical Layer, the coverage planning considerations were identified as one of the most important criterion for selecting a Service Distribution Contribution.

This chapter elaborates on general aspects of coverage planning and provides some recommendations regarding coverage planning.

These in turn may influence the Distribution Model of the service under consideration, when selecting a Service Distribution Configuration for the service under consideration. On the other hand, this chapter also provides consequential recommendations and helpful data should the Service Distribution Configuration be pre-set by a management decision already: There still is the need to support the pre-set Service Distribution Configuration with proper coverage planning.

*This chapter is relevant for services with* ***and*** *without Physical Layer,* although “coverage planning” implies some limitations to services with Physical Layer at face value. However, services *without Physical Layer also have a “coverage area”*, which – by default and maximum – is the geographical area of competence for the administration setting up the service.

There are requirements and benefits for services without Physical Layer to actually plan for a subdivision of their default “coverage area”.

Hence both kinds of services, services with and without Physical Layer, are addressed in this chapter. For services without a Physical Layer, the statements specifically regarding the coverage planning of Physical Layer can be ignored.

The *goals* of this chapter are:

* Elaborate the *bearing of coverage planning on the Distribution Model* of the service under consideration, and *vice versa*.
* Describe generally the *options available in terms of coverage* for setting up an Remote Shore Station (RSS) of the service under consideration, taking into account combinations of sectorized (i.e. directional) vs. omnidirectional Physical Link Couplers, i.e. the options derived from a sectorized Physical Link Coupler (PLC) Layer. Hence, this section elaborates the bearing of these options in terms of component setup at the RSS sites of the service on the Distribution Model.
* Recognize the resulting requirements for the functionality of the PSS and the SM in particular. These requirements will be taken up by the appropriate **Annex 9** **and 11**, describing the PSS and SM functionalities accordingly.
* Lay the foundation for abstract data modeling for the needs of the service itself as well as for its eventual integration into the shore-based e-Navigation system architecture.

## The concept of the Nominal Coverage Area

* + 1. Benefits of defining Nominal Coverage Area

For any coverage planning it is *essential* to determine the desired or *Nominal Coverage Area* for the service under consideration. The nominal coverage area definition offers benefits for

* *the management decision making process, even before starting the planning:* The Nominal Coverage Area provides a clean-cut service statement in operational and management terms within the competent authority and to the public;
* *the regulatory and even legal framework* for any and all aspects of the service related to geographical coverage, including mutual agreements between neighboring competent authorities of different countries;
* *the foundational framework for any planning and/or run-time calculation of quality features* of the service such as service reliability and continuity: In most cases the amount of data to be calculated by the service is dependent on its coverage area in some way. The amount of data to be processed has direct bearing on the resources needed, in particular if the data processing is distributed geographically. This in turn has a bearing on quality features like service reliability and continuity of the data processing;
* *the effective exclusion of unwanted or unknown fluctuations over time or time-variants when integrating the service into the shore-based e-Navigation system*: The Nominal Coverage Area effectively hides any unwanted but technology-specific fluctuations of the service’s coverage area over time to other services of the shore-based e-Navigation system, if it is determined in such a way that it covers that area for which data can be gathered, processed or distributed with the required reliability;
* *the functionality definition of components of the service*: The Nominal Coverage Area provides a means to support computerized algorithms regarding
* *for all kind of services:* selecting data only from areas of interest to the requesting service or to the user;
* *in the case of services with Physical Links:* message reception evaluation and message transmission routing within the service under consideration;
* *the specific planning of RSS locations in the case of a service with a Physical Layer:* The Nominal Coverage Area provides the most important criteria for determining location(s) and numbers of Remote Shore Stations (RSS) of the service under consideration, taking into account technology specifics of its Physical Link(s);
* *the reduction of complexity* for the shore-based e-Navigation system by supporting the *encapsulation principle*.
  + 1. Features of the Nominal Coverage Area

Important features of the Nominal Coverage Area are:

* It can *always* be *stated* *in precise terms*, e. g. by one or more polygon(s) of geographical co-ordinates.
* It is a *simple means* *to exchange the coverage area designation* between stakeholders of the AIS Service (humans and/or organizations and/or machines).
* It must be defined *always smaller* thanthe coverage theoretically predicted and/or physically achieved by the Physical Layer of the service. In this case, it must be defined *such smaller* than the theoretical coverage predictions would allow for, to meet the desired quality features within the resulting Nominal Coverage Area. To put it in another way: There will not be reliable data transmission receptions at the margins.

It should be noted, that the concept of Nominal Coverage Areas is both required and beneficial for *data modeling* within and external to the service under consideration.

* + 1. Definition of Nominal Coverage Areas for the service under consideration

Taking into account the Structure Model (refer to Main Body of this Recommendation), a Nominal Coverage Area can be defined for both the service as a whole and in addition for relevant functional components of the service. Hence, the following definitions are required:

* The ***Service Coverage Area*** is the Nominal Coverage Area of the whole of the service under consideration. In the case of a service with a Physical Layer the Service Coverage Area *always* is the inclusive overlay sum of all the PSS Coverage Areas (see below) of the service. In the case of a service without a Physical Layer, the Service Coverage Area is the area of responsibility of the administration setting up the service by default. By definition, the Service Management always operates within the full Service Coverage Area. Hence, the Service Coverage Area is particularly relevant for the Service Management.
* The ***LSS Coverage Area*** is the Nominal Coverage Area of one instance of the Logical Shore Station (LSS). This is the area for which the requesting service of the shore-based e-Navigation system configures the requested Basic Services, and this is the area for which the service delivers the Basic Services to that requesting service. For a given instance of the LSS, the LSS Coverage Area can comprise any subset of the Service Coverage Area or can be set equal to the Service Coverage Area.
* The ***PSS Coverage Area*** is the Nominal Coverage Area of one Remote Shore Station (RSS) of the service with a Physical Layer under consideration: Within the Physical Layer of the service it is the PSS which performs the appropriate algorithms related to the Nominal Coverage Area of one Remote Shore Station (RSS). Hence, the PSS Coverage Area could also be correctly called ***RSS Coverage Area***. Regularly, the size of the PSS Coverage Area is the inclusive overlay sum of all Sector Coverage Areas of the RSS under consideration, but it can be also defined smaller than that inclusive overlay sum.
* The ***Sector Coverage Area*** is the Nominal Coverage Area of an individual sector of a Remote Shore Station (RSS) of the service under consideration. The Sector Coverage Area of a given sector is determined by the Physical Link Couplers in that sector, although the sector also comprises the Physical Link Terminal Equipment (PLTE) Layer of the sector under consideration. The Sector Coverage Area allows for space/direction diversity regarding the range / coverage. While there are often several Sector Coverage Areas defined for one RSS, conceptually wise there may be only one sector in a given RSS, which may be called a One-Sector RSS. The Sector Coverage Area of a given sector is generally based on technology-specific range calculations and/or predictions, but a smaller area than theoretically calculated or predicted is generally used.

Note: *There is* ***no*** *Nominal Coverage Area defined for the Physical Link Terminal Equipment Layer*: It is the common feature of the Physical Link Terminal Equipment to offer at their Presentation Interface to the PSS everything they have received physically and/or which was meant for them. When transmitting, any data which is forwarded to a Physical Link Terminal Equipment for transmission will be received within the area solely determined by the Physical Link Couplers Layer. Hence, the Physical Link Terminal Equipment is transparent as far as Nominal Coverage Area is concerned.

* + 1. Receive Nominal Coverage Area vs. Transmit Nominal Coverage Area

Many services of the shore-based e-Navigation system are capable of data distribution in both directions, “receiving” and “transmitting”. Some services may only “receive”, while others may only “transmit”. The conventional terminology of services with Physical Layers is generalized to convey a precise meaning for all services of the common shore-based e-Navigation architecture as follows:

* **“Receiving”:** Data distribution takes place in the ***data flow direction*** ***from bottom of the service to top*** of the service under consideration (“own service”), compare Structure Model. This means
* *for services with a Physical Layer:* The Physical Layer receives signals from the Physical Link and forwards data derived from the signals to the requesting service via the Logical Layer (External Basic Services) or to the Service Management (Internal Basic Services).
* *for services without a Physical Layer:* The own service receives data from other services requested by own service, i.e. from requested services, and data is forwarded to the requesting service or the user via the Logical Layer (External Basic Services) or to the Service Management (Internal Basic Services).
* **“Transmitting”:** Data distribution takes place in the ***data flow direction from top of the service to bottom*** of the service under consideration (“own service”), compare Structure Model. This means
* *for services with a Physical Layer:* The Physical Layer *transmits* *signals* *to the Physical Link(s)* by using data received from the requesting service via the Logical Layer (External Basic Services) or from the Service Management (Internal Basic Services).
* *for services without a Physical Layer:* The own service *sends* *data* to other services *requested* by own service, i.e. *to requested services*, based on received data from a requesting service or the user via the Logical Layer (External Basic Services) or from the Service Management (Internal Basic Services).

While there are always implicitly defined both Receive and Transmit Nominal Coverage Areas for every relevant entity for ontological reasons, which are equated by default. The Receive and Transmit Nominal Coverage Areas may be different, also regarding different entities of the service under consideration. Hence, there may be a Receive and distinct a Transmit Service Coverage Area, a Receive and distinct Transmit LSS Coverage Area for the same instance of an LSS, a Receive and a distinct Transmit PSS Coverage Area for the same PSS, and so forth. It is recommended, however, to only deviate from that default when there is a good justification.

There can be receive-only Remote Shore Station (RSS) configurations.

There can be transmit-only Remote Shore Station (RSS) configurations.

It should be noted, that Transmit Nominal Coverage Areas of the same instance of an entity of the service *should not overlap* in order to avoid ambiguity.

* + 1. Visibility and encapsulation of Nominal Coverage Area definitions

The following table summarizes features of the above Nominal Coverage Area definitions in

terms of the visibility or encapsulation.

**Table A3.2: Visibility and encapsulation of Nominal Coverage Areas**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Nominal Coverage Area** | **Visibility to shore-based e-Navigation system** (outside own service) | **Visibility to Service Management** | **Visibility to LSS instances** | **Visibility to PSS** |
| **(Rx/Tx) Range on Physical Link(s)** | **No** | **No** | **No** | **Yes** (by transparency of Physical Link Terminal Equipment in this regard) |
| **(Rx/Tx) Sector Coverage Area** | **No** | **Yes** (SM configures it) | **No** | **Yes** (used for reception evaluation (Rx) and message to sector routing (Tx)) |
| **(Rx/Tx) PSS Coverage Area** | **No** | **Yes** (SM configures it) | **Yes** (used for reception evaluation (Rx) and data to PSS routing (Tx)) | **Yes** (own data) |
| **(Rx/Tx) LSS Coverage Area** | **Yes** (requesting service determines it for the LSS instance(s) requested) | **Yes** (SM invokes and configures LSS instance(s)) | **Yes** (own data) | **No** |
| **(Rx/Tx) Service Coverage Area** | **Yes** (= maximum nominal coverage area to choose LSS Service Area(s) from) | **Yes** | **No** | **No** |

### Generic examples of the Nominal Coverage Area and of the Sector concepts

Generic examples employing the above concepts assuming a service with a Physical Layer and a radio technology capable of both receiving and transmitting are given in the Figures A3.5 for the PSS Coverage Area and in the Figure A3.6 for the LSS Coverage Area. The examples in Figure A3.5 and A3.6 show sectorized RF antenna (= Physical Link Couplers of that example service) setup of the RSS. To arrive at an example of an omnidirectional RF antenna setup simply combine the coverage areas of the sectors of the same PSS to one circumscribing circle.

**Figure A3.5: Example setup for Receive-/Transmit-PSS Coverage Areas using the Sector concept**

Note: The PSS Coverage Areas are defined arbitrarily smaller than the inclusive overlay sum of the two Sector Coverage Areas in this example.

**Figure A3.6: Example setup for LSS Service Area using the Sector concept**

Note 1: For reasons of simplicity the Sector Coverage Areas are not shown (compare Figure A3.5).

Note 2: The example shows a LSS configured to deliver a Basic Service which employs both Rx- and Tx-functionalities using identical Receive / Transmit LSS Service Areas.



# Allocation options of the PSS functionality

For the Multiple-Node and for the One-Node Service Distribution Configuration there is the following option regarding allocation of the PSS functionality to functional site. This option does not exist – by definition – for the One-Site Service Distribution Configuration.

## Regular and alternative allocation of the PSS

The allocation of the PSS functionality is one configuration parameter of the service under consideration *at planning time*. The options are: ***PSS at Remote Shore Site (RSS)*** (Figure A3.7), which is the regular case, and ***PSS at Node Site*** (Figure A3.8), which is the alternative allocation. Both configurations have specific advantages and consequential requirements, both of which depend on the geographical conditions and topological setup of the service under consideration. This chapter will introduce the alternative allocation by contrasting it with the regular allocation.[[1]](#footnote-1)

It should be noted, that even if the PSS functionality should be alternatively allocated at the Node site(s) instead of the Remote Site(s), the PSS functionality would still be independent of LSS functionality. LSS and PSS would still constitute different entities in the AIS Service. That is due to the PSS’s orientation towards the Physical Link.

## Comparison of regular with alternative allocation configuration

The differences between the two allocation configurations may *appear* *small at face value*. The consequences may be profound, however. They are in particular

* the functional site ***allocation*** of the PSS and therefore the ***housing requirements*** for different sites;
* the control and net data exchange between PSS and Physical Link Terminal Equipment Layers is done ***locally*** (regular allocation configuration) or ***remotely*** (alternative allocation configuration);
* the PSS ***either*** controls and processes data to/from ***locally*** installed Physical Link Terminal Equipment (maybe arranged in sectors) ***of the local RSS*** ***only*** as in the regular allocation configuration ***or*** controls and processes data to/from ***remotely*** installed Physical Link Terminal Equipment (maybe arranged in sectors) ***of one or more remote RSS(s)*** connected to that PSS by appropriate WAN feeder links (as in the alternative allocation configuration);
* the ***permissible modes of operation for Physical Link Terminal Equipment at some technologies*** due to time latency considerations by introduction of the remote functional connection (WAN feeder link). Example from the AIS Service: With the alternative allocation of the PSS, only AIS Base Stations operating in Independent Mode can be used, while the regular allocation with the PSS at the Remote Site would still allow for a choice between the AIS Base Station in Dependent and Independent Mode;
* the ***different sets of requirements for the WAN feeder links*** connecting the RSS sites with the Node site(s) ***and different costs incurred***: While the PSS at the Remote site may pre-process incoming data from the Physical Link before sending data to the Node sites (and vice versa for outgoing data to the Physical Link) with the goal to reduce the bandwidth required for the WAN feeder link in the case of the regular allocation configuration, this may not be done with the alternative allocation configuration. The latter may require higher bandwidth for all WAN feeder links involved in total. This may have a direct bearing on the amount of running costs for the WAN feeder links;
* ***Should the WAN feeder link fail***, the PSS may still perform relevant control and some data processing functionalities autonomously on-site in the regular allocation configuration, while this is no longer possible with the alternative allocation configuration. Hence, the different allocation configurations differ ***regarding availability, reliability, and continuity***.

From the above list it follows, that the bearing of the two different allocation configurations on the design of the service of an administration is more significant than it appears at face value. Hence, these aspects should be considered when creating the Distribution Model for the service under consideration.



**Figure A3.7: Regular allocation configuration; PSS at the Remote Shore Site (premise A)**



**Figure A3.8: Alternative allocation configuration; PSS at the Node Site (premise N)**

## Typical fields of application and general recommendation

This section finally identifies criteria and provides recommendation regarding the fields of application of the two modes of operation, which use the concepts developed in previous chapters.

### Typical fields of application for the regular PSS allocation configuration

Criteria which support the regular PSS allocation configuration are:

* *Multiple sectors at one RSS:* The more sectors at RSS are needed depending on the coverage planning, the larger the demands on the PSS regarding pre-processing of received data in order to avoid superfluous transmission of data via WAN Feeder links. The same holds true in principle for the transmission of data, the extent of which is dependent on the specific Physical Link served by the service under consideration.
* *Several or many different Physical Links to be served at one RSS of the same service under consideration:* similar rationale as with multiple sectors, but more demand on the PSS regarding co-ordinated control (and data pre-processing as above) of the different sets of Physical Link Terminal Equipments serving the different Physical Links.
* *Combination of several or many different Physical Links to be served at one RSS of the same service under consideration with multiple sectors:* combination of the reasons above.
* *Highly unreliable landlines*

### Typical fields of application for the alternative PSS allocation configuration

Criteria which support the alternative PSS allocation configuration are:

* *One-Sector-RSS result predominantly from coverage planning:* If coverage planning of the service under consideration results in a dominant number of RSS with only one sector and a single piece of Physical Link Terminal Equipment and Physical Link Coupler each at those RSSs, alternative PSS allocation configuration should be considered.

### Hybrid allocation configurations

The two different PSS allocation configurations could also be used in a geographically extended service in a *hybrid* fashion, when local or regional conditions require so. In particular, there may be different PSS allocation configurations *from one to another* Node site in *Multiple-Node Service Configurations*, but also hybrid PSS allocations configurations within the *same* Node for both the *Multiple-Node and the One-Node Service Configurations*.

It should be noted, that from a life-cycle management point of view, hybrid PSS allocation configurations within the same service under consideration may incur additional expenditure and/or workload for Technical Operation Personnel as well as for Technical Development Personnel, and may be more susceptible for run-time configuration errors made by the Technical Operation Personnel.

### General Recommendation

***While it is generally recommended for the above reasons, that the regular PSS allocation setup should be used,*** the potential benefits and the potential disadvantages of the alternative PSS allocation should be carefully considered taking into account the local or regional conditions and requirements.

1. Regarding Figures A3.7 and A3.8 please note: For simplicity’s sake, there is only one Node shown. Also, only one Remote Site is shown. [↑](#footnote-ref-1)