IALA

IALA RECOMMENDATION (NORMATIVE)

R0124 (A-124) APPENDIX 3
DISTRIBUTION MODEL OF THE AIS SERVICE (INCLUDING RELEVANT COVERAGE PLANNING ASPECTS)

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

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APPENDIX CONTENTS

List of Tables

APPENDIX CONTENTS

List of Figures

1 INTRODUCTION

1.1 INDEX OF APPENDICES TO IALA RECOMMENDATION R0124 (A-124) ON THE AIS SERVICE

General:

Appendix 0	References, Glossary of terms and Abbreviations

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

Appendix 1	Basic AIS Services, Data model & AIS Service specific MDEF sentences
Appendix 2	Intentionally blank

Architecture of the AIS Service:

Appendix 3	Distribution model
Appendix 4	Interaction and data flow model
Appendix 5	Interfacing model
Appendix 6	Internal Time Latency model
Appendix 7	Internal Reliability model
Appendix 8	Test model

Functional components of AIS Service:

Appendix 9	Functional description of the AIS Logical Shore Station
Appendix 10	Functional description of the AIS PSS Controlling Unit
Appendix 11	Functional description of the AIS Service Management

Installation and life-cycle management issues of the AIS Service:

Appendix 12	Co-location issues at Physical Shore Stations (PSS) and on-site infrastructure considerations
Appendix 13	Recommendation regarding efficient operation and maintenance

Runtime configuration management of the VDL:

Appendix 14	FATDMA planning and operation
Appendix 15	Assigned mode operation
Appendix16	DGNSS broadcast via the AIS Service
Appendix 17	Channel management
Appendix 18	VDL loading management
Appendix 19	Satellite AIS considerations

1.2 PURPOSE OF THE APPENDIX

This appendix expands on the description of the AIS Service regarding the Distribution Model.

In most cases, due to coverage area requirements, the AIS Service of an administration spans a larger part of its coast or even the whole of its coast(s). The actual geographical topology of the coastlines may vary from country to country. The actual number of AIS Physical Shore Stations (AIS-PSS) of the AIS Service needed depends on a variety of aspects, as does the number of sites, where AIS Logical Shore Stations (AIS-LSS) would reside. In some cases, the AIS Service may shrink to a 'one spot AIS Service', e.g., when there is a geographically isolated administration in remote areas.

Despite the differences in individual geography and topology there are functional similarities regarding the distribution of components of the AIS Service, and also certain criteria to select a specific distribution configuration. The distribution model of the AIS Service describes some standard distribution configurations, which would apply to most administrations, and also provides AIS-specific rationales and criteria.

The distribution model is essentially functional and generic. It needs to be applied ('tailored') to the geography and topology by every administration. To that end guidance is provided how to arrive at a proper individual distribution model taking into account the following aspects:

- coverage requirements and coverage planning;
- coastal topology (concave, convex, line, one spot, ...);
- required functionality setup of an AIS Service, i.e. required Basic AIS Services;
- distribution of receive / transmit functionalities;
- maintenance and life-cycle considerations;
- data transfer network considerations; and
- infrastructure requirements.

2 AIS SERVICE DISTRIBUTION CONFIGURATIONS

There are three AIS Service distribution configurations defined:

- the Multiple-Node AIS Service distribution configuration;
- the One-Node AIS Service distribution configuration;
- the One-Spot AIS Service distribution configuration.

They are described in the following sections. It should be noted that the AIS Service may be a sub-service of a larger distribution configuration such as the VTS Service or e-Navigation.

2.1 MULTIPLE-NODE AIS SERVICE DISTRIBUTION CONFIGURATION

At least two Node sites and at least two Remote Sites characterize the Multiple-Node AIS Service distribution configuration topologically. All AIS Physical Shore Stations (AIS-PSS) of the AIS Service residing at the Remote Sites are connected to the Node sites used by the AIS Service by WAN feeder links (multiple star configuration). In addition, *all* Node sites used by the AIS Service are connected by WAN backbone links. This is necessary e.g., for master control of the AIS Service and for data replication. It is recommended that all Nodes used by the AIS Service are connected with all other Nodes used by the AIS Service.

Typically, even in geographically large Multiple-Node AIS Service distribution configurations there are only two or three Nodes required.

The Multiple-Node AIS Service distribution configuration would best serve administrations:

- whose area of responsibility and/or interest is *geographically 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; 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 AIS service management (AIS-SM) master functionality to two (or even more) Nodes. In this case, however, only one AIS–SM master should be active at any point in time.

2.2 ONE-NODE AIS SERVICE DISTRIBUTION CONFIGURATION

The One-Node AIS Service distribution configuration is characterized topologically by one Node site and at least one remote site. All AIS-PSS of the AIS Service residing at the remote sites are connected to the One-Node by WAN feeder links (logical star configuration).

The One-Node AIS 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 AIS Service distribution the most economically feasible solution, in particular when considering costs related to the WAN feeder links; or
- where centralization of all geographically dispersed functionality into one Node is desired for whatever reason regardless of the coastal topology.

2.3 ONE-SPOT AIS SERVICE DISTRIBUTION CONFIGURATION

The One-Spot AIS Service distribution configuration is the simplest AIS Service distribution configuration: the AIS-PSS, the functionalities of the Logical Layer and the functionalities of the AIS-SM are co-located on one location.

Therefore, all technical operation, maintenance and further development would be done at this one location.

The One-Spot AIS Service distribution configuration would best serve administrations, whose area of responsibility and/or interest is confined to one geographical area. The same administration could set up several One-Spot AIS Services at multiple distinct locations with considerable geographic separation; each would constitute an independent AIS Service. Hence, the One-Spot AIS Service distribution configuration may serve administrations in geographically large countries with only one or few geographically distinctly separated ports.

There are two principal cases of application for One-Spot AIS Service distribution:

- *case 1:* national competent authority interested in individually confined geographic coverage area(s) within a vast geographical topology; and
- *case 2:* localized competent authority operating (Limited) Base Station(s) delegated by a national competent authority.

2.4 SELECTING AN APPROPRIATE AIS SERVICE DISTRIBUTION

Three different AIS Service Distributions were introduced in the previous sections. This section defines criteria-based recommendations for selecting the appropriate AIS Service Distribution.

The criteria and recommendations for selecting an appropriate AIS Service Distribution are provided in Table 1 however, the following *explanations* should be considered:

1 Node site diversity 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 AIS Service Distribution are not feasible.

2 Resulting Number of AIS Physical Shore Stations: This column provides an entry point into the table for those competent authorities, where the planning for AIS-PSS locations has been finalized already. The table would allow for double-checking the results of that AIS-PSS planning in terms of the AIS specific

consequences. The table also provides guidance when the Node site arrangement has not yet been finalized.

3 Garbling mitigation and coverage redundancy beyond garbling mitigation: To achieve garbling mitigation from ashore, dual coverage of the same sea area from different angles of perspective is recommended, ideally from opposite (180°) directions. Hence, the dual coverage is used for garbling mitigation.

Table 1 Criteria and Recommendation for selecting an appropriate AIS Service Distribution

Recommendation	Criteria related to				
	Coverage area characteristics	AIS VHF Data Link loading			Site diversity required for Node site (Node site redundancy)
		AIS VDL traffic intensity (1)/ garbling mitigation	Site separation for Rx and Tx	Coverage redundancy beyond garbling mitigation	
Multiple-Node AIS Service distribution	Very large or distinct and separate areas to be covered	Capable of • high AIS VDL traffic intensity • garbling mitigation by smaller cells • dual coverage	Capable / possible	Capable / possible	Possible
One-Node AIS Service distribution	Intermediate to large, or contiguous area to be covered	Capable of • high AIS VDL traffic intensity • garbling mitigation by smaller cells • dual coverage	Capable / possible	Capable / possible	Not possible
One-Spot AIS Service distribution	Small, contained area to be covered	Capable of only low AIS VDL traffic intensity and suitable only for situations where garbling is unlikely	Not possible	Not possible	Not possible

Note 1: The AIS VHF data link traffic intensity should *not be confused* with the traffic intensity of vessels. While there is a correlation, the AIS VHF data link traffic intensity depends on many more factors than the number of vessels present. Those factors are, amongst others, the speeds of the vessels, their navigation and manoeuvre status, the amount of message transmission retries, the reservation of slots for Fixed AIS stations and AIS AtoN stations, the reporting rate or slot assignments in operation. The aspects of the AIS VHF data link traffic intensity will be further discussed in a dedicated Appendix 'General loading management by an AIS Service' (**appendix 18**), which summarizes the content of the 'Appendices related to the VDL usage and the VDL management by AIS Service' (**appendices 14-17**).

3 COVERAGE PLANNING AND THE AIS SERVICE DISTRIBUTION

The previous chapter has introduced different AIS Service distributions. Certain criteria were given to competent authorities for selecting which AIS Service Distribution to use. *AIS VDL coverage planning considerations were identified as* ***one of the most important criterion***.

This chapter elaborates on the AIS VDL coverage planning and provides some specific recommendations when selecting an AIS Service distribution for the competent authority. This chapter also provides recommendations and helpful information should the AIS Service distribution have been pre-set by a management decision: there is still a need to support the pre-set AIS Service distribution with proper coverage planning.

The *goal* of this section is four-fold:

1 Describe the relationship of coverage planning on the Distribution Model of the AIS Service.

2 Describe the options available for setting up an AIS-PSS of the AIS Service, taking into account the possible combinations of:

   a directional vs. omnidirectional RF antenna setup.

   b number and variety of Fixed AIS Stations, in particular AIS Base Stations, per one AIS sector.

   c number and variety of individual RF antennas, per one AIS sector.

3 Recognize the resulting requirements for the functionality of the AIS-PCU and the AIS-SM in particular. These requirements are covered in Appendices 9, 10 and 11, describing the AIS-PCU and AIS-SM functionalities accordingly.

4 Lay the foundation for abstract data modelling for the needs of the AIS Service itself as well as for its eventual integration into the shore-based system architecture.

3.1 THE CONCEPT OF THE NOMINAL COVERAGE AREA

3.1.1 Benefits of defining nominal coverage area

For any coverage planning it is essential to determine the required nominal coverage area for the AIS Service. The nominal coverage area offers benefits for:

1 The management decision making process: The nominal coverage area provides a clean-cut service statement in operational and management terms within the competent authority and to the public.

2 The planning phase: The nominal coverage area provides the most important criteria for determining location(s) and numbers of AIS-PSS in the AIS Service under consideration, taking into account factors such as nominal VHF range, antenna heights etc.

3 The functional definition of components of the AIS Service: The nominal coverage area provides a means to support computerized algorithms regarding message reception evaluation and message transmission routing within the AIS Service.

4 The foundational framework for any planning and/or run-time calculation of quality features of the AIS Service such as service reliability and continuity.

5 The integration of the AIS Service into the shore-based e-Navigation system, both during planning and during operation: The abstraction level brought by the nominal coverage area effectively hides the intricacies of the AIS VHF data link, i.e. the science of the AIS, to other services of the shore-based e-Navigation system. Thus, the nominal coverage area supports the encapsulation principle of the shore-based e-Navigation system architecture.

6 The regulatory and legal framework for any and all aspects of the AIS Service related to geographic coverage, including mutual agreements between neighbouring competent authorities of different countries.

Important features of the nominal coverage area are:

1 It is stated in precise terms, e.g., by one or more polygon(s) of geographical co-ordinates. Hence the concept of the nominal coverage area achieves *independence of the fluctuating margins of the physical VHF range and of the unpredictable time-variants of the AIS VDL*.

2 Hence, the nominal coverage area is also a *simple means to exchange the coverage area designation* between stakeholders of the AIS Service (humans and/or organizations and/or machines).

3 It is defined such that it is *always smaller than* the physical VHF range which could be achieved theoretically by VHF range calculations.

4 It is defined by taking into consideration the desired AIS service quality within the nominal coverage area.

3.1.2 Definition of nominal coverage areas for the AIS Service

A nominal coverage area can be defined for both the AIS Service as a whole, and for relevant functional components of the AIS Service. The following definitions are also described graphically with Figure 1 below:

1 The ***AIS Sector Coverage Area*** is the conservative theoretical coverage area of the RF equipment of an AIS Fixed Station. This is the nominal coverage area, which is to be achieved by the antenna setup, and it is generally based on VHF range calculations and/or VHF range predictions. The AIS Sector Coverage Area is the most fundamental nominal coverage area.

2 The ***AIS-PCU Coverage Area*** is the nominal coverage area of one AIS-PSS. The size of the AIS-PCU Coverage Area is the sum of all AIS Sector Coverage Areas of the AIS-PSS controlled by the AIS-PCU. The AIS-PCU Coverage Area may also be defined as a smaller area smaller than the sum of the AIS Sector Coverage Areas.

3 The ***AIS-LSS Service Area*** is the nominal coverage area of one instance of the AIS Logical Shore Station (AIS-LSS). This is the area for which the requesting service of the shore-based e-Navigation system configures the requested Basic AIS Services, and this is the area for which the AIS Service delivers the Basic AIS Services to that requesting service. For a given instance of the AIS-LSS, the AIS-LSS Coverage Area can comprise any subset of the AIS Service Coverage Area or can be set equal to the AIS Service Coverage Area.

4 The ***AIS Service Coverage Area*** is the nominal coverage area of the whole of the AIS Service. The AIS Service Coverage Area is the sum of all the AIS-PCU Coverage Areas of the AIS Service. By definition, the AIS-SM operates within the AIS Service Coverage Area. Hence, the AIS Service Coverage Area is particularly relevant for the AIS-SM.

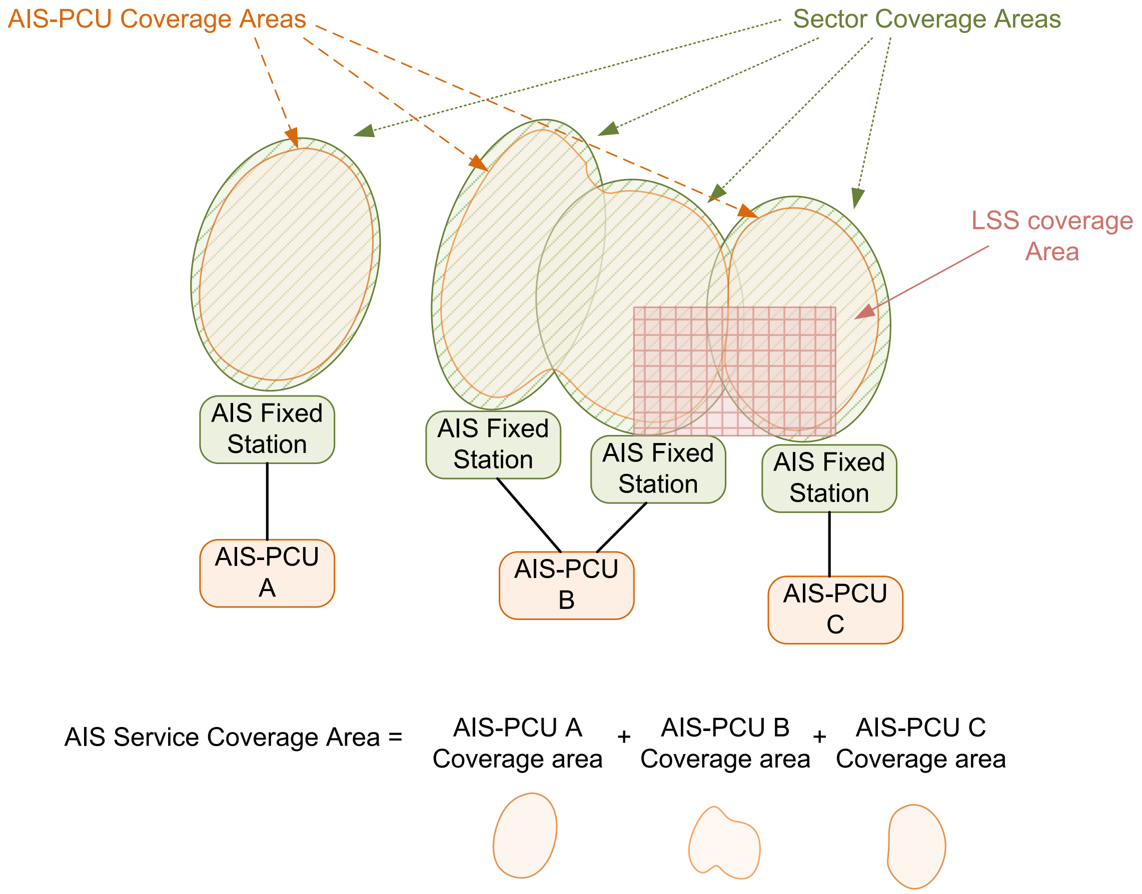

Figure 1 Graphical representation of nominal coverage definitions

3.1.3 Receive Nominal Coverage Area vs. Transmit Nominal Coverage Area

The AIS Service is capable of receiving and transmitting. For optimum AIS VDL usage and optimum AIS VDL management (refer to Appendices 14-18), the nominal coverage areas for reception and for transmission can be different. There can be:

- receive-only AIS-PSS configurations;
- transmit-only AIS-PSS configurations.

To allow optimal usage of the AIS VDL, nominal coverage areas should conceptually be subdivided into receive (Rx) nominal coverage area and transmit (Tx) nominal coverage area.

3.2 DIRECTIONAL RF ANTENNA USAGE AND THE AIS SECTOR CONCEPT

3.2.1 Introduction

The RF antenna interfaces the Fixed AIS Station to the AIS VHF data link (AIS VDL). The RF antenna setup determines whether the nominal coverage area can meet the required level of service. By default, there are two options of RF antenna setup at an AIS-PSS:

- Omnidirectional RF antenna setup;
- Directional RF antenna(s).

3.2.2 Benefits of sectorised AIS-PCU coverage

The benefits of a sectorised AIS-PCU coverage setup are:

1 An Area can be subdivided into multiple smaller AIS Sector Coverage areas to obtain better overall coverage; e.g. using a directional antenna to extend range in a specified direction.

2 For areas with higher AIS VDL traffic intensity, *effective garbling mitigation* can be achieved.

3 *Coverage redundancy* can be planned for.

4 *Transmission*s *can be routed* to the relevant (Tx) AIS Sector Coverage Area to improve FATDMA efficiency.

5 A sectorised AIS-PCU coverage setup may exclude *areas* where there are no ships, thus resolving potential regulatory and/or environmental issues already at planning stage.

6 Low antenna height with directional RF antennas allows for AIS Sector Coverage Areas that can be confined to small geographical area to meet very specific requirements. This benefit may be easier to achieve if local topology features, such as hills or mountains, can increase the separation of the AIS Sector Areas by limitation of the physical RF range.

7 Antenna heights can be adjusted for each AIS Sector independently. This allows fulfilling different coverage requirements of different sectors at the same AIS-PSS site.

3.2.3 Definitions for the sectorised AIS-PCU coverage

The following description of the AIS sectorised AIS-PCU concept holds equally true for an omnidirectional or a directional RF antenna setup.

The composition diagram in Figure 2 shows, comprehensively that:

- the definition of the nominal coverage areas as introduced in the previous section, as far as the Physical Layer of the AIS Service is concerned: part of the Figure entitled 'Coverage Area realm';
- the components of the Physical Layer in their functional relationship and in their relationship to the nominal coverage area definitions: part of the Figure entitled 'Component realm'; and- the definition of the compound 'AIS Sector' and its functional relationship to the definition of the AIS Sector Coverage Area.

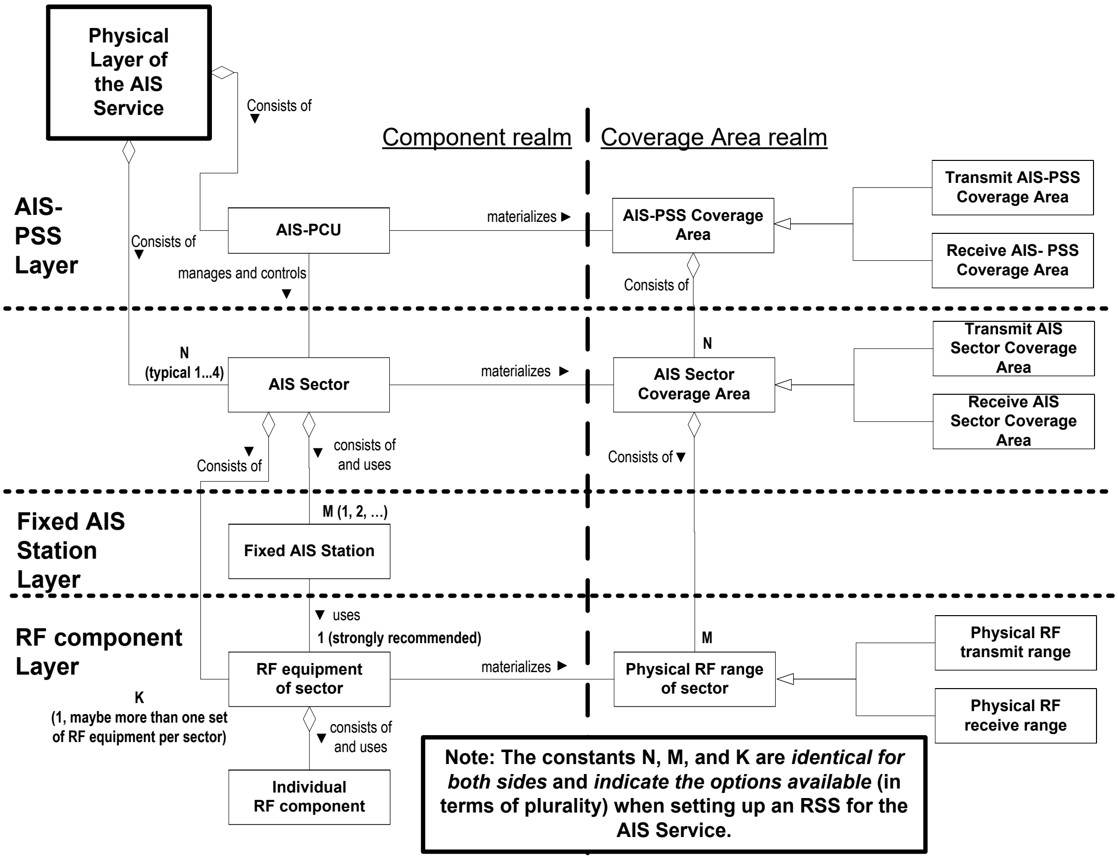

Figure 2 Relationship between Coverage Area Definitions and relevant Components of the Physical Layer of the AIS Service

Regarding Figure 2 it should be noted that the:

- constant N identifies the number of AIS Sectors per AIS-PSS. Practical values of N are 1 (omnidirectional or directional antenna), 2, 3, and 4.

  When using 2, 3, or 4 directional antennas with a nominal open angle of 90°, the half, three-quarter or full circle can be covered by individual and largely independent AIS Sectors.

- *constant M* identifies the *number of Fixed AIS Stations (e.g. AIS Base Station)* per AIS Sector. M=1 means one Fixed AIS Station (e.g. AIS Base station) per sector, while M=2 allows for simultaneous transmission on each frequency (AIS-A and AIS-B) in the same time slot, or for redundancy planning of Fixed AIS stations.
- *constant K* identifies the *number of different antennas* (omnidirectional or directional) connected to the radio front end(s) of the Fixed AIS Station(s).

Concluding, Figure 2 provides a complete overview of the options available for AIS-PSS configuration, while being compatible with data modelling requirements.

3.3 GENERIC EXAMPLES OF THE NOMINAL COVERAGE AREA AND OF THE AIS SECTOR CONCEPT

Generic examples employing the above concepts are given in Figure 3 (following page) for the AIS-PCU Coverage Area and in t Figure 4 for the AIS-LSS Coverage Area. The examples in Figure 3 and 4 show sectorised RF antenna setup of the AIS-PSS. To arrive at an example of an omnidirectional RF antenna setup simply combine the coverage areas of the sectors of the same AIS-PCU to one circumscribing circle.

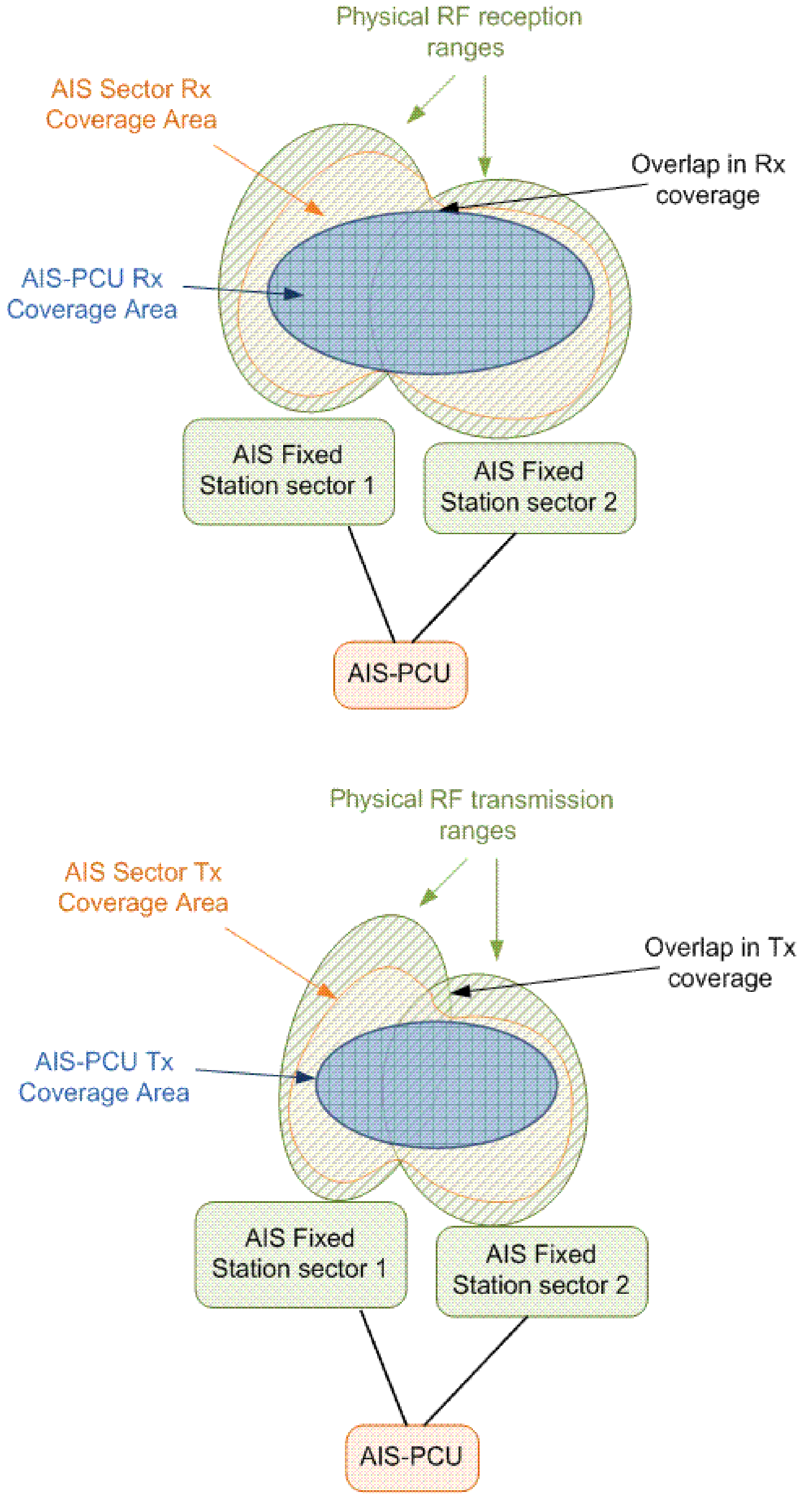

Figure 3 Example setup for Receive / Transmit-AIS-PCU Coverage Areas using the AIS Sector concept

Note: For simplicity's sake, there is only one AIS Base station shown per each AIS Sector.

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

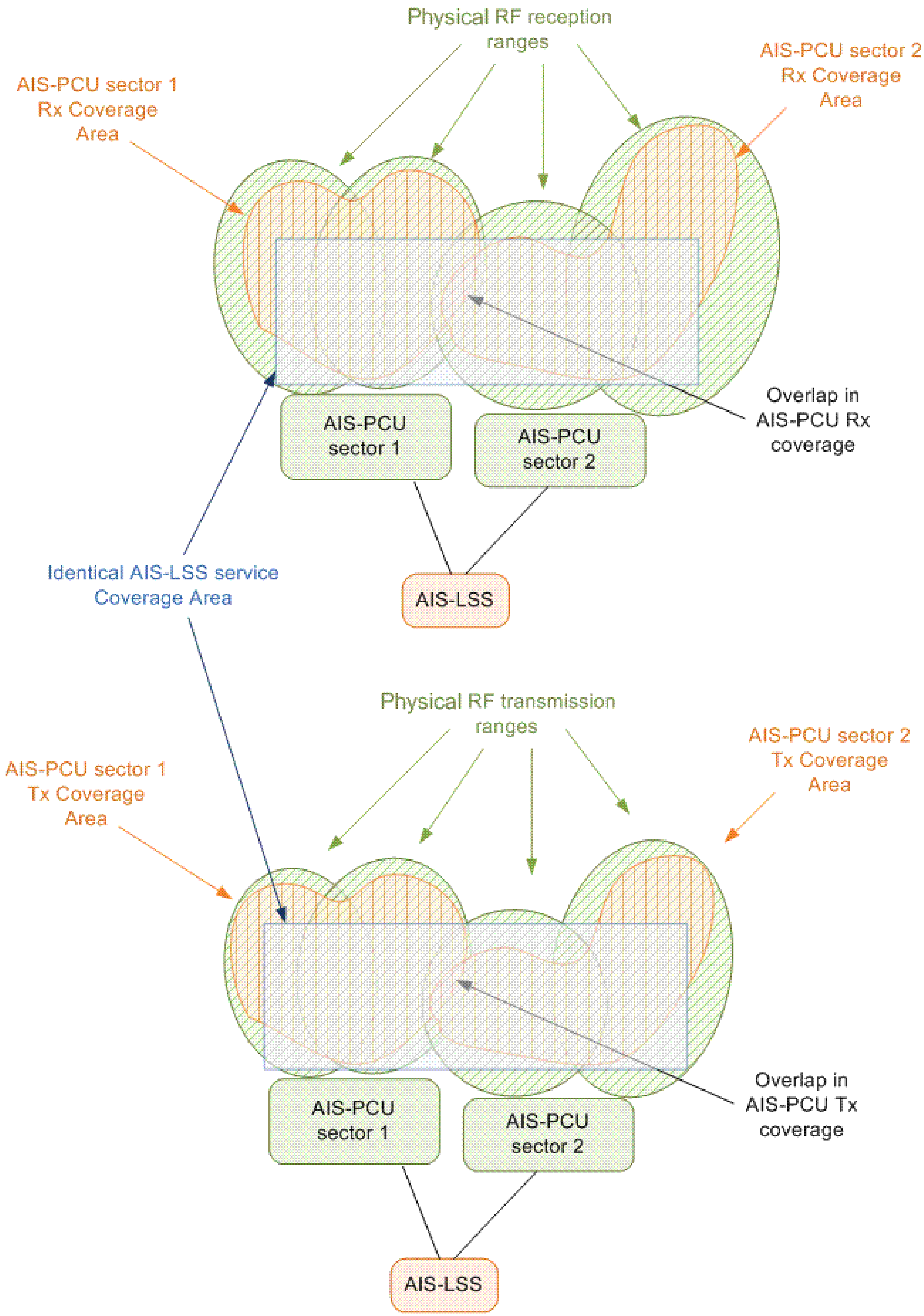

Figure 4 Example setup for AIS-LSS Service Area using the AIS Sector concept

Note 1: For reasons of simplicity the AIS Sector Coverage areas are not shown.

Note 2: The example shows the situation for a Basic AIS Service configured for the AIS-LSS, which both employs Rx- and Tx-functionalities.

The following sections use the above definitions, statements and recommendations to achieve the desired coverage in a high VDL load area. The options introduced above are combined to those ends.

3.4 GARBLING MITIGATION USING DUAL COVERAGE AND AIS SECTORS

Garbling mitigation for the receiving side can be achieved for the shore-based AIS Service by using dual coverage of the same coverage area from different angles of perspective, ideally from opposing angles (180°) of insight into the coverage area under consideration.

In order to achieve the best garbling mitigation – garbling is an indication of relatively high AIS VDL traffic load – the two AIS fixed stations involved should use directional antennas at lowest possible antenna heights.

3.5 AIS-PSS SITE PLANNING FOR AIS VDL LOADING-FRIENDLY TRANSMISSIONS

This section addresses some AIS-PSS site planning issues for AIS VDL loading-friendly transmissions. It should be noted, that there is a correlation between the following considerations and the FATDMA further detailed in Appendix 14.

3.5.1 Use of AIS sectors with low antenna heights

In coverage areas with relatively high AIS VDL channel loading anticipated, the transmit coverage area of any individual AIS-PSS, i.e. the Transmit-AIS-PCU Coverage Area of that AIS-PSS, should be limited to that coverage area where the transmissions are really only relevant.

This recommendation holds true regarding the range (influenced by antenna height and antenna gain) and lateral angle (can be influenced by using directional antenna). Since directional antennas introduce some antenna gain, there is trade-off between the two options.

Taking into account the relatively high sensitivity of the AIS stations, this may lead to directional antennas with relatively narrow-lobed antenna sectors (e.g. 60° degree or even narrower antenna lobe) installed at relatively low heights.

3.5.2 The pooling concept for confined coverage areas

The actual amount of time slots reserved by transmitting station(s) into the coverage area is of more interest than the actual number of time slots used by each station. To reduce the number of time-slots reserved, competent authorities can use pooling. The pooling concept involves different AIS-PSS around the coverage area that can use time slots in an alternating fashion while keeping constant the total actual amount of time slots reserved. For the pooling concept, the actual locations of the AIS-PSS do not matter. Hence, the global FATDMA plan introduced in Appendix 14 can be area oriented.

The pooling concept provides a large degree of local flexibility regarding time slot usage for shore-based transmissions, while not overstepping the boundaries set by the global FATDMA planning.

4 LOCATION OPTIONS OF THE AIS-PCU FUNCTIONALITY

Remote site location vs. node-site location of the AIS-PCU: The location of the AIS-PCU functionality is one configuration parameter of the AIS Service. The options are: AIS-PCU at an AIS-PSS and an AIS-PCU at a Node Site. Both configurations have specific advantages and consequential requirements, both of which depend on the geographical conditions and topological setup of the AIS Service under consideration. This chapter will introduce the node-site location by contrasting it with the remote site location. Figure 5 shows the remote site and Figure 6 shows the node-site location in comparison.

Regarding Figures 5 and 6 please note the following: For simplicity's sake, there is only one Node shown. Also, only one Remote Site is shown.

The differences between the two different location configurations as shown in Figures 5 and 6 may appear small. The main differences between the Figures 5 and 6 are the:

- Functional site location of the AIS-PCU and therefore the housing requirements for different sites;
- Transformation of local data exchange/control capabilities between AIS-PCU and AIS Fixed Stations (remote site location configuration) to remote data exchange/control capabilities between AIS-PCU and AIS Fixed Stations (node-site location configuration);
- Control range/responsibility of the AIS-PCU for either only the locally installed AIS Fixed Stations in the locally configured AIS Sectors (remote site location configuration) vs. all AIS Fixed Stations in all Remote Sites connected to the AIS-PCU by the appropriate functional links (node-site location configuration);
- Permissible modes of operation for the AIS Fixed Stations due to time latency considerations by introduction of the remote functional connection: With the node-site location of the AIS-PCU, only AIS Fixed Stations operating in Independent Mode can be used, while the on-site location with the AIS-PCU at the Remote Site would still allow for a choice between the AIS Fixed Station in Dependent and Independent Mode.

From the above list it follows that the bearing of the two different location configurations on the design of the AIS Service of an administration are more significant than they appear to be from Figures 5 and 6. Hence, the following introduction into the different modes of operation of the AIS Fixed Station is needed to eventually assess the advantages of either location configuration.

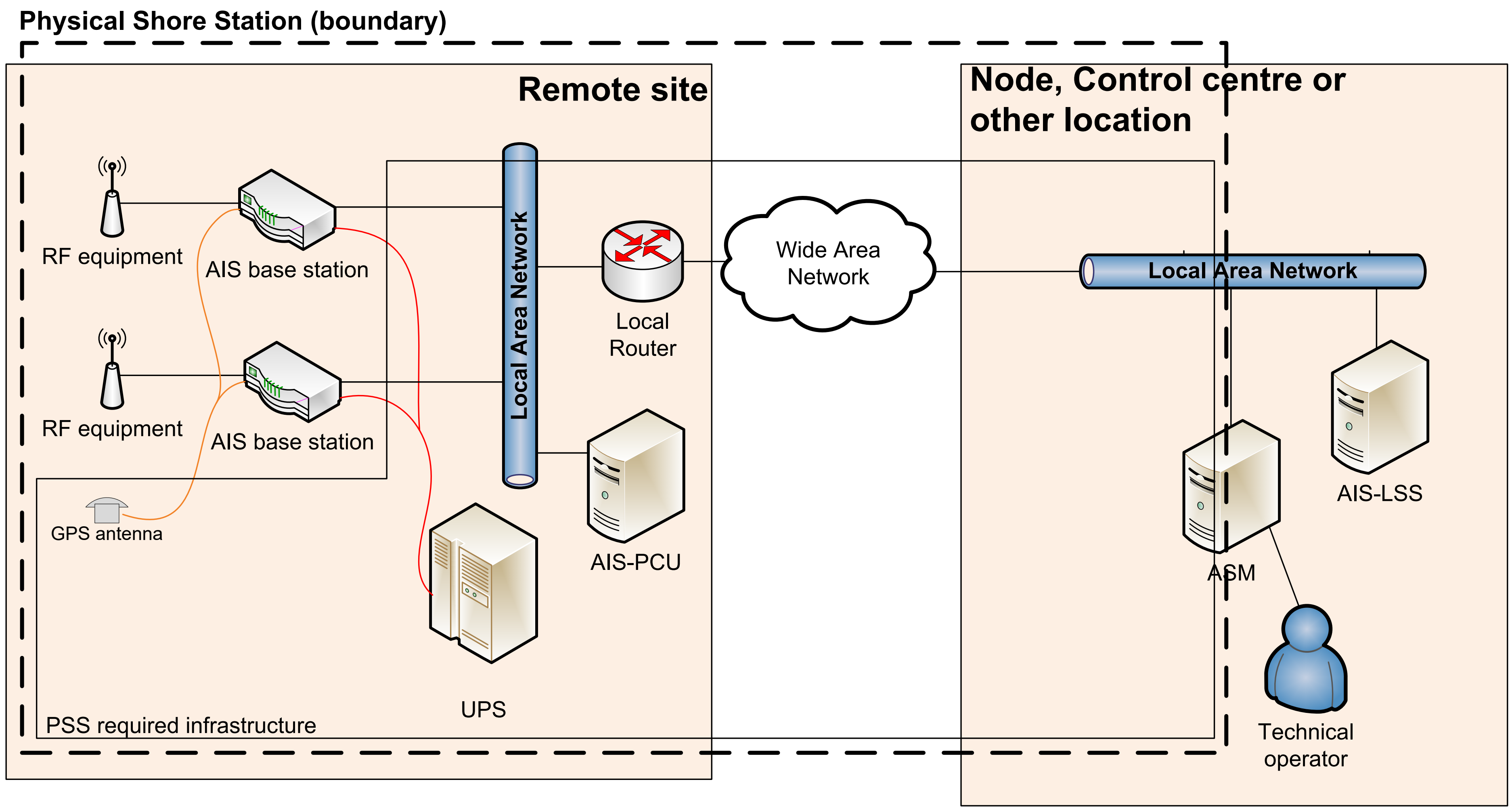

Figure 5 Remote Site Location configuration; AIS-PCU at the AIS Physical Shore Site

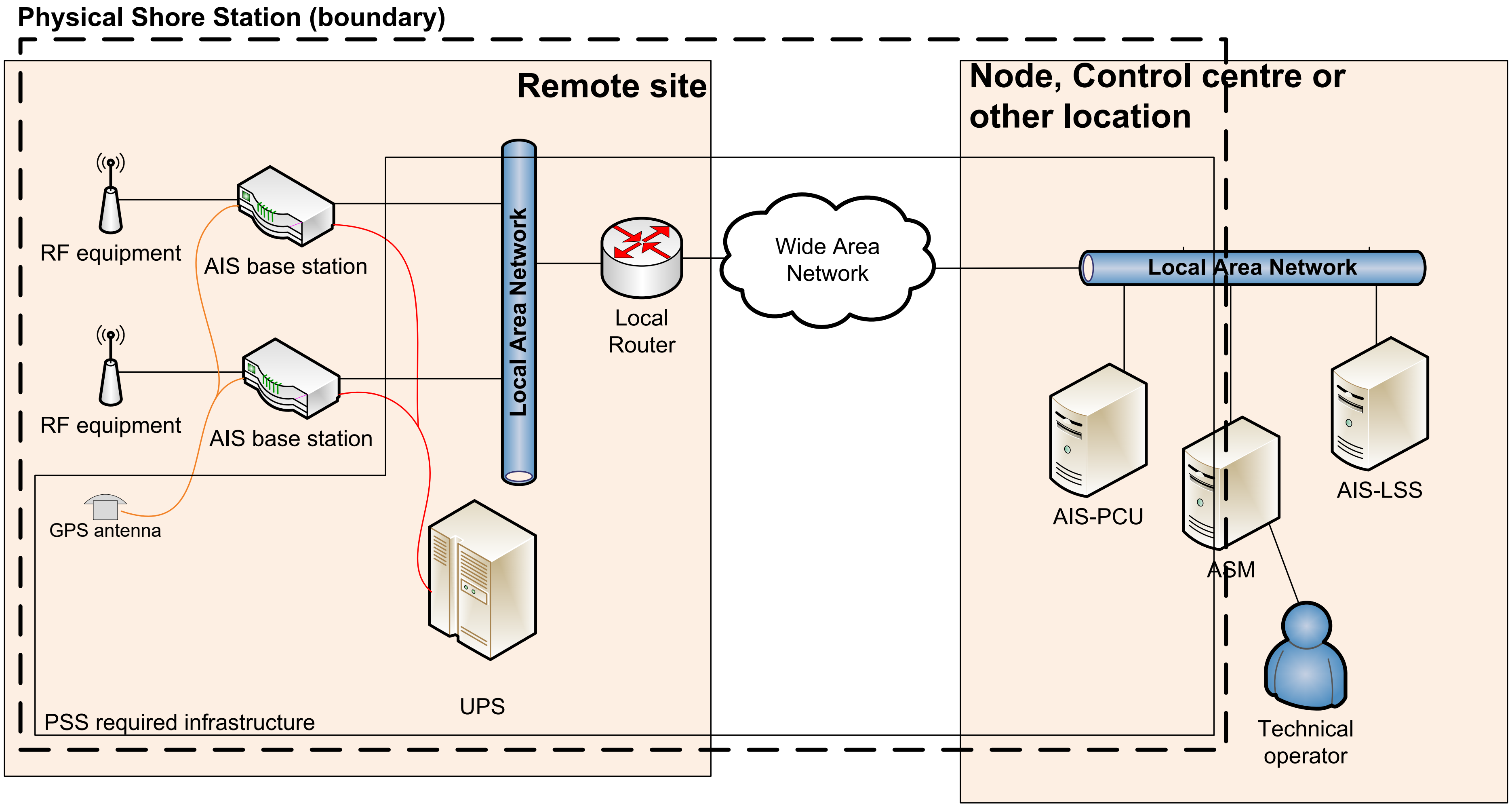

Figure 6 Node Site Location configuration; AIS-PCU at the Node Site

4.1 DEPENDENT MODE VS. INDEPENDENT MODE OF AIS BASE STATION

This section introduces the main features of both modes of operation of the AIS Base Station and their consequential requirements. The advantages of both modes of operation are explained, and also the different fields of application are indicated.

Sources of VDL messages for transmission

In order to transmit VDL messages, the Base Station may derive the messages to be transmitted from three sources:

1 Generate and transmit VDL messages autonomously as per the configuration received via sentences;

2 Generate and transmit VDL messages automatically based on data input received via the PI, using different sentences than the VDM;

3 Transmit predefined VDL messages input via the PI. The VDM sentence shall be used to input the content of the VDL messages via the PI to the AIS Base Station. The VDL message shall then be transmitted by the Base Station on the VDL.

When operating the Base Station independently, these three VDL message sources shall be supported in parallel.

When operating the Base Station dependently, only VDM messages received via the PI shall be transmitted as noted in item c) above.

4.1.1 Dependent operation

When operating as a dependent Base Station the FATDMA access scheme shall be used. The Base Station shall use the slot(s) provided by the AIS-PCU.

Dependent operation shall not use the RATDMA access scheme.

4.1.2 Independent operation

The default access scheme for a Base Station shall be FATDMA.

The AIS Base Station may also use RATDMA access schemes if implemented. The AIS Base Station may use the FATDMA and RATDMA access schemes concurrently. The use of pre-reserved FATDMA slots shall take priority over RATDMA access.

When using the FATDMA access scheme, the absolute slot numbers for transmission shall be determined by one of the following methods:

- the PI combination of linked TSA+VDM sentences shall provide the absolute slot number in which the AIS Base Station transmits;
- the AIS Base Station shall autonomously select an appropriate pre-reserved FATDMA slot as determined by its configuration.

Both methods shall be available and operate concurrently.

Remote AIS Base stations, without any connection to a network, should be programmed to operate in the independent mode.

4.1.3 Comparison of Base Station dependent and independent operation

Further details regarding the Dependent and Independent Modes of the AIS Base station can be found in the test standard IEC 62320-1 on AIS Base stations.

Table 2 Comparison of AIS Base Station operation in dependent mode versus independent mode

Criteria	Base Station dependent mode	Base Station independent mode
System architecture		
Compliance with Service Architecture	Entire VDL control functionality in AIS-PCU	Distributed VDL control between BS and AIS-PCU
FATDMA management	FATDMA coordination in AIS-PCU for all BS within the AIS shore station; AIS-PCU has a common slot map for all connected BS	FATDMA coordination is distributed between AIS-PCU and BS; each BS has its own slot map
Delegation of VDL control	No delegation of VDL-control functionality to BS	delegation of VDL-control functionality to BS; monitoring by AIS-PCU necessary
Fail safe	All transmissions are initiated by AIS-PCU, in case of communication failures between AIS-PCU and BS; No transmission by the BS will occur	Some transmissions are autonomously initiated by BS; In case of communication failures between AIS-PCU and BS those transmissions by the BS will be continued
Dependency from ITU-R M.1371	Changes regarding functionality do not affect the BS; Changes are only necessary in AIS-PCU	Changes regarding functionality do affect both BS and AIS-PCU
Technical operation		
Maintenance	Little maintenance required for BS, maintenance required for AIS-PCU	Maintenance required for both BS and AIS-PCU
Possible update	Mainly AIS-PCU only	For both BS and PCU needed
Flexibility	More flexible because all functionality is in AIS-PCU, changes have an effect on PCU only	Less flexible because changes have an effect on both BS and AIS-PCU
Technical requirements		
HW requirements	AIS-PCU: high regarding performance and speed, BS less complex HW structure	BS: high regarding performance and speed, PCU low
SW requirements	AIS-PCU: high regarding performance and speed, real time processing, BS: low	BS: high regarding performance and speed, real time processing; AIS-PCU: low

Criteria	Base Station dependent mode	Base Station independent mode
Availability on the market	BS: type certified off the shelf product AIS-PCU: Development necessary (high complexity)	BS: type certified off the shelf product; AIS-PCU: Development necessary (low complexity)
Integrator	Detailed AIS knowledge by the AIS-PCU integrator necessary	Detailed AIS knowledge mainly in BS 'implemented'
Quality assurance		
AIS VDL control	AIS-PCU is sole controlling entity	Distributed between AIS-PCU and BS; AIS-PCU is supported by BS (e.g. semaphore operation, periodic transmission for channel management messages, response on interrogation, VDL access)
Certification	BS certification: mainly RF parameter (IEC standard): AIS-PCU certification: AIS functionality (no test standard available)	BS certification: RF parameter and AIS functionality (IEC standard)

4.2 COMPARISON OF THE REMOTE SITE AND NODE SITE AIS-PCU LOCATION CONFIGURATION

This section compares the remote site and node site AIS-PCU location configuration and identifies the relative advantages of each of the AIS-PCU location configurations.

4.2.1 Criteria and recommendations regarding the fields of application

While it is generally recommended that the remote site AIS-PCU location configuration should be used, the potential benefits and the potential disadvantages of the node site AIS-PCU location should be carefully considered taking into account the local or regional conditions and requirements.

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

4.2.2 Typical fields of application for the remote site AIS-PCU location configuration

Criteria that support the remote site AIS-PCU location configuration are:

- Multiple AIS Sectors and/or many Fixed AIS Stations at one AIS-PSS: The more AIS Sectors at AIS-PSS are needed depending on the coverage planning, the larger the demands for an AIS-PCU localized at the AIS-PSS site.
- Unavailability of reliable or even redundant communication lines: Loss of communication between AIS-PCU and the AIS-PSS will cause the termination of the ability to perform maintained remote site broadcasts, e.g. AIS-AtoN.

4.2.3 Typical fields of application for the node site AIS-PCU location configuration

Criteria which support the node site AIS-PCU location configuration is:

- Coverage Planning: If coverage planning of one AIS Service results in a dominant number of AIS-PSS with only one sector and a single AIS Base Station at those AIS-PSSs, node site AIS-PCU location configuration should be considered.

4.2.4 Concluding notes

It should be noted, that the two different AIS-PCU location configurations could be used in a geographically extended AIS Service in a *hybrid* fashion, when local or regional conditions require so. In particular, there may be different AIS-PCU location configurations from one Node site to the next Node site in Multiple-Node AIS Service configurations, but also hybrid AIS-PCU location configurations within the same Node for both the *Multiple-Node and the One-Node AIS Service configurations*. For the *One-Spot AIS Service Configuration*, by definition, there is no option regarding the AIS-PCU location configuration, but there is still the option to use the Dependent Mode and/or the Independent Mode AIS Base station(s). It should be noted, that from a life-cycle management point of view, hybrid AIS-PCU location configurations within one AIS Service may incur additional expenditures and/or workload for Technical Operation Personnel and may be more susceptible to run-time configuration errors made by the Technical Operation Personnel.

It should also be noted, that even if the AIS-PCU functionality should be located at the Node site(s) instead of the Remote Site(s), the AIS-PCU functionality would still be independent of AIS-LSS functionality. AIS-LSS and AIS-PCU would still constitute different entities in the AIS Service. That is due to the AIS-PCU's orientation towards the AIS VHF data link (compare section 'Functional Components' in the Main Body of this Recommendation, and in particular Figure 6).