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IALA International Association of Marine Aids to Navigation and Lighthouse Authorities

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APPENDIX 17

Channel Management by an AIS Service

Edition 1

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10, rue des Gaudines
78100 Saint Germain en Laye, France
Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
e-mail: contact@iala-aism.org Internet: www.iala-aism.org

Document Revisions

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

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1 INTRODUCTION

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1.2 Purpose of the Appendix

Every aspect of channel management is not well understood at this stage of the development of the AIS. This chapter provides an introduction to Channel Management for competent authorities. Some recommendations will be derived at the end of the chapter.

A section introducing most fundamental definitions and concepts is presented first. This introduction starts with the mobile AIS station and assumes that it is this station that has to operate in accordance with regional operating settings that are different from the default operating settings. It then moves on to the consequential requirements for the shore infrastructure set up by the competent authority.

The justification for this appendix is to describe the potential for altering the VDL characteristics of mobile AIS equipment, the implications and the reasons why competent authorities may wish to do so.

It should be noted that channel management is an activity that requires careful planning and a tested recovery plan is recommended before proceeding to implement this feature of the AIS service.

2 CHANNEL MANAGEMENT

2.1 Fundamental concepts

In response to a request from IMO seeking global channels for AIS, the ITU designated two worldwide channels from the VHF maritime mobile band for this purpose (refer to ITU-R Radio Regulations (RR) Appendix 18). The channels are AIS1 – No. 2087 (161.975 MHz) and AIS2 – No. 2088 (162.025 MHz) - with 25 kHz bandwidth, and in accordance with Recommendation ITU-R M.1084. Two channels were selected to increase capacity and mitigate Radio Frequency (RF) interference. AIS1 is the ‘primary channel’ and AIS2 the ‘secondary channel’ in ‘high seas’ areas. This distinction will become relevant when considering some details of the transition between regions.

By default every mobile AIS station operates on these two channels, AIS 1 and AIS 2, as defined in Recommendation ITU-R M1371-4. A mobile AIS station is thus capable of receiving two messages, from two different stations concurrently, provided that it does not transmit at the same time. Every mobile AIS station transmits at its ‘nominal reporting interval’. This nominal reporting interval is given in ITU-R M.1371-4, Annex 1 §4.2.1. Each of the two channels by default is used to transmit scheduled transmissions, such as autonomous and continuous position reports, at half of the ‘nominal reporting interval’ e.g. a Class A shipborne mobile AIS station moving at a speed of more than 23 knots is supposed to report its position in intervals of 2 seconds. Therefore the nominal reporting interval would be once per two seconds. This means, that each of the two channels AIS1 and AIS2 will receive a scheduled position report from this mobile AIS station once every four seconds, i. e. at half the rate of the nominal reporting interval. To understand this fact is crucial for the understanding of the impact of channel management on reporting intervals. This behaviour is called dual channel operation.

It should be noted that it is recommended to perform channel management using the default values (see section 2.1.2) to decrease the risk of having mobiles using different parameters and bring back any rogue configuration to the default parameters.

2.1.1 Reasons for Channel Management

The ITU also provided for administrations to designate ‘regional frequency channels for AIS’ where channels 2087 and 2088 are unavailable and, if necessary, to derive new RR Appendix 18 channels using Recommendation ITU-R M.1084-4 (simplex use of duplex channels, note that the optional narrowband channels are no longer used by the AIS).

In addition channel management may be used to mitigate throughput breakdown caused by (local) RF interference, or blocking of one or both of the default operating channels by locally switching over to alternate operating channels.

2.1.2 Parameters subject to channel management and their default settings

The following operating parameters (of any mobile AIS station) may be changed by channel management. Also their default setting and range of possible settings are given (see Recommendation ITU-R M.1371-4, Annex 2, §4.1).

2.1.2.1 Frequency of operating Channels

1 Frequency of the primary operating channel = channel A (as expressed by channel number in accordance with Recommendation ITU-R M.1084-4).

a Default: channel number 2087 = AIS1.[1]

b Possible range: all channels of 25kHz nominal bandwidth which can be identified by a channel number given in Recommendation ITU-R M.1084-4. However, consider that the AIS Class B'CS' (refer to Annex 7of Rec. ITU-R M.1371-4) is only required to tune from 161.500 MHz to 162.025 MHz, and thus frequencies below 161.500 MHz should be avoided if possible. Local possibilities may depend on regulatory considerations.

2 Frequency of the secondary operating channel = channel B.

a Default: channel number 2088 = AIS2.[2]

b Possible range: refer to primary operating channel.

2.1.2.2 Transmitter power level setting

1 Default: high power level setting. Possible range: low power level setting = 1W; high power level settings = 12.5W for Class A, 5W for Class B 'SO' and 2W for Class B 'CS'.

2 Transmit/Receive mode:

3 Default: Dual channel operation (receive on both channels A and B simultaneously; transmit on channels A and B alternately, using half the nominal reporting interval on both channels A and B. Assigned mode may change the reporting interval of a mobile station without affecting the use of dual channels alternately.) = TxA/TxB; RxA/RxB

4 Possible range:

a (TxA/TxB, RxA/RxB).

b (TxA, RxA/RxB) = transmit only on primary operating channel (channel A) and receive on both channels simultaneously (while not transmitting).

c (TxB, RxA/RxB) = transmit only on secondary operating channel (channel B) and receive on both channels simultaneously (while not transmitting).

5 Transition zone size:

a Default: 5 nautical miles.

b Possible range: 1 to 8 nautical miles in steps of 1 nautical mile.

6 Addressed mode:

1 Narrow bandwidth is no longer supported as of ITU-R M.1371-4. Hence the option to change the bandwidth of AIS frequencies is no longer available as part of the channel management message (message 22)

2 See note 1.

3 Note: There is a slight ambiguity at the corners of the High Seas Transition Zone Boundary. Figure 2 is drawn using the 5 nautical mile distance from the region X boundary. Some equipment designers may use lines of constant latitude and longitude that are 5 nautical miles from the region X boundary. This would result in 90 degree corners

2 See note 1.

A base station can command specific channel management behaviour, using the above parameters, to an individual mobile AIS station.

7 Geographical region:

Region defining latitudes and longitudes - not only do these values establish the location and size of the region, they are also used to identify the region and the station characteristics data for that region. See below.

Channel management is performed, when mobile AIS stations are switched from their default operating settings to any different operating setting, which may only differ in one parameter.

The whole set of channel management settings and region specification is called ‘regional operating settings’.

The above list highlights that channel management is not just about changing operating frequencies. Channel management should rather be understood as the management of a multi-dimensional channel parameter space. The complexity of channel management results from the many inter-dependencies between these parameters.

2.1.3 The definition of a region and its transitional zone

Depending upon the geographic location of the station and the regional operating settings stored in memory, a mobile AIS station is supposed to automatically change several fundamental operating characteristics from their default values. This feature is designed into the operation of every mobile AIS station. This feature allows local authorities to automatically manage mobile AIS stations' use of the VHF marine band.

Channel management data is organised by geographic regions. This section describes how these geographic regions are defined. In fact, channel management in effect is *only* possible within *precisely defined geographical regions*. This means, that any channel management operation applies to the specified region, only. Mobile stations outside all regions, to which channel management settings apply, will either revert to, or continue to use the default settings.

The regional operating areas are designated by a Mercator projection rectangle with two reference points using WGS84 datum. The first reference point is the geographical co-ordinate address of the north-eastern corner (to the nearest tenth of a minute) and the second point is the geographical co-ordinate address of the south-western corner (to the nearest tenth of a minute) of the rectangle. Since it is an area on the curved surface of the earth, a region is not a true rectangle in shape. The sides of the region follow either constant latitude or longitude lines. A rectangular representation of this area is shown in.

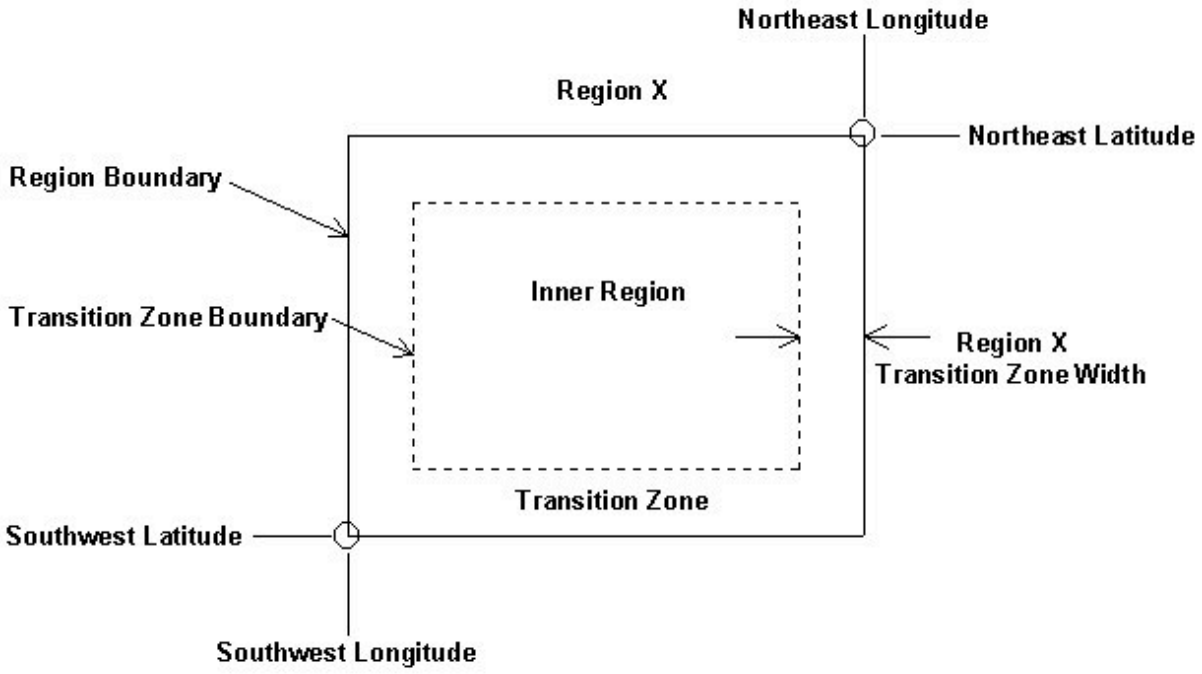


Figure 1 Rectangular representation of a region and its components

Inside every region's boundary there exists a 'transition zone.' The width of the transition zone is one of the parameters that are used to define the region. The transition zone for a region is the area between the 'Transition Zone Boundary' and 'Region Boundary' as shown in Figure 1. The transition zone width is specified in increments of one nautical mile and range of one to eight nautical miles. If no value is given in the region's definition, the default width is five nautical miles. The zone size is the same on the 4 inside borders of a region.

While the transition zone is expressively defined in ITU-R M.1371-4, Annex 2, §4.1.5, the portion of the region that is not inside the transition zone is not given a special name. In order to simplify the discussion below, the term 'Inner Region' will be used to refer to this area. This means that the area of a region can be described as being equal to the area of the transition zone plus the area of the inner region.

When the mobile AIS station receives different channel management commands for the same geographical region, the latest information received will be used in accordance with an algorithm described below.

Any Class A shipborne mobile AIS station can internally store information for eight different regions. This gives the possibility to 'download' to Class A shipborne mobile AIS stations information for several regions (for example covering inland waterways) from one shore station.

The AIS automatically changes to a transitional mode of operation when it is within the specified transitional zone which surrounds the region boundaries. In this zone ships transmit and receive on one of the channels for the area it is leaving and one of the channels for the area it is entering. Within the transitional zone, the reporting interval will be the nominal reporting interval for *both* channels (as opposed to just half the nominal reporting interval in each individual channel during default dual channel operation).

Within the transitional zone, Class A shipborne mobile AIS stations will ignore any assignment of higher nominal reporting intervals by shore stations. This guarantees that the broadcasts of mobile AIS stations operating in the transition zone will be received at nominal reporting interval for the benefit of other mobile stations in the immediate vicinity of that station.

The precise details of the behaviour of a mobile AIS station within a transition zone are described below.

2.1.4 A Region's relationship to the high seas (or default) region

The ‘high seas’ or default region has the primary channel of AIS1, and the secondary channel of AIS2. The size of the transition zone is 5 nautical miles. The power level is ‘high power’ and all of the mobile AIS station‘s receivers and the frequency-agile transmitter are used. Figure 2 shows the relationship of Region X from Figure 1 and the high seas region.

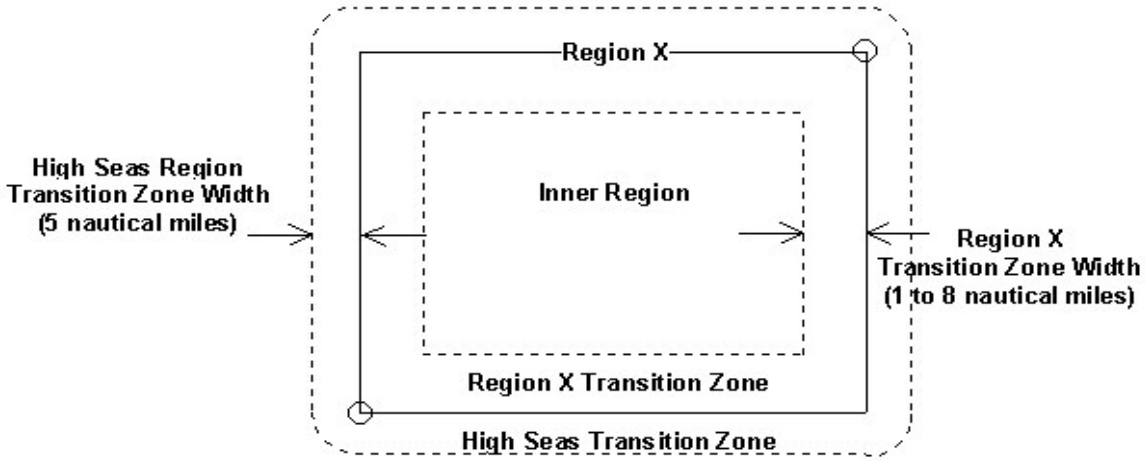


Figure 2 Relationship of region X to the High Seas Region

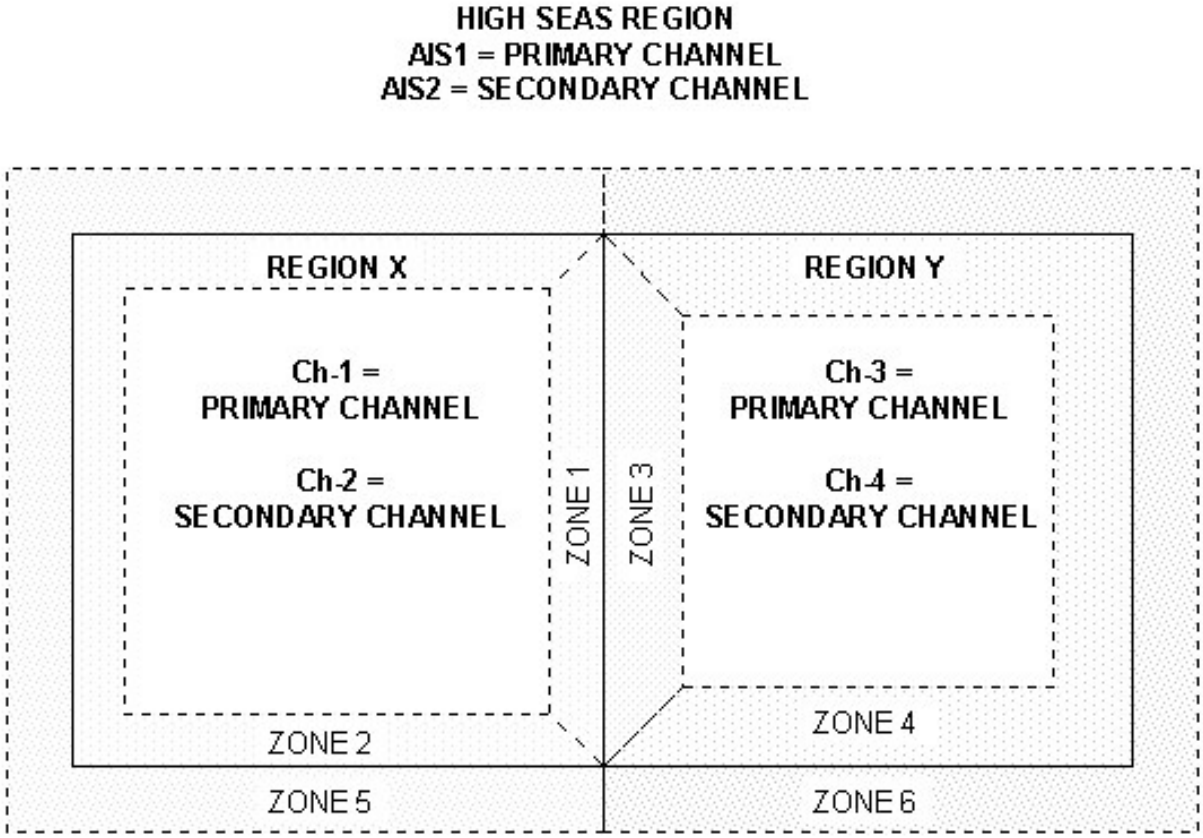


Figure 3 Breakdown of operating zones for two adjacent regions

The high seas region's regional operating settings are all equal to the default values. They cannot be changed by channel management. Channel management data can only create additional regions that exist within the high seas region. Wherever a defined region is created, if not adjacent to another defined region, this relationship with the high seas region is automatically created.[3]

2.1.5 Two Regions' relationship including the High Seas Region

If two regions are defined with either a latitude or longitude boundary exactly the same, to 1/10 minute, the two regions exist adjacent to each other (see the common side of Region X and Region Y in Figure 3). If the boundary of a region falls inside the boundary of another region, the regions conflict and a decision about which region to use must be made by the mobile AIS station. Recommendation ITU-R M.1371-4, Annex 2, § 4.1.8, states, 'The most current and applicable commands received should override previous channel management commands.' Applying this rule would mean the most current regional definition would apply and the older definition ignored. This also implies that the data and time that a region's data is received should be retained along with the region's data.

Figure 3 shows two adjacent regions, Region X and Region Y, surrounded by the high seas region. The Region X transition zone is further broken down into zone 1 and zone 2. Zone 1 is the portion of the Region X transition zone nearest to the boundary in common with Region Y. Zone 2 is the portion of the Region X transition zone nearest to the boundary in common with the high seas region. Recognition, that the transition zone may be sub-divided depending on the relationship it has with adjacent regions, is important to understanding how a mobile AIS station will safely operate as it travels between and among regions that use different radio frequencies, power, etc.

3 Note: There is a slight ambiguity at the corners of the High Seas Transition Zone Boundary. Figure 2 is drawn using the 5 nautical mile distance from the region X boundary. Some equipment designers may use lines of constant latitude and longitude that are 5 nautical miles from the region X boundary. This would result in 90 degree corners rather than constant radius corners. These optional interpretations do not represent a significant operational safety issue. Because accurate curved lines are difficult to draw, the remaining diagrams will use 'square' corners on the high seas transition zone boundary - with this ambiguity implied.

In a similar fashion, the Region Y transition zone is broken down into zone 3 and zone 4; and the high seas region's transition zone is broken down into zone 5 and zone 6.

How a mobile AIS station will safely operate as it travels between and among regions will be described in detail below, using the above definitions.

2.1.6 IMO requires maximum extent of automated channel management

The AIS is designed as an automatic system. Accordingly, even operating conditions that differ from the default, such as channel management should be automated as much as possible. This is in full accordance with the appropriate IMO guidance (refer to IMO/NAV47 'Draft Liaison Statement to ITU-R Working Party 8B', which is Annex 15 of document NAV47/13, 26 July 2001, paragraph 1.2):

> 'IMO notes that there may be areas where alternative frequencies are in use but where no base stations exist. This should be an unusual situation, however where it exists, information should be available to all ships sailing in these areas. Therefore, IMO requests that all Administrations notify IMO of these areas for the circulation by the appropriate IMO circulars as well as promulgate this information to shipping in these areas by a suitable means. Also IMO recognises that from the viewpoint of avoiding accidents due to human error, automatic switching should be the normal procedure and manual switching should be limited to specific purposes such as maintenance for the equipment.'

This statement clearly applies to both shipboard and shore side.

2.1.7 Overview on means for automatic and manual channel management

Automatic switching of regional operating settings for mobile AIS stations can be done by one of the three means described below. Automatic switching is considered a safer way than manual switching. Among the automatic means, there are two ways to switch regional operating settings from the shore by the competent authority and one automated way to switch regional operating settings on board the ship.

A competent authority may set up AIS shore stations utilising the internal BAS 'VDL channel management', that uses Message 22 ('Channel Management message') and that gives information of region boundaries, channels and other parameters to be used within the region. The internal BAS 'VDL channel management' also provides a service that requests the DSC service to transmit a channel management command via DSC Channel 70.

In addition, a shipborne information system, which may be connected to the AIS, may input regional operating settings to the AIS. This information may be derived automatically from i.e. a database or from a manual input to this shipborne information system.

Manual channel switching by the AIS operator on the ship can be performed via any suitable interface. The Class A shipborne mobile AIS station provides for manual inputs via the Minimum Keyboard and Display.

Manual channel switching should be avoided if possible, in normal operation and should only be based on information issued by the competent authority of that region (see IMO statement in section 2.1.6).

The database of the shipborne information system may not fully reflect the current regional operating settings required for the particular region, or the manual input may be flawed. Therefore, regional operating settings received from a shipborne information system or by manual input, will not be accepted by a Class A shipborne mobile AIS station, if a regional operating setting was received for the same region from a shore station recently.

2.1.8 Channel management as a privilege and as a responsibility for competent authorities

Since the exchange of navigational data between ships and between ship and shore can only be done when both the transmitting and the receiving station use the same channel with compatible operating settings, a wrong operating setting in just one mobile AIS station may result in it being

'invisible' as far as the AIS service is concerned. This may be a safety issue. Therefore, ITU only allows competent authorities to undertake channel management.

Since channel management is one of the most complex of the AIS functionalities and since channel management, when done wrongly, can be potentially hazardous to safety, it is strongly recommended that every competent authority should consider the use of channel management carefully before implementing it. As a consequence, careful planning is required before a Competent Authority implements a Channel Management scheme.

2.1.9 Channel management commands to a Class A shipborne mobile AIS station

All Class A shipborne mobile AIS stations are using the following algorithm to keep the internal eight store memory up to date and to accept new regional operating settings. This algorithm, in general, has three different stages:

1 Continuous checking of stored regional operating settings, and possibly automatic erasure of remote or old settings.

2 Checking of input before accepting it as new regional operating settings. It should be noted, that this is an exception from one fundamental concept of shipborne equipment design, i.e. that the receiving device normally does not check the data it is receiving. For example, the mobile AIS station does not check the sensor data it receives for reporting.

3 Operations performed after a new regional operating setting has been accepted.

In detail the Class A shipborne mobile AIS station will perform the following steps (in the following order, if applicable):

1 All stored regional operating settings will be time/date-tagged and they will be tagged with information by what input means this regional operating setting was received onboard (via AIS VDL, DSC telecommand, Manual input via Minimum Keyboard and Display (MKD), input via Presentation Interface).

2 The Class A shipborne mobile AIS station constantly checks, if the nearest boundary of the region of any stored regional operating setting is more than 500 nautical miles away from its current position, or if any stored regional operating setting was older than 24 hours. Any stored regional operating setting which fulfils any one of these conditions will be erased from the memory. This means, that the AIS station automatically 'forgets'.

3 Any regional operating settings will be handled as a whole, i.e. a change requested for any parameter of the regional operating settings will be interpreted as a new regional operating setting input to the device.

4 When the mariner requests to manually input a regional operating setting via the MKD, the regional operating settings in use, which may be the default operating settings, will be presented to the user on the MKD. The mariner will then be allowed to edit these settings partly or in full. The Class A shipborne mobile AIS station will always ensure that a manually input region conforms to the most fundamental rules for regions. After completion of input of an acceptable regional operating settings set, the Class A shipborne AIS station will require the mariner to confirm a second time that the input data shall be stored and possibly used instantaneously.

5 Regardless of means of input, automatic or manual, the Class A shipborne AIS station will ignore any new regional operating setting which includes a region, which does not conform to the most fundamental rules for regions. In addition, it will not accept a new regional operating setting, which was input to it via its Presentation Interface, if the area of this new regional operating setting partly or totally overlaps the areas of any of the stored regional operating settings, which were received from a base station via AIS VDL or by DSC telecommand within the last two hours.

6 A channel management command or a DSC telecommand addressed to one individual Class A shipborne mobile AIS station will be accepted only if that station is in a region defined by one of the stored regional operating settings. In this case the set of regional operating

settings will be composed by combining the received parameters with the stored region in use. A channel management command addressed to an individual Class A shipborne mobile AIS station will not be accepted for the high seas area.

7 If the area of the new, accepted regional operating setting partly or totally overlaps the area of one or more older regional operating settings, this or these older regions will be erased instantaneously from the memory ('overlap' rule). The region of the new, accepted regional operating setting may be adjacent and may thus have the same boundaries as older regional operating settings. This will not lead to the erasure of the older regional operating settings.

8 Subsequently the Class A shipborne mobile AIS station will store a new, accepted regional operating setting in one free memory location of the eight memories for regional operating settings. If there is no free memory location, the oldest regional operating setting will be replaced by the new, accepted one.

9 No means other than defined herein are allowed to clear any or all of the stored regional operating settings of the Class A shipborne AIS station. In particular, it is not possible to solely clear any or all of the stored regional operating settings by a manual input via the MKD or by an input via the Presentation Interface without input of a new regional operating setting.

There is not yet a similar algorithm developed for other classes of mobile equipment, except the most fundamental rules in Recommendation ITU-R M.1371-4, Annex 2 §4.1.8. A new algorithm to improve overall efficiency and safety of using channel management is being proposed and is shown in ANNEX B.

2.1.10 Behaviour of a shipborne mobile AIS station entering or moving in a channel management scheme

When a mobile AIS station enters a transition zone, it changes operation to the 'two-channel transitional operating mode.' How the mobile AIS station operates among zones and regions will now be discussed. In particular, how the mobile AIS station schedules periodic repeated messages.

'Two-channel transitional operating mode' is entered when there is a change of operating frequency from one region to the next. This mode of operation begins when a transition zone is entered. There are three exceptions to this rule:

1 If the regional operating settings in both regions use the same channels, operation in the 'two-channel transitional operating mode' is not necessary.

2 If the primary channel is the same in both regions, the mobile AIS station should use only that single primary channel at nominal reporting interval while operating in the 'two-channel transitional operating mode'.

3 If the primary channel in one region is the same as the secondary channel in the other region and that secondary channel is a simplex channel, the mobile AIS station should use only that channel at the nominal reporting interval while operating in the 'two-channel transitional operating mode.'

2.1.11 Description of mobile AIS station operation in the 'two-channel transitional operating mode'

The following describes the operation of a mobile AIS station as it moves between Regions X and Y through zones 1 and 3 of Figure 3. The possible movements of the station are shown with notes describing changes to the station's operation.

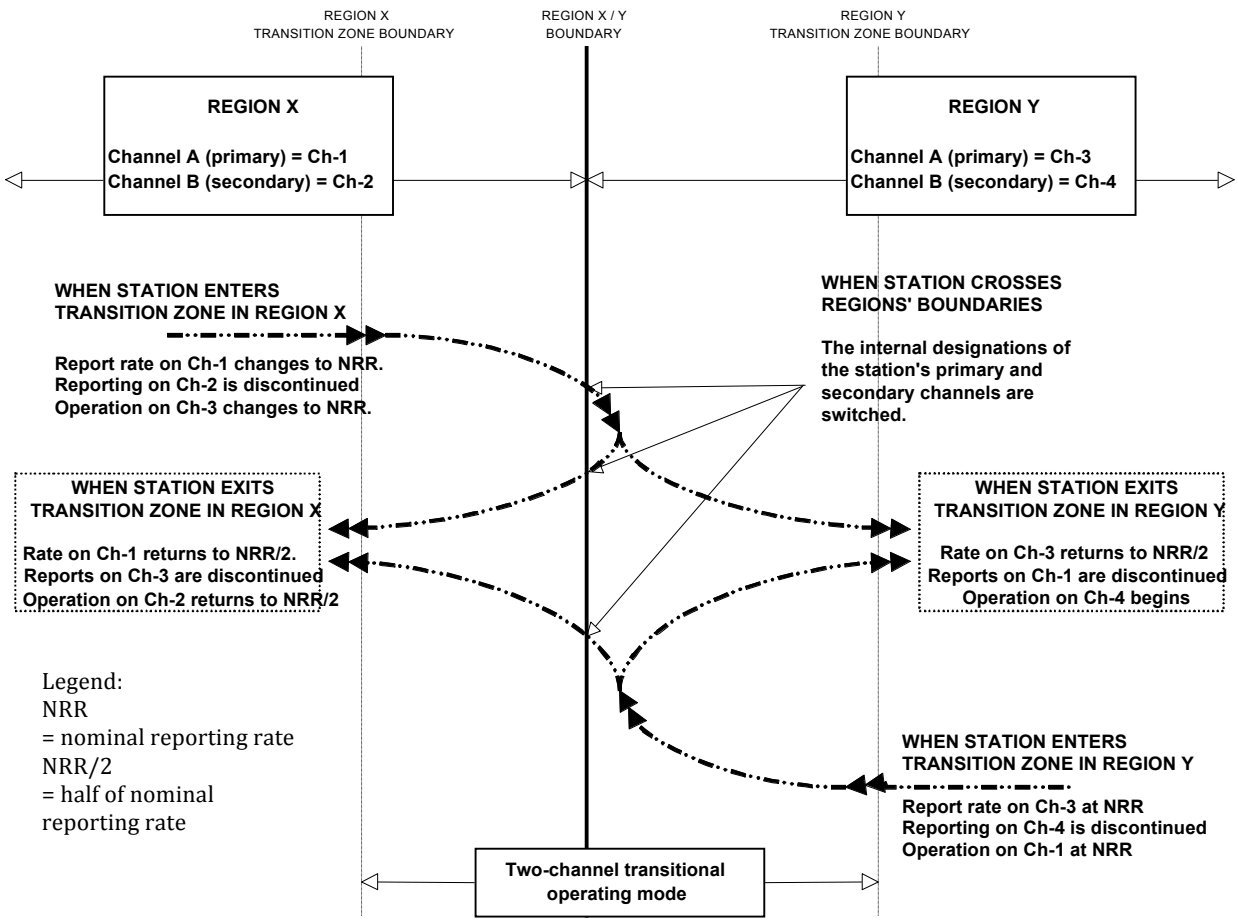


Figure 4 Expected operation of a mobile AIS station in 'two-channel transitional operating mode'

Upon entering the transition zones between two regions, the mobile AIS station should switch to the 'two-channel transitional operating mode' by:

1 Switching the secondary receiver channel to the primary channel of the adjacent region and begin initialisation phase. while,

2 Continuing to broadcast and receive on the primary channel (channel A) for the occupied region for one minute, and broadcast on the secondary channel (channel B) for one minute closing out the previously reserved slots.

3 Increasing the reporting interval on channel A to the nominal reporting interval, and after the first minute.

4 Beginning broadcasts on the adjacent region's primary channel - at the nominal reporting interval.

Note: While inside the transition zones, the mobile AIS station's primary channel (channel A) is defined as the primary channel for the region that the mobile AIS station is inside at any given moment. The mobile AIS station should use this rule to change the primary channel, as needed, while it is in the 'two-channel transitional operating mode.' While inside the transition zones, the mobile AIS station's secondary channel (channel B) is defined to be the primary channel (channel A) of the nearest adjacent region. This rule should be used, as needed, to change the secondary channel while the mobile AIS station is in the 'two-channel transitional operating mode.'

Upon exit of the transition zones, the mobile AIS station should discontinue 'two-channel transitional operating mode' by:

1 Switching the secondary receiver channel to the secondary channel of the occupied region and begin initialisation phase.

2 Decreasing the reporting interval on the primary channel (channel A) for the occupied region to half of the normal channel reporting interval (this will take about one minute), and

broadcast on the secondary channel (channel B) for one minute closing out the previously reserved slots, then,

3 Beginning broadcast on the secondary channel - at half of the nominal reporting interval.

2.1.12 Operation of a mobile AIS station moving between and among three regions

The description of mobile AIS station operation during movement between two regions can be used to describe more complex relationships. As described above, once a mobile AIS station enters the transition zone, it operates at nominal reporting interval on both the primary channel for the region it is in, and the primary channel for the next closest region. This is the rule used to draw the zones of Figure 5. Figure 5 repeats Figure 3 and is followed by Table 1, which indicates the proper operating channels for each of the zones in the figure. In this example the third region is the high seas region.

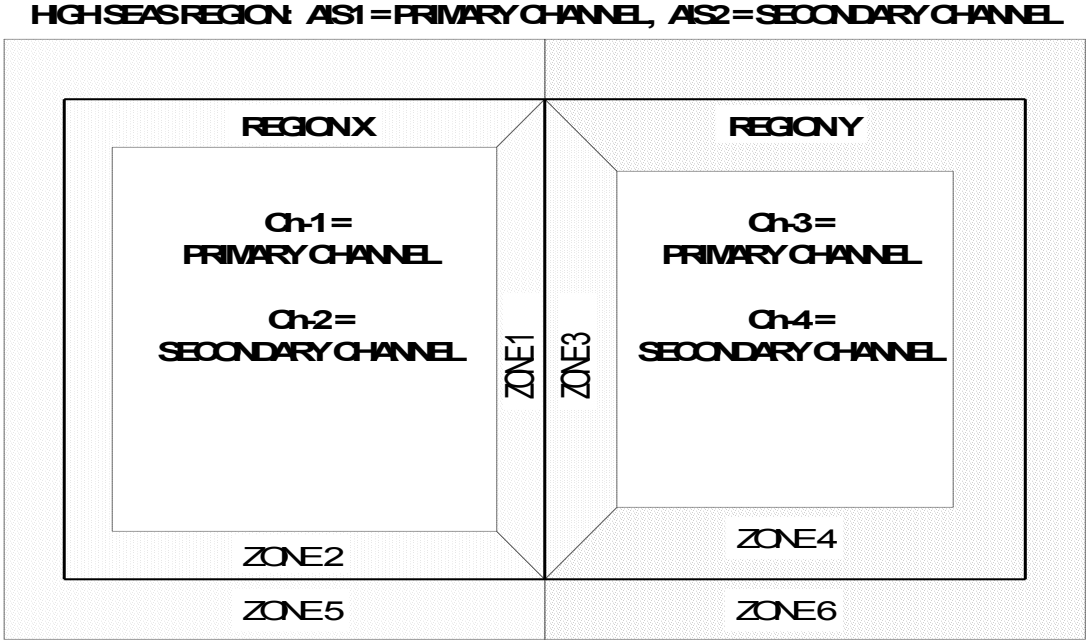


Figure 5 Channel selections for transition zone operation

Table 1 Proper operating channels for each of the zones in Figure 5

Location of mobile AIS station	Primary channel	Primary channel reporting interval	Secondary channel	Secondary channel reporting interval
ZONE 1	Ch-1	NRR	Ch-3	NRR
ZONE 2	Ch-1	NRR	AIS1	NRR
ZONE 3	Ch-3	NRR	Ch-1	NRR
ZONE 4	Ch-3	NRR	AIS1	NRR
ZONE 5	AIS1	NRR	Ch-1	NRR
ZONE 6	AIS1	NRR	Ch-3	NRR

Using the table in Figure 5 and the concepts described in Figure 5, the operation of a mobile AIS station can be described for any possible movements between and among the three regions of Figure 5. For example, Table 2 shows the channel selection and reporting intervals during mobile AIS station movement between the regions described below:

- Start in Region X;
- Enter zone 1;
- Cross into zone 3;
- Cross into zone 4;

- Cross into zone 6;
- Exit into high seas region.

Table 2 Example of channel selection and reporting intervals during mobile AIS station movement between regions

Step	Movement of mobile AIS station	Primary channel	Primary channel reporting interval	Secondary channel	Secondary channel reporting interval
1	REGION X	Ch-1	NRR/2	Ch-2	NRR/2
2	ZONE 1	Ch-1	NRR	Ch-3	NRR
3	ZONE 3	Ch-3	NRR	Ch-1	NRR
4	ZONE 4	Ch-3	NRR	AIS1	NRR
5	ZONE 6	AIS1	NRR	Ch-3	NRR
6	HIGH SEAS REGION	AIS1	NRR/2	AIS2	NRR/2

Other examples can be similarly constructed and analysed. Under all combinations and circumstances, the station must have one channel in common with nearby stations.

2.1.13 Single-channel operation

The possibility of single-channel AIS operation is briefly addressed under the parameter Tx/Rx Mode. Little, if any, information is given elsewhere in the ITU recommendations. Conditions that may warrant single-channel operation include areas with severe spectrum limitations and remote waterways with little marine traffic.

If the Region Y secondary channel (Ch-4) is not defined, Figure 5 can be used to describe how the mobile AIS station should operate as it moves from any location in Figure 5 into the inner region of Region Y. For example, Table 3 shows channel selection and reporting intervals during mobile AIS station movement between region X and region Y, when region Y secondary channel is not defined:

- Start in Region X;
- Enter zone 1;
- Cross into zone 3;
- Exit into Region Y's inner region.

Table 3 Example of channel selection and reporting intervals during mobile AIS station movement between region X and region Y, when region Y secondary channel is not defined

Step	Movement of mobile AIS station	Primary channel	Primary channel reporting interval	Secondary channel	Secondary channel reporting interval
1	REGION X	Ch-1	NRR/2	Ch-2	NRR/2
2	ZONE 1	Ch-1	NRR	Ch-3	NRR
3	ZONE 3	Ch-3	NRR	Ch-1	NRR
4	REGION Y	Ch-3	NRR/2	None	N/A

2.2 Requirements and recommendations for competent authorities with regard to implementing channel management

After this description of how the mobile stations operate within a given frequency management scheme, it becomes obvious, that the regional operating settings should be set up by the competent authority in such a way that the transition between the different regions is safe. The onus for safe and proper channel management is on the competent authority. The following sections will focus on the considerations to account for when doing channel management.

2.2.1 Fundamental recommendations (Golden rules)

These fundamental recommendations must be considered before implementing channel management. Competent authorities should ensure that proper justifications have been identified and carefully evaluated before choosing not to follow the following recommendations:

1 Any channel management configuration should keep the primary AIS channel on AIS 1 or AIS 2 (default frequencies).

2 The primary AIS channel should be the same for adjacent channel management zones.

2.2.2 Fundamental layout rules for when planning regions

In order to fulfil this requirement the competent authority should make sure that the following conditions are met (requirements taken directly from Recommendation ITU-R M.1371-4 Annex 2 §4.1.5 or inferred from description above):

1 For practical reasons, in order to provide safe transitions between regions, the regions should not be smaller than 20 nautical miles but not larger than 200 nautical miles on any boundary side (from ITU-R M.1371-4 Annex 2 §4.1.5). However, the regions of 21 to 190 nautical miles on any boundary side is strongly recommended to avoid unsafe behaviour of the mobile AIS stations, such as some accept and some reject the channel management due to the boundary size calculation accuracies from geographical coordinates.

2 The boundaries of adjacent regions need to be identical. A gap between adjacent regions, however small, will be interpreted by mobile AIS stations as a combination of three regions in total: two regions with regional operating settings different from default, separated by the ‘high seas’ region. Therefore, the mobile station will enter the transition zone behaviour of three different regions when moving from one region to the other through the ‘high seas’ region.

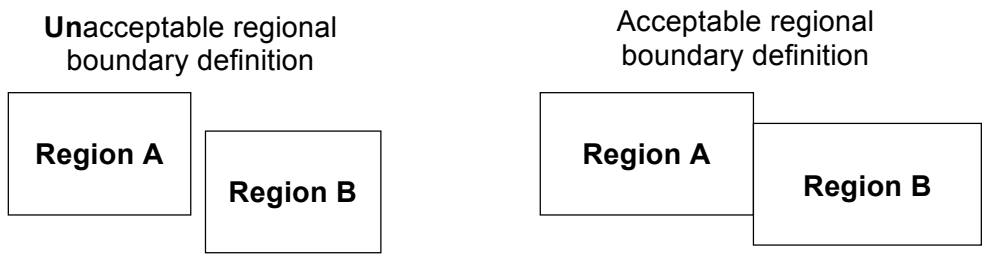


Figure 6 Neighbouring regions

The distance between regions, which are meant to be neighbouring, but not to be strictly adjacent, should be at least the sum of the size of the transition zones of the two regions plus one nautical mile.

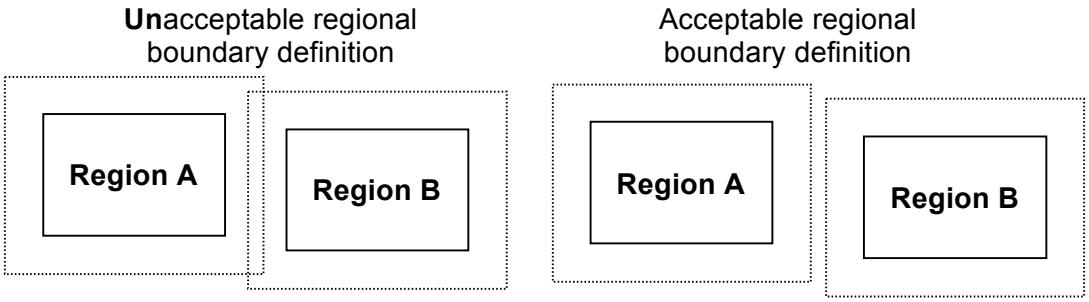


Figure 7 Transitional zones

Having more than three adjacent regions at any regional boundary intersection must be avoided. When there are three or more adjacent regions, the minimum distance between the first and the second adjacent corners on one side and any other corner should be at least 8 nautical miles (which is the maximum size of a transition zone). This 8-miles-distance rule will be checked by the Class A shipborne mobile station before accepting a new regional operating setting.

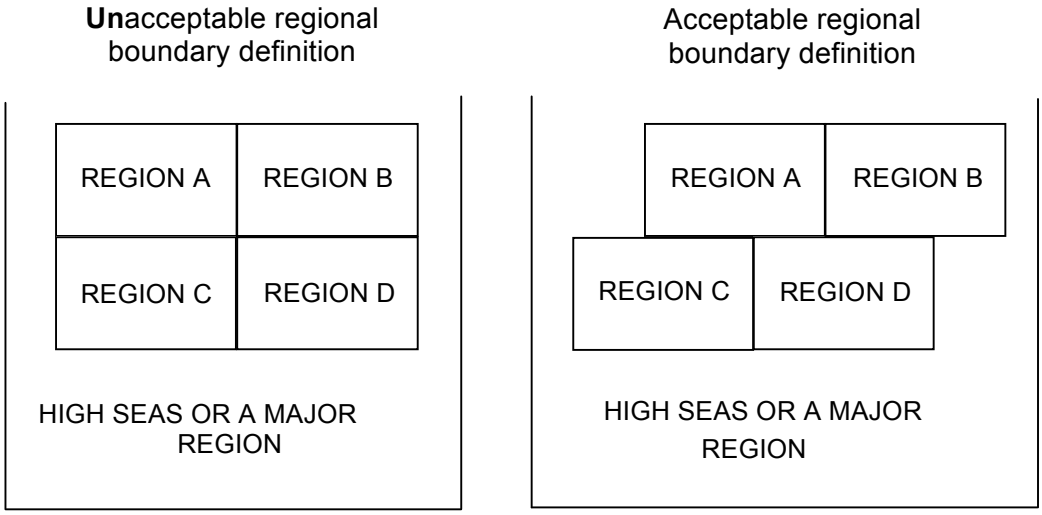


Figure 8 Multiple regions

The region rules and general operation of the mobile AIS station are designed to successfully operate under the 'worst case' conditions where every channel in every region is different. Although the AIS technology and methods adequately deal with these possible conditions, the actual application of channel management should recognise that AIS channel management is safest when the primary channel of the regions is either AIS1 or AIS2.

2.2.3 General considerations for channel management

There are 3 conditions to consider when doing channel management. Once a competent authority has designed a channel management strategy, it should review each one of the following conditions to identify how the proposed strategy addresses these conditions and what are the risks involved.

1 Condition A: AIS participants in the channel management region, already compliant to the channel management configuration. These participants need to have the channel management configuration renewed periodically.

2 Condition B: AIS participants in adjacent channel management regions, using a different channel management configuration. These participants need to be informed of the channel management configuration that will take effect when they reach the transition zone between regions.

3 Condition C: AIS participants in the channel management region who are not yet part or compliant with the channel management configuration. These participants can include a new AIS transponder just installed that will, by default, use channels AIS1 and AIS2 or AIS participants not able to perform channel management such as AIS-SART devices and Class B 'CS'[4]. These participants need to be informed of the channel management configuration that should be used in their zone and/or be ensured that their transmissions will be received by other participants compliant with the channel management configuration (condition A) and vice versa.

These conditions are especially important when the golden rules cannot be respected and both channels need to be changed between adjacent regions.

It is also very important to consider that some AIS stations will not respond to Channel Management commands. In particular, AIS AtoN Stations, AIS Base Stations, AIS Repeater Stations will need to be configured to use the correct parameters within the channel management scheme.

2.2.4 Size of the transition zone

If both channels need to be changed between adjacent regions (and this is extremely dangerous and strongly discouraged), it is also important to pay special attention to the size of the transition zone. In effect, AIS participants that have not yet entered the transition zone will be unable to receive transmission of participants in the adjacent region that are also not in the transition zone. If the transition zone is very small, e.g. 1 nautical mile for both regions, ships in different regions will have to be within 2 nautical miles of each other to receive each other's transmission.

This effect is called the transition zone wall. Participants on one side of the wall are not aware of what is happening on the other side of the wall.

Hence, when both channels need to be changed between adjacent regions, the size of the transition zone should never be below 5 nautical miles for each region. The competent authority in charge of setting the transition zone should proceed to a safety evaluation of the particular sector considering typical ship speed, weather conditions and other risk factors to establish the appropriate transition zone size to ensure safety.

2.2.5 Channel management by base stations

It is strongly recommended – in full accordance with the IMO guidance cited above - that all areas where the default operating settings does not apply should be covered by AIS shore stations utilising the internal BAS 'VDL channel management', that uses Message 22 ('Channel Management Message'), and that gives information of region boundaries, channels and other parameters to be used within the region. Hence, complete VHF coverage of the area is

4 Class B 'CS' devices are allowed to be half-band devices and include DSC. Competent authorities should be aware that since Class B 'CS' devices are half-band devices, channel management performed on the devices will be limited to the range of acceptable frequencies.

recommended. The same BAS also provides a service to transmit a channel management command via DSC Channel 70. Both methods of doing channel management, DSC and AIS, are explored in the sections below.

Base Stations that provide channel management service in regional operating areas should use only one of the above mentioned methods for a given area and all regions surrounding that area.

It is recommended that Message 22 should be used by a competent authority for all regions at least once per epoch (6 minutes) per channel. The actual rate should depend upon the speed of vessels within regional transition zones.

2.2.5.1 Channel management by base station using DSC

Using DSC to perform AIS channel management can somewhat simplify the task for competent authorities since AIS participants capable of doing channel management will maintain a constant monitoring of the DSC channel for new channel management commands[5]. Hence, changes in channel management are easily transmitted to AIS participants. Using DSC, competent authorities will have to:

1 Broadcast regular channel management messages on the DSC channel within the region itself to renew channel management configuration for participants already using the specified configuration (Conditions A & C – participants able to do channel management).

2 Broadcast regular channel management messages on the DSC channel in all adjacent regions for incoming participants to be aware of the specified configuration for this region (Condition B).

3 Maintain constant monitoring of AIS1 and AIS2 channels within the region to ensure reception of AIS messages from AIS participant not able to comply to channel management (Condition C – AIS SART and Class B 'CS').[6]

4 Ensure that the total load of safety and urgency traffic does not exceed 0.075 Erlangs on the DSC channel, according to ITU-R M.822-1 §2.2.3.

5 Use both broadcast DSC channel management commands and assigned DSC channel management commands.[7]

It is important to realize that maintaining constant monitoring of AIS1 and AIS2 channels within the region might be impossible and/or not very efficient, especially if the region's channels were changed because of unavailability of frequencies or interference.

An important aspect to consider is that AIS participants in condition C that cannot comply with the channel management configuration will be unable to receive and be received by other participants that do comply.

Examples of how to perform DSC channel management using AIS base stations are available in ANNEX A of this Appendix.

2.2.5.2 Channel management by base station using AIS

When exclusively using AIS to perform channel management, additional considerations must be taken to ensure proper behaviour of AIS participants. Using AIS to perform channel management, competent authorities will need to:

[5] Class B AIS devices only receive on Ch 70 for specified time durations per hour, this is defined in ITU-R M. 1371-4 Annex 7, Table 42

6 May not be required if the golden rules are respected.

7 Competent authorities wishing to perform channel management using DSC should be aware that according to tests run by the USCG, not all AIS transponders will accept broadcast channel management commands on DSC channel. Hence, it is recommended to also broadcast assigned DSC channel management commands. When using assigned messages, it is important to know that not all ships have the capacity to send acknowledgments and that authorities should not necessarily wait for the acknowledgement or rebroadcasted the assigned command if no acknowledgement is received.

1 Broadcast regular channel management messages on the specified AIS channels within the region itself to renew channel management configuration for participants already using the specified configuration (Condition A).

2 Broadcast regular channel management messages in all adjacent regions on their respective frequencies for incoming participants to be aware of the specified configuration for this region (Condition B).

3 Broadcast regular channel management messages on the default AIS channels within the region itself to inform participants on default AIS channels of the channel management configuration for this region (Condition C – participants that have not received previous channel management commands).

4 Maintain constant monitoring of AIS1 and AIS2 channels within the region to ensure reception of AIS messages from AIS participant not able to comply to channel management (Condition C – AIS SART and Class B 'CS').

The last points may not be required if the golden rules are respected.

As with DSC, it is important to realize that broadcasting channel management messages and maintaining constant monitoring on AIS1 and AIS2 channels within the region might be impossible and/or not very efficient, especially if the region's channels were changed because of unavailability of frequencies or interference.

An important aspect to consider is that AIS participants in condition C that cannot comply with the channel management configuration will be unable to receive and be received by other participants that do comply.

2.2.6 Conflicting channel management

A channel management conflict is defined as two zones having at least one different parameter (including geographical coordinates). There are a number of reasons why a channel management conflict might occur:

- Problem with configuration;
- Problem with coordination between competent authorities;
- Ill-intentioned party wishing to interfere with AIS operations.

The current rules and algorithm used by Class A units are described in section 2.1.10 of this document.

A new algorithm is being proposed by ITU to deal more safely and efficiently with channel management commands, especially when receiving conflicting channel management commands. This new algorithm, which has not yet been implemented, is shown in ANNEX B of this Appendix.

2.2.7 Change of regional operating settings over time

The change of regional operating settings over time may be required in some situations. Although this potential of the AIS needs much more investigation, some fundamental principles can be stated already.

2.2.8 Recommendations for change of regional operating settings over time

Since the Class A mobile AIS station stores regional operating settings for up to 24 hours, carefully planned overwriting of the older, stored regional operating settings is needed when there are changes required for the same area over time.

Channel management regions should only be changed – for safety reasons - over a longer period of time, i.e. in the order of half-hours instead of minutes.

The steps should be carefully planned beforehand, and the effects of any change should be well understood before implementing it. After one change step the system should be allowed to return to a stationary mode, i.e. all transitional states should have had time to subside. When there is a

need to change operating frequencies within a region, there should be a minimum time period of 9 minutes, 12 minutes (2 epochs) is recommended, after the first operating frequency has been changed before the second operating frequency is changed (refer to Recommendation ITU-R M.1371-4, Annex 2, §4.1.9).

Base stations should never change two channels (A and B) simultaneously within any region. Whenever possible, it is recommended to keep one of the two working frequencies on AIS1 or AIS2 to facilitate transition from one zone to the other, especially with high seas (defaults) areas.

2.2.9 Procedures to change regions over time: Changes in region boundaries

Two possible changes of regional boundaries apply:

1 A region will be deleted, i.e. operation is intended to return to default if the competent authority determines, that a region should no longer exist as a defined region, and the settings of that region should be changed to the default settings, the procedure as described as follows should be applied for that particular region.

A channel management command must be transmitted by a base station to change the first operational frequency and all other parameters except the second operating frequency set to the default values, followed by a second channel management message after at least 9 minutes, 12 minutes recommended, to change the second operational frequency.

a The region (geographical area) should be identical in size and location as the region to be deleted.

b Even if all AIS stations in that region are using the new operational frequencies, periodical channel management messages set to the default settings are recommended.

c The regional operating settings, which are stored in the memory of the AIS participants, will then be deleted in accordance with the algorithm given above, i. e. after 24 hours latest.

2 A region will be moved or a new region will overlap the current region.

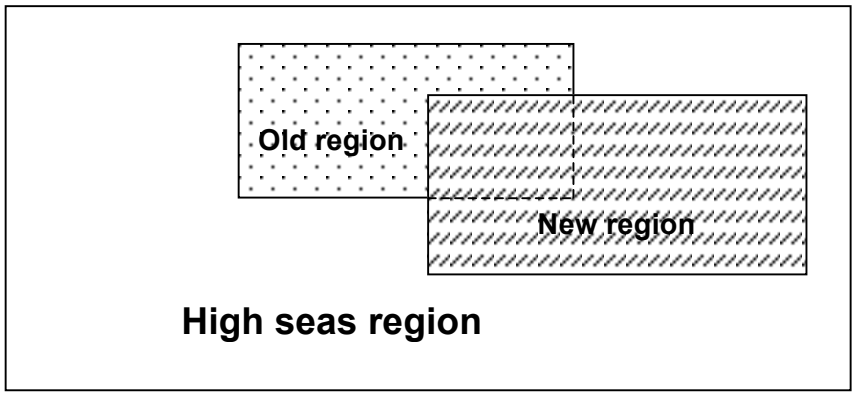


Figure 9 Overlapping regions

The picture illustrates the possible movement of a region from the old position to the new position. The same applies if a new region overlaps the old region. Any new region that partially overlaps and old region, overwrites the stored old region as a whole immediately (refer to description of memory algorithm above). All mobiles, which have been in an old region and are no longer in any specifically region – because the old region has been overwritten – would automatically be in 'high seas' and would thus use default settings for *all* parameters immediately.

Therefore, the change from old to new could be accomplished in one step. While this may be desired with some parameters other than operating frequency or just one operating frequency to be returned to default, this would not be a safe procedure. It is recommended to proceed with a step-by-step approach, where the old region would first be deleted (see algorithm above) and then

(after 2 epochs) the new region would be created with the appropriate settings. Concerns expressed in the previous sections should also be considered before attempting such a change.

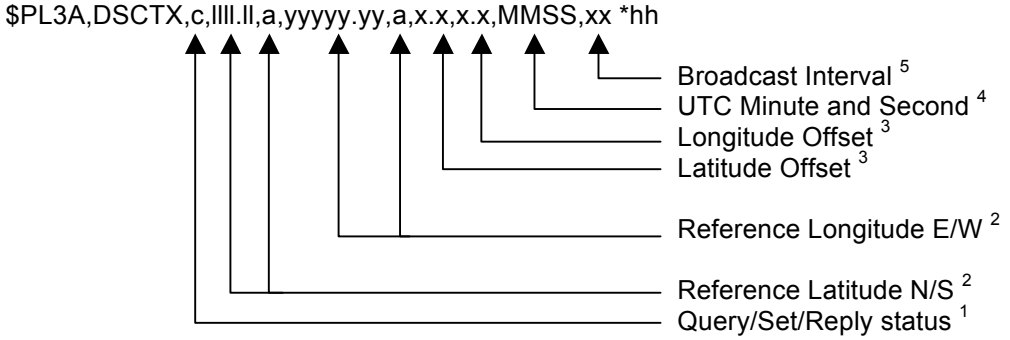
Note: AIS equipment may operate on a *subset* of the VHF Maritime Band (ITU-R M.1371-4, Annex 1, §5), yet, most AIS Class A and Class B (ITU-R M.1371-4, Annex 7, §3.2) units are able to tune to the *entire* VHF Maritime Band (RR Appendix 18).

ANNEX A EXAMPLE OF CHANNEL MANAGEMENT BY A BASE STATION USING DSC

Base Stations may be used for DSC channel management on channel 70 to perform broadcast and addressed channel management transmissions. The following sentences may be used to support this operation:

1 BROADCAST CHANNEL MANAGEMENT

The content for the Broadcast Channel Management transmission will come from the IEC ACA sentence which is also used to configure the VDL Message 22. Additional information required to transmit the DSC message will come from a proprietary sentence specific to the equipment in use. For example, some base stations use the $PL3A sentence 'DSCTX'. The new sentence will include the geographical area for the DSC calling address and the broadcast interval for the transmission. The transmit interval will have a range of 1 to 60 minutes. If more than one channel management area is defined, then the base station will cycle through them one at a time as defined by the transmit interval.



Note 1: This field is used to indicate if this is a command sent to the base station, if this is a query for the information or if this is a reply from the base station.

'S' – Set the data in the base station.
'Q' – Query the information from the base station.
'R' – Reply from the base station.

Note 2: The North/West corner Latitude/Longitude for VTS Area call address.

Note 3: The offset in minutes from the reference location which defines the VTS Area call address, valid range 00.00 – 99.99.

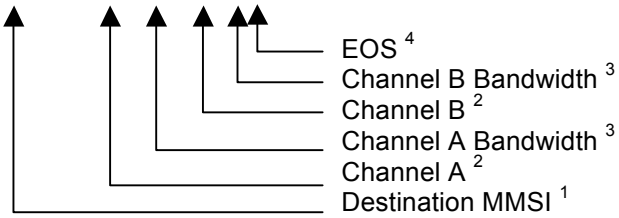
Note 4: UTC Minute and Second reference. This is the reference point within the UTC Hour that the DSC transmission will start its channel access. Note that the DSC transmission are subject to the VDL transmit schedule of the base station which may cause a delay in the DSC transmission. This delay can be up to 15 seconds.

Note 5: The broadcast interval for channel 70 transmissions in minutes, valid range 0 – 60, 0 – disable transmit. Then interval must map evenly within a 60 minute frame (Interval Modulo 60 = 0).

2 ADDRESSED CHANNEL MANAGEMENT

Additional information required to transmit the DSC message will come from a proprietary sentence specific to the equipment in use. For example, in the case of the L3 bases station the content will come from the $PL3A sentence 'ADDCM'. This is a one- time transmission.

$PL3A,ADDCM,xxxxxxxxx,xxxx,x,xxxx,x,x *hh



Note 1: The destination MMSI for the channel management command.

Note 2: The VHF channel number to be used by the AIS unit.

Note 3: The bandwidth used for the specified channel.

'0' – As defined by the 25 kHz channel number; always use for AIS.
'1' – For use as a 12.5 kHz channel; never use for AIS.

Note 4: The End Of Sequence used for the call

'0' – EOS = 117, requests an acknowledgement, but it is understood that AIS does not respond.
'1' – EOS = 127, requires no acknowledgement.

3 DSC CALLING DETAILS

The **Addressed Channel Management** transmitted on channel 70 as defined by ITU 825-3 and includes the following fields:

Format: 120
Destination MMSI: Target DSCID
Category: 103
Source MMSI: Base Station DSCID
Expansion Data 09 – Primary Channel
Expansion Data 10 – Secondary Channel
EOS 127 – No response required

Example DSC Call:

Base Station DSCID: 003660234
Target DSCID: 366012224
Primary Channel – 2082, 25 kHz, Normal RF
Secondary Channel – 1026, 25 kHz, Normal RF

DSC Call String: 120, 36, 60, 12, 22, 40, 103, 00, 36, 60, 23, 40, 104, 09, 20, 82, 00, 104, 10, 10, 26, 00, 127

The **Broadcast Channel Management** transmitted on channel 70 as defined by ITU 825-3 and includes the following fields:

Format: 103
Area: DSC Calling area
Category: 103
Source MMSI: Base Station DSCID
Expansion Data 09 – Primary Channel
Expansion Data 10 – Secondary Channel
Expansion Data 12 – North/East corner for VTS Area.
Expansion Data 13 – South/West corner for VTS Area.
EOS 127 – No response required

Example DSC Call:

Base Station DSCID: 003660234
DSC Calling Area definition – NE corner: 54° 30.00 N, 004° 30.00 E
SW corner: 53° 00.00 N, 003° 00.00 E

Primary Channel – 2082, 25 kHz, Normal RF
Secondary Channel – 1026, 25 kHz, Normal RF
VTS Area (channel management zone) –
NE corner: 54° 20.00N, 004° 20.00 E; note that for AIS, last digit of minutes is always 0.
SW corner: 52° 10.00N, 002° 10.00 E; note that for AIS, last digit of minutes is always 0.

DSC Call String: 103, 05, 43, 00, 00, 03, 00, 00, 90, 00, 90, 00, 103, 00, 36, 60, 23, 40, 104, 09, 20, 82, 00, 104, 10, 10, 26, 00, 104, 12, 05, 42, 00, 00, 04, 20, 00, 104, 13, 05, 21, 00, 00, 02, 10, 00, 127

ANNEX B NEW ALGORITHM FOR CHANNEL MANAGEMENT

Figure 10 shows the proposed algorithm for dealing with channel management operational parameters received via a message 22 or a DSC command. In the case where the operational settings are already known, then the unit should simply reset the 24 hours timer for those settings.

In the case where the newly received operational settings are unknown to the unit, it should verify if the settings conflict with existing settings it has in memory. If there are no conflicts, then the settings should be written to memory (erasing the oldest settings if required) and the implementation timer (1 epoch) should be started. Once the implementation timer ends, the settings will be implemented if the ship is in the region defined by the operational settings.

In the case where a conflict is detected between stored operational settings and the newly received settings, both settings should be erased from memory and the unit should fall back to default AIS operational settings for both regions. This should happen even if the implementation timer of the stored settings is currently running or completed and the settings are currently in-use.

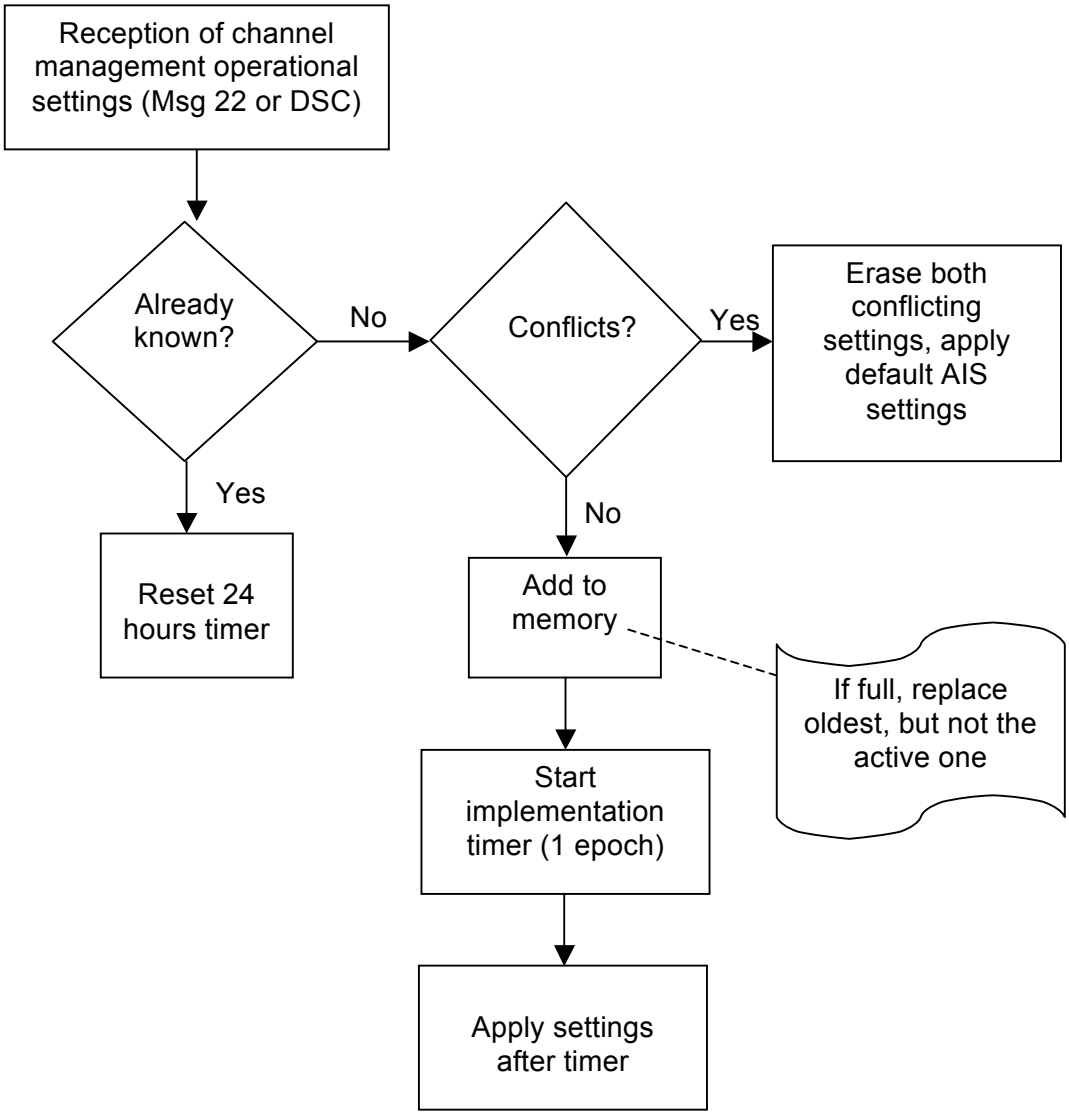


Figure 10 New proposed Channel management algorithm used by AIS participants.

When combined with regular broadcast of channel management messages by a competent authority, the new algorithm will have the following benefits:

- It will cater for the reception of multiple operational settings in case of high propagation conditions;
- It will mitigate the risks of an ill-intentioned party trying to interfere with the operation of the AIS;
- It will ensure, in most cases, that ships will be able to receive and be received by others in case of conflicting operational settings;
- It will allow competent authorities to rely on a deterministic behaviour of AIS units in case of conflicting operational settings;
- Allow for a step-by-step approach for competent authorities wishing to modify their channel management operational parameters in specific regions.

The algorithm implies that as soon as an AIS participant realizes that there is a channel management conflict, it should ignore both channel management configurations and revert to the default AIS parameters.

In the case where there is a very slight overlap between channel management zones, both regions would essentially be ignored by all participants aware of the 2 zones. Competent authorities should be aware that this may create a situation where some participants are still using one set of operational settings, while others, who are aware of the conflict, have reverted back to the default AIS settings.