# ANNEX Virtual AIS AtoN

# General Considerations

Virtual AtoN can be used to inform mariners about dangers to navigation, safe waterways, areas where extra caution may be necessary and areas to be avoided. It can be used to represent a line, area, position or other forms that may be displayed graphically.

Virtual AtoN should be used primarily as temporary deployments, where there is a time-critical consideration, and also in a permanent context, where permanent physical AtoN cannot be established or maintained. However, Virtual AtoN is intended as an enhancement, not as a replacement for physical AtoN. These two applications of Virtual AtoN, temporary and permanent, should be reflected in Maritime Safety Information (MSI).

The potential benefits of Virtual AtoN include enhancing safety and environmental protection, timely notification, quick deployment and modification, ease of presentation, low cost, etc.

The use of Virtual AIS AtoN should be overseen by the competent authority. Notifications to mariners of the presence of Virtual AIS AtoN, integrity monitoring and verification of the effectiveness of the Virtual AIS AtoN are essential elements of such oversight. Robust processes and procedures should be established for approval and promulgating information, together with integrity monitoring and record keeping.

Competent authorities should use all available means to ensure that mariners have the necessary information concerning the presence and purpose of Virtual aids and notify their national hydrographic offices for inclusion and updates in nautical publications, including charts.

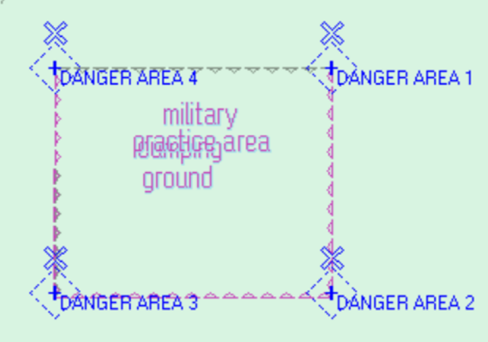
# Technical Deployment

The AIS AtoN name is part of the information contained in the AIS AtoN digital message (Message 21). Given the lack of uniformity worldwide concerning the naming, some guiding principles will enable greater consistency. Some of the important elements to consider are:

* Using a short name will prevent cluttering the shipborne display when users are displaying the name tag. Recognized international or national abbreviations or acronyms might help reduce the length.
* Numbering and lettering should respect IALA’s Maritime Buoyage System (MBS).
* Avoid repeating some of the information already available in other fields of the Message 21 and/or Nautical Publications (e.g. fixed, floating, MMSI, Virtual, colour, etc.).
* Message 21 has two name fields, the main field (20 char.) and the extended one (14 char.). Consider that not all shipborne navigational equipment may display the extended field.
* Consider that adding the MSI number as a reference in the Virtual AtoN name requires editing the information broadcast as it changes and that this might be limiting when using a stand-alone AIS AtoN mobile station.

In addition to regular maritime safety enhancement measures, it may be advisable to use Virtual AtoN to identify temporary restriction areas, to prevent intrusion.If the area is marked with several Virtual AtoNs, the name for each object should be the name together with the serial number as shown in Figure 1.It should be noted that the display of the user terminal may be limited, and the AtoN name may be too long to be fully displayed, so important information such as the serial number should be proritised at the front.

The number of Virtual AtoN and/or their reporting interval (i.e. refresh rate) that can be provided within a local area may be limited due to the capacity of the communication link. Furthermore, there may also be a limitation on the shipborne processing capability.



Source: Swedish Maritime Administration and Swedish Transport Agency

1. Four virtual AIS AtoNs marking the limits of a military area

To mark areas, binary AIS Application Specific Messages (ASM) may be used, rather than multiple Virtual AIS AtoN (Message 21). There is a limit to the number of Virtual AIS AtoN that can be in the same area due to available timeslots in the AIS system. Multiple Virtual AIS AtoN (Message 21) could increase clutter on the display. The competent authority should be aware that the number of MMSIs available for use by AIS AtoN is a finite resource, and for this reason the Maritime Resource Name (MRN) should be considered as the means of linking Virtual AtoN to relevant MSI or chart objects.

MMSI numbers are normally assigned to a transmitting device. For a Virtual AIS AtoN using Message 21, the MMSI number represents the unique identity of the AtoN itself, rather than the transmitting source. The repeat indicator field is used to identify whether the signal is transmitted from another station. It allows an AIS base station to repeat the Message 21 of another entity which may extend the coverage of a less powerful mobile station. Competent authorities should consider broadcasting from more than one AIS base station to ensure redundancy.

The nominal report rate of Virtual AIS AtoN broadcasts is specified by ITU. However, due to the limitations in data link capacity, a more flexible approach is recommended, taking data link capacity and power consumption at transmitting stations into account.

It should be noted that Virtual AtoN transmitting sites must deliver a specified minimum signal strength at the user antenna within a specified service area.

# Delivery Method

## Application

Virtual AIS AtoN can be used to mark an artificial or natural object or at a single location, or to define an area. It can be used in time-critical situations, temporary events, hydrographical or meteorological situations and for permanent usage.

Virtual AIS AtoN is particularly useful in time-critical situations and in marking/delineating dynamic areas where navigational conditions change frequently, or in applications where the use of physical aids is not practical or possible.

Table 1 provides specific usage for temporary and permanent applications.

## Display

The Virtual AtoN should clearly indicate its name, other relevant attributes and MSI relating to the provision of the Virtual AtoN.

The display or representation of symbols for Virtual AtoN on shipborne displays must comply with international standards.

When the lifetime of a Virtual AtoN object is timed out or cancelled, it should be removed from the displays of shipborne navigational systems. Objects relying on repeated transmissions that have exceeded the nominal reporting rate but not yet reached the timeout should clearly indicate that the information may not be current.

1. Application of Virtual AtoN

| Application Mode | Function | Conditions | Suggested Type of Virtual AIS AtoN | Consideration |
| --- | --- | --- | --- | --- |
| Permanent Marking | Marking of Shoals and Reefs, Fairway and its Limits. | Virtual AtoN can be effectively utilized where it is difficult to place or maintain a physical AtoN due to meteorological, topographical or hydrographical conditions. | Isolated Danger Marks, Cardinal Marks, and Lateral Marks. | * Conditions could be sea state such as crashing waves and submerged reef, strong current, water depth, strong ice movement, poor holding ground, etc. | |
| Permanent Marking | Marking of Fairway | Virtual AtoN can be effectively utilized where it enhances vessel traffic flow patterns. Potential applications are to mark the centre of each traffic lane or the separation between two lanes of a TSS and other usual routes. | Safe Water Marks and Lateral Marks. | * This is not a substitute for a TSS zone as the implementation of these methods or the modification of it must be investigated first. * The efficiency of vessel traffic flow patterns is the goal of this application. | |
| Permanent Marking | Marking of Fairway | Virtual AtoN can be effectively utilized in approaches to a harbour entrance where a ship changes its course and where it is difficult to install a physical AtoN. | Safe Water Marks and Lateral Marks. |  | |
| Permanent Marking | Marking of Fairway | Virtual AtoN can be effectively utilized where it is difficult to deploy or maintain a physical AtoN due to vessel to vessel or vessel to AtoN interaction (collision and hits). | Lateral and Cardinal Marks. | * Existing AtoN with history of multiple hits and with no repositioning options are good candidates. | |
| Permanent Marking | Marking Reference Points. | Virtual AtoN can be effectively utilized where there is a need to verify if a potential AIS position offset exists on shipborne navigational displays through the use of schematic reference point patterns. This is generally a need in confined waters where high accuracy and performance of shipborne equipment is required. | Reference Points. | * Predefined accurate coordinates as well as distance and bearing between virtual marks need to be used and made available through publications. | |
| Permanent Marking | Marking of Special Area (e.g., anchorage area, area to be avoided) | Virtual AtoN can be effectively utilized where precaution or special caution required.  A clear marking of special areas will improve safety of navigation. | Special Marks |  | |
| Temporary or Permanent Marking | Marking of Special Area. | Virtual AtoN can be effectively utilized where it enhances the protection of the environment and/or the protection of species. | Special Marks | * Risk of damaging the seafloor of a sensitive area with a physical AtoN might be a consideration. * Timely speed reduction zones or restricted areas for protecting mammals or other species. | |
| Temporary Marking | Marking of Fairways and Marking of the Limits of Safe Waters | Virtual AtoN can be effectively utilized where navigation becomes difficult due to a thick fog, heavy rain, etc. (This application can also be adapted as a temporary marking during limited visibility.) | Lateral Marks & Safe Water Marks |  | |
| Temporary Marking | Marking of a Navigational Restricted Areas (time critical only) | Virtual AtoN can be effectively utilized when navigation restriction is required due to military operations, marine accidents or when marking a wreck or offshore operations. | Cardinal Marks, Emergency Wreck Marks, Isolated Danger Mark & Special Marks | * Need to be monitored/updated. * Timely deployment is required where it is difficult to have the proper resource available for a physical AtoN deployment. * The dynamic nature of the event, i.e., short duration or having to relocate an AtoN, reinforces the use of a Virtual AtoN. | |
| Temporary Marking | Designation of Temporarily Recommendable Fairways (time critical only) | Virtual AtoN can be effectively utilized for indication of fairways when a large scale disaster hits the area. | Lateral Marks & Safe Water Marks |
| Temporary Marking | Marking of AtoNs that are Malfunctioning or Off Position | Virtual AtoN can be effectively utilized when a physical AtoN has lost its ability to perform regular functions. | Same as the physical AtoN, or Isolated Danger Marks. | * Timely deployment required. | |
| Temporary Marking | Pilot Boarding | Virtual AtoN will be useful in marking a pilot boarding station where the position is dependent on sea/ice conditions. |  | * Timely deployment required. | |

# Risks and Limitations

Virtual AIS AtoN are increasingly portrayed on the displays of many ships, though there are still some challenges to be addressed. These challenges include the lack of consistent symbology causing confusion, equipment not being properly configured to show data, information overload or absence, and some displaying a position offset.

Other risks and limitations may include GNSS or radio wave vulnerability, jamming and spoofing, and overloading of the VHF datalink.

## Limitations

### GNSS Vulnerability

In the event of GNSS service interruption due to jamming or interference, ships may lose their positioning capability unless they have an alternative positioning system. Poor installation or failure of shipborne equipment can similarly interfere with or degrade GNSS reception which could lead to a loss of the Virtual AtoN or a positional offset of the AIS AtoN symbol.

Errors in the GNSS position, for example, those caused by time lag, will directly impact the appearance of the Virtual AIS AtoN symbol on the radar, potentially misleading mariners into thinking that the Virtual AIS AtoN broadcast position is faulty, which is most likely not the case.

Once the AIS AtoN provider has validated that the Virtual AIS AtoN broadcast is adequate and contains no errors, some assumptions can be made regarding the possible causes of shipborne-related errors.The potential sources of errors can be classified into three categories: limitations of the GNSS interfacing with the radar system, limitations of the shipborne navigational system, and antenna offset.

### Spoofing and jamming of Virtual AtoN

Some spoofing methods can be detected through careful monitoring of the transmission channel, for example by monitoring MMSI numbers within the service coverage area. Duplicated or non‐existent MMSI numbers within the coverage area may indicate spoofing.

Increased spoofing detection capability can be achieved through regional cooperation between neighbouring countries, exchanging valid MMSI numbers and cooperating on identifying invalid MMSI numbers.

Competent authorities who provide Virtual AtoN services should maintain a database of all valid MMSI numbers assigned to Virtual AtoN. This database should be shared with such stakeholders as neighbouring countries.

Both spoofing and jamming can compromise and/or shut down a Virtual AtoN service. Jamming will typically block the service in a certain geographic region. Spoofing is more sinister since the targeted receiver cannot detect the deception, which could mislead the navigator.

### AIS VDL capacity and FATDMA planning

Virtual AtoN services transmitted on an AIS VDL typically use the FATDMA protocol. If the population of Virtual AtoN in a given area is too high, this may overload the VDL FATDMA slot capacity, which should be overcome through careful FATDMA planning.

## Risk mitigation

This section provides some potential mitigation measures for the different risks.

1. Potential risk mitigation measures

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| --- | --- |
| Risk | Potential mitigation measures |
| Complete dependence on Virtual AtoN. | Mariners should not rely solely on Virtual AtoN but cross-check it with other data or information. |
| Not all mariners will receive or be able to display Virtual AtoN. | MSI should be maintained as the primary notification.  Virtual AtoN supplement MSI.  Encourage the integration of Virtual AtoN with navigational displays, where fitted. |
| Information overload | Use of lines and areas (such as ASM) instead of points.  Only competent authorities are permitted to approve.  Limit use of Virtual AtoN in any area. |
| Confusion from varying symbology. | Standardize symbology by IMO, IHO, IALA, IEC. |
| Confusion from message options for locations, areas and lines. | IMO / IALA define message formats. |
| Loss of Virtual AtoN signal. | Publish standards for availability, continuity, and integrity.  Verification of transmission by originator.  Provide redundancy and integrity warnings.  Include relevant information in MSI and chart.  Shipborne navigational displays able to manage and display the lost target symbol. |
| Virtual AtoN vulnerability; jamming/spoofing. | Verification of transmission by originator.  Correlation with MSI and/or charts data link monitoring by competent authority.  Implement counter‐spoofing measures. |
| No confirmation of receipt of message. | Repeated or addressed / acknowledged transmissions.  Verification of transmission by originator.  Multiple transmission paths (MSI). |
| Erroneous message transmitted. | Procedures for message checking.  Verification of transmission by originator. |