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***Develop software application forming
hydro-meteorological binary messages
and aids to navigation report messages for
AIS broadcasting***

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INTRODUCTION

1.1 Aim of the document

This document describes the software module developed by Cybernetica AS for the Estonian Maritime Administration (EMA) to provide a marine electronic Aid-to-Navigation (AtoN), including health status of traditional AtoN. The module adds the support for synthetic and virtual AIS AtoNs for marine AtoN objects.

The document is aimed for end-users and software engineers alike. The document provides instructions on how to use the software, explains the architectural background, and describes use cases to help with the router's implementation and integration with the existing AIS system of the EMA.

1.2 Terms and conditions

The software is provided "as is", without warranty of any kind, express or implied, including but not limited to the warranties of merchantability, fitness for a particular purpose and non infringement. In no event shall the authors or Cybernetica AS be liable for any claim, damages or other liability, whether in an action of contract, tort or otherwise, arising from, out of or in connection with the software or the use or other dealings in the software.

1.3 How to use this document

The document contains five chapters:

- "SOFTWARE OVERVIEW" explains the purpose of the software, lists the features and explains the operational principles.
- "OPERATING PRINCIPLES OF AIS ROUTER" explains AIS router operational principles and focuses on the use cases of all AIS messages handled.
- "Installing and using the module" explains how to install, compile and configure the module from source package and gives as a quick introduction on how to launch the application.
- "
- "ROUTER SOFTWARE ARCHITECTURE" gives detailed explanations about the module's architecture and logical components.

- “ROUTER LOG MESSAGES” explains the error messages logged by the module and provides guidelines for troubleshooting.

1.4 Abbreviations

- AIS** – **Automatic Identification System** is a radio communication system used by ships and the Vessel Traffic Service principally for identifying, tracking, and locating vessels and other objects within the range of their VHF transceivers.
- AtoN** – **Aid to Navigation** is a device or system external to vessels that is designed and operated to enhance the safe and efficient navigation of vessels and/or vessel traffic. Common types of such aids include lighthouses, light beacons, buoys, fog signals, and beacons (daymarks). An AtoN capable of transmitting AIS messages is called an **AIS AtoN**.
- VTS** – **Vessel Traffic Service** is a service implemented by competent authority, designed to improve safety and efficiency of vessel traffic and to protect environment..

1.5 References

- Ref. 1: IALA Recommendation A-126, “The Use of the Automatic Identification System (AIS) in Marine Aids to Navigation Services”, Ed. 1.4, Dec. 2008.
- Ref. 2: IALA Guidelines No. 1028 on “The Automatic Identification System”, Volume 1, Part I (Operational Issues) Ed. 1.3, Dec. 2004.
- Ref. 3: Doc. N-B76250-2, Packet-oriented NMEA- δ PCYBA protocol description, Cybernetica AS, 2007 (in Estonian).

2 SOFTWARE OVERVIEW

2.1 Purpose

Introduction to AIS AtoN

Since 2002, the use of AIS on all SOLAS class vessels is mandatory for safety purposes. Since then¹, the IALA² recommends using the Automatic Identification System for marine Aids to Navigation. All marine AtoN carrying devices capable of transmitting AIS messages are henceforth referred to as AIS AtoNs.

¹ In addition to the transfer of data ship-to-ship, ship-to-shore and shore-to-ship, as per the ITU standard ITU-R M. 1371

² Association of Marine Aids to Navigation and Lighthouse Authorities

According to *ITU-R M. 1371*, the AIS message 21 (“Aids to Navigation Report”) is designated for AtoNs for the broadcast of the following:

- Type of the AtoN;
- Name of the AtoN;
- Position of the AtoN;
- Position accuracy indicator;
- Type of position fixing device;
- On/Off position status;
- Real and virtual AtoN identification;
- Dimension of the AtoN and reference positions;
- Status of the AtoN systems.

In addition to the report, an AIS AtoN may also transmit messages 6, 8, 12, 14, 25, as well as other appropriate messages. The routing and synthesizing of those AIS messages are described in Section 2.2 “Features”.

Need for synthetic and virtual AIS AtoNs

For practical or economic reasons, not all AtoNs are equipped with an AIS transmitter. AtoNs can break down or be lost (e.g. floating AtoNs), it might be difficult to access them for maintenance, harsh weather conditions may degrade their operation, etc.

Synthetic AIS AtoN overcomes such problems by using an approach whereby a remote AIS station sends AIS messages with AtoN static identification information, combined with real-time information received through the AtoN monitoring data link.

Sometimes an AtoN needs to quickly inform approaching vessels about navigational hazards, or a malfunctioning or lost AIS AtoN needs to be replaced. In such cases, a **virtual AIS AtoN** could be set up using a nearby base station or another AIS AtoN for the time being.

2.2 Features

The AIS Router is a VTS communication system module that routes standard AIS messages and AIS AtoN messages, and manages the transmitting of synthetic AtoNs (i.e., AtoNs without AIS transponders installed).

The AIS Router module supports the following:

- Routing the standard *ITU-R M. 1371* AIS messages with the following sentence types: !--ABM, !--BBM, !--VDM and !--AIR.
- Enhanced routing for the following AIS messages:

- a. Message 8, Broadcast Binary Message, meteorological and hydrological data.
 - b. Message 12, Addressed Safety Related Message or broadcast message 14.
 - c. Message 21, “Aids to Navigation Report”.
- Decoding the standard AIS ship position report messages M1, M2, and M3 to obtain the position of ships relative to AtoNs.
 - Creating the synthetic AIS message 21 from an NMEA- $\$$ PCYBA³ sentence received from an EKTA PaSS⁴ server.
 - Creating an alert area in the vicinity of a faulty AtoN, based on the information received from an EKTA $\$$ PCYBA sentence or AIS message 21, and notifying the ships in the area with message 12 or all ships by broadcasting message 14.
 - Transmitting AIS messages through an AIS base station closest to the AtoN in question.
 - Transmitting meteorological and hydrological data (message 8) through site-specific AIS base stations.

3 OPERATING PRINCIPLES OF AIS ROUTER

This chapter describes the operating principles of AIS Router, and the use cases for handling the AIS messages M8, M12, M14, and M21. Other AIS messages are forwarded unmodified.

3.1 General concepts

The AIS AtoN Router is capable of listening to multiple incoming TCP/IP connections from AIS configuration system, extract the supported AIS and EKTA PaSS messages from traffic, and forward routed traffic to configured AIS base stations. The AIS Router does not simply relay the received information, but also monitors ship positions and AtoN reports, regularly updating its virtual map of AtoN and ship positions.

Some messages will pass through AIS Router unmodified, while others might be altered or, if an AtoN malfunctions or reports off-positioning, recreated.

In the context of AIS AtoN message routing and synthesizing, the **alert area** is a key concept. It’s a circular area on the virtual map around the AtoN’s original position (the diameter of the area, given in nautical miles, is specified in the configuration file). The area is created whenever an AtoN malfunctions or reports off-positioning. All vessels stationed in or passing through the area (based

3 $\$$ PCYBA is a custom NMEA sentence type following the NMEA 0183 (IEC 61162-1) format for radio communication using a GPRS data link. For more information about the type of $\$$ PCYBA sentence, see Ref. 3 or contact Cybernetica.

4 PaSS is a software produced by the Department of Navigation Systems of Cybernetica under the trademark EKTA. PaSS is used to communicate with AtoNs produced by EKTA and are currently use by the Estonian Maritime Administration.

on received AIS messages 1, 2 or 3) are informed about the nature of the danger by an addressed AIS message M12 or alternatively by message M14. For both AIS messages, the router module finds the closest operational AIS base station that knows the location of the AtoN in question to transmit a safety-related message. Broadcast messages will be repeated continuously for a configurable interval or until the AtoN in question no longer reports failure or off-position.

The addressed AIS messages are repeated until the addressee has replied with an acknowledgement (AIS message 13). Broadcasted messages will be repeated continuously for an adjustable interval. The alert area will switch off if the AtoN in question no longer reports failure or off-position, or if a certain amount of time has passed as defined in module's configuration file.

3.2 Routing AIS message 21

If the support for EKTA \$PCYBA is turned off from the module's configuration, the software switches to routing mode, extracting and decoding any incoming traffic from the VTS system. If the type of a decoded message is AIS 21, the following actions ensue:

- Obtain both the position of the AtoN and the status report from the AIS message 21.
- Route the received AIS message 21 through the AIS base station closest to the AtoN. The coordinates of the base station are taken from the configuration.
- If the AIS AtoN is off-positioned or reports a technical failure according to AIS message 21, that is, AtoN status bits have the "Alarm Flag" set⁵, **then the router is waiting for a special AIS message 12 or 14** to activate an alert area and start notifying the nearby ships. The special format of AIS message 12 or 14 is described in the next section.

3.3 Routing AIS messages 12 and 14

The AtoN-specific AIS messages 12 or 14 can't be composed based on the AIS message 21, because it doesn't provide the extra safety-related information about the AtoN.

In order to use alert areas and send AtoN-specific AIS messages of type 12 in a VTS communication system that is not using EKTA \$PCYBA sentences, an AIS message 12 with a specially formatted safety message has to be passed to the AIS Router module.

Attention: AIS message 12 (or 14), which activates an alert area around the failed AtoN must be formatted as follows:

- Set the "Source ID" field to "0",
- Set the "Destination ID" field to "0" (applies to AIS message 12 only),

⁵ See Ref. 1, page 14 for the full use of AtoN status bits in the AIS message 21

- Format the safety message as follows: "Errortemplate for <MMSI number of AtoN>: <desired safety-related message>".

The template message won't be forwarded and a new AIS message 12 will be synthesized.

Note: When transmitting AIS message 14 instead of message 12, message 14 must use the same special format.

Finally, the routing policy is as follows:

- Decode and check the safety-related message. If it matches the three formatting conditions described above, proceed to step 3.
- Forward the AIS message.
- Pair the received AIS message 21 and the special AIS message 12 or 14 based on the AtoN MMSI number. If the numbers don't match, wait for the corresponding AIS message 21 to create an alert area.
- Synthesize a new AIS message 12 or 14 with the desired safety message. Route the new message through AIS base stations closest to the ships in the alert area.

3.4 Synthesizing AIS message 21

AIS message 21 is synthesized from \$PCYBA sentences sent by an EKTA PaSS server. A \$PCYBA sentence contains all the necessary information for compiling AIS message 21 and also AtoN's error report message that will be used in AIS message 12 or 14. Every \$PCYBA sentence received creates one AIS message 21.

When the AIS AtoN Router receives a \$PCYBA sentence, the following actions ensue:

- Decode the \$PCYBA sentence and verify its integrity. Invalid sentences will be ignored as \$PCYBA sentences should be arriving regularly;
- Find a known AIS base station closest to the AtoN location.
- Compose AIS message 21 and transmit it.
- Check the Off-Position Indicator (OPI) bit status: if $OPI = 1$, proceed to step 7;
- Check the LSB of 8-bit Regional Bits (RB): if $RB0 = 1$, the AtoN is malfunctioning and you need to proceed to step 7;
- If the AtoN alarm is active, stop the alarm.
- If the AtoN has reported off-positioning or malfunction:
 - Establish an alert area around the AtoN.
 - If the AtoN alarm timer is not activated, start the timer.
 - Create a list of ships in the alert area using the ships' AIS position reports.

- Extract the error report message from the \$PCYBA sentence. Depending on the configuration, use this error message to send AIS message 12 or 14 (refer to section 3.5).

3.5 Synthesizing AIS messages 12 and 14

If EKTA PaSS is connected to an AIS Router, the latter will synthesize the AIS safety messages 12 or 14; if not, refer to section 3.3 “Routing AIS messages 12 and 14.”

By default, AIS message 12 is synthesized and includes the cause of the AtoN's failure obtained from a \$PCYBA sentence. Alternatively, AIS message 14 could be used.

The AIS AtoN Router will transmit safety-related messages as long as the AtoN alarm is active and there are ships stationed in or nearing the alert area. The alarm will stop after a certain period (specified in the configuration file) or when the cause of the alarm is overridden by a new \$PCYBA sentence confirming that the AtoN is no longer in a faulty state.

3.6 Routing AIS message 8

The AIS Router module expects any received AIS message 8 to contain meteorological and hydrological data. The AIS message must follow the guidelines as proposed in page 91 of [Ref. 2]. After confirming that the received message is a Binary Broadcast Message, it should be routed as follows:

- Check the message's Application Identifier. The values “DAC” = 001 and “FI” = 11 indicate that this is AIS message 8 containing hydrological and meteorological data.
- Decode the measuring point coordinates from the message.
- Find all AIS base stations in the vicinity of the measuring point as specified by the variable *ais_meteo_hydro_range_nm* in the module's configuration file.
- If there are no operational AIS base stations in the range, transmit nothing and log the result.
- Transmit AIS message 8 through the AIS base station(s).

Caution: Original AIS messages of type 8 will not pass the message filter!

4 INSTALLING AND USING THE MODULE

4.1 System requirements

The AIS Router is distributed as a Debian GNU/Linux package or as a archived source files. Its system requirements are as follows:

- GNU/Linux Debian 4.0 "Etch" or Debian 5.0 "Lenny" supporting Qt 4.4 or later;
- Pre-installed packages: debhelper (>> 4.0.0), g++, automake (>> 1.9);
- Properly configured broadband Internet connection.

Detailed descriptions about compiling and installing the application from the source files refer to Chapter 4 .By default, the configuration file is installed to `/etc/vhf/ais_router.conf` and the application itself to `/sbin/vhf-ais-router`. The configuration file must be manually modified according to your AIS system (see Chapter 4 for instructions).

4.2 Installing and compiling

Extracting the source archive

The source for the AIS Router is distributed as a packaged archive file:

```
vhf-ais-router-<library.version.number>.tar.gz.
```

To extract the files, copy the above file to a suitable directory, right-click the archive icon, and then select "Extract Here", or use following terminal command:

```
tar xvzf vhf-ais-router-<library.version.number>.tar.gz
```

A new directory, "`vhf-ais-router-<library.version.number>`" is extracted, containing the source code and the necessary scripts to compile and install the application. For detailed instructions, see the files README and INSTALL in the directory root.

Compiling and installing the source

To compile the source code and install the application, follow these steps.

1. Change to the source directory and enter:

```
./configure
```

The script gathers information about the current system and creates appropriate Makefiles.

2. Compile the source code by entering:

```
make
```

Optionally, enter `make check` to compile and run any self-tests that come with the package.

3. Finally, install the application, its data files and documentation by entering:

```
make install
```

By default, everything is installed under `/usr/local` (the application files to `/usr/local/bin`, include files to `/usr/local/include`, etc). You can specify another top directory by entering `./configure --prefix=/another/directory`

4. To uninstall, recompile or reconfigure the source code, use the following commands:

▲ To remove the installed files and documentation:

```
make uninstall
```

▲ To remove the program binaries and object files from the source code directory:

```
make clean
```

▲ To remove the files created by the `configure` script (e.g. to compile the package for another platform):

```
make distclean
```

Note: Read the `INSTALL` file in the source code directory root for more information about various compiler flags and configure options.

4.3 Building debian packages from the source

The files necessary for creating Debian packages can be found in the subdirectories of `packaging/<distro>-<release>` (for example, `packaging/debian-lenny`), where `distro` refers to the distribution name and `release` refers to the release name.

The build process depends on the following packages; make sure they have been installed:

- `build-essential`
- `fakeroot`
- `pkg-config`
- `debhelper`
- `libqt4-dev`
- `g++`
- `make`
- `automake`

Note: Debian packaging depends on packaged Qt libraries.

The easiest way to build the packages is to use the provided script `update_debs.sh`. For instance, to create packages for Debian Lenny, run:

```
cd packaging/debian-lenny
./update_debs.sh
```

If the build succeeds, the subdirectory `packaging/debian-lenny/debs` will be created, containing new binary package(s) and the file `Packages` (or `Packages.gz`). This new directory can now be used as an APT source.

Note: Repeated runs of `update_debs.sh` will not remove previously built packages. If you wish to remove older builds, you'll have to do it manually.

Installing the Debian binary package with APT

Once the Debian package has been created and the folder containing the "Packages" file has been made public, others, too, can now install the binary package. To install the new Debian package, log in as root and either edit the file `/etc/apt/sources.list` manually or use the Synaptic Package Manager ("Settings", "Repositories") to add the line below. The line should contain a direct path or URL to the directory containing the Packages file, for example:

```
<address to location containing the binary package and Packages> ./
```

Note: Replace `http` with `file` to include it as local file repository.

Note: Run `man sources.list` for more information.

Once the list of sources is updated, the package can be installed by running:

```
apt-get install vhf-ais-router
```

or by using the Synaptic Package Manager to install the package.

4.4 Configuring the AIS Router

The AIS Router module can be configured either dynamically or statically using a configuration file. Use the configuration file provided (by default `/etc/vhf/ais_router.conf` or from the source package directory: `../ais_router/ais_router.conf.sample`) as an example.

To use the custom configuration file, launch the application from the terminal using the command:

```
/sbin/vhf-ais-router -c <path to custom configuration file>
```

or to run the currently compiled program from the source package directory issue in the `ais_router` directory:

```
./vhf-ais-router -c <path to custom configuration file>
```

Note: use the `-h` flag to list all possible options for the application.

Caution: There are no default values for proper router operation in the default configuration file. You must edit the file and set the values according to your VTS communication system.

Configuration file

The default configuration file contains only example values. Edit the file and enter the actual port numbers of the AIS client used, as well as information about the AIS base station to be used by the AIS AtoN Router.

The file contains the following variables:

```
// Log level. Defaults to 0. Increase to get more verbose logging.  
//log_level = 2
```

```
// Path to the PID file. Do not change the default value unless you know  
// what you are doing.  
//pid_file = /var/run/vhf/ais_router.pid
```

```
// TCP port for listening of connections from the AIS AtoN message sender.  
// REQUIRED, no default value.  
listening_port = 9000
```

Important: You must specify the TCP port number to which either the VTS system's AIS client or EKTA PaSS send AtoN-related messages. The AIS AtoN Router monitors any incoming traffic and extracts supported messages.

```
// If true, then transponders configuration will be retrieved dynamically,  
// otherwise static configuration will be used.  
//use_dynamic_configuration = true
```

```
// Address of the dynamic configuration server.  
dynamic_configuration_address = "127.0.0.1"
```

```
// TCP port of the dynamic configuration server  
dynamic_configuration_port = 9010
```

Uncomment the `use_dynamic_configuration` line to retrieve transponders' configuration from your VTS system configuration server.

Attention: If dynamic configuration is in use, the configuration server IP and port must be provided.

```
// Statically configured transponders. Will be ignored if dynamic configuration  
// is in use.
```

```
transponders = [  
  {  
    name: "Harbor AIS transponder",  
    configured_id: 1,  
    address: "127.0.0.1",  
    port: 9001,  
    position: "12*34.0'N 23*46.0'E"  
  },  
  {  
    name: "North-West AIS station transponder",  
    address: "lost",  
    port: 9003,  
    position: "58*23'N 26*43'E"
```

```
}  
]
```

Important: If dynamic configuration is not used, you must configure an array of transponders. For any given transponder, its name, configuration ID, IP address, port number, and geographic position must be defined. The `configured_id` value is optional, but transponders with a negative ID are considered non-operational.

```
// Enable support for $PCYBA sentences from EKTA PaSS server. Default is false.  
ekta_pass_support = false
```

```
// Changes type of alarm messages created when AtoN reported via EKTA PaSS  
// server reports failure. Defaults to addressed AIS messages (AIS12), set this  
// to true if broadcasted AIS messages (AIS14) are desired.  
ekta_pass_alarm_broadcast = false
```

Note: The above variables configure EKTA \$PCYBA support for the AtoN Router. For the systems not supporting EKTA \$PCYBA, send a special AIS message 12 or AIS message 14 (described in section 3.3) to the router to start airing AtoN-specific safety messages.

```
// Timeout in seconds from the last AtoN report (AIS21) before the AtoN alarm  
// messages will be shut off.  
aton_alarm_timeout_seconds = 1800
```

```
// Period between repeated AtoN alarm broadcast messages.  
aton_alarm_broadcast_period_seconds = 300
```

Note: The above variables define, in seconds, the duration of the alarm and the broadcast message repetition rate.

```
// If the distance between AtoN and ship is less than this value (in nautical  
// miles), then this ship will receive addressed AtoN alarms in case of  
// AtoN failure.  
aton_alarm_range_nm = 20
```

```
// If the distance between measuring point in meteo-hydro message and transponder  
// is less than this value, then that transponder will be used to send AIS 8  
// message.  
meteo_hydro_range_nm = 30
```

Note: The range variables are given in nautical miles. The `aton_alarm_range_nm` specifies the radius of the alert area around the faulty AtoN; ships within this area will receive safety-related AIS messages.

The `meteo_hydro_range_nm` sets the range specific to weather and hydrological data report (AIS message 8) site. All AIS base stations within the range of the measuring site are allowed to transmit this message.

5 ROUTER SOFTWARE ARCHITECTURE

5.1 Overview

The module's library is written in C++ and designed as a simple Qt-based, networked (TCP/IP) console application. AIS message handling and all the features of the router are implemented in the `libais` library. Its central management class `VHFAisManager` binds together all ship and AtoN

data managers, message filters, and filter handling. The source code for the router application can be found in the `ais_router` subdirectory of the application's source code directory.

5.2 AIS Router module

The following sections provide a logical component view of the operational principles of the AIS Router module, and briefly describe each object in the application class diagram. (Fig. 1).

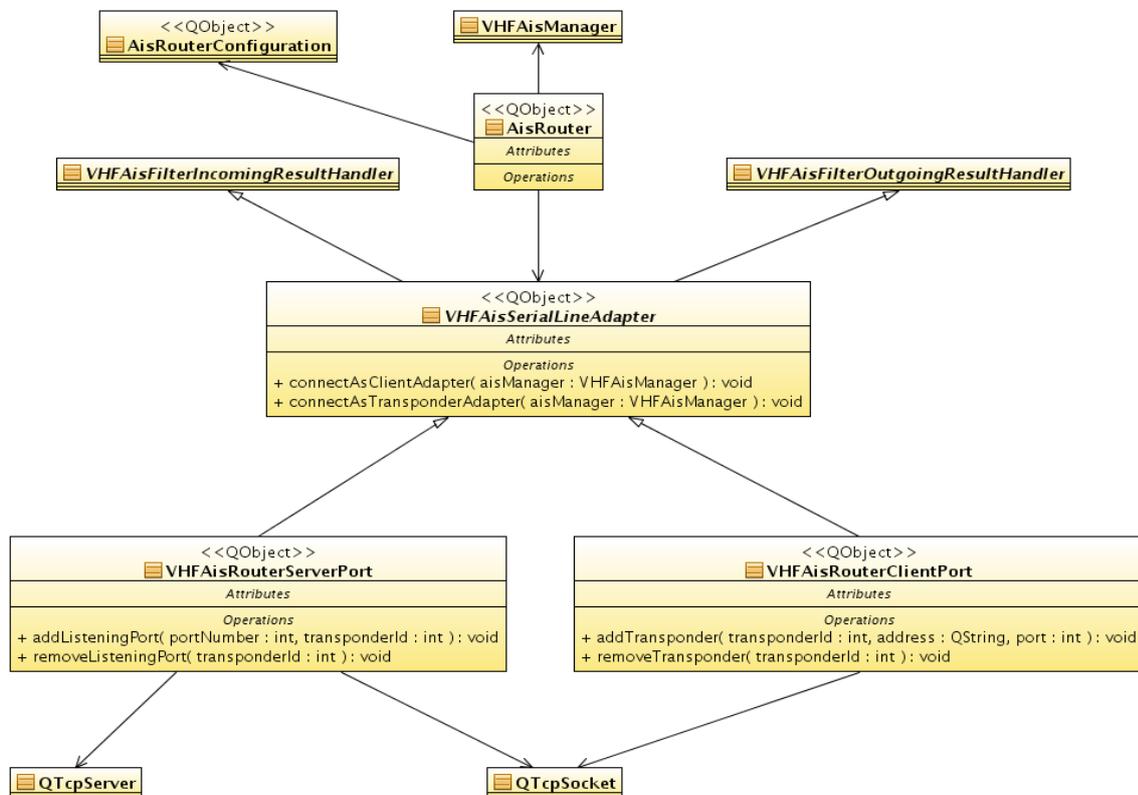


Figure 1: AIS Router module structure

AisRouter

`AisRouter` is the main class that wraps the `libais` library (`VHFaisManager`), the Qt-based server-client classes (`VHFaisRouterServerPort` and `VHFaisRouterClientPort`), and the configuration management class (`AisRouterConfiguration`).

AisRouterConfiguration

The `AisRouterConfiguration` class is only responsible for updating and loading the router's configuration file to set up the rest of the application instances.

VHFAisSerialLineAdapter

`VHFAisSerialLineAdapter` is the adapter base class used for connecting a serial line to a `VHFAisManager` instance. It converts received serial data to `VHFAisFilterMessage` instances and passes the instances to incoming or outgoing message filters depending on connection type.

You can connect to the AIS Router `VHFAisSerialLineAdapter` as a client. Forward AIS messages using the `VHFAisManager::filterOutgoingMessage()` method to find the most suitable transponder for transmission. Alternatively, you can connect to the adapter as transponder, registering it to handle your messages by using the `VHFAisManager::filterIncomingMessage()` method to find a suitable client.

In other words, connecting as a client adapter indicates that you wish to initiate AIS message transmission and receive AIS messages. Connecting as a transponder indicates that you wish to wait until an AIS message can be transmitted.

Note: The same interface can't be used to simultaneously connect as a client and transponder adapter.

VHFAisRouterServerPort

This is the port that is used for listening to TCP connections (managed as `QTcpSockets`) from clients; bi-directional AIS message transport is supported. Incoming messages (e.g. `$--ABK` reply sentences) from `VHFAisManager` can be directed to the requested clients according to `clientId` values.

VHFAisRouterClientPort

This is the port that establishes connections (managed as `QTcpSockets`) with all AIS transponders listed in the configuration file. Outgoing messages must have the transponder name set by `VHFAisManager`. For incoming messages from a transponder, the client port itself will set the name of the source transponder.

6 ROUTER LOG MESSAGES

This chapter lists and describes some of the AIS Router module's log messages. These messages are visible on the console, or found in `syslog` if the AIS Router is running on the background.

Note: All log messages that follow the pattern “<log message type>: <class name>::<method name>: <error message>” are either debug messages or indicate an internal error, and as such won’t be described here. These messages should not appear when the AIS Router module is configured to “log level 0” and experiences no runtime errors.

Informative messages:

- “AIS connection from <full address>: <operation result>” – The remote host closed the connection as expected.
- “AIS connection to '<transponder name>' failed: <reason>” – Expected termination of TCP connection between the AIS Router and AIS base station.
- “AtoN <AtoN MMSI number>: AIS 12 alarm set” – The AtoN with the given MMSI number has reported a failure. An alarm is activated and AIS message 12 is used to inform nearby ships.
- “AtoN <AtoN MMSI number>: AIS 14 alarm set” – The AtoN with the given MMSI number has reported a failure. An alarm is activated and AIS message 14 is used to inform nearby ships.
- “AtoN <AtoN MMSI number>: ship <ship MMSI number> got out of range” – Informs about ships leaving the alert area.
- “AtoN <AtoN MMSI number>: ship <ship MMSI number> is now in range” – Informs about ships entering the alert area.

Warning messages:

- “AIS connection to <name of transponder> lasted less than 60 seconds, next connection attempt will be in 30 seconds” – Connections lasting less than 60 seconds are considered as “not established” and will be retried automatically. If the problem persists, check your network and AIS Router configuration. The reason of failure will be given in the log as an error message preceding this message.
- “Invalid type of acknowledgement (<type of acknowledgement message>) received via transponder <transponder name>: <binary AIS sentence>” – Indicates an unexpected type of acknowledgement message received as a reply to the addressed safety message. A safety message might not have been transmitted properly.
- “Invalid destination MMSI in message: <binary AIS message sentence>” – The routing destination is unknown, so the message in question will be sent through all stations.
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Error messages:

- “AIS connection from <full address>: <operation result>” – The remote host closed the connection unexpectedly.
- “AIS connection to '<transponder name>' failed: <reason>” – Unexpected termination of TCP connection between AIS Router and AIS base

station. Examine the error reason for more details.

- "Cannot bind to port <port number>" – Failed to listen to incoming connections on all network interfaces for the given port. Check your network or firewall configuration.
- "Failed to send <number> bytes of AIS data to transponder '<transponder name>'" – The complete AIS sentence wasn't transmitted to the AIS base transponder due to connection failure.
- "Invalid AIS data from transponder '<transponder name>': <reason>: <received sentence>" – Indicates that the router received a data message from a transponder which was not formatted according to IEC 61162 or IEC 61993 and therefore its decoding failed. Examine the error reason for more details.