AIS Identification System

Advanced Protocols

WAVECOM NACHRICHTENTECHNIK

AIS Overview

Collision avoidance is one of the major challenges facing shipping. The introduction of AIS is one of the measures taken to mitigate this threat. Increasingly the system is now also used for surveillance of coastal waters and vast ocean areas.

AIS is a short range VHF system used for location and identification of vessels and is mandatory for vessels above 300 BRT. Originally conceived as a shipping anti-collision communication system in the late 90s, AIS is now on its third version of the ITU recommendation M.1371, which governs its development.

Recent developments have seen an adaptation of the specification to the requirements of inland waterways shipping, the introduction of AIS-SARTs (Search-and-Rescue Transmitters) and the bringing into operation of LEO satellites (ORBCOMM) collecting AIS message traffic from vast areas of the oceans. This is possible because the vertical range is about 400 km in contrast to the horizontal range which is nominally 40 km.

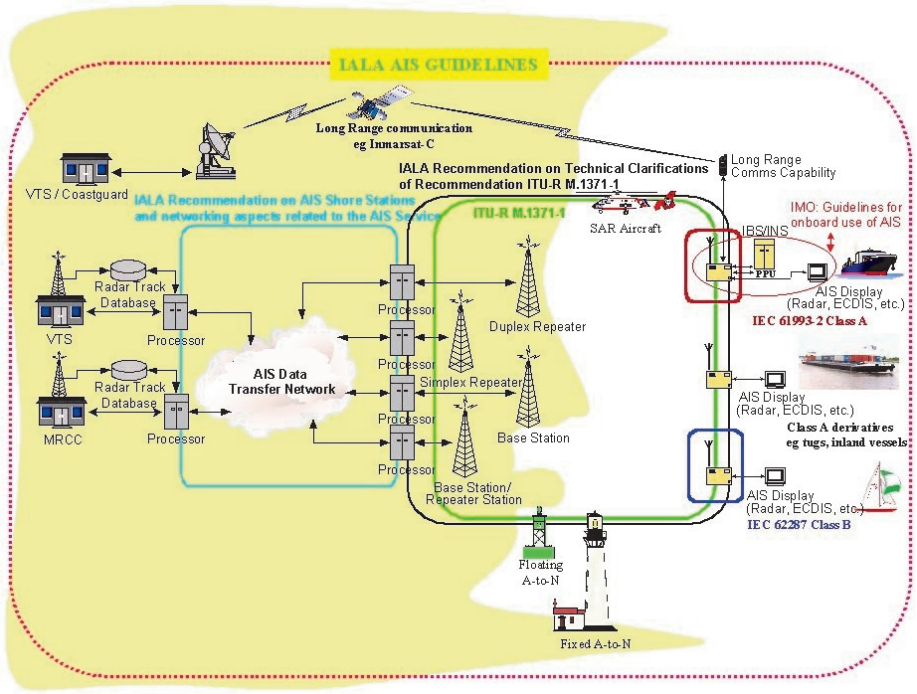

Fig. 1 AIS architecture

AIS Architecture

An integrated AIS network with mobile stations, base stations and a transfer network connecting to Vessel Traffic Services (VTS) and Maritime Rescue Coordination Centers (MRCC) is shown in fig. 1. On top of this, regional organizations, e.g. HELCOM set up by the states with a Baltic Sea coast line are collecting and disseminating AIS data on a regional basis. Several states have launched small satellites for proof-of-concept of satellite based AIS based surveillance. Ocean located buoys are also being used for this purpose.

Fig. 2 below shows a snapshot of vessel traffic in the Dover Straits using AIS position telegrams. AIS messages can be displayed as text on a MKD (Minimum Keyboard and Display), as overlay on a radar screen or an ECDIS (Electronic Chart Display).

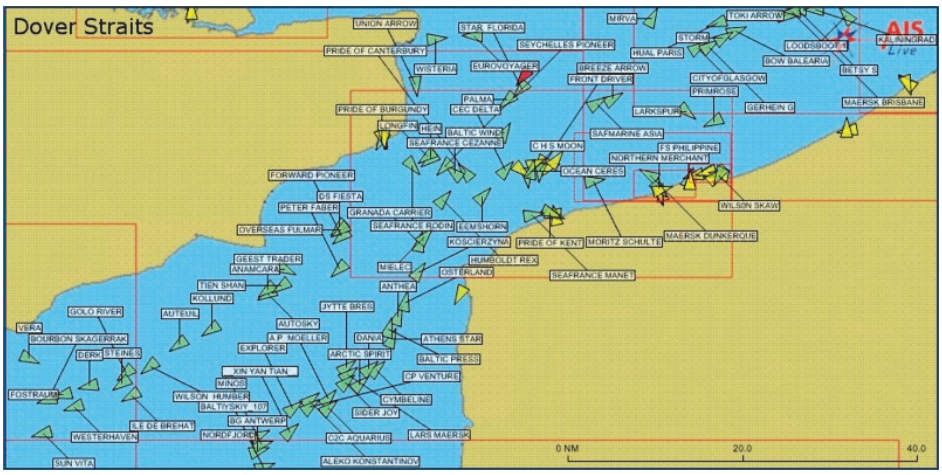

Fig. 2 AIS based vessel positions using standard icons

Mobile AIS transponders transmit short messages containing information on the vessel's course, heading, position, rate of turn, MMSI identification of the vessel. Other messages contain ship static and voyage related data, UTC and date requests and SAR aircraft position reports. Base stations transmit reports on themselves, data link and mobile station management messages and commands. The architecture allows for commands to be sent to the mobile transponder via DSC (Digital selective Calling) on VHF channel 70.

Two major classes of AIS units exist, Class A which is regulated under the SOLAS (Safety of Life at Sea) convention, roughly for "big", commercial vessels and Class B for non-SOLAS and leisure craft.
A Class A station has two VHF TDMA receivers, one TDMA transmitter and one DSC receiver. It is connected to displays and sensors. To achieve proper timing it also has a GPS receiver. A block diagram of a Class A unit is shown in fig. 3.

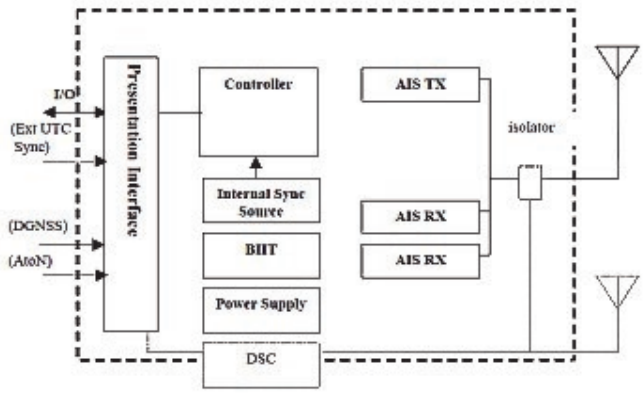

Fig. 3 Block diagram of a Class A unit

AIS Protocol

The core of AIS is the concept of Self-Organizing Time Division Multiple Access (SOTDMA) which is used for Class A devices. Each frame (one minute long) is divided into 2250 slots which gives 4500 slots as AIS signals are transmitted on two frequencies, AIS1 (161.975 MHz) and AIS2 (162.025 MHz). Based on previous traffic history, each station when transmitting reserves a future slot for its next message. Messages may be longer than one slot. To avoid overlap stations continuously synchronize to each other (see fig. 4).
Base stations use another access method, FTDMA (Fixed TDMA) with fixed slots. Class B equipment use CSTDMA (Carrier Sense), an adaptation of the Ethernet collision sense access method.

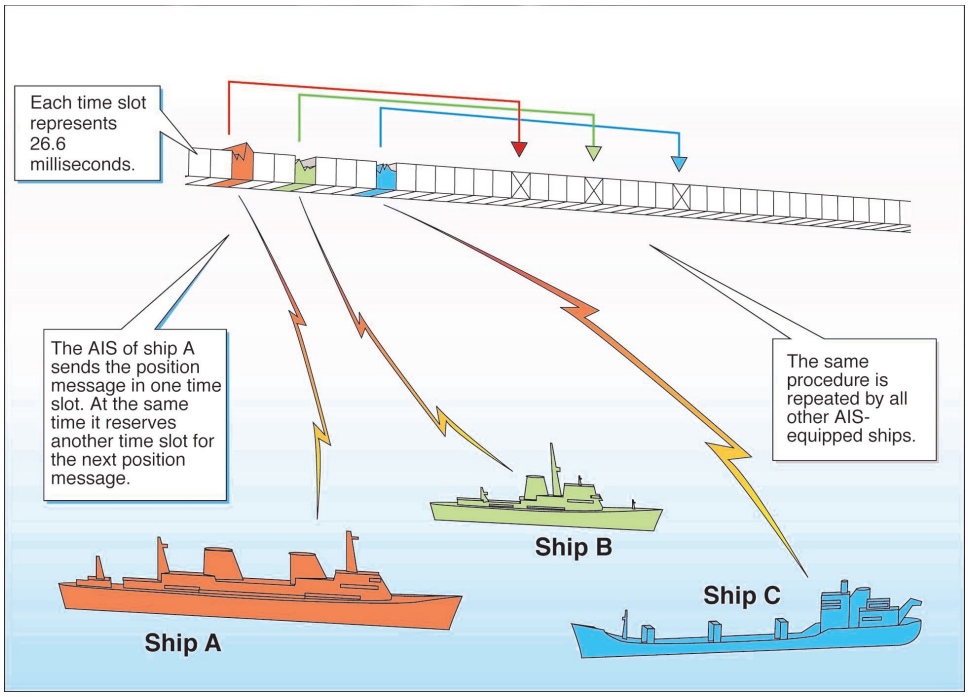

Fig. 4 How SOTDMA works

AIS utilizes GMSK (Gaussian Minimum Shift Keying) modulation at 9600 bit/s. Adjacent channels can be spaced either 12.5 kHz or 25 kHz. Data is encapsulated in HDLC-like packets, which are NRZI encoded, see fig 5 and fig. 6.

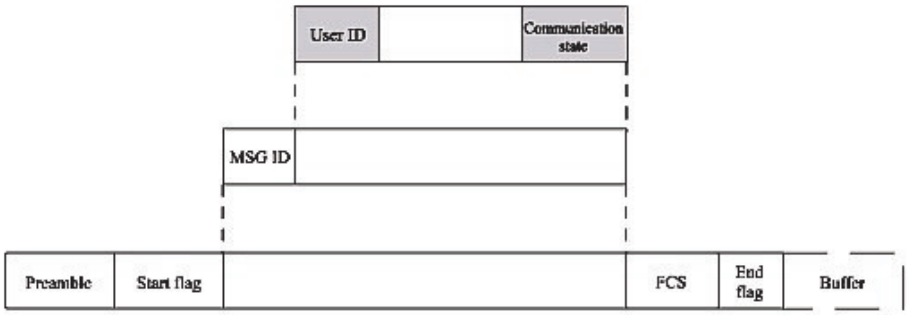

Fig. 5 AIS message composition

A generic transmission packet consists of:

- Ramp-up time (8 bits)
- Training sequence (24 bits)
- Start flag (8 bits)
- Data (168 bits)
- CRC (16 bits)
- End flag (8 bits)
- Buffer (24 bits)

CRC is the 16 bit HDLC FCS. The packet is bit-stuffed to prevent false flag characters (0x7E) and is transmitted with LSB first.

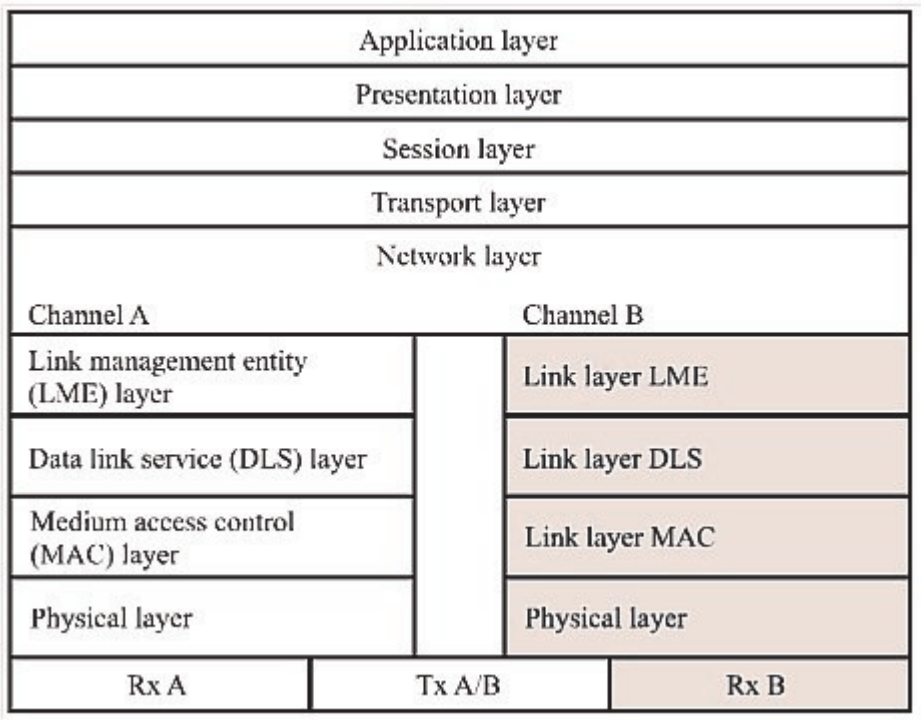

Fig. 6 AIS protocol stack

AIS Messages

No #	Message Name	No #	Message Name
0	Undefined	14	Safety related broadcast message
1	Position report (scheduled)	15	Interrogation
2	Position report (assigned)	16	Assigned mode command
3	Position report (when interrogated)	17	DGNSS broadcast binary message
4	Base station report	18	Standard Class B equipment position report
5	Static and voyage related data	19	Extended Class B equipment position report
6	Addresses binary message	20	Data link management message
7	Binary acknowledge	21	Aids-to-navigation report
8	Binary broadcast message	22	Channel management message
9	Standard SAR aircraft position report	23	Group assignment
10	UTC and date inquiry	24	Class B “CS” static data
11	UTC/Date response	25	Single slot binary message
12	Safety related addressed message	26	Multi slot binary message
13	Safety related acknowledge	27 - 63	Undefined

Table 1 AIS messages

The messages can roughly be divided into two groups, broadcast and addressed. Broadcast messages are directed to all vessels or units or to mobile stations based on specific position, type of vessel or type of cargo. Addressed messages are directed to a specific mobile station based on its MMSI.

Some messages are called application specific because their content is determined by an application. The binary content is either defined by ITU, by IMO or by national authorities. Examples of application specific usage are messages used along the St.Lawrence Seaway between Canada and USA, Inland AIS binary messages for the waterways of the Rhine-Danube area, or the messages recommended by IMO with information on safety, locks, weather conditions, tidal information, vessel traffic, water levels etc.

AIS is also used to broadcast navigational aid positions, either as synthetic AIS or virtual AIS. In the first case a base station transmits the position of navigational aids which do not themselves have an AIS transmitter. In the second case the navigational aid or object (e.g. a wreck) does not physically exist.

The maintenance of the ITU M.1371 recommendation has been transferred to IMO for binary messages and to IALA for technical clarifications.

AIS Implementation

The AIS module of the Wavecom W-CODE will decode all packet information for both, standard AIS, Inland AIS and most binary (application specific) messages. From top to bottom, the screenshot in fig. 7 shows a position message (msg 1), a data link management message (msg 20) from a Canadian base station and finally a St. Lawrence Seaway specific hydro message (a binary broadcast message, msg 8).

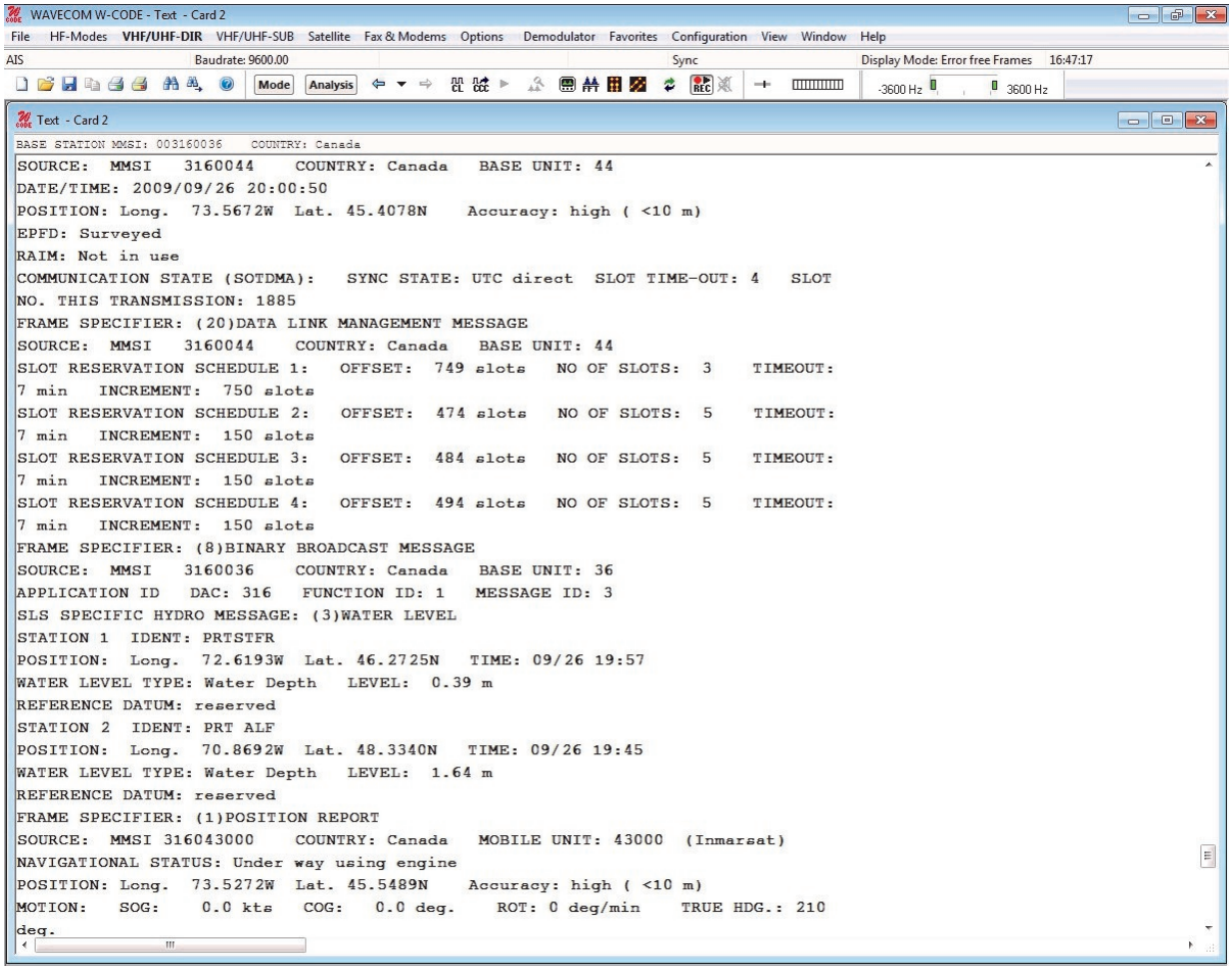

Fig. 7 Decoded AIS signals

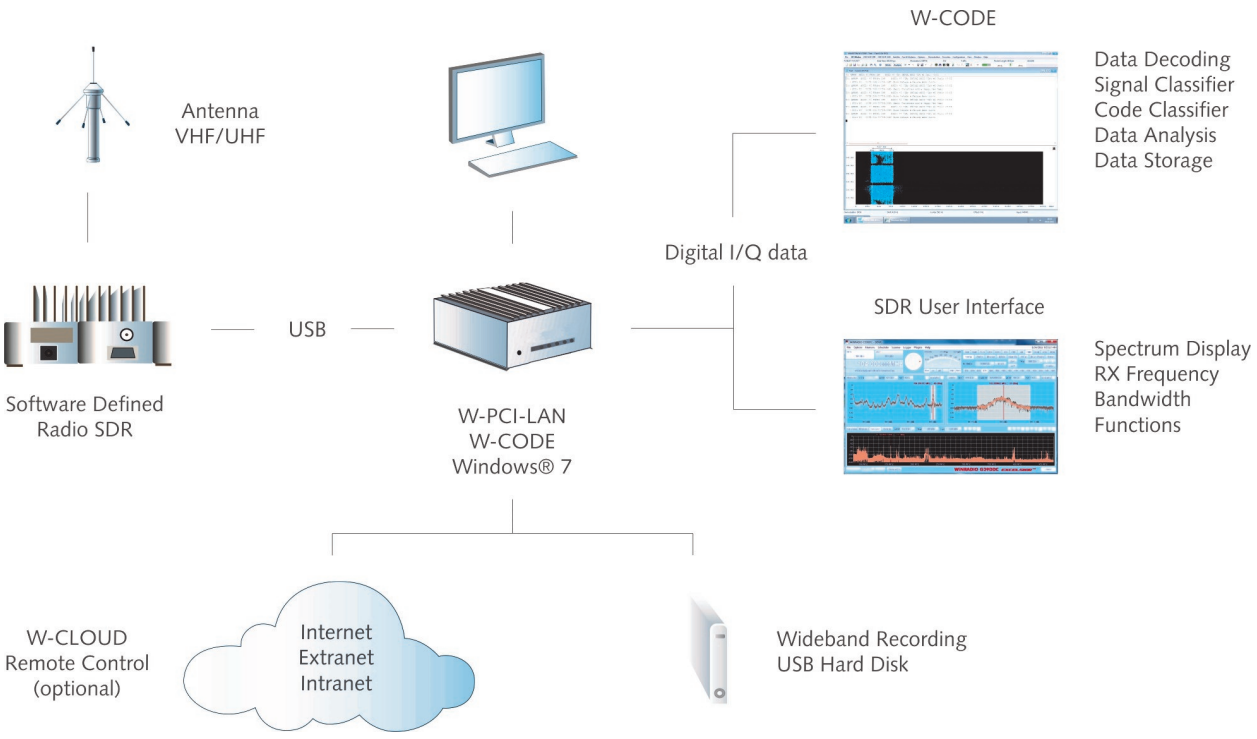

Fig. 8 Configuration for optimal AIS decoding results

W-CODE accepts input from the host built-in sound card, a number of SDRs, digital audio outputs, WAV files, I/Q data or TCP/IP streams.

W-CODE provides all functions required to analyze, decode and process radio data communications throughout the radio spectrum from HF, VHF, UHF to SHF.

Since more than thirty years Wavecom Elektronik AG has developed, manufactured and distributed high quality devices and software for the decoding and retrieval of information from wireless data communication in all frequency bands. The nature of the data communication may be arbitrary, but commonly contains text, images and voice. The company is internationally established within this industry and maintains a longstanding, world-wide network of distributors and business partners.

Product Information

Products	http://www.wavecom.ch/product-summary.php
Datasheets	http://www.wavecom.ch/brochures.php
Specifications	http://www.wavecom.ch/product-specifications.php
Documentation	http://www.wavecom.ch/manuals.php
Online help	http://www.wavecom.ch/content/ext/DecoderOnlineHelp/default.htm
Software warranty	One year free releases and bug fixes, update by DVD
Hardware warranty	Two years hardware warranty
Prices	http://www.wavecom.ch/contact-us.php

System Requirements

	Minimum	*Recommended*
CPU	Core i5 or Core i7 2.8 GHz	Core i7-6700 3.4 GHz
Memory	4 - 8 GB RAM	16 - 32 GB RAM
OS	Windows 7	Windows 10 32-bit or 64-bit

Distributors and Regional Contacts

You will find a list of distributors and regional contacts at http://www.wavecom.ch/distributors.php

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