Welcome to AIS Concepts and Changes

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What is AIS?

An automated autonomous system for the exchange of navigational information between suitably equipped vessels, aids to navigation and shore stations using 27 (currently) distinct messages and operating on two designated marine VHF channels. There are two equipment Classes – A and B - which have distinct differences.
Why do we need AIS?

Creates a much improved situational awareness for the Navigators by overcoming the inherent limitations of sight, VHF voice and radar for collision avoidance – regardless of vessel size. In addition, with the ever increasing enhancements of AIS, the information readily available to the Navigator is superior to past methodologies.
How does AIS work?

The heart of the system is a transmission protocol called Self Organizing Time Division Multiple Access (SOTDMA). This protocol is what allows AIS to be autonomous and continuously operational.
SOTDMA

60 Seconds
2250 Slots

AIS-1
161.975

A

B

C

A

C

...

AIS-2
162.025

B

C

A

...

26.67 ms
1 Slot = 256 Bits

- Identity
- Position
- Speed over Ground
- Course over Ground
- Heading
- Rate of Turn
- Navigation Status
- Time Stamp
**ITDMA - Incremental TDMA**
A variant used during the first frame phasing and during a change of Reporting Rate by the vessels

**RATDMA - Random TDMA**
The protocol used to broadcast additional position reports

**FATDMA - Fixed TDMA**
The protocol used by Shore Station messages and Aids To Navigation (e.g. buoys)
Carrier Sense TDMA

This is a Class B protocol where the transponder is ‘listening’ for the absence of a carrier in a slot before it will transmit.

The fundamental idea is to ensure that the Class B transmissions are ‘polite’ and secondary to the Class A transmissions.
Class A transponders

2 to 10 second Tx interval while underway dependent on speed

3 Minutes Tx interval while at Anchor

Supplemental (Static) Data at 6-minute Intervals

12.5 watt transmitter
Class B transponders

Two types of units – one uses CSTDMA and the other uses SOTDMA

The transmitter outputs of both units are lower than for a Class A unit

The TX intervals for moving vessels are also different
<table>
<thead>
<tr>
<th>Shipboard AIS</th>
<th>Class A</th>
<th>Class B/TSO</th>
<th>Class B/CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit Power (Watts)</td>
<td>12.5 W / 2 W (low-power)</td>
<td>5 W / 2 W (low-power)</td>
<td>2 W</td>
</tr>
<tr>
<td>Primary Access Scheme</td>
<td>Self-organizing Time-Division Multiple Access (SOTDMA)</td>
<td>SOTDMA</td>
<td>Carrier-sense TDMA non-competing with SOTDMA units</td>
</tr>
<tr>
<td>Position Reporting Rate</td>
<td>Either every 2, 3 ½, 6 or 10 s based on speed and course change. Every 3 min. when ≤ 3 kts.</td>
<td>Either every 5, 15 or 30 s based on speed (2-14, 14-23, &gt;23 kts) Every 3 min. when ≤ 2 kts.</td>
<td>Every 30 s Every 3 min. when ≤ 2 kts.</td>
</tr>
<tr>
<td>Static Data Reporting Rate</td>
<td>Every 6 min</td>
<td>Every 6 min</td>
<td>Every 6 min</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>25 kHz bandwidth between 156.025 MHz to 162.025 MHz</td>
<td>25 kHz bandwidth between 156.025 MHz to 162.025 MHz</td>
<td>25 kHz bandwidth at minimum between 161.500 MHz to 162.025 MHz</td>
</tr>
<tr>
<td>Dedicated DSC Receiver for Channel Management</td>
<td>Yes</td>
<td>Yes</td>
<td>Time-shared</td>
</tr>
<tr>
<td>Position Source / WGS-84 to 1/10,000 of minute of arc</td>
<td>Internal Global Navigation Satellite System &amp; connection to an External Electronic Positioning System (EPFS)</td>
<td>Internal GNSS</td>
<td>Internal GNSS</td>
</tr>
<tr>
<td>Digital Interfaces</td>
<td>2 Input-Output &amp; Multiple Presentation Outputs</td>
<td>Optional</td>
<td>Optional</td>
</tr>
<tr>
<td>Display</td>
<td>Multiple Keyboard Display (MKD)</td>
<td>MKD</td>
<td>Optional</td>
</tr>
<tr>
<td>Safety Text Messaging</td>
<td>Receive &amp; Transmit</td>
<td>Receive &amp; Transmit</td>
<td>Transmit Optional, and only with non- alterable pre-configured messages</td>
</tr>
<tr>
<td>Application Specific Messaging</td>
<td>Receive &amp; Transmit</td>
<td>Receive &amp; Transmit (up to 3 slots)</td>
<td>Receive Optional, cannot Transmit</td>
</tr>
<tr>
<td>Transmit Data</td>
<td>All</td>
<td>No Rate of Turn, Navigation Status, Destination, ETA, Draft, or IMO#</td>
<td>No Rate of Turn, Navigation Status, Destination, ETA, Draft, or IMO#</td>
</tr>
</tbody>
</table>
Schematic Diagram of Class “A” Ship-borne AIS Station

*1) The external keyboard/display may be e.g. radar, ECDIS or dedicated devices.
*2) The internal keyboard/display may optionally be remote.
Schematic Diagram of Class B Ship-borne AIS Station
AIS Dynamic & Nav Status
Broadcasts (variable times)

- Latitude (both Classes)
- Longitude (both Classes)
- Speed over Ground (both Classes)
- Course over Ground (both Classes)
- Position Accuracy (both Classes)
- Time Stamp (both Classes)
- MMSI Number (both Classes)
- True Heading (A requirement - B optional)
- Rate of Turn (class A only)
- Navigation Status (class A only)
- DSC receiver fitted Y/N? (Class B only)
AIS Static & Nav Info
Broadcasts (6 minutes)

- MMSI (both Classes)
- Radio Call Sign (both Classes)
- Name (both Classes)
- Type of Ship/Cargo (both Classes)
- Dimensions of Ship (both Classes)
- Location of Reference Point (both Classes)
- IMO Number (class A only)
- Type of Position Fixing Device (class A only)
- Draught of Ship (class A only)
- Destination (class A only)
- ETA at Destination (class A only)
- Vendor ID (class B only)
U.S. Carriage Requirements

**Vessels on International Voyages**
- Self-propelled, > 65 Feet
  (Except Fishing or Small Passenger Vessels)
- Tankers
- Passenger Vessels > 150 Gross Tons
- Any Other Vessel > 300 Gross Tons (SOLAS)

**Vessels Transiting VTS Areas**
- Self-propelled, > 65 Feet
  (Other Than Fishing or Small Passenger Vessels)
- Towing Vessels > 26 Feet and > 600 Horsepower
- Passenger Vessels > 150 Gross Tons
Installation Considerations

VHF Antennas and cabling
GPS Antennas
Equipment Interfaces and cabling
Ship’s Power Sources and cabling
Pilot Plugs and AC power
VHF Antennas

The AIS frequencies are on the high end of the VHF-FM band (@ 162 mhz). Because of this, the majority of standard marine VHF antennas are not manufactured for optimum performance at those frequencies.
VHF Antennas

- VHF Antenna
  - Possibly Integrated GPS Antenna
- 6’ Feet from Conductive Objects
- Ideally 6’ Directly above or below VHF
- Otherwise 30’ Horizontal Separation
VHF Antennas
VHF Antenna Cables

The IMO Safety Nav Circular 227 recommends the use of RG-214 coax which is a double screened coax cable which has better shielding capabilities (only 3% more than RG-8).

As a matter of comparison, here are the four common types:

<table>
<thead>
<tr>
<th>Type</th>
<th>Length @ 50 ft</th>
<th>DB Loss</th>
<th>Loss Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-58</td>
<td>@ 50 ft</td>
<td>3.0 db</td>
<td>50% loss</td>
</tr>
<tr>
<td>RG-8 Mini</td>
<td>@ 50 ft</td>
<td>2.3 db</td>
<td>40% loss</td>
</tr>
<tr>
<td>RG-8</td>
<td>@ 50 ft</td>
<td>1.2 db</td>
<td>20% loss</td>
</tr>
<tr>
<td>RG-214</td>
<td>@ 50 ft</td>
<td>1.2 db</td>
<td>20% loss</td>
</tr>
</tbody>
</table>
GPS Antennas

The suggested mounting is one which gives a complete sky view from 5 degrees above the horizon to 90 degrees (the zenith).
GPS Antennas
NMEA 0183 Interfacing

RS232 to RS485 Converter Wiki by Magneto Tech Research
Interface Cabling

All interconnection cables used to interface NMEA 0183 inputs from external GPS units, Gyrocompasses, Satellite Compasses, Speed Logs, and the like should use shielded pair type cables.
Ship’s Power

For Class A systems, the IMO recommendation SN Circ. 227 is that the unit should be connected to an Emergency Source.

For IMO vessels, this means the Emergency Generator to which all the Communication and Navigation equipment is to be connected.

In addition, an Supplement to the Recommendation also requests that the AIS be connected to a UPS to ensure that the 45 second switchover from Main to Emergency does not reset the AIS.

For non-IMO vessels – in light of the increased reliance on AIS units, I would suggest that the AIS unit be connected to a battery.
Ship’s Power Cabling

DC voltage drops <3%

Class A units: ~5 A @ 24 vdc
10 awg for 50 ft

Class B units: ~2 A @ 12 vdc
14 awg for 25 ft
Pilot Plugs

Required for Class A – Ships on International Voyages

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmit A</td>
</tr>
<tr>
<td>4</td>
<td>Transmit B</td>
</tr>
<tr>
<td>5</td>
<td>Receive A</td>
</tr>
<tr>
<td>6</td>
<td>Receive B</td>
</tr>
<tr>
<td>9</td>
<td>Shield</td>
</tr>
</tbody>
</table>
Pilot Plugs

Required for IMO Ships using the Panama Canal and the St. Lawrence Seaway Canal

Also required for U.S. Flag Ships over 1600 GT
Pilot Plugs

Credit to Marimatech website
Configuration
## Configuration

### NMEA 0183 Sentence Format

<table>
<thead>
<tr>
<th>Data</th>
<th>Preferred</th>
<th>Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Datum</td>
<td>DTM</td>
<td></td>
</tr>
<tr>
<td>Positioning System:</td>
<td>GNS, GLL</td>
<td>GGA, RMC</td>
</tr>
<tr>
<td>Time of Position, Latitude / Longitude, Position Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed over Ground (SOG)</td>
<td>VBW</td>
<td>VTG, OSD, RMC</td>
</tr>
<tr>
<td>Course over Ground (COG)</td>
<td>RMC</td>
<td>VTG, OSD</td>
</tr>
<tr>
<td>Heading</td>
<td>HDT</td>
<td>OSD</td>
</tr>
<tr>
<td>RAIM Indicator</td>
<td>GBS</td>
<td></td>
</tr>
<tr>
<td>Rate of Turn (ROT)</td>
<td>ROT</td>
<td></td>
</tr>
</tbody>
</table>

**NMEA Input Sentences for Class A units**
Configuration

Vessel Data

Maritime Mobile Service Identity (MMSI) Number
Vessel Name
Vessel Type and Cargo Type
GPS Antenna Location/Reference Position/Dimensions (in meters!)
IMO Number (Class A fittings)
Radio Call Sign (if assigned)
### Configuration

<table>
<thead>
<tr>
<th>GPS/Reference Location</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Distance (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong> 0 – 511 m</td>
</tr>
<tr>
<td>511 m = 511 m or Greater</td>
</tr>
<tr>
<td><strong>B</strong> 0 – 511 m</td>
</tr>
<tr>
<td>511 m = 511 m or Greater</td>
</tr>
<tr>
<td><strong>C</strong> 0 – 63 m</td>
</tr>
<tr>
<td>63 m = 63 m or Greater</td>
</tr>
<tr>
<td><strong>D</strong> 0 – 63 m</td>
</tr>
<tr>
<td>63 m = 63 m or Greater</td>
</tr>
</tbody>
</table>
As the final check of the system, make sure that you have entered all the Static information correctly.

Confirm with another vessel or shore station that they can receive ALL your vessel’s info correctly and that you are seeing others as well before you leave the vessel.

**USCG Alert # 05-10**
AIS is only as good as the information provided and exchanged, therefore, users must ensure their unit is always in effective operating condition and broadcasting accurate information.
Configuration

Take the time to teach the Customer how to operate the AIS and how to decipher what it is telling the Navigator.

Don’t assume they will ‘figure it out’ – especially when they get into the Voyage data fields (destinations, cargo type, etc.)

Remind them that it is an AID to navigation
AIS Enhancements

Application Specific Messages (ASM)

&

Aids To Navigation (ATON)
AIS Enhancements

Examples of ASMs

Wind Information Message
Weather Station Message
Water Level Message
Estimated Lock Times Message
Water Flow Message
Tidal Information Sensor and ASM Broadcast Station

Transmitted every 3 minutes or as needed
Types of AIS ATONs

Real AIS ATONs – physical with a transponder fitted

Synthetic AIS ATONs – physical with Base Station ID transmission overlay
(not recommended for floating ATONs)

Virtual AIS ATONs – non-existent with Base Station ID transmission overlay
(envisioned for temporary use)
ATON – AIS Equipped Buoy
AIS Surveillance

✓ Maritime Awareness
✓ Security and Defense Issues
✓ Environmental Protection
✓ Search and Rescue Support
✓ Public Service to our Industry
AIS Surveillance

Nationwide AIS Operational View

- NAIS Storage, Correlation, & Dissemination
- Global Positioning System
- Provides position information to vessels
- Operations Systems Center
- Navigation Center
- NAIS Management & Monitoring
- Network Node
- Maritime Intelligence Fusion Centers & other Users of NAIS data
- Current AIS Coverage in some VTS Ports
- Sector Command Center
- Provided direct feed of AIS data
- NAIS Increment 1
  Critical Port Coverage
- NAIS Increment 2
  Nationwide Coastal Coverage
- Encrypted AIS Used for Blue Force Tracking
- Shipboard AIS used on AIS equipped vessels for navigation safety
- Class A User
- Class B User
- Coastal (24 nm) Coverage
- NAIS Increment 1
  Critical Coastal Coverage
AIS Surveillance

Popular AIS Monitoring Services

Marine Traffic (Free – Terrestrial)
AIS Live (Fee – Terrestrial and Sat)
VesselFinder (Free – Terrestrial)
ShipFinder (Free – Terrestrial)
AI S Surveillance
AIS Surveillance

International Space Station
AIS Surveillance

AIS Reception from Space in 2010
AIS Surveillance

Space Based AIS Monitoring Services

ORBCOMM

exactEarth

SpaceQuest
SpaceQuest AprizeSat Microsatellite Bus

- Low Cost, High Performance
- 5 Year Mean Mission Duration
- 13 kg, 25 cm cube
- 20 Watts of Solar Power
- 1 Watt Bus Power Consumption
- 3 CPUs, 12 RXs, 3 TXs, 12 ANT
- Inexpensive Piggyback Launch
- Autonomous Operation
Website Resources

www.navcen.uscg.gov
www.iala-aism.org
www.imo.org
www.nmea.org
Questions?