All Things Digital

Amateur Radio for the 21st Century

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Air and marine radio communications are conducted on internationally standardized analog AM/FM and MF/HF voice plus digital data systems. The term "watercraft" is used to describe a wide range of self-propelled vessels whether commercial or private: ships, sailboats, motor boats, hovercraft, tugs, etc.

THE [MARITIME] AUTOMATIC INFORMATION SYSTEM (AIS)

Hams and other radio hobbyists enjoy scanning the RF spectrum from "DC to light" and in sharing collected information with others. Given the number and variety of radio modes it's not easy to focus on more than a handful and we tend to pick and choose the ones that appeal to us for as many reasons as there are modes! Many of us live on or near the Great Lakes, the St. Lawrence River Seaway (and other major world-wide waterways) or coastal regions and enjoy watching the big freighters, tankers, container ships, etc., sailing by; with the addition of AIS, you can do this all electronically—at a distance—in the comfort of your radio shack, plus if you are also a mariner, you'll appreciate the collision avoidance and other features provided by AIS.

Using a 2m vertical or beam antenna, a VHF FM radio with packet radio data port, or a scanner with a discriminator tap, or a dedicated AIS receiver, or an SDR (software defined radio) plus some decoding software you can monitor and track water watercraft on the major waterways, and with Internet connectivity, you can access AIS data using desktops, laptops or iDevices (Android or Apple).

Note: In Canada and U.S., any person may intercept and make use of (for legal purposes) AIS signals because they are not encrypted and are considered broadcasting.

People are often amazed to learn that commercial watercraft just can't go "willy-nilly" from point A to point B especially when crossing international borders. We have ATC (Air Traffic Control) to direct aircraft and we have VTS (Vessel Traffic Services) to regulate watercraft using standardized shipping routes, traffic lanes, zones and CIPs (calling-in-points) printed on nautical charts, along with published international regulations ("rules of the road") all mariners must obey subject to the safety of their vessel, cargo or crew.

WHAT IS AIS?

Initially called the Universal Shipborne AIS or 4S-Transponder System (ship-to-ship and ship-to-shore), AIS is a 2-way maritime VHF (FM) packet radio transponder (transmitter-responder) digital data communication system enabling watercraft, coast stations or aircraft (all collectively called “stations”) to identify, track and monitor, and optionally communicate with each other to enhance the SOLAS (safety of life at sea) program. It is a “black box” system collecting telemetry from various onboard sensors and continuously transmits and receives data on two separate (dedicated) VHF marine frequencies (dual-channel redundancy) and also via satellite. It is a mandatory carriage requirement for most commercial watercraft based on various factors of gross tonnage, classification and size, plus geographical area (Lake Superior is one exclusion area for commercial vessels working solely therein).

All AIS transponders use a unique 9-digit MMSI (Maritime Mobile Security Identity) number (much like a phone number) because it allows you to lookup specific details on any watercraft or to contact it digitally (if within range). This number is also used by another international maritime 2-way VHF/MF/HF packet radio distress, messaging and paging system called DSC (digital selective calling). For example: Thunder Bay coast guard radio’s Rabbit Mountain (local) repeater site’s MMSI is 003160072 (coast stations are identified by a “00” MMSI prefix) while “316” identifies the station as Canadian. Any ship wanting to “page” VBA using DSC would use this MMSI and their DSC enabled radio to transmit their message/request on VHF marine channel 70 (if within radio range) and the DSC transceiver at VBA would alert the coast guard radio officer and he/she can reply back either digitally or by voice.

A BRIEF TECHNICAL DESCRIPTION

Technical standards for AIS, DSC and other such devices are defined by NMEA (National Marine Electronics Association) and are often called “NMEA talkers” or “NMEA listeners”. AIS messages are encoded as binary packets (bits of 0’s and 1’s) and transmitted at 9600 bps (bits per second) using GMSK (Gaussian minimum shift keying) with channel bandwidths of 12.5 kHz or 25 kHz and are transmitted in less than 30 milliseconds! GMSK is fancy form of FSK (frequency shift keying) which is widely used in commercial and amateur radio digital communications because the transmitter can operate at full power and adjacent channel interference is minimized as opposed to some other digital modes which require transmitter power reduction and careful transmitter drive adjustment to prevent “splatter”.

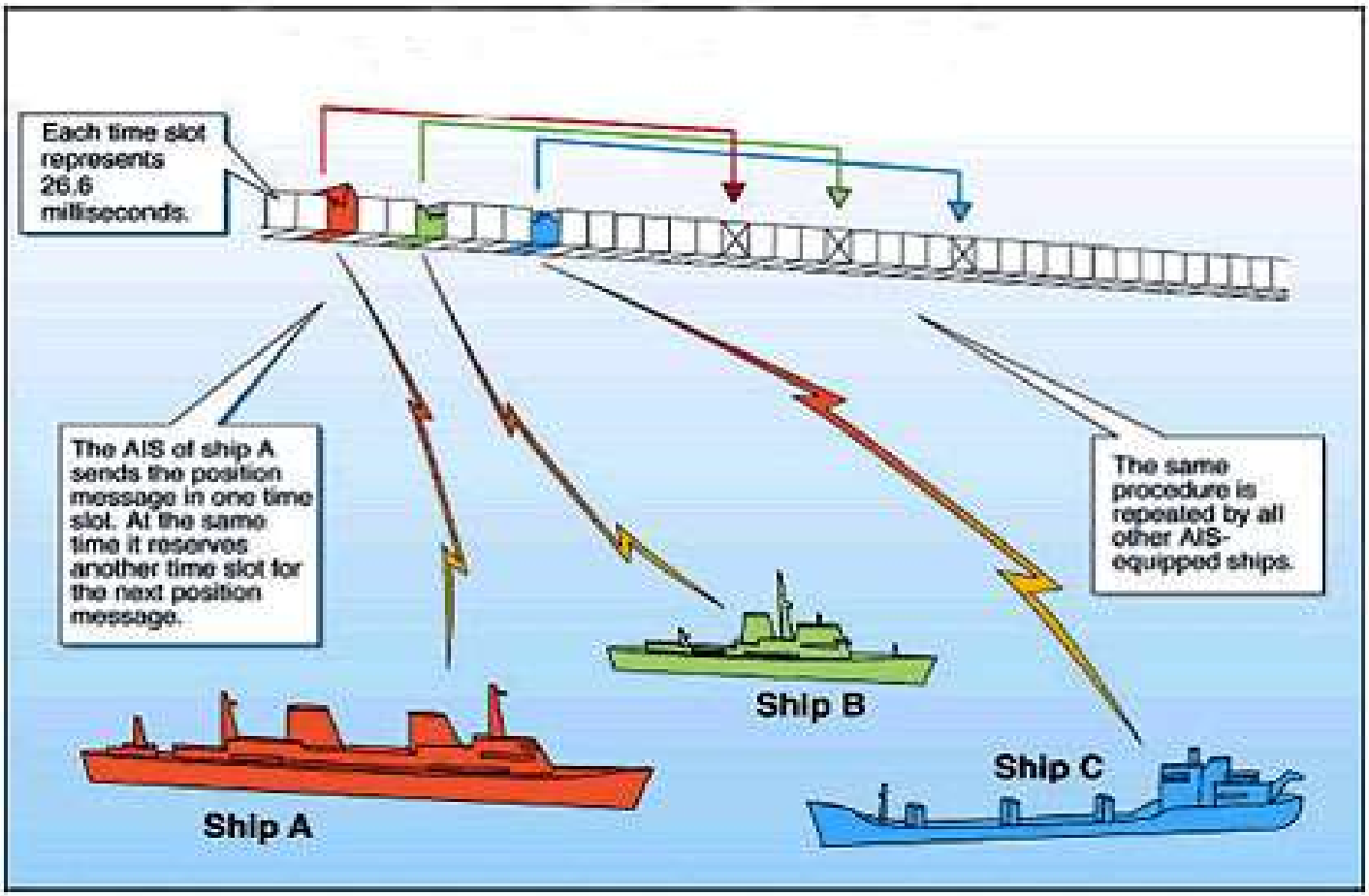


FIGURE 1: SOTDMA IN ACTION. (*Image courtesy of US coast guard.)*

To aid in preventing local interference, AIS transponders (Figure 3) "talk" among themselves and arrange the timing of their packet radio beacons using a technique called SOTDMA (self-organized time division multiple access) and with dual channel redundancy the system can be overloaded 500% and provide almost 100% message handling capability between stations closer than 8nm. In any overload situations, the system automatically selects more important (closer-in beacons) and disregards those farther away (less risk of a collision hazard).

Two dedicated VHF maritime channels called AIS1 and AIS2 are used: 87B (161.975 MHz) and 88B (162.025 MHz) with the same data transmitted alternately on each channel. Depending on the height of the AIS antenna above the water, the normal line-of-site (LOS) radio range is10-20nm (nautical miles) between watercraft. Between watercraft and coast stations (with their higher antennas on radio towers) this range can easily exceed 50nm. AIS signals literally ride and hide in background noise (static), sounding like quick, sharp clicks popping in and out of the Ether, therefore an <u>unsquelched</u> receiver is used. The wide bandwidth signal must be extracted from the receiver's IF (intermediate frequency) or discriminator stage not the audio stage (as can be done with DSC signals).

Note: We can't take the AIS output from the audio stage because it will be mangled and distorted by the narrow-band (5 kHz) audio filter(s).

Static Information	Dynamic Information	Voyage related Information
Name	Position (To 1/10,000 of a deg.)	Destination
Type of ship	Speed Over Ground (SOG)	Depth
Call sign	Course Over Ground (COG)	ETA
MMSI number	Rate Of Turn (ROT)	Navigational Status
IMO number	Heading (HDT)	Size

FIGURE 2: TRANSMITTED TRIP INFORMATION

Transmitted "trip" information consists of three data types (Figure 2): static, dynamic and voyage. Dynamic information (position, speed, heading, etc.) is transmitted every 2 to 10 seconds depending on the speed and maneuvers of the watercraft; static and voyage related information (type of ship, size, cargo, destination, ETA, etc.) is transmitted every 6 minutes or upon request from other stations, and every 8 minutes when anchored or docked. Depending on the "action" around you, it can take a few minutes before a complete picture of all the AIS equipped stations in your area is received.

Note: There are two types of AIS transponders: class-A (required for commercial watercraft) using a 12.5 watt transmitter and class-B (optional for pleasure watercraft) using a 2-watt transmitter. Manufacturers are including built-in AIS receivers (with radar-like displays) on newer VHF marine base station transceivers (Figure 3). Military SAR (search and rescue) maritime aircraft are also equipped with AIS transponders to provide information directly to JRCC (joint rescue coordination centre), VTS or coast guard radio stations.

FIGURE 3: AIS CLASS-B TRANSPOINDER

AIS QUICK START

1. Internet Method: Point your browser to any free AIS website—that's it (Figures 4 and 5). Many Hams are "boatnerds" and feed AIS data to various web servers. The Amateur Radio based APRS.FI server takes this and adds it to the other data (APRS [automatic packet reporting/tracking system], weather and other telemetry and shows everything on a Google Map display. If you prefer, you can download and try various iDevice programs (Android or Apple) for AIS on the go!

FIGURE 4: APRS.FI AMATEUR RADIO DATA WEBSITE

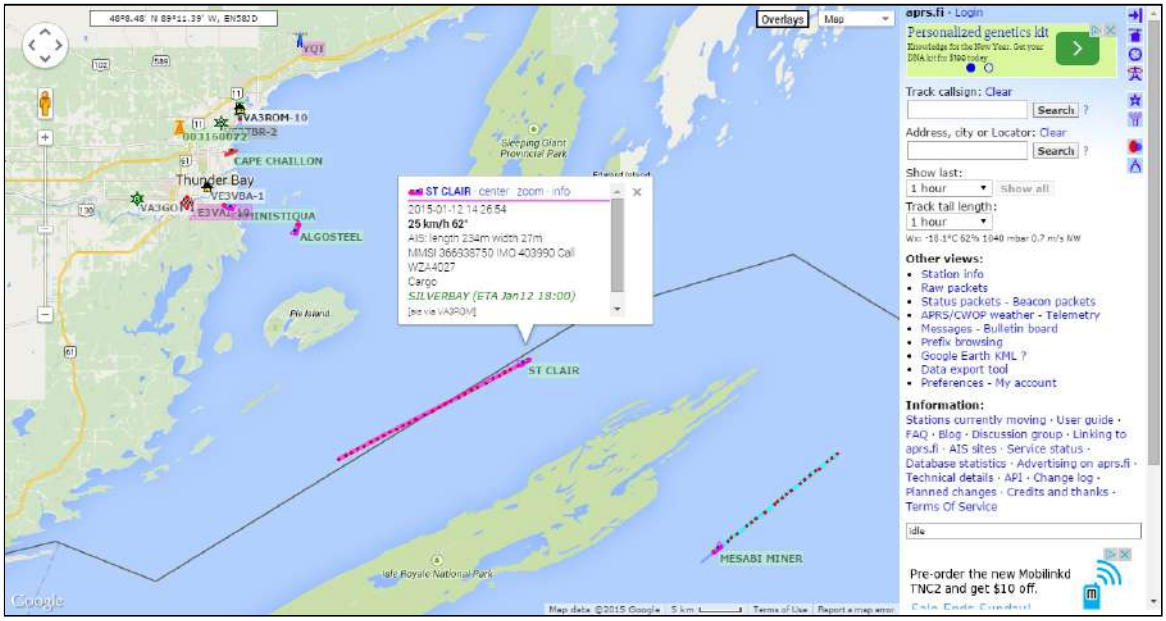
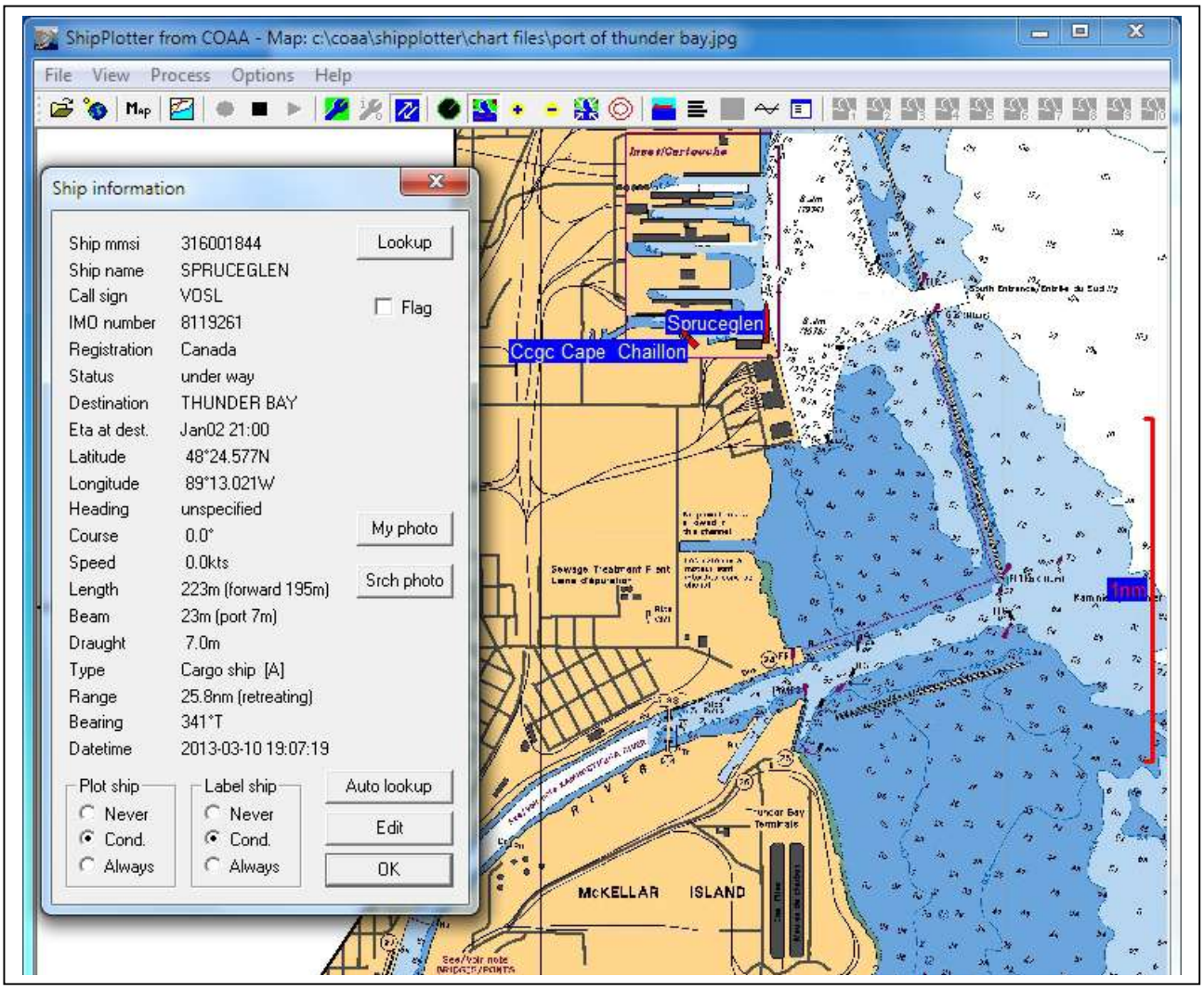


FIGURE 5: IDEVICE AIS

2. <u>Radio Method:</u> In my opinion there are only two suitable (Windows based) AIS programs (I don't use Linux or Apple computers). One is a commercial program called "ShipPlotter" (SP) by COAA (*Centro de Observação Astronómica no Algarve)* and the other is a free program called "SeaClear II" (SC2) by "Sping". SC2 is free but it's designed from the point of view of the mariner for use as a stand-alone charting and navigation system. It only supports USB/serial port AIS dedicated receivers and has no Internet file sharing capability or API (application programming interface).

SP (Figure 6) provides Internet file sharing of data (many AIS websites get their data from the COAA central AIS webserver), provides soundcard processing of packet radio and scanner IF/discriminator outputs with support for RS232/USB AIS receivers. There is an excellent API for computer programmers to extract data for other use by other software, along with many "advanced" features for the serious hobbyist (almost too many!). SP comes with a 21-day trial but there's no file sharing until it you buy the inexpensive user license. Detailed instructions and an excellent Yahoo user group will help you get started very quickly.

FIGURE 6: SHIPPLOTTER TRACKING SHIPS IN THUNDER BAY HARBOUR



SP better suited my needs and I started out using my Yaesu FT7800 mobile transceiver (and the 9600 bps packet radio port) with a 2m vertical antenna. Later, I switched to a Realistic 2004 scanner with an added IF/discriminator tap. The packet radio and IF/discriminator packet radio outputs were connected to my computer's soundcard input (line or microphone) and processed internally by SP. Eventually, I purchased a dedicated AIS receiver with marine beam antenna (Figure 7) which is aimed at the shipping lanes in/out of Thunder Bay.

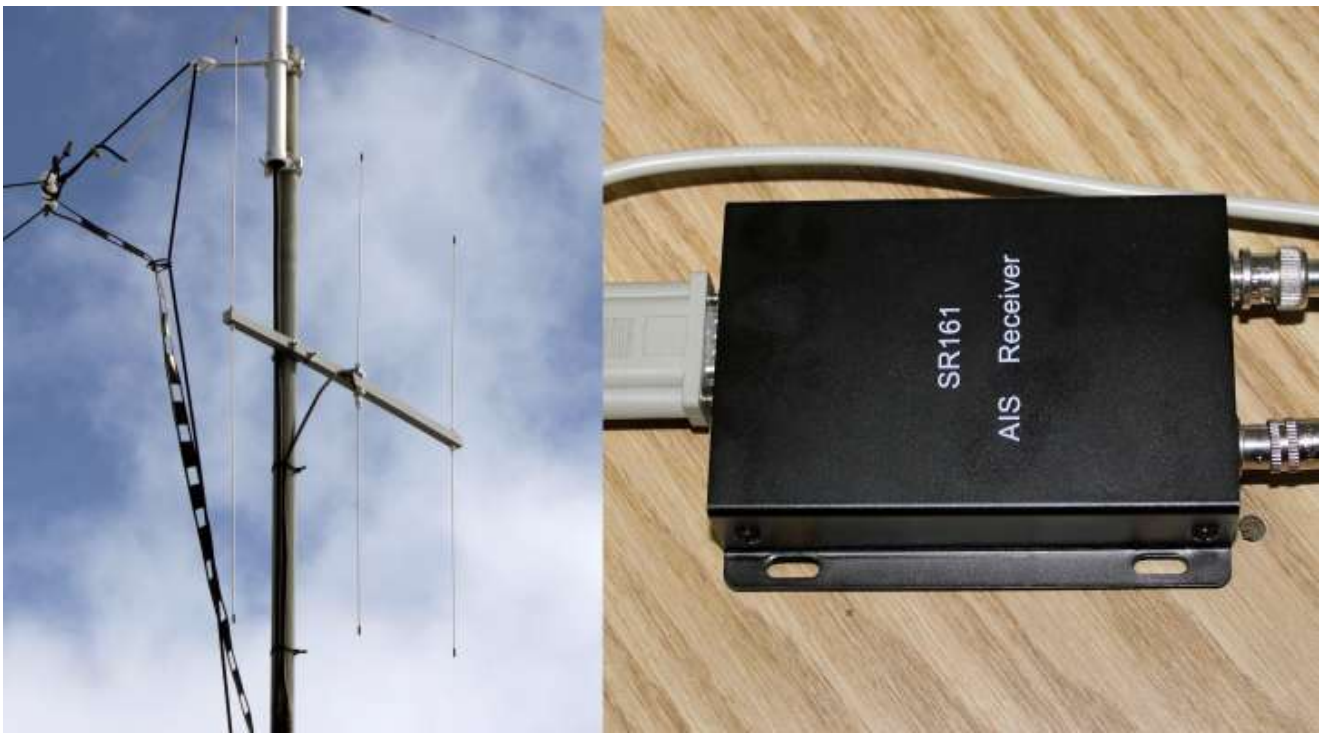


FIGURE 7: MY AIS MARINE YAGI AND DEDICATED AIS RECEIVER

CHARTS AND MAPS

SP can download simple satellite maps and you can also download detailed nautical charts (raster and vector) from NOAA (National Oceanic and Atmospheric Administration). NOAA provides free downloads of U.S. charts with overlapping areas for those of us who live near the US/Canada border waterways. *Note: The CHS (Canadian Hydrographic Service) sells charts through commercial dealers and doesn't provide any free download service.*

SP can convert almost any type of graphical map into a nautical chart with its built-in calibration system and I have converted various maps of inland lake areas and added navigation features and markers for my own use (combined with a GPS) because SP can also be used like any shipboard charting system.

My Final

In the next column, we'll be receiving commercial aircraft ADS-B (automatic dependent surveillance broadcast) transmissions using another COAA program (plus others), combined with inexpensive VHF/UHF USB receiver dongles. It was recently discovered that these can be easily reprogrammed into wide-frequency, multi-mode SDRs (software defined radios)! For those who can't wait, you can check out this article: *Cheap and Easy SDR by Robert Nickels, W9RAN (QST, January 2013, p. 30).*—73

REFERENCES AND RESOURCES

APRS.FI
http://aprs.fi

COAA Shipplotter
http://www.coaa.co.uk/shipplotter.htm

iDevice Sample AIS Software (Android & iTunes)
AIS Mobile, AIS Radar, Boat Beacon, easyAIS, iAIS Plotter, MarineTraffic, mAIS, Ship Finder, VesselTracker, et al.

International Maritime Organization
http://www.imo.org/OurWork/Safety/Navigation/Pages/AIS.aspx

Milltech Marine
http://www.milltechmarine.com

MMSI
http://en.wikipedia.org/wiki/Maritime_Mobile_Service_Identity

NOAA (Nautical Charts)
http://www.nauticalcharts.noaa.gov/mcd/Raster/download_agreement.htm

SAILWX Info
http://sailwx.info

SeaClear II
http://www.sping.com/seaclear

SOLAS
http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx

Transport Canada Information
http://www.tc.gc.ca/eng/marinesafety/oep-navigation-radiocomms-faqs-1489.htm

US Coast Guard
http://www.navcen.uscg.gov/?pageName=AISFAQ

Vessel Finder
http://www.vesselfinder.com