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# Automatic Identification Systems – the Effects of Class B on the Use of Class A Systems

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The standards for CSTDMA Class B AIS will shortly be published by the International Electrotechnical Commission and equipment will become available during 2006. The perceived benefits that Class B brings to leisure craft users and its relatively low cost will make it attractive in the market place. A rapid take-up of Class B use can therefore be expected. This paper considers the impact that increased use of Class B will have on users of Class A AIS that are compulsorily fitted to larger vessels to meet the requirements of the International Maritime Organization Safety of Life at Sea convention. The CSTDMA Class B system has been designed to prevent overloading of the AIS VHF data link. This is briefly reviewed but there are a number of other aspects that need to be considered. These include: the increased garbling of Class B messages compared to those of Class A; the problems accruing from the low update rate of Class B information; the increase in display information that will need to be managed; and the possible increase in inappropriate manoeuvres of leisure craft caused by misplaced reliance on AIS. As a result of the investigation the paper highlights the fact that Class B users must not assume that their own presence, in the form of Class B transmissions, will be particularly visible on the bridge of many SOLAS vessels. This will continue to be the case for many years into the future, until such vessels are mandated to carry radar with AIS target overlay capability.

KEY WORDS

1. AIS. 2. Marine Safety.

1. INTRODUCTION. The introduction of Automatic Identification Systems (AIS) to ships that need to comply with the Safety of Life at Sea (SOLAS) convention of the International Maritime Organization (IMO) has now been completed. Such systems, known as AIS Class A, are proving to be useful in giving positive vessel identification and other information to shore based applications such as Vessel Traffic Management Systems (VTMS) and national security forces. Also, the ship-to-ship use of AIS is being increasingly considered by mariners to be a valuable additional tool to enhance situational awareness.

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AIS Class B is aimed at the 'non-SOLAS' user, particularly the leisure market. Its reduced specification will make it lower cost compared to Class A and, because of its perceived benefits by users, it is likely to sell in large numbers. This will eventually bring down the market price of such systems to perhaps below £500 for a basic unit, including display. Potential users will see Class B as a low cost 'radar' that not only 'sees' other vessels in poor visibility but also enables other vessels, particularly ships, to see them. The Class B market may also include display-less systems, which solely act as beacons for other AIS systems. The lack of display will make these systems particularly low cost and they have the additional benefit in their ease of installation. The anticipated popularity of such systems will have knock-on effects to the users of AIS Class A systems. This paper explores these effects and emphasises that careful training is therefore required for users of both Class A and Class B systems to maintain the inherent usefulness of AIS.

2. AIS TRANSMISSION STANDARDS. Class B has been designed for use on craft not covered by mandatory carriage requirements under SOLAS Chapter V Regulation 19, [Ref. 1]. In general, Class B systems are expected to use the Carrier Sense Time Division Multiple Access (CSTDMA) transmission protocols currently being defined in the international standard known as IEC 62287 [Ref. 2]. This standard will be published by the International Electrotechnical Commission in 2006, when the first equipment sales can also be expected.

It is possible that certain national maritime administrations could specify that all or certain types of non-SOLAS use of AIS should conform to a postulated alternative Class B standard based on the Class A Self Organising Time Division Multiple Access (SOTDMA) transmission protocols. This alternative was introduced to the meeting of the Navigation Subcommittee of IMO held in June 2005 (NAV51). SOTDMA Class B has still to be defined and it is unclear at present what level of international support it will have. For the purposes of this paper, references to Class B only encompass those systems performing to the evolving IEC 62287 CSTDMA standard.

AIS works on Time Division Multiple Access (TDMA) transmissions. The basis of TDMA is that time is divided up into discrete 'slots' and only one station (base-station, ship-station, etc) will be transmitting during a particular time slot. For AIS there are 2,250 slots in every minute on each of the two AIS VHF channels, which are known as AIS 1 and AIS 2. UTC is used as the time reference. When an AIS Class A station is first switched on it pre-determines its transmission slots by 'listening' to the existing traffic. This establishes which slots are free, helped by stations already 'on-air', which broadcast their future slot selection as part of their transmitted messages. The algorithms for determining transmission slots form part of the International Telecommunication Union (ITU) AIS standard M.1371 [Ref. 3]. The fact that each station determines its own slots within an organised regime gives this technique the name 'Self Organising TDMA'. The SOTDMA algorithms are embedded within the software of each AIS unit.

In busy areas unused slots become rare and then stations select slots already in use by the most distant stations. These are readily calculated because of the positional data contained within the AIS messages. The organised reuse of slots from distant stations makes AIS degrade gracefully as the number of stations in an area increases

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by making the effective range of AIS decrease to match the increase in station density. The characteristics of the frequency modulated (FM) signal used by AIS helps in ensuring that the strong signals from close stations are properly demodulated in the presence of weaker signals from more distant stations sharing the same slot. This is known as co-channel interference rejection. However, if confronted with signals of similar strength the demodulator becomes confused and 'garbling' occurs. In fact there are a number of mechanisms that can make signals from distant stations similar in strength or even larger than some closer stations. For instance, poorly situated AIS antennas can cause 'masking' in some directions and enhanced sensitivity in other directions. Also, anomalous propagation of VHF signals during particular climatic conditions can provide a focusing effect, giving even very distant stations unusual prominence. For these reasons the inbuilt features of SOTDMA do not always ensure that closer stations are received in preference to more distant stations.

Class B systems working under CSTDMA also listen to the existing traffic to determine a free slot. However, in this case each station makes a 'one-off' decision as to when it can transmit a message. It does this by listening to the first portion of an intended transmission slot to see whether it is in use. The fact that it is sensing for the carrier frequency gives the transmission protocol its name. If it is sensed that the slot is not in use, it uses this slot for its own transmission, which it starts about 2 ms after the nominal slot start time, giving due time to sense the presence of Class A transmissions. Because Class B stations do not reserve future slots, they have a much smaller impact on the loading of the VHF data link (VDL).

The actual process used is more detailed. For a particular transmission, the Class B unit will identify by random selection 10 candidate slots within a 10 second period, centred on the nominal reporting time. It will then test each of these slots in turn until a free slot is found for its own transmission. If all the 10 slots are occupied it will abort transmission until the next reporting period. This added detail reduces the potential for repeated transmission conflicts of nearby Class B stations, which could result in a whole series of garbled messages. In the standard 'Autonomous Mode' the Class B unit is programmed to automatically report navigational 'dynamic data' every 30 seconds (when the vessel is underway); every 6 minutes 'static data' is reported. Static data includes information such as the vessel's name, call sign, vessel type and vessel dimensions. Navigational data includes position, course over ground (COG) and speed over ground (SOG).

The decision that a Class B makes as to whether there is another station transmitting in a candidate slot amounts to determining whether the received signal level is more than 10 dB greater than the minimum received signal during the last 60 seconds (the threshold). This means that not only does the CS mechanism work when there are no determinable signals in unused slots but it also works when all or most slots are occupied. In the latter case slots will be considered to be usable providing the received signals within the slots are not more than 10 dB above the threshold. This automatically reuses slots occupied by more distant stations. Also, as traffic increases the threshold will increase, making the operational area effectively reduce.

## 3. CHANNEL CAPACITY EFFECTS.

The transmission features of both Class A and Class B AIS ensure that with increased numbers of stations the AIS

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service degrades gracefully. Equally importantly, the CSTDMA protocols discussed above ensure that Class B stations do not significantly affect the channel capacity of Class A traffic. This is additionally helped by the fact that Class B equipment transmits at the lower power of about 1–2 watts, compared to the 12·5 watts needed on Class A equipment. (In principle, therefore, Class B has a range capability that equates to only 40% or less of that of Class A).

However, the use of Class B will increase the number of garbled messages. This will happen because of two effects:

(i) Class B stations will increase slot re-usage. If all or most slots are occupied Class B reuses slots occupied by the lowest level signals (normally being used by stations furthest away). This will increase the occurrence of garbling of Class A messages.
(ii) Two or more Class B stations can randomly select the same slot for a message and therefore garbling could result. This only affects Class B performance.

Fairly sophisticated simulations are required to determine AIS performance, particularly for the effect identified in (i) above. Data from a complex simulation published in a paper from the US Coast Guard Research and Development Center [Ref. 4] for simulated scenarios, based on actual vessel movements in Florida and San Francisco, show that effect (i) is small but is noticeable at distances above about 15 miles from the receiving vessel. In particular, for the San Francisco simulation and for targets in the 0 to 5 mile range, it was calculated that 99·4% of messages from Class A vessels would be received correctly when no Class B traffic was present and 99·3% of Class A messages would still be still received correctly, even when the VDL was loaded with additional Class B traffic making the total vessel density over five times larger.

Some insight on effect (ii) above may be obtained from a simple analysis. If $N_f$ is the effective number of free slots available for Class B use and $B_n$ is the number of Class B users attempting to use these slots, then the probability $P_c$ that two Class B users or more will occupy the same slot and give the possibility of garbling is given by the equation:

$$P_c = 1 - \left(\frac{N_f - 1}{N_f}\right)^{B_n - 1} \tag{1}$$

When underway, Class B systems will transmit every 30 seconds in Autonomous Mode, (ignoring the relatively infrequent static data broadcasts). Therefore, for a Class B operating in an area with no Class A traffic, there would be 2,250 slots in total to choose from the AIS 1 and AIS 2 channels, every 30 seconds. At, say, a 20% channel loading of Class A systems, the number of slots ($N_f$) available for choice by a Class B station becomes 1,800. From Equation. (1), this yields a 10·5% probability ($P_c$) that two or more vessels will transmit in the same slot.

Whether garbling actually occurs at a given receiving station depends upon the relative signal strengths of the two conflicting signals. Receiver specifications for both Class A and Class B systems require that signals should be received un-garbled from a stronger signal, provided that there is at least a 10 dB difference between this signal and any others being simultaneously transmitted (co-channel interference rejection). This implies, in idealised circumstances, that for garbing not to occur the two

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conflicting stations need to have a range ratio to the receiving station of more than 3·2:1. Any garbling of Class B stations will typically 'freeze' target information for affected targets until the next transmission, preventing a new update for around 60 seconds from the previous update.

It can be easily shown for transmitting stations uniformly distributed around a receiving station that if the co-channel interference is given by $I_{co}$ dB, then the probability $P_g$ of receiving garbled information is given by:

$$P_g = 1 - 10^{-I_{co}/10} \tag{2}$$

Therefore, for $I_{co} = 10$ dB, 90% of transmitters will be at ranges that will not give a sufficient difference in received signal strength to be un-garbled (in idealised receiving conditions). This means that for the example above, the 10·5% probability of two (or more) transmissions in the same slot will be reduced by 10% (i.e. to 9·4%) through the action of co-channel interference rejection. (In practice, there is evidence from work performed by the Northern Lighthouse Board suggesting that co-channel interference is normally rather better than 10 dB [Ref. 5]).

The effect of garbled Class B messages is qualitatively noticeable in the USCG simulations. For the 'San Francisco' simulation, 99·3% of Class A messages from vessels in the range 0–5 miles are correctly received by a Class A system, whereas only 89·9% of Class B messages are received. Importantly, if the non-SOLAS vessels had been using Class A equipment instead of Class B, the probability of a SOLAS vessel receiving other SOLAS-originated Class A messages from within the 0-5 mile region reduces from 99·3% to 90·6%. Reception of transmissions from non-SOLAS vessels would also reduce – from 89·9% to 74·9%. The San Francisco simulation used 150 SOLAS and 700 non-SOLAS vessels across the broad geographical area of the simulation.

Sensible use of Equations (1) and (2) above, which are plotted in Figures 1 and 2 can give a very good and quick understanding of the effects of Class B garbling in a variety of situations, which would otherwise need comprehensive simulation. To establish the probability of Class B garbling, it is simply a matter of determining from Figure 1 the probability that two (or more) Class B stations will transmit in the same slot, given the percentage channel loading from Class A use. $B_n$, the number of Class B vessels, should be taken as the average number of Class B vessels in range of an AIS receiver system. This probability is then multiplied by the factor derived from Figure 2, which effectively adds the garbling protection given by the co-channel interference rejection capability of AIS receivers. There is a small inconsistency in that Figure 2 assumes that only two Class B transmissions are attempting to use the same slot, whereas the curves in Figure 1 are for the case when two or more transmissions are attempting to transmit simultaneously.

The important aspect concerning garbling, compared to other statistical effects on signal reception, is that it equally affects close targets – the very targets that are of immediate interest to detect and possibly avoid. For such targets, the probability of garbling can be looked on as being the probability that an individual AIS report from a nearby Class B vessel will be missed; for close targets other factors concerning reception probability are generally small and the garbling due to Class B to Class B slot sharing becomes dominant.

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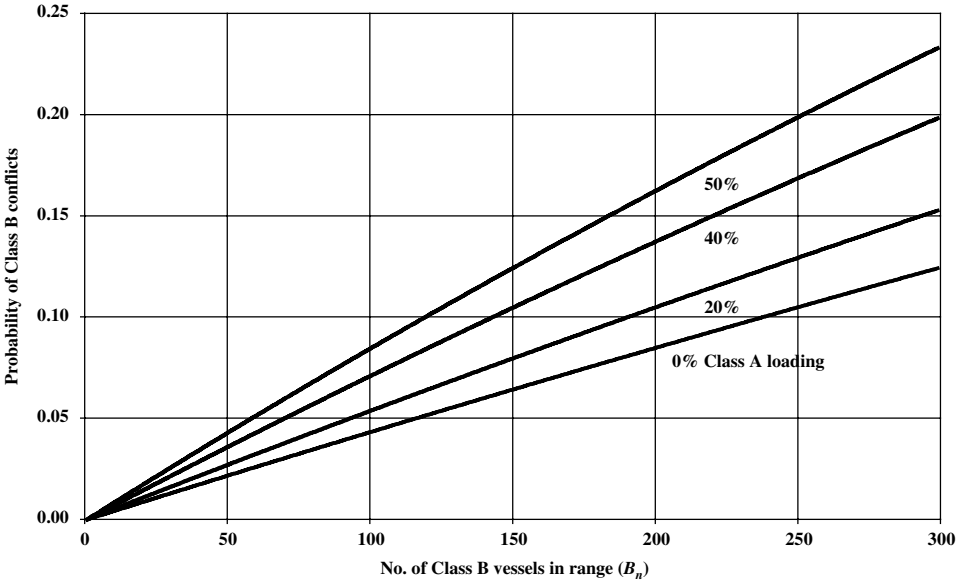



Figure 1. Probability of class B conflicts.

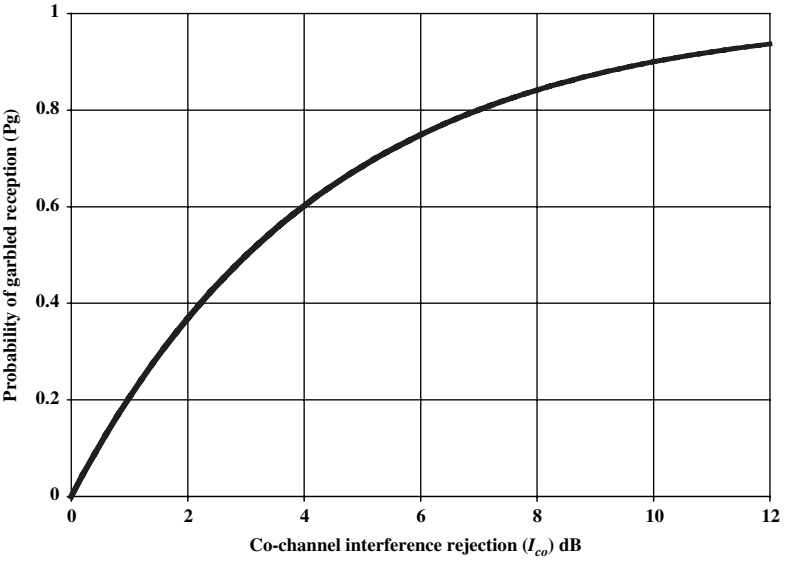



Figure 2. Probability of garbled reception as a function of co-channel interference rejection.

4. AIS AND THE COLLISION REGULATIONS. AIS is frequently discussed with relevance to collision avoidance. Class B is particularly spoken about as decreasing the possibility of collisions of small craft with SOLAS vessels. However, over the years since its conception, the emphasis on the ship-to-ship role of AIS has changed from being an anti-collision device into a system for improving

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the situational awareness of the mariner. The use of AIS is not yet explicitly recognised within the Collision Regulation (COLREGS) [Ref. 6], which are written around the concepts of sight and hearing of other vessels and the proper use of radar. However, Rule 5 (Lookout) does use the words "all available means", as follows:

> "*Every vessel shall at all times maintain a proper lookout by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and the risk of collision*"

AIS has many features that makes it a good complement to both visual and radar techniques for enhancing situational awareness. These include:

- It uses the VHF band, which is not restricted to line of sight operation that also affects radar
- It gives the heading of a vessel, which is sometimes difficult to be assessed by radar. (Heading is used in the COLREGS to determine the correct collision avoidance action). However, Class B vessels are not obliged to transmit heading
- It gives a rapid indication of the change of heading/course of a vessel, which cannot be matched by a tracking radar (ARPA/TT)
- It gives the static and voyage related data of a target that can help clarify its intentions – although experience has shown that this can be misleading, particularly if the voyage related data is not up-to-date [Ref. 7]
- It gives the name and call sign of a vessel, enabling a more positive identification if radio contact has to be made to assess difficult situations. (However, this still remains a controversial technique)

But AIS has the following drawbacks:

- Decisions based on AIS information must take into account that the integrity of broadcasts from other vessels (which are outside the control of own-vessel) may be suspect
- It relies on vessels using an accurate (or at least a common) source of positional data and will entirely fail if positional data is lost
- It is susceptible to spoofing (maliciously misleading transmissions) both of AIS messages and the positional data system used (e.g. GPS)
- Many floating objects that need to be avoided do not carry AIS, such as smaller vessels and floating debris

Unfortunately, some of these drawbacks are commonly found, making even Class A AIS to be unsuitable as a sole source of collision avoidance data, except in the most extreme circumstances.

The standards for Class B have been set in the light of the experience that has been obtained from the use of Class A systems. In particular, it has been found that the interconnection of the AIS unit with navigational sensors can be problematic, even with professionally installed equipment. For this reason Class B units have an integral GPS/GNSS, which is used internally to provide position, SOG and COG. (Unlike Class A systems, it is not used to derive UTC because CSTDMA assesses slot timing from the reception of Class A transmissions). However, heading may be optionally input from an external sensor. Noting the problems that even some Class A vessels have had with heading, any indication of heading transmitted from a Class B station should be taken with extreme caution. Also, because the user of a Class B

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system may not be navigating with the same position sensor information supplied by the internal GPS/GNSS, a positional or other fault in the AIS GPS/GNSS derived data may not be recognised by the transmitting user. This may increase the propensity of Class B systems to give erroneous data (offset by the fact that such positional data is 'untouchable' by the Class B user, which will generally increase the likelihood of the data remaining valid).

5. DISPLAY OF CLASS B TARGETS. It may not be realised by potential Class B users that there is no requirement for SOLAS vessels to show AIS targets on a spatially related display, such as a plan position indicator (PPI). Such vessels are required to carry an AIS that has a display that meets the requirements of a Minimum Keyboard and Display (MKD) configuration [Ref. 8]. This need only show the data of three vessels at any one time, listing just the bearings, ranges and names of the vessels. In reality, most, if not all manufacturers provide additional features to that required by the standard, even on their most basic units. Often a simple PPI display mode is available. However, manufacturers supplying such a mode are not required to meet any minimum standards for the mode and therefore it may not be suitable for navigational use. In general, built-in displays of AIS Class A units are small and any data displayed in PPI mode can appear cluttered and therefore difficult to read. Furthermore, on many vessels because of space or other restrictions, the AIS unit is not situated conveniently close to the conning position and is therefore not observed as frequently as radar.

As discussed further in Section 7 below, all newly installed SOLAS radars from 1 July 2008 will have to be able to display AIS targets overlaid onto the radar display. Only a few vessels are fitted with such radars at present and there is no current legislation mandating that such radars need to be retrofitted to all vessels. The relatively large displays of radar are very suitable for displaying AIS targets. Vessel masters have reported to the author that well designed systems can give an impressive performance at sea, both in indicating AIS targets that are not visible to radar and also in fusing (merging) radar and AIS data. Fusion decreases the complexity of the displayed image by showing a single merged target rather than displaying both an AIS target and a radar-tracked target. Fusion also increases the confidence in the data accuracy of the target. Conversely, non-fusion indicates that more attention may need to be paid to targets – why is there not fusion? For instance, there actually may be two targets (one seen only by AIS and one seen only by radar), or perhaps the transmitted AIS data of a target is in error.

Unfortunately, it is clear that for many years most SOLAS vessels will not have such an AIS capability. Any confidence that the potential user of Class B equipment has in expecting own-vessel's presence to be highlighted to all surrounding SOLAS vessels is misplaced. Class B users must not assume that they will be any more visible than they already are to conventional visual and radar observation. Any other assumption could lead to a serious risk of collision. Any misplaced confidence will become a hazard to all seafarers.

The 30 second update rate of Class B stations is slow compared to both radar and Class A performance. Even for relatively slowly moving targets (up to 14 knots and on a steady course) the Class A update rate is every 10 seconds. This rises to 2 seconds for vessels at speeds at 23 knots and above and for all vessels at speeds above 14 knots

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that are changing course. Radar typically provides a 2 second update rate. The slow update rate of Class B targets has implications even when AIS is displayed on a radar screen. At 30 knots a vessel travels a quarter of a mile in 30 seconds. At 1 nautical mile this can correspond to a bearing difference of up to 14 degrees. A garbled Class B message would make the next update a half mile away from the previous plot, with a maximum 28 degrees of bearing difference at one mile range. This is clearly not precision target positioning and must be borne in mind by bridge staff when using Class B target information to make navigational decisions, particularly as leisure vessels can make frequent changes in course. For the equivalent situation, a Class A fitted vessel at 30 knots will only travel 31 metres between updates and will have a maximum change in bearing of less than 1 degree at 1 mile. At best, a Class B target travelling at speed will only provide an indication of its presence, perhaps suggesting that a more careful visual or radar based search should be made to properly identify its range, bearing and speed. In many circumstances it may be quite difficult to mentally associate the AIS target correctly with the appropriate radar target. Automatic data fusion is probably inappropriate for such targets and hence the display presentation will remain cluttered with both radar and AIS returns of all Class B targets having to be shown.

Such proliferation of Class B targets on a navigation display, particularly considering the potential high density of Class B targets in some areas, may tend to lead to information overload of the SOLAS navigator, unless there is the provision of suitable filters, perhaps based on closest point of approach (CPA) and time to closest point of approach (TCPA) calculations. To filter out all Class B targets would be a drastic measure but intelligent user-switchable filters that can temporarily remove targets that are determined to be of no consequence may need to be developed.

One additional aspect that SOLAS users need to know about the display of Class B data is that their existing AIS MKD is unlikely to be able to display the name and other static data of Class B targets. This is because Message 24A/B used for transmitting this data has only recently been defined and it is not included within the display requirements of current AIS MKDs. (Message 18, which is the dynamic data message transmitted by Class B systems every 30 seconds, is recognised). On most MKDs it can be expected that the Maritime Mobile Service Identity (MMSI) number of a Class B target will be displayed in place of the vessel name. (The MMSI is used as the electronic tag that identifies the source of transmitted messages). In principle, a Class B message would not necessarily be identified as being from a Class B vessel simply because the standard does not require this. For the same reason even the MMSI may not be available in the display field, although this is unlikely in practice. However, Class A AIS units are required to pass every received AIS message through to its digital data output, even if the message type is not recognised. Therefore, even older MKDs will be able to pass all messages through to newer radar and ECDIS systems that have AIS display capabilities, where the messages will be handled correctly.

6. TRAINING. AIS is not a system that can be used in ignorance, whether by Class A or Class B users. The Class A user has access to training courses at colleges and to good remote learning packages. Also, in 2006 IMO is publishing a Model

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Course that defines approved AIS (Class A) training. The Class B user also needs to be educated, perhaps by suitable articles in the leisure marine press and by AIS use being included into courses for national boating qualifications. The education must stress that although the displayed data can be extremely useful it is possible to be in error and is very unlikely to be a complete portrayal of all floating hazards. Also, Class B users need to be fully aware that their transmissions are (today) unlikely to be observed on most SOLAS vessels, therefore the use of radar reflectors or transponders are still recommended and the usual cautions to bear in mind when navigating in the presence of SOLAS vessels should still be observed. Although users of Class B with a display will get the benefit of being able to detect surrounding Class A (and B) targets the Class B display-less user does not even get this advantage. A receive-only Class B perhaps remains an option worth considering, if a lower cost unit is essential.

The apparent precision that such parameters as CPA and TCPA are given by AIS equipment is also of concern. The inexperienced leisure user may consider, even in restricted visibility, that there is no risk of collision ('I have at least 20 metres clearance and hence no collision avoidance action need be taken'). The experienced SOLAS navigator will be looking for CPAs far in excess of these and will take appropriate collision avoidance action in an attempt to ensure them. This may, in turn, confuse the leisure sailor, with the possibility that resultant erroneous action leads to a collision.

Equipment manufacturers in the leisure boating sector can be more innovative than the SOLAS sector as the market is larger and the type approval requirements are not so tight. It can therefore be expected that there will a fairly rapid evolution of AIS Class B devices. It is therefore also important that manufacturing companies fully understand the issues, such that innovation does not create additional dangers. For instance, it is easy to imagine a future Class B display that gives a perspective impression of the surrounding situation, taking into account the size and type of vessels, their relative positions and their orientations. Such displays could use all the graphics technology available to the latest generation of computer game technology. Since SOLAS ships are uniquely identified by their MMSI, the screen graphics could even include stored images of target vessels with the correct perspective and with photo-realism. Such systems are quite feasible using today's technology but the added realism may only serve to further a belief that the graphics represents a true and complete picture of the real world. Although this is far from the truth, it would perhaps be even less apparent to the inexperienced user than if the data was displayed on a simple PPI. Effective user education is of paramount importance. In particular, the manufacturer needs to be closely involved in this process.

The leisure user is gradually being given all the sophistication (and more) of SOLAS equipment but at present training remains an optional extra. The greater the apparent ease that small boat navigation becomes, the greater the chance that ignorant decisions will be made. Also, the need for proper training becomes less obvious to the first-time user of seemingly easy-to-use equipment. This is clearly a potential hazard for the bridge team of a SOLAS vessel.

7. STANDARDS. Presently, SOLAS vessels are effectively required to carry AIS that are in conformance with IEC 61993-2 [Ref. 8], which has been written to

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comply with all the relevant requirements of IMO for an AIS Class A MKD. Manufacturers use this standard to ensure that their specific designs will meet international requirements; it is also used by type approval authorities as the standard to which submitted equipment is tested. As previously mentioned, equipment tested to this standard will not ensure that it is suitable as a device to alert bridge officers that a Class A or B target of potential significance to the overall situation awareness of the vessel has been detected. The present Class A MKD equipment standard is more directed to providing good ship-to-shore data and to establish a greater level of information from targets that have been originally detected visually or by radar.

If such equipment is to be used to alert bridge staff of targets that are of safety significance it would require a major rewrite of the standard, including a requirement to have a PPI display of substantial size. This is not a practical proposition – not least because many ships would not have space for an additional display at the conning position. The alternative, of requiring AIS data from the unit being mandatorily displayed on an existing large navigation display such as radar or ECDIS, is also impractical at present because the vast majority of existing radar and ECDIS units do not have input and display facilities for such data.

Not surprisingly, IMO has anticipated these issues [Ref. 9] and has decided that all new radars fitted to ships after July 2008 must be able to display AIS targets. This solution ensures that AIS data is available at the conning position on a suitable display designed to enhance situation awareness. (The IEC is currently drafting equipment standards based on this resolution, which will be available in 2007). At some stage in the future it can be expected that IMO will mandate the fitting of all vessels with radars complying with the new standard. It is perhaps unlikely that this will be required within the next 10 years.

Since the future is for AIS to be displayed on radar (and optionally on ECDIS) it is therefore unlikely that the standard for the basic AIS unit (MKD) will evolve to include the requirement for better display facilities. It will become the ship's AIS 'sensor' connected to the navigation data network but generally accessed through other equipment, such as radar and ECDIS, which will also be used to load AIS voyage related data and to check that the AIS is correctly operating and transmitting valid information.

8. CONCLUSIONS. Although this paper has concentrated on the potential problems that Class B will bring to Class A users, the author remains of the opinion that the use of Class B will be beneficial to the safety of life at sea. The knowledgeable use of Class B display equipment on leisure and other vessels will usefully enhance the situational awareness of their users and enable them to make better-informed decisions. Because of its perceived safety benefits, its potential low cost and the relative ease of fit (compared to radar) it will be an attractive purchase proposition, even to owners of quite small vessels. Also, as more SOLAS vessels incorporate radar with AIS display facilities, it has the potential to make a significant impact on safety.

The paper has highlighted the following points:

- Even quite large densities of CSDTMA Class B fitted vessels do not adversely affect the ability of AIS to detect Class A transmissions

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- AIS overlaid on a radar display is the appropriate way for SOLAS vessels to use AIS data in order to obtain satisfactory improvements in situation awareness. From 1 July 2008 all new radars must have this capability
- At present and for an undefined time into the future, many SOLAS vessels will rely on their AIS 'MKD' to provide AIS information. Such equipment is approved to a standard that does not require a display suitable for determining that an AIS target is of navigational significance. Also, the MKD may not be positioned to be easily accessible from the conning position. Therefore Class B users must not assume that their AIS will make their vessel more prominently displayed to SOLAS vessels
- The update rate of Class B at twice per minute is very low, compared with the potential manoeuvrability of small vessels and the update rates of radar and Class A AIS. This will cause:
  - Less effective situational awareness for such targets, compared to Class A targets
  - Automatic fusion with radar to be probably an inappropriate technique to reduce the complexity of the displayed scene
  - Manual association with radar targets to be more difficult
- Class B suffers inherently from an increased amount of garbling, even for close targets. This will further reduce the effective update rate, exacerbating the related problems
- In some areas there may be problems in there being too many Class B targets to be displayed without causing information overload to the Class A user. Since automatic fusion is likely to be inappropriate, research needs to be performed as to what filtering strategies could be used to safely alleviate this problem
- The education and training of Class A and B users is essential to obtain the full benefits of AIS without creating potentially dangerous situations through misuse. In particular, users of Class B display-less devices should be aware that not only are they unlikely to be more prominently displayed to SOLAS vessels but their systems cannot give them potentially useful information concerning surrounding AIS-fitted vessels

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