Forum

'A Note on the Use of the Global Positioning System (GPS) for the Identification of Marine Radar Contacts'

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In Stawell's article,[1] in the September 1993 issue of the *Journal*, two possible schemes are outlined in which GPS provides position information to a VHF ship–ship identification system. The author concludes that both individual interrogation and broadcast methods of identification will 'suffer catastrophic failure at high (but not impossible) traffic densities'. In this comment we contend that although the system concept is valid, the basis for the conclusion is flawed. Furthermore, we suggest that a number of refinements will provide a significant improvement in performance compared with the systems described.

In the individual interrogation method, described in his section 3, a number of very reasonable assumptions are made, and it is correctly deduced that the number of identifications which must be made in time T is $2\pi R_v^2 R_r D^2 \bar{v} T$, where R_v = radio range, R_r = radar range, D = density of shipping and v = average speed. Furthermore, it is correctly deduced that if p_t is the probability that a single transmission attempt fails, then the average number of interrogations per identification will be $1/(1-p_t)$. The total number of identifications required within a VHF area πR_v^2 in time T is thus indeed $2\pi R_v^2 R_r D^2 \bar{v} T/(1-p_t)$, as stated in equation (3). If each interrogation takes a time t_t, and if there are no simultaneous interrogations or responses by different ships, then the proportion of time that the VHF channel is occupied will be $2\pi R_v^2 R_r D^2 \bar{v} T t_t/(1-p_t)$. In equation (4) it is stated, incorrectly, that this is the same as the probability p_t that a single transmission attempt fails. That it is incorrect is a consequence of the fact that the occupancy figure was derived under the assumption that there are no simultaneous interrogations or responses by different ships, and hence no mechanism by which the transmissions can fail. If the traffic load is small, then the probability of failure is approximately equal to the channel occupancy, but this relationship will certainly not hold when the probability of failure is equal to 0·5. Since the conclusions are based on precisely this value for the probability of failure, we contend that the conclusions are invalid. A similar argument is used in section 4 to deduce the performance of a broadcast method and, for the same reason, we contend that the conclusions for this system are also flawed. In reality, transmissions will fail if two *or more* occur either simultaneously or overlap, and under these conditions the actual channel occupancy will be *less* than the proportion of time, accumulated over all ships within VHF radio range, in which transmission attempts are made.

We suggest that there exist a number of refinements which can be made to the system in order to improve its performance significantly, and that the system possesses a number

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of properties which can be exploited to make a substantial reduction in the traffic load on the channel.

Maritime VHF channels have a bandwidth of 25 kHz, and it is not difficult to transmit data at a rate of 10 kbit/s. This will provide an improvement in capacity by a factor of ten compared with the 1 kbit/s assumed in reference 1. Against this improvement, we contend that in the form in which it is described in reference 1 the scheme cannot work because there is no mechanism by which a ship can distinguish between the responses which it receives from its own interrogations and those of other ships within VHF radio range. The response message must therefore contain GPS position information. This means that the length of the response will need to be rather more than the 50 bits assumed in reference 1, and this will reduce the overall system capacity. However, all ships within radio range will now be able to receive and interpret every interrogation response, with a consequent reduction in the total number of interrogations required. This property of the system will reduce the traffic demand on the channel, and thereby increase the system capacity. As a result of the above refinements it is no longer a simple matter to calculate the overall system capacity: both the temporal distribution of radio messages, and the spatial distribution of ships, will have a significant effect on system performance.

REFERENCE

[1] Stawell, W. B. (1993). A note on the use of the Global Positioning System (GPS) for the identification of marine radar contacts. This *Journal*, **46**, 437.

KEY WORDS

1. Radar. 2. Satellite navigation. 3. Vessel traffic services.

The Author Replies

May I thank Dr Stansfield for his interest in my paper. However, I cannot agree with him that my analysis depends on the assumption that there are no simultaneous interrogations or responses by different ships; it is precisely the probability of such simultaneous interrogations and responses that I derive as p_t.

His final paragraph seems to propose a cross between my individual interrogation and broadcast systems and though I cannot agree that individual interrogation will not work as stated (either the next response received will be the wanted one or there will be interference), such a system might well provide greater system integrity. I am also in entire agreement with the thinking behind his final sentence that it is 'no longer a simple matter to estimate system performance'.

My paper did make it clear that it was only a preliminary and elementary analysis with the object of showing the need for further and more sophisticated studies. May I repeat that it is of vital importance to make such a thorough study before deciding on the final universal system; the limited environment of a VTS will provide no worthwhile information on the performance of a universal system. Today, advances in microwave components and solid state devices mean that the magnetron as a power source and the conventional waveguide plumbing can be eliminated from a secondary radar identification system giving an order of magnitude reduction in its cost, making it comparable with a GPS-based system. This finally removes any justification for considering a GPS-based system as the only solution to the marine identification problem.