Outline of "Investigation for Navigation Safety System on Tankers"

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1　Introduction

In keeping pace with the expansion of international ocean trade, oil tankers and other ocean vessels are increasing both in size and in number, aggravating congestion of marine traffic. Accidents involving these large ships such as collisions and stranding, and the resulting spills of crude oil and fuel can cause large-scale marine pollution and therefore serious environmental, economic, and social problems. There is a growing demand, therefore, for effective measures to prevent accidents involving large ocean vessels including large tankers.

In this project, a study was conducted to evaluate the feasibility of a navigation safety support information system for tankers, a system which enables a ship to determine its own and nearby ships' positions accurately and exchange information by making effective use of a number of information technologies including , by The Petroleum Association of Japan .

(1) Electronic chart information technology,
(2) Global positioning system (GPS)technology,
(3) Geographic information technology, and
(4) Digital communications technology.

An outline about the possibility is described below .

2 Fact-finding Survey of Marine Accidents

Accident reports and shipping companies were surveyed to collect information on the causes of past marine accidents. The survey revealed that the causes of marine accidents such as collisions due to dense fog, squalls, or obstructive weather conditions and strandings due to discrepancy between charts and actual ship positions, except for accidents caused by human carelessness, can be categorized as follows (see Fig. l):

(1) Inadequacy of communication
(2) Inaccuracy of information
(3) Difficulty of processing a large amount of information quickly

These collisions and strandings can be prevented by taking appropriate preventive measures. What needs to be done, therefore, is to propose a system capable of solving these problems.

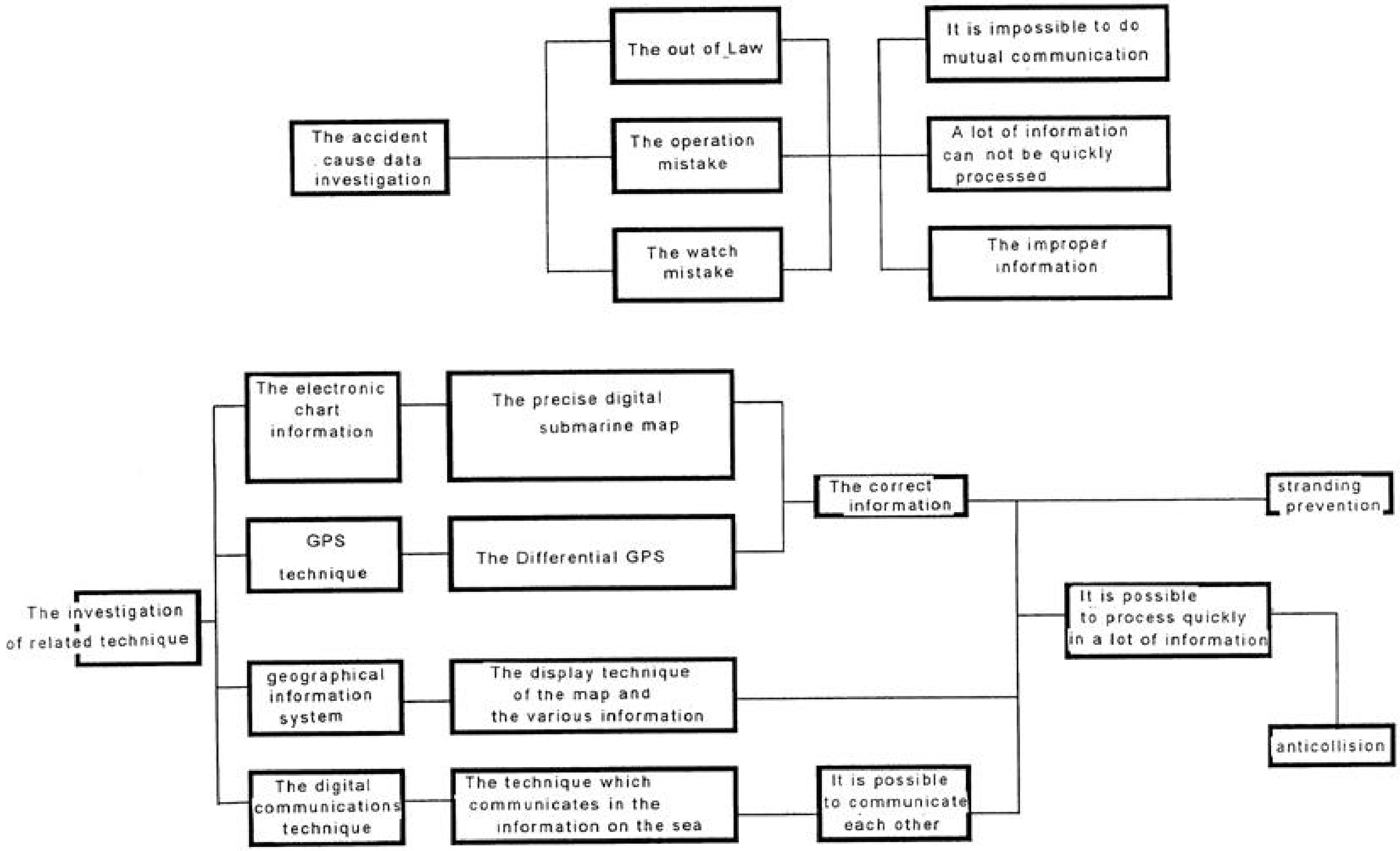

Fig.1 The actual state investigation and the measure of the shipwrek accident

3 Survey of Related Technologies

Technologies needed to build an effective safety system include the following:

(1) For better communication Digital communications technology to improve communication

(2) For more accurate information Electronic chart information technology Global positioning system technology

(3) For faster processing of more information Geographic information technology

4 Outline of the System

In proceeding with system design taking into consideration the causes of accidents and available technologies that can be used to prevent such accidents, it is necessary not only to coordinate with international trends toward standardization and unification but also to seek operational and economical efficiency.

These related technologies include the following:

(1) IBS (Integrated Bridge System)

(2) GPS (Global Positioning System)

(3) ECDIS (Electronic Chart Display Information System)

(4) DSC (Digital Selective Calling)

(5) GMDSS (Global Maritime Distress and Safety System)

(6) VTS (Vessel Traffic Service)

The navigation safety support information system for tankers, therefore, uses the technologies to collect, integrate, and display various information, including positional information from GPS, information from satellite communications systems and automated communications systems Such as DSC (Digital Selective Calling),and electronic chart information.

The navigation safety support information system enables the shore base station to keep track of the conditions in the service area on the basis of information received from individual ships. By monitoring transmissions from other ships, each ship can obtain the same information that the shore base station receives.

Information on other ships monitored by each ship can be limited to information on nearby ships, instead of all ships in the service area. Thus, the shore base station is responsible for controlling the timing of transmissions in its service area to prevent interference and does not have to retransmit received information to ships in the service area.

The key to successful implementation of such a system is the communications method to be used.

4-1 Functions as Viewed from the Shore Base Station

(1) A ship enters the service area of the system. The shore base station has been transmitting signals requesting the ship that has entered the service area to register with the station.

Automatically alerted that it has entered the service area, the ship sends to the base station relevant information, including the type of message, identification, and the GPS-determined position, course, and speed of the ship (registration of entrance).

After completing the registration as requested, the base station assigns a zone and a time slot to the ship.

The assignment of the time slot involves specifying the time at which each ship is to transmit its information. The purpose of time slot assignment is to make sure that information from a great number of ships is transmitted in turn without interference.

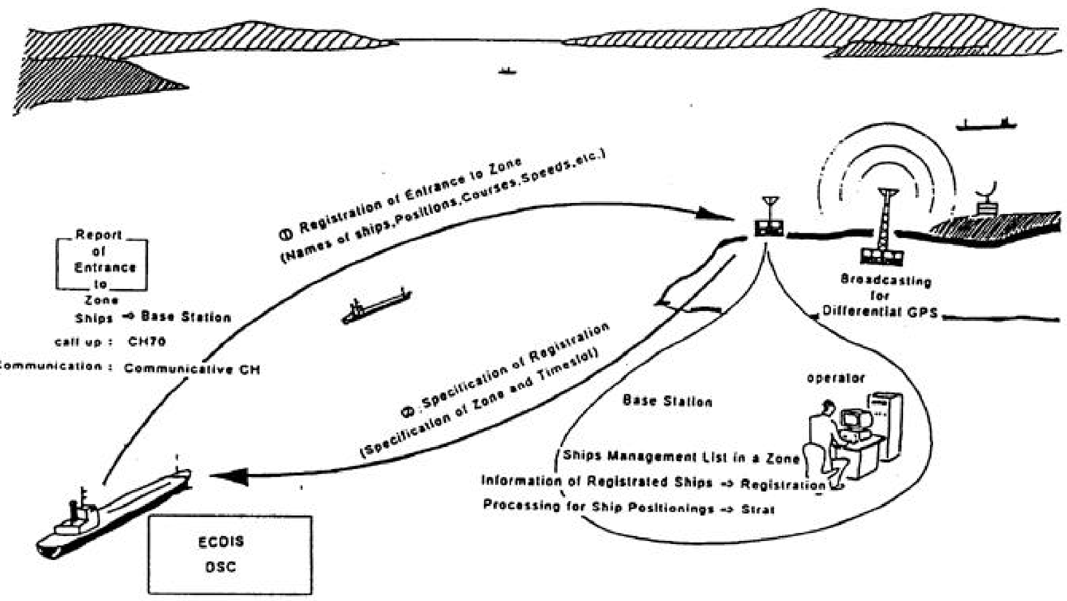

Fig.2 Enter to Service Zone (Getting Information of Ships)

(2) In the service area, the base station requests each ship to send its information according to the assigned time slot (request for scheduled reporting) .

Ships that have been requested to send such information transmit to the base station information on themselves, including information on the type of message, identification, ship location, course, and speed.

The above process proceeds automatically.

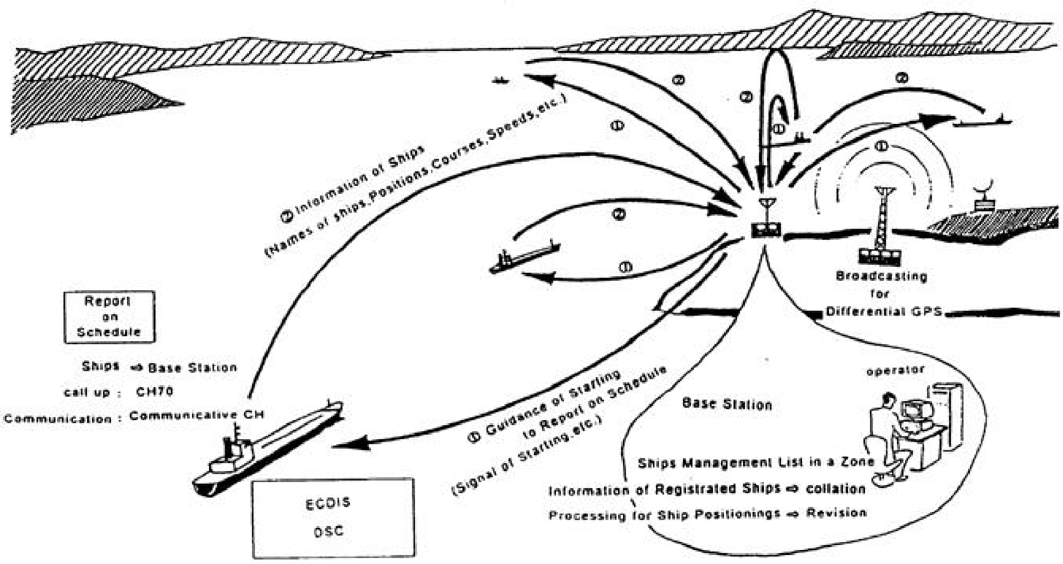

Fig.3 In a Service Zone

(3) Any ship desirous of leaving the service area requests the shore base station for a registration of exit.

In response to this request, the shore base station acknowledges receipt of the request and terminates its service by transmitting appropriate signals.

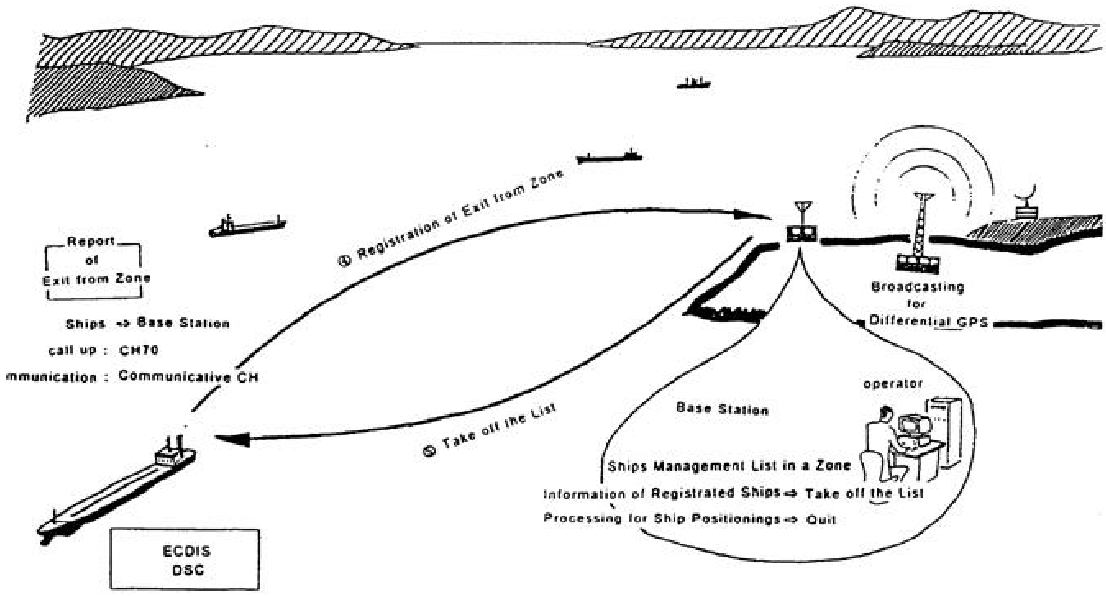

Fig.4 Exit from Service Zone

4-2 Functions as Viewed from Ships

(4) A ship enters the service area of the system. Automatically alerted that it has entered the service area, the ship sends to the base station relevant information, including the type of message, identification, and the GPS determined position, course, and speed of the ship (registration of entrance).

After completing the registration as requested, the base station assigns a zone and a time slot to the ship.

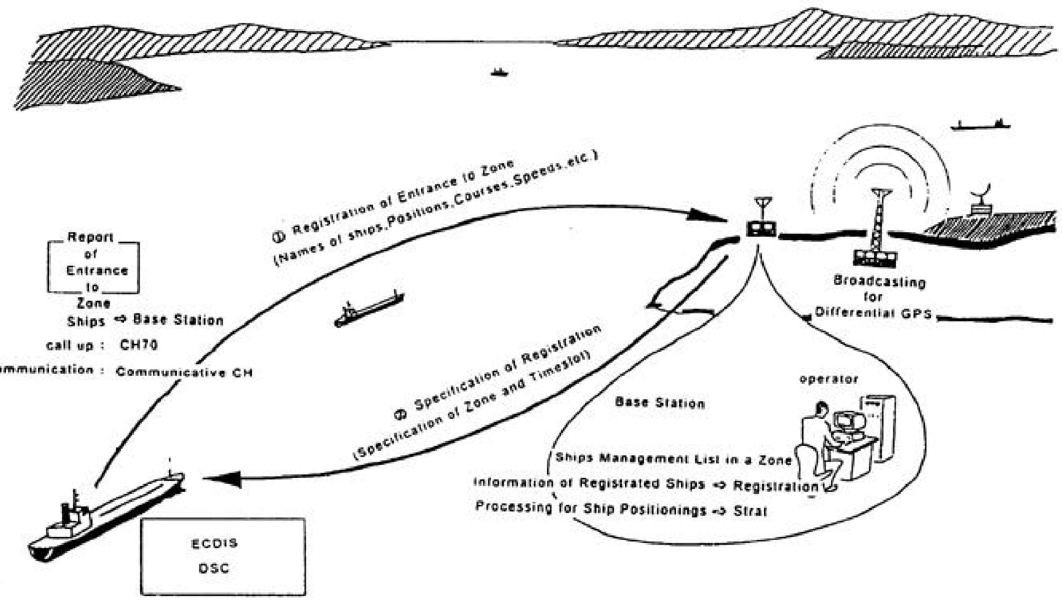

Fig.5 Entrance to Service Zone
(Giving Information of Ship's own)

(5) Each ship monitors transmissions that other ships transmit to the shore base station according to the assigned time slots. Information thus obtained is displayed on the ship's monitor, along with electronic charts, GPS-determined position of the ship, and other navigation support information. Thus, each ship can acquire the same information that other ships send to the shore base station.

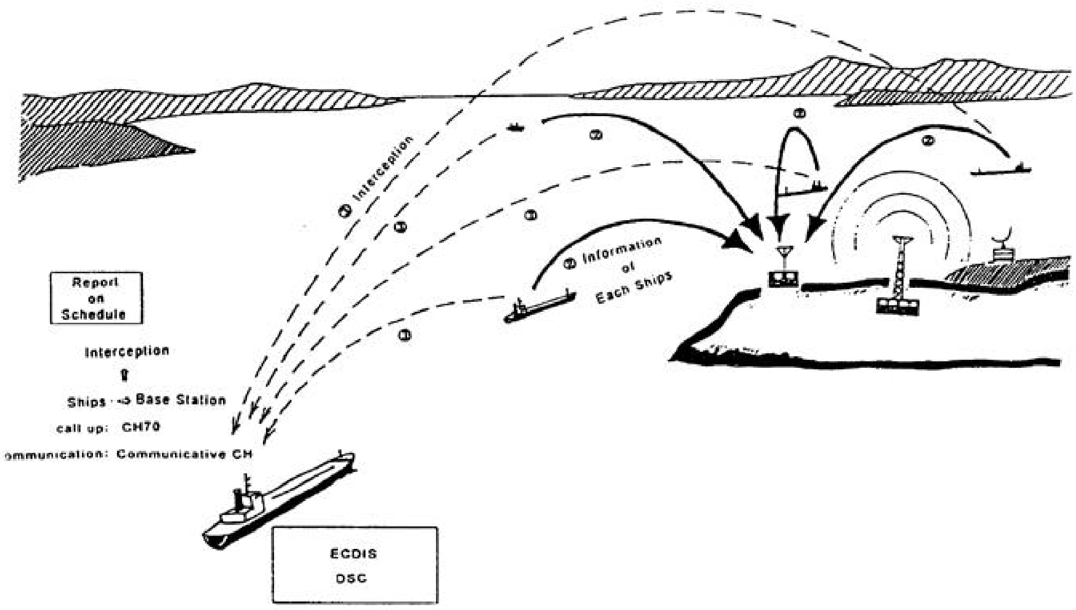

Fig.6 The Times of Report on Schedule

(Interception to Information of Another Ships)

(6) Any ship desirous of leaving the service area requests the shore base station for a registration of exit.

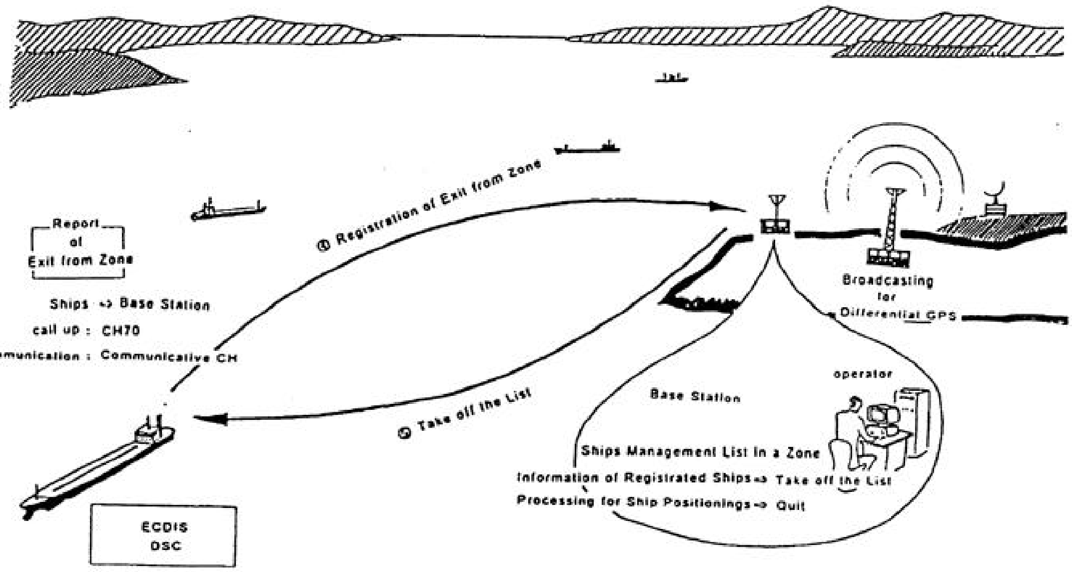

Fig.7 Exit from Service Zone

4-3 Inter ship Communication on International Waters

(7) On international waters where ship trafficis not heavy, ships are allowed to communicate with each other without heeding the possibility of interference.

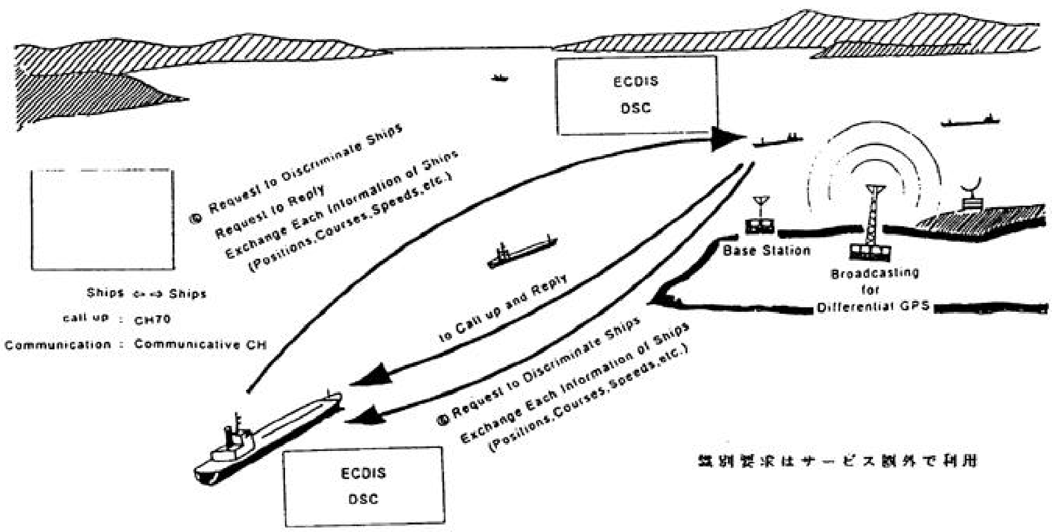

Fig.8 Out of the Service Zone
(Exchange Each Information of Ships)

5 Prototype Development and Performance Testing

A prototype system has been developed according to the design concept Outlined above. Figs. 9 to 2 1 show examples of simulation screens of the system.

Fig. 9 The on-ship system accumulates information on other ships by monitoring their transmissions to the base station.

Fig. 10 The system issues a collision alarm if the ship is on a collision course with another ship.

Fig. 11 The system issues a stranding alarm if the system decides, on the basis of data on shallows and sunken rocks shown on electronic charts, that the ship might be stranded. The white dots show the locations of sunken rocks.

Fig. 12 Following a collision alarm, the oncoming ship on a collision course is identified and called up.

Fig. 13 The selective call in Fig. 12 has been answered.

6. Conclusions

In the simulations carried out using the prototype system, calling up a selected ship took 25 seconds. In a test of area calling, calling up 5 ships took 12.5 seconds. The maximum response time in the case of selective calling soon after the start of scheduled communications according to the DSC controller's communications schedule was 12.5 seconds. This is because selective calling is carried out after completion of scheduled communications.

Concerning response time in scheduled communications, since scheduled communications with one ship takes 2.5 seconds, the response time for 250 ships is 625 seconds (about 10 minutes).

Ship symbols shown on the system display are updated every I O minutes because positional information for each ship is obtained from scheduled communications. Since scheduled communications can take up to 1 O minutes, inter ship communications may have to wait for up to I O minutes. Therefore, if a registration of entrance is made during scheduled communications, contention may result.

As the transmission rate of the existing system is 1 200 baud, scheduled communications for one ship takes 2.5 Seconds. If the transmission rate is raised to 9600 baud, the time required for scheduled communications for 250 ships will be reduced to 10 minutes to 2 minutes, a feasible range. This will decrease the waiting time in selective calling, helping to prevent the occurrence of contention. It also helps to reduce interference with communications for registration of entrance and scheduled communications.

In this study, only one radio channel was used for communications. In order to raise the transmission rate and prevent radio interference, it is necessary to use two channels instead of only one. Allocating one channel to scheduled communications between the base station and ship stations and the other to emergency communications between ships (selective calling, area calling) and registration of entrance will greatly contribute to prevention of interference and contention.

By investigating a shipwreck accident, it was possible to investigate to process a lot of information for which it is difficult to communicate will mutually it was improper and quickness of it and that these which are difficult were cause. It found that these were a factor. Therefore, the stranding accident can be prevented in one's own ship's having correct information. Also, the collision accident can be prevented in specifying shipping in font in sharing the correct information of the other ship by each shipping and summoning it individually and confirming mutual intention. This system made it a system concretely. As for this system, the effective thing could be confirmed to prevent from the stranding accident and the collision accident of the large-sized shipping such as the tankers. And the system of this study, that all the ships are equipped with this system becomes a presupposition. Therefore, the realization of this system in the early stage is waited for.

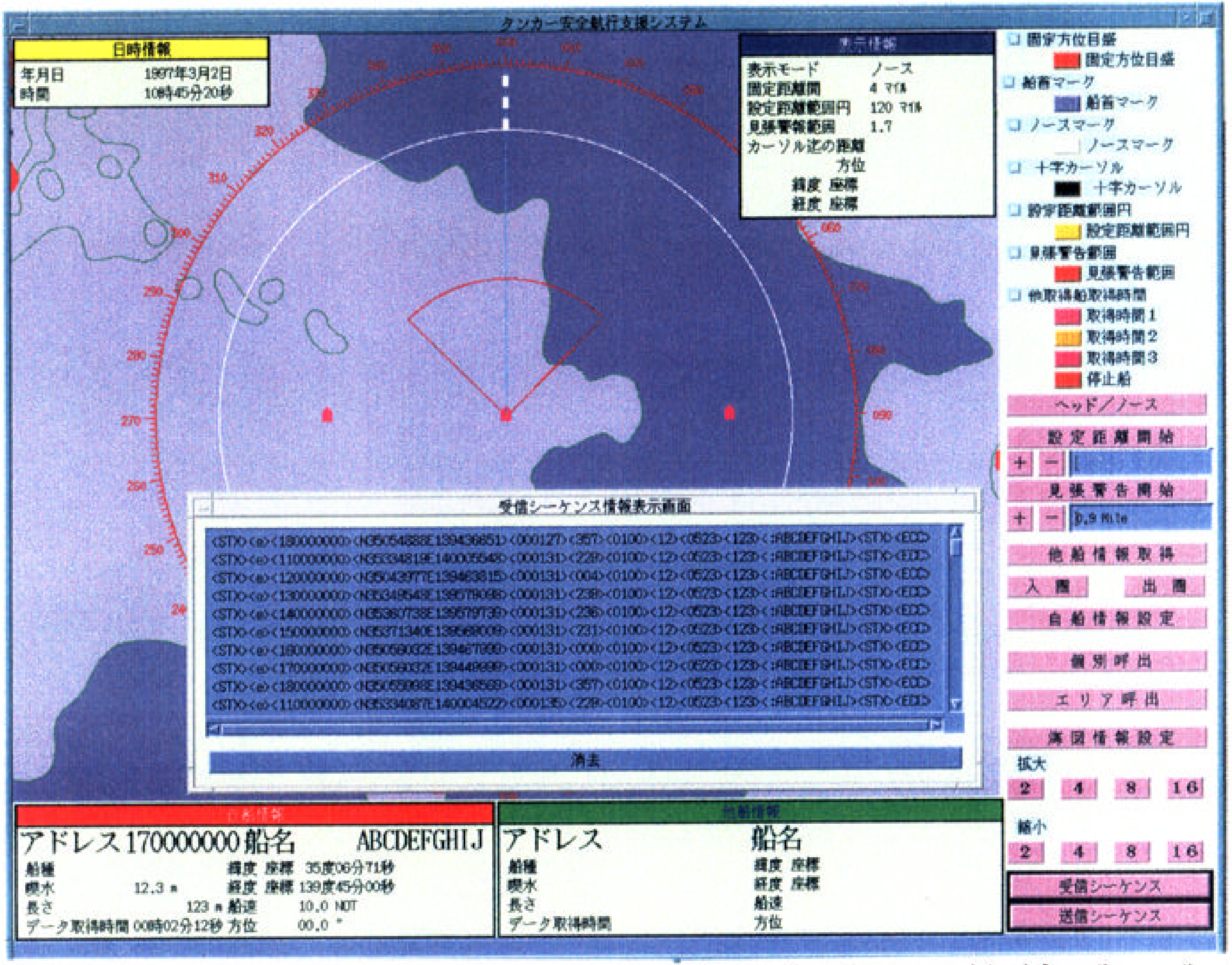

Fig.9　他船が基地局に各船の情報を送信しているときに傍受することで自船のシステムに他船の情報が蓄積される．

The on-ship system accumulates information on other ships by monitoring their transmissions to the base station.

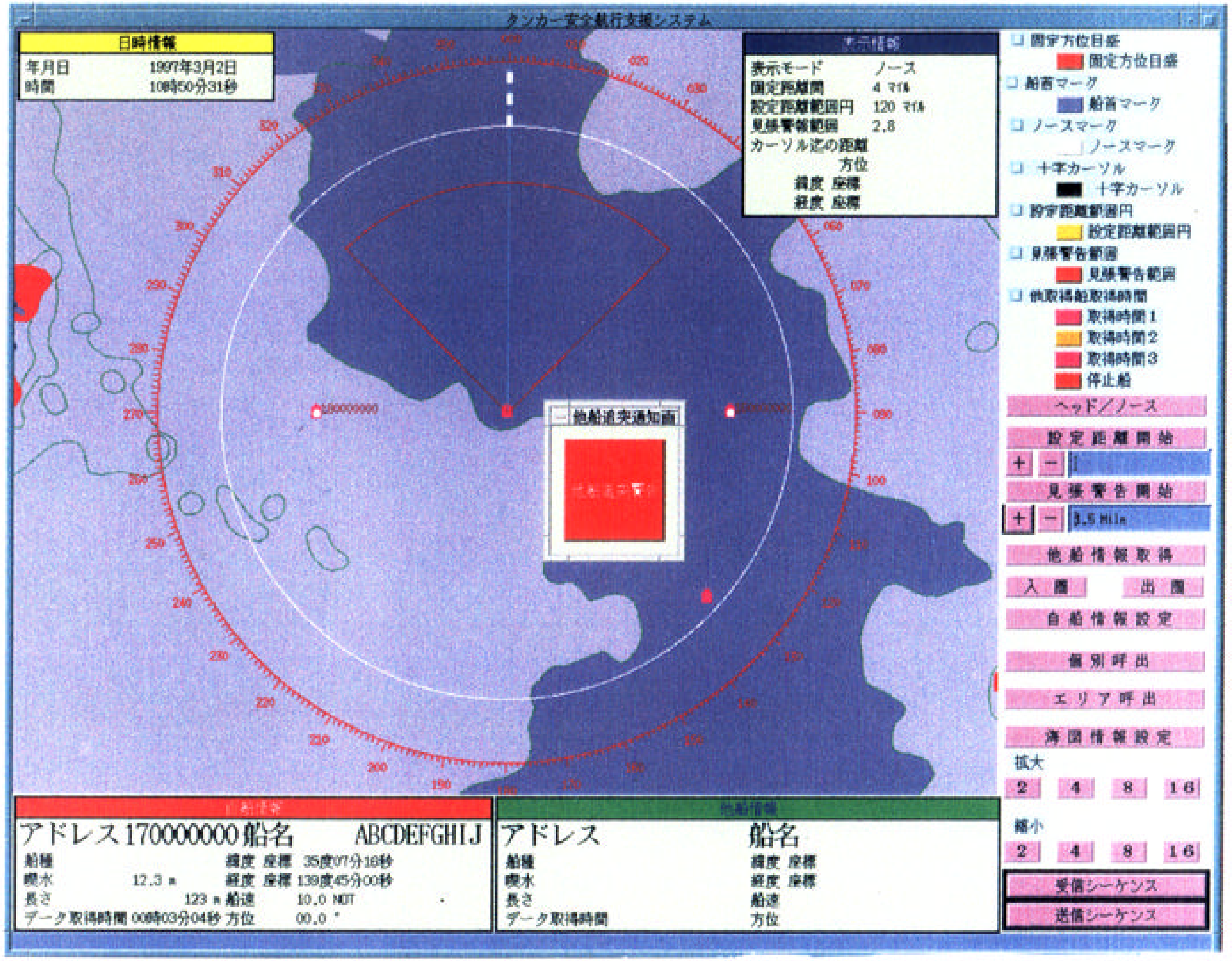

Fig.10　自船の進行方向に他船が進行し，衝突の可能性がある場合衝突アラームを発生させる.

The system issues a collision alarm if the ship is on a collision course with another ship.

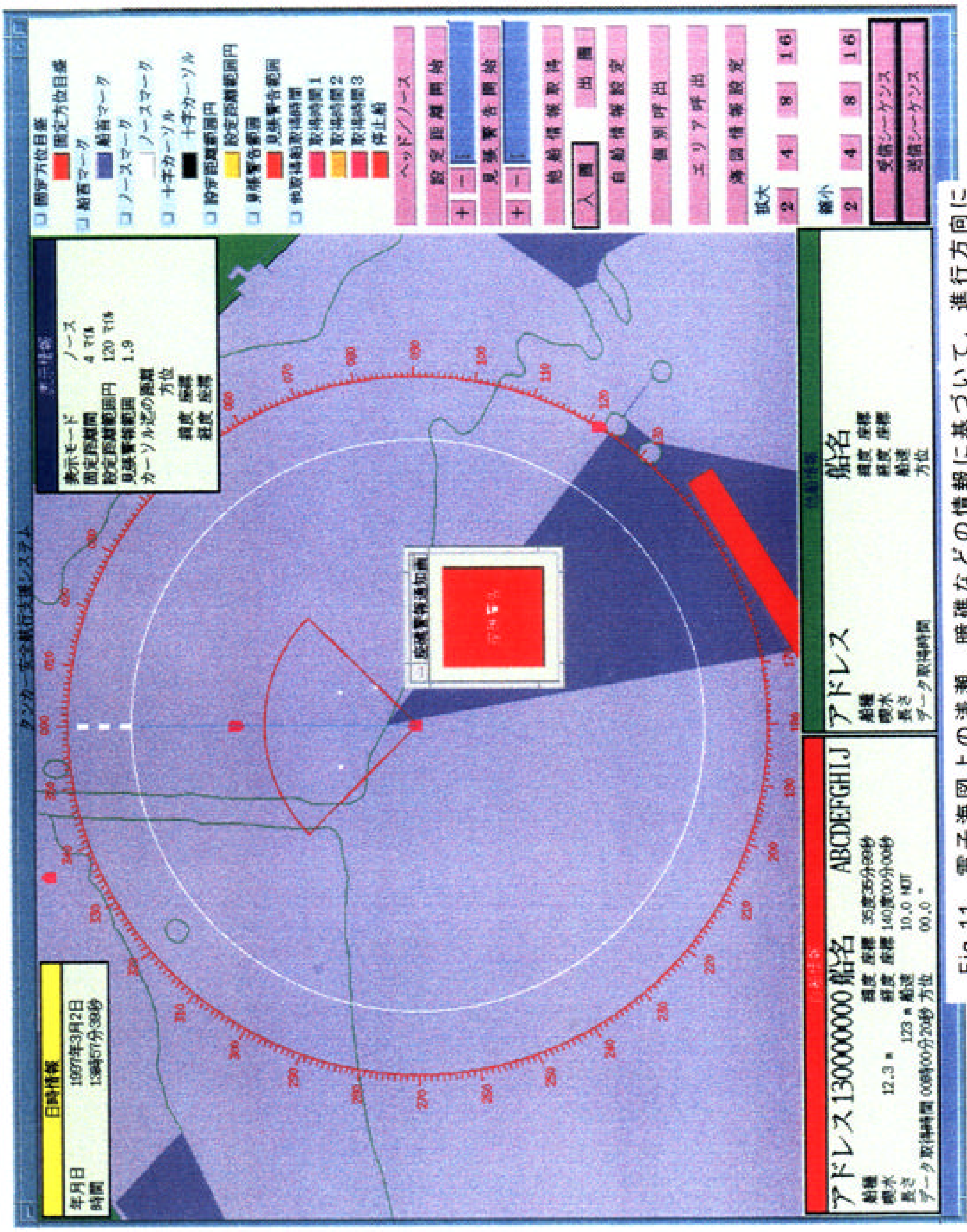

Fig.11　電子海図上の浅瀬，暗礁などの情報に基づいて，進行方向に座礁のおそれがある場合，座礁アラームを発生させる．図中の白い点が暗礁

Fig. 11　The system issues a stranding alarm if the system decides, on the basis of data on shallows and sunken rocks shown on electronic charts, that the ship might be stranded. The white dots show the locations of sunken rocks.

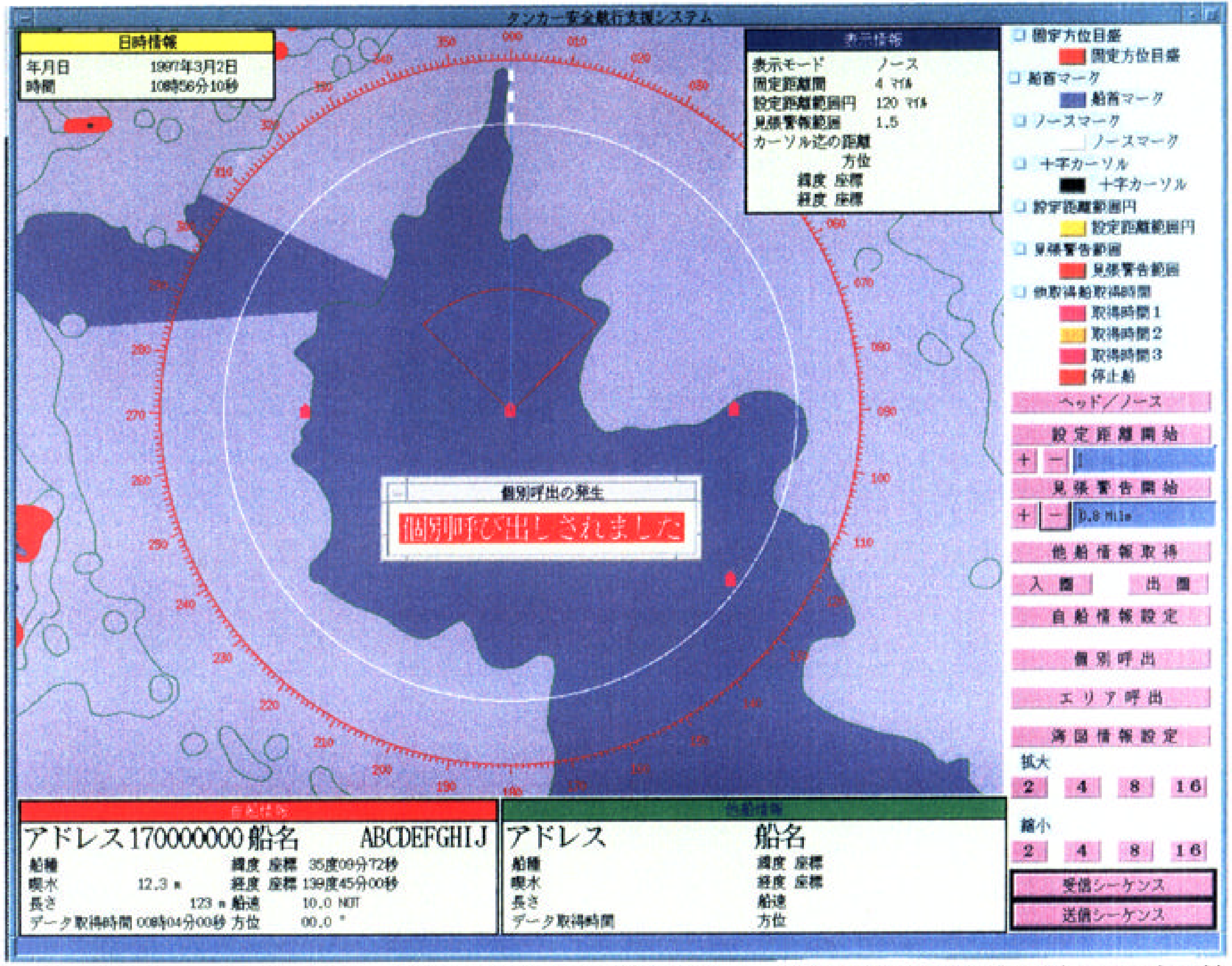

Fig.12 衝突アラームに基づいて，進行方向の衝突の可能性のある船舶を特定して呼び出した． Following a collision alarm, the oncoming ship on a collision course is identified and called up.

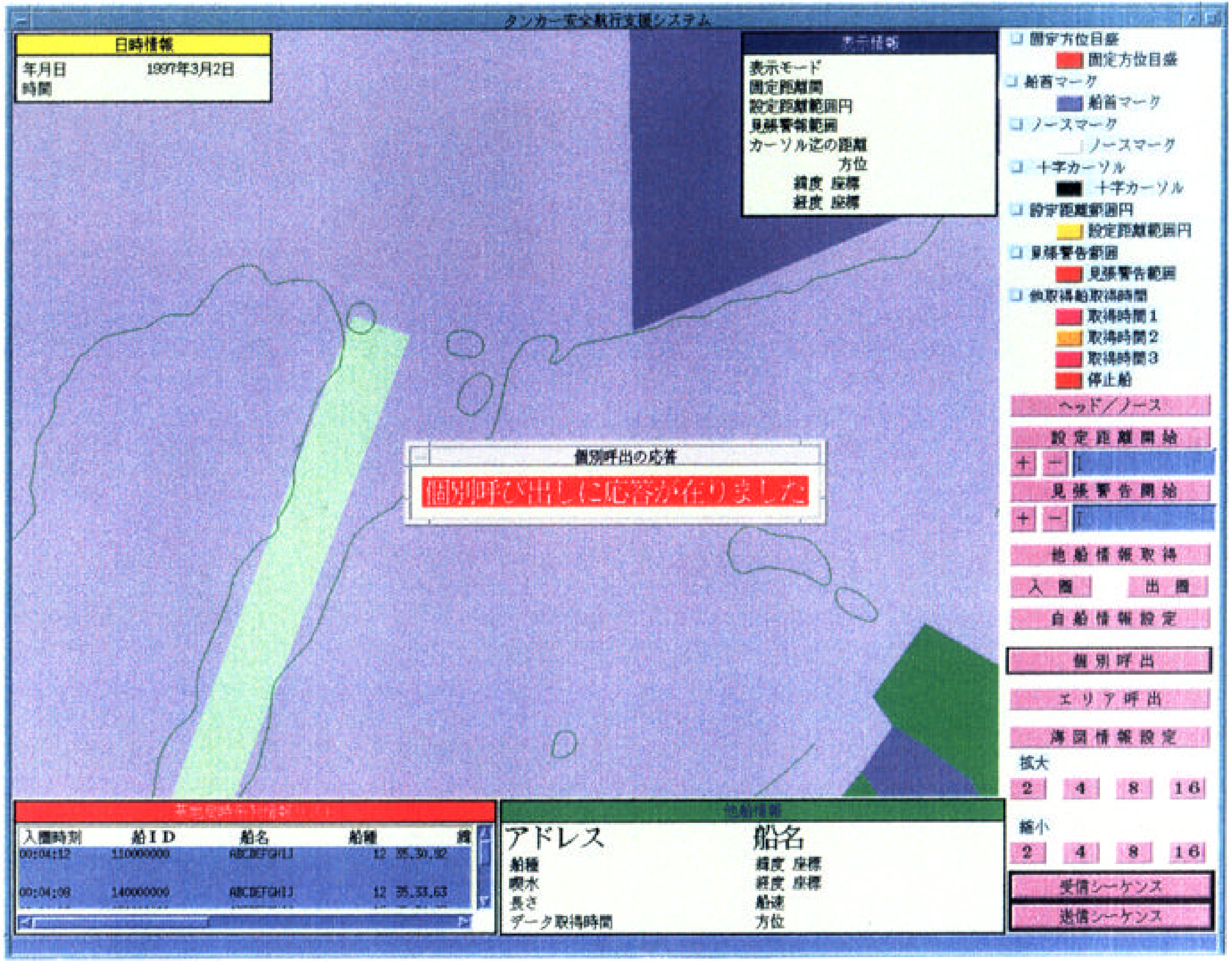

Fig.13　Fig.12に基づいた個別の呼び出しに対して，該当船から応答があった場合.　The selective call in Fig. 12 has been answered.