Satellites for Maritime Applications

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Theme

THE purpose of this paper is to show that communication and navigation satellites can provide significant economic benefits to shipping company operations and alleviate the problems of distress alerting, search and rescue, and losses due to collisions, groundings, and heavy weather damage.

This paper presents the first complete survey of maritime service deficiencies and needs in four functional areas: communications, navigation, distress alerting and search and rescue, and casualty loss avoidance.

The paper examines the extent to which space technology, primarily communication and navigation satellites, could satisfy the requirements and alleviate the deficiencies. Satellite services were costed and revenue bases were examined parametrically. A comparison was then made between the SATCOM service cost and today's HF/MF radio costs. This was followed by an evaluation of potential economic and safety benefits of satellite communication and navigation services.

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Recent studies[1,2] have shown that by 1980 there will be almost 14,000 large ships (greater than 10,000 tons) in service, of which 70% will be at sea at any given time. These vessels represent about a third of the seagoing ships in the world and carry about 80% of world ocean-going trade. They are the prime probable users of a maritime satellite system. It has been estimated that a third of these ships (about 4000) would use such a system within a decade.[3] This is four times the number of intercontinental jet aircraft.

Communications. Presently 93% of messages to and from ships are carried by CW Morse code on HF/MF radio. This very old transmission system is inefficient and unreliable, with frequent delays of up to 6 hr in message delivery due to propagation conditions and other causes. As a result, the average message content between each ship and shore is only about 45 words per day. Voice messages are limited to an average of about one 15 min call per ship per week. The result of the delays and high cost of present facilities, and the low volume of communications, is that it is not possible to make the effective management decisions regarding ship operations which are desirable.

The use of satellite facilities could greatly reduce delays and result in increased traffic and therefore more effective fleet management. Table 1 gives traffic estimates and delays for a 1980 maritime satellite communications system. The delays indicated there would be regarded as essentially instantaneous by the industry.

Navigation. It has been estimated in the Department of Transportation National Plan for Navigation that on the high seas a fix accuracy of 4 naut miles (95% of the time) every 2 hr is adequate for the next 20 yr. In restricted and confluence waters an rms accuracy of ¼ naut mile is required, continuously available. Existing nonsatellite systems all have various limitations which make them unsuitable for universal use. The only operational satellite system is the U.S. Navy TRANSIT. It is highly successful and accurate but has problems for commercial use such as relatively expensive shipbard equipment and fix frequency which is inadequate in restricted waters. Although not operational, the concept of navigation using geostationary satellites have been fully demonstrated at vhf and partially demonstrated at L-band using ATS satellites. Accuracy of such a system is adequate for restricted waters, except for areas close to the equator.

Table 1 1980 marsat channel estimates and message delivery delay characteristics

	Duplex Voice Channels		100 WPM Telex Type Circuit	Total No. of Circuits[b]
	Business	Personal		
Atlantic	5.5	3.4	6.6[a]	9.6
Pacific	4.4	2.5	4.9	7.5
Indian	2.8	1.6	3.2	5.0
Expected wait time in queue	12 min	20 min	1.4 min	
Expected control center access time	5 min	5 min	5 min	
Total expected wait time for message transmission	17 min	25 min	6.4 min	

[a] 6.6 telex circuits require just over 1/4 of the satellite power or one vice circuit.
[b] The totals in this column include the access control circuit which requires the equivalent satellite power of between 1/3 to 1/2 of one voice channel.

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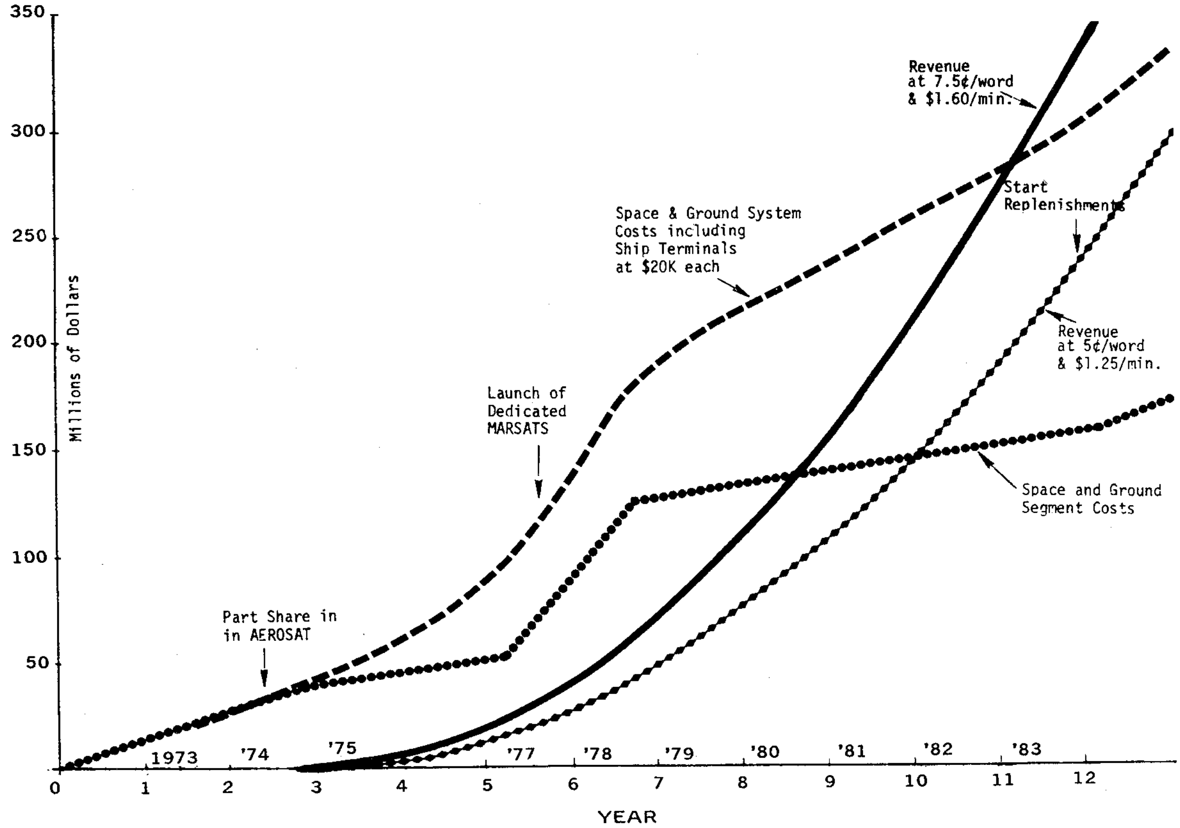

Fig. 1 Maritime satellite system cumulative costs and revenues.

Distress Alerting and Search and Rescue. Present methods of distress alerting and search and rescue fall short of the desirable requirements due to poor communications and sometimes errors in determining position. A satellite relay system is under development. The Global Rescue Alarm Network (GRAN)[4] is a joint Navy/Coast Guard/NASA project based upon the NASA/GSFC OPLE system which was demonstrated on ATS satellites.

Casualty Loss Avoidance. According to the Liverpool Underwriters Association 1966 annual report[5] collisions and groundings occur at the rate of 15 per day. At this rate more than one third of all ships over 500 tons will be involved in an accident, and one in 200 totally lost each year. By providing better determination of position, as well as more rapid and more reliable communications, satellites could substantially reduce these losses.

By 1980 the use of satellites could accomplish both the required large increase in communications capacity and speed, and also provide the required navigational accuracy both on the high seas and in confluence areas (except the Malacca Straits which are too close to the equator). A multipurpose system could be implemented for communications, precision navigation in confluence areas, and high seas navigation. Because the Omega system is satisfactory for the last use, a satellite service for this is needed less urgently. The satellites would also provide the relays for distress alerting, and to assist in search and rescue operations.

In order to provide a most cost effective system, tradeoffs must be made between satellite size and complexity and shipboard equipment, especially antenna size and pointing. The greater the cost of the space segment, the lower will be the cost of the shipboard installation for a given system capability.[6] The revenue which would be derived from the system depends upon the type and volume of traffic, and the charges imposed. Figure 1 summarizes the projected system costs and revenues for a communications system based upon estimates taken from the studies made to date. They indicate that the space and Earth segments could be paid for in seven years, and the total system in nine years. The extra cost to the ship owner would be about $14,000 per year per ship, with an additional cost of $6 to 12,000 annually to include navigation. Studies which have been made by various agencies indicate that the benefits in terms of faster turnaround of ships, more optimum routing and damage avoidance would exceed this cost for a communications system, and also for a navigation system. In addition there is the benefit of increased safety.

The optimum technological solutions to the problems of providing the required services have all been studied extensively. Complete systems have not been experimentally validated, although feasibility has been demonstrated in experimental programs. It is expected that the necessary research and development of systems will have to be funded and accomplished by government agencies such as NASA, DOC and DOT, with the shipowners and operators paying for the use and operation of the final system.

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