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The introduction of modern maritime communication technology in Ghana in the 1990s

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THE INTRODUCTION OF MODERN MARITIME COMMUNICATION TECHNOLOGY IN GHANA IN THE 1990s

by

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Ghana

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I certify that all material in this dissertation which is not my own work has been identified and that no material is included for which a degree has been previously conferred upon me.

The contents of this dissertation reflect my personal views and are not necessarily endorsed by the University.

(Signature) ____________

(Date) 28 Oct. 1991

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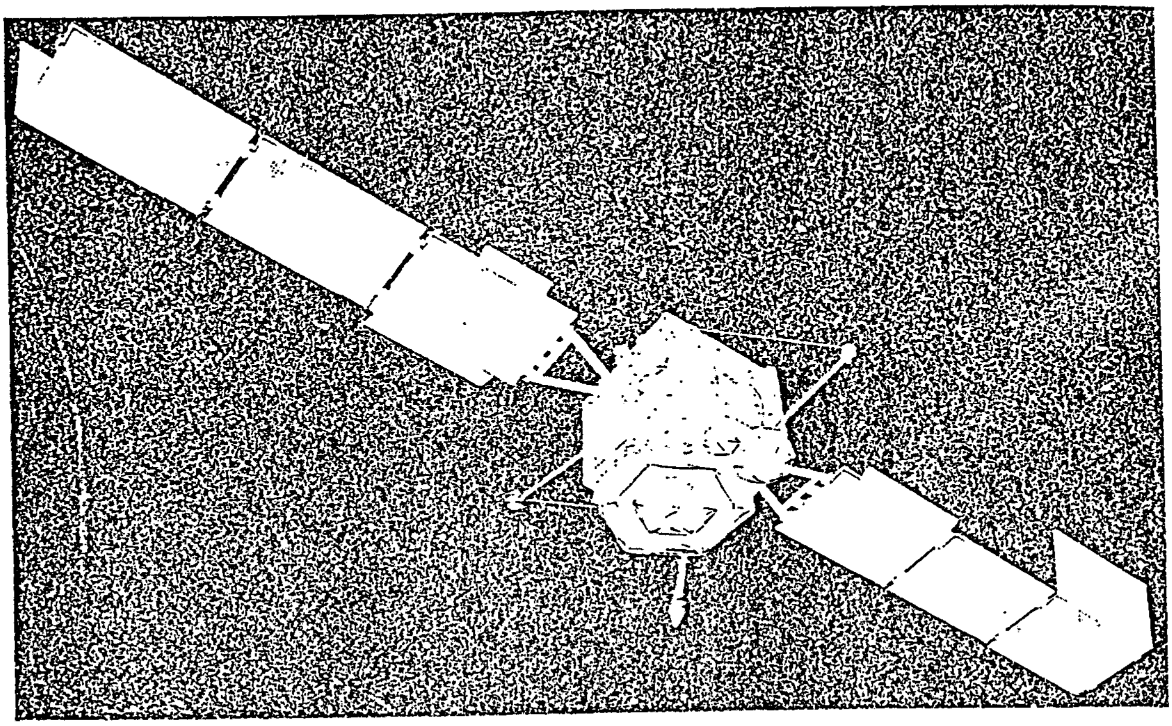
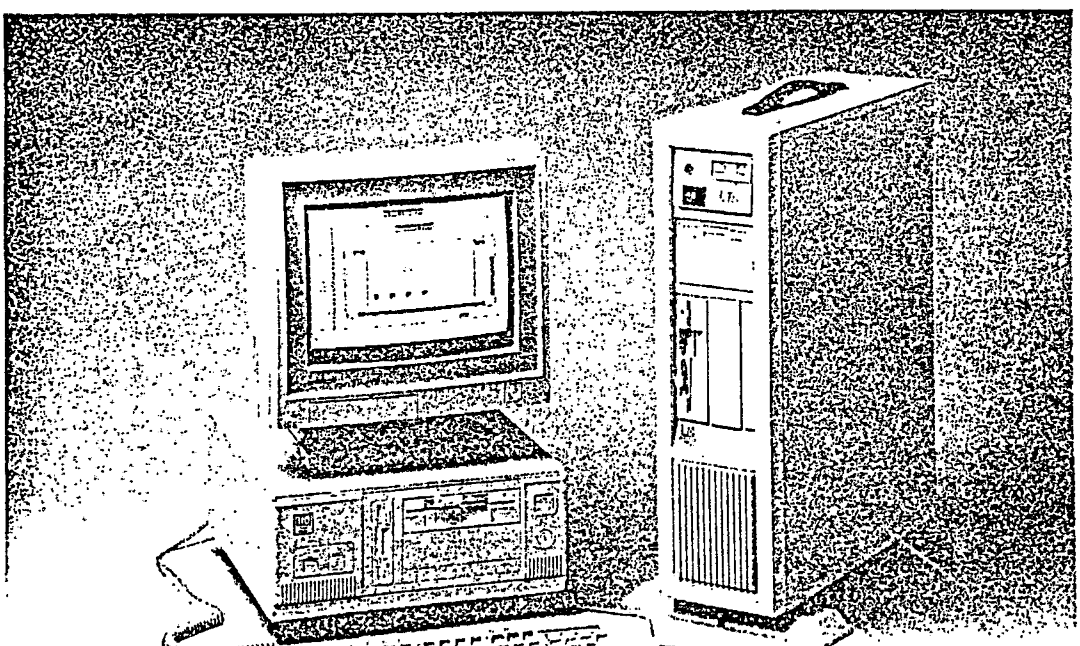
INMARSAT

DEDICATED TO MY CHILDREN
FOR THE LONG WAITING





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PREFACE

The structure of this dissertation reflects the architectural model of modern maritime communication in Ghana and in West Africa in General. The message of this dissertation is primarily to show the technological developments and possibilities in mobile communication.

Chapter 1 forms an introdution to the history of maritime communication and telecommunication, and sets the scene for the remainder of this dissertation.

Chapter 2 discusses developments in communication systems. The discussion attempts to embrace the influence of satellite and digital communication in the shipping industry while at the same time looking at the future communication needs for Ghana.

Chapter 3 outlines INMARSAT services and discusses the implementation of satellite communication in Ghana.

Chapter 4 In view of the many new developments some of which are not covered in this dissertation, chapter 4 principally introduces some earth based communication systems in Ghana.

Chapter 5 is not intended to cause any radical changes in the RMA current degree programme, but rather stresses the awareness of modern maritime communication and the need to adapt to future training and educational needs of the industry. It therefore attempts to propose education and training strategies for the 1990s .

Chapter 6 highlights the main elements in chapters 1, 2, 3, 4, and 5, giving conclusions and recommendations.

ABBREVIATIONS

ACIS	Advanced Cargo Information System
ADE	Above Deck Equipment
BDE	Below Deck Equipment
CDMA	Code-Division Multiple Access
CES	Coast Earth Station
CLU	Central Logistics Unit
DSC	Digital Selective Call
EGC	Enhanced Group Call
ELT	Emergency Locator Transmitter
FDMA	Frequency-Division Multiple Access
GMDSS	Global Maritime Distress and Safety System
GPS	Global Position System
HF	High Frequency
IMO	International Maritime Organisation
INMARSAT	International Maritime Satellite Organisation
ITU	International Telecommunication Union
LUT	Local User Terminal
MCC	Mission Control Centre
NBDP	Narrow Band Direct Printing
NCS	Network Co-ordination Station
OCC	Operation Control Centre
PSDN	Packet-Switched Data Network
PSTN	Public Switched Telephone Network
RASCOM	Regional African Satellite Communications
RCC	Rescue Co-ordinating Centre
RMA	Regional Maritime Academy
SADCC	South African Development Co-ordination Conference.
SART	Survival Craft Radar Transponder
SCC	Satellite Control Centre

SES	Ship Earth Station
SOLAS	Safety of Life At Sea
TDMA	Time-Division Multiple Access
USAID	United States Agency for International Development.
VHF	Very High Frequency
WARC	World Administrative Radio Conference

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CHAPTER 1

1.1 MARITIME COMMUNICATION

1.1.1 INTRODUCTION

Evolutionary forces dating back as far as the Adam and Eve era showed that the oldest form of communication system is the person to person type within hearing distance. It operates when people talk to each other, transmitting messages back and forth through conversation. However there was one difficulty for a long time, and that was the inability to transmit messages over long distances. Primitive as they were, attempts were made to find a solution to this natural system. This was achieved by using fire, smoke, doves, horses, and so on. They were satisfactory for human needs at that time, but as man's quest to conquer the universe grew, the primitive system gradually gave way to innovations of today to transmit messages over longer distances, using known as telecommunication.

1.1.2 RADIOTELEGRAPHY

Maritime telecommunication would not have been possible until the invention and the development of radio equipment for the transmission of messages at the beginning of the century. Until then telecommunication between distant points had relied entirely on cable and wires between the point of transmission and point of reception of message. It was singularly unhelpful for ships in the telegraphic era, the simple reason that once a ship left sight of land, it and its crew were effectively cut off from all contact with other persons at sea and on land except for the occasional random sighting of another ship. It is therefore no exageration to say that the invention of radio by Guglielmo Marconi in 1895, and the subsequent development of the technique and technology of radio communication through the efforts of several other scientists in other countries, created a revolution in telecommunications in general and maritime communication in particular.

The first recorded use of the new invention for saving life at sea occured in March 1899 when the lightship on the Goodwin Sands near Dover, which was fitted with Marconi's wireless apparatus, used it to report that the steamer ELBE had run aground. A lifeboat was sent out in response to the message and was able to rescue the crew.The next rescue involving the use of radio at sea occured in Russia in January 1900. An apparatus built by Alexander Popov was used to send a message to the icebreaker YERMAK as a result of which the ship was able to go to the rescue of some fishermen trapped on an icefloe in the Gulf of Finland. These incidents served to demonstrate that radio was in fact becoming an indispensable international tool for telecommunication. Indeed, within a few years, radio had become so well established that there was some concern about whether its use could be effectively controlled.

In particular there were fears that commercial rivalry could have a harmful impact on maritime safety and there was also much concern that the proliferation of radio links would lead to severe and ultimately dangerous congestion. In 1903, just two years after the first radio message across the Atlatic, a radio conference met in Berlin to consider preliminary studies for the international regulation of radiocommunications.

In 1906 the first international radiotelegraphy conference was held, out of which the International Telegraph Convention was modelled. Further basic principles were also established which were to be of great importance to the future of radio at sea. Contracting parties to the convention were obliged to connect coast radio stations to the International telegraph network, so as to give absolute priority to all distress messages and to avoid radio interference as much as possible.

The conference laid the basis for the regulated development of radio communications at sea. The increasing number of accidents at sea showed the importance of radiocommunications in saving lives. In 1909 two ships, the REPUBLIC and VOLTURNO, collided off the east coast of the United States. A radio distress message was picked up by a coast radio station and within 30 minutes of the accident another ship equiped with radio, the BALTIC, had arrived at the scene. All 1700 people on board the two ships were saved and what could have been a major disaster was averted.

In 1912 a well known accident took place, the TITANIC hit an iceberg and sank within a few hours. More than 1500 people died, but thanks to a distress message picked up by the liner CARPATHIA more than 700 were saved.

The TITANIC disaster might have been reduced had the CALIFORNIAN, which was a relatively short distance from the scene, picked up the liner's distress message but her radio officer was off duty. Three months after the TITANIC sank, another international radio conference met in London.

Installation of radio equipment on board all ships was not mandatory at that time, so steps were taken to improve carriage of radio equipment and radio coverage. At the same conference the letters SOS were adopted as the international distress call. (The MAYDAY distress call used later in radio telephony is a corruption of the French `m`aidez' which simply means help me).

1.1.3 SOLAS

Two years later in 1914 the first International Convention for the Safety of Life at Sea (SOLAS) was adopted, Chapter V of which dealt with radiotelegraphy. Ships carrying more than 50 passengers were required to be equiped with a radio installation having a range of at least 100 nautical miles. The convention made reference to the International Radiotelegraphy Convention of 1912 and used the same classification for ships. Another important regulation required larger passenger ships to maintain a continuous radio listening watch. The convention also made it obligatory for ships receiving a distress call to go to the assistance of the ship concerned and the master of a ship in distress the right to requisition the services of any ships answering his call. Although the convention was adopted in January 1914 it did not enter into force while Europe was at war. It however established a precedence which was followed by subsequent conferences. In 1929 the second SOLAS conference was held again in London. It adopted a convention that entered into force in 1935. The convention took account of technical progress made in the intervening years, and also the problem of providing a continuous watch,solved by the development of the auto-alarm. The convention allowed some exemptions regarding watchkeeping for ships fitted with such a device.

Early as 1914, some of the passenger liners, like the AQUITTANIA'S life boats had been fitted with radio equipment even though there was no international requirement for this. Pressure increased and the requirement for carriage became a must in the foreseable future, when the TREVESSA sank in the Indian Ocean. Although a distress message was transmitted and acknowledged, the ship sank before assistance arrived. However the crew in two lifeboats, sailed for 22 and 27 days respectively before finally reaching Mauritius. It was realised that had there been an international requirement for radio equipment to be carried in at least some of the ship's lifeboats, this ordeal might have been prevented. One of the regulations of the 1929 SOLAS Convention did indeed require larger passenger ships to have some lifeboats equipped with radio equipement.

By 1948, however the covention was becoming outdated and so a new conference was called to adopt a third version of the SOLAS Convention. Like its predecessor, it made carriage of a radiotelegraph installation a requirement for all passenger ships and for cargo ships of 1600grt and above. The new convention also took into account other developments in radio communication, radiotelephony and radio direction finding.

1.1.4 RADIOTELEPHONY

The radiotelephony originated in the early days of this century. One of the most important pioneers was the American, Lee De Forest who made a major contribution to radio electronics when he developed the triode valve. This discovery made it possible to transmit the human voice by AM and as early as 1907 De Forest installed one of his appliances on a ferry boat on the Hudson River. Although adoption was to be fairly gradual, radiotelephony proved very useful over relatively short distances and is now widely used over all possible ranges.

Another major advance in radiocommunications came in the 1950s with the introduction of miniaturisation in the form of transistors. This made it possible to use much higher frequencies than before and also helped to reduce the size, power consumption and failure rate of the radio equipment

1.1.5 IMO

In 1959 IMO, then called the International Maritime Consultative Organisation (IMCO), came into being and one of its first tasks was to update the 1948 SOLAS Convention. The 1960 version followed the same pattern as far as radiocommunications were concerned but the regulations of Chapter IV were made much more detailed than those of the previous conventions. It placed the emphasis on ensuring that equipment conformed to stringent conditions; the maintenance of adequate radio watches; the fitting of radio equipment in certain lifeboats and reference was made to the Radio Regulations adopted by the International Telecommunication Union (ITU).

IMO adopted a new SOLAS Convention in 1974, and chapter IV which dealt with Radiotelegraphy, and with Radiotelephony was further improved. In 1981 some of the regulations dealing with Radiotelegraphy and Radiotelephony were replaced and others amended. These amendments entered into force on September 1st 1984. Chapter IV of the SOLAS Convention mainly deals with facilities intended for distress and safety purposes and does not specifically provide for equipment intended for public correspondence. The technical requirements of equipment intended for this purpose are covered by the Radio Regulations of the ITU. By adopting the SOLAS Convention and adopting various recommendations, IMO has been able to keep pace with most of the developments taking place in maritime communication.

1.1.6 CONSTRAINTS IN MARITIME COMMUNICATION

Maritime radio communication has always suffered from inherent shortcomings that no amount of development will completely eliminate . One of the major problems in the past rested with the terrestial radio systems linking pairs of countries, and offering point to point services.It was a popular arrangement because the under sea telephone cables were expensive even though they provided excellent transoceanic links. Countries bordering the oceans became gateways, and controlled telecommunications access to the land-locked neighbours. It became more costly for ships trying to communicate with these countries, since they had to pass through these gateways. Other problems included the relatively low strength of the radio signal from the ship, the unstable relationship between transmission distance and radio frequency and the effects of various natural phenomena on radio propagation. It was also admitted that radio operators only keep 8 hour watches. Such arrangements were considered inadequate for modern business communications and maritime safety. Ship operators also wanted ships to become part of their day to day operation of the shore side. All these shortcomings have been quickly overtaken by the implementation of reliable satellite links, reliable and offering the maritime community round the clock communication as to be seen in the subseguent chapters.

1.2 MARITIME TELECOMMUNICATION SYSTEMS

1.2.1 INTRODUCTION

Telecommunication in general refers to the transfer of messages in the form of electromagnetic signals, and ranges from satellite broadcasts and computer-to-computer communications, to the ordinary telephone. These signals can take the form of:

- radio waves travelling through space
- electrical currents flowing along a wire
- pulses of laser light travelling along optic fibre wire.

Some electromagnetic communications take place over very short distances, others take place over a considerable dis tance, and all these are referred to as telecommunications.

A telecommunication system consists primarily of three main parts, in addition to the source and the destination, shown in fig.1.2.1, the system is made up of a transmitter, a link, or channel, and a receiver. The function of a telecommunication system is to transport information from the source to the destination.

The transmitter's function is to accept the information from the source and convert it into a signal suitable for transmission through a link. Having discovered that electro -magnetic waves, unlike sound waves, can travel greater distances without much attenuation, a transmitter which could transform a speech signal to an electromagnetic signal was developed. The link is one of the key components of the communication systems, and is the transmission medium or channel between transmitter and receiver. The link is classified into two areas, (a) natural link:

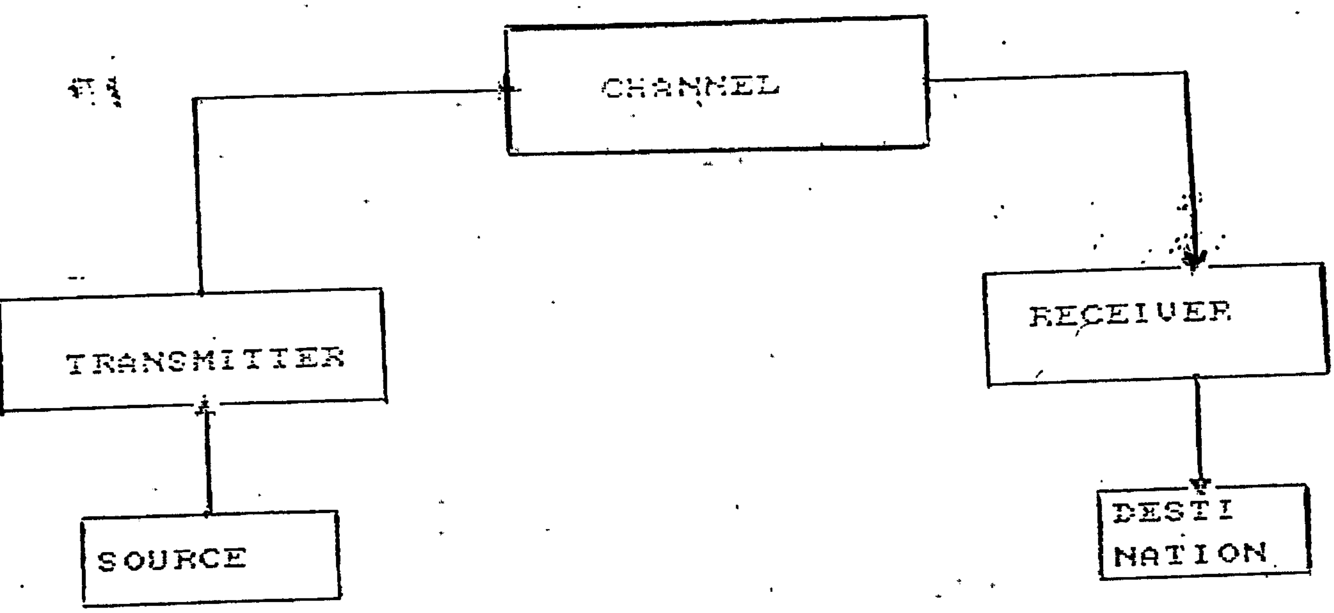


Fig. 1.2.1

Souurce: General Communication System

which is the free space between source and destination of information, this imcludes satellite links. (b) Artificial links: which are cables and synthetic fibre glass cables.

The introduction of metallic links has resulted in an increase in the volume of information transmission between national and international networks. There are serious restrictions which do accompany these links, the major being noise. Links often carry unpredictable noise caused by electrical discharges and other space phenomena. It is therefore very important that in introducing a telecommunication system, serious consideration should be accorded to the signal to noise ratio.

At the arrival of a message at the end of the link, it will first encounter the receiver whose function is to accept the signal that comes out of the link and extract the information. In other words the receiver in general performs the inverse operation of the transmitter. The efficiency of the receiver is defined by:-

- its capability to select the received signal
- the noise generated in the receiver.

1.2.2 ARTIFICIAL LINKS

Telephone lines today are the most common link used for land communication of some of the links to be examined:

CABLE- One of the most common media in communication is the cable also known as the wire pair or the twisted pair, and coaxial cable. They are always insulated. These are frequen -tly used to transmit messages over short distances. The drawback of cable is that it is susceptible to electrical interference, shortcircuiting and breaking, fig.1.2.2a and

Communications links. (a) Wire pairs are pairs of wires twisted together to form a cable, which is then insulated. (b) A coaxial cable. (c) Fiber optics consists of hair-like glass fibers that carry voice, television, and data signals

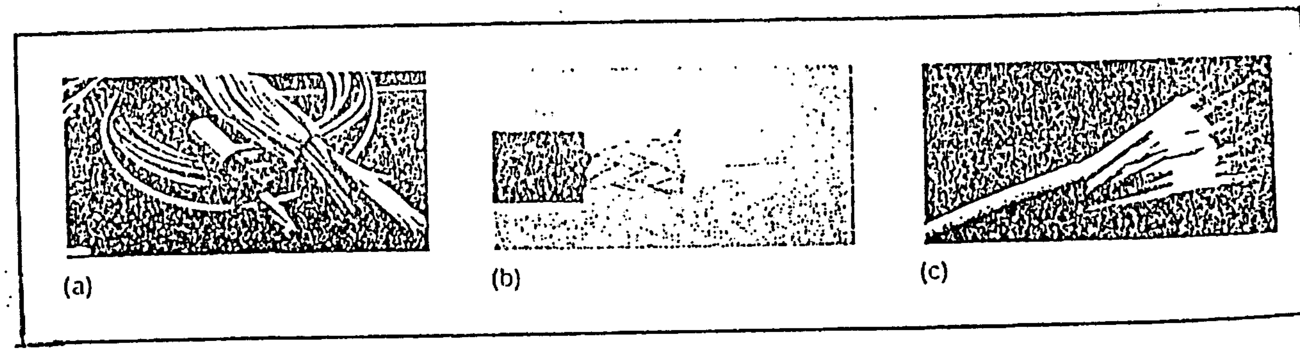


Fig 1.2.2

Source: Communication and Radar Systems

FIBRE OPTICS-See fig.1.2.2c. To overcome the problem of water and corrosive substances normally adherent to wires, usually copper, fibre optics technology was developed to solve these problems. Instead of using electricity to send data, fibre optics uses light. The cables are made of glass fibre, thinner than the human hair, and guide light beams for miles. Fibre optics material are lighter, less expensive, more reliable and transport data faster than those mentioned above.

1.2.3 NATURAL LINKS

The conductor which radiates or receives the radio wave is called aerial or antenna. The radiated energy from a transmitting aerial will reach the receiving aerial by one or more of five different modes: See fig.1.2.3.

(i) Ground wave
(ii) Sky wave
(iii) Space wave
(iv) Via satellite
(v) Scatter

The ground wave follows the contour of the earth as it is radiated from transmitting to receiving antennae. This mode of propagation is used for world-wide communication in the low-frequency bands and for broadcasting in the MF band.

The sky wave is directed from the earth towards the ionosphere, which consists oflayers of ionised gas lying approximately between 50Km and 300Km above the earth's surface. The frequency of the radio wave directed towards the ionosphere is important and LF radiation is reflected

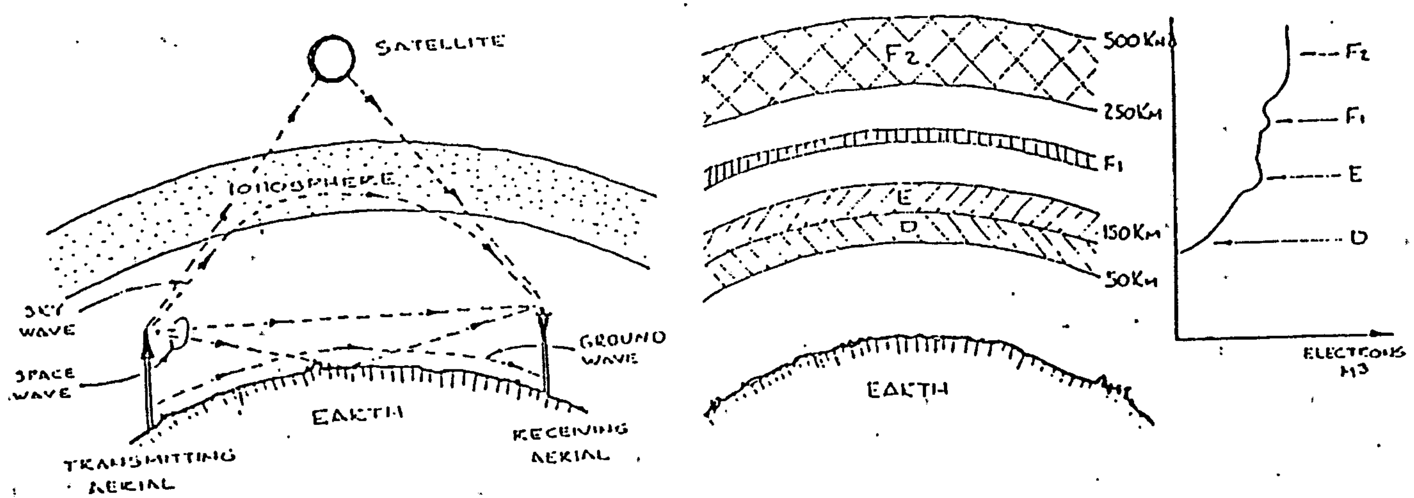


Fig. 1.2.3

Source: Communication and Radar Systems

with little loss. It is also possible for VLF and LF waves to travel great distances by multiple reflections between the earth's surface and the lower layers of the ionosphere. The amount of refraction that the ionosphere produces is a function of frequency and the number of ions per m^3, and at VHF and above the signal will normally pass straight through the layers. The sky wave is used for MF/HF communication including long-distance radio-telephony and sound broadcasting.

The space wave is made up of two components, one which travels in a straight line between transmitting and receiving antennae, and the other travels by one reflection from the earth surface. The space wave is used for radio and T.V broadcasting, multi-channel telephone systems, satellite communications and for various mobile communication systems operating in the VHF, UHF, SHF, and higher bands. Space wave communication gives "line of sight" opera tion between transmitter and receiver, see fig. 1.2.4b.

Satellite communication involves transmitting a radio wave to a satellite which then amplifies the wave and transmits it back to receiving antennae on earth at a different frequency, see fig.1.2.4a. Communication satellites are used to carry multi-channel telephony systems, TV, and marine communication, using the UHF and SHF bands.

Radio communication by troposheric scatter is the UHF/SHF equivalent to the use of a sky wave and is for long distance communication.

.atellite transmission. This satellite acts as a relay station and to transmit data signals from one earth station to another. A signal is sent from an earth station to the relay satellite in the sky, which changes the signal frequency before transmitting it to the next earth station.

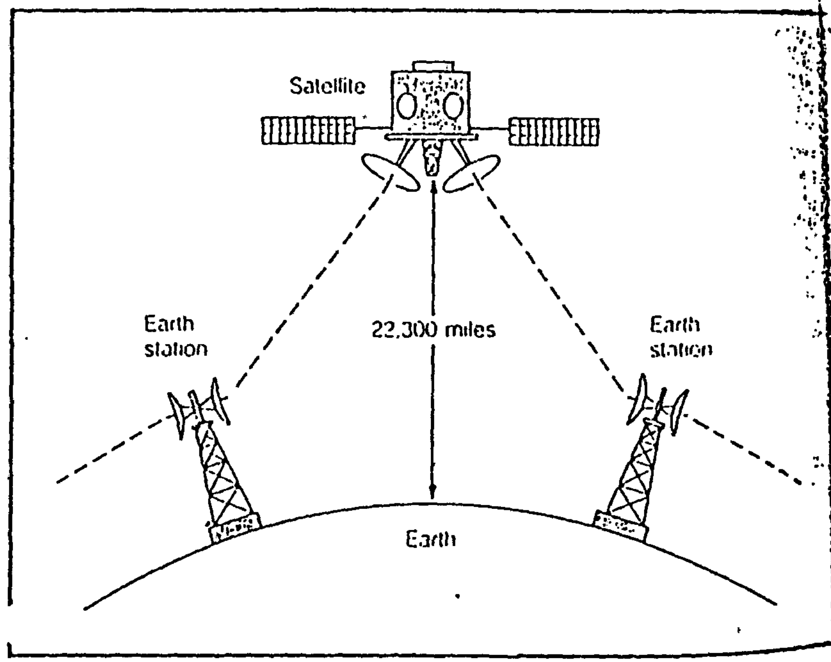


Fig. 1.2.4a

Source: Communication and Radar Systems

Microwave transmission. To relay microwave signals, dish-shaped antennas such as these are often located atop buildings, towers, and mountains. Microwave signals can follow only a line-of-sight path, so stations must relay this signal at regular intervals to avoid interference from the earth's curvature.

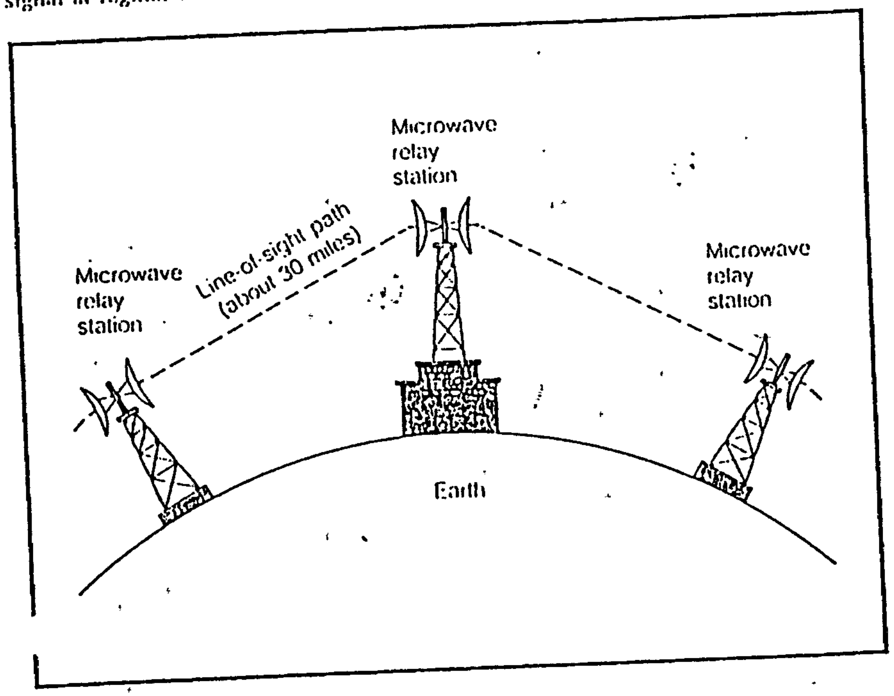


Fig. 1.2.4b

Source: Communication and Radar Systems

1.2.4 MODULATION

A key feature for telecommunication is the use of a carrier wave. For a radio wave to carry any data or information, it is necessary to superimpose in some way the information or signal that is to be transmitted on to the radio wave. In other words, the radio wave acts as a carrier of the information. The process of superimposing the signal on the carrier wave is called modulation. The principle of modulation is to vary one of the characteristics of the wave. The most common modulation methods are amplitude -modulation, frequency-modulation, and phase-. modulation.

AMPLITUDE MODULATION (AM)- To achieve this, the frequency of the carrier wave is fixed, but the amplitude of the radio wave is varied to match the amplitude of the modulating signal, then the radio wave will carry the signal, see fig.1.2.5. This type of modulation is used for radio broadcast, on short, and long wave, a derivative of the basic form is also used for telephone. It has the disadvantage that it is greatly affected by noise generated by atmospheric static and electric equipment.
FREQUENCY MODULATION (FM) - The other characteristic of the radio wave which can be varied is the frequency, while the amplitude of the carrier wave is fixed and this gives frequency modulation. FM is used for very high frequency (VHF) radio broadcasts, see fig.1.2.6. FM is very noise-resistant.
PHASE MODULATION (PM)- An application of PM is reversing the phase of the carrier wave each time a binary bit is encountered. it can be used to carry digital information. See fig. 1.2.7.

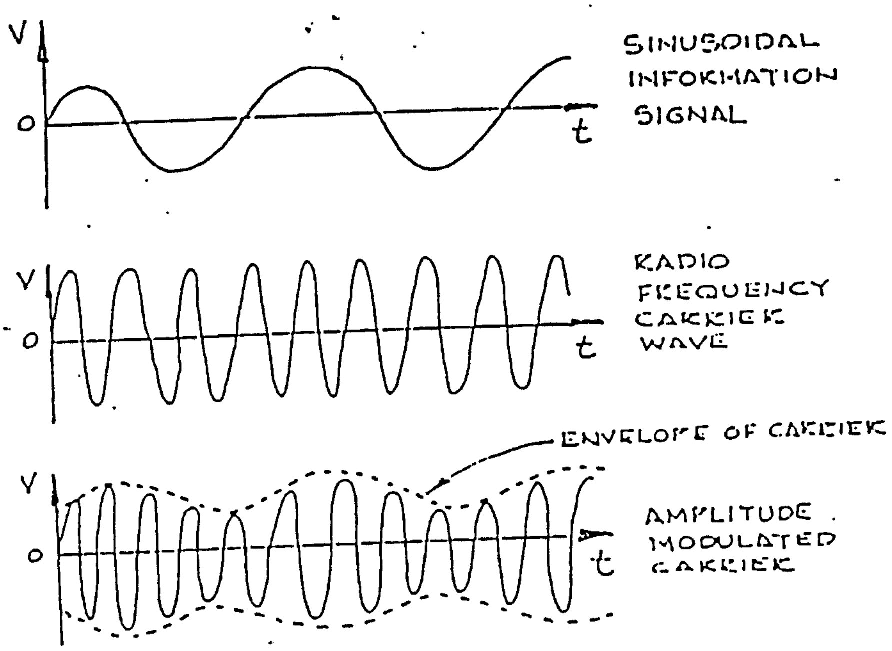


Fig. 1.2.5

Source: Communication and Radar Systems

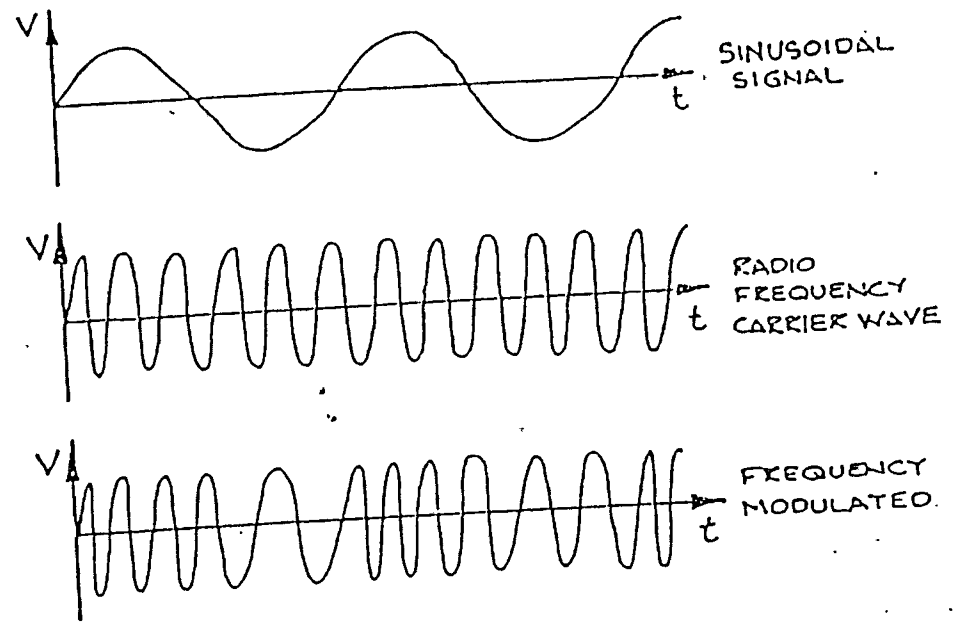


Fig. 1.2.6

Source: Communication and Radar Systems

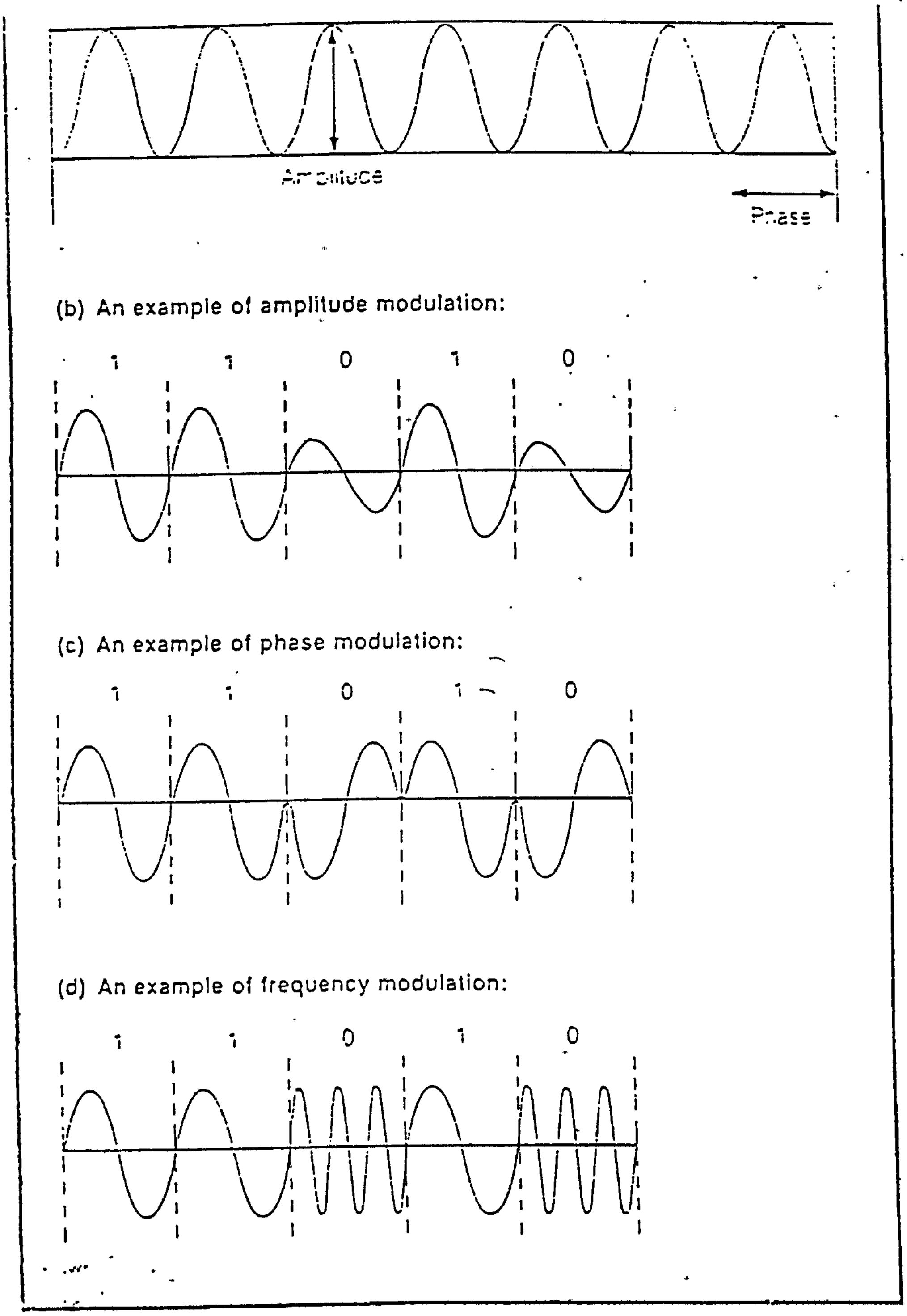


Fig. 1.2.7 (a) In this figure a wave is labeled with its characteristics: amplitude, phase, and frequency. The lower figures show how a wave can be changed to accept a message, either through (b) amplitude modulation (in this case, a change to smaller wave height), (c) phase modulation (in this case, waves reverse direction), or (d) frequency modulation (in this case, wave signals are more frequent).

1.3 INFRASTRUCTURE OF COMMUNICATION AND TRANSPORT IN GHANA

1.3.1 INTRODUCTION

Ghana is situated on the southern coast of the West African bulge. It has an area of 238,537 sq km(92,099sq mi), exten ding 672km (418mi) N-S and 536km (333mi)E-W. It is bordered in the East by Togo, in the South by the Atlantic Ocean (Gulf of Guinea), in the West by Cote dIvoire, and on the North West and North by Burkina Faso. Ghana has a total boundary length of 2,628km (1,633mi), see fig.1.3.1 and a population of about 15 million with Accra, the capital accommondating about 5 million people.

1.3.2 MINISTRY OF TRANSPORT AND COMMUNICATIONS

The Ministry of Transport and Communication being one of the largest ministries maintains responsibilities stret-ching into maritime transport, inland water transport, civil aviation and communication in general. The government of the Provisional National Defence Council (PNDC) in Ghana has since 1983 initiated the national economic recovery program . This involved taking various measures to revamp, rehabilitate and restructure various sectors of the national economy in order to ensure sustained growth and put the economy on the road to recovery. The government's development program has given much attention to improving internal and external communications. The Ministry of Transport and Communication was therefore charged with a responsility, to improve the communication network of rail transport, road transport, sea and inland-water transport, port development and facilities, and civil aviation.

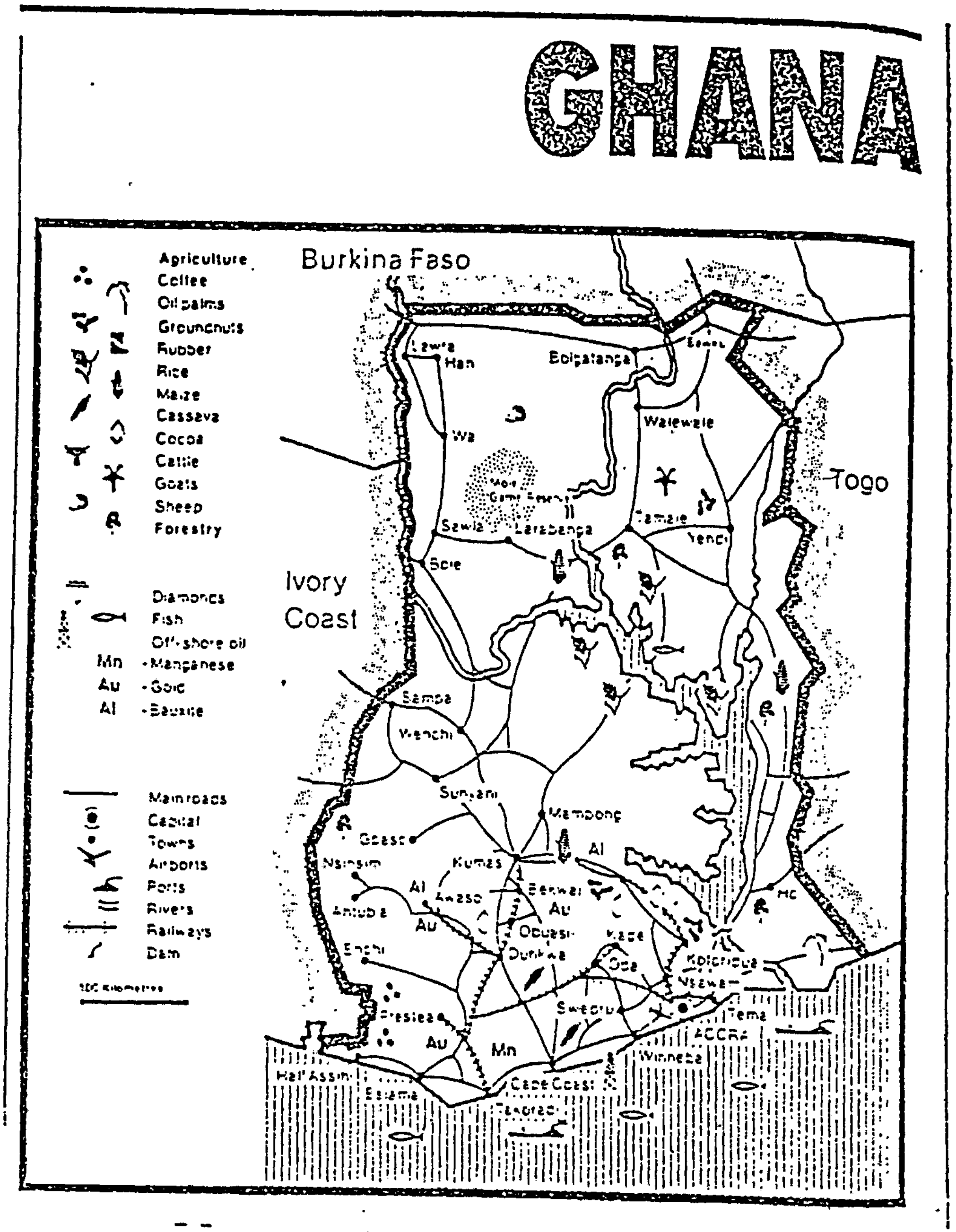


Fig. 1.3.1

Source: Regional Surveys of the World Africa South of the Sahara

Rail lines are the main means of transport for such products as cocoa, logs, sawn timber, gold manganese, and bauxite, they are also widely used for passenger services. There were 953km (592M) of railway lines in 1985, with the main line linking Secondi-Takoradi with Accra and Kumasi. In 1985, the railways carried 2,115,000 passengers and 509,600 tons of freight.

About the same year, in 1985, Ghana had about 28,300km (17585M) of roads. Good roads and main rail lines link Accra with the principal cities in the various regions. The government operates a cross-country bus service, with municipal transport facilities being made available in all main towns.

The State Shipping Corporation (The Black Star Line) owned by the government operates liner services to UK and the European continent and also renders charter services world wide. Volta lake Transport Company provides inland water services between Akosombo and Yapei to the Northen part of Ghana. There are two artificial deep water ports, located in Takoradi and Tema, to promote export and import. The Takoradi port was built in 1920 and expanded after the 2nd world war. The Tema port was opened in 1962 with further extension made in 1963.

Ghana,s International airport serves intercontinental as well as local West African traffic. Smaller airports are located at Sekondi-Takoradi, Kumasi, Tamale, and Sunyani. Ghana Airways, owed by the government, operates domestic air services and International flights to African countries, and Europe.

The Post and Telecommunication Corporation provides both postal and telecommunication services nationally and Internationally. It is also responsible for maritime communication services, including the maintainance and operation of the coast radio stations, at Takoradi, Blackstar radio, and Tema.

1.4 TELECOMMUNICATION SYSTEMS IN GHANA

1.4.1 GENERAL

The general communication structure and responsibilities of the country rest with the Postal and Telecommunication Organisation.

The present Postal and Telecommunication Organisation has its headquarters located in Accra and embracing a network of nine regions. Each region is interlinked with a district service as shown in figure 1.4.1.

Development at the Telecommunication organisation shows anticipated arrangements regrouping the nine regions into five Zones. The Zonal offices will be named Western, Central, Accra, Northern, and Eastern shown fig.1.4.2. They will all report to Headquarters. Within the arrangements, Area offices will report to specified Zonal offices shown in fig.1.4.3. The various services at Zonal offices will be co-ordinated by the corresponding functions at headquarters.

It is intended that policy matters will be decided at Headquarters level and that day to day operations will be managed at Area and Zonal office level.

There are discussions going on for the P & T to be split into two legal entities: 1. Postal and Services functions to be established in Zones and Areas to serve the Postal entity, and similarly, 2. Telecommunication and Service functions to be established, in Zones and Areas, to serve the Telecommunications entity.

P & T ORGANISATION

REGIONAL AND DISTRICT OFFICES

DISTRIBUTION NETWORK

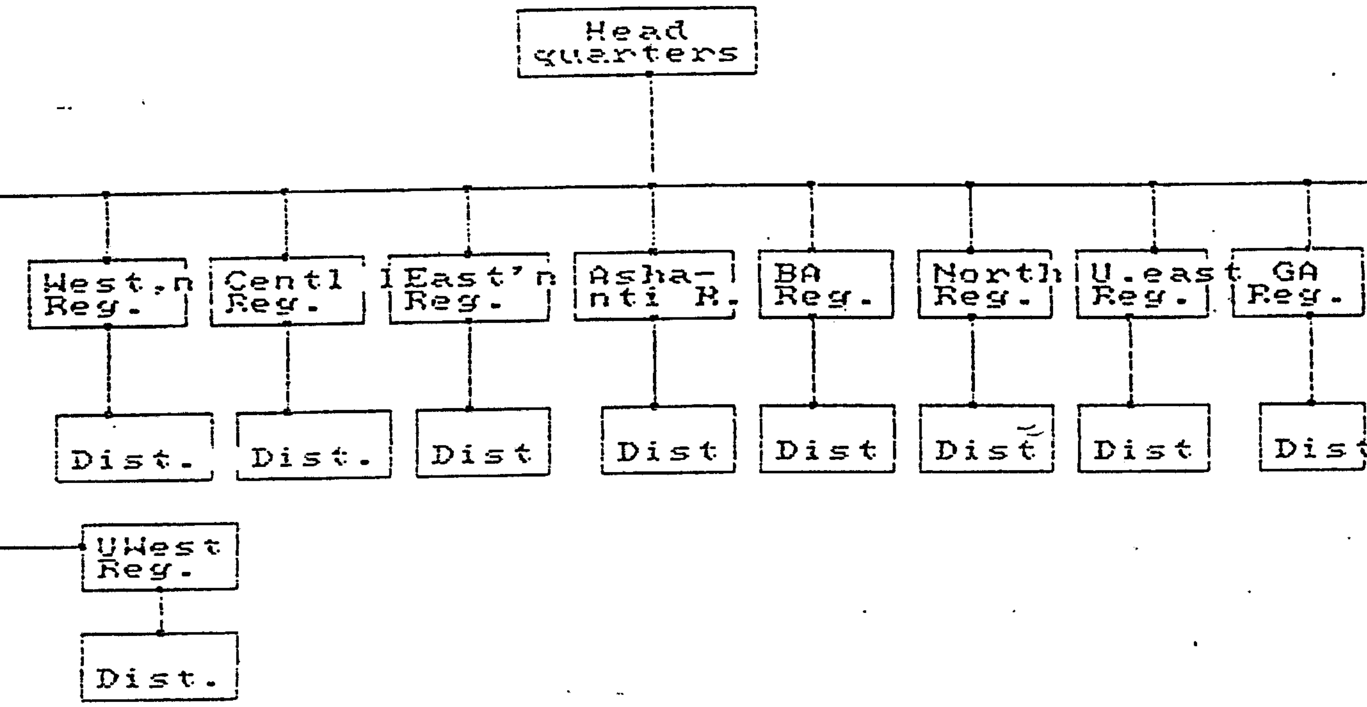


Fig. 1.4.1

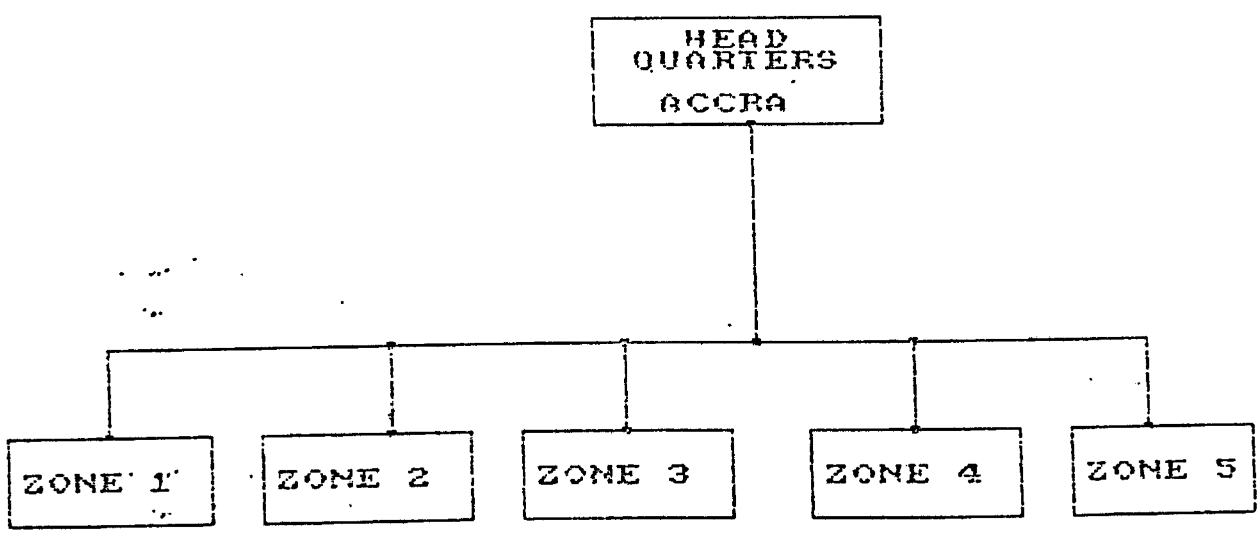


Fig. 1.4.2

ANTICIPATED ARRANGEMENT BY P & T

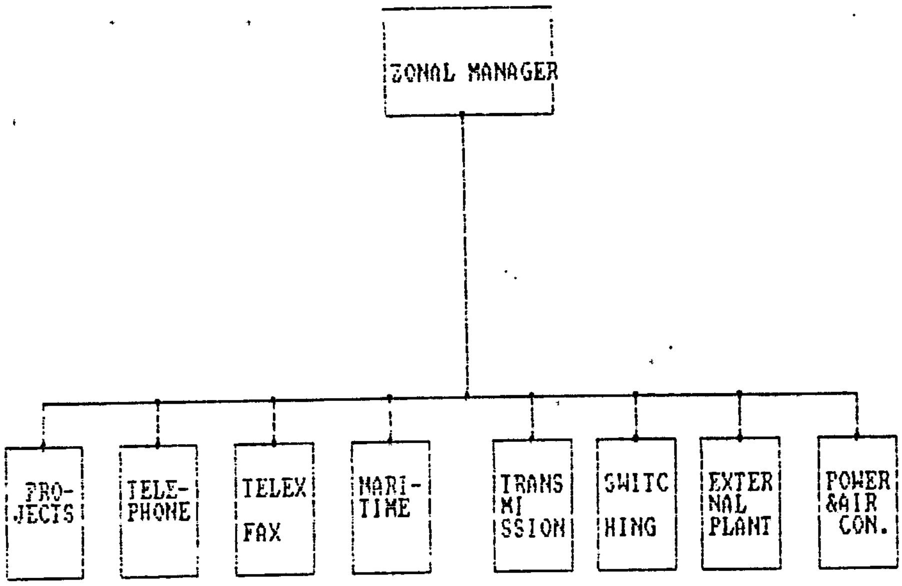


Fig. 1.4.3

PROPOSED ORGANISATION STRUCTURE
FOR A ZONAL OFFICE

The writer is of the opinion that the economic recovery programe pursued by the Ghanaian Government, in the direction of restructuring and modernisation at both services would make each entity income generating and self-supporting. Both entities when suspended have increased responsibilities as well as a challenge to expand services to the Rural and remote areas of Ghana.

The telecommunication system links most parts of the country and the outside world through the following networks:-

-**LOCAL NETWORK:** subscribers are limited by lines to local telephone exchanges.

-**JUNCTION NETWORKS:** establishes telephone links between adjacent local exchanges and between local and trunk exchanges.

-**TRUNK NETWORKS:**provides trunk exchanges and interconnecting transmission links from Zonal areas to headquarters

-**INTERNATIONAL NETWORK:**provides the gateway exchanges and interconnecting transmission links to other countries.

Telephone facilities are provided at the area level. Telephone, telex, facsimile, and telegraph offered at zonal and international level. It also offers Maritime Telecommucation, that is, ship to shore, and shore to ship telephone and telegraph services.

Transmission systems are the means used to interconnect telephone exchanges, while the switching method used enables a subscriber dialing a number to be connected to the same exchange or to different exchanges.

1.4.2 KUTUNSE EARTH STATION

The Kutunse Earth Satellite Station was envisaged in the mid-seventies to improve and enhance Ghana Radio and Television broadcast and telecommunication system in general. The sod cutting for the construction of the station was performed on the 15th December, 1977. The actual construction of the station was undertaken by a Canadian firm, Spar Aerospace. The inaugural operation of the satellite station took place on the 12th August, 1981. The station operates on INTELSAT 6 (F-2) in the Atlantic Ocean Region (335.5 E).

The number of transit carriers is 4 (that is 3 Frequency Division Multiplier + 1 Division Reserve). The number of receive carriers is 8 (that is 7 Frequency Division Multiplier + 1 DR). The station offers television and receive capabilities and has also made available a TV standard conversion of PAL, SECAM, AND NTSC. Services are offered to the following destinations:

- United Kingdom
- France
- Germany
- Italy
- USA
- Netherlands
- Kenya.

The future plan for the station is to convert all FDM circuits to Time Division Receivers (TDR). A second antenna will be constructed to face the Indian Ocean Region satellite, upgrading the 32m Diameter antenna.

1.4.3 COAST RADIO STATIONS

Takoradi Coast Radio station was established on a hilly location called "Monkey Hill", just after the 2nd world war, and was to provide ship stations with radio communications service. The highest priority in the operation of the coast station is to handle all telecommunications concerning safety at sea. The communications not only deal with domestic flag ship stations but also with foreign-flag ships. It was originally designed to give long-distance communication, HF band; medium-distance communication, MF band and communication within or in the vicinity of the port.

The Takoradi CRS was initially equiped with a Marconi transmitter working on MF at 5KW and later replaced by a Japanese transmitter called Korusai. The MF cannot be used to provide radiotelephone services. A 5kw standby transmitter operating on short wave was cut off from services in early 1983, and it has not been restored since. A 150 watt GEC short wave transmitter which broke down in the early 80s was replaced by a Siemens transmitter. In general the station is equiped with 3 MF transmitters, using one at a time with two left on standby. Its equipment also includes 2 HF Siemens transmitters but there is no VHF facility. The transmitting aerial is a construction of the fielded dipole type, about 150 ft for the MF transmission, 25-60 ft for SW transmission. The receiving aerial is the wide band type, about 50 to 75 ft high.

The Takoradi Coast Radio Station is manned and operated by trained staff and radio operators comprising a Chief Radio Officer and two trained radio operators. Other members of the staff include 8 riggers, 3 fitters, resposible for standby generators, and one tradesman. Almost all the staff members were trained in the P&T Engineering school in Accra. The main services rendered by the CRS is sending messages to ships from Agents and operators and vice versa. The main link is Radiotelegraphy. Messages received from ships are sent by telex through the P&T network to the addressee. These services are rendered 12hrs daily from 6am to 6pm.

Obsolete communication equipment contributes mainly to the hampered operation of the station. Experience and observation at the station explains that in practice, ship-shore data communications are not quite that fast, because of noisy land lines and interference. Atmospheric interference has marred communication between and ship-shore stations. However seasonal changes, especially in the Hanmattan period, which normally occurs around late November-December, has proved that transmission range increases.

1.4.4 THE STATE SHIPPING CORPORATION COMMUNICATION NETWORK

The State Shipping Corporation (Black Star Line) Instrument L.I. 434 1965 sets the objectives of the corporation:
- to carry out on marine business
- to undertake maritime enterprises

In september 1957, the Black Star Line was established as a joint venture between the Government of Ghana and Zim Israel Navigation of Haifa. However, in 1967, the Government of Ghana purchased the Zim shares, thus making the Black Star Line fully Ghanaian owned. The corporation was operating a fleet of 16 ships till 1980 when four more multi-purpose ships were added to the fleet. Early in the 1980s, recession in shipping almost grinded the corporation activities to a halt, reducing the fleet of 20 to the 4 acquired 1300 grt multi-purpose ships.

The corporation provides regular services to Europe and also engages in a worldwide chartering of vessels. The Line is managed by Ghanaians and presently boasts of highly qualified Ghanaian officers including female navigating and radio officers. The company keeps track of its fleet at sea and in foreign ports through a traffic list broadcast every hour on various frequencies. This is made possible through **Blackstar Radio**, established and housed in the corporation's building at Tema, two years ago. Blackstar Radio operates on VHF, MF, HF radio telephone and radio telegraph and also provides telex services. Blackstar Radio is manned by two radio officers within working hour mondays to saturday. Their services enable the corporation to get in touch with ships and agents both locally and abroad.

1.4.5 CONSTRAINTS ON WEST AFRICA COAST RADIO STATIONS

- Difficult to get in touch with a station and shipshore communication slow for modern communication needs.
- Interference, atmospheric and propagation disturbances, noisy lines, clarity of message poor.
- Long routeing of message, most messages are forced to pass through Portishead before reaching a West African CRS even sometimes when less than 100M from a station.
- No 24 hour service by majority of the CRSs, see table 1.4.5.
- Countries bordering the oceans become gateways and control communication to landlocked states, eg. Burkina Faso, Mali etc. and costly.
- Weak transmission.
- Obselete communication equipement.

COAST RADIO STATIONS ON THE WEST AFRICAN COAST

COUNTRY	VHF	MF	HF	WORKING HOURS
SENEGAL				
Dakar Radio	yes	yes	yes	0700 - 2200 HRS
GUINEA				
Kamsar Radio	yes	yes	yes	0800 - 2200 HRS
SIERRA LEONE				
Freetown Radio	yes	yes	yes	0700 - 2200 HRS 24 HRS
LIBERIA				
Monrovia Radio	yes	yes	yes	0800 - 2400 HRS
COTE D'IVOIRE				
Ibidjan Radio	yes	yes	-	24 HRS
GHANA				
Takoradi Radio	yes	yes	yes	0800 - 1800 HRS
BLACKSTAR Radio	-	yes	yes	0800 - 1700 HRS
TOGO				
Lome Radio	yes	yes	-	0800 - 2400 HRS
BENIN	yes	yes	yes	0500 - 2000 HRS
NIGERIA	yes	yes	yes	0700 - 1900 HRS
CAMEROON				
Duala Radio	yes	yes	-	0500 - 2000 HRS
GABON				
Lbreville Radio	yes	yes	-	0600 - 1800 HRS

FREQUENCIES:	POWER	RANGE:
VHF 156.6/156.8 MHz	400 Watts	50/100
MF 472/500 Khz	to 5 Kw	300
1813/2182 KHz		
HF (8-22) MHz		>1000M

Table 1.4.5

1.4.6 AERONAUTICAL COMMUNICATION

Air transport is one of the functions of the Ghana Civil Aviation Authority. The Authority regulates the air transport activities in Ghana. In this direction, Flight Safety, Air Traffic Services (ATS) and Corporate Planning Department (CPD) perform specific functions to coordinate aeronautical activities in the country. This involves signing and reviewing of Bilateral Agreements, Aircraft and personnel licensing, and investigations.

The organisation structure of the Civil Aviation Authority takes the ATS to task when it comes to communication. The organisation chart of the ATS, fig.1.4.4, identifies two main areas, the Air Traffic Control (ATC) and the Communication Centre (CC), using a Redifon Equipment. The ATC is sectionalised into three areas, Flight Information Region (FIR), Flight Information Centre (FIC), and Control Tower (CT).

The CC uses the Radio Tele-Tex (RTT) system, enabling it to have direct communication links with the following West African Airports: ABIDJAN, LAGOS, KOTONOU, LOME, TAMALE(VHF), KUMASI(HF), SUNYANI(HF). The CC is linked to Labadi Transmitting Station directly by cable network, and then linked to the above mentioned Airport communication centres. The Receiving Station linked by radio from an outer station is also directly linked by cable to the CC. The communication centre houses 5 tele-printers with a Reca Control Panel. Labadi Transmitting and the Kwatana Receiving stations are manned 24 hours a day.

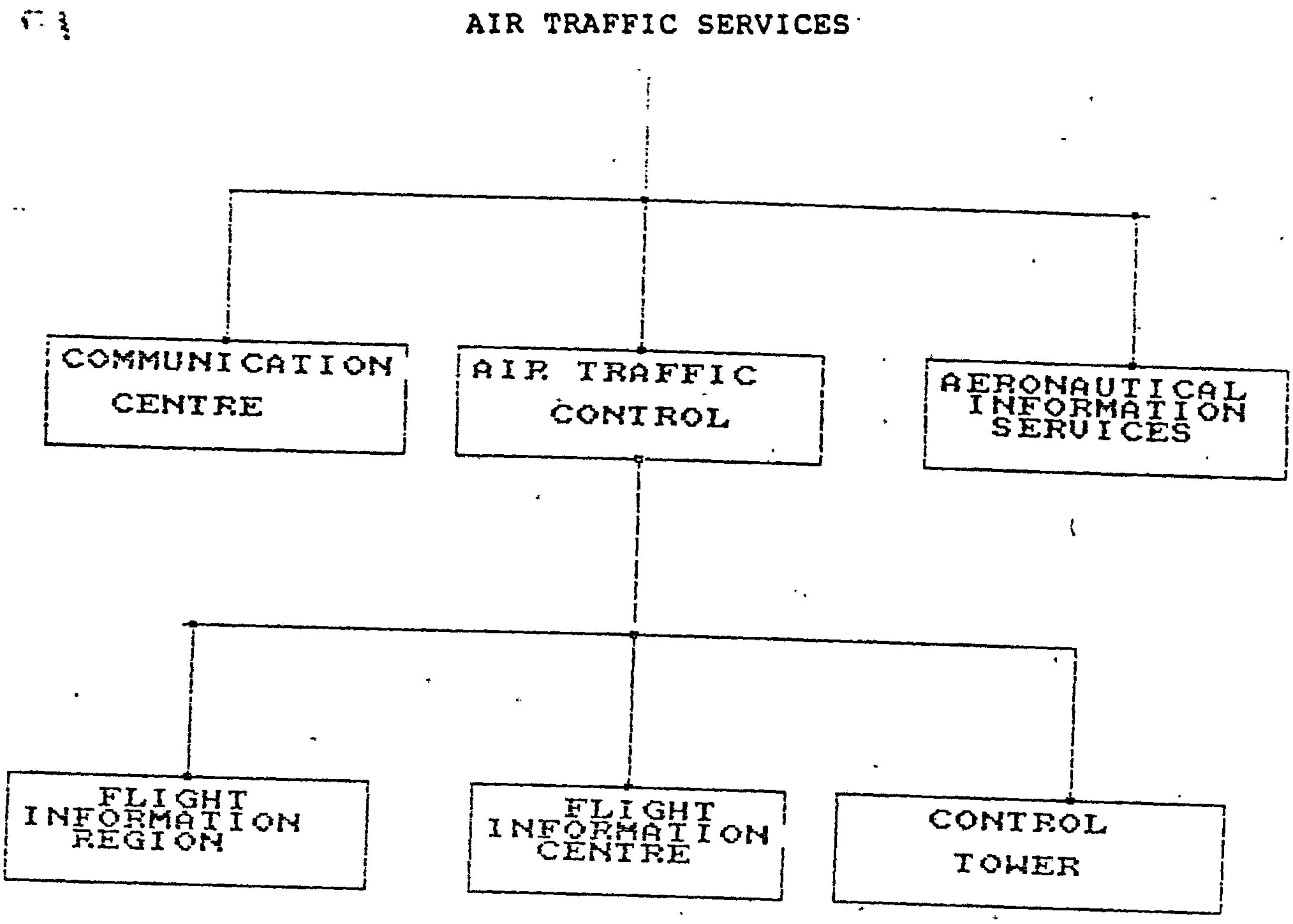

AIR TRAFFIC SERVICES
COMMUNICATION CENTRE
AIR TRAFFIC CONTROL
AERONAUTICAL INFORMATION SERVICES
FLIGHT INFORMATION REGION
FLIGHT INFORMATION CENTRE
CONTROL TOWER

Fig. 1.4.4

International airport to airport communication is conducted on HF while the regional aviation centres communicate by VHF and HF. The major problems observed to interfere with this kind of radio communication has been traced to atmospheric and propagation conditions.

In the light of the above difficulties there are future plans for extension and improvement of the Civil Aviation Communication network. The improvement falls under a project titled Aeronautical Satellite Telecommunication Project For Central and Western Africa. The project is to be financed by the European Economic Community European Development Fund (EDF). The project will cover two seperate Lots of 15 Standard INTELSAT Satellite Earth Stations with associated communications equipment and of aviation systems for 8 Airports namely: Cameroun, Central African Republic, Congo, Gabon, Ghana, Niger, Nigeria, and Chad. Other provision will include installation in the above countries, Testing, Commissioning and Provision of training and the Technical Assistance Services. At the of time writting this dissertation, Notice of Invitation to Tender No 3443 had been issued by the Governments of the above countries.

Satellite communication to be introduced by 1992, will be sponsored by ICAO and EEC. The project will incorporate computers in the communication network.

CHAPTER 2

DEVELOPMENTS IN COMMUNICATION SYSTEMS

2.1 COMPUTERS AND COMMUNICATIONS SYSTEMS

2.1.1 INTRODUCTION

Computer revolution has just started and will probably roll on into the next century. Similar to the industrial revolution, the computer revolution is bringing dramatic shifts in the way we live and even the way we think. In the industrialised world goverment organizations are probably the biggest user of computers. Computer utilisation stretches far into areas like administration, education, research and control.

When it comes to banking sector, every banking transaction, checque deposits, saving account deposits, withdrawals, bond purchases, and the stock exchange, utilises computer. The police and the other law enforcement agencies use the computer to keep track of stolen automobiles, analyse evidence, and identify finger print.

Engineers design bridges, chemists identify compounds, geographers draw maps, and scientific research in the field of atomic physics, cellular biology, and astronomy all use computers. The space programme, would not be possible without the modern tool of computer.

The computer, directly or indirectly affects almost every phase of our modern life. A computer is a modern tool and its introduction into the maritime industry especially communication will prove itself as the most powerful and useful tool ever developed.

2.1.2 COMPUTER APPLICATIONS IN MARITIME TRANSPORT

Application of computers to transportation is becoming increasingly very important as we enter the 1990s. However, until recently computers aboard merchant and passenger ships has been limited to the shipping giants. Modern technology have made it possible today to employ computers to help control the operation of ships. Nowadays it is extremely possible to use computers to control the engine, navigational aids, give warning of potential dangerous situations, monitor fuels, cargo, and electrical equipment aboard. Merchant ships are increasingly using satellite information to help navigation through computers. It has to be admitted here that there are 1001 applications to the use of computers outside the maritime scope. Maritime transportation alone hosts an uncountable number of applications. Cargo shippers around the developed and some developing countries have already approved the versatility of computers to handle container bookings. Even with a complete cargo list, a computer can assign space to the containers by weight in order to maintain safety stability throughout the voyage. The application does not end there, it also prepares numerous documents, ranging from 12 to 14 per container, to facilitate complete cargo documentations as seen in the NEDLLOYD Flowmasters Concept in The Netherlands.

Ocean routeing is becoming more and more reliable. High speed computers have enabled a wider range of weather data to be handled and used in preparing forecasts. The data covers everything from wind, wave conditions to atmospheric recordings. The sources range from government weather bureaux, navy oceanographic institutions to localised weather reports from vessels at sea which participate in the World Meteorological Organisation (WMO) weather reporting scheme. An observation centre at the Hydro Meteo Center Rijnmond, The Netherlands demonstrates that super computers can generate models which predict enviromental weather conditions over a far longer period, than was previously possible.

Shipowners for sometime have been very astute in looking at the vast potential of computer application aboard ships. However, the shipyards perception into computer application in ship designing has a far reaching effect in the transport industry as a whole. In that respect shippers in the developed countries have taken up the challenge to pursue the advantages found in computer application.
At this stage it will be very disappointing for developing countries to just sit on the fence and watch the game of technological advancement by the industrialised countries.

2.1.3 COMPUTERS FOR INTEGRATED SHIPBOARD SYSTEMS

Computer technology has provided for integrated navigational systems on board ships. The idea of introduction of computer aided systems on board ship is to increase safety of navigation at sea with an operational view of reducing cost for the shipowner. Especially in areas of fuel consumption, collision avoidance.
Integrated systems comes under many titles, one such name

which is fast gaining popularity with the industry is the Integrated Ship Control (ISC). This system combines the monitoring and remote control of different systems into one single computer system, which in itself consists of a number of computers. This arrangement makes it possible to operate and monitor systems from one console. The various computers are connected by means of a data bus. A couple of special computers are used for communication with the system. These computers also have interconnection to displays keyboards, and assemblies of different kinds. Consoles and handling panels may be placed on the bridge, in bridge wings, in the ship's office and in the engine control room.

Another area where computers are expected to play a dominant role is the development of the Electronic Chart Display and Information System (ECDIS), soon to replace paper charts. ECDIS has also felt the surge in computer application. It offers the ECDIS shown in fig 2.1.1 the capability of monitoring, the integrated navigation of a ship.

New ships are coming out with installed computers, interfaced with radio navigational equipment, Decca, Loran, Satnav, Gyro compasses, Log, and capable of converting positions obtained automatically into geographic coordinates. Experiments carried out show that integration of navigation systems could produce faster and more accurate results as against the conventional method of plotting position lines, allowing the watch officer to attend more to other duties on the bridge.

2.1.4 USE OF COMPUTERS IN MARITIME EDUCATION

Navigation today has been very well developed in electronic and automation techniques and therefore the required knowledge and expertise of ship officers are extremely

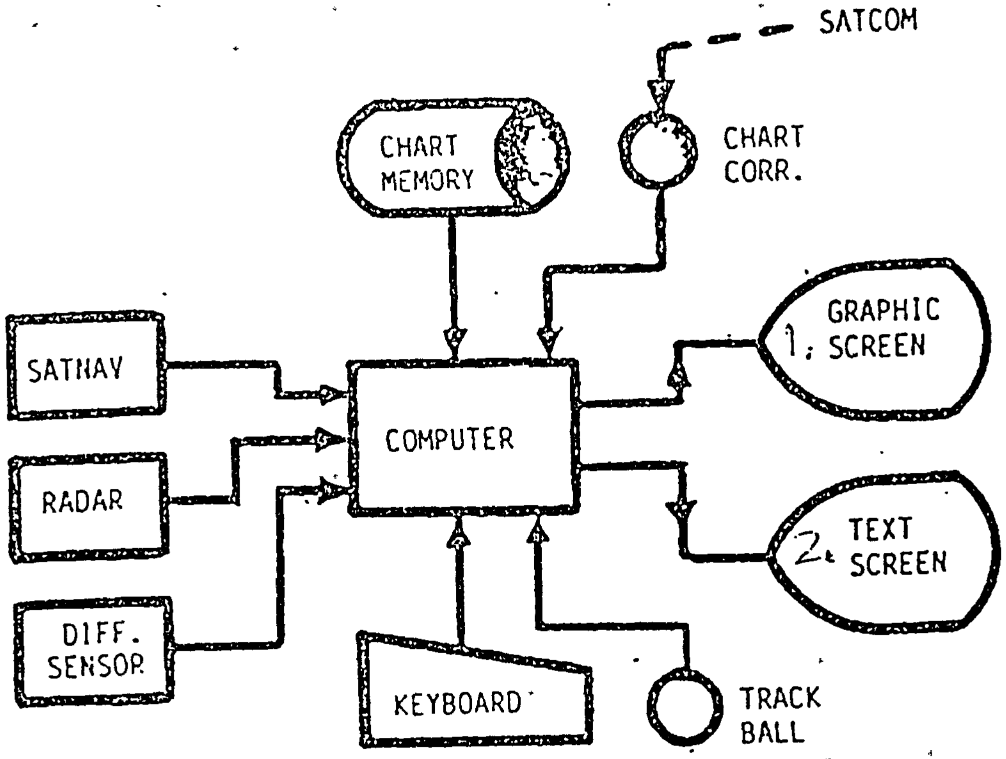

SATCOM
CHART
MEMORY
CHART
CORR.
GRAPHIC
1. SCREEN
SATNAV
COMPUTER
RADAR
TEXT
2. SCREEN
DIFF.
SENSOR
KEYBOARD
TRACK
BALL

Fig. 2.1.1

demanding. To meet the challenges posed by technological advances in the maritime industries, some Maritime Education And Training Intitutions have started to adapt to the new trend. Such challenges earlier in the '70s had seen the introduction of radar simulation training in nautical institutions. Today radar simulation which has been the basis for training ship officers in the process of collision avoidance and radar navigation, is the standard in many Maritime Academies. Information systems and modern communication systems for shipboard operation have begun to generate a new approach to training aids in maritime institutions. The computer has already proved its worth in higher learning institutions. Its utilization in Maritime Education training has already been identified in :

- preparing academic and departmental time tables and programs.
- reinforcement of teaching methods, facilitating studies and making learning more effective.

In an institution like the Regional Maritime Academy Ghana, a personal computer can be used as a server or a central store for all examination data. Each department is then connected to this central store via a network and can retrieve information from the central store, use, add to or modify it, and then send it back. Owing to the network concept, the speed of data transfer is greately increased and the distribution of data processing is more efficient.

2.1.4.1 COMPUTER AIDED INSTRUCTIONS (CAI)

Computer aided instructions or Computer-based training(CBT) or Computer aided learning(CAL) is a well-established and effective technique. Its use can give significant advantages over traditional learning methods. A typical CBT lesson lasts between 15 and 30 minutes, and will be computer-based. A lesson may be broken into several learning episodes, each of which consists of:

-the learning material , which may take the form of a text and graphics displayed on the computer screen or presented via some other medium.

-questions on the learning material, which are displayed on the screen and which the learner has to answer by typing at the keyboard.

-feedback on the computer screen, telling the learner whether he has answered correctly and giving help and further information if required.

-scoring, meaning that the computer gives marks according to the correctness or otherwise of the learner's responses, and scores them so tha the learner and the Tutor can asses performance.

-branching, meaning (a) that the computer routes the learner through the lesson material on the basis of performance(so that, for example, learners exhibiting poor performance re-do the lesson, or are routed to appropriate remedial material), and (b) that the learner is able to exercise some degree of control over his route through the the material, by being presented with choices at appropriate points.

ADVANTAGES: Highly effective, learning times are reduced, retention is enhanced, the material can be used over and over again by a large number of people resulting in low cost per student hour. Learning is flexible. These adavantages can be demonstrated in the International Regulations for Preventing Collisions at Sea as well as the International Buoyage systems. The flexibility of CAI will reduce teacher-student contact and hours resulting in utilisation of lecturer hours in other learning areas.

2.2 SATELLITE COMMUNICATION

2.2.1 IMO's VIEW TO MODERN MARITIME COMMUNICATION

In the Annex of IMO Assembly Resolution A.666 (16), it is mentioned that a study on a World-wide Radionavigation system has been taking place since 1983 with the objective of providing a basis on which regulation v/12 of the 1974 SOLAS Convention might be ammended to include a requirement that ships shall carry a means of receiving transmissions from a suitable radionavigation system throughout any intended voyage.

A means of receiving transmission from a suitable radionavigation system throughout the intended voyage led the IMO Marine Safety Committee in the direction of satellite navigation systems in general. One of the tasks of the Maritime Safety Committee study was to determine the operational requirements of such systems, which must be reliable, of low user cost and meeting the needs for general navigation as well as the requirements of the Global Maritime Distress Safety System. Furthermore, the study was also to determine the extent to which existing or planned terrestial navigation systems might contribute and supplement the operational requirements for general navigation, as well as the GMDSS.

Combining to the World-wide radionavigation systems, there are some satellite and terrestial systems currently in use and providing services for shipping. Such include the Global Position System, GPS (USA) and GLONASS (USSR) satellite radionavigation systems both being global systems. These are already in the advanced stage of developement and will probably be fully operational in 1992 or 1993.

2.2.2 OPERATIONAL REQUIREMENTS

Appendix 1 of IMO Resolution A.666 (16) details the operational requirements for world-wide navigation systems. It highlights four main areas including:

- **coverage:-** Given that merchant fleets operate world-wide, it is necessary for the information provided by a radio-navigation system to be suitable for geral navigation by ships engaged in international voyages anywhere in the world.
- **accuracy of position determination:-** Systems should be capable of providing position information with an accuracy not less than given in Resolution A.529(13). This degree of accuracy is suitable for the safety of general navigation and for SAR-information in the GMDSS.
- **update rate of position data:-** The maximum time interval between updates of position information depends upon the accuracy of the particular system and the accuracy required for navigation.
- **availability:-** Systems should enable a position fix, adequate to meet the accuracy and update rate requirements, to be obtained for 99.9% of the time.

Other requirements of such a WWNS include: low user cost, duties of the responsible authorities for the WWNS, and receiver performance standards.

Some other satellite systems, which are also under development, and would need to be trialed, have been planned for communication and the navigation of ships. The general analysis is that satellite systems satisfy the operational requirements of a WWNS best.

2.2.3 SATELLITES IN TELECOMMUNICATION

An increasingly important component of an integrated Bridge system is the satellite communication system. The reason lies in the ability to send large quantities of data in a short time over large distances. Many communication systems now in use on land, sea, and in the air operate as part of a satellite based system. Satellite communication and information technology nowadays is to become the central part of management in the developed and some parts of the developing world.

At this stage of satellite development, it will be difficult to overstate the impact satellite cummunication has on the maritime community, and commercial trade on land in general. But looking at the maritime industries alone, the impact can be identified in some industries such as fishing where fleets can be directed to schools of fish and the best market. It is also admitted that satellite communication will play a major part in the reduction of manning levels, by increasing efficiency for most types of shipping. The off-shore industry is also grateful to satcom, using it as a tool as well as a key channel in its safety systems.

Nonetheless one cannot only look at the bright side of satellite link in the communication chain, without also to examining the historical background, operational principles, user areas and user problems accompanying this innovation.

2.2.3.1 HISTORICAL BACKGROUND OF SATELLITE COMMUNICATION

The author feels it is important to recapture these areas for the fact that some of the developing countries began to embrace this innovation with very high suspicion. Unknown to its inherent user problems, a developing country in West Africa jumped onto the band wagon in the early 1980s to build an Intelsat earth station. It was to improve its communication and broadcasting in general. Not to mention technical problems, breach of contract by the project executors, operational setbacks and lack of technical knowledge rendered the station inoperational till the late 1980s.

About five decades ago, in October 1945, a fascinating prediction by A. Clarke in an article , "Extra Terrestrial Relays," described a complete worldwide communication network of geostationary satellites. This dream was soon to become a reality when the U.S Signal Corp's Project Diana proved that by bouncing radar signals off the moon and back to earth again, communication, using microwave in space, could be established. In 1954, the U.S Navy successfully reflected the first voice messages from the earth to the moon and back again. This discovery was celebrated. In 1957 the first satellite launch was performed by the USSR, with the Sputnik 1. The U.S followed some months later by launching its first satellite, the Explorer 1.

From then on the pace for satellite development and launching continued unabated. The first generation of satellites served military purposes until 1961 when the first civil satellite was used for transoceanic communication. It improved the abilities to transmit telephone, telegraph, and television messages across the ocean. There was a steady increase in the number of military satellite launches till 1965 when one of the early enthusiatic satellite developers, International Telecommunication Satellite Consortium (Intelsat), launched its commercial satellite, the Early Bird. Years later, the goal of the U.S government and its regulatory body, the Federal Communication Commission, was, quote "make available so far as possible, to all people of the United States, a rapid, efficient, nationwide and worldwide wire and radio communications service with adequate facilities at reasonable charges." Today the ensuing progress continues. More powerful and sophiscated satellites for broadcasting,telecommunication, and other special uses are constantly being developed. At present there are approximately over 200 geostationary satellites in orbit, including those developed by one of the most powerful bodies, the International Maritime Satellite Organisation (INMARSAT). The U.S and the USSR have made considerable progress in developing the Global Positioning System, and the GLONASS respectively, primarily however for military purposes.

2.2.3.2 OPERATION

Excellence of our satellite communication will depend upon launching durable space vehicles into stable geostationary orbit. Since booster rockets prove inadequate to position the satellite directly into the geostationary orbit, extra rockets in the communication vehicle are used to reposition the satellite from its low parking orbit to its final geostationary position.
The time it takes the satellite to complete one orbit is

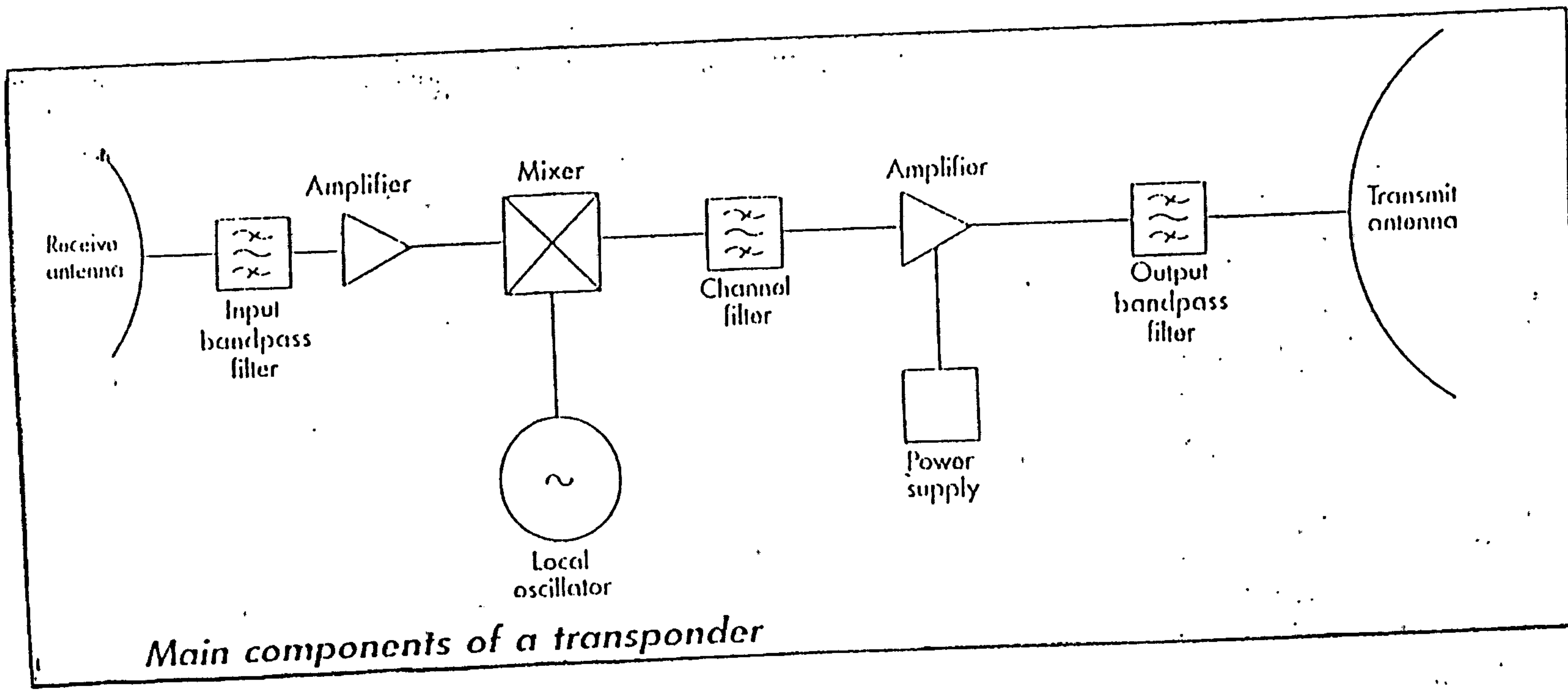
the same as the rotation period of the earth, close to 23 hrs 56m 04s. The satellite's orbit is in the equatorial plane and moves in the same direction as the earth's rotation, therefore making it appear stationary with respect to the earth. Using fixed antennas, this makes communication possible 24 hrs per day. One third of the earth's surface is visible to a single satellite at a height of 35,786km. The designed life span of a satellite is about 7.5 years average.

Satellites used for telecommunication have the function of receiving, processing and retransmitting the microwave carrier waves back to earth. The main component of the satellite is the Transponder, which basically comprises an "uplink" (receive) antenna system, a receiver, channel filtering, an amplifier, output filtering and "downlink" (transmit) antenna system, shown in fig.2.1.1 Signals with very low power from uplink stations reach the satellite where these microwaves are amplified many thousands of times. their frequency is also increased so that the powerful radio waves relayed earthward do not interfere with the original uplinked message. Finally the antenna on board the satellite relays 5 to 10 watt signals into a well defined beam to complete the circuit. The overall quality of satellite telecommunication depends on:

- how accurately receiving and sending antennas are pointing.
- the power of the signal relative to the associated noise. (SNR)

2.2.3.3 RADIO SPECTRUM SAVING TECHNIQUES

As technology has improved, so has our ability to create and detect electromagnetic waves for use in commu-



Main components of a transponder

Fig. 2.2.1

Source: Never Beyond Reach

nication. VHF and higher frequencies of electromagnetic waves are known to travel in an almost straight line and therefore to communicate with a satellite an earth terminal must have a direct line of sight to the spacecraft.

Each type of communication medium uses a characteristic bandwidth. Signals covering a large band of frequencies can carry more information than one covering a narrow band. Media such as television require a substantially wider bandwidth than radio or telephone. It is with this background of requirement that has resulted in a number of satellite users exploiting the radio frequency spectrum. See table 2.2.1. In the spectrum saving techniques, a number of arrangements have been worked out to facilitate multiple use of transponders as follows:-

- **Frequency-division multiple access (FDMA):** Each caller is allocated by pre-arrangement, or by assignment on demand, a segment of the RF bandwidth of the transponder. The control station allocates any frequency channel which is free at the time. When the user has finished the channel is free to be reassigned.

- **Time-division multiple access (TDMA):** Each user has the full bandwidth and RF power available in short time intervals. Each user transmits his message in digital form in the allocated slot, with each burst containig information on its source and destination.

- **Code-division multiple acess (CDMA):** in CDMA the pulse is spread in time over a wide bandwidth. Each user is assigned a unique high-speed digital code sequence which is incorporated into his message. At the destination all

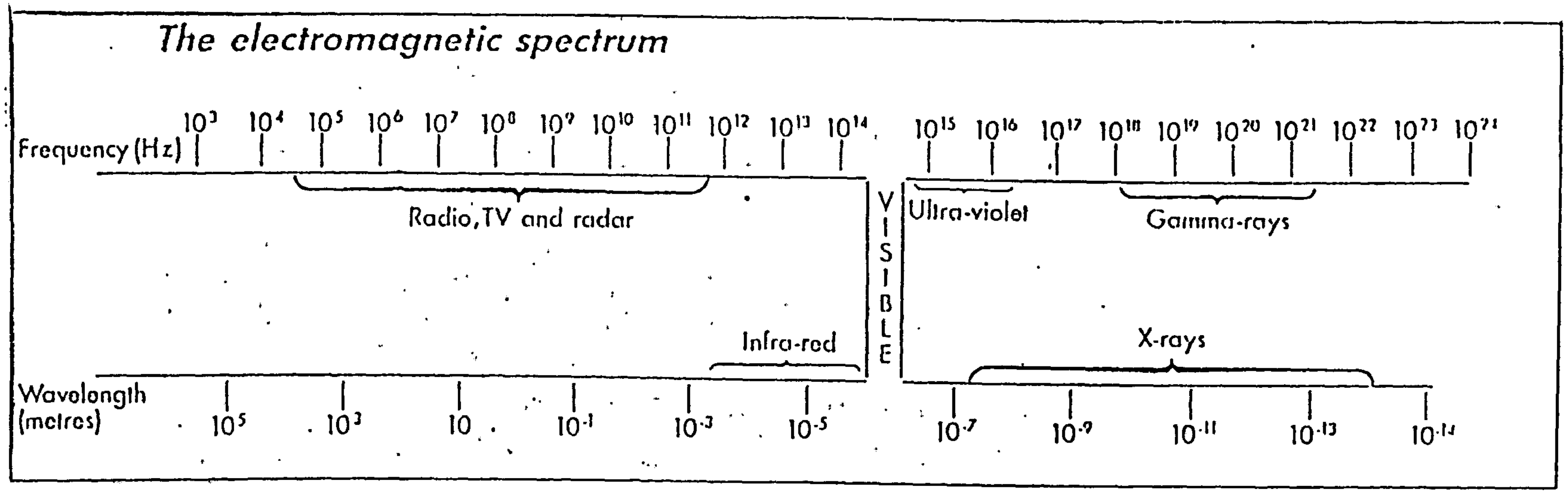


Table 2.2.1

Source: Never Beyond Reach

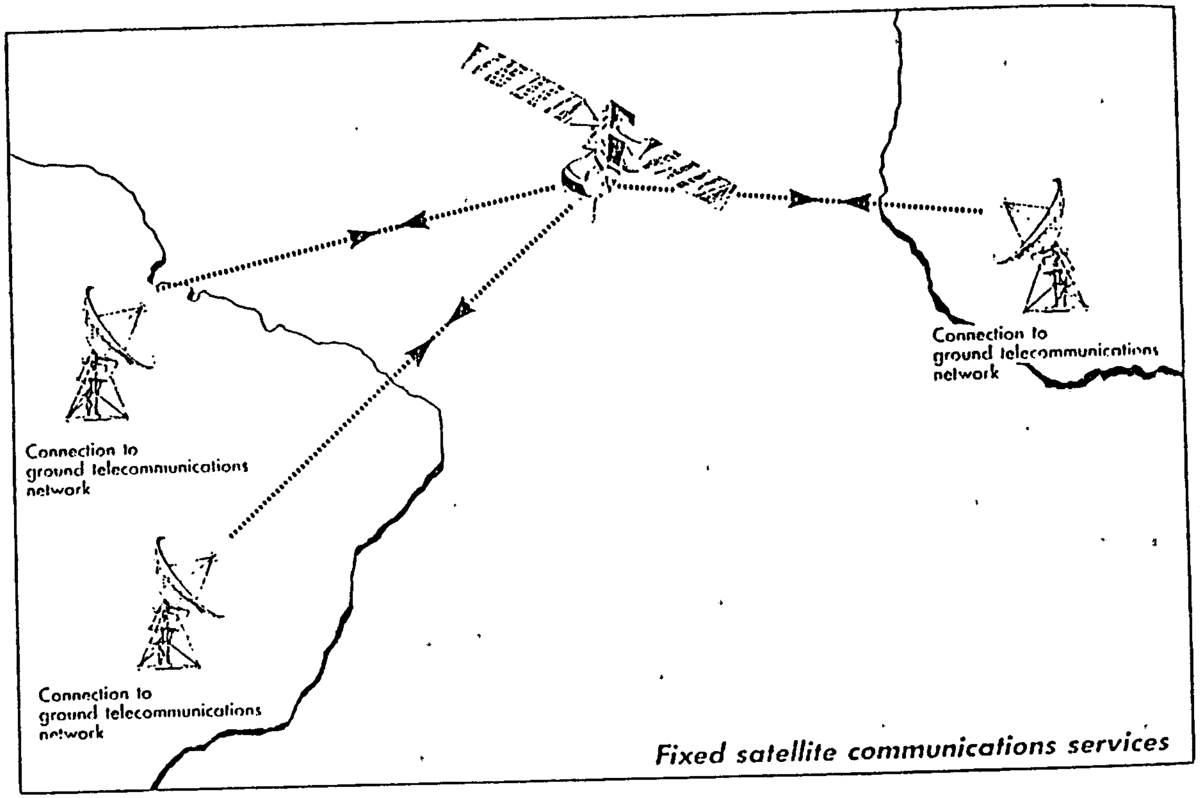
signals are received simultaneously and then distinquished from one another by means of their unique codes.

Communication arrangements can be either analogue or digital in nature. Although performance has shown that digital systems offer a number of advantages, current satellite communications systems incorporate both types. It is possible to convert analogue signals into digital form and transmit them over a digital link. At the destination the digital signal may be converted back into analogue form.

2.2.3.4 FIXED SATELLITE SERVICES

Since the space race began for satellite launching many organisations have sprung up trying to capitalise on the wider pontentials of satellite services. The fixed satellite services were the first to develop, see fig.2.2.2 It opened up new global possibilities necessitating the creation of a new kind of international organisation. This led to the creation of Intelsat, an international organisation totalling about 117 members, and based in Washington. It has taken the responsibility to provide fixed satellite communications services all over the world under a definite agreement which came into force in 1973. Unfortunately the Soviet Union is not a member of Intelsat. However, it has a similar organisation called Interspunik, and provides satcom services to its 14 member states and a number of other countries. Interspunik uses the various families of Soviet communication satellites. It operates much the same way as Intelsat, except that it utilises both Geostationary and highly elliptical orbits, offering polar coverage as well.

Other regional organisations, as a result of the success of



Fixed satellite communications services

Fig. 2.2.2

Source: Never Beyond Reach

the global Intelsat services have sprung up from Europe, Asia, Australia, and the Arab community:

- **EUTELSAT**, the European Telecommunications Satellite Organisation, founded in 1977 and based in Paris.
- **PALAPA**, the Palap satellites have been operated by the Indonesian authorities since 1976.
- **AUSSAT**, a private company set up in 1982 with the Australian government backing.
- **ARABSAT**, the Arab Satellite Communication Organisation was founded in 1976, and based in Riyadh.

2.2.3.5 MOBILE SATELLITE SERVICES

Mobile satellite service permits communications between mobile station and a subscriber to a terrestial telecommunications network, or between ships, aircraft or other vehicles, see fig.2.2.3. The International Maritime Satellite Organisation, INMARSAT, with headquarters in London, had taken a giant step in this direction in making maritime communication the most developed of the mobile services.

One of the major advances over the past decade has been the evolution of satellite based Global Positioning System (GPS) of the United States and the Glonass of the Soviet Union. Both are military systems, accessible for civilian use. GPS is based on radio transmissions from satellites which circle the earth twice a day in three orbital planes about 19,000Km from the earth's surface.

GPS receivers collect the radio signals and, using a complicated software program, automatically determine the user's location in three dimensions. This position determination is based on a set of measurements of distance to four or more satellites and the associated time-delay.

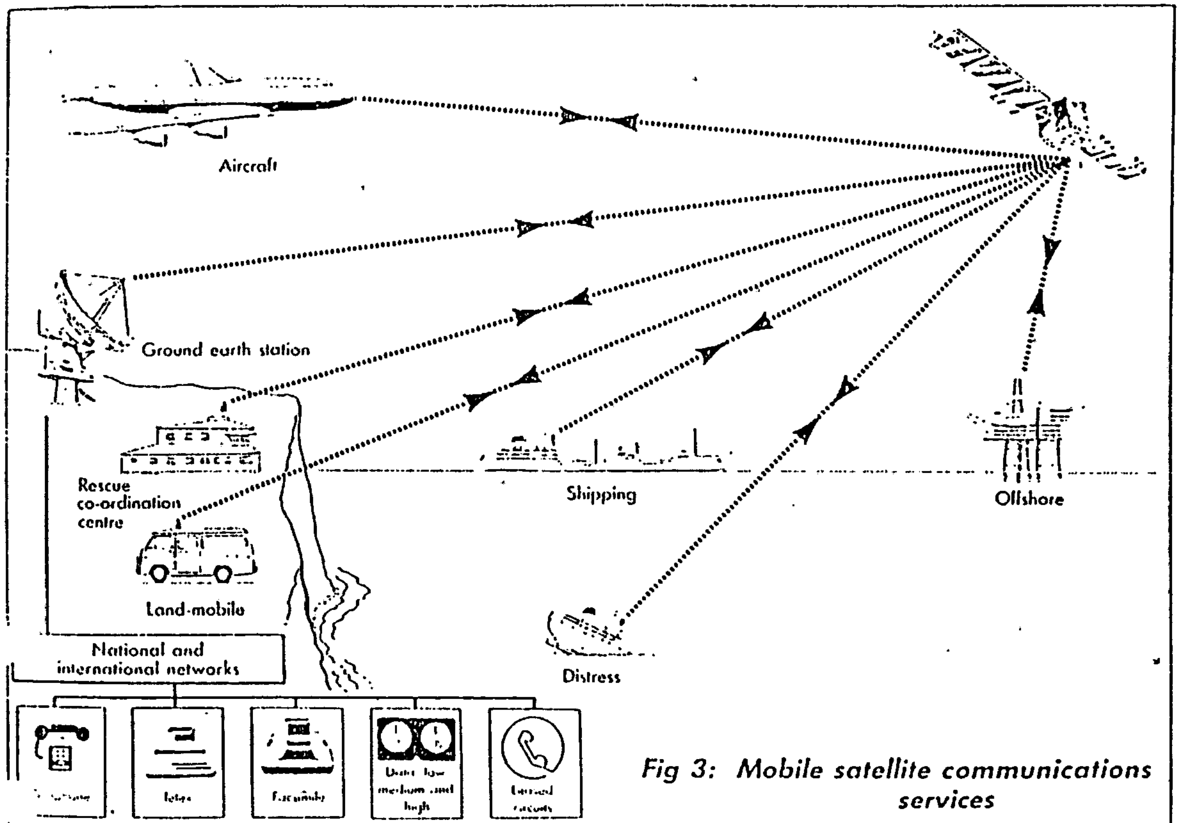


Fig 3: Mobile satellite communications services

Fig. 2.2.3

Source: Never Beyond Reach

Real-time GPS can can produce accuracies of up of 25m or less. As a security measure, the US military intends to degrade the accuracy available to civilians to 100m in real time. Currently , nine GPS satellite have been launched and are in operation. When the scheduled full constellation is in place , in 1992 there will be twenty one GPS satellites and three spares.

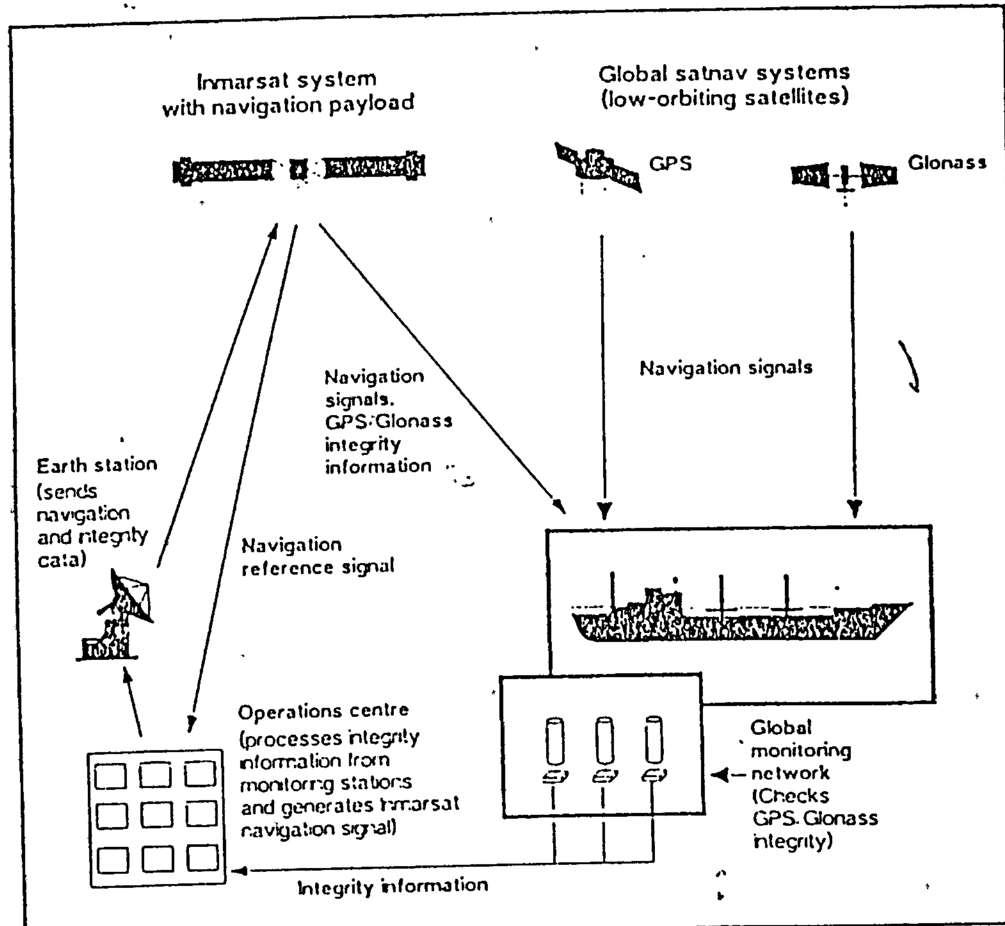
INMARSAT has carried out several studies which have demonstrated the feasility of using geostationery communications satellites to augment the GPS and GLONASS radionavigation networks, see fig.2.2.4. Today, even though Satcoms and Satnav have followed separate but similar courses, both are offering the posibility for worldwide differential satellite positioning. The combination of satcom and satnav may soon enhance real time monitoring and response to accidents, oil spills and other marine hazards.

The linked technologies could help ensure the integrity of the satellite positioning systems. Linking the two technologies could facilitate just-in-time delivery programmes, by tracking marine and land carriers to their pick-up and delivery points. Furthermore, by communicating position linked data, satnav and satcom will allow shipping companies and VTS to monitor onboard systems and locations.

2.2.3.6 STRENGTH OF SATELLITE COMMUNICATION

Because of their inherent capabilities, satellites have found uses in the communication community for the following reasons:

1. Distance is no problem for satellites. In general, the cost of sending a message via satellite is the same for a link between two points 2000 Km apart as for a link between two points only 10 Km apart.



Inmarsat's navigational overlay will provide a back-up reference signal and integrity check for satnav systems

Fig. 2.2.4

Source: Never Beyond Reach

2. Satellites are inherent wideband devices. Tens of megahertz are available in each transponder channel, each channel may be utilized between any two or more points within the coverage of the satellite. Terrestial radio links are generally limited to a few low-capacity trunks between major markets.

3. The satellite may technically operate into any station within its antenna's view, approximately 42% of the earth's surface is within view of a geostationary satellite. Regulatory restrictions of the International Telecommunication, (ITU) and national regulatory agencies (e.g., the FCC in the United States) may limit the actual use to a much smaller region.

4. Satellites are not affected by natural limitations such as mountains, cities, deserts, oceans, and so on within their coverage area, however, at low angle of elevation to the satellite, mountain may mask view of the satellite. Thus, nation that comprises separated elements e.g offshore may utilize satellites to provide a unified national servi ce. An example of this is the United states with Hawaii and Alaska.

5. Satellite systems may serve large and small cities with identical forms of service. Traditional terrestrial telecommunications networks have favored the large, dense cities with the most modern equipment in the system, whereas the rural areas have been handled by older equipment (often retired from the cities). Thus, the flow of industry and its data-processing facilities from the cities to the more rural areas could be accelerated by the availability of satellite communications. This ability of the satellite, to serve equally both the developed and the undeveloped areas of a nation (or the world), would permit diversification of industry that heretofore has been considered impossible because of problems associated with labour, defense, and

manufacturing reasons.

6. The wideband go-anywhere service provided by the satellite plus the competition from the terrestrial alternatives has led to the need to investigate the possibilities for satellite systems to serve either new markets, or under utilized communications links. This need and desire has resulted in the emergence of specialised satellite television networks for cable television (pay-TV), ethnic and language groups, religious groups, sports, and so on.

7. The availability of satellites has led to the emergence of new common carriers, some of these are owners of satellite systems (eg., Telsat Canada). They take the wholesale leases and sublease individual circuits or television channels to others. The resulting competition produces opportunities for further expansion of the markets for satellite services.

8. Traditional methods of midocean communications (HF radio) have been stretched to the limits of technology and still were not providing adequate service under many conditions, particularly in an emergency. Inmarsat is a particular example of a satellite service. It provides mobile voice, data,low-speed video to ships via satellites. Collection of data from a regional or global sensor platform may be done by using communications satellites to pick up the data and relay it to one or several data reduction points. The same satellite may be used to disseminate the results (e.g., earthquake warnings) back to source areas.

9. Very small aperture earth station terminals (VSATs) use satellites to provide immediate access to data bases branch offices, and management information systems. these terminals are usually placed directly on the customer's premises.

10. Satellite offers point to point, point to multipoint (broadcast), multipoint to point (data collection), and multipoint to multipoint capabilities.

11. Satellites are readily compatible with new technology (e.g. with both digital computers and analog high definition TV)

2.2.3.7 WEAKNESSES OF SATELLITE COMMUNICATION

There are many weaknesses to consider when investing in satellite systems:

1. High initial investment in space segment are normally required.
2. New investments may be required in earth stations.
3. Short Satellite Lifetimes (7-10years).
4. Orbit/spectrum crowding, frequency sharing, power flux density limits .
5. Access to end user may be difficult for engineering or regulatory reasons.
6. Institutional/legal/regulatory aspects .
7. Possible difficult, awkward, or expensive maintenance.
8. Launch vehicle reliability is limited.

2.2.3.8 SATELLITE COST

The changing perception of satellite potential has been related to the change in satellite cost. The first four generations of INTELSAT satellites carried increasing numbers of channels and have progressively longer design lives as shown in fig.2.2.6. Consequently the cost per voice channel per year dropped dramatically. The bottom line of fig. 2.2.6 shows the drop in cost per satellite voice channel per year. Fig. 2.2.7 plots the trend. The figure shows the investment cost of a satellite and its launch cost. The cost to a subscriber will be much higher because it must include the earth station and its links and must take into consideration the fact that the average channel utilization may be low.

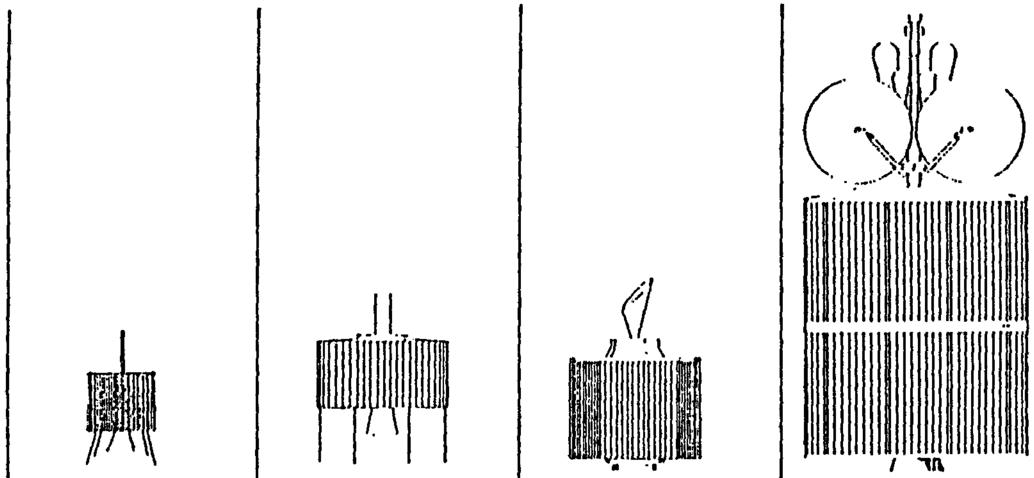
The extraordinary cost reduction shown in fig 2.2.7 will continue, if sufficient traffic is sent over satellites to permit the possible economies of scale. Massive reductions in the cost per voice channel could result if satellites with a much larger capacity than today's were launched and the market place provided sufficient volume of usage. The satellites and their launch costs are referred to as the space segment of satellite communications. The space segment costs are dropping to such a low level that overall system costs will be dominated by the ground facilities.

The cost of an earth station, however, has not dropped. The first COMSAT earth stations cost more than $10 million. INMARSAT Earth Stations is currently costing around $7-10 million dollars.

There is a trade-off between the cost of the satellite and the cost of its earth station. If the satellite has a large antenna and considerable power, smaller earth stations can be used. If the satellite makes more efficient use of its frequency allocation, the cost per channel will be lower. The main effect of increasing satellite cost will be to reduce earth antenna size and cost. The certainty is a trade-off. That is why a single voice channel in Inmarsat system has a higher user's charge than a comparable voice channel in the Intelsat system.

2.2.3.9 A MEASURE OF SUCCESS IN SATELLITE SYSTEMS

The most common criteria for determining the success of a satellite communication system are the amount of traffic handles and its economic returns on the funds invested. Certainly, Intelsat has met these criteria. After an initially exploxive begining the traffic growth rate has settled at a still impressive 15-20% per year in 1988.



Name	Intelsat I (Early Bird)	Intelsat II	Intelsat III	Intelsat IV	Intelsat V
Year of launch	1965	1967	1968	1971	≈ 1979
Diameter	28 inches	56 inches	56 inches	93 inches	600 inch sails
Height	23 inches	26 inches	78 inches	111 inches	264 inches
Weight in orbit	85 lbs	192 lbs	322 lbs	1547 lbs	3200 lbs
Number of antennas	1	1	1	3	6
Primary power (watts)	40	75	120	400	1000
No. of transponders	2	1	2	12	27
Bandwidth of transponder	25 MHz	130 MHz	225 MHz	36 MHz	
Cost of satellite	$3.6 million	$3.5 million	$4.5 million	$14 million	$ 25 million
Cost of launch	$4.6 million	$4.6 million	$6 million	$20 million	~ $ 23 million
Design lifetime	1.5 years	3 years	5 years	7 years	10 years
Total cost per year	$5.47 million	$2.70 million	$1.90 million	$4.85 million	~ $ 4.8 million
Maximum No. of voice circuits	240	240	1200	6000	≈ 24,000
Cost/voice circuit/year	$23,000	$11,000	$1600	$810	$200

Figure 1.3 The INTELSAT birds—four generations of satellites in six years.

Fig. 2.2.6

Source: Communications Satellite Systems

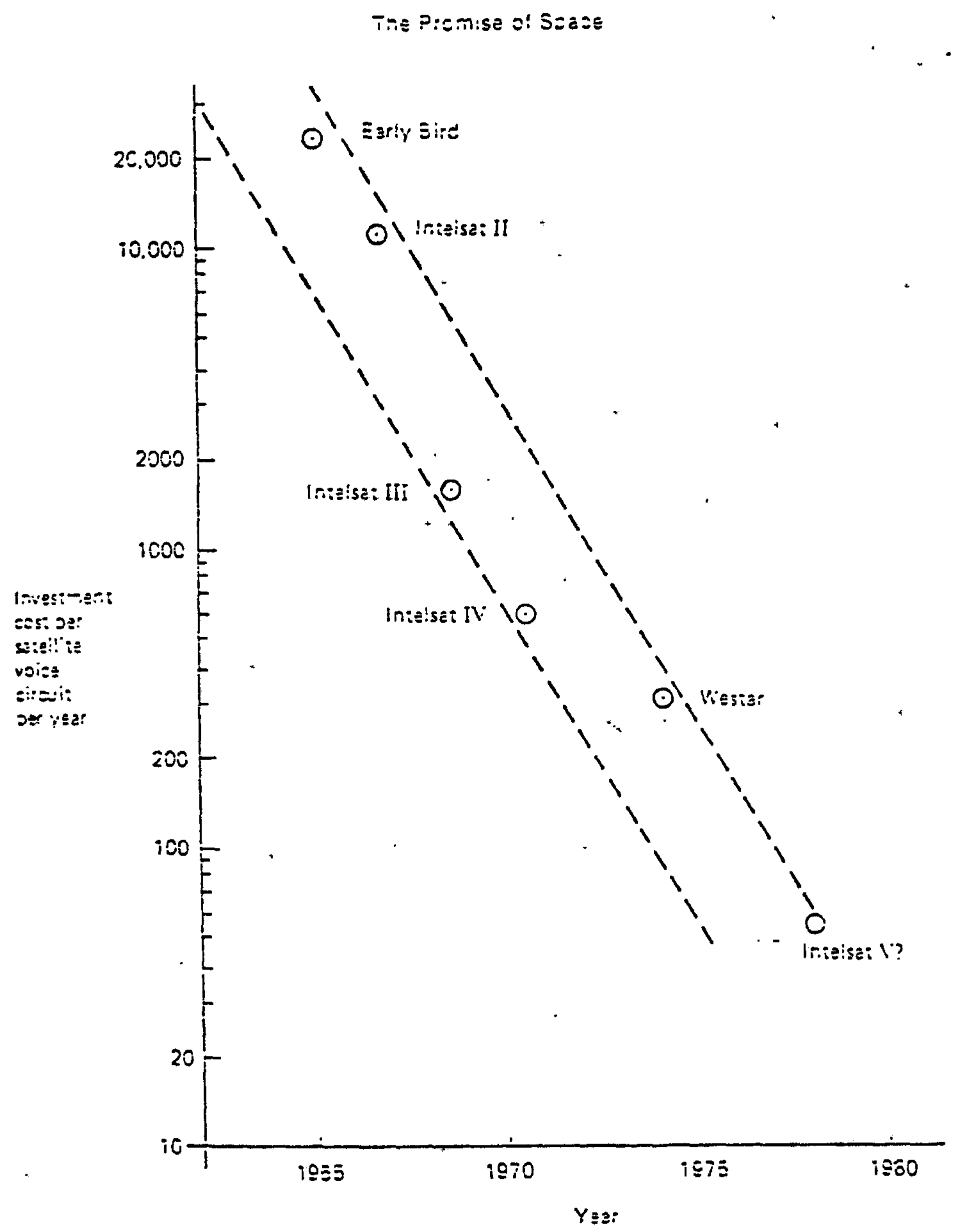


Fig. 2.2.7

Source: Communications Satellite Systems

2.3 FUTURE COMMUNICATION NEEDS FOR GHANA

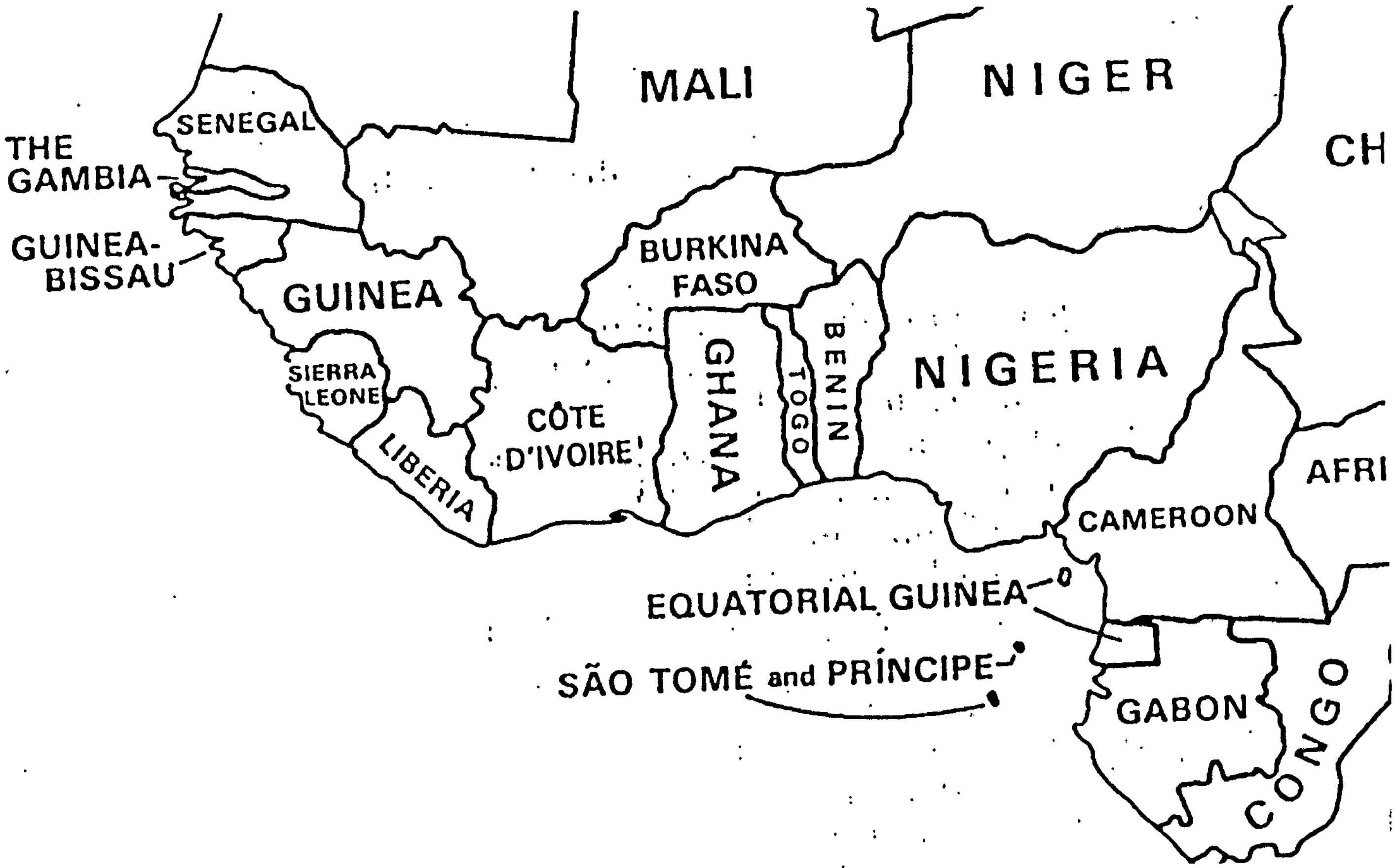
An efficient, easy to use, availabe all the time and cost beneficial telecommunication system is needed by a country like Ghana, whose socio-economic development depends upon its trade links with the outside world. It is therefore not only necessary to provide responsive services to the outside world but also to provide services and information to its mass media.

2.3.1 CONSTRAINTS ON LANDLINE COMMUNICATION IN GHANA

Ghana and West African countries in general suffer a host of communications deficiencies common to each together, summarised below are:

- **Inadequate communication system and facilities.** Statistical survey for the West African region showed that there is 1 telephone to every 400 people in Nigeria 1 to every 9 people in Liberia, both in extremes, while there is 1 telephone to every 100 people in the rest of the counrtries. On the other hand the developed countries efficiency in communication showed that there is about 70-80 telephones to every 100 people. See table 2.3.1.
- **Inefficient local network.**
- **Inefficient intersate lines or absent,** sometimes difficult to connect to nearby state.
- **Services not very reliable.**
- **Rain** is a common threat to communication lines as insulations of trunk connections are affected.
- **Cable theft** resulting in discontinued services.
- **Services not available round the clock,** not favourable for modern bussiness.

The telecommunication system needed to service the Ghanaian



STATISTICAL SURVEY

COUNTRY	POPULATION	TELEPHONE
SENEGAL	6.4 million	54,000 units
GAMBIA	0.7	-
GUINEA	6.4	15,000
SIERRA LEONE	3.9	13,000
LIBERIA	2.4	271,000
COTE D'VOIRE	6.7	88,000
GHANA	13.7	60,000
TOGO	2.7	14,000
BENIN	3.5	22,000
NIGERIA	102	235,000
CAMEROON	7.7	47,000
GABON	1.2	14,000

DEVELOPED COUNTRIES APPROX. 70-80 TEL. TO 100 PEOPLE

Table. 2.3.1

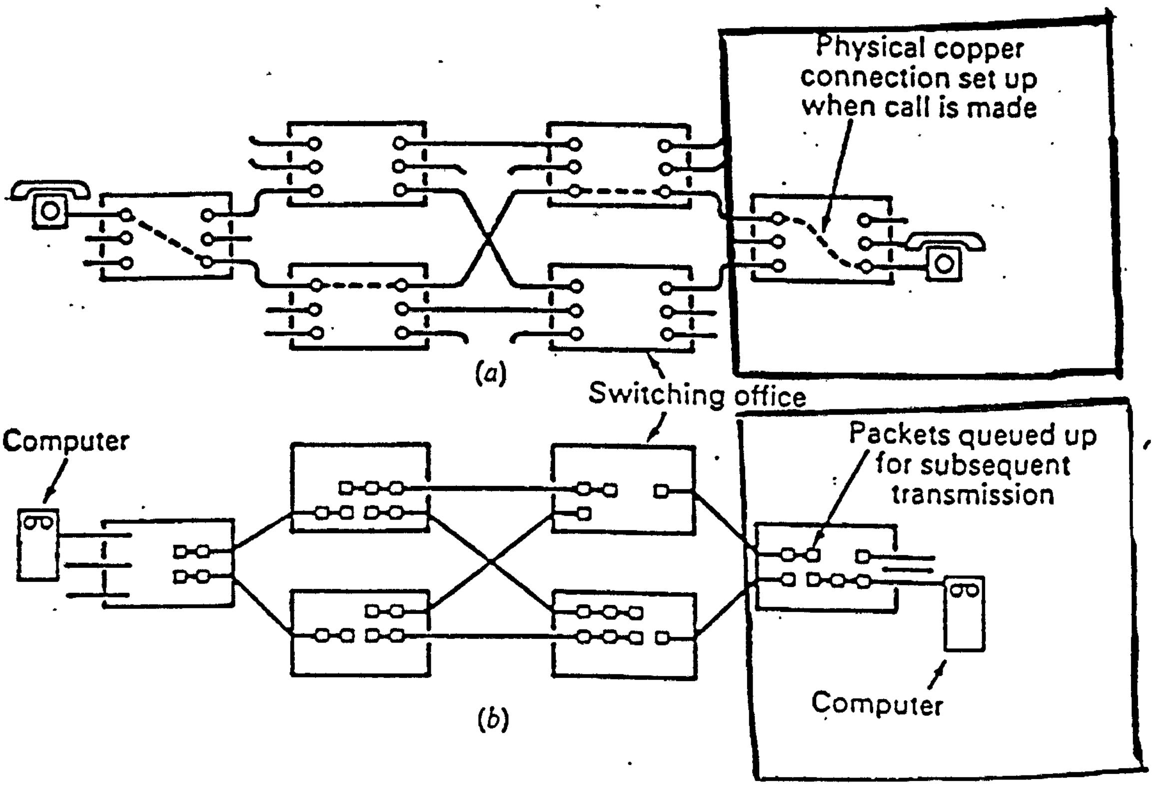
Source: Regional Surveys of the World
Africa South of the Sahara

2.3.2 COMMUNICATION NEEDS

user community can be categorized under a number of headings:-

VOICE COMMUNICATION- associated with telephones in normal business and social activities, whereby any person may wish to contact another nationally and internationally.

DATA COMMUNICATION- associated with computer, fascimile or telex traffic passing from one location to another. Information links will range from telex, facsimile, voice, and on-line computer traffic. Computer traffic may require relatively higher speeds, between say 56 kbits/second to 1Mbit/second. Such high rate of data exchange requires high speed links. The Inmarsat system to be introduced in Ghana in the future comprises of two main elements. The user vessel which needs a ship earth station (SES), and the Coast Earth Station (CES). Signals from the ship earth station are relayed via the satellite to a coast earth sta tion. Its correspondent requirement is to provide a Public Switched Telephone Network (PSTN), telex network, a Packet Switched Data Network (PSDN) see fig. 2.3.1, or leasedlines Owing to the anticipated growing demand for high speed-data communication, introduction of a dedicated network such as a PSDN via Inmarsat would be an ideal. It does not have the short comings of the PSTN, limited by distortion, interference, and in some cases high cost. However, Terrestial networks carry traffic to and from the CESs. Therefore depending on the location of the land based user, various transmission media have to be employed. These include cable, and microwave links. The PSTN in this case cannot be overuled completely as traffic does pass through it, at least for some part of its transmission. A CES, most needed an Inmarsat one, will link the satellite with the terrestial communication networks, changing frequencies and amplifying signals as required to and from the satellite.



(a) Circuit switching. (b) Packet switching.

Fig. 2.3.1

Source: Lecture Notes

Another component needed to complement, and improve our maritime telecommunication systems, and to herald the implementation of the comming Global Maritime Distress Safety system, is a **Coast Radio Station.** it is desirable that public telephone lines are easily available to the coast station. Our CRS needs to be developed at least to a **second class station**, providing telex and telephone services 24 hours a day, shown in table.2.3.2. It should provide the following:

- Maritime safety telecommunications service, safety at sea, harbour traffic control, pollution warning.
- Public telecommunications between mobiles.
- Private telecommunications service between ships and their owners.
- Broadcasting services, weather reports, governmental notices, and navigational warnings.

The 1990s will see Ghana and the West African sub region seriously going into mobile communications, both terrestial and satellite. The expansion will need to move the region from unsophicated services to highly advanced services. Africa is at the moment endevouring to emerge with a satellite communication organisation. This is being demonstrated in the meeting of African Telecommunication Ministers, for a Secretariat of proposed African Satellite Communications Project (**RASCOM**). The meeting to be held in Abuja, Nigeria, date to be scheduled. This initiative is to set the forum for discussing African Telecommunication problems. In that direction a West Africa Regional Co-operation serving as a basic formula to solve inter-state communication issues will enhance the process and objectives of RASCOM.

Major Specifications of Coast Stations by Class

Item / Class of Station	Traffic per Day	Type of Transmission	Communication Distance	Hours of Service	Frequency Band	Transmitter Power Output	Quantity of Transmitters	Transmission Reception Site
First-Class Telegraph & Telephone Station	More than 300 messages & More than 100 calls	Telegraphy	250–1000km	24	MF 405–535kHz	1–5kW	2 sets	Separate sites
		Telegraphy	1000km or more		HF 4000–27500kHz	5–10kW	According to Traffic	
		Telephony	1000km or more		MF/HF 1605–4000kHz 4000–27500kHz	5–10kW		
Second-Class Telegraph & Telephone Station	Less than 300 messages & Less than 100 calls	Telegraphy	250–1000km	24	MF 405–535kHz	1–5kW	2 set	Separate sites
		Telegraphy	1000km or more		HF 4000–27500kHz	1–5kW	2 sets	
		Telephony	1000km or more		MF/HF 1605–4000kHz 4000–27500kHz	1–5kW	MF 1 set HF 1 set	
Third-Class Telegraph & Telephone Station	Less than 100 messages & Less than 30 calls	Telegraphy	250–750km	16	MF 405–535kHz	0.25–1kW	1 set	Same site
		Telegraphy/ Telephony	250–4000km 150–1000km		MF/HF 1605–4000kHz 4000–27500kHz	0.25–1kW	1 set	
Fourth-Class Telegraph Station	Less than 50 messages	Telegraphy	250–750km	8	MF 405–535kHz	0.25–1kW	1 set	Same site
Fourth-Class Telephone Station	Less than 30 calls	Telephony	150–1000km	8	MF/HF 1605–4000kHz	0.1–1kW	1 set	Same site

Table. 2.3.2

Source: Communication Technology Today and Tomorrow (Japan Radio Co. LTD.)

CHAPTER 3

INTRODUCTION OF SATELLITE COMMUNICATION SYSTEMS IN WEST AFRICA

3.1 THE BACKGROUND OF INMARSAT

While the maritime community had watched the development of fixed satellite service with great interest plans were being worked out to offer an alternative to mobile terrestial service.The US MARISAT SYSTEM was to stir the beginning of commercial mobile communications. The system was owned and operated by Comsat General which started communication service to ships at sea in 1976, and extended to global communication a year later. But 10 years earlier in, 1966, the basis for an international maritime satellite organisation had grown out of an idea originated by IMO. Following extensive study by IMO experts an international conference was convened which on 3rd September 1976, unanimously adopted the Convention and Operating Agreement of the International Maritime Satellite Organisation, Inmarsat. According to its Convention Inmarsat is " to make provision for the space segment necessary for improving maritime communications...".

The MARISAT system, with three maritime satellites launched, was leased by Inmarsat in 1982. Inmarsat provided an international framework for mobile satellite communication and has continued to develop and expand the system. The original three Marisat satellites have now been relegated to a standby role, behind other operational and spare satellites.

The Inmarsat system comprises one Marecs satellites leased from the European Space Agency (ESA) and three maritime communication subsystems (MCS) packages on Intelsat-V satellite also a new generation of satellites (Inmarsat 2) are already in operation since 1989.

Inmarsat comprises three bodies: the Assembly (composed of representatives of all member countries), the Council (the governing body, with the representation of owner organisations), and a Directorate (consisting of 350 staff carrying out day to day tasks). Inmarsat is owned largely by telecom munication organisations (known as signatories) with invest ment shares allocated in proportion to traffic carried. As at October 1991 Inmarsat member-countries had grown to 64. The nerve centre of the system is the Operational Control Centre (OCC) located at Inmarsat's headquarters in London.

3.2 INMARSAT FACILITIES

The **INMARSAT** development programme, since its inception has been far perceived in three potential areas, including sea, land, and air mobile services. Inmarsat, at present is working on a wide range of new mobile communication services relying on the development of new types of mobile terminals, see table 3.1.2. Also under contract is a new generation of satellites employing spot-beams, providing higher radiated power, and increased capacity. General objectives of these developments are to:

- expand the range of services available including aviation and land mobile services;
- develop smaller and cheaper mobile terminals;
- harness advanced technology and thereby use satellites more efficiently;
- achieve economies of scale in the space segment and

thereby reduce costs for the users, placing the services within the reach of many more customers;
- achieve large increases in the number of users as a result of reduced cost for services.

The Maritime community was the first to embrace the mobile services of Inmarsat. The result was the emergence of the earlier maritime terminals (Ship Earth Stations). The **Inmarsat-A** terminal initially provided only telephone and telex capability, but nowadays all kinds of communication are possible.

A future system SES called **Inmarsat-B**, offers a similar though improved range of services to those provided by Inmarsat-A. Being all digital will enable Inmarsat-B to make more efficient use of the space segment and to offer a wider range of services. These include a facsimile rate of 9.6Kbit/s and a data rate of up to 16Kbit/s over the satellite channel.

A new system which recently became available to the maritime user is the **Inmarsat-C**, which employed a small, low cost terminal with an omni-directional antenna. This service is also aimed to attract users with smaller boats, yachts, vehicles, or hand carried terminal for whom the Inmarsat-A equipment is either too sophiscated, too big, or too expensive. This service is being adapted for both maritime and land mobile users and will be used for a variety of applications. It includes general telex and electronic mail communications, information distribution from one ship or vehicle to a group of specified users, remote monitoring and control, position reporting and fleet management. The Inmarsat-C SES transmits and receives

Inmarsat system characteristics (maritime applications)

	Inmarsat-A	Inmarsat-B	Inmarsat-M	Inmarsat-C
Introduction	In service	1992/93	1992/93	1990
Antenna diameter/size	0.85-1.3m	0.85m	0.4-0.5m	0.3m
SES weight (typical)	100kg	80kg	30kg	7kg
CCITT Group-3 facsimile	up to 9.6kbit/s	9.6kbit/s	2.4kbit/s	—
Shore-to-ship telex channel modulation/coding	1200bit/s, TDM, BPSK	6kbit/s, TDM, BPSK rate-1/2 FEC	—	600bit/s, BPSK, rate-1/2 FEC
Ship-to-shore telex channel modulation/coding	4800bit/s, TDM, BPSK	24kbit/s, TDM, O-QPSK rate-1/2 FEC	—	600bit/s, BPSK, rate-1/2 FEC
Digital data services	—	9.6/16kbit/s	2.4kbit/s	600bit/s
Group calls	Yes	Yes	Yes	Yes
High-speed data	56kbit/s (ship-to-shore)	Planned	No	No
Multi-channel SES capability	2/4 channels	Planned	No	No

Abbreviation for summary table

O-QPSK – offset quadrative phase-shift keying; FEC – forward error correction; TDM – time division multiplex; BPSK – bi-phase shift keying; TDMA – time division multiple access

Table 3.1.2

Source: Never Beyond Reach

messages at an information rate of 600 bits/s. The characteristics of the SESs are shown in table 3.1.2. The expected growth of Inmarsat-C terminal users is projected to be more than 35,000 users in the year 2000.

Another important feature of the Inmarsat service is the possibility it offers for **Enhanced Group Calling (EGC).** The main point about ECG is that it enables messages to be sent to specified group of ships, rather to all ships within range. Messages can be sent, for example, to ships flying a particular flag, or to ships in a given geographical area. They may be sent to one ship or all ships. The ability of EGC to be selective has considerable advantages as far as safety is concerned. For example it enables messages to be sent to ships in the area nearest to a ship in distress and would enable the RCC to select the fastest (or nearest) ships to respond to a distress call. No other ship would have to be inconvenienced. The dedicated message processor and printer required can be added to an Inmarsat-A or C terminal or can stand alone.

Inmarsat has also planned, besides Inmarsat-C, to introduce a light weight, low-cost satellite telephone system, with full global coverage, by late 1992 or early 1993. The new system, known as **Inmarsat-M,** will allow the development of a new type of compact terminal. It is aimed at bringing voice communication by satellite within reach of a whole new community of users. It will be characterised by low power consumption and expected low price. Some 30,000 terminals are projected to be operating by the year 2000.

The latest areas into which Inmarsat is expanding is the land mobile area. The initial land mobile services are expected to use the Inmarsat-C system,providing service to long distance trucks, buses, trains and even individuals. There is also a need for voice communications, for two main applications, firstly to connect to the public telephone network as part of the normal telephone service and secondly for closed user groups (fleet despatch operations). It is expected that the Inmarsat-M terminal mentioned earlier on will fulfil this function.

When Inmarsat commenced service as a maritime organization it was recognised from its inception that technically there was much in common between providing services to ships at sea and to aircraft in the sky. In this regard,the Inmarsat Convention and Operating Agreement were amended by the Inmarsat Assembly in 1985 to permit INMARSAT also to provide commununication services to aviation. The amended Convention came into force in 1988.

3.2.1 MOBILE STATION REQUIREMENT

In the process of providing mobile station operative needs, Inmarsat found it necessary to work closely with the International Maritime Organisation(IMO), to draw up Ship Earth Station (SES) requirements. It is a direct response to developments of existing equipment and demand for new and improved services. Whereas in fixed satellite communications few ground stations are needed, because messages are sent to the individual user by neans of terrestial networks, the mobile user at sea by contrast, requires his own surface station, an Inmarsat-A terminal requires the antenna to remain pointing at the satellite all the time. It it therefore necessary that an Inmarsat-A SES must meet the usual requirements imposed on standard shipboard radio equipment:

- ease of operation;
- ability to run on conventional ship power and to make use of ship emergency power if necessary;
- high reliability.

Additionally it must also meet certain special requirements arising primarily from the use of the ultra-high frequencies related to maritime services. The fact that the antenna must be be kept pointing steadily at a fixed point in space calls for a means of azimuth and elevation control that is immediately responsive to the ship's movements. The Inmarsat-c SES however has an omnidirectional antenna.

Installation of a SES comes in two sections, the above deck part (ADE) which includes the antenna and its accessery, and the below deck part. The below deck equipment (BDE) comprises a standard telephone and a teleprinter with message storage, message directory, and text editing capability. Other options are facsimile, interconnections to on board navigation receivers, computer, remote alarms and control units, and connection to shipboard telephone systems. Nowadays many maritime users are offered the opportunity of telecommunications services now available to land correspondents.

The other major requirement for introducing satellite communication systems in the West African sub-Region is to pull their efforts together in establishing some CESs.
The number of CESs in Africa should be few enough such that the volume of the traffic is sufficient to pay for the operation. CESs need good terrestial interface into PSTN, PSDN and telex network. All known Coast Earth Stations are owned and operated by telecommunication carriers. A CES is much larger than a SES, and consists of a parabolic antenna about 11-14m in diameter, used to transmit signals to the

satellite at 6 GHz and for reception from the satellite at 4 GHz. The same antenna or another dedicated antenna can be used for L-band transmission at 1.6 GHz and reception at 1.5 GHz of network control signals. Three satellite control centres, at Southbury (USA), Yamaguchi and Ibaraki (Japan), serve as network co-ordination stations. Fig.3.2.1 shows Inmarsat Global Coverage. The Inmarsat Operations Control Centre (OCC) in the UK provides overall system control of these stations. A CES should be able to provide at least a telex and telephone services.

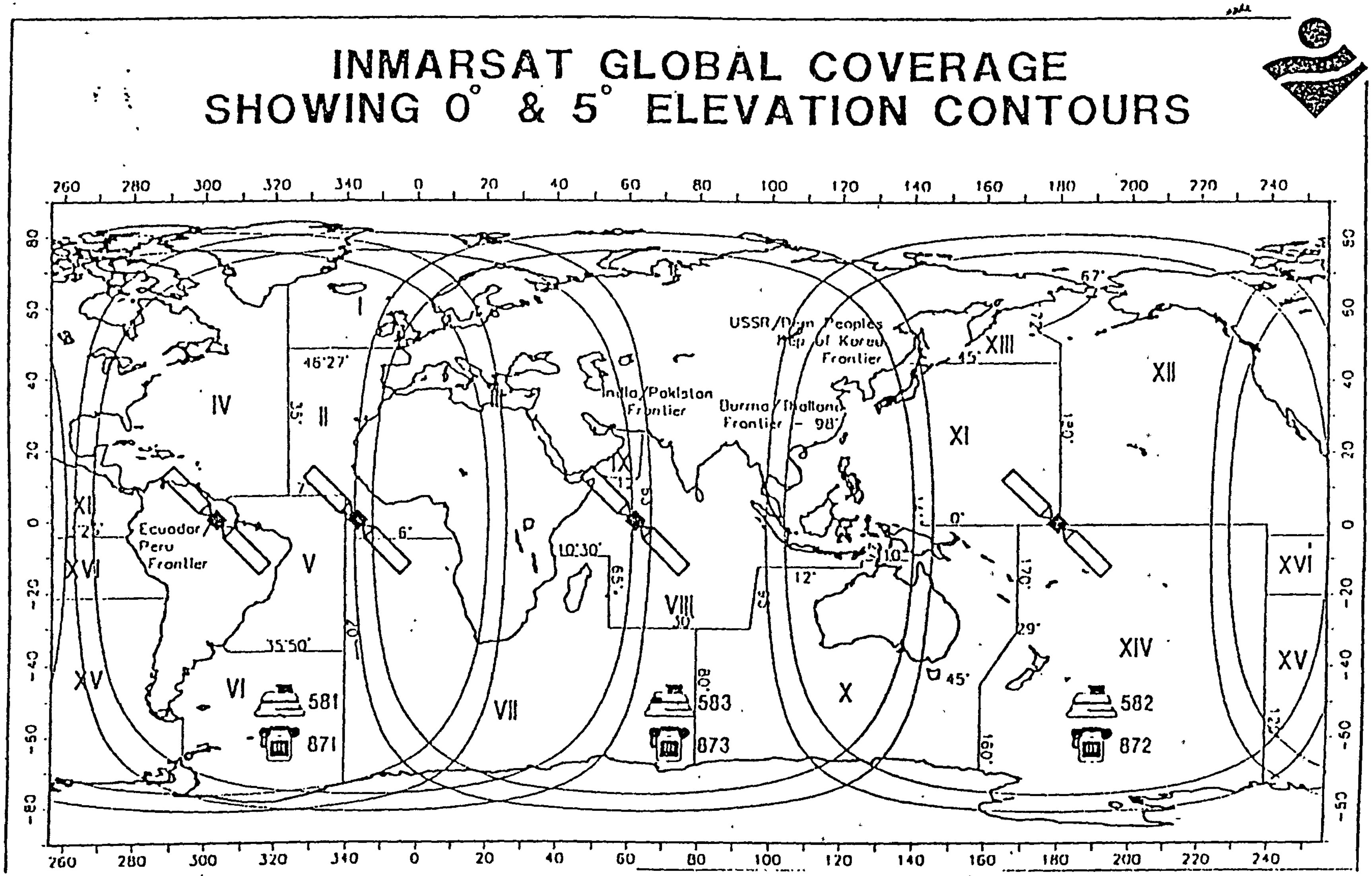


Fig. 3.2.1

Source: INMARSAT Familiarisation Programme

3.3. IMPLEMENTATION OF A SATELLITE COMMUNICATION SYSTEMS IN GHANA/WEST AFRICA

One of the biggest advances in maritime safety communications has been given the go of the GMDSS ahead by the International Maritime organisation (IMO). The new system known as the Global maritime distress and safety system (GMDSS) will make use of satellite communications, terrestrial communication systems, computers, and other new technologies. The satellite communication element will be provided by Inmarsat, in keeping with its institutional aim of "improving maritime communications, thereby enhancing safety of life at sea". The GMDSS due for implementation from 1st February 1992, will integrate terrestrial and satellite communications for both safety and commercial purposes. The result will be gradual phasing out of radiotelegraphy which has formed the basis of the maritime distress system for a long time.

3.3.1 DEVELOPMENT OF GMDSS

The GMDSS was developed by the IMO and was introduced by means of amendments in the International Convention for the Safety of Life at Sea (SOLAS) 1974. The amendments were adopted in 1988 and agreed to enter into force in 1992, The GMDSS will be operating under the umbrella of a host of conventions and regulations namely:

(i) SOLAS Convention 1974
(ii) SAR Convention 1979
(iii) ITU (Radio Regulation): WARC-MOB-87
(IV) IMO Resolution: Technical standard for main equipment to be used, 420 etc.
(v) CCIR (Recommendation): DSC(493-3), NAVTEX(540-1)
(vi) STCW Convention

3.3.2 THE AIMS OF GMDSS

GMDSS is designed to overcome the shortcomings of the existing maritime safety communication system, which is a combination of radiotelephony and Morse Radiotelegraphy. The range is not guaranteed above 150M and even within that range reception of messages can be affected by bad propagation conditions and other factors. Sea casualties have confirmed that ships still do vanish without trace due to the fact that a distress message is not sent in time or simply not received. Other objectives of GMDSS are to alert SAR Authorities ashore without impeding possible assistance from shipping in the vicinity of the emergency, and to facilitate co-ordinated search and rescue operations with the minimum delay.

In the opinion of the experts, there were other technical and operational reasons to justify the introduction of the new system as against the conventional system (see table 3.3.1):

- to improve distress, urgency and safety communications.
- to relieve the present congestion in the medium frequency (MF) and high frequency (HF) bands.
- to improve reliability, quality and speed of communications.
- to improve geographical coverage and continuous availability of services.
- to make circuits more reliable and permit automation of radiotelephony and teleprinters.
- to cater for services not possible at present in the MF and HF bands, such as high speed data transmission.
- to provide radio determination satellite services (RDSS).

EXISTING SYSTEM/GMDSS SYSTEM (Comparison of Two Systems)

	Conventional distress/safety alert system	GMDSS system
Outline	• It is based on to rescue a distress ship mutually at sea.	• Rescue Coordination Center on shore will command and control the rescue operation.
	• The distress ship can communicate with a ship sailing in vicinity or coast station that has enough propagation condition with the ship.	• Coast station can watch a distress alert and communicate with a distress ship regardless of ship's position.
Object of system	• To be applied to all passenger ships and cargo ships over 300 tons engaged to international voyages.	• same to the left
Installation of Radio Equip.s	• Being classified according to category of ship and tonnage of ship.	• Being classified according to sea area to be sailed.
Usable Radio Equip.s	• Radio equipment is controlled manually, a communication is achieved by Morse code or telephone.	• The equipment for automatic reception/transmission and a digital selecall equipment, a radio telephone equipment, NBDP equipment, satellite EPIRB, NAVTEX, EGC, SART.
Watching of Distress Alert	• It is chiefly based on listening by ear.	• It is based on fully automatic reception.

Table. 3.3.1

Source: Communication Technology Today and Tomorrow (Japan Radio Co. Ltd)

3.3.3 SHIPS GMDSS FUNCTIONS

The GMDSS was designed to ensure a combination of safety and efficiency. In that connection, the largely automated system will require ships to carry a range of equipment capable of simple operation. Thus providing the ship the capabilities of performing the following communication functions.

- Distress alerting: ship-to-shore, shore-to-ship, and ship-to-ship.
- Search and rescue co-ordition
- On-scene communications
- Signals for locating
- Maritime Safety Information
- General radiocommunications
- Bridge-to-bridge communications

3.3.4 OPERATIONAL AREAS FOR THE NEW SYSTEM

The IMO objective for the system requires a wide-range of changes in the conventional shipboard radio installations that rely on the manual operation of Morse telegraph on 500kHz, radiotelephone on 2182kHz and 156.8MHz, and reception of audible distress signals as specified under the current SOLAS Convention. It further defines the basic concept of GMDSS, that Search and Rescue authorities ashore, as well as vessels in the immediate vicinity of ship in distress will be rapidly alerted to the distress incident, also enabling them to assist in a coordinated search and rescue operation without delay. It therefore follows that, the radio equipment to be carried on a ship is determined by the ship's area of operation, and a continuous radio watch on distress and safety frequencies applicable to that area is automatically maintained.

The ship areas of operation are designated as follows:

Area A1 - within range of shore-based VHF coast stations, including DSC capabilities.

Area A2 - withing range of shore-based MF coast stations, (excluding A1 area) including dsc capabilities

Area A3 - within the coverage area of INMARSAT geostationary satellites (excluding A1 and A2 areas).

Area A4 - the remaining sea areas outside areas A1, A2 and A3 (generally the extreme polar areas).

3.3.5 SHIPBOARD REQUIRED INSTALLATION

General carriage requirements for ships sailing in GMDSS areas can be summarized as follows: See table 3.3.2.

- area A1 ships will carry VHF equipment;

- area A2 ships will carry VHF and MF equipment;

- area A3 ships will carry VHF, MF and either HF or satellite equipment;

- area A4 ships will carry VHF,MF and HF equipment;

- all area A2, A3 and A4 ships will carry a satellite Epirb;

- all area A1 ships will carry either a satellite EPIRB or a VHF EPIRB; and
- all ships operating in areas where NAVTEX service is provided will carry a NAVTEX receiver; outside NAVTEX servce areas they will carry an EGC receiver facility.

BASIC SHIP CARRIAGE REQUIREMENTS FOR THE GMDSS

○ required

Equipment / Area	VHF RT DSC	MF RT DSC	MF/HF RT DSC NBDP	NAVTEX EGC, or HF MSI RX	INMARSAT SES STD-A or STD-C	406MHz SATELLITE EPIRB	SART 9GHz Radar Transponder	VHF Two-Way	2182kHz Watch Keeping RX
Area A1	○	—	—	○	—	○ or INMARSAT L-Band EPIRB or VHF EPIRB	○	○	○
Area A2	○	○	—	○	—	○ or INMARSAT L-Band EPIRB	○	○	○
Area A3	○	○ If item 3 not carried	○ As alternative to item 5	○	○ As alternative to item 3	○ or INMARSAT L-Band EPIRB	○	○	○
Area A4	○	○	○	HF ○	—	○	○	○	○
JRC Models (examples)	JHS-31 TRX NRE-63 Watch RX	JSS-710 TX and RX NCT-60G DSC NCL-800 NBDP NRD-220 Watch RX		NCR-300A NAVTEX JHR-6A EGC RX NRD-230 HF RX	JUE-45A STD-A SES JUE-65A STD-C SES	JQE-2A SATELLITE EPIRB	1 set 2 sets (for above 500 GRT)	JHS-7 Portable 2 sets 3 sets (for above 500 GRT)	JXA-7 Watch-Keeping RX

Note. The GMDSS equipment available from JRC is not limited to the models described in the table.

Table. 3.3.2

Source: Communication Technology Today and Tomorrow (Japan Radio Co. LTD.)

Convention ships will be obliged to comply with the carriage requirements for the GMDSS implementation stepwise during the period between February 1, 1992 and February 1, 1999 for all ships. The amendments to the SOLAS convention will make it compulsory for ships to carry equipment, which will vary not according to the size of the ship as now, but according to the area in which it operates.

The satellite equipment for Ship Earth Station mainly utilises Inmarsat-A SES, for global, multi-media communications service, telephone, telex, fascimile and data. It also provides reception of broadcast navigational/ meteorological warning and forecast messages from Rescue Coordination Center (RCC) through Coast Earth Station. Alternative provision is the Inmarsat-C SES which offers two-way message data transmission interfaced with the international telex network and a wide range of terrestrial data networks. It also offers reception of SafetyNET and FleetNET messages.

The **NAVTEX** receiver is required for all ships operating in areas where NAVTEX transmission is available and permits reception of Maritime Safety Information broadcast in English on a schedule from national NAVTEX coastal stations supervised by IMO. Maritime Safety Information service is an international system of radio broadcasts containing information needed for safe navigation. Messages are received in all ships using the NAVTEX Receiver which automatically monitors the MSI frequencies and prints out in English only that information which is relevant to the individual ship. The messages include navigational and meteorological warnings, forecasts and other related safety information. The International Navtex operates on a single frequency of 518 KHz based on NBDP. Its use is to become

mandatory for ships on August 1, 1993.
The Maritime Safety Information service comprises:
- the international Navtex service for coastal regions
- the Inmarsat Enhanced Group Call SafetyNET covering all the waters of the globe except those in polar regions.

The amendments to the SOLAS Convention also require the carriage of the following radio equipment which could assist in the location of survival craft:

(i) One **satellite EPIRB** capable of floating free and being automatically activated when afloat. It shall be capable of being activated manually, and of being carried by one person into a survival craft.
The choice for the mariner is between these satellite Epirb systems:
- One designed to operate on 406MHz and 121.5MHz, providing positioning accuracy of 2 to M approx. via COSPAS/SARSAT Local User Terminal (LUT);
- the other **L-Band EPIRB**, operating through the Inmarsat system. The L-Band Epirb covers all but the polar region and operates on 1.6 GHz (L-Band).

A ship in area A1 has the option of using a VHF EPIRB operating on channel 70 (DSC) instead of a satellite EPIRB.

(ii) One 9GHz **SART** (Search and Rescue Radar Transponder) to be carried on each side of the vessel (only one required for ships 300-500 tons).They are to be stowed in such locations that they can be rapidly placed in any survival craft. SART is battery-powered and should be able to operate in the standby mode for at least 96 hours in ambient temperatures of -20 to 55 degrees celsius.

(iii) **Three two-way vhf survival craft radiotelephone** sets (two for ships 300-500 tons) shall be provided.

(iv) An **"efficient radar reflector"** shall be stowed in each survival craft, unless a survival craft radar transponder is stowed in the survival craft.

3.3.6 SHORE SYSTEMS FOR GMDSS

The Coast Earth Station, a component of the Inmarsat system will provide the link between the satellites and the national and international communication networks. In this way it provides an interface between the terrestrial communications networks and the ship earth station (SES) which is communicating through the satellite. As at late 1990 there are about 37 INMARSAT CES dotted globally, but presently with the exception of Egypt, none at the coast of Africa. See table 3.3.3. It follows that routing transmissions through CES stations which are further located from the shores of Africa make the implemenentation of the GMDSS more expensive. Therefore, a collective effort by the West African states to install one Inmarsat CES in the Sub-Region, in the opinion of the writer, will not only facilitate the implementation of the GMDSS but also enhance the communication capabilities of the region. The main functions of a CES are to assign and set up channels in response to shore or ship-originated calls; to record call and processing information; to file and collate SES identities; and to listen for distress priority calls from ships. All SESs that are active in the ocean region are required to register with the National Control Centre (NCC). A copy of the list of all registered SESs is held at each CES and used as basis for accepting or rejecting a call.

xisting and planned coast earth stations

Country	Location/Coverage region	Operational status
Denmark, Finland, Norway, Sweden	Eik/*Indian*	In operation
Japan	Ibaraki/*Pacific*	In operation
Japan	Yamaguchi/*Indian*	In operation
Singapore	Singapore/*Pacific*	In operation
UK	Goonhilly/*Atlantic*	In operation
USA	Santa Paula/*Pacific*	In operation
USA	Southbury/*Atlantic*	In operation
Kuwait	Umm-al-Aish/*Atlantic*	In operation
France	Pleumeur Bodou/*Atlantic*	In operation
Brazil	Tangua/*Atlantic*	In operation
USSR	Odessa/*Atlantic*	In operation
USSR	Odessa/*Indian*	In operation
Italy	Fucino/*Atlantic*	In operation
Greece	Thermopylae/*Indian*	In operation
USSR	Nakhodka/*Pacific*	In operation
Saudi Arabia	Jeddah/*Indian*	In operation
Poland	Psary/*Atlantic*	In operation
Poland	Psary/*Indian*	In operation
Egypt	Maadi/*Atlantic*	In operation
Turkey	Ata/*Indian*	In operation
Turkey	Ata/*Atlantic*	In operation

Country	Location/Coverage region	Operational status
Canada	Weir/*Atlantic*	Feb 1990
China	Beijing/*Pacific*	March 1990
China	Beijing/*Indian*	March 1990
Australia	Perth/*Indian*	April 1990
Australia	Perth/*Pacific*	April 1990
Denmark	Blaavand/*Atlantic*	Mid 1990
Argentina	Balcarce/*Atlantic*	Mid 1990
Netherlands	Burum/*Atlantic*	Sept 1990
Germany (FR)	Raisting/*Atlantic*	Dec 1990
Korea, Republic	Kumsan/*Pacific*	Dec 1990
Denmark, Finland, Norway, Sweden	Eik/*Atlantic*	Dec 1990
Netherlands	Burum/*Indian*	Dec 1990
Iran	Boumehen/*Indian*	End 1990
Spain	Buitrago/*Atlantic*	1990
Bulgaria	Varna/*Atlantic*	1990
Bulgaria	Varna/*Indian*	1990
India	Aarvi/*Indian*	1991
Saudi Arabia	Jeddah/*Atlantic*	Early 1993
Cuba	N/A/*Atlantic*	1991/95

*Standard-C only

Table. 3.3.3

3.3.7. THE COSPAS-SARSAT SYSTEM

The Cospas-Sarsat system is an integral part of the GMDSS The 406 MHz system provides expanded coverage and enhances the ability to pinpoint the location of distress beacons known as Emergency Locator Transmitters (ELTs) and EPIRBs. The ELTs are fitted on aircrafts whilst the EPIRBs are fitted on board ships. The ELT or EPIRB is designed to be activated automatically in the event of an aircraft or ship distress. The signal from the ELT or EPIRB is received by the Cospas-Sarsat satellite, processed and retransmitted to the next Local User Terminal (LUTs), which are earth stations, to come into view, see fig.3.3.1. The LUT uses the data in the signal to calculate (by Doppler Effect) the position of the casualty. This is then passed on to Mission Control Centre (MCC), where the most appropriate rescue cordinating centre (RCC) is selected and notified.

The Cospas-Sarsat consortium consists of four partner nations (Canada, France, USA, and USSR), plus 19 other participating countries, providing a satellite-based distress alerting service. Currently there are four operational satellites in orbit, including two Soviet Nadezhda satellites and two US NOAA satelliets. Eight replacement satellites are being built at present, the first of which should be launched in early 1991.

3.3.8 OTHER FACTORS INFLUENCING THE IMPLEMENTATION OF GMDSS.

Ghana and West Africa as a whole cannot even boast of the few coast radio stations scattered on its coast. Most of them can not be relied upon for communication as well as for safe navigation along our coastal waters. The reasons

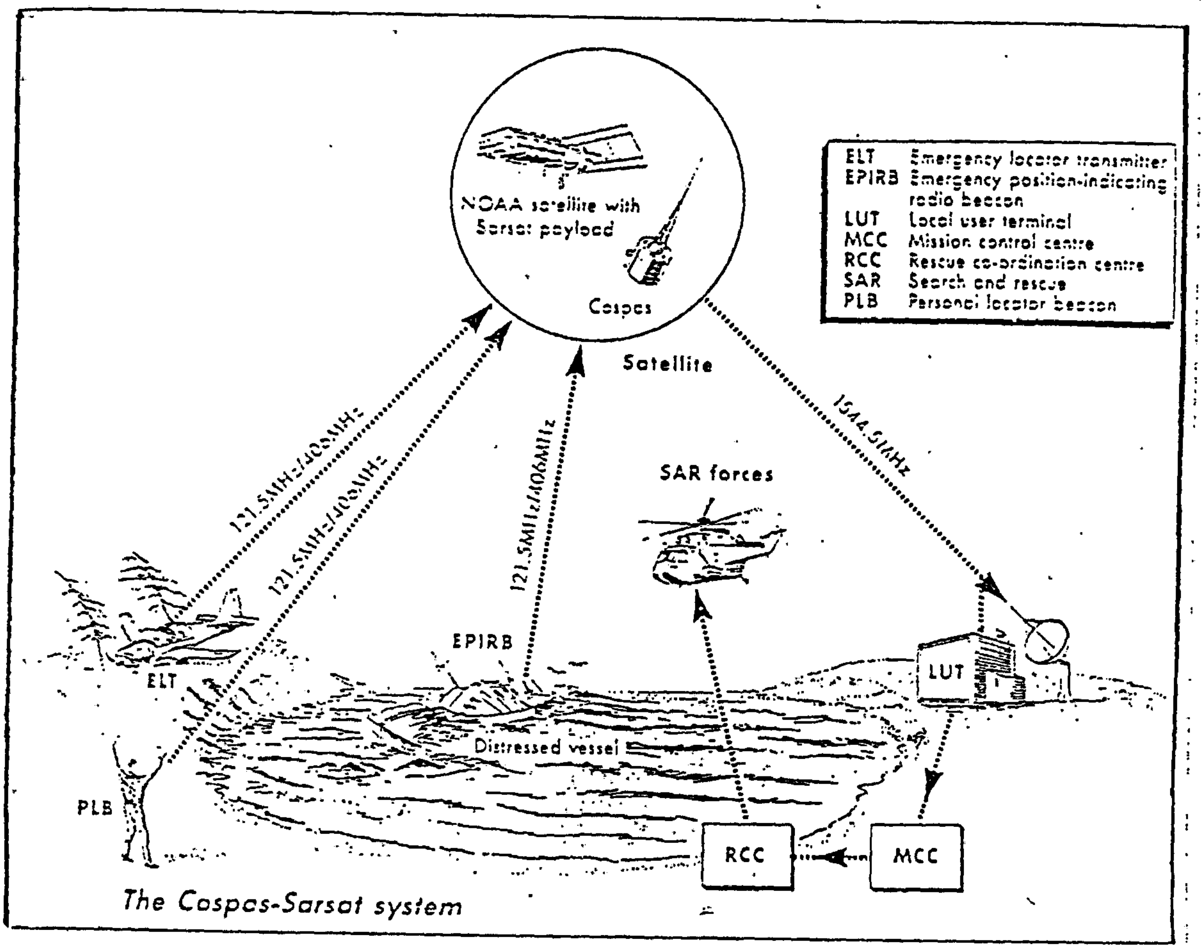


Fig. 3.3.1

Source: Never Beyond Reach

are more of economical nature, rendering some of them inoperative. The ones which do operate do not function to full capacity. To introduce therefore the GMDSS in West Africa the necessity has come to restructure CRSs along the coast, stretching from Senegal to Gabon. In that regard the CRS could provide various services of communications between ocean-going vessels, public telephone communications between vessels and land-line subscribers.

The requirements of these CRSs will include handling of four types of traffic:

-telex

-telephone

-telegram.

Taking into account that the implementation of the (GMDSS) is very dependent upon an efficient and well-developed international search and rescue organisation with functioning rescue co-ordination centres responsible for search and rescue operations, member governments of the SAR convention were invited to submit a questionnaire (MSC/Cir 327 of 14 April 1982) see table 3.3.4. This was to enable the IMO Secretariat to obtain basic information on existing search and rescue capabilities which would assist the Organisation in developing search and rescue plans for various ocean region. So far SAR.3/Circ.3/Rev.1 shows that information on national maritime SAR facilities, and provisional information on shore-based facilities in the GMDSS in the following areas, have been compiled on the basis of material submitted by the Governments concerned.

1.9 GHANA

1.9.1. NATIONAL SAR AGENCY: ....

MAILING ADDRESS: ....
....
....
Tel: .... Telex: ....

MRCC or MRSC	Landline communi-cations, including SES installed at RCC	Associated CRSs	Associated or nearest INMARSAT CESs	Associated or nearest COSPAS-SARSAT MCCs	Associated ARCC	Rescue units available	Other units available	Remarks
1	2	3	4	5	6	7	8	9

[INFORMATION REQUESTED]

Fig. 3.3.4

Source: SAR. 3/Circ.3/Rev.1

1. Eastern South Atlantic (area 4) (annex 1)
2. Western South Atlantic (area 5) (annex 2)
3. Eastern North Pacific (area 6) (annex 3)
4. Eastern South Pacific (area 8) (annex 4)
5. North West India Ocean, including Red Sea (area 10A) (annex 5)
6. South West Indian Ocean (area 10B) (annex 6)
7. Mediterranean (area 12A) (annex 7)
8. Black Sea (area 12B) (annex 8)
9. Arctic Ocean (area 13) (annex 9)

Unfortunately, Ghana, Nigeria, Gabon, Gambia, Guinea, Guinee Bissau, Cote d'Ivoire, Liberia, Senegal, Sierra Leone, and Cameroon, had not yet submitted the following provisional information.

The missing link for the implementation of GMDSS and Satellite Communication in the West African sub-region is an efficient inter state landline communication network. Many of the countries in this region are experiencing some kind of communication deficiency in their national network, and the situation needs to be addressed as early as possible. In most normal circumstances, a subscriber in a regional city goes under considerable strain in raising another subscriber say a kilometre away. Yet almost all the West African countries in one form or another provide about 85% automatic dialling facilities internationally. The services cannot be relied upon sometimes. With this background it is realised to firmly establish the missing link in the West African Sub region. To achieve this objective:

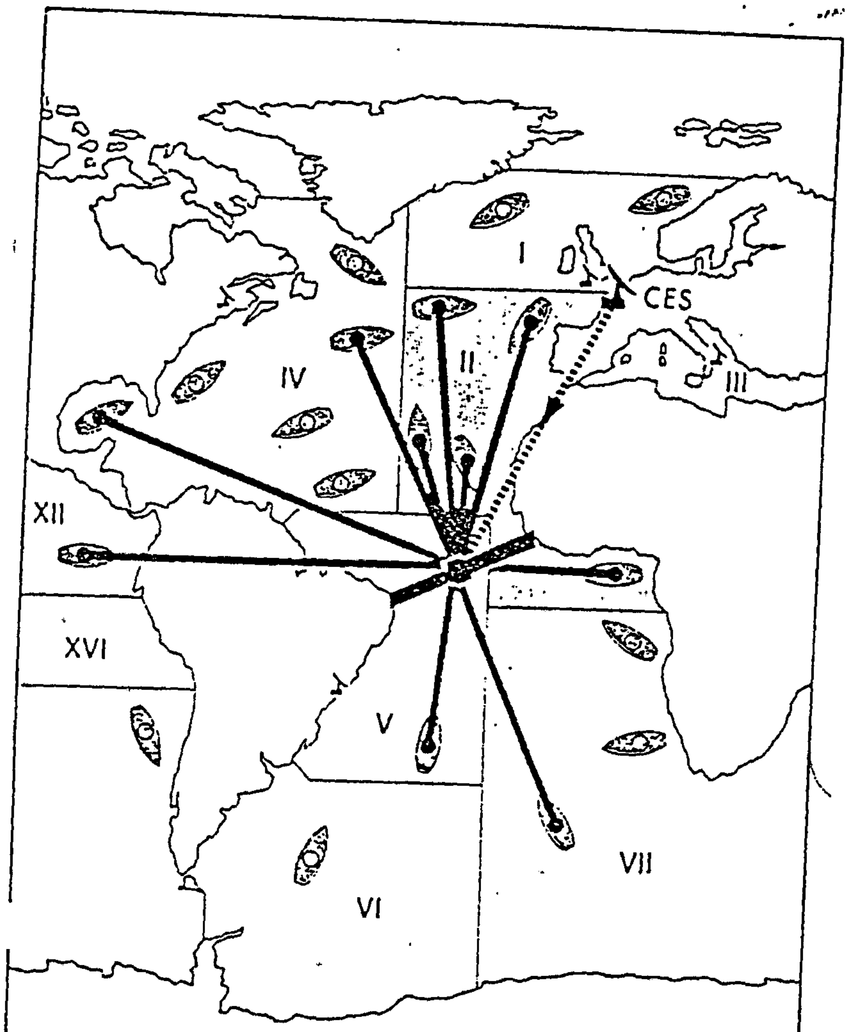
- Any telecommunications service which is to be easily accessible to the entire population of the world must be public in nature.

- Mobile communication, CES, CRS, must have access to the public systems.
- Channels should be able to provide non-voice messaging services such as telex and telegraphy.
- The basic requirements of fixed services have to be met before widespread provision of mobile service can be attempted.

3.3.9 GMDSS SAFETY PROVISION

1. **Enhanced Group Calling (EGC)** is an important feature of the Inmarsat service. It enables safety messages to be sent to a specified group of ships via the Inmarsat **SafetyNET** service, rather than to all ships within range, see fig 3.3.2a. Messages can be sent, for example to ships flying a particular flag, the **FleetNET** service, or to ships in a given geographical area, see fig.3.3.2b. They may be sent to one ship or all ships. The ability of EGC to be selective has considerable advantages as far as safety is concerned. For example, it enables messages to be sent to ships in the area nearest to a ship in distress, or it will enable the RCC to select the fastest (or nearest) ships to respond to a distress call. No other ships would have to be inconvenienced.

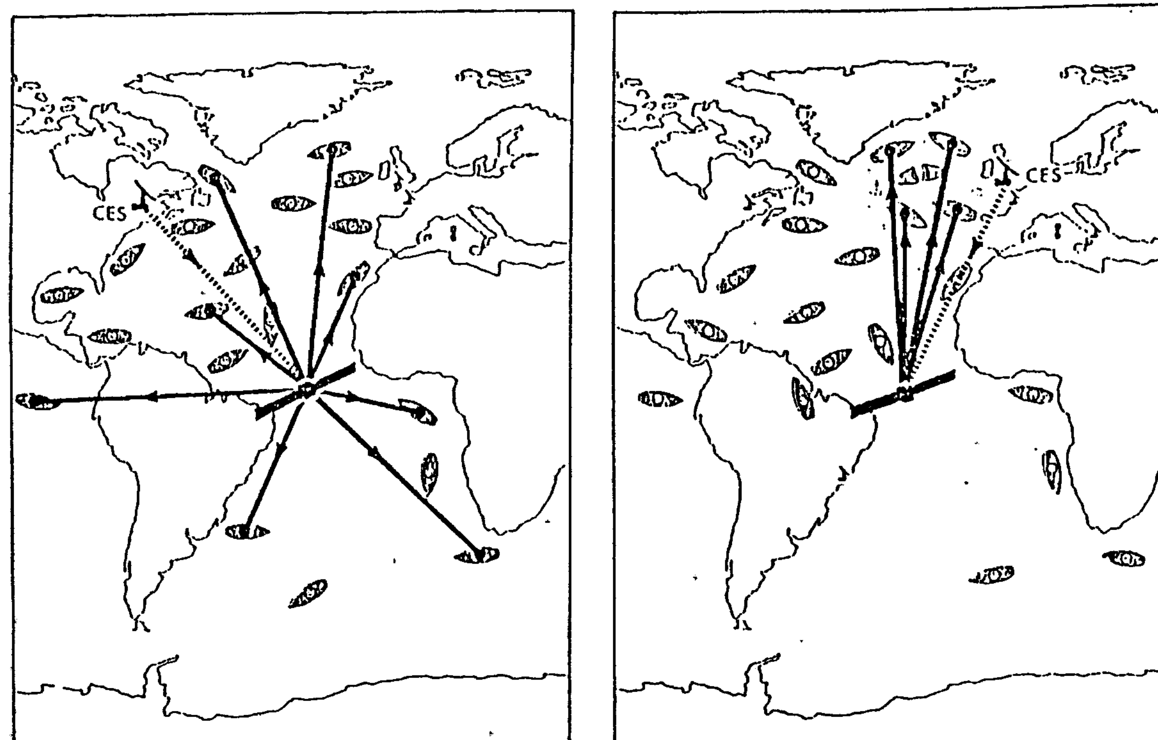
2. **DIGITAL SELECTIVE CALLING (DSC)** has the obvious advantages for distress and safety purposes and looks likely to play a dominant role in the terrestrial component of the GMDSS. The adoption of the Single Frequential Frequency Code (SFFC) system over 20 years ago did little to guarantee accessibility on long-range MF/HF communications between ship and shore. The subsequent DSC system, incorporating narrow-band direct printing (NBDP)



SafetyNET call from meteorological centre to all vessels in and approaching a designated navarea

Fig. 3.3.2a

Source: Never Beyond Reach



FleetNET call from shipping company to all of its vessels

SafetyNET call from rescue co-ordination centre to all vessels in the vicinity of an emergency

Typical applications of Inmarsat FleetNET and SafetyNET Enhanced Group Call services

Fig. 3.3.2b

Source: Never Beyond Reach

techniques, enables distress alerting and safety calling on terrestrial frequencies MF/HF/VHF to be carried out. DSC distress messages include such information as the identity of the transmitting vessel (automatically), the nature of the distress (it provides for nine different indicators ranging from fire or explosion to abandoning ship), and the position of the ship and the time, both of which may be included in the message if the ship has position fixing equipment and a navigation interface. After the initial distress alert and acknowledgement, subsequent communication will be by radio telephony or NBDP as indicated in the distress message. For distress and safety purposes a number of frequencies have been assigned. They are 2187.5 KHz in the MF band, 4207.5 KHz, 6312 KHz, 8414.5KHz, 12,577 KHz and 16,804.5 KHz in the HF bands; and 156.525 MHz (channel 70) in the VHF band.

3. **MARITIME SAFETY INFORMATION (MSI)** is an international system of radio broadcasts containing information needed for safe navigation. Messages are received in all ships by equipment which automatically monitors the MSI frequencies and prints in English only that information which is relevant to the individual ship. Messages include navigational and meteorological warnings, forecasts and other safety-related information, and distress alerts. Each national administration may ,at its discretion, use other means of communicating maritime safety information in its native language. These include national Navtex services on 429.5KHz and 490KHz. HF frequencies are also set aside for the transmission of MSI in narrow-band direct printing form in certain sea area. The full services will comprise:

- the international Navtex service for coastal regions;
- the EGC SafetyNET, covering all waters of the globe except those in the polar regions.

3.3.10 THE IMPLEMENTATION OF GMDSS

The GMDSS will be introduced by means of amendments to the International Convention for the Safety of Life at Sea, 1974 (SOLAS 1974) and the Protocol to SOLAS adopted in 1978. The intention is that these amendments will enter into force on 1st February 1992 under a procedure known as tacit acceptance. The ammenments specify that :

- Between 1 February 1992 and 1 February 1999, existing ships can comply either with the GMDSS or the existing chapter IV of SOLAS.

- Ships built after 1 February 1995 must comply with all applicable GMDSS requirements.

- After 1 February 1999, all ships must comply with the GMDSS, see table 3.3.5.

The above time schedule shows that the GMDSS will not come into effect overnight. In that connection, the present system will continue for existing ships until almost the end of the century, although some GDMSS equipment will be mandatory long before that date. See table 3.3.5.

There were six resolutions adopted by IMO assembly to assist in the implementation of Gmdss:

-A.659 (160 Contracting Governments to SOLAS to make available shore based facilities.

-A.660 (160 Carriage of satellite EPIRBs, mandatory 1st August 1993.

-A.661 (16) Carriage of INMARSAT EPIRB

-A.662 (16) Float Free Release and activation arrangement for emergency radio equipment, so that in case the ship sink the EPIRB will be released automatically.

-A.663 (16) INMARSAT-C SES accepted as alternative to **INMARSAT-A** capable of transmitting/receiving direct printing.

-A.664 (16) covers performance standards for **EGC.**

3.3.11 AVAILABILITY OF EQUIPMENT

For full details of the resolutions, see annex II.

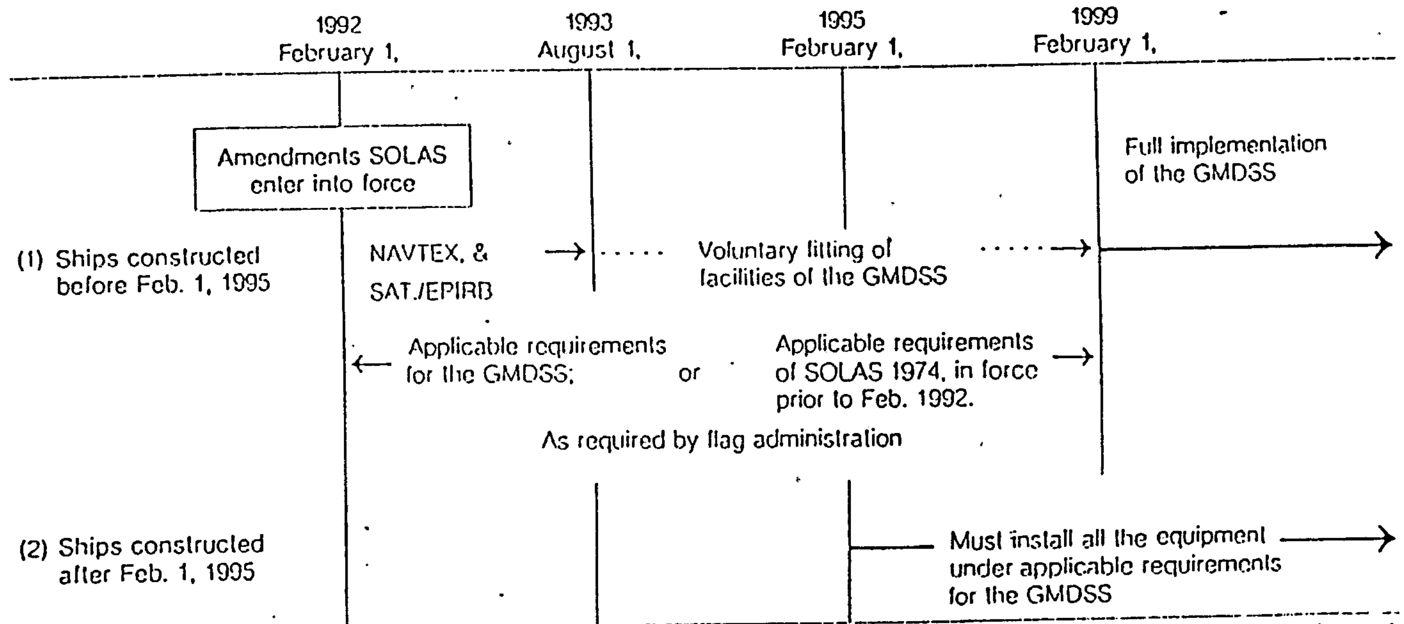
A system which proves its reliance by continous availability could also be said to be dependable. But for how long could it be available? As expressed by Captain Fear of Inmarsat, "There are numerous factors which affect the availability of equipment, such as power source, design reliability, spare parts, access for repair, skill to repair, tools etc, quote 41". The system will also require that the Mean Time Between Failure (MTBF) is kept as high as possible, and offering an alternative solution to redundancy. In that connection the responsility of ensuring availability of the GMDSS equipment is placed at the door step of the Administration under which the ship is registered.

"For ships which confine their operations to Sea Area A1 and A2, availability of equipment shall be ensured by using such methods as duplication of equipment, shore-based maintenance, or a combination of these methods. For ships on voyages in sea area A3 and A4, availability shall be ensured by using a combination of at least two methods such as duplication of equipment, shore based maintenance or at-sea maintenance. It is generally understood that duplication of equipment means a functional duplication, ie, an HF installation could duplicate for an Inmarsat-A ship earth station, quote 41".

3.3.12 SHIPBOARD PROCEDURES IN GMDSS AREAS

With the implementation of GMDSS it is expected that shipboard personnel, especially the ship command should be familiar with the procedure and sequence of events between the distress and subsequent rescue. Knowledge about these steps is expected to enhance response time to a rescue operation. The diagrams and procedures shown in annex IV are to provide a step by step guide to what action should be taken by the Master and when it should be taken.

ANTICIPATED TIME SCHEDULE FOR INTRODUCTION OF THE GMDSS



This schedule will be applied to all passenger ships and cargo ships of over 300 gross tonnage under the SOLAS Convention and engaged in international voyages.

Table. 3.3.5

Source: Communication Technology Today and Tomorrow (Japan Radio Co. Ltd.)

CHAPTER 4

INTRODUCTION OF EARTH BASED COMMUNICATION SYSTEM IN WEST AFRICA

4.1 INTRODUCTION

There is a proverb in Ghana saying that if the music changes the dance must also change. Modern shipping has changed from the single transport mode to multimodal transport arrangement. This means the shipper's responsibilties must also alter to multimodal transport operator's mode. In order to bring these varying conditions to a reality there is the need to first introduce an efficient earth based communication systems. These systems will embrace the land mobile transport, Electronic Data Interchange, a European answer to EDI (the Marinet), an African answer to EDI (the ACIS). The second reason for introducing modern communication systems in West Africa supports the fact that modern ship-shore interfaces in way of management need to become efficient and operational.

4.2 LAND MOBILE COMMUNICATION

With reference to the industrialised world, modern manufacturers and retailers work with the smallest possible stocks in order to minimise wastage of space on warehousing and maximise their freedom to switch quickly to new products. In West Africa and Africa in general, maritime and land communication is drowned in an inefficient operation, thus making reliable transshipment of goods to the hinterlands and landlocked countries sometimes impossible. In Europe the stakes are being raised still further by prospect of greatly increased competition following the opening up of the continent's national markets in 1992. The secret of success in this environment will be access to a constantly updated, comprehensive picture of the location and status of the whole fleet and a way of contacting individual vehicles and nodes at any time to issue revised instructions.

In that connection a mobile communication system combined with Inmarsat-C would need to be introduced onboard vehicles, trains, with onboard monitoring systems as part of a road-haulage fleet management and cross-border land-mobile operators' set up. If this is to become possible, then at any point in time a multimodal transport operator can monitor its cargo from say the port of Tema up North to Burkina Faso. At the heart of the system is a computer which records data from many sources, a data input and display unit operated by the driver, and automatic sensors distributed around the mobile to act as the link between the mobile and its base, permiting real-time monitoring of ship, vehicle/train, plane location and status.

4.3 ELECTRONIC DATA INTERCHANGE

The Electronic Data Interchange (EDI) is a communication mode designed to serve as basis for all future electronic conversation. It is a way of sending standardised electro nic messages anywhere in the world, with the ultimate aim of providing cheap, efficient data handling. It is a way of allowing two electronic minds to look into each other and interact.

Organisations such as :
-Customs Co-operation Council (CCC)

-International Chamber of Shipping (ICS)

-EDI Association (EDIA)

-International Association of Ports and Harbours (IAPH)

-UN

have maximised their collective effort to facilitate the implementation of EDI. The operating bodies are the shipping companies, national and international organisations, the industries, and EDI operators in the industrialised world as well as the developing countries where large EDI networks are surfacing. To look at what is going on in Europe at the moment, about ten reputable companies have given it a common approach by coming together to form what is known as "Ediship Tradanet" which was set up in April 1990. The companies are: ACT Group Lines, Compagnie Generale Maritime, Cunard Ellerman, Hapag-Lloyd, Maersk Line, Nedlloyd, NYK Line, OOCL, P&O Containers and Sealand Services Inc. It allows trading partners to exchange commercial documents electronically between computers regardless of their type, size or location, and the package of facilities concentrates on the exchange of seven messages designed in accordance with EDIFACT standards. Some companies are still evaluating the system.

4.3.1 THE PURPOSE AND USERS OF EDI

The purpose of EDI is:

1.to eliminate some of the wasteful use of paper for local and international trade.

2.to facilitate the direct transfer of information without putting it in printed form, thus ensuring that the right pieces of information get to the right recipient at the right time with a receipt acknowledgement. The system proposes to allow exporters and importers to, conduct their business electronically with the shipping lines of their choice

3.EDI would allow computers to talk to computers in an intelligible formatted standardised information language. The EDIFACT standard developed under the auspices of the United Nations, allows users to make bookings with their preferred shipping lines and receive bills of lading, invoices and status messages electronically.

The long predicted future in which paper documents would be completely eliminated from the transport chain is certainly bound to attract potential users of a much wider spectrum of the transport industries. Cargo operators using EDI can send cargo information, manifests, and bayplans directly from offices ashore to ship's port of call. Certainly trade observers believe that it will enable goods to be delivered in time, as goods tend to stay longer than necessary in West African ports owing to voluminous documentation and processing. As Ocean Voice put it, " an essential part of the communication pipeline will be ships providing position information so that cargo can be tracked in real time".

Other users include port authorities, (the six IMO Facilitation Forms (FAL), worked together by organisations such as the ICS, IMO, Customs Cooperation Council and Inmarsat would share a place on EDI application platform) Export companies, Freight forwarders, Port Agents, Customs brokers. There are other potentials for ships using EDI, they include vessel performance monitoring, updating of hydrographic charts, despatching weather information, automatic position reporting and cargo status monitoring.

Ship Suppliers are seen as the next potential users of this system which is surely going to play a major role for ordering ship supplies in advance.

It will also provide means to send repair estimates, work authorisation and repair nvoices, while increasing the speed at which workshops can receive repairs authorisation. Other advantages include:

1. **decrease in paperwork,**
2. **greater accuracy of information due to the elimination of transcription errors.**
3. **reduced cost in moving, sorting and storing of documents**
4. **Immediate accessibility of information permitting "just in time" programs to operate efficiently.**

Containerization is becoming increasingly large scale, and as a result, ever more stringent requirements are being made on container terminals. They must function more and more as a "transit point", with an emphasis on "transit speed" as ships and throughput requirements grow. Faster throughputs are essential especially in some of our West African ports where goods are moved to the hinterlands or landlocked states, with minimum time in the terminal. For container terminals, this results in peak loads, in which speed, reliability, safety, and cost control form the main goals of an efficient port management, Electronic Data interchange becomes increasingly important.

4.4 MARINET FOR COST CONTROL

Marinet is a communication system introduced by Radio Holland in the Netherlands. With emphasis on cost control in todays shipping, Radio Holland has devised Marinet which in the writer's opinion would become an important earth based system in the West African shipping industries, mainly cutting communication cost.

Marinet is a message switching and data transmission system specifically built and optimised for use over radio and satellite circuits. Transmission rates approaching 180,000 characters per minute can be achieved over good quality voice grade circuits. Marinet transmissions are transparent, messages and files may contain data in any form text: files, binary files, data files, spreadsheet files or executable program files. The system can be interfaced to public and private networks such as Telex, Fax, Local Area Networks, Mini and Main Frame computer networks. It can also act as a front end communications processor to any other system.

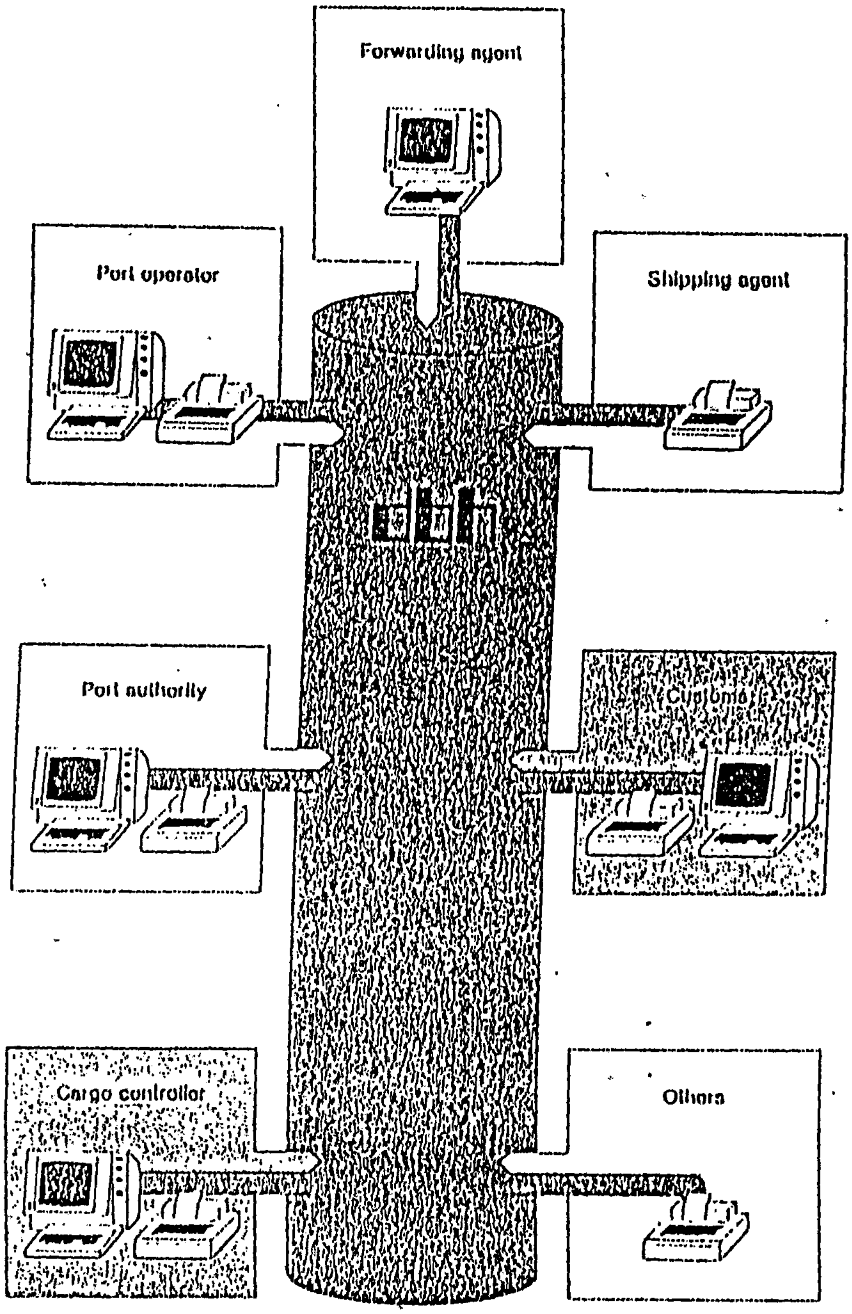
Marinet uses a sophisticated full duplex modem connection and can achieve in practice cost savings in the region of 70% to 85% when compared with standard mediums. It is capable of transferring information at an overall throughput rate approaching 180,000 characters per minute, even with noisy lines, comparing with 200 characters per minute from telex and two minute fax. It offers a single system capable of handling all your communications, text, data, telex and fax at a fraction of the normal cost. An example of the cost saving by Marinet is shown in Annex I. Marinet is capable of operating in a completely unattended mode, and can transmit, receive and automatically process: **Passenger or Cargo Manifests, Bills of Lading, Charter Parties, Ship Performance Data, Purchasing /Inventory Information, Payroll, Management and administrative telex communication, Text or word processing documents, Financial and spreadsheet data.**

4.5 THE COMPASS PRINCIPLE

A very remarkable EDI-service was observed in Bremen. The Company known as the **Datenbank Bremische Hafen, (dbh)** has established a sophiscated data processing system for port economy called the **COMPASS** system, see fig. 4.5.1. The system links up all the parners involved in goods transport. Each participant can get all the information he needs directly from the data base, and he also feeds in his own data. Instead of time wasting with paperwork, COMPASS users with the necessary access rights have the advantages of direct control, information and documentation. Further improvement to the system was in the customers direction, introducing what is known as **"Logistics-Tele-Service" (LOTSE)**. This offers a simple solution to all compactibility problems. No matter what system or lines the customer has, LOTSE opens the way the way into the Bremen data systems. This eliminates the need for a lot of single connections. It also guarantees that all programmes, not only now, but also in the future, can be used without having to change your hardware or software.

4.6 SUB-SAHARAN SYSTEM FOR WEST AFRICA

Another Earth based sytem, tailor made for Sub-Saharan and due to be implemented by South African Development Co-ordination Conference **(SADCC)** countries by late 1991, is the **Advanced Cargo Information System (ACIS)**. It is a project funded by UNDP and the United States Agency for International Development **(USAID)**. The project is executed by Unctad on behalf of ten governments of SADCC. Although SADCC has become the first sub-region to implement the project, Acis is to be implemented in the whole of Sub-Saharan Africa, including The Ministerial Conference on



COMPASS is the world's first information and communication system for ports.

THE COMPASS-PRINCIPLE

Fig. 4.5.1

Source: Bremen Port Promotion Association

Maritime Affairs of West & Central African States (**Mimconmar**).

ACIS is designed to monitor and control the movement of cargo by all transport modes. It is specifically targeted at improving the flow of cargoes in transit between the major seaports and the landlocked countries.

The system is to be composed of several subsystems which have to be interlinked to form a whole system. The information-gathering structure of ACIS is that every country is to have its own **Central Logistics Unit (CLU)**. That is a computer center acting as that country's information hub.

The CLUs are to be linked to smaller computer systems, known as the antennae. These will be located inside major transport operators' organisations, such as those of railways, lake services, road hauliers, inland freight terminals, seaports, forwarders, shipping agents, port authorities, stevedores' organisations, Shippers' council, And Customs Departments. In the earlier stage independent CLUs are to be linked together. The network interconnecting the CLUs has been named the "backbone". Other operators in the transport community whose activities do not qualify them for antenna status can access data from the ACIS Backbone by linking their computers with the system through telephone lines. The outlets for these broader base of users have been named "interfaces to ACIS". Where potential users do not have their own computers for plug-in, they will be able to make use of the computer facilities which will be available to them at CLU locations, to be known as ACIS "**shop-windows**" or common-user computer sreens.

The system provides:

(i) **cargo flow projections,**

(ii) **live consignment monitoring and**

(iii) **historic track data.**

The advantages of using ACIS seem tremendous, through these form of access, operators eventually are able to track consignments of interest to them from door to door. they will also be able to communicate with ACIS Backbone. As far consignment tracking is concerned, a shipping agent will be able to compile an accurate container control inventory of an entire sub-region. In another application of the system, a road haulier will be able to calculate a few weeks in advance the locations where demand for his transport will be strong or weak. Access to data will be filtered to users on a "need-to-know" basis, using codes and password procedures.

ACIS operation is almost similar to COMPASS, and **StarNet,** which is an electronic network established by the Singapore air cargo industry. It was designed to provide an efficient network for communication, information, dissemination and exchange of documents within the air cargo complex. Besides StarNet, Singapore in the Far East Region, operates a country-wide electronic network system for trading and shipping community, called TradeNet. By these arrangement, air cargo agents who subscribe to TradeNet can gain access to StarNet through their existing computer systems. The difference is that while StarNet and TradeNet are operating nationally, ACIS is projected to operate on national and regional basis.

CHAPTER 5

COMMUNICATION, EDUCATION AND TRAINING STRATEGIES

5.1 THE NEED FOR COMMUNICATION OPERATORS

5.1.1 OLD TECHNOLOGY TO NEW TECHNOLOGY

The sudden step forward from old to very new communication technology is a major problem. Developing countries shipping industries, maritime training institutions, freight forwarders, and shipping operators, suddenly need communication operators with different skills. The problems are likely to lie with the number, competence, and skills of the operators, and the commercial pressures under which they are required to operate. Even today, when it would seem that ships of the future with their sophisticated systems are increasing working practices, not unlike the aircraft industry where skilled loaders load, skilled voyage planners plan routes, skilled communicators communicate, skilled data analysers analyse and all such people are shore based, the present role of the ship operator is seen as an expansion not contraction. There is currently talk of the ship operator/communicator as GMDSS sees the exit of onboard radio officers, and ship operator /dual watchkeeper as the navigating bridge becomes the focal point of all data processing, both for ship to ship and between ship and shore.

5.1.2 COMMUNICATION OPERATORS

The inevitable interaction between ship systems and the

interdependence of one system upon another seems to demand of those responsible for the ship's operation, a thorough understanding of the total ship communication system.
Not very long ago, all deep-sea ships had a radio officer, normally extremely well trained in the field of electronics who only dealt with a small part of the ship, generally, encompassing the radio room, bridge and perhaps the entertainment equipment. Some ships still use this considerable talent for basic tasks such as paying ship officers'advances and dealing with the crew's mail.
We could also have an electrical officer, highly trained and with high technical qualification, busy changing the light bulbs on the boat deck or mending the dough mixer in the galley. These shared responsibilities are on the verge of dying out, and the possibility to integrate and operate the Radio Officer and the Electrical Officers' work under one function has already been experimented by some developed countries. Utilising a Satcom installation on ships has acknowledged the reality of integration and endorsed the replacement of these kind of officers with an Electronic communication engineer.

5.1.2.1 SHIPBOARD OPERATORS IN GMDSS

One important issue before IMO and ITU while developing the GMDSS concerned the role of the radio officer under the new system. Under present regulations, ships that are required to be fitted with radio telegraphy equipment must carry a radio officer trained in the use of Morse Code. The introduction of GMDSS, will however result in a gradual phasing-out of Morse Radiotelegraphy in favour of direct printing telegraphy ("TELEX" by radio) or other non-manual communication.

As a result, many administrations maintain that there will be no need to have a radio officer on board, since it requires no technical skills to use radio telephone or operate the other emergency equipment that will be required by the GMDSS.

Other administrations insist that although a radio officer may not be required for communication, a radio specialist still will be needed to carry out on-board maintenance and emergency repairs. A compromise between these two positions was emerging during the GMDSS Conference, and, under **Regulation 15 of the amended Chapter IV of SOLAS**, operating in areas A1 and A2 must ensure the availability of equipment, shorebased maintenance capability or a combination of these, as may be approved by the Administration. In areas A3 and A4 a combination of at least two of these methods must be used.

Regulation 16 of SOLAS Chapter IV deals with radio personnel. This states that every ship shall carry personnel qualified for distress and safety radiocommunication purposes to the satisfaction of the administration. The personnel shall be holders of certificates specified in the radio regulations as appropriate, any one of whom shall be designated to have primary responsibility for radio communications during distress incidents.

5.1.2.2 RCC OPERATORS

IMO Assembly Resolution A.659 (16) deals with the provision of radio services for the GMDSS. It notes that the 1988 SOLAS amendments require Governments to make available shore based facilities for terrestrial and space radio services and goes on to list other instruments concerned with the provision of radio services. It recommends Contracting Governments to SOLAS to review the need for shore-based services to support the GMDSS.

In this connection, the coast stations along the West Coast of Africa require the installation of certain equipment and facilities before or during its implementation period. It follows that certificated radio personnel manning these stations would require updating to the new system. On the other hand new trainees for shore operation will require a mandatory course in the new system.

Currently, SAR radio facilities aboard ships and ashore are mandated for commercial vessels by SOLAS, and the International Telecommunications Union final Acts of the World Administration Radio Conference (Geneva 1979). The introduction of the GMDSS requires shore facilities providing services in ship-to-shore, shore-to-ship, ship-to-ship, and RCC-TO-RCC, and also digital selective calling, and Narrow Band Direct Printing (NBDP). Operators for the RCC's shore communication facilities would need to be trained in order to achieve the objectives of a SAR Organisation.

5.1.2.3 VTS OPERATORS

A Vessel Traffic Services (VTS) is any service implemented by a competent authority, designed to improve safety and efficiency of traffic and the protection of the environment. It may range from the provision of simple information messages to extensive management of traffic within a port or waterway. However, a greater number of our West African ports are not complex in terms of coastal and port dangers, and also in reference to entry requirements. On the other hand future economic developments may require most of these ports introducing VTS services, probably within 24 nautical miles from a control center or tower. In this direction a Basic Training Course for VTS Operators would have to be introduced.

5.1.2.4 OFF-SHORE OPERATORS

The West African Coast is gradually adding up to Nigerians ever growing oil and Gas fields. In oil or natural gas pipeline fields or on off-shore platforms, HF radio communication systems are installed to provide complex service communications between marine production facilities and land headquarters. The aim is to sustain perfect operation and maintenance of production facilities as well as for safety. The Radio communication also has to provide telephone, telex, and facsimile communications. In this connection ship/shore communication operators would be needed to perform the tasks.

The Telecommunication Engineering school in Ghana provides basic and refresher courses in telecommunication. Training programmes include : International Exchange course; General Telecommuination Traffic Administration, Auto Exchange Power supply corse; Digital Electronic Fundamental Course; Telephone Set Course, Cable Fault Testing and Locating Course; and Installation and Maintenance Course. These courses make provision for officers to perform their varied duties in the Post and Telecommunication Corporation.
The kind of people they train cater for : Assistant Telecommunication Superintendent-in-training; Technicians; and Telephonist/receptionists. The course does not make

provision for Satellite Communication Operators or GMDSS operators. Current indcations show that there will be a greater demand for these kind of expertise .

Indications are that Civil Aviation expresses the interest for extension and improvement of their telecommunication system, with much emphasis on Satellite Communication by 1992. This is a project to be co-sponsored by ICAO and EEC. The question therefore is, would it be necessary for Civil Aviation to send its trainees in Satcom overseas for training, since they have been partly dependent on the Telecommunication Engineering School for training of some of their Radio Operators.

Customs and Freight Forwarders would require entirely experienced officers in Satellite and Computer Communication if Electronic Data Interchange is to succeed in West Africa.

5.2 DEMAND ON MARITIME EDUCATION AND TRAINING

5.2.1 INTRODUCTION

While the climate of opinion towards the introduction of modern communication technology in West Africa could be a favorable one, there remains a question to be asked, that, and how much has this actually affected our training academies and the syllabi ? Other areas to be examined look at the direction, trend and demand of Maritime Education and Training.

5.2.2 TREND IN THE MARITIME INDUSTRY

Examining the speed with which technology is sweeping across every industry, it is becoming impossible for any one industry to escape the changes in communication. Maritime Education and Training quickly has to adapt to the current trend of training, and also in the light of regional needs.

Integrated or Dual-capacity or Polyvalent training has been conducted of forms in different countries .These programmes have met with varying levels of success. An Integrated Officer is a Ship Officer who has been trained to perform both navigation/deck and engineering duties. This officer has been selected from his entry into the marine field as a combined engineer/navigator. There are the old generation officers who are at the moment caught in between the conventional method of ship operation and current growing automation in ship operation. In this connection, an Officer who is either an engineer or navigator and receives additional training to perform duties in the other discipline is referred to as cross-trained officer.

An integrated bridge system encompasses all the navigation, control, monitoring and communication functions of the bridge into one electronically and ergonomically engineered unit. The benefits result in greater efficiency, safety and operational economy. The high level of automation means that all the ship's essential systems are monitored electronically. In that regard a single deck officer is capable of carrying out watch duties using modern systems. One man operation of a total ship-control centre is only feasible if the operator can acquire the aggregate skills and knowledge of the present deck officer, engineer officer and the radio operator.

5.2.3 DEMAND ON MARITIME EDUCATION AND TRAINING

The present situation increasingly finds many of the Engineering Officers to perform bridge watchkeeping duties, vice versa, Deck Officers are required to have engineering knowledge to enable them control the engine in all situations. To prepare these engineers or deck officers, for bridge or engineroom duties, they must receive some level of training either way. In this respect Radio Officers could not be ruled out entirely while being suitable for cross training, enabling on board or ashore operation of the present sophiscated communication network. The other option is to provide Radio training for the Dual Purpose Officers having Satellite Communication qualification or/ and a GMDSS Operators Certificate.

Modern electronic equipment reduces the workload and increases the potential of ship operations Devices as satellite communications, digital networks and operations automatic plotting aids, (ARPA), future ECDIS, that make ship operation safer and more efficient provided they are used by well trained and experienced officers.

Shipowners, have a great interest in the reduction of the number of shipboard personnel. A substantial part of them also seems to favour the combination of tasks onboard and the training of integrated or cross-trained officers. In addition to these interests they also must require safe manning of their ships. Therefore those remaining on board must be sufficiently qualifed to cope with the normal operation of the ship and with shipboard emergency situations.

The safety and maritime environment protection aspect demand that certain minimum requirements in maritime education and training (International Convention on Training, and Certification and Watchkeeping of Seafarers, 1978; STCW-Convention) have to be fulfillled by all member countries of IMO. Amendments to the STCW Convention provide recommendations for training of Radio Operators Personnel For The Global Maritime Distress and Safety System (GMDSS).

The current situation in shipping predicts a global demand for shipboard personnel. In that connection the exit of the Radio Officers from the ships' outfit makes it even more demanding on the maritime institutions to facilitate the training and education of new breed of shipboard operators for the industry.

5.3 MET STRATEGIES IN THE REGIONAL MARITIME ACADEMY (RMA)OF GHANA

5.3.1 MET PROGRAMME AT RMA

The existing programme which addresses the issue of upgrading the academic course to the degree level, is an undergraduate, 4 academic year B.Sc. Engineering-Marine Technology course with 3 options in Marine Electronics Marine Engineering and Nautical Science. The existing course is structured to combine scientific and technological knowledge with practical experience training.

It is envisaged that the graduates from the proposed programme would be equiped to. aspire to:

(i) Sea-going officers positions on board merchant ships in the West African sub-region and beyond.

(II) Managing, Engineering and Technological officers positions on shore based maritime transport facilities;

(iii) Engineering and managerial positions at shipbuilding and repair facilities.

(iv) Managing, Electrical/Electronic engineering positions at Coast Radio Stations, Maritime Safety Administration, RCCs, Offshore Installations and Telecommunication Organisations.

5.3.2 THE REASONS FOR THE CURRENT STRATEGY AT RMA

Our maritime industries have always considered that seafarers should be trained in an isolated condition at nautical colleges. Unfortunately, this system gives poor results, both for shipowner and the seafarers. The system prevented graduates entering the business, it ensured that the trainee had no knowledge of alternate areas of employment, and it has prevented seamen from obtaining chartered status ashore. It appears that the shipowner thinks that this is the most effective way of obtaining long-term commitments from his senior staff, who have to work in adverse conditions.

Vessels are now designed to eliminate operators, with consequent reduction in personnel function. Modern satellite communication systems, computers and data-logging systems have made it desirable to achieve this reduction in manning.

Ships are heavy floating engineering structures, propelled by complex power plants and nowadays fitted with high technology process plants, requiring the right expertise and knowledge to operate these ships

Shipping managers are deciding on more automated ships with more centralised controls, while the young potential seafarers are deciding on their future career prospects.

Officers of the deck department see themselves as restricted to ships and the sea for future career development while the deck people see the engineers, radio and catering people as being able to shift to shore employment.

In other words deck people see their career horizons limited to the ships and to the sea while the career horizons of the engineering, radio and catering people overlap ashore. We must therefore rethink the methods by which people go to sea initially, their training while at sea and their career progression.

The state and objectives of our national education and training system have had an impact on maritime education and training as can be seen in the introduction of academic degrees for maritime studies in UK, or the equivalence of maritime education and training certificate to academic degrees FRANCE, or the issuance of certificate of competency and academic degrees to seafarers FRG. Such adaptation to and integration into the national education and training system does not only give the seafarer recognition but also provides some linkage to the national system.

5.3.3 JUSTIFICATION FOR THE PROPOSED PROGRAM

With so much preparation towards the ushering-in of GMDSS early next year, most maritime institutions have found the need to design a syllabus on GMDSS meeting the need of modern communication operators. While waiting for IMO to come out with approved recommendation on training of radio operators, countries like Sweden, Germany, etc, had taken the lead to introduce a GMDSS syllabus for their Maritime institution. Recommendations for training and certification of radio operators for GMDSS can be found in annex II.

2. However IMO's Sub-committee on Standards of Training and Watchkeeping- 22nd session (STCW 22/5, 13 September 1990) has discussed a note by the ICFTU, on the recommendations on training of radio personnel for the GMDSS. The paper defines two classes of operators: i) First class Radio and Electronic Certificate and ii) Second - class Radio Electronic Certificate. While at the same time recommending two parts for the syllabus in annex 3. The proposed Extended Course for Diploma in Satellite Communication is designed to enable the RMA to equip the graduates with

adequate and technological skills to enable them cope with the rapid advances, challenges and demands of the maritime transport industry in Anglopphone West and Central Africa. The syllabus of the training program on GMDSS recommended by ICTFU is not included in the four year course curriculum for marine technology. The writer is strongly opinio- nated after carefully studying both the proposed syllabi of Germany and Sweden as well as the IMO recommendations, the right direction is to follow a similar course in the Regional Maritime Acdemy.

5.3.4 THE PROPOSED PROGRAMME

The following proposed programme is designed for training operators of GMDSS Equipment. The course gives training for operator's certificate of GMDSS radio equipment including satellite terminals, and also meeting the requirements of ITU (WARC) and IMO. The training covers Transmission and reception of Voice, Telex, and Data ship to shore and shore to ship, Distress Procedures and reception of Group Calls. It will also offer trainees useful familiarisation with computers at the same time.

COURSE PROGRAMME : GMDSS COMMUNICATION OPERATORS

ENTRANCE LEVEL : Candidates for dual purpose course, Coast radio station operators, RCC operators, with knowledge of the principles of electricity and the theory of radio and electronics sufficient to meet the requirement of the programme.

DURATION OF COURSE : FOUR WEEKS (120 HOURS)

EXAMINATION AND CERTIFICATE: Examination and college Certificate awarded with approval from the Administration.

STANDARD/LEVEL OF COURSE: Meeting requirements of ITU and IMO.

SUBJECT AREA	LEARNING OBJECTIVES
G11 Equipmment	Knowledge about the requirements, regulations for radio equipment in GMDSS.
G12 Distress	Links for Distress and Safety communications.
G13 Procedures (PRACTICALS)	Procedures in Maritime Distress and Safety Communitions.
G14 Safety Communinication	Urgency and Safety messages, including Maritime Safety Information.
G25 Technical Aspects of Telecommunication	The assessment of the technical reliability of equipment.
G26 Microprocessors	Knowledge of microprocessors and microprocessor system fault diagnosis.
G27 Testing, Faults and analysis (PRACTICALS)	Know the performance of test sequences, Fault identification, Correction for simple faults as far as is possible on board.

G28 Accuracy	Knowledge of reliability, availability, maintenance procedures and test equipment circuits.

OPERATIONAL PROCEDURES OF:

G39 Satcom	Acquire sufficient skill in procedures with Satcom installations.
G40 DSC	DSC-transmision, reception and confirmation.
G41 Telex	Provide for a Telex-communication links.
G42 Law and Regulations	Knowledge of relevant national and international regulations as far as concerned with GMDSS.
G42 Exercises with equipment (PRACTICAL)	The operational aspects for Telex- and Satcom-terminals and the DSC-receiver.

SUBJECT AREA NO G11

LECTURE CONTENTS

A1-A4 areas; DSC and Satcom-equipment; Inmarsat- A and C; Distress Radio Beacon; SART; EGC; NAVTEX.

SUBJECT AREA NO G12

LECTURE CONTENTS

Frequency allocations in GMDSS; Protection of Distress frequencies; Transmission methods; Transmission priorities priority 3.

SUBJECT AREA NO G12

LECTURE CONTENTS

Distress alarm; Transmissions; Procedures for relay and confirmation of distress calls; Reception and confirmation by CRS, CES or RCC; Preparation for the handling, further transport, coordination and finalization of Distress traffic.

SUBJECT AREA NO G14

LECTURE CONTENTS

Navtex receiver, Worldwide Maritime Safety transmissions, Navareas, Priorities 2 and 1, Limitation of Information quantity.

SUBJECT AREA NO G25

LECTURE CONTENTS

Technical Manual of installation, Blockdiagrams, Control of indicators, Antennae, Gyroscopes, Earth connection, Status alarms, Status reports, Printer tests, paper transport

SUBJECT AREA G27

LECTURE CONTENTS

Fuses, Measurements at test-points, power failures, Communication with service/maintenance companies, replacing PCB's

SUBJECT AREA G28

LECTURE CONTENTS

Redundancies of equipment, MTBF, MTTR, IMO Recommendations MNAP.

SUBJECT AREA G39

LECTURE CONTENTS

Transmitter engagement, Choice of CES and signalling methods (Telex, Telephone, Fax), Priority Zero, Country identification, Abbreviation used in Telex traffic, reception of group calls, Paths through the Satellite Transponder and signals exchanged between SES, CES and NCS.

SUBJECT AREA G40

LECTURE CONTENTS

Choice of appropriate frequencies, procedures for making a connection, Repeating messages.

SUBJECT AREA G41

LECTURE CONTENTS

Choice of appropriate frequencies, operation of a terminal.

SUBJECT AREA G42

LECTURE CONTENTS

Telecommunication regulations, Ship Safety regulations, INMARSAT regulations.

SUBJECT AREA G43

LECTURE CONTENTS

Special codes, Message identification, UK and European Keyboards, Flawless operation, changing and mixing of texts Buffering of messages, DSC messages.

5.3.4.1 TRAINING AID FOR GMDSS COURSE

Satellite communications simulator, three of its kind in operation are: (i) **INPRO** (developed by Leith Maritime College UK), (ii) **JEPPSEN** (by Norway), and (iii) **MAREC** (by Greece). INPRO is currently been manufactured by **Radio Holland** in the Netherlands, where it was introduced and demonstrated.

The simulator is a totally integrated system operating with -in its own environment. All current INMARSAT features, Inmarsat-A & C, as well as additional enhancements that are expected to become operational within the next few years are included in the INPRO software. Any CES or NCS that are currently in use or planned by Inmarsat may be in corporated within the simulator. The heart of the system is the instructor's console to which can be connected from 4 to 30 student simulator SES, which can be located up to 1 KM from the instructor, connected by a single cable. The instructor's console consists of: a sophiscated 16 bit computer, keyboard, 2 video display units, printer, modem, telephone and INPRO software. The distress message generator facility is also included. The student position has equipment similar to that found on any ship. Students using the SES terminals will rehearse all the procedures they will later ues at sea, sending and receiving messages by telex or speech, and aerial positioning technicques needed to connect with the Inmarsat network. The instructor can control, interrupt, and record all network activity, operating both manually, and automatically according to the programme. The instructor can artificially position SES terminal at any latitude and longitude. He can also simulate the effects of different weather conditions on the reception and transmission of signals. At the time of writing this dissertation the price of the complete equipment was not known.

5.3.5 THE EXTENTED PROGRAMME

The International Maritime Organisation encourages maritime transport training institutions to move towards higher scientific knowledge and technological principles based training programmes as expressed in the propose programme.

Nowadays and future developments demand that maritime education and training has to adapt to operational necessities. Changes in shipping, which are dictated by economy, will have to be foreseen by maritime education and training, and to be responded to by updating of contents and methods of education training, by designing and specifying new syllabi and thereby assisting in the development of new career structures for shipboard personnel.

The author believes that Organisations, Establishments, Corporations in West African countries would need to plan now on how the new satellite facilities will change their telephone and data network, their word processing and mail, their travel budgets, training, and human communications. There will be many new business opportunities in using Satellite Communications envisaged in the shipping industry, and therefore a proposed extended course for a Diploma in Maritime Communication is designed to be a future solution to technological demand.

PROGRAMME: DIPLOMA IN MARITIME COMMUNICATION

ENTRY QUALIFICATION: Advance Level passes in physics and maths, Basic qualification in Radio and Electronics.

DURATION : 1 YEAR

EXAMINATION AND CERTIFICATE: Diploma in Maritime Communication

STANDARD/LEVEL OF COURSE: To be approved by the Administration.

5.3.6 COURSE CURRICULUM

SUBJECT NO.	SUBJECT TITLE	LECTURE
DC001.	INTRODUCTION TO SATELLITE AND	30
	COMPUTER COMMUNICATION	30
DC002.	ELEMENTS AND PERFORMANCE OF	
	COMMUNICATION SATELLITE	36
DC004.	SATELLITE ORBITS AND POSITIONING	30
DC005.	TELETRAFFIC	30
DC006.	SATELLITE COMMUNICATION SYSTEMS	36
DC007.	EARTH STATIONS AND TERRESTIAL LINKS	30
DC008.	MULTIPLE ACCESS TECHNIQUES	30
DC011.	DIGITAL COMMUNICATIONS	39
DC012.	USE OF SATELLITE CIRCUITS FOR DATA	
	TRANSMISSION	30
DC013.	USE OF SATELLITE FOR INTERACTIVE	
	COMPUTING	34
DC014.	ERROR IN TRANMISSION	26
DC015.	TRANSMISSION LOSSES	25
DC020.	AVAILABILITY	39
DC022.	LOCAL AREA NETWORK AND STANDARDS	30
DC023.	TYPES OF LAN	60
DC024.	MICROPROCESSORS	34
DC025.	COMPUTER TECHNOLOGY	20
DC027.	OPERATING SYSTEMS	40P+40T, 60

DC028.	WORD PROCESSING	20P+20T,	30
DC031.	AMPLITUDE-MODULATION SYSTEMS	6P+46T	49
DC032.	FREQUENCY-MODULATION SYSTEMS	6P+19T	22
DC033.	ANOLOG-TO-DIGITAL CONVERSION		38
DC034.	DIGITAL MODULATION TECHNIQUES		20
DC035.	NOISE IN AMPLITUDE-MODULATION SYSTEMS		30
DC036.	NOISE IN FREQUENCY-MODULATION SYSTEMS		22
DC037.	DATA TRANSMISSION	16P+30T	38
DC038.	INFORMATION THEORY AND CODING		42
DC039.	TELEPHONE SWITCHING	40P+40T	60
DC041.	CODING		30
DC042.	FILTERS	20P+20	30
	TOTAL HOURS		1030

REFERENCE: P=PRACTICALS HOURS T=THEORY HOURS
2 Hours of P = 1 Hour of T

The author hopefully believes the GMDSS Communication Operators Certificate and the Diploma in Satellite Communication would meet the growing need of the maritime industry. The courses will be available on regional basis serving the participating countries of the Regional Maritime Academy, namely: Ghana, Gambia, Liberia, Sierra Leone and Cameroune. See annex III for detailed subject contents for the Diploma course.

CHAPTER 6

CONCLUSION AND RCOMMENDATIONS

The present question going on in the minds of personnel in the shipping industries is what should be the acceptable manning levels on ships and for that reason what standard should the personnel attain. The IMO answer to this question requires that a ship should carry sufficient crew to enable it to safely navigate the oceans, without accident or loss to the crew, the cargo or itself and without damage to the environment. Combining the regulations from both the IMO and ILO conventions gives an outline of the basic requirements and supplementary requirements for qualifications of personnel on sea going ships.

In the light of the various factors analysed in this paper and the points enumerated above it is pertinent to draw the following conclusions:

6.1 COMPUTERS AND SATELLITE IN THE MARINE ENVIRONMENT

Maritime radio communication has always sufferred from inherent shortcomings that no amount of development will completely eliminate, while attention is focused on the expressed advantages of computer assisted satellite communications. Congestion and reception difficulties as well as the uncertainty of messages being received will be eliminated.

Takoradi Coast Radio Station one of the oldest on the shores of West Africa and which for the past decade could only boast of obsolete communication equipment contributing mainly to a hampered operation, could now look at satellite and computer assisted communication as a source of inspiration to improve their services. To introduce the GMDSS in West Africa the necessity has come to restructure our CRSs along the coast, stretching from Senegal to Gabon. In that regard it will be more appropriate for the CRS to provide various services of communications between ocean-going vessels, public telephone communications between vessels and landline subscribers.

"Computer technology is not at the moment the most important problem facing any particular country. But it may well be the fastest changing component of many economies. The technology is improving and costs are falling with great rapidity, the range of application is very broad, and the impact of the technology on the relationship between labour and non-labour costs of production is significant in many industries, 35 "
One of the most freqently made and least frequently kept demands on computer systems is that they should save money. And a more realistic hope for most computer systems is that they earn their keep in situations where the work load is expanding and where projected increase in staff can be eliminated or reduced. The computer can absorb additional work, thereby containing costs at a certain level. The advent of the microcomputer will hopefully make a major breakthrough in life on board. Hopefully paperwork could be deleted by over 90% and information that is required elsewhere can be sent by high-speed data transmission at relatively low cost. Filing cabinets or cupboards full of paper will be replaced by disks and tapes and retrieval will be simple and rapid.

The use of PCs is gradually permeating the life of seafarers as ship to shore communications become daily practice on modern vessels. Masters and senior officers are required not only to produce reports for head office management, but also to carry out a number of monitoring functions, for example, automated ship stores' inventory, fuel oil quality, plant performance monitoring and budgeting. Similarly, shore managers in both ship operating and management companies are increasingly expected to be PC conversant. However it is a dreadful blow for the average user to realise that the computer will not fulfil every fantasy. It becomes necessary to prepare users early for this, and make sure that they understand and appreciate both immediate and long-term constraints.

Ship operators will be able, with the push of a button, to enquire the current position of a vessel without involving the ship's command in any message sending. Modern microelectronics and information technology will begin to gain acceptance by shipowners, particularly in developing countries. Onboard computer-based training aids will continue to gain acceptance as part of the trend as desktop microcomputers and their associated software become readily available and as more and more equipments have simulation functions built in.

RECOMMENDATION

In the recent issue of the Peoples Daily Graphic of Ghana, there was a call by the Secretary for Industries, Science and Technology for a programme under which the youth would be trained in basic computer Languages, Repair and Maintenance." Under the programme, drawn up by the Technology Transfer Centre (TTC) and approved by the government, a number of secondary schools and polytechnics would be equipped to give students training in the basic use of computer, 38". Quote People's Daily Graphic, Tuesday, July 23 1991 No. 12646. In that connection, it would be timely and most appropriate for the RMA to respond to the call with an earlier strategy which could be formulated to pursue a full programme not only in Satcom but Computer ware, Networking, Usage, and Maintenance.

The increasing emphasis on recruitment and training of officer cadets in nautical colleges worldwide has prompted the development of marine engineering training equipment. By using a PC to simulate the operation of a typical marine propulsion unit with auxiliary systems, the cost of training, which has traditionally been carried out on real equipment can be reduced.

6.2 SATCOM

"Modern communications installations on board the vessels and ashore guarantee the uninterrupted information flow between the ship and the operating headquarters. Satellite communication systems and Global Positioning System will further improve the constant contact between ship and shore, 39". Reduced manning has created a need to devise electronic systems for making navigating decisions easier. Vessels turn around times are getting shorter, while ships are steaming faster in increasingly congested waters. This leaves the officer of the watch and the ship master with very little time to attend to many routine navigational tasks. Another area where computers and satellites are expected to play a dominant role is the development of the Electronic Chart Display System and Information (ECDIS), soon to replace the paper chart.

The importance of satellites in helping to improve distress and safety of life at sea communications has been recognised by the International Maritime Organisattion, leading to the introduction of GMDSS. Satcom enhances the quality of a company's operation. It offers clear links, free from interference and static, required for modren data and fascimile transmissions. It promises instantaneous and positive connections expected by businesses for their telephones and telex links. Satcom ensures reliability and is always available around the world, regardless of distance and around the clock. The above qualities are the characteristics of an Inmarsat system. In emergencies, the Inmarsat network provides the clear, reliable and fast communications that are essential, from ship to shore and shore to ship. The traditional method of alerting vessels in distress (ship to ship) in future will be changed and the responsibility will be shifted to shore authorities. It offers great advantages in alerting and locating ships in cases of distress or emergency; facilitating search and rescue operations; issuing safety and urgency messages, and a number of other functions such as automatic reporting of ship's positions, position determination, traffic guidance, automatic navigation warnings and weather routeing. Meterological warning service, Navtex, SafetyNet Telex and Telephone service will eliminate the Morse Radio Telegraphy. DSC and Narrow Band Printing will be used.

RECOMMENDATION

The states in the West African Region should make provision for ushering in the GMDSS especially with regard to SOLAS Convention 1974 ; SAR Convention; ITU Radio Regulations; and IMO Regulations related to: implementation dates, Basic Carriage Requirements, and required Shore Systems.

The missing link for the implementation of GMDSS and satellite Communication in the West African sub-region is an efficient inter state landline communication network. A greater number of the countries in this region is experiencing some kind of communication deficiency in their national networks, and the situation needs to be addressed. The prevailing decline common to many West African countries are: Cable theft, Rotten cables and user congestion. A major solution to this dilema would be to place a greater emphasis on satellite applications in local, regional, and international networking.

In the absence of an Inmarsat Coast Earth Station, the Telecommunication corporation of Ghana needs to upgrade its present satellite earth station services at Kutunse, in order to accomodate the growing need of satellite applications.

Ghana should ratify the International Convention on Maritime Search and Rescue 1979, with arrangements of establishing a National Search and Rescue Centre.(RCC)

The RCC should be equiped with the INMARSAT ship earth station to avoid delays with the public switched network and to help in the rapid exchange of distress and safety information between various RCC's.

The GMDSS regulations covering the carriage of communi- cations equipment aboard ships will be implemented during the period 1992 to 1999. Ships of 300 gross tons and over trading virtually anywhere in the world except the extreme polar regions would have to fulfil the mandatory communica tions requirements. In that connection West African Flag

States, including Ghana should start amortizing the equipment of present and future ships. A larger percentage of the West African fleet is made up fishing vessels and the regulation does not make specific requirements for them under the GMDSS implementation period, except for a ship 300 GRT or more. See cost estimates in table 6.1.

6.3 REGIONAL TELECOMMUNICATIONS

Telecommunications can be split into two major divisions, namely radio and video, which are mainly intended for audio and video broadcasts, and telephone networks, originally designed for voice. Previous chapters have discussed radio telecommunications. Local communications, e.g between two computers, have always been digital, but telecommunications have generally been analogue. However, digitization has a number of advantages for telecommunications, including:

- packet switching instead of circuit switching
- all information can be handled by the same equipment
- the information can be handled by computer, and so computer based facilities can be offered which would not be possible otherwise
- dissipation of the signal and noise are minimized
- systems such as optic fibres offering broadband communications can be used.

In view of the listed advantages, the telephone networks of many countries are rapidly being digitized, and digital radio and TV is the favour of the industrialised world. The main types of data communications that take place are inter computer communications, local area networks, circuit switched networks, packet-switched networks, and broadcast networks.

The 1990's will see Ghana and the West Africa sub region seriously going into mobile communication, both terrestial and satellite. The expansion will need to move the region from unsophisticated services to highly advanced services. These services will be available to many on the move and influencing their business. On land cellular telephones and paging will soon need to be placed. Mobile communication satellite is well established for maritime users and is now set to expand to aviation and land users.

RECOMMENDATIONS

The telecommunications services observed in the advanced countries are telephone networks including the telephone, telex, teletex, facsimile, electronic mail, videotex, bulleting boards, on-line databases, videophones, and videoconferencing. The writer is highly convinced that should the West African states, particilarly Ghana, become concerned about the broader advantages of the modern communication technology, their communication deficiencies would be replaced by a rapid economic growth.

To oversee the operation of the future telecommunication network, to see that systems are correctly maintained, and adapt to changing modes for future expansion requirement, dictates that suitable qualified personnel should be trained. It is also necessary to recruit experienced telecommunication engineers.

The Sub-Saharan System (ACIS) requires a carefull conside-ratio in West africa. The system provides: cargo flow projections, live consignment monitoring and historic track data.

6.4 TRAINING INSTITUTIONS

Maritime Academies in developing countries will re-examine their syllabi, and will abandon outdated contents and introduce new ones. Electronics and Automation will receive increased attention in the syllabi for shipboard personnel. Methodological subjects including the use of computers and economics subjects will grow in importance. Maritime academies will continue to offer specialised refreshing and updating courses eg GMDSS. Ship-shore bivalence will receive more attention in future than now. Maritime Education and Training will provide for qualifications on board and in the maritime industry ashore. Certificates of competency will be connected to academic degrees normally equivalent to a Bachelor of Science-degree will qualify for further studies leading to higher degrees. In this direction, the RMA has addressed the issue by embracing a four year degree programme in Bsc. marine technology with options in Marine Engineering, Electrical and Electronic Engineering, Nautical Science.

RECOMMENDATION

Future training in the academy should look at possible areas of personnel management, and also management of ship operation. Both the shore and the ship master need to be aware of the complex innovation of ship technology and a "psychology" of a community at sea. Today's ship master is increasingly expected to be a competent manager, representing the company onboard the ship and capable of running the vessel as a commercially efficient unit. Not only that but with a small crew of which the various members are qualified to carry out tasks in different disciplines.

The Computer Aided Instructions have been with the Aircraft industries for decades, and such demonstration was observed at the Luftansa Trainning Instsitute in Bremen. Certainly with growing introduction of computers in the maritime institutions, CAI will be a prominent issue in the 1990s, and RMA should look in that direction.

The author wishes to note here that the biggest users of computers are mostly found in the public sector, generally authorities like electricity and water boards, central statistical offices, ministries of finance research centres, transport organizations, and national banks. Private enterprises too are adopting computers at an accelerated rate. Currently, Ghana Postal Administration is automating its sorting centres, developing mail transport network and computerising its offices. At the time of writing this project, Ghana Port Authority has already embarked on a programme to computerise the organization. The initiative was noticed at Takoradi port where a mainframe and 6 computer terminals have been installed. Similar arrangements were being placed at the Tema port. For Satcom and Computer programmes RMA should not hestitate to draw its customers of trainees from the shipping industries and extending it to the public and private sectors.

A two year Diploma course in management of ship opera tions would aim to develop skills in the areas of shipping operations, finance, manpower, and information management. Besides preparing managers to better face future challenges in the shipping industry, a trainee can gain a Diploma in Management of Ship Operations, taking a closer look at Multimodal Transport Operations.

It can be expected that new requirements for shipboard training will emerge from future ship, cargo and communication operations. This will result in a continued need for theoretical studies and shipboard experiences. Ship board personnel have to be trained in more advanced studies than now, and to be able to adapt to future changes.

The need for professional mobility in the maritime labour market will have to be responded to by the developing countries as well, having been already envisaged in the developed countries. Subjects will have to be introduced or enlarged in the syllabi for ship officers which are of use aboard and ashore, eg personnel management and computer science .

With the launch of a new SOLAS radio charter early in 1992, onboard staff will have to be reorganised and retrained. Which means the traditional radio officer will eventually be replaced by a radio operator, most probably a navigator with limited background in the field of maritime telecommunications. Although radio equipment manufacturers will produce products adapted to this new category of operators the bulk of exixsting radio equipment was designed to be operated and maintained by the specialist radio officer. Because of this an extensive training programme will be required to prepare the bridge staff for their new tasks in handling transmitters and receivers.

A closer look at the present computer usage in many developing countries reveals, however, a considerable uncertainty as to real achievements and benefits. There is therefore a somewhat less intensive debate about what hampers the utilization of computers in developing countries. One phenomenon is the discrepancy between today's computer architecture, designed for fast data communication, on one hand, and poor data communication facilities in many developing countries on the other hand For efficient and effective communication systems the country will therefore need a data link in their communication network both national and International.

"Modern broadband transmissions via fibre optics, microwave and satellite will lead to the merger of telecommunications and audio-visual technologies. A "service expolsion" is the result: such innovations as telemetry, videotex and video-conference will soon be joined by telenewspaper, speech fascimile, videotelephony, mobile communications and many other applications, 36". Quote, ILO Information. Participation of the teaching staff in the introduction of these modern technologies in our training programmes is essential.

6.5 IMO CONVENTIONS RELATED TO MARITIME COMMUNICATIONS

"The International Conference on safety of Life at sea, 1960 adopted Recommendation 47 on "Merchant ship position reporting" which recommends Contracting Governments to encourage all ships to report their positions when travelling in areas where arrangements are made to collect these positions for search and rescue use. The conference recommended that States should arrange that countries participation in such systems shall be free of message cost to the ships concerned, 37". This recommendation has been reinforced in more recent document.

The final text of amendments to the International

Convention on SOLAS, 1974 concerning Radiocommunications for the GMDSS part B, Regulation 5, it states that each contracting Government undertakes to make available, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, appropriate shore-based facilities for space and terrestrial radiocommunication services having due regard to the recommendations of the Organization. These services include :

1. a radiocommunication services utilizing geostationary satellites in the Maritime Mobile-Satellite Services;

2. a radiocommunication service utilizing polar orbiting satellites in the Mobile-Satellite Service.

Regulation 7, states that every ship shall be provided with:

1. a **VHF radio installation** capable of transmitting and receiving:

(a) DSC on the frequency 156.525MHz(channel 70)

(b) **Radiotelephone** on the frequencies 156.300MHz(channel 6) 156.650 MHz (channel 13) and 156.800 Mhz (channel 16);

2. a **radio installation** capable of maintaining a continuous DSC watch on VHF channel 70 which may be separate from, or combined with, that required above.

3. **a radio facility** for reception of maritime safety information by the INMARSAT enhanced group calling if the ship is engaged on voyages in any area of INMARSAT coverage but in which an international NAVTEX service is not provided.

4. a satellite emergency position-indicating radio beacon **(satellite ERPIRB)**.

5. Until 1 February 1999 or until such other date as may be

determined by the Maritime Safety Commitee, every ship shall, in addition, be fitted with a radio installation consisting of a radiotelephone distress frequency watch receiver capable of operating on 2,182 KHz.

6. Until 1 February 1999, every ship shall, unless the ship is engaged on voyages in sea area A1 only, be fitted with a device for generating the radiotelephone alarm signal on the frequency 2,182 KHz.

6.6 COST FOR FITTING GMDSS EQUIPMENT

The estimated costs for the GMDSS radio equipment were developed by an IMO ad-hoc working group, which attempted to predict the "price tag" for each item of required GMDSS equipment, see table 6.1. The IMO cost estimates were based on assumed present-day manufacture and technology, with projected cost trends towards 1990. The estimates cover only basic equipment, or duplication of essential equipment, the cost of spares and redundant systems are not included in the IMO estimates. They do not also include installation costs which vary widely from case to case. Carriage requirements for these and other radio systems will vary according to the ship's operating area.

For ships trading strictly in coastal area (A1) within VHF range, the total estimated cost is $11,600.

For ships sailing in areas A1 and A2, it will cost $25,600.

For ships in international trade on the high seas (A3), within the coverage of INMARSAT satellites, the costs are estimated to be $39,500 for vessels not fitted with INMARSAT SES and $60,000 for Inmarsat-A SES-equipped ships.

For vessels whose routes take them outside the Inmarsat coverage area (e.g., the polar regions), the carriage requirements, and therefore the costs are essentially identical to those for a non-SES-equiped ship in area A3 ($39,500). These estimates were projected costs in 1984, and at that time the total cost per ship was valued to run upwards of $60,000. However, marketing trends on inovations like the simple pocket calculator which cost about $50.0 in the early 1970s can now be purchased off counter for $7 Onboard satnav equipment price has fallen dramatically. Current computer market price indications tells us that prices are on the downward trend. Should history repeat itself the estimated prices for the GMDSS equipment above would certainly fall till a steady state. It is the opinion of the writer that awaiting for steady state prices would be a difficult task. But the GMDSS implementation period would permit party states enough time to adjust to the new system.

6.7 CO-OPERATION WITH NEIGHBOURING COUNTRY MET INSTITUTION

Maritime Education and Training for any country has proved very expensive and in many cases development is hampered by the shortage of funds. Regional co-operation may enhance development and as a starting point, a closer link can be forged with the Maritime Academy at Abidjan. It would be more beneficial for each instituion to concentrate on one area of expertise. As an example RMA, could concentrate on ARPA ship-simulator training while Abidjan Maritime Academy develops their expertise on the ship handling simulator area

PROVISIONAL COST ESTIMATES FOR GMDSS EQUIPMENT

SHIPBORNE FACILITIES			SHOREBASED FACILITIES	
NO.	EQUIPMENT	ESTIMATED COST (US$)	EQUIPMENT	ESTIMATED COST(US$)
1.	VHF radiostation capable of voice digital selective calling(DSC) communications	5500	VHF DSC	25000
2.	MF radiostation capable of voice and DSC communications	7400	MF DSC	47500
3.	MF/HF radiostation capable of voice, DSC and direct printing communications	11100	HF DSC + radiotelex NBDP	150000 90000
4.	NAVTEX receiver	1000	NAVTEX	90000
5.	INMARSAT SES INMARSAT-A INMARSAT-C	30000 30000 5000	INMARSAT CES	7-10m
6.	Satellite EPIRB (406 MHz)	500-1000	COSPAS-SARSAT LUT	800000
7.	VHF EPIRB	2000	INMARSAT sat CES EPIRB pro. equipment	1000000
8.	SAR transponder	500-1000	SES for use at RCC	30000
9.	Portable VHF equipment(2 sets)	1100	-	-

Table 6.1

Source: IMO Publication no. ISBN 92-801-1216-3

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ANNEX I

COST EFFICIENCY OF MARINET

Real not theoretical Figures!

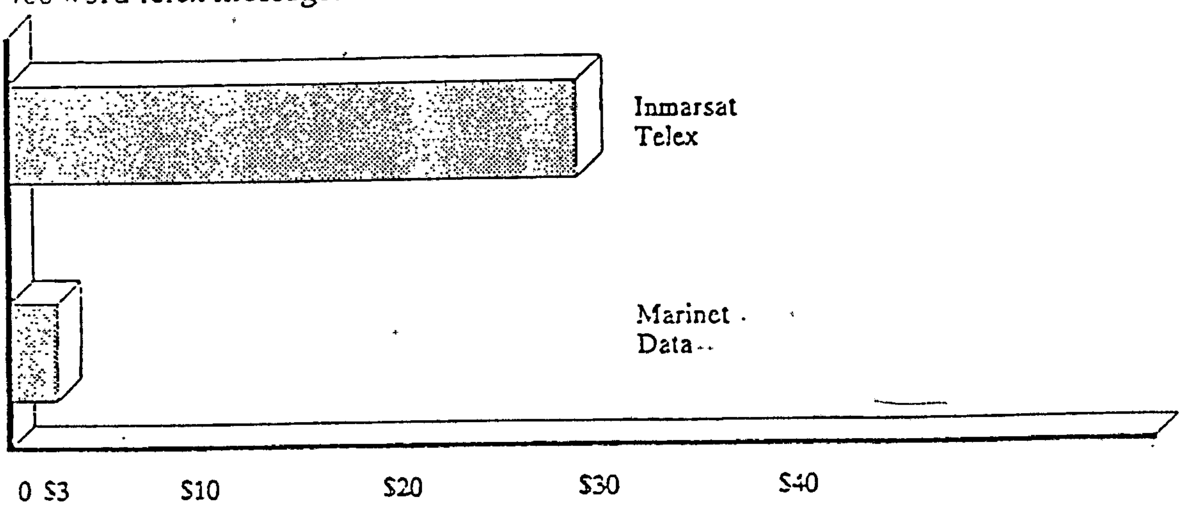
The major savings in air time used and cost achieved with the MARINET system are not simply theoretical calculations they are real savings being achieved by a large existing user base ranging from tanker operators, to passenger vessels, to hotels, to research vessels and naval vessels. These users have assisted in the compilation of this document by providing feedback on real time operating costs.

Example 1

Take the following simple example of sending a single 400 word telex message (one average page of information) via the INMARSAT satellite network.
The telex message takes approximately 7.5 minutes over a standard INMARSAT telex channel. At a charge of $4.00 per minute for standard telex time the overall cost is $30.00. The same message costs $3.00 via MARINET'S high throughput system.
A single cost of one tenth the rate of telex or a percentage cost saving of 90%!

TELEX		
7.5 minutes on line including connect overheads and ansback exchanges.	Rate $4.00 per minute standard.	total $30.00
MARINET		
Total on line time including all overheads 16 seconds (overheads 12 seconds).	Rate $10.00 per minute standard.	total $3.00

Cost efficiency of Marinet v standard Inmarsat telex.
Single 400 word telex message.



This simple cost comparison shows a one way transmission only it does not take into account the substantial fact that MARINET system's are able to send and receive message and data files simultaneously. In other words we can receive a 400 word telex at the same time as we send the above 400 word example. It can be demonstrated that when sending and receiving simultaneously the effective cost of transfer is halved.

DATA : 2400 BPS

1 STOP BIT

1 START BIT

8 DATA BITS

HANDSHAKING 15 SECONDS

THIS MEANS 1 CHARACTER = 10 BITS

2400 / 10 = 240 CHAR / SECOND

DATA COMPRESSION OF 60 %

THIS MEANS 1 A4 PAGE OF 3038 CHARACTERS WILL BECOME

3038 X 60 % = 1822 CHARACTERS

1 A4 PAGE WILL TAKE 1822 / 240 = 7.6 SECONDS

7.6 SEC + 15 SECONDS (HANDSHAKING) = 22.6 SECONDS

22.6 / 6 = 4 UNITS OF DFL 2,20 = DFL 8,80

ANNEX II

ANNEX 23

DRAFT ASSEMBLY RESOLUTION

TRAINING OF RADIO PERSONNEL (GMDSS)

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning maritime safety,

CONSIDERING the 1987 amendments to the Radio Regulations, the 1988 amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974 and the 1991 amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, (STCW), 1978 for introduction of the global maritime distress and safety system (GMDSS),

NOTING that the 1991 amendments to regulation IV/2 of the STCW Convention require that in determining the appropriate level of knowledge and training for certification of GMDSS radio personnel, the Administration shall also take into account the relevant recommendations of the Organization,

NOTING ALSO that resolutions 14 and 15 of the International Conference on Training and Certification of Seafarers, 1978 concerning the training and certification of radio officers and radiotelephone operators do not apply to radio personnel on ships operating in the GMDSS,

NOTING FURTHER that the [draft] Assembly resolution on radio maintenance guidelines for the GMDSS related to sea areas A3 and A4 includes provisions permitting Administrations to approve at-sea electronic maintenance qualifications which are equivalent to those recommended for holders of certificates specified by the Radio Regulations,

RECOGNIZING the need for developing recommendations on training for radio personnel in ships operating in the GMDSS,

HAVING CONSIDERED the recommendation made by the Maritime Safety Committee at its fifty-ninth session,

1. ADOPTS:

(a) Recommendation on Training of Radio Operators related to the First-Class Radioelectronic Certificate, set out in Annex 1;

(b) Recommendation on Training of Radio Operators related to the Second-Class Radioelectronic Certificate, set out in Annex 2;

(c) Recommendation on Training of Radio Operators related to the General Operator's Certificate, set out in Annex 3;

(d) Recommendation on Training of Radio Operators related to the Restricted Operator's Certificate, set out in Annex 4; and

(e) Recommendation on Training of personnel performing maintenance of the GMDSS installations aboard ships, set out in Annex 5;

ANNEX 1

RECOMMENDATION ON TRAINING OF RADIO OPERATORS RELATED TO THE FIRST-CLASS RADIOELECTRONIC CERTIFICATE

1 General

1.1 Before training is commenced, the requirements of medical fitness, especially as to hearing, eyesight and speech, should be met by the candidate.

1.2 The training should be relevant to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), the provisions of the Radio Regulations annexed to the International Telecommunication Convention (Radio Regulations) and the provisions of the International Convention for the Safety of Life at Sea (SOLAS) then in force, with particular attention to provisions for the global maritime distress and safety system (GMDSS). In developing training requirements, account should be taken of knowledge of the following items, which is not an exhaustive list.

2 Theory

2.1 Knowledge of the general principles and basic factors necessary for safe and efficient use of all the subsystems and equipment required in the GMDSS sufficient to support the training requirements listed in the practical section of this Annex.

2.2 Knowledge of the use, operation and service areas of the GMDSS subsystems, including satellite system characteristics, navigational and meteorological warning systems and selection of appropriate communication circuits.

2.3 Knowledge of the principles of electricity and the theory of radio and electronics sufficient to meet the requirements specified in paragraphs 2.4, 2.5, 2.6, 2.7 and 2.8 below.

2.4 Theoretical knowledge of GMDSS radiocommunication equipment, including narrow-band direct-printing telegraphy and radiotelephone transmitters and receivers, digital selective calling equipment, ship earth stations, emergency position-indicating radiobeacons, marine antenna systems, radio equipment for survival craft together with all auxiliary items, including power supplies, as well as general knowledge of the principles of other equipment generally used for radionavigation, with particular reference to maintaining the equipment in service.

2.5 Knowledge of factors that affect system reliability, availability, maintenance procedures and proper use of test equipment.

2.6 Knowledge of microprocessors and fault diagnosis in systems using microprocessors.

2.7 Knowledge of control systems in the GMDSS radio equipment including testing and analysis.

Knowledge of the use of computer software for the GMDSS radio equipment methods for correcting faults caused by loss of software control of the ipment.

Regulations and documentation

The operator should have knowledge of:

.1 the SOLAS Convention and the Radio Regulations with particular emphasis on:

.1.1 distress, urgency and safety radiocommunications;

.1.2 avoiding harmful interference, particularly with distress and safety traffic;

.1.3 prevention of unauthorized transmissions;

.2 other documents relating to operational and communication procedures for distress, safety and public correspondence services, including charges, navigational warnings, and weather broadcasts in the Maritime Mobile Service and the Maritime Mobile Satellite Service;

.3 use of the International Code of Signals and the IMO Standard Marine Navigational Vocabulary.

Watchkeeping and procedures

Training should be given in:

.1 communication procedures and discipline to prevent harmful interference in the GMDSS subsystems;

.2 procedures for using propagation prediction information to establish optimum frequencies for communications;

.3 radiocommunications watchkeeping relevant to all GMDSS subsystems, exchange of radiocommunications traffic, particularly concerning distress, urgency and safety procedures and radio records;

.4 use of the international phonetic alphabet;

.5 monitoring a distress frequency while simultaneously monitoring or working on at least one other frequency;

.6 ship position-reporting systems and procedures;

.7 communication procedures of the IMO Merchant Ship Search and Rescue Manual (MERSAR), using radiocommunications;

.8 radio medical systems and procedures.

Practical

Practical training, supported by appropriate laboratory work, should be given in:

.1 correct and efficient operation of all GMDSS subsystems and equipment under normal propagation conditions and under typical interference conditions;

.2 safe operation of all the GMDSS communication equipment and ancillary devices, including safety precautions;

.3 adequate and accurate keyboard skill for the satisfactory exchange of communications;

.4 operational techniques for:

.4.1 receiver and transmitter adjustment for the appropriate mode of operation, including digital selective calling and direct-printing telegraphy;

.4.2 antenna adjustment and re-alignment, as appropriate;

.4.3 use of radio life-saving appliances;

.4.4 use of emergency position-indicating radio beacons (EPIRBs);

.5 antenna rigging, repair and maintenance, as appropriate;

.6 reading and understanding of pictorial, logic and circuit diagrams;

.7 use and care of those tools and test instruments necessary to carry out at-sea electronic maintenance;

.8 manual soldering and desoldering techniques, including those involving semiconductor devices and modern circuits and the ability to distinguish whether the circuit is suitable to be manually soldered or desoldered;

.9 tracing and repair of faults to component level where practicable, and to board/module level in other cases;

.10 recognition and correction of conditions contributing to the fault occurring;

.11 maintenance procedures, both preventive and corrective for all the GMDSS communication equipment and radionavigation equipment;

.12 methods of alleviating electrical and electromagnetic interference such as bonding, shielding and bypassing.

ANNEX 2

RECOMMENDATION ON TRAINING OF RADIO OPERATORS RELATED TO THE SECOND-CLASS RADIOELECTRONIC CERTIFICATE

1 General

1.1 Before training is commenced, the requirements of medical fitness, especially as to hearing, eyesight and speech, should be met by the candidate.

1.2 The training should be relevant to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), the provisions of the Radio Regulations annexed to the International Telecommunication Convention (Radio Regulations) and the provisions of the International Convention for the Safety of Life at Sea (SOLAS) then in force, with particular attention to provisions for the global maritime distress and safety system (GMDSS). In developing training requirements, account should be taken of knowledge of the following items, which is not an exhaustive list.

2 Theory

2.1 Knowledge of the general principles and basic factors necessary for safe and efficient use of all the subsystems and equipment required in the GMDSS sufficient to support the training requirements listed in the practical section of this Annex.

2.2 Knowledge of the use, operation and service areas of the GMDSS subsystems, including satellite system characteristics, navigational and meteorological warning systems and selection of appropriate communication circuits.

2.3 Knowledge of the principles of electricity and the theory of radio and electronics sufficient to meet the requirements specified in paragraphs 2.4, 2.5, 2.6, 2.7 and 2.8 below.

2.4 General theoretical knowledge of GMDSS radiocommunication equipment, including narrow-band direct-printing telegraph and radiotelephone transmitters and receivers, digital selective calling equipment, ship earth stations, emergency position-indicating radiobeacons, marine antenna systems, radio equipment for survival craft together with all auxiliary items, including power supplies, as well as general knowledge of other equipment generally used for radionavigation, with particular reference to maintaining the equipment in service.

2.5 General knowledge of factors that affect system reliability, availability, maintenance procedures and proper use of test equipment.

2.6 General knowledge of microprocessors and fault diagnosis in systems using microprocessors.

2.7 General knowledge of control systems in the GMDSS radio equipment including testing and analysis.

Knowledge of the use of computer software for the GMDSS radio equipment methods for correcting faults caused by loss of software control of the ipment.

Regulations and documentation

The operator should have knowledge of:

.1 the SOLAS Convention and the Radio Regulations with particular emphasis on:

.1.1 distress, urgency and safety radiocommunications;

.1.2 avoiding harmful interference, particularly with distress and safety traffic;

.1.3 prevention of unauthorized transmissions;

.2 other documents relating to operational and communication procedures for distress, safety and public correspondence services, including charges, navigational warnings, and weather broadcasts in the Maritime Mobile Service and the Maritime Mobile Satellite Service;

.3 use of the International Code of Signals and the IMO Standard Marine Navigational Vocabulary.

Watchkeeping and procedures

Training should be given in:

.1 communication procedures and discipline to prevent harmful interference in the GMDSS subsystems;

.2 procedures for using propagation prediction information to establish optimum frequencies for communications;

.3 radiocommunications watchkeeping relevant to all GMDSS subsystems, exchange of radiocommunications traffic, particularly concerning distress, urgency and safety procedures and radio records;

.4 use of the international phonetic alphabet;

.5 monitoring a distress frequency while simultaneously monitoring or working on at least one other frequency;

.6 ship position-reporting systems and procedures;

.7 communication procedures of the IMO Merchant Ship Search and Rescue Manual (MERSAR), using radiocommunications;

.8 radio medical systems and procedures.

5 Practical

Practical training, supported by appropriate laboratory work, should be given in:

.1 correct and efficient operation of all GMDSS subsystems and equipment under normal propagation conditions and under typical interference conditions;

.2 safe operation of all the GMDSS communication equipment and ancillary devices, including safety precautions;

.3 adequate and accurate keyboard skill for the satisfactory exchange of communications;

.4 operational techniques for:

.4.1 receiver and transmitter adjustment for the appropriate mode of operation, including digital selective calling and direct-printing telegraphy;

.4.2 antenna adjustment and re-alignment, as appropriate;

.4.3 use of radio life-saving appliances;

.4.4 use of emergency position-indicating radio beacons (EPIRBs);

.5 antenna rigging, repair and maintenance, as appropriate;

.6 reading and understanding of pictorial, logic and module interconnection diagrams;

.7 use and care of those tools and test instruments necessary to carry out at-sea electronic maintenance at the level of unit or module replacement;

.8 basic manual soldering and desoldering techniques and their limitations;

.9 tracing and repair of faults to board/module level;

.10 recognition and correction of conditions contributing to the fault occurring;

.11 basic maintenance procedures, both preventive and corrective for all the GMDSS communication equipment and radionavigation equipment;

.12 methods of alleviating electrical and electromagnetic interference such as bonding, shielding and bypassing.

ANNEX 3

RECOMMENDATION ON TRAINING OF RADIO OPERATORS RELATED TO THE GENERAL OPERATOR'S CERTIFICATE

1 General

1.1 Before training is commenced, the requirements of medical fitness, especially as to hearing, eyesight and speech, should be met by the candidate.

1.2 The training should be relevant to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), the provisions of the Radio Regulations annexed to the International Telecommunication Convention (Radio Regulations) and the provisions of the International Convention for the Safety of Life at Sea (SOLAS) then in force, with particular attention to provisions for the global maritime distress and safety system (GMDSS). In developing training requirements, account should be taken of knowledge of the following items, which is not an exhaustive list.

2 Theory

2.1 Knowledge of the general principles and basic factors necessary for safe and efficient use of all the subsystems and equipment required in the GMDSS sufficient to support the training requirements listed in the practical section of this Annex.

2.2 Knowledge of the use, operation and service areas of the GMDSS subsystems, including satellite system characteristics, navigational and meteorological warning systems and selection of appropriate communication circuits.

3 Regulations and documentation

The operator should have knowledge of:

.1 the SOLAS Convention and the Radio Regulations with particular emphasis on:

.1.1 distress, urgency and safety radiocommunications;

.1.2 avoiding harmful interference, particularly with distress and safety traffic;

.1.3 prevention of unauthorized transmissions;

.2 other documents relating to operational and communication procedures for distress, safety and public correspondence services, including charges, navigational warnings, and weather broadcasts in the Maritime Mobile Service and the Maritime Mobile Satellite Service;

.3 use of the International Code of Signals and the IMO Standard Marine Navigational Vocabulary.

4 Watchkeeping and procedures

Training should be given in:

.1 communication procedures and discipline to prevent harmful interference in the GMDSS subsystems;

.2 procedures for using propagation prediction information to establish optimum frequencies for communications;

.3 radiocommunications watchkeeping relevant to all GMDSS subsystems, exchange of radiocommunications traffic, particularly concerning distress, urgency and safety procedures and radio records;

.4 use of the international phonetic alphabet;

.5 monitoring a distress frequency while simultaneously monitoring or working on at least one other frequency;

.6 ship position-reporting systems and procedures;

.7 communication procedures of the IMO Merchant Ship Search and Rescue Manual (MERSAR), using radiocommunications;

.8 radio medical systems and procedures.

5 Practical

Practical training should be given in:

.1 correct and efficient operation of all GMDSS subsystems and equipment under normal propagation conditions and under typical interference conditions;

.2 safe operation of all the GMDSS communications equipment and ancillary devices, including safety precautions;

.3 accurate and adequate keyboard skills for the satisfactory exchange of communications;

.4 operational techniques for:

.4.1 receiver and transmitter adjustment for the appropriate mode of operation, including digital selective calling and direct-printing telegraphy;

.4.2 antenna adjustment and re-alignment as appropriate;

.4.3 use of radio life-saving appliances;

.4.4 use of emergency position indicating radio beacons (EPIRBs).

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4 Watchkeeping and procedures

Training should be given in:

.1 communication procedures and discipline to prevent harmful interference in the GMDSS subsystems used in sea area A1;

.2 VHF communication procedures for:

.2.1 radiocommunications watchkeeping, exchange of radiocommunications traffic, particularly concerning distress, urgency and safety procedures and radio records;

.2.2 monitoring a distress frequency while simultaneously monitoring or working on at least one other frequency;

.2.3 digital selective calling system;

.3 use of the international phonetic alphabet;

.4 ship position-reporting systems and procedures;

.5 communication procedures of the IMO Merchant Ship Search and Rescue Manual (MERSAR) using VHF radiocommunications;

.6 radio medical systems and procedures.

5 Practical

Practical training should be given in:

.1 correct and efficient operation of the GMDSS subsystems and equipment prescribed for ships operating in sea area A1 under normal propagation conditions and under typical interference conditions;

.2 safe operation of the relevant GMDSS communication equipment and ancillary devices, including safety precautions;

.3 operational techniques for:

.3.1 use of VHF, including channel, squelch, and mode adjustment, as appropriate;

.3.2 use of radio life-saving appliances;

.3.3 use of emergency position-indicating radio beacons (EPIRBs);

.3.4 use of NAVTEX receiver.

ANNEX 4

RECOMMENDATION ON TRAINING OF RADIO OPERATORS RELATED TO THE RESTRICTED OPERATOR'S CERTIFICATE

1 General

1.1 Before training is commenced, the requirements of medical fitness, especially as to hearing, eyesight and speech, should be met by the candidate.

1.2 The training should be relevant to the provisions of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), the provisions of the Radio Regulations annexed to the International Telecommunication Convention (Radio Regulations) and the provisions of the International Convention for the Safety of Life at Sea (SOLAS) then in force, with particular attention to provisions for the global maritime distress and safety system (GMDSS). In developing training requirements, account should be taken of knowledge of the following items, which is not an exhaustive list.

2 Theory

2.1 Knowledge of the general principles and basic factors, including VHF range limitation and antenna height effect necessary for safe and efficient use of all the subsystems and equipment required in the GMDSS in sea area A1, sufficient to support the training requirements listed in the practical section of this Annex.

2.2 Knowledge of the use, operation and service areas of the GMDSS sea area A1 subsystems, e.g. navigational and meteorological warning systems and the appropriate communication circuits.

3 Regulations and documentation

The operator should have knowledge of:

.1 those parts of the SOLAS Convention and the Radio Regulations relevant to sea area A1, with particular emphasis on:

.1.1 distress, urgency and safety radiocommunications;

.1.2 avoiding harmful interference, particularly with distress and safety traffic;

.1.3 prevention of unauthorized transmissions.

.2 other documents relating to operational and communication procedures for distress, safety and public correspondence services, including charges, navigational warnings and weather broadcasts in the Maritime Mobile Services in sea area A1;

.3 use of the International Code of Signals and the IMO Standard Marine Navigational Vocabulary.

6 **Miscellaneous**

The operator should have knowledge of, and/or receive training in:

.1 the English language, both written and spoken, for the satisfactory exchange of communications relevant to the safety of life at sea;

.2 world geography, especially the principal shipping routes, services of Rescue Co-ordination Centres (RCCs) and related communication routes;

.3 survival at sea, the operation of lifeboats, rescue boats, liferafts, buoyant apparatus and their equipment, with special reference to radio life-saving appliances;

.4 fire prevention and fire-fighting with particular reference to the radio installation;

.5 preventive measures for the safety of ship and personnel in connection with hazards related to radio equipment, including electrical, radiation, chemical and mechanical hazards;

.6 first aid, including heart-respiration revival technique;

.7 Co-ordinated Universal Time (UTC), global time zones and International Dateline.

GMDSS covered by six resolutions

Several resolutions adopted by the Assembly are designed to assist implementation of the Global Maritime Distress and Safety System (GMDSS), which will be introduced during the 1990s following the adoption of amendments to the International Convention for the Safety of Life at Sea, 1974. These amendments, which were adopted in October 1988, are expected to enter into force on 1 February 1992.

Resolution A.659 (16) deals with the provision of radio services for the GMDSS. It notes that the 1988 SOLAS amendments require Governments to make available shore-based facilities for terrestrial and space radio services and goes on to list other instruments concerned with the provision of radio services. It recommends Contracting Governments to SOLAS to review the need for shore-based services to support the GMDSS.

Three recommendations are annexed to the resolution. The first deals with the provision of radio systems for the GMDSS, the second with criteria for use when providing shore-based digital selective calling (DSC) facilities and the third with criteria for establishing GMDSS sea areas.

Resolution A.660 (16) deals with the carriage of satellite emergency position-indicating radio beacons (EPIRBs). The carriage of EPIRBs, which are designed to float free from the ship in the event of the ship sinking and automatically transmit a distress message, will be mandatory on all ships from 1 August 1993. The resolution recommends Administrations to encourage the fitting of such EPIRBs before this date.

Resolution A.661 (16) is related to the previous resolution and contains performance standards for float-free EPIRBs operating in the 1.6 GHz band through the system operated by the International Maritime Satellite Organization (INMARSAT). EPIRBs of this type are permitted in certain sea areas within INMARSAT range as an alternative to satellites operating on 406 MHz, the COSPAS-SARSAT frequency. Performance standards for the latter were adopted by the 15th IMO Assembly in resolution A.611 (15).

Resolution A.662 (16) contains performance standards for float-free release and activation arrangements for emergency radio equipment. The standards are designed to ensure that EPIRBs are automatically released from a sinking ship and automatically activated.

Resolution A.663 (16) is concerned with performance standards for INMARSAT Standard-C ship earth stations capable of transmitting and receiving direct-printing communications. Standard-C equipment has been accepted as an alternative to INMARSAT Standard-A equipment. Its main advantage is that it is small and cheap, making it suitable for small craft such as yachts and fishing vessels. It permits communications by telex but not voice.

Resolution A.664 (16) covers performance standards for enhanced group call (EGC) equipment. EGC is a means of providing safety information through the INMARSAT system and is required on ships operating within range of INMARSAT services unless they are fitted with another service known as NAVTEX. It operates through a dedicated receiver or through INMARSAT Standard-A or Standard-C receivers.

ANNEX III

DIPLOMA IN MARITIME COMMUNICATION
SUBJECT CONTENT

SUBJECT NO. DC001 INTRODUCTION TO SATELLITE AND COMPUTER COMMUNICATION

<u>SUBJECT CONTENT</u>

COMMUNICATION SATELLITE DEVELOPMENT
USE OF SATELLITE FOR COMMUNICATION
EMERGENCE OF COMPUTERS IN COMMUNICATION
TOTAL 30 HOURS

SUBJECT NO. DC002 ELEMENTS AND PERFORMANCE OF COMMUNICATION SATELLITE

<u>SUBJECT CONTENT</u>

SPACE SEGMENT
GROUND SEGMENT
TOTAL 36 HOURS

SUBJECT NO. DC004 SATELLITE ORBIT AND POSITIONING

<u>SUBJECT CONTENT</u>

ORBITS AND INCLINATION
ANGLE OF ELEVATION
PROPAGATION DELAY AND ORBITAL SPACING
TOTAL 30 HOURS

SUBJECT NO. DC005 TELETRAFFIC

SUBJECT CONTENT

TYPES OF TRAFFIC
INTERFACE BETWEEN TERRESTRIAL AND
SATELLITE SYSTEMS
SOURCE OF SATELLITE TRAFFIC AND TELETRAFFIC
TOTAL 30 HOURS

SUBJECT NO. DC006 COMMUNICATION SATELLITE SYSTEMS

SUBJECT CONTENT

COMMUNICATIONS FREQUENCIES AND BANDWIDTH
POLARIZATION AND FREQUENCY REUSE
TRANSPONDERS AND REPEATER CHANNELIZATION
POWER AMPLIFIERS
RECEIVERS AND NOISE CONSIDERATIONS
UP-LINK BUDGETS
DOWN-LINK BUDGETS
INTERSATELLITE LINK BUDGETS
OVERALL LINK PERFORMANCE
SIGNAL-TO-NOISE RATIOS
DIGITAL LINK PERFORMANCE
CARRIER TO-NOISE RATIO
TOTAL 36 HRS

SUBJECT NO. DC007 EARTH STATIONS AND TERRESTRIAL LINKS

SUBJECT CONTENT

EARTH STATION SUPPORTING SYSTEMS AND ELECTRONICS
TERRESTRIAL LINKS AND DISTRIBUTION

LOW NOISE RECEIVER
SIGNAL AND NOISE LEVELS IN TRANSMISSION SYSTEMS
TOTAL 30 HRS.

SUBJECT NO. DC008 MULTIPLE ACCESS TECHNIQUES

SUBJECT CONTENT

OVERVIEW OF MULTIPLE ACCESS
FREQUENCY DIVISION MULTIPLE ACCESS (FDMA)
TIME DIVISION MULTIPLE ACCESS(TDMA)
SPACE DIVISION MULTIPLE ACCESS (SDMA)
CODE DIVISION MULTIPLE ACCESS (CDMA)
RANDOM MULTIPLE ACCESS (RMA)
TOTAL 30 HRS.

SUBJECT NO. DC011 DIGITAL COMMUNICATIONS

SUBJECT CONTENT

SAMPLING PRINCIPLES
PULSE-AMPLITUDE MODULATION
PULSE-CODE MODULATION
PULSE-TIME MODULATION
DELTA MODULATION
DIGITAL SGNALING
DETECTION OF DIGITAL SIGNALS
TOTAL 30 HRS.

SUBJECT NO. DC012 USES OF SATELLITE CIRCUITS FOR DATA TRANSMISSION

SUBJECT CONTENT

THE EFFECT OF FRAME COUNT
INEFFICIENT TRANSMISSION
CURVES SHOWING THE EFFECT OF ERRORS
FLOW CONTROL AND PACING
TOTAL 30 HRS

SUBJECT NO. DC013 USES OF SATELLITE FOR INTERACTIVE COMPUTING

SUBJECT CONTENT

TERMINAL DIALOGUES
TRANSMISSION SPEEDS
SPORADIC TRANSMISSION
SHARING
PEAK/AVERAGE RATIOS
TERRESTRIAL LINE CONTROL
TOTAL 34 HRS

SUBJECT NO. DC014 ERROR IN TRANSMISSION

SUBJECT CONTENT

SETELLITE TRANSMISSION DELAY
CHANNEL EFFICIECY
RESPONSE TIME
RETRANSMISSION PROBABILITIES
FORWARD ERROR CORRECTION
CODING COMPLEXITY
TYPES OF CODE

EFFECT OF ERROR CORRECTION
TOTAL 26 HRS.

SUBJECT NO. DC015 TRANSMISSION LOSSES

SUBJECT CONTENT

ISOTROPIC RADIATION
ANTENNA GAIN
GAIN IN RECEIVING ANTENNA
FREE SPACE LOSS
LINK LOSS
LOSS IN UP-LINK
LOSS IN DOWN-LINK
ATMOSPHERIC ABSORPTION
BAD WEATHER
TOTAL 25 HRS.

SUBJECT NO. DC020 AVAILABILITY

SUBJECT CONTENT

SPACE SEGMENT AVAILABILITY
ECLIPSE AND OUTAGES
GROUND SEGMENT AVAILABILITY
SATELLITE CONTROL FACILITY
BIT ERROR RATE
TOTAL 39 HRS

SUBJECT NO. DC022 LOCAL AREA NETWORK AND STANDARDS

<u>SUBJECT</u> <u>CONTENT</u>

CHARACTERISTICS OF LOCAL AREA NETWORKS
LAN STANDARDS
SERVICE AND PROTOCOL SPECIFICATION
THE IMPORTANCE OF STANDARDS
TOTAL 30 HOURS

SUBJECT NO. CD023 TYPES OF LAN

<u>SUBJECT</u> <u>CONTENT</u>

CLASSIFICATION OF LANs
INTER-COMPUTER COMMUNICATIONS
LOCAL AREA NETWORKS
CIRCUIT-SWITCHED NETWORKS
PACKET SWITCHED NETWORKS
BROADCAST NETWORKS
TELECOMMUNICATION SERVICES
APPLICATIONS
TOKEN RING AND BUS
HIGHER LEVEL PROTOCOLS
NETWORK MANAGEMENT
TOTAL 60 HOURS

SUBJECT NO. CD024 MICROPROCESSOR

<u>SUBJECT CONTENT</u>

HOW A MICROPROCESSOR WORKS

THE CENTRAL PROCESSING UNIT

THE CONTROL UNIT

THE ARITHMETIC/ LOGIC UNIT, LOGIC GATES, LOGIC CIRCUITS

BITS, BITES, AND WORDS

BINARY NUMBERS

SEMICONDUCTOR STORAGE UNIT

RAM AND ROM

COMPUTER PROCESSING SPEEDS

TOTAL 34 HOURS

SUBJECT NO. CD025 COMPUTER, TECHNOLOGY

<u>SUBJECT CONTENT</u>

THE COMPLETE HARDWARE SYSTEM

INPUT DEVICES

MEMORY DEVICES

OUTPUT DEVICES

STORAGE DEVICES AND FILE PROCESSING

CLLASSIFICATIONS: COMPUTERS BIG AND SMALL

HOW SOFTWARE WORKS

SOFTWARE AND TYPES OF SOFTWARE

TOTAL 20 HOURS

SUBJECT NO. CD027 OPERATING SYSTEMS

<u>SUBJECT CONTENT</u>

OPERATING SYSTEMS FOR PRESONAL COMPUTERS, USING MS-DOS

LOADING DOS

GUIDE TO DOS

EXERCISES FOR DOS

TOTAL 60 HOURS

SUBJECT NO. CD028 WORD PROCESSING

<u>SUBJECT CONTENT</u>

HOW WORD PROCESSING WORKS

TOTAL 30 HOURS

SUBJECT NO. CD031 AMPLITUDE MODULATION SYSTEMS

<u>SUBJECT CONTENT</u>

ELECTROMAGNETIC COMMUNICATIONS
CARRIER WAVES AND MODULATION
FIBRE OPTICS
FREQUENCY TRANSLATION
AMPLITUDE MODULATION
THE SQUARE LAW DEMODULATOR
SINGLE SIDE BAND MODULATION
METHODS OF GENERATING A SINGLE SIDEBAND
MULTIPLEXING
MODEMS
TOTAL 49 HOURS

COURSE NO. CD032 FREQUENCY MODULATION SYSTEMS

<u>SUBJECT CONTENT</u>

RELATIONSHIP BETWEEN PHASE AND FREQUENCY MODULATION

SPECTRUM OF AN FM SIGNAL
BANDWIDTH OF A SINUSOIDALLY MODULATED FM SIGNAL
SPECTRUM OF NARROWBAND ANGLENMODULATION
SPECTRUM OF WIDEBAND FM (WBFM)
BANDWIDTH REQUIRED FOR A GAUSSIAN MODULATED WBFM SIGNAL
THE ARMSTRONG SYSTEM, AN INDIRECT METHOD OF FREQUENCY MODULATION
FREQUENCY MULTIPLICATION APPLIED TO FM SIGNALS
FM DEMODULATORS
TOTAL 19 HOURS

SUBJECT NO. CD033 ANALOG-TO-DIGITAL CONVERSION

SUBJECT CONTENT

PULSE MODULATION SYSTEMS
THE SAMPLING THEOREM: LOW-PASS SIGNALS, HIGH-PASS SIGNALS
BAND-PASS SIGNALS
PULSE-AMPLITUDE MODULATION (PAM)
CHANNEL BANDWIDTH FOR A PAM SIGNAL
NATURAL SAMPLING
SIGNAL RECOVERY THROUGH HOLDING
PULSE-CODE MODULATION (PCM)
ELECTRICAL REPRESENTATION OF BINARY DIGITS
PCM SYSTEM
MULTIPLEXING PCM SIGNALS
TOTAL 38 HOURS

SUBJECT NO. CD034 DIGITAL MODULATION TECHNIQUES

SUBJECT CONTENT

BINARY PHASE-SHIFT KEYING (BPSK)
BINARY FREQUENCY SHIFT KEYING (BFSK)

SIMILARITY OF BFSK AND BPSK

PARTIAL RESPONSE SIGNALING

AMPLITUDE MODULATION OF PARTIAL RESPONSE SIGNAL

TOTAL 20 HOURS

SUBJECT NO. CD035 NOISE AMPLITUDE-MODULATION SYSTEMS

SUBJECT CONTENT

AMPLITUDE-MODULATION RECEIVER

ADVANTAGE OF THE SUPERHETERODYNE PRINCIPLE: SINGLE CHANNEL

SINGLE SIDEBAND SUPPRESSED CARRIER (SSB-SC)

DOUBLE-SIDEBAND SUPPRESSED CARRIER (DSB-SC)

DOUBLE SIDE BAND WITH CARRIER

SQUARE-LAW DEMODULATOR

THE ENVELOP DEMODULATOR

TOTAL 30 HOURS

SUBJECT NO. CD036 NOISE IN FREQUENCY-MODULATION SYSTEMS

SUBJECT CONTENT

CALCULATION OF OUTPUT SIGNAL AND NOISE POWERS

COMPARISON OF FM AND AM

PHASE MODULATION IN MULTIPLEXING

COMPARISM BETWEEN FM AND PM IN MULTIPLEXING

EFFECT OF TRANSMITTER NOISE

TOTAL 22 HOURS

SUBJECT NO. CD037 DATA TRANSMISSION

SUBJECT CONTENT

BASEBAND SIGNAL RECEIVER
PROBABILITY OF ERROR
WHITE NOISE
PHASE SHIFT KEYING
FREQUENCY SHIFT KEYING
BIT-BY-BIT ENCODING VERSUS SYMBOL BY SYMBOL ENCODING
RELATION BETWEEN BIT ERROR RATE AND SYMBOL ERROR RATE
TOTAL 38 HOURS

SUBJECT NO. CD038 INFORMATION THEORY

SUBJECT CONTENT

DISCREET MESSAGES
INFORMATION RATE
CODING TO INCREASE AVERAGE INFORMATION PER BIT
SHANNON's THEOREM, CHANNEL CAPACITY
CAPACITY OF GAUSSIAN CHANNEL
USE OF ORTHOGONAL SIGNALS TO ATTAIN SHANNON's LIMIT
EFFICIENCY OF ORTHOGONAL SIGNAL TRANSMISSION
TOTAL 42 HOURS

SUBJECT NO. CD039 TELEPHONE SWITCHING

SUBJECT CONTENT
ELEMENTARY PHONE SYSTEM
CENTRAL SWITCHING
SIMPLE EXCHANGE
AUTOMATIC DIALING SYSTEM
TRAFFIC LOAD AND SERVICE GRADE
HIERARCHY OF SWITCHING OFFICES
MULTIPLE STAGE SWITCHING
TIME-DIVISION MULTIPLEXING
ANALOG TIME-DIVISION SWITCHING

TIME SLOT INTERCHANGE (TSI)

COMPARISON OF TSI WITH SPACE SWITCHING

SPACE ARRAY FOR DIGITAL SIGNALS

COMBINED SPACE AND TIME SWITCHING

MOBILE TELEPHONE COMMUNICATION- THE CELLULAR CONCEPT

TOTAL 60 HOURS

SUBJECT NO. CD041 CODING

SUBJECT CONTENT

PARITY CHECK BIT CODING FOR ERROR DETECTION

CODING FOR ERROR DETECTION AND CORRECTION

BLOCK CODES-CODING AND DECODING

BURT ERROR CORRECTION

COMPARISON OF ERROR RATES IN CODED AND UNCODED TRANSMISSION

AUTOMATIC-REPEAT-REQUEST(ARQ)

PERFORMANCE OF ARQ SYSTEMS

TOTAL 30 HOURS

SUBJECT NO. CD042 FILTERS

SUBJECT CONTENT

TWO STATE FILTERS

ALPHA BETA FILTERS

KALMAN FILTERS

THE MATCHED FILTER

TOTAL 30 HOURS

ANNEX IV

DIAGRAM A1 shows the procedure to be adopted onboard a vessel fitted with VHF equipment only, navigation in the A1 sea area.

DIAGRAM A2 shows the porcedure to be adopted onboard a vessel fitted with VHF and MF equipment navigation not beyond the A2 sea area.

DIAGRAM A3 shows the procedure to be adopted onboard a vessel with INMARSAT-SES navigating not beyond the A3 sea area.

DIAGRAM A4 shows the procedure to be adopted onboard vessels not fitted with INMARSAT-SES navigating in area A3 and all vessels navigating in Area A4.

Diagram A1

GMDSS OPERATING PROCEDURES FOR VESSELS IN DISTRESS NAVIGATING NOT BEYOND AREA A1

A 1

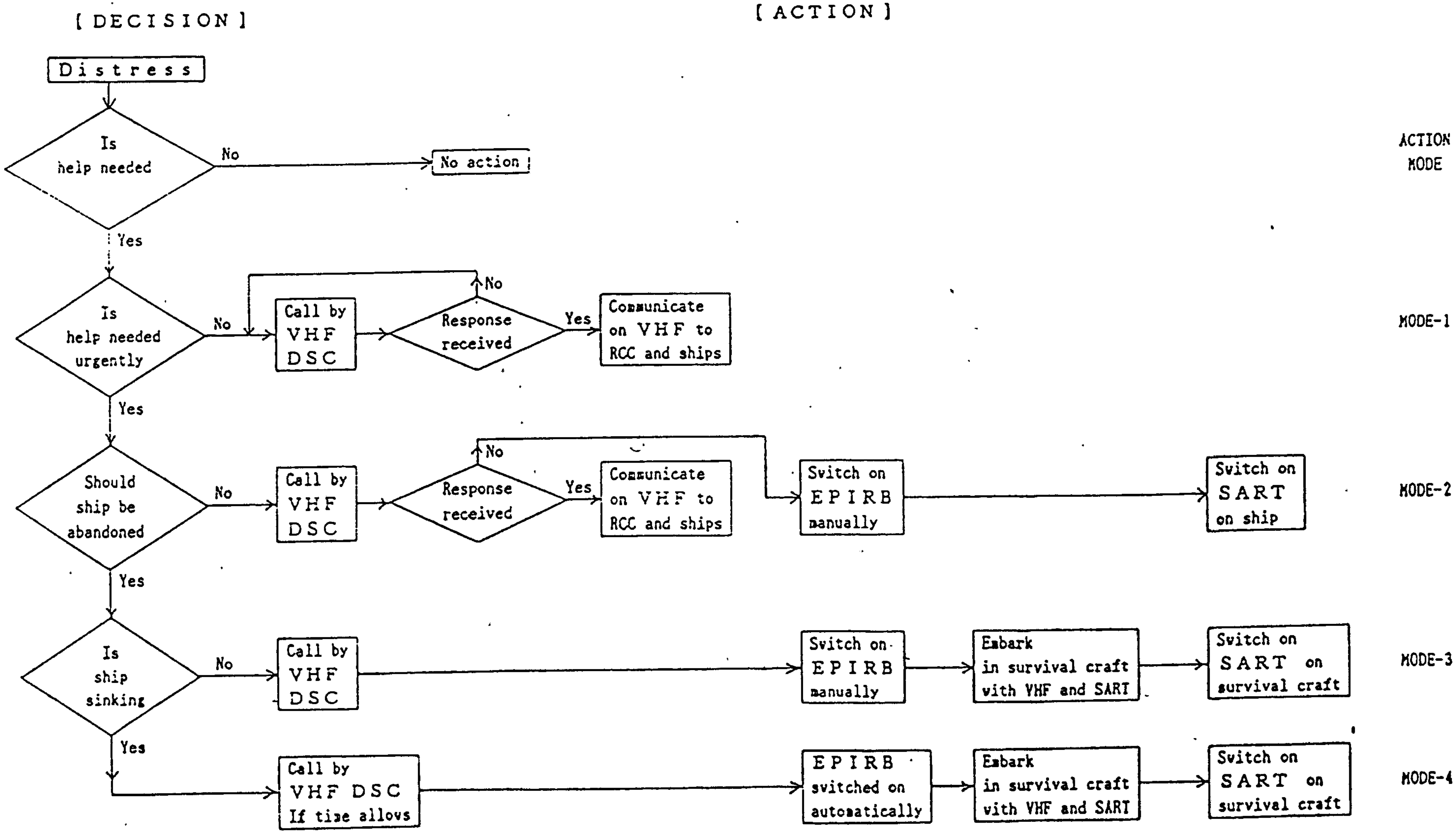
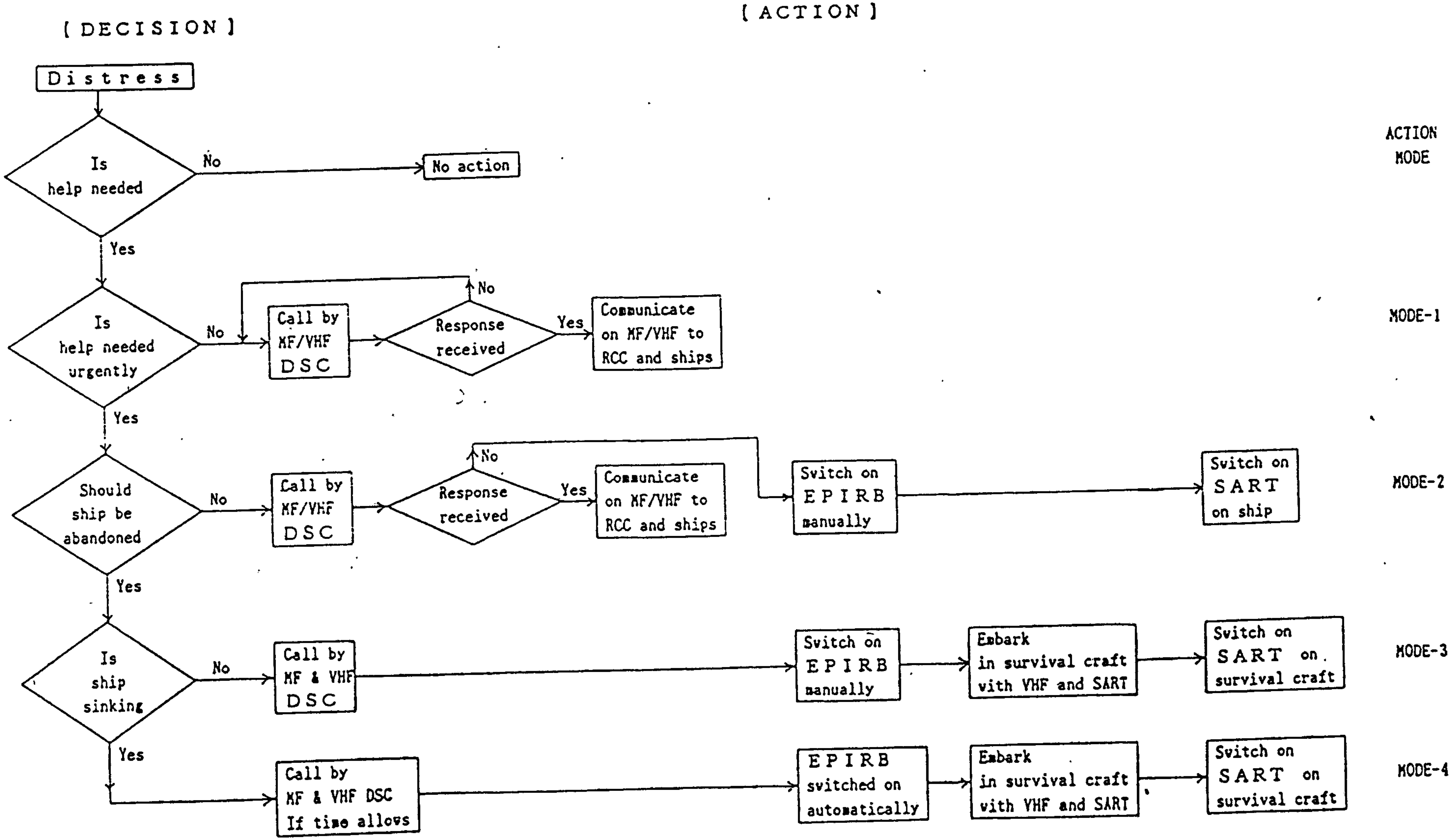


Diagram A2

GMDSS OPERATING PROCEDURES FOR VESSELS IN DISTRESS NAVIGATING NOT BEYOND AREA A2



GMDSS OPERATING PROCEDURES FOR VESSELS IN DISTRESS EQUIPPED WITH SATELLITE COMMUNICATIONS SYSTEMS AND NAVIGATING NOT BEYOND AREA A3

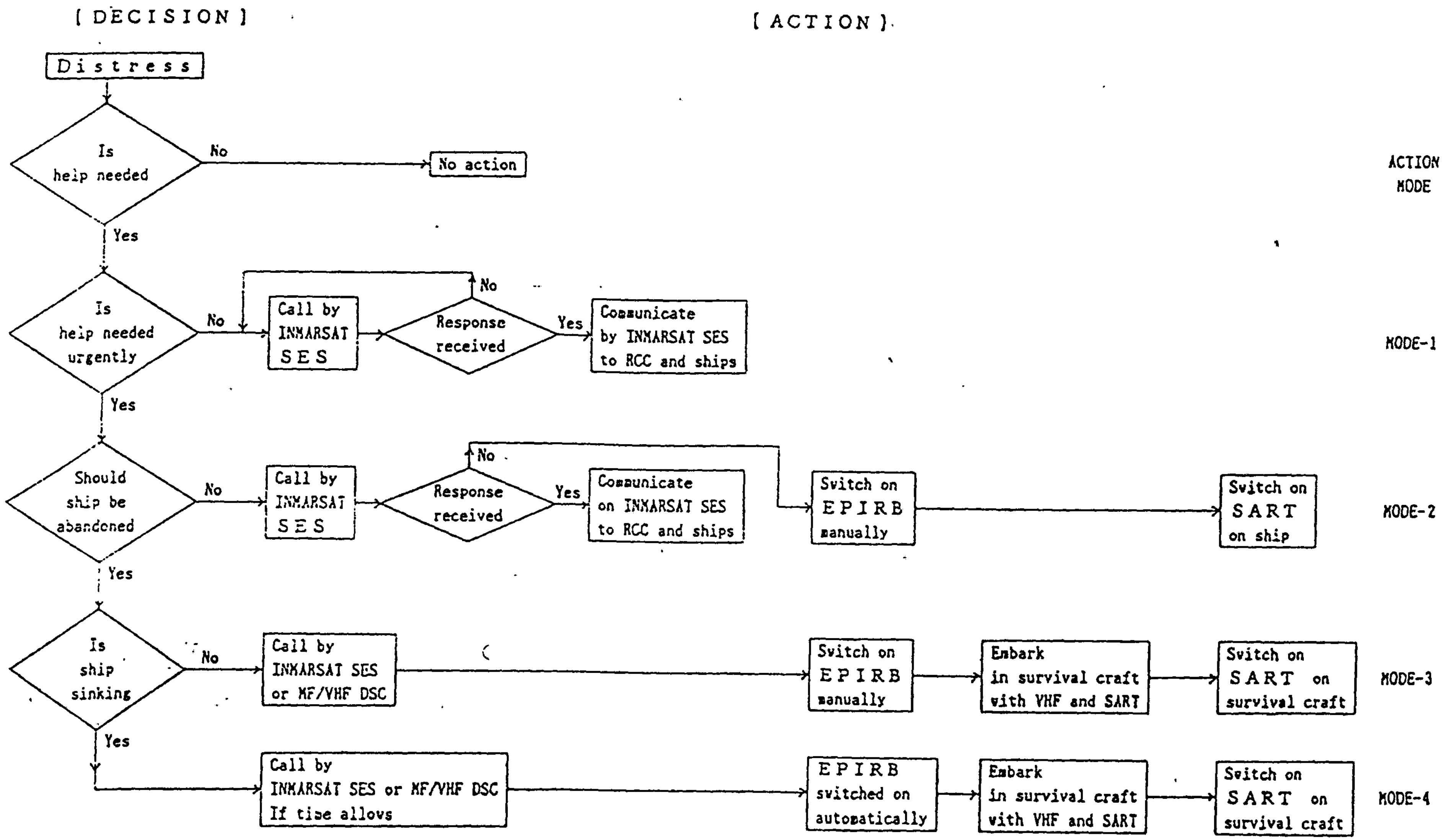


Diagram A4

GMDSS OPERATING PROCEDURES FOR VESSELS IN DISTRESS NOT EQUIPPED WITH SATELLITE COMMUNICATIONS SYSTEMS NAVIGATING IN AREA A3 AND ALL VESSELS NAVIGATING IN AREA A4