Interfacing the Automated Maritime Mobile Telephone System with the U.S. Public Switched Telephone Network

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August 1978

PREFACE

The study reported here is part of a continuing program being conducted by the National Telecommunications and Information Administration for the U.S. Maritime Administration of the Department of Commerce. The program manager for the Maritime Administration is Mr. C. S. Mathews.

The views and opinions expressed in this report are those of the authors and should not be construed as an official position or policy of the U. S. Maritime Administration.

The comments and suggestions from members of the Radio Technical Commission for Marine Services, Special Committee 71 (RTCM SC-71), in particular from Mr. Ross H. Herrick, Consultant to Loraine Electronics Corporation and from Mr. W. H. Keller of the American Telephone and Telegraph Company (A.T. & T), are gratefully acknowledged.

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AMMTS	Automated Maritime Mobile Telephone System
AT&T	American Telephone and Telegraph Co.
CCIR	International Radio Consultative Committee
CCIS	Common Channel Interoffice Signaling
CCITT	International Telephone and Telegraph Consultative Committee
DDD	Direct Distance Dialing
DTMF	Dual Tone Multifrequency
EO	End Office
FCC	Federal Communications Commission
FNPA	Foreign Numbering Plan Area
FM	Frequency Modulation
HNPA	Home Numbering Plan Area
Hz	Hertz or cycle per second
IWP	Interim Working Party (CCIR)
MARAD	Maritime Administration (U.S.)
MSC	Maritime Switching Center
NC	National Center
NPA	Numbering Plan Area
PABX	Private Automatic Branch Exchange
PTT	Postal, Telephone & Telegraph administration
RC	Regional Center
TDMA	Time Division Multiple Access
UHF	Ultra High Frequency (300 MHz to 3 GHz)
U.S.	United States
VHF	Very High Frequency (30 MHz to 300 MHz)
WATS	Wide Area Telephone Service

INTERFACING THE AUTOMATED MARITIME MOBILE TELEPHONE SYSTEM WITH THE U. S. PUBLIC SWITCHED TELEPHONE NETWORK

R. F. Linfield and T. de Haas*

This report summarizes the characteristics of the U. S. public switched network and the maritime radio service, which impact the development of an Automated Maritime Mobile Telephone System (AMMTS). Features and performance parameters which appear desirable to an AMMTS user are reviewed and some basic system concepts capable of satisfying these user's needs are presented. The interface between the public switched network and coast stations serving the maritime community is discussed in detail. Techniques for automatically placing a call to ships whose location is unknown are described. The development of an AMMTS involves a number of issues which may be different in the U. S. than in other countries of the world. The final section of the report defines some issues requiring further study.

Key words: Maritime communications, automated telephone systems, network interfacing

1. BACKGROUND

The International Radio Consultative Committee (CCIR) is studying the functional requirements, operational characteristics and technical specifications for Automated VHF/UHF Maritime Mobile Telephone Systems (AMMTS).

This report summarizes some of the concepts, issues, and alternatives which should be carefully considered in developing such a system. The emphasis is on the interface between the U.S. public switched network and the maritime public correspondence radio telephone. The characteristics of these two facilities in the U.S. are discussed first since they differ considerably from most countries of the world. Then, some of the basic requirements for an automated mobile maritime telephone service are summarized so that some procedures and techniques for meeting these requirements can be described. Finally, some issues are raised which require further study so that the most economical system satisfying the U. S. and the international maritime community can be developed.

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2. CHARACTERISTICS OF THE U.S. SWITCHING ENVIRONMENT

The public switched telephone service and the maritime communication service in the U.S. have distinct characteristics which differ from many other countries. It is necessary to interface the two types of service in order to extend automatic telephone service beyond its present limits. The establishment of these interface requirements involves our understanding of the unique character of these services if the needs of the U.S. and the international maritime community are to be satisfied with the most economical system.

In most countries outside North America the telecommunications networks are almost exclusively controlled by government departments or semi-governmental corporations; for example, Postal, Telegraph and Telephone (PTT) administrations, Post Office corporations, etc. However, in the United States public voice and record telecommunications services are predominantly provided by the private sector, i.e., private operating agencies, often referred to as common carriers.

Distinct characteristics of the public switched network in the U.S. which should be considered include the following (Polishuk, 1977; AT&T, 1975; CCM, 1975):

- Telecommunication services and equipment manufacture (e.g., telephone service, record transmission, satellite transmission facilities, mobile radio communications) are furnished by private industries.

- All commerce in communications (interstate and international) by radio and wire is regulated by the Federal Communications Commission. This includes approval of rate structures for the various service offerings, frequency allocations, and station licensing.

- The largest private industry is the telephone service industry with over 150 million telephones in service (as of January 1977). The 23 operating companies of the Bell System supply 80 percent of the telephones in service. The other 20 percent of the telephones in service are furnished by some 1600 so-called independent (i.e., non-Bell System) operating companies. Several independent operating companies are of a size serving over one million telephones, such as General Telephone and Equipment (GTE), United Telephone (UTC), Continental Telephones, and Central Telephone and Utilities. On the other side of the scale, many small independent operating companies serve only one community or rural area with only a few hundred telephones.

- Telephone industry standards are largely derived from Bell standards and are not necessarily compatible with CCIR/CCITT standards.

- There is an increased emphasis by the U. S. government to establish competition in the telecommunications industry.

- Telephone equipment, dialing equipment, switching equipment and signaling equipment may differ throughout the network. For example, step-by-step, crossbar, and electronic switching centers may all be interconnected. Decentralized signaling, similar to CCITT signaling system R1 (CCITT, 1977b), is used in large portions of the telephone trunking network in the U.S. In this system the signaling information is progressively carried forward over the same trunk circuits that will form the end-to-end connection. As new switching centers are installed Common Channel Inter-office Signaling (CCIS), similar to CCITT signaling system No. 6 (CCITT, 1977c) is gradually replacing the R1 system for signaling between switching centers equipped with stored program control. CCIS is based on central processing of all signaling information in the switching center and transmission of the signaling information over separate common signaling channels.

The hierarchical structures and associated class numbers given to different levels of switching centers in North America are shown in Figure 1. Subscriber loops are normally terminated in end offices, which in turn are interconnected via the hierarchical structures. The basic switching system for an end office is illustrated in Figure 2. Access to the switching

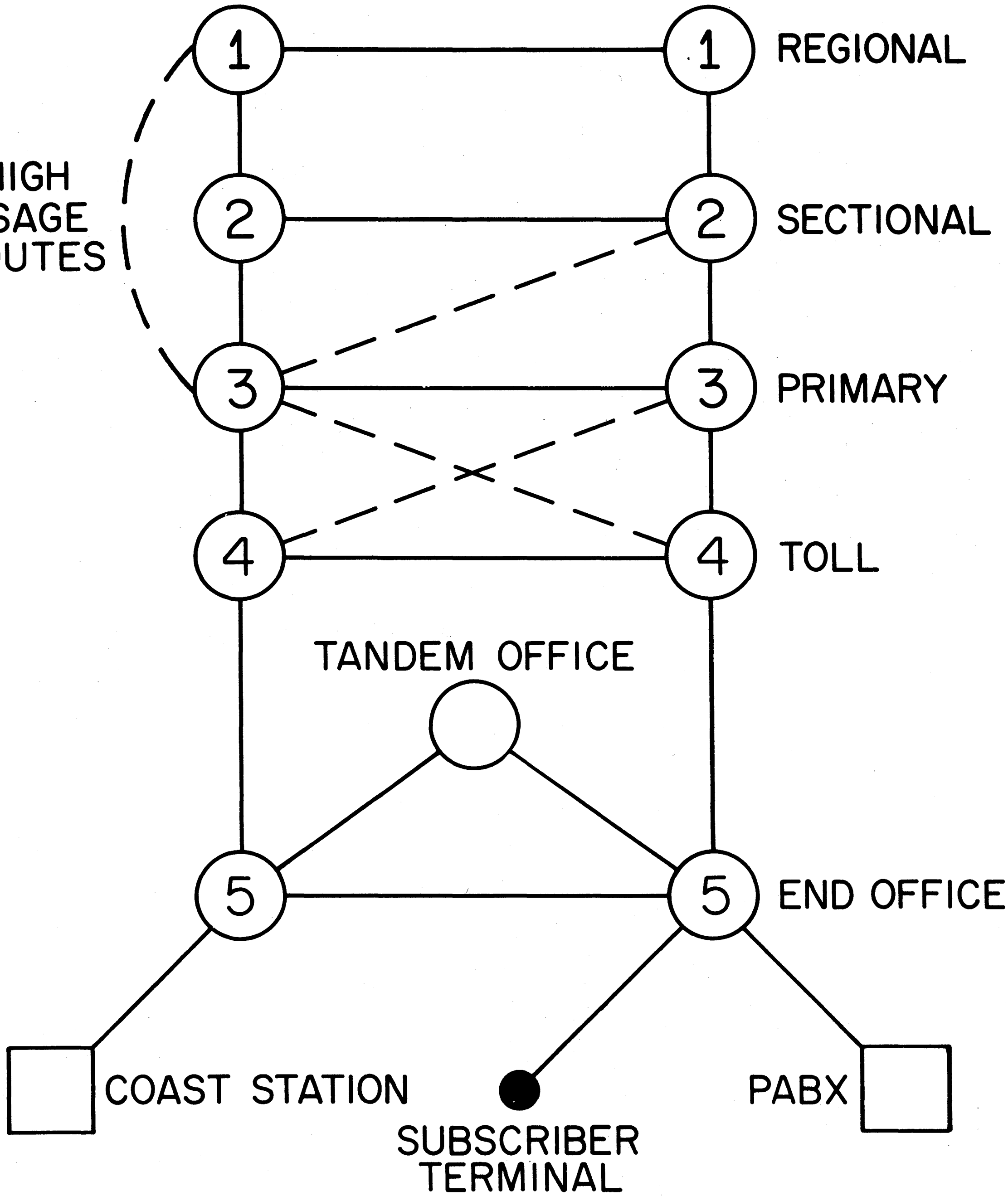

Figure 1. Switching centers in North American hierarchy.

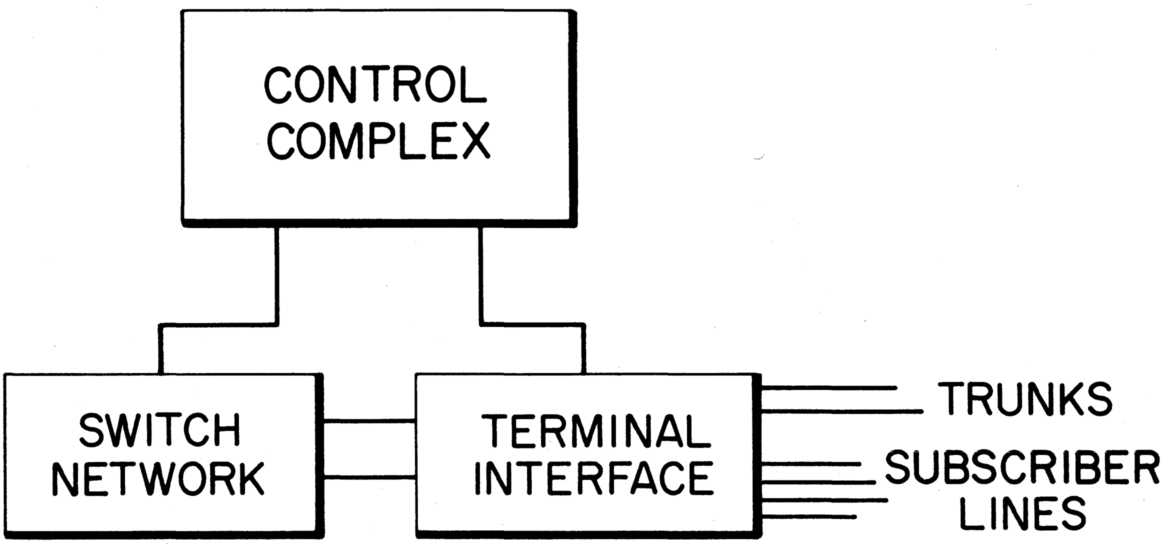

Figure 2. Basic end office switching system.

hierarchy below the class 5 (end office) level could be considered as a "class 6" level. Examples of this level include Private Automatic Branch Exchanges (PABX) serving office complexes or a coast station serving the maritime community.

This outside access to the network requires access lines to an end office, with the end office usually providing the accounting functions, line test facilities, and dc dial pulse or dual-tone multifrequency (DTMF) signaling capabilities normally associated with subscriber line type connections.

2.1. Numbering Plan

Table 1 indicates some common dialing procedures currently in use in the United States, Canada, and parts of Mexico. Some variations exist due to the variety of switching equipment still in use. The North American continent is divided geographically into Numbering Plan Areas (NPAs) and each area is assigned a 3-digit code. Subscriber connections within a given area (i.e., those having the same area code) are considered to be in a Home Numbering Plan Area (HNPA). Subscribers calling within a HNPA need not dial the area code but may need to dial a 1 prefix. Direct-dialed connections to a "Foreign" Numbering Plan Area (FNPA) usually requires the subscriber to dial a prefix 1, followed by a 3-digit area code. In addition to this, a 3-digit office code and a 4-digit station code must be dialed. Together these 10 digits provide a unique address (i.e., national number) for each telephone.

For operator assisted calls such as person-to-person calls, collect calls, credit-card calls, and third-number billing calls, the prefix 0 is used.

Toll-switching offices (i.e., those above class 5) generally use step-by-step, crossbar, or electronic switches with common control. The signaling equipment from these switches is technically capable of registering 13 to 15 digits although they are usually required to outpulse no more than 10 to 12 digits. The more recently designed electronic switches are arranged to handle only 10 digits. Digit deletion, substitution or addition is feasible between certain offices. It is possible to delete an office or area code, for example, when pulsing into that office or area (AT&T, 1975).

Table 1

Common Dialing Procedures
used in
North America

	Prefix	Area	Office	Terminal
Home No. plan area (HNPA)				
o local call	--		NNX	XXXX
o toll call (DDD)	(--/1)		NNX	XXXX
o operator assisted call	0		NNX	XXXX
"Foreign" no. plan area (FNPA)				
o toll call (DDD)	(--/1)	N(0/1)X	NNX	XXXX
o operator assisted call	0	N(0/1)X	NNX	XXXX
		national number (Area + Office + Terminal)		
International				
o direct call	011	(country)	(national number)	
0 operated assisted call	01	(country)	(national number)	
		maximum 12 digits (country + national number)		

Notes

(--/1): no prefix or prefix 1

(0/1): digit is 0 or 1

N : any digit between 2 and 9

X : any digit between 0 and 9

DDD: Direct-Distance-Dialed call

In order to conserve office codes, paging service is sometimes provided on an end-to-end signaling basis, rather than assigning a unique address to each receiver. A subscriber to this service must first dial the paging control terminal. He then dials the multidigit number of the desired receiver using a push-button station equipment which transmits unique dual frequency tones for each digit. This two-step procedure has potential application in the maritime-mobile service, as discussed in section 5.

International direct-distance-dialing requires the use of the international access code 011 or 01 for operator assistance. The second digit (1) must follow the first digit (0) by less than 3 seconds in order to distinguish this prefix from the operator assistance prefix 0. The number of subscriber-dialed digits, excluding the international prefix, should not be more than 12 (CCITT, 1977d). A total of 12 digits actually exceeds the capacity of the toll network and is accommodated by two-step outpulsing by the switching office.

2.2. Performance

In order to make it simpler for the user, a desirable objective of the AMMTS would be to provide a service similar in all respects to the service provided by the public switched networks on land. This includes the dialing procedure, access time, voice quality, disconnect time, grade of service, and other performance aspects viewed from a user's standpoint.

Therefore, it is useful to consider the present performance of the public switched network in this subsection.

It is difficult, if not impossible, to predict with certainty the quality of service any particular user might encounter on the public switched network. This is due to the complexity and variety of systems in use. However, some average values of pertinent parameters have been measured or at least indicated as design objectives, and these can be summarized.

Grade of Service is one design goal which may vary considerably over different portions of the network. However, a blocking probability of less than $p = 0.01$ is normally maintained on the telephone network.

Recently a survey was conducted thoughout the Bell System by Duffy and Mercer (1978) to gather information on network performance. Results derived from that survey are of interest here.

The mean access time for direct-distance-dialed (DDD) attempts is indicated in Figure 3 for a user with a Dual Tone Multifrequency (DTMF) dialer. The DTMF dialer uses 10 push buttons to send the 10 decimal digits, 0 through 9, using a code consisting of two in-band frequencies emitted simultaneously when a button is depressed. The two frequencies are taken from two mutually exclusive groups of four frequencies each (CCITT, 1977d).

The time needed for the dialing operation increases by about a factor of two when a rotary dial telephone is used. The rotary dialer emits a controlled sequence of dc pulses on the subscriber line by breaking the circuit. The number of pulses between breaks corresponds to the decimal digit except 10 pulses are used to indicate 0. The connect time from end of dialing to ring return is approximately 11 seconds. When all switching centers are controlled by Common Channel Interoffice Signaling (CCIS), this connect time is expected to be reduced to 2 or 3 seconds. The tabulation below summarizes the total mean access times

Dialer	Signaling	Access Time
Rotary	Conventional	35s
DTMF	Conventional	28s
DTMF	CCIS	20s

The disconnect time is typically 4 to 5 seconds.

3. CHARACTERISTICS OF MARINE RADIO SERVICES IN THE U.S.

Radio telephone and telegraph service for the maritime community in the U.S. also differs in many respects from that found in other countries where these services are usually provided by the governmental or semi-governmental telecommunications administration. Some factors which may influence the development of an economical AMMTS in the U.S. include the following: (Renner, 1977; McIntyre, 1977; Panks, 1976):

- o There are two types of U.S. coast stations operating for the marine services. They are public coast stations and limited coast stations. These stations operate in the MF, HF, and VHF bands depending on the service and coverage desired. Approximately 250 coast stations serve the public correspondence needs, and over 3700 limited coast stations serve the operational and

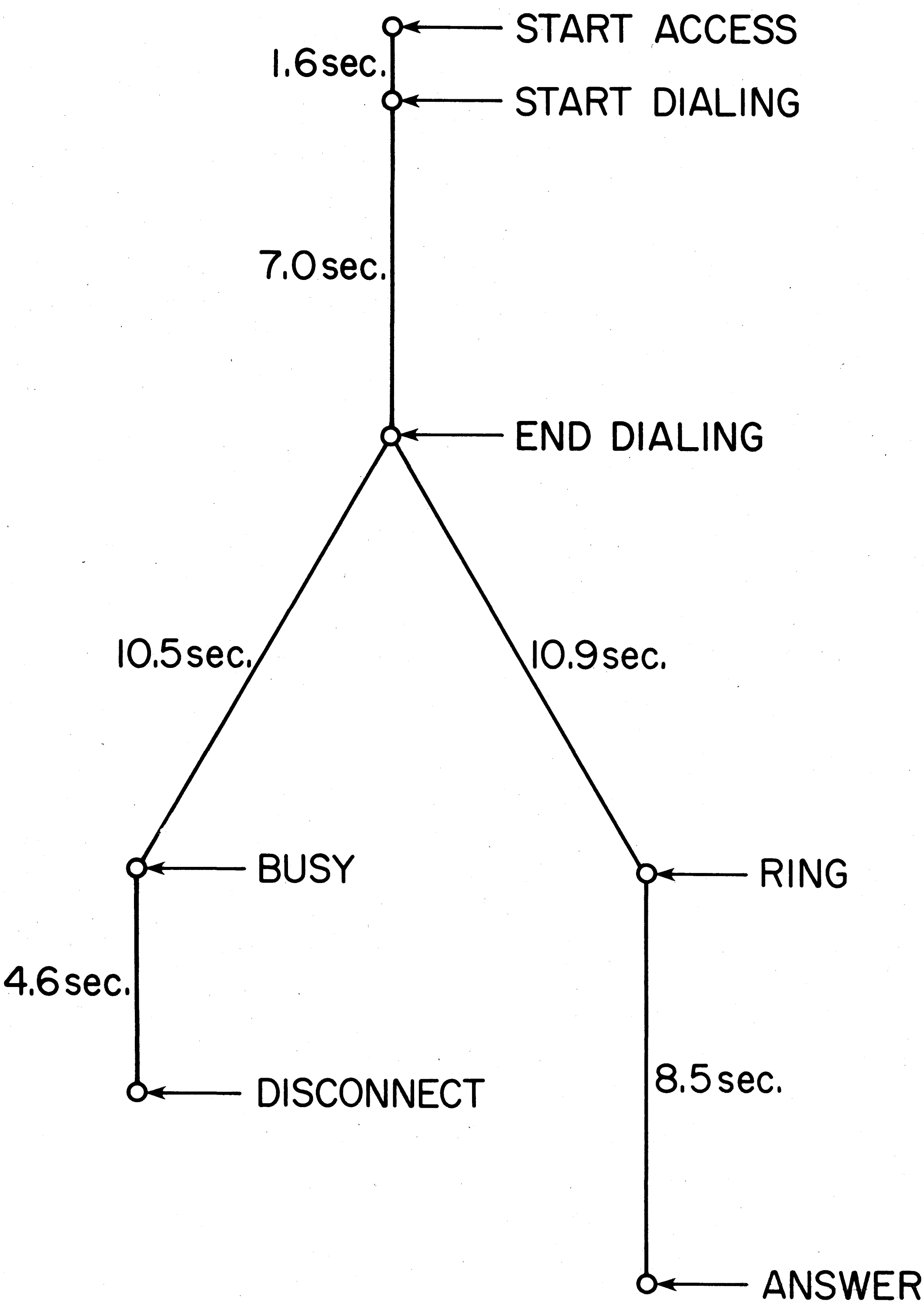

Figure 3. Mean access time on DDD network using pushbutton DTMF dialer.

business needs of the maritime community.

- There are approximately 230 VHF-FM public correspondence stations in the U.S., 40 percent of which are owned by telephone companies.

- There are approximately 40,000 km of coastal and inland waterways carrying marine traffic. The navigable distance on inland rivers (e.g., Mississippi, Missouri, Ohio, Illinois, Tennessee, etc.) is over 8,000 km. The combined area of the Great Lakes is about 245,000 square kilometers.

- Large numbers of commercial and recreational vessels may be expected to require access to the public switched network in the future. Over 270,000 vessels were licensed by the FCC for VHF equipment by January 1977.

- The communication traffic over public correspondence channels varies both temporally and spatially. Channel overloading occurs in many areas and at certain times as the result of large changes in the number of pleasure craft using communications facilities.

- VHF coverage is limited because of the limited number of stations, the large areas to be covered, and terrain factors which attenuate the signals (e.g., rough terrain between bends in a river).

- VHF channels are susceptable to interference from distant co-channel stations due to ducting. Ducting may necessitate additional channel allocations in certain areas irrespective of the traffic loading requirements.

- A network of automated VHF stations currently exists on the Great Lakes for public correspondence service. Interconnection with the public switched network is made directly through each Great Lakes coast station to and from the nearest end office of the telephone network.

- Nine VHF-FM channels (Nos. 24, 25, 26, 27, 28, 84, 85, 86, and 87) have been allocated by the FCC for use as public correspondence channels for maritime mobile service (see Table 3-1). Each 25-kHz channel could provide full duplex operation between ships and the shore, although half-duplex operation is commonly used due to equipment availability and because such equipment is considerably lower in cost. This is particularly true for the ship equipment.

Table 2

Public Correspondence VHF Channels
Allocated for Maritime Mobile Service
in the U. S.

Channel	Frequency in MHz	
	Ship	Shore
24	157.000	161.800
84	157.225	161.825
25	157.250	161.850
85	157.275	161.875
26	157.300	161.900
86	157.325	161.925
27	157.350	161.950
87	157.375	161.975
28	157.400	162.000

Coast stations use various methods to interface with the public switched networks. One common method is the phone patch shown in Figure 4. A phone patch provides an interconnection between the radiotelephone system and an access line to the telephone network. The phone patch may be used at both ends of a radio link, i.e., to the on-board telephone system in the ship as well as for the interconnection to the telephone network at the coast station. Usually the phone patch is hardwired although sometimes acoustic coupling may be employed. A hardwired patch is permitted if the equipment is type approved and registered by the FCC, otherwise a voice connecting arrangment or protective network is required. Telephone company tariffs

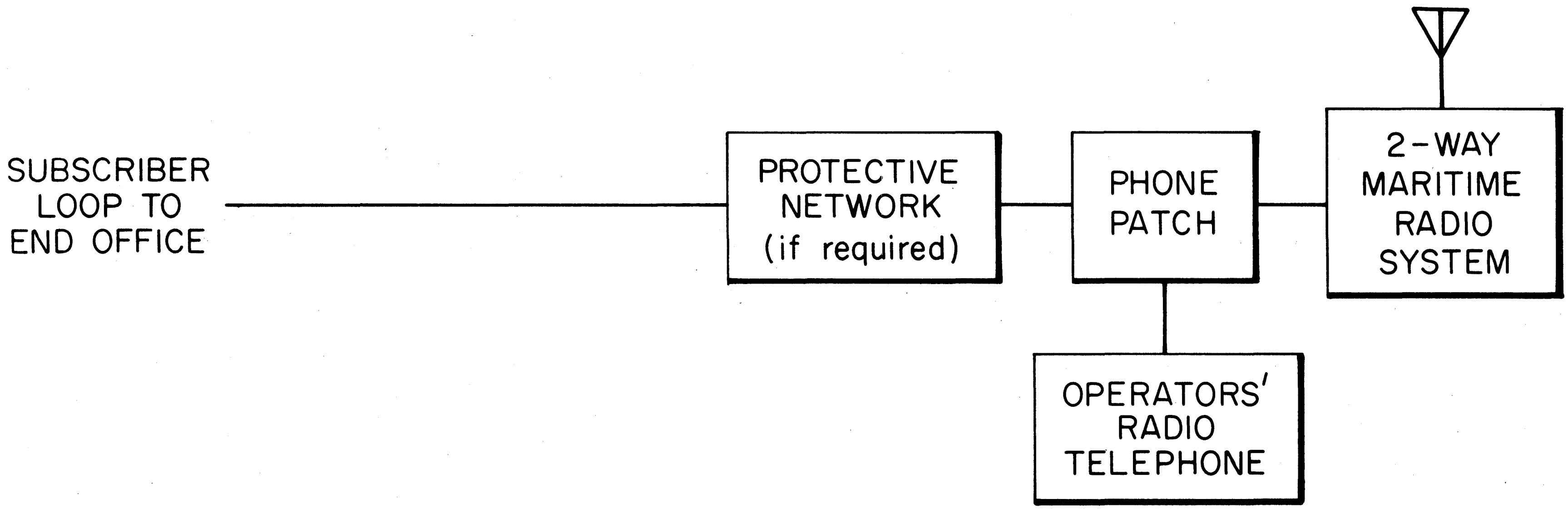

Figure 4. Typical arrangement for hardwire phone patch connection to public switched network.

include phone patches under interconnection arrangements or similar designations.

The phone-patch system permits the two-way radio operator to connect an incoming call to the ship by operating a special switch. For ship-to-shore calls, the operator dials the desired number over the public switched network and actiivates the patch when the call is completed to connect the ship's caller to the network.

4. DESIRABLE FEATURES AND PARAMETERS

When the public switched network and the maritime mobile radio services are interfaced to provide automated telephone service between vessels and public network subscribers there are certain desirable features and parameters which should be considered. Generally these features and parameters fall into one of two categories, operational or technical. They are summarized below. An extensive list of desirable features and operational requirements for the AMMTS is given in CCIR Report 587-1 (CCIR, 1978b).

Operational

- The system should perform in a manner similar, if not identical, to the existing public switched network. This includes access phase, information transfer phase, and disengagement phase.

- Dialing procedures for establishing connections from ship-to-shore and shore-to-ship ideally should be identical and simple to use.

- Land-side callers should be able to dial directly to contact a ship without operator assistance via the coast station nearest that ship. This completely automated procedure requires that the land-side caller knows the ship's location and registration number and the number of the coast station nearest the ship.

- Land-side callers should be able to contact ships whose registration number is known but whose location is unknown. In an AMMTS, this initially may require an operator's assistance but ultimately it is desirable that such contacts also can be made by automatic means.

- The system and the public correspondence channel being used should be capable of operating with either automated or manual terminals.

Technical

- The AMMTS should be compatible with the existing public switched network and be adaptable to other networks in the future, including record carriers and specialized common carriers.

- It is preferred that common channel(s) be provided for digital signaling during the access phase and separate (working) channnel(s) be used for the information transfer phase. This may not always be feasible; e.g., in areas where the channels allocated for public correspondence are limited and the traffic load is high, or conversely, in areas where the traffic load is so low that allocation of separate calling and working channels is not justifiable.

- A standard signaling technique (modulation, format, and coding) is required for national and international system compatibility. The digital selective calling system described by CCIR (1978a) and de Haas (1977), could serve as the common calling channel signaling.

- A universal numbering plan is necessary for vessel identification, and a standardized location registration plan will be required for selective calling.

5. INTERFACING CONCEPTS

In order to discuss interface concepts, it is necessary to describe the basic access procedures necessary for automated radio-telephone service. Some of these procedures have already been implemented by a private corporation to provide automated VHF service over certain portions of the Great Lakes (Lorain, 1975). Alternatives to the Great Lakes system are also described along with some of their advantages and limitations.

Since access procedures have considerable impact on the connection time these procedures should be designed to be simple to use and preferably the same as the procedures commonly used for normal access to the public network. The procedures may vary to some extent depending on 1) the origination of the call (ship or shore); 2) the equipment used (push button or rotary dial); 3) the numbering plan employed; 4) the land subscriber's a priori information concerning the vessel's location, the vessel's access number, and the telephone number of the accessing coast station, and 5) the network topology.

The case of a land subscriber calling a ship is the most difficult problem as the ship's number, in general, may not fit in the national telephone numbering plan. Paragraphs 5.1 and 5.2 describe two general concepts to overcome this problem, separated as to whether a one-step or two-step dialing procedure is required on the part of the calling land subscriber.

For a fully automated system in which no customer a priori knowledge of the ship's location is required, some form of ship location registration is required. This is briefly discussed in paragraph 5.3.

Access to the public switched network by a ship subscriber is relatively straightforward as the called land subscriber is identified by a number in the national numbering plan. Thus, the access problem reduces to making the ship-to-coast station link appear to be an extension of the telephone plants' local loop. Concepts for accomplishing this are discussed in paragraphs 5.4, 5.5, and 5.6.

5.1 One-Step Dialing

To fully meet the requirement that the system should perform in a manner similar, if not identical, to the existing public switched network the calling subscriber preferably should be allowed to dial, following the appropriate long-distance or international access code, all necessary digits identifying the called subscriber without interruption. The use of an 8- or 9-digit ship station identification number* is not compatible with U.S. national numbering plans which allow at most only 4 digits for station identification independent of geographical location designation (i.e., area code plus office code) or service designation (e.g., inwards WATS service). However, the digital capacity of the local office registers dealing with international traffic is 12 digits. In addition, the "country code" 87 has already been reserved for the maritime mobile service (CCITT, 1977a). Thus, even if a third digit is reserved for service or tariff differentiation within the maritime mobile service (e.g., terrestrial/satellite, national/ international), up to 9 digits would be available for subscriber selection. A contribution by the Netherlands to CCIR IWP8/5, reproduced in Appendix A, proposes a system based on the use of country code 87. The unique feature of this system is the assumption of a Maritime Switching Center (MSC) in each country into which all land subscriber-dialed calls would be directed for (automatic) routing to the called vessel via the appropriate coast station. Thus, a land subscriber would dial as follows:

International Prefix	National Maritime Switching Center	Ships Station Number
011†	87X	XXXXXXXXX 9 digits maximum

†in the U.S.

The 87X indicates maritime mobile service where X = 1, 2 or 3 for maritime mobile satellite service and X = 4 or 5 for maritime mobile terrestrial service, the 4 or 5 distinguishing the tariff used (e.g., national/international).

*CCIR Interim Working Party IWP 8/6 is studying maritime mobile numbering plans. Although no decision has been reached on this subject, it has generally been accepted that unique identification of each vessel will require at least 8 digits. CCITT Ad Hoc Joint Working Party I/II (common ship station numbering scheme) has recommended a 9-digit ship station identification number (CCITT, 1978), see Appendix B.

A system based on the above concept would fulfill the requirements of the Automated VHF/UHF Maritime Mobile Telephone Service. A disadvantage of the concept is that it would be comparatively more difficult to introduce such a system on a gradual basis. This, in turn, would mean that the system might not be cost effective for a period of several years. In the U.S., where such a system would involve several separate interests, significant problems of technical and political cooperation, as well as cost and revenue sharing, would additionally have to be surmounted.

The concept described above implies the simultaneous introduction of ship location registration, as the information that the land subscriber can enter into the system does not include a priori ship location information. It also means that a land subscriber in San Diego, for example, calling a ship known to be in the San Diego area, still enters the system through the MSC which may be located elsewhere, say in New Orleans. However, as transmission costs tend to become less significant in relation to the total call costs, this disadvantage may be outweighed by the somewhat simpler one-step dialing procedure.

For a practical implementation, the MSC could be supported on a cooperative basis by the maritime industry and could, of course, be co-located with a particular coast station. Alternatively, the MSC could be co-located with any class of telephone network switching center. This latter alternative does not imply that the MSC would be owned, or the operating costs would be borne, by the telephone companies.

For the U.S. telephone network, the concept of an MSC means that all local offices must be equipped to recognize the "country code" 87X, and that routing procedures must be established to the MSC "gateway".

The CCITT Ad Hoc Joint Working Party I/II Draft Recommendation, reproduced in Appendix B, allows for some schemes by which a limited number of ships might be accessed using one-step dialing without exceeding the capacity of the national network and without resorting to an MSC. The applicability of such techniques to the U.S. network requires further study, in particular as no spare area codes are available in the North American numbering plan for assignment to public coast stations, and assignment of office codes to such stations involves questions of availability of codes, tariffs, and charging principles.

5.2 Two-step Dialing

As an alternative to one-step dialing, two-step dialing can provide for gradual introduction of the fully automated telephone service since the incompatibility of an 8- or 9-digit ship identification number with the national numbering plan can then be circumvented. With two-step dialing, the calling land subscriber first dials the telephone number of a specific coast station, regional center, or national maritime switching center, as appropriate.

When the called station or center is reached, the calling subscriber hears a second dial tone and then dials the ship identification number, which may consist of any number of digits, after which the circuit to the called vessel is set up.

One major advantage of the two-step procedure is that it does allow implementation on a gradual basis. In the simplest form, individual coast stations could go automatic. This would, of course, require the land subscriber to know that the vessel he is calling is accessible through that coast station.

In the next evolutionary step, a number of coast stations could form a regional or semi-regional service. This process could continue until full national coverage is attained. The Great Lakes-wide VHF Automated Radiotelephone System might be considered an example of a system falling in between the first and second step. Each of the constituent (unattended) coast stations provides fully automated service, and a common control center provides operator assistance and manual call control, as well as system-wide administrative and operational control.

The major disadvantage of the two-step dialing is that, in general, the telephone network, after completion of the first step, establishes a voice-frequency circuit that normally does not pass further dc dial pulses. There is, of course, no problem if the land subscriber is equipped with DTMF dialing facilities or special DTMF dialers that can be attached to rotary dial telephone sets. However, not all end offices, as yet, are capable of handling DTMF dialing.

Equipping the maritime station (i.e., coast station, regional, or national center) with a pulse counting device to accommodate land subscribers without DTMF dialing facilities may be feasible but is likely to be sensitive to pulse type interference, e.g., due to fading and protection switching in microwave links. Such interference may cause errors in the signaling information which would result in an uncompleted call or a connection to a wrong vessel.

In the end, most of the political coordination, the cost and revenue sharing problems, and some of the technical problems referred to in the discussion of one-step dialing need to be resolved for a fully automated two-step dialing system as well. However, gradual implementation of automation can proceed while those problems are being resolved.

5.3. Ship Location Registration

Ship location registration is defined here as that information which specifies the coast station that provides the final link (i.e., the radio circuit) between the land network and a particular ship at a particular time.

Two distinct aspects to ship location registration can be distinguished: (1) acquisition of the ship location registration and (2) at what point the location registration is stored in the system.

Acquisition and updating of the ship location registration can be achieved in a number of ways, among which

(a) the ship location registration is assumed to be the coast station that last (within some time limit) provided communication with the ship, until such time as the ship initiates a call via a different coast station. Beyond this time limit, and at least for certain classes of vessels, this could be supplemented by automatic interrogation from the coast station;

(b) the ship location registration is determined in accordance with a filed route and time schedule plan for the ship; or

(c) the ship registers (either on a voluntary or mandatory basis) with a coast station whenever it enters the service area of that coast station.

A mixture of the above and possibly some other methods will probably be used initially and for some time to come.

From a technical point of view there does not appear to be a clear advantage as to where the ship location registration should be stored, assuming that high efficiency data-transmission techniques are used either to update centralized storage center(s) (i.e., the MSC or the regional centers) or to poll decentralized storage centers (i.e., coast stations or regional centers). Some advantage might be given to the centralized storage center, since polling of decentralized centers would have to be done in real time in order to keep the call connect time to a minimum. Updating would allow some margin of departure from real time.

From an operational point of view, safeguards against multiple registration of a single ship would also favor the centralized approach.

5.4. End Office Connection

It is necessary to consider various cases, including direct-dialed calls, operator assisted calls, and paging calls. Figure 5 illustrates a simple situation where all public correspondence traffic enters and leaves the public switched network via access lines between each coast station and its nearest end office.

The simplest case to consider is when the access number of the coast station covering the ship's location is known. A land subscriber contacts the coast station by dialing (7 or 10 digits) via the national network. When the station goes off-hook answer supervision is returned and a second dial tone is provided. The subscriber then dials the ship's access number with his DTMF dialer (either his push-button telephone set or a DTMP attachment). These DTMF tones are transmitted via the network and the coast station's common calling channel or working channel directly to the ship where they are detected and decoded by logic circuits in the receiver. When the ship's access number is detected, an alerting signal is actuated. The coast station, if necessary, assigns a working channel and completes the connection through its control equipment. Alternatively, the ship's access number can be translated at the coast station in another appropriate format for establishing the radio circuit with the ship; e.g., using the digital selective calling system (CCIR, 1978a).

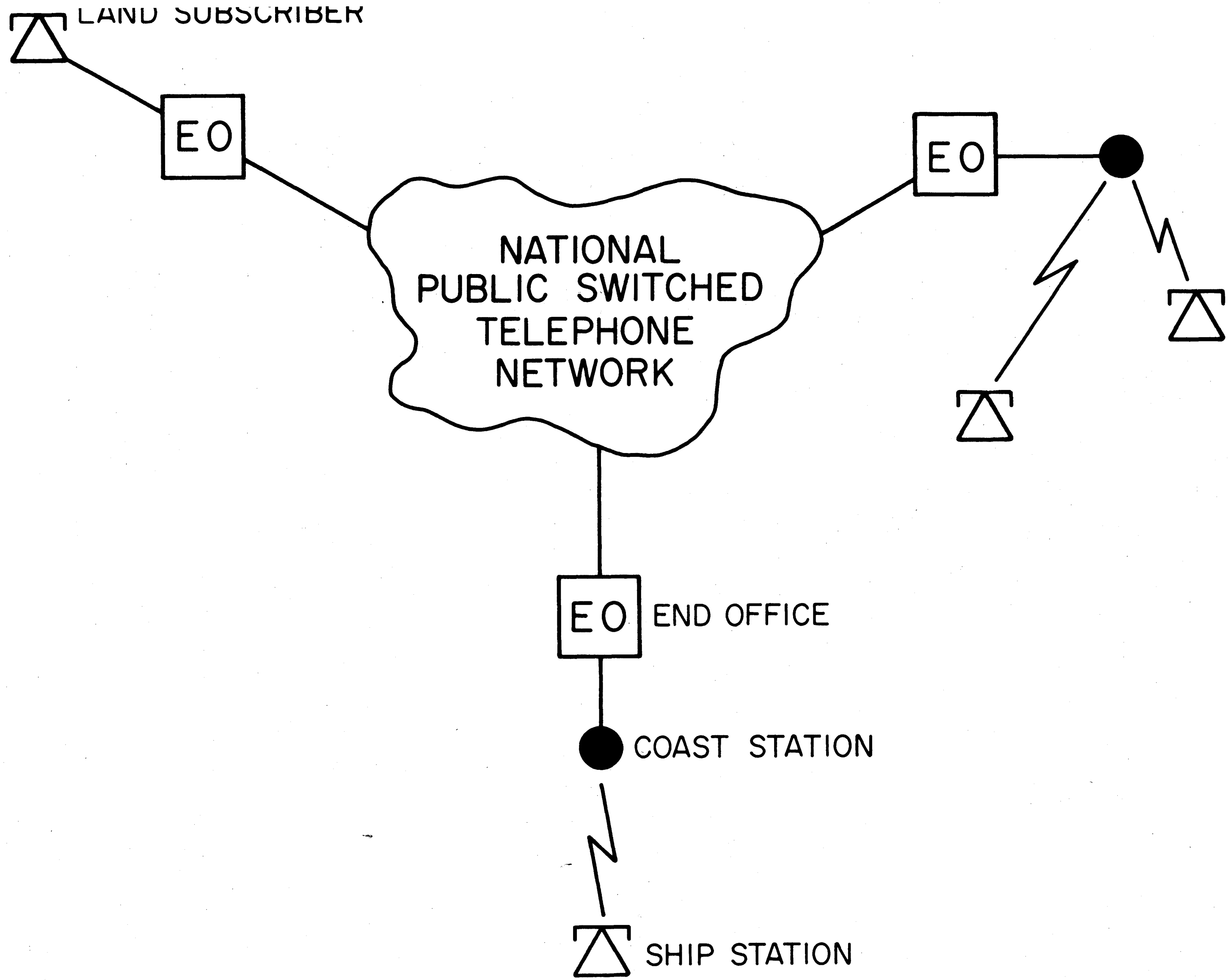

Figure 5. Network access via end office switching centers.

In the ship-to-shore direction, the ship subscriber selects the calling channel or a working channel, as appropriate, of the nearest coast station. If the channel is clear, the transmitter is actuated. This automatically transmits the ship's registration number to the shore station, which responds with a dial tone. The ship subscriber then dials any required service selection code, for example "0" for operator assistance or "1" for a direct-dialed call. In this latter case, an access line between coast station and network end office is automatically seized and the ship subscriber then dials the desired number directly to the end office.

The manual channel selection process can be eliminated if a commonly assigned (calling) channel is available. With such a method, an off-hook condition on the ship automatically signals the ship's identification over the calling channel. A coast station within range responds either on the calling channel or with a distinctive marker on a "ready" working channel. After completion of a "hand shake" procedure and seizure of an access line, the coast station puts a dial tone on the working channel and the ship subscriber dials directly to the coast station's end office.

Besides availability of a common calling channel, some degree of automation for working channel selection by the ship's radio equipment is desirable either by means of channel scanning and automatic seizure or in response to a coast station command via the calling channel.

A system based on automatic seizure of a working channel has been developed for the Great Lakes communications system (Herrick, 1977), although it has not yet been put into use.

The calling channel in this situation could utilize the digital selective calling system (CCIR, 1978a). Co-channel interference from coast stations with overlapping coverage areas may be mitigated using Time Division Multiple Access (TDMA) techniques as proposed by Mathews and Fee (1978).

One difficulty with the configuration in Figure 5 is that switching and signaling equipment in use at the various end offices around the country may differ and various dialing procedures may be required. Another limitation is the requirement for a DTMF dialer, as discussed previously.

Finally, the subscriber must know the access number for the coast station within the ship's contact range and locating the ship must be accomplished either by the subscriber himself calling the various coast stations or with operator assistance.

5.5. End Office With Regional Control Center

This last limitation can be eliminated to some extent using the network access configuration depicted in Figure 6. Coast centers providing coverage in a limited region can still be accessed as before, but, in addition, they are connected by leased line to a regional coast center (which may itself be a coast station). This is essentially the configuration used for the Great Lakes system described by Lorain (1975). Coast stations could be unattended and controlled from the regional center. The leased lines shown dotted in Figure 6 are for control and management data only and carry no voice traffic. The leased-line costs can be reduced using multidrop lines and conventional polling techniques to each coast station from the regional center. Various polling networks are illustrated in Figure 7.

Paging, i.e., to locate a particular ship, in the Great Lakes system is accomplished via the system operator in the central control center (regional center), who locates the ship by calling via the leased lines through one or more coast stations as may be necessary. Having located the ship, the call is established by remotely controlled dialing through the appropriate coast station and its local telephone network end office back to the land subscriber's telephone.

An alternative method could be that the regional center accepts the land subscriber call information, puts the land subscriber on "hold" while it locates the ship and completes the call via a dial-up line (or via a permanently leased line) between the appropriate coast station and the regional center.

The relative advantages of these two methods depend, among other things, upon the amount of traffic coming into the regional center (rather than directly to the coast station) and the average time it takes to locate and establish the radio link with the called ship.

As in the preceding case, a two-step dialing procedure would be used, as discussed in paragraph 5.2.

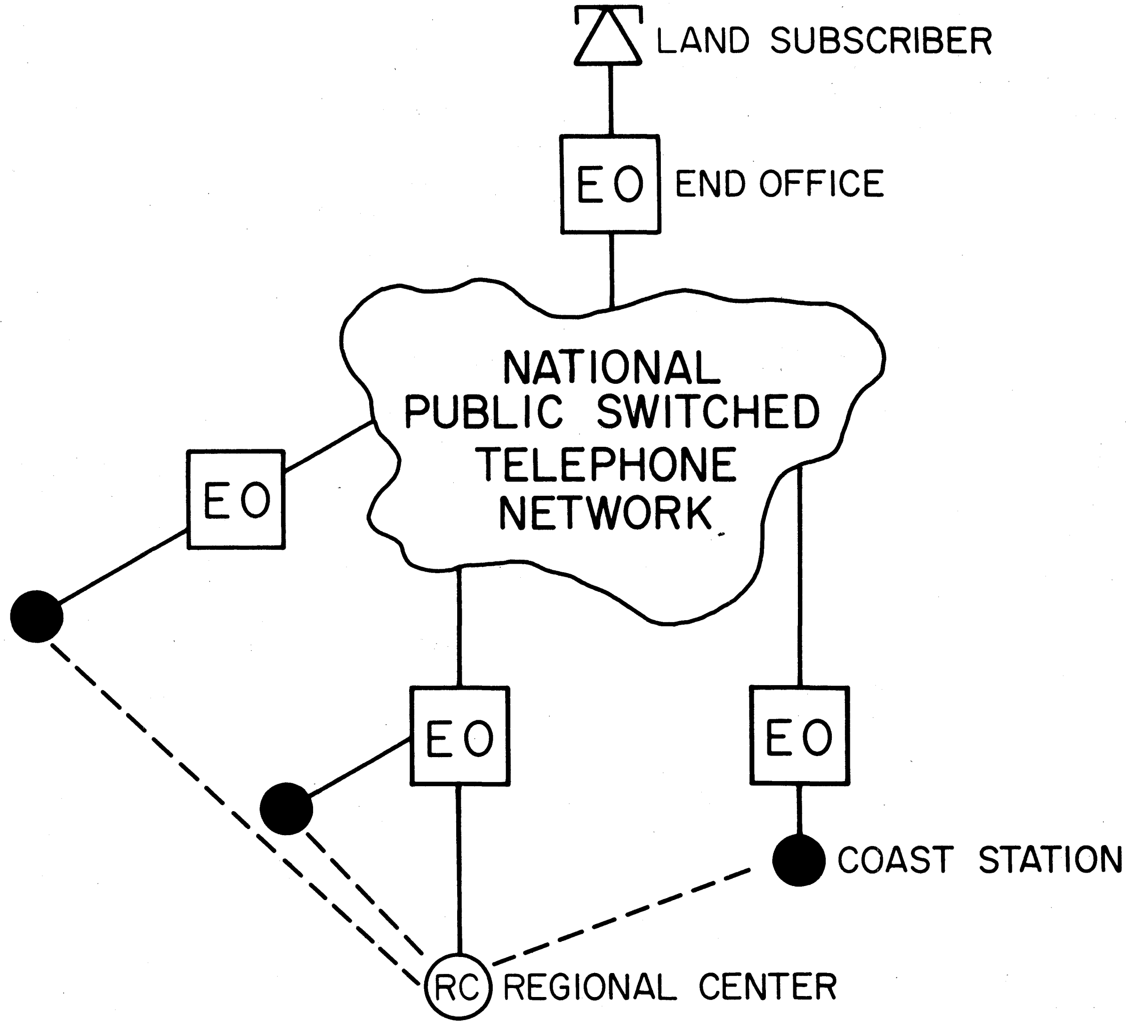

Figure 6. Network access via regional centers.

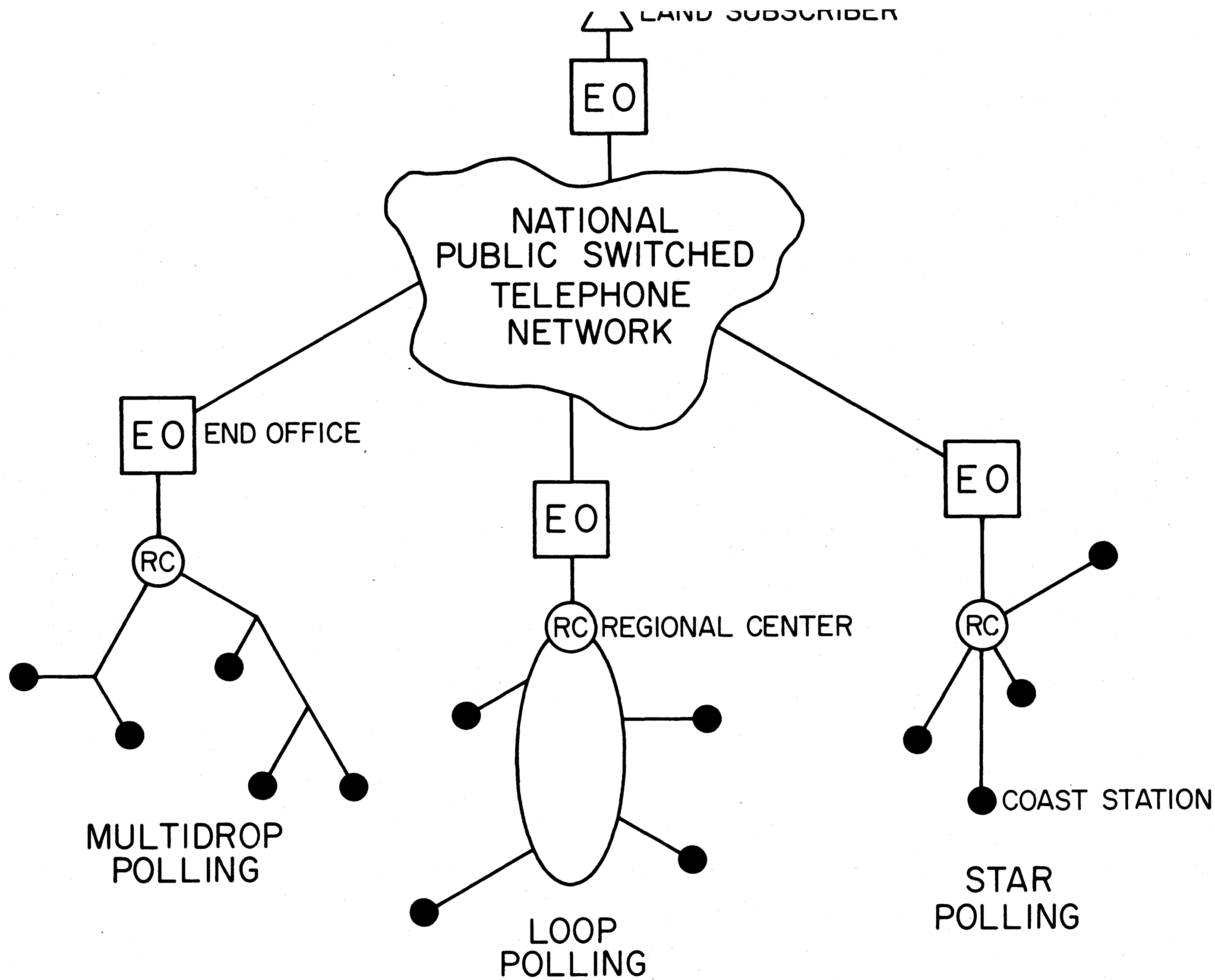

Figure 7. Network topologies for access polling.

5.6. End Office With Regional and National Control Center

It is possible to envision a hierarchical control network for coast stations similar to the one for the public switched network given in Figure 1. The various levels for a hierarchy of coast station centers are shown in Figure 8. Note that the national center could be co-located with a regional center and that regional centers could be co-located with a coast station.

Ship-to-shore calls could still be accomplished in the same manner as in the previous cases except that, if the interconnections between coast stations, regional centers and national center consists of leased lines, it might be economically advantageous to use these lines as much as practicable for ship-to-shore connections as well.

However, the cost of leased lines for this hierarchical structure is probably prohibitive on a national basis (in the U.S.) due to the large number of public correspondance coast stations, and it would be more practical to use the public switched network itself for the interconnections on an "as needed" basis.

Figures 9 and 10 show two of several possible configurations using the public switched network for all major interconnections. The dotted interconnections in Figure 10 between coast stations and regional center are analogous to the control (order) lines in the Great Lakes system. The choice of the actual final configuration will depend primarily on economic and historical growth considerations, and may be subject to change as the economic factors change. It must also be noted that Figures 9 and 10 are not mutually exclusive; i.e., a final system could comprise elements of both.

Internal connections between centers using the public switched network can always be established using two-step dialing as it would be practical for any center in the system (i.e., coast stations, regional centers and national centers) to be equipped for DTMF dialing.

If the land subscriber is to be provided with one-step dialing, access to the system must always be via the national center, as was discussed in paragraph 5.1. With two-step dialing for the land subscriber, as described in paragaraph 5.2, the system could, in principle, be entered at any level, i.e., national center, regional center, or coast station.

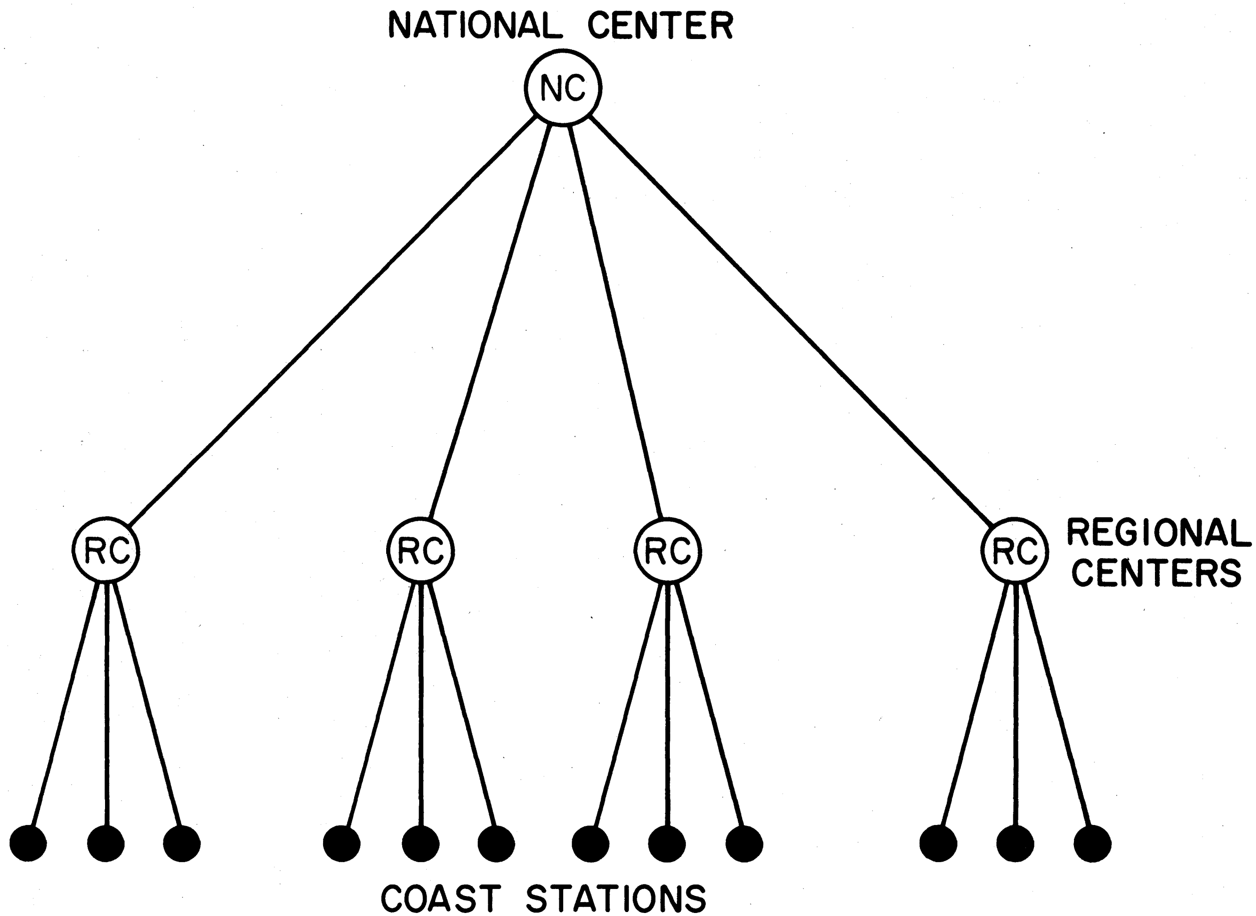

Figure 8. Hierarachial coast station network.

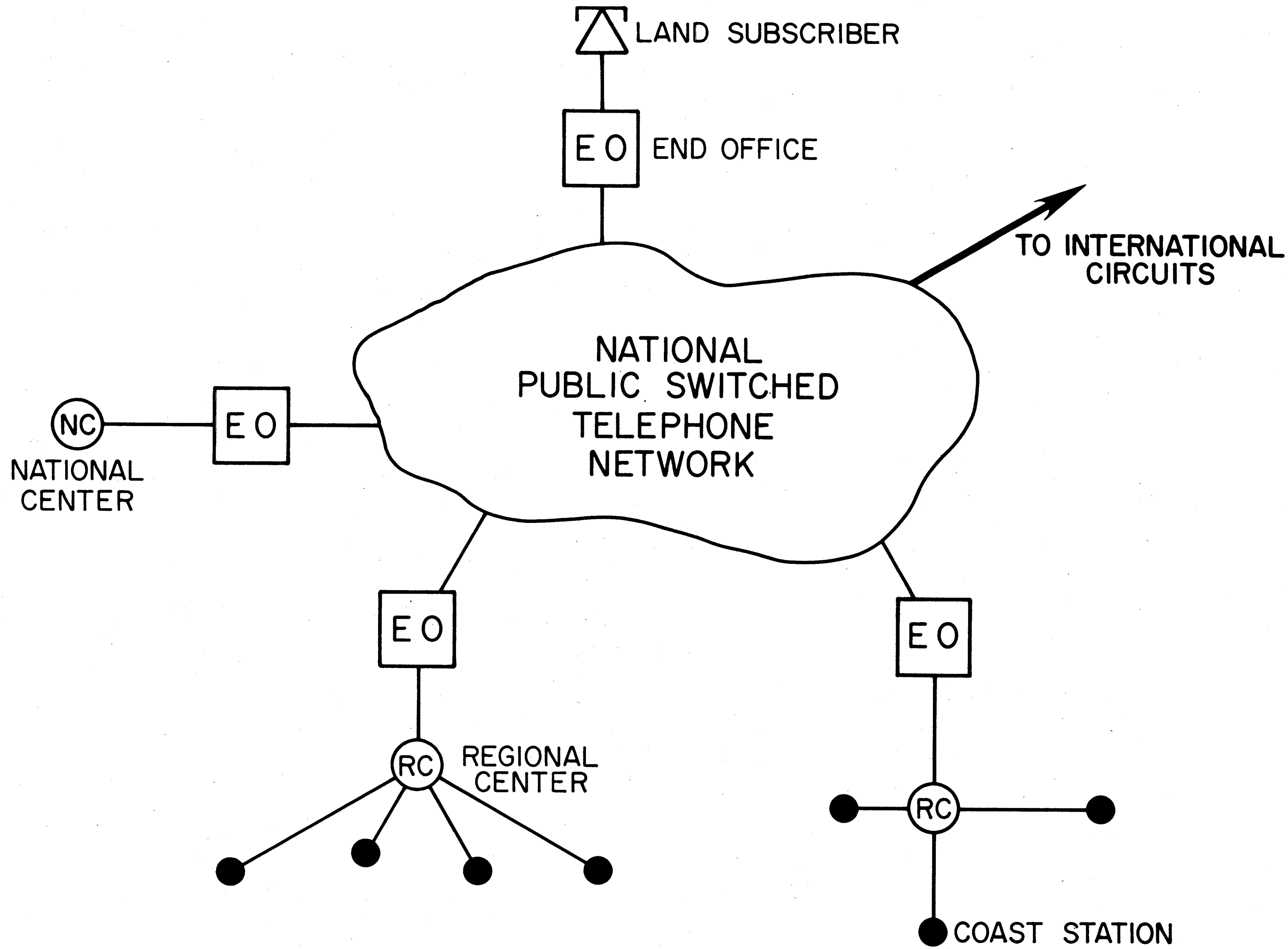

Figure 9. Network access arrangement via regional centers and a national center with regional star configurations.

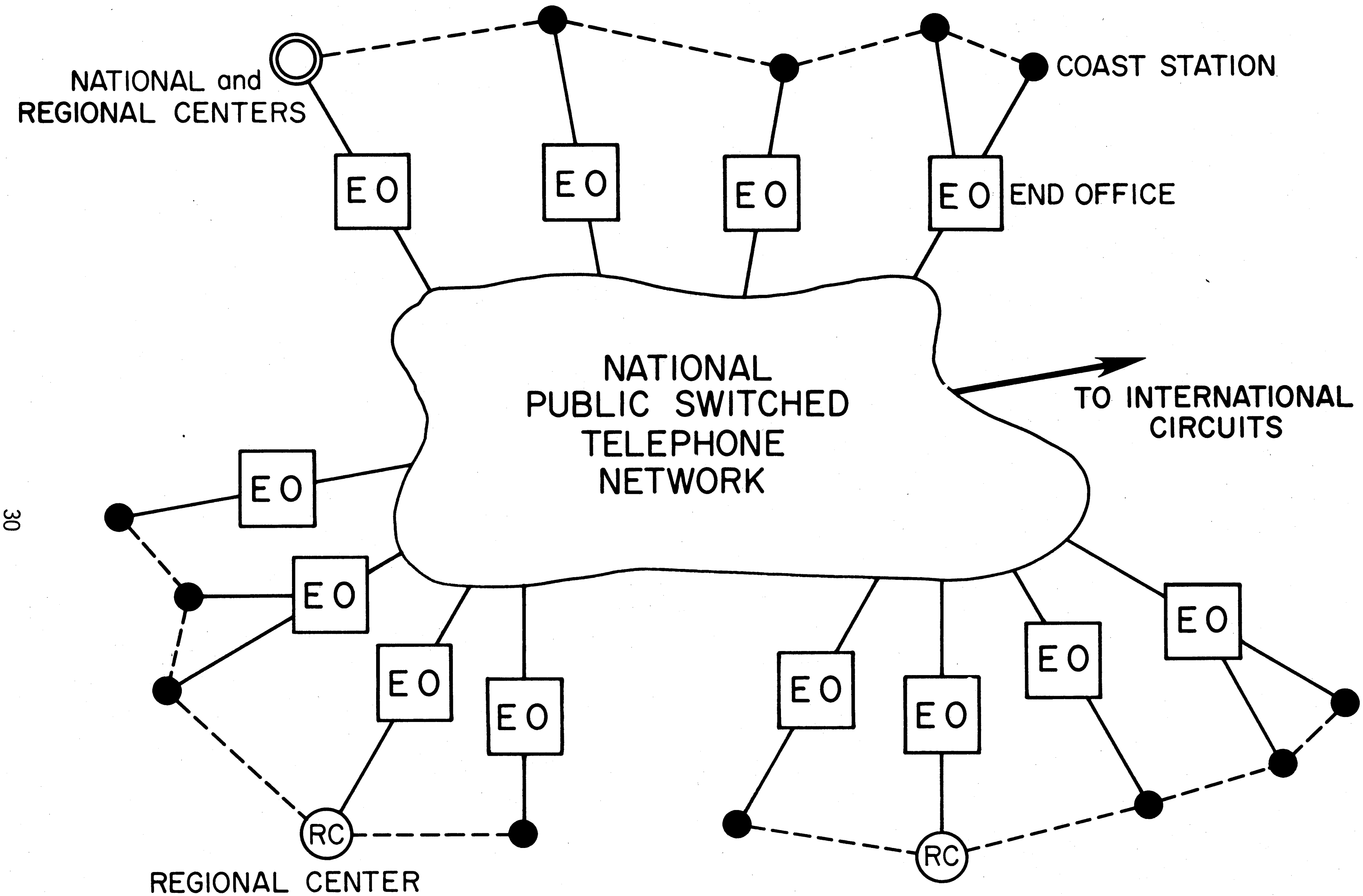

Figure 10. Network access arrangement with regional and national centers in a distributed configuration.

In either case, the center dialed by the land subscriber would accept and store the called ship number and then proceed to set up the desired connection in much the same way as was described in paragraph 5.5.

Finally, as an intermediate step towards a fully automated system, the national and regional centers could initially be set up as information centers only. A land subscriber not knowing the location of the ship dials the national or a regional center, which determines the ship location registration and informs the land subscriber which coast station to call.

5.7. Example of Detailed Access Arrangement

Figure 11 illustrates in more detail the access arrangement of Figure 9. In this example it is assumed that the ship's location registration information is stored at the appropriate regional center. A land caller, trying to locate a ship via the national center, sends the ship's identification number to the national center which in turn sends it to all of the regional centers. This identification number would then be scanned by the processor at each regional center and checked against a register file in its memory. If the ship is registered for that location then the national center is notified by returning the number of the coast station nearest the ship. The national center then completes the call via that coast station.

6. RATE STRUCTURES

Because of the complexities of services, features, equipment, and options offered, the following paragraphs only provide an overview of the rate structure used in the United States. Details are covered by tariffs filed by each carrier with the FCC. The domestic long-distance telephone FCC tariff, for example, is AT&T No. 253 which also covers private land-mobile radiotelephone service.

6.1. Common Carrier Services

The charging rates for long-distance telephone calls over the public switched networks in the U.S. are based on: 1) the class of call, 2) the distance, 3) the call duration, 4) the time of day, and 5) whether the call is interstate or intrastate.

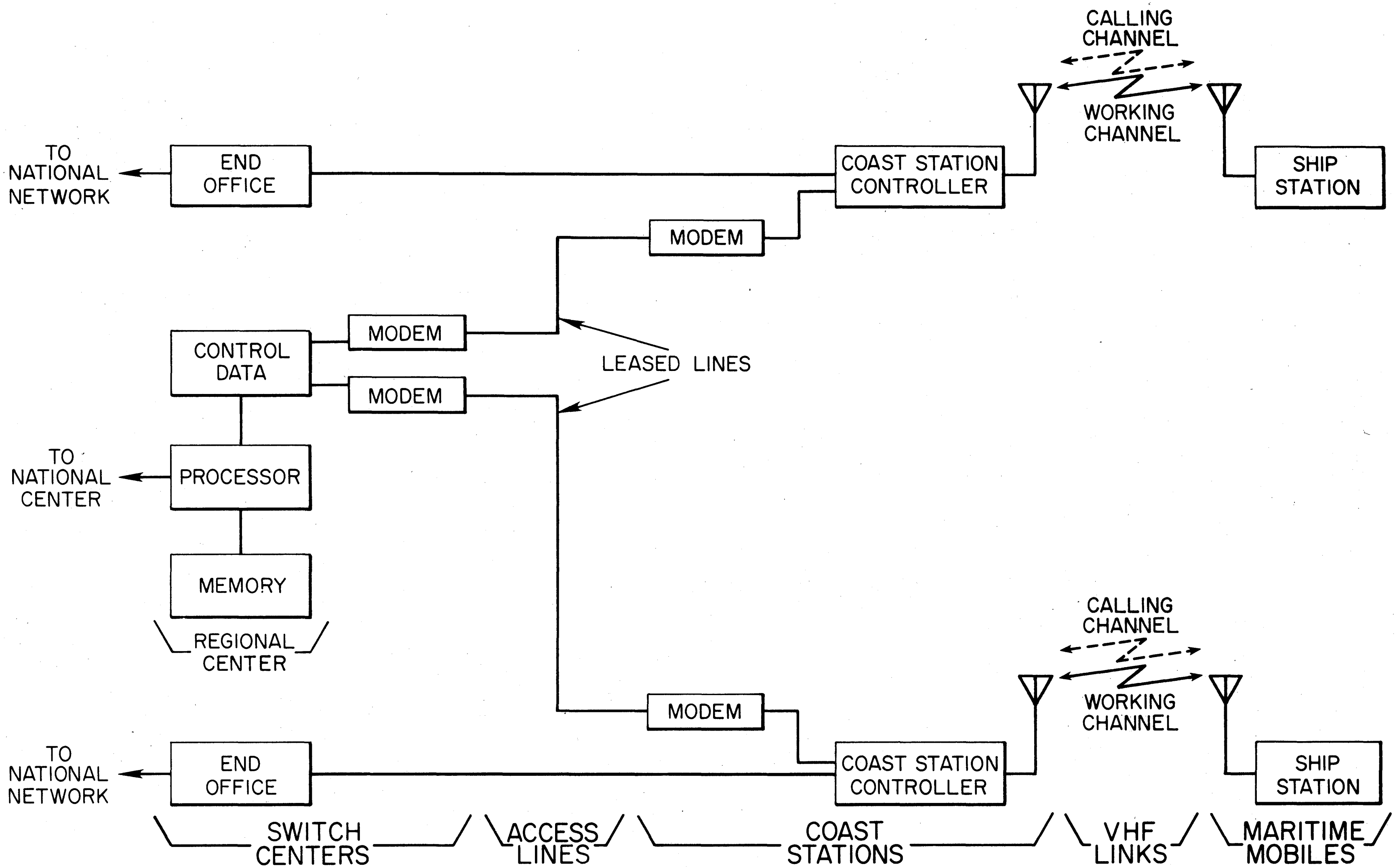

Figure 11. Maritime access arrangement.

There are three basic classes of long-distance calls. The least expensive is a direct-dial, station-to-station call. Timing starts as soon as the telephone is answered. Operator involvement for billing purposes in offices without automatic recorders does not change this class of call. Station-to-station calls requiring operator assistance to place the call, e.g., credit-card calls and collect calls, are tariffed at a higher rate. A person-to-person call is the most expensive, but timing only starts when the desired person is reached.

The charge rate increases with distance and the duration of a call. The minimum charge is three minutes for all operator-assisted calls and one minute for direct-dialed calls. An incremental charge is added for each additional minute in both cases.

Full rates are charged for interstate calls within the continental U.S. between 8:00 A.M. and 5:00 P.M. on Monday through Friday. A 35% discount from the full rate is applied from 5:00 P.M. to 11:00 P.M, Sunday through Friday. A 60% discount is applied during the remaining hours (AT&T, 1977).

The telephone industry has both local and centralized systems in many offices for automatically recording (ticketing) the charging information. Ticketing data usually includes:

1. Class of service
2. Caller's number (7 digits)
3. Called number (7 or 10 digits)
4. Date and time
5. Call duration
6. Billing number.

Local-Automatic-Message-Accounting (LAMA) systems are located in class 5 offices. Centralized-Automatic-Message-Accounting (CAMA) systems are located in class 4 or higher level offices. The calls for several class 5 offices may be handled by one CAMA-equipped office. (AT&T, 1975)

Bulk billing is used for single and multi-unit short-haul calls. The customer is charged on the basis of total message units used during a billing month.

Wide Area Telephone Service (WATS) is a special switched service offered by the Bell system, for a bulk discount. The service is designed for customers who make or receive large numbers of calls to or from a geographic area. There are two service offerings -- outward WATS and inward WATS. Outward WATS allows the user to dial a certain geographic area within the U.S. at a rate lower than a corresponding DDD call. A minimum usage charge per month is applied. Inward WATS service is similar except the caller dials a special area code which connects the caller to the WATS line in the customer's location. Customer costs are based on the service area covered and the hours of service, and the caller is not charged.

It is also possible to lease lines. Leased lines are private-line circuits provided by the major common carriers on a monthly rental basis. They are commonly known by a series number which indicates the bandwidth and service grade. Series 2000 circuits, for example, are voice-grade, voice-only circuits.

6.2. Maritime Mobile Radio Services

Ships may be connected to any telephone in the public network via a coast station and the appropriate land telephone central office (usually class 5). The charges for the radio portion of these calls are based on tariffs filed with the FCC. The maritime mobile tariff is based on air time used. Thus, the FCC requires a log of shore station operations including a record of actual air time used by the customers.

For the radio service, the Great Lakes system (Lorain, 1975) has considered a flat rate or contract service for large users of that system to encourage use during slack periods. The contract service offers the system facilities to users of public channels at a fixed monthly rate without restricting the number of calls. Some tariffs provide a lower rate for certain limitations on use, such as night calls only. Other tariff provisions encourage certain types of calls during hours when channel usage is low.

Interconnections to the public network are usually made through a coast station's telephone to a local central office via subscriber lines.

The station's telephone must be answered prior to placing the call to a ship. A long-distance caller who dials the station directly is therefore charged for the call to the coast station even though the desired ship may not be reached.

Leased services may be offered by coast stations by special contract to provide equipment and operating functions for a particular use. These leased services must use radio channels allocated for such special use by the FCC. Services provided include facsimile, printer, and data transmission as well as voice.

7. INTERFACE ISSUES

A public correspondence radiotelephone system provides interconnection with the land-telephone network. We have attempted to define the unique characteristics of the public switched network and the VHF maritime mobile radiotelephone system in the U.S. Possible interfacing concepts have been described which would provide a fully automated public correspondence system capable of meeting certain operational and technical requirements.

There are several issues which still must be resolved in order to implement fully an automated public correspondence radio system for the international maritime community. The more pertinent issues are summarized below.

Some of the issues raised can only be resolved by the regulatory process (e.g., channel allocations), others require extensive field trials with operating systems (e.g., contention). They all can benefit from further study, but to varying degrees depending on the complexity of the issue.

7.1. Channel Allocations

Preferred methods proposed for AMMTS require a common calling channel for universal contact and separate working channels for public correspondence. However, in some areas the number of channels presently available for public correspondence already is insufficient to handle the working channels traffic load. In such areas assignment of additional channels may be a prerequisite for separate common calling channel methods. In the VHF band, channel 16 is presently allocated for distress, safety, and calling.

As calling traffic increases, the use of this channel may become impractical. An additional dedicated channel for calling ships may be required. Separate calling channels for manual and automated calling may become necessary.

In high traffic areas, it is desirable to assign more than one working channel to the coast station(s) covering that area. The greater the volume of traffic, the larger the number of working channels required for a given grade of service and service delay. When several channels are assigned to a given coast station, there will be occasions where any given channel is not being used. If all channels could be made available to all coast stations, with proper coordination procedures, then a more uniform occupancy per channel could be obtained.

7.2. Co-channel Interference and Co-channel Sharing

When co-channel transmitters are operating at the same time, interference may result even though the transmitters are separated by some distance. At VHF this is caused by propagation conditions known as ducting. Even without ducting, the allocation of a common channel for contact purposes can cause interference between adjacent coast stations if they are within reception range of each other, or if a ship is within the reception range of both.

Various methods for alleviating the problems caused by ducting have been proposed. One method is to disable the interfering co-channel station when ducting is detected. The detection process is normally accomplished at the shore stations because the appropriate equipment is fairly complex and costly. The method is not an ideal solution because of the loss of traffic capacity of the disabled station(s).

If sufficient channels are available to handle the traffic it is possible to alleviate co-channel interference by providing increased separation between co-channel stations. The Great Lakes prototype system experienced this type of interference and separations of 360 km were required to provide acceptable protection. (Herrick, 1977)

Another method involves sharing the co-channel on a time division basis by assigning time slots for transmission on a coordinated basis. (Mathews and Fee, 1978). This proposed coordinated assignment scheme raises several questions concerning its implementation. For example: What slot duration should be used? How can these be synchronized? What timing accuracy is required?

The regional coast centers with dedicated data lines to each coast station can be used to provide timing information to stations. In areas where the traffic is highly variable between coast stations, the center could also allocate transmission slots of different lengths to each station.

There are several other techniques which should be studied for developing an optimum maritime system. For example, each coast station could monitor adjacent station transmissions. Stations having limited need for calling time would so indicate, and an adjacent station could utilize this time when it senses no other transmissions were taking place. Several random-access techniques have been evaluated for various types of networks. Schwartz (1977) summarizes some of the techniques which have been proposed for multiple access to a single satellite channel. Although these are designed for packet-switched data networks, they appear to have application in any multiple-access, single-channel system.

7.3. Range Extension

The coverage range of VHF-FM stations is relatively short, typically 30 to 80 km from shore. It is feasible that this range could be extended by relaying signals from ship to ship. This aspect should be considered in developing the AMMTS. A closely related consideration is automated calling between ships as well as ships to shore.

7.4. Performance

There are various ways in which a communications system's performance can be evaluated. The performance objectives and the system which evolves to meet these objectives depends on conflicting viewpoints. The system user wants to minimize costs by using the service as little as possible and at the same time have fast access with service always available. On the other hand, the system supplier wants to maximize revenue by selling as much service as possible and by sharing facilities among many users. These conflicting viewpoints in the U.S., along with those of other nations, should be considered in the system development so that the needs of the international maritime community can be satisfied.

7.5. Internetting

The study reported here is primarily concerned with interfacing the AMMTS with the U. S. public switched telephone network for public correspondence. International record carriers and foreign administrations offer teletype (TELEX,TWX) and cablegram services to compatible terminals around the world. There are also a number of specialized common carriers and value-added networks in the U. S. and overseas. These networks offer various types of switched services to specialized users including data, facsimile, and video signal transmissions.

The AMMTS development program should recognize that ultimately it may be desirable to be able to interconnect with these other networks in addition to the public switched telephone network. The impact of such internetting on the AMMTS should be considered as the system evolves.

7.6. Location Registration

The location registration system must be able to accommodate some special features. For example, some ships, for commercial or other reasons, may not wish for any land subscriber to be able to determine its location by merely calling into the system, or to be called by anyone except certain specific parties. This can, to some extent, be compared to an "unlisted" number. Another example might be ships that wish to be registered at all times with their "home" coast station regardless of whether they are actually in the normal or assigned service area of that coast station. Methods for incorporating these restrictive features need to be evaluated.

7.7. Cost

A basic issue involving cost is financing the establishment of Regional and National Maritime Centers and any investments made by the common carriers to extend specialized service to coast stations. One method of financing would be a pay-as-you-go basis, i.e., implementation of AMMTS would occur on a gradual and probably fragmented basis as individual maritime mobile service providers decided that their traffic load and revenues warranted automation of their services. Local, regional, and national location registration would come into being as the need arose and agreement on sharing of the costs thereof would be reached. Some of the advantages of this approach are that it minimizes organizational and other non-economic barriers to an early start of automated services (e.g., the Great Lakes system), and that it provides maximum assurance of cost effectiveness. Some of the disadvantages are that attempts at resolution of problems inherent in the formation of a truly nationwide public AMMTS are easily put off to "some future time," and that it could foster the creation of a different and not necessarily compatible automated system which could add to the problems of integration in a single AMMTS in the future.

An alternative concept would be to implement the AMMTS in a relatively much shorter timespan and to recover the costs incurred from future traffic revenues. To be viable, this would require a single entity to be responsible for both the technical and economical soundness of the implementation plan. Such an entity could, for example, be a consortium of maritime mobile service providers.

The maritime mobile communications environment is subject to Federal regulation and is also of considerable interest to, for example, maritime safety. The role of the Federal Government (if any) in providing regulatory or economic stimuli, or both, towards the development of a nationwide public AMMTS should be given serious consideration.

7.8. Rates and Rate Structuring

The existing heterogeneous makeup of the maritime communications industry has resulted in a wide variety of independently developed methods of rates and charges. In addition, actual operating costs and the ratio of required investment (for AMMTS) to the amount of public correspondence traffic handled may vary widely between different coast stations. At present, the cost to a subscriber for a call to (or from) a vessel consists of two independent charges; the telephone network charge for the connection of land subscriber to coast station plus the charge for the radiotelephone connection set by the particular coast station. To arrive at a uniform rate structuring for the AMMTS will require major action by the FCC in addition to cooperation between maritime mobile and telephone network service providers. On a secondary level come related problems such as allocation of charges between various carriers, accounting and billing, and technical interconnect arrangements associated therewith.

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APPENDIX A

AUTOMATIC (VHF) MARITIME MOBILE TELEPHONE SYSTEM, CONTRIBUTION TO IWP 8/5, NETHERLANDS 8/5/2; NOV. 1977

Contribution to
IWP 8/5
Netherlands 8/5/2
November 1977

ANNEX II

NETHERLANDS

Original: English

AUTOMATED (VHF) MARITIME MOBILE TELEPHONE SYSTEMS
Question 23 - 1/8

1. INTRODUCTION

One of the prime requirements, when introducing an automated Maritime Mobile Telephone system, is a unique identification of the ship stations.

It is the feeling of the Netherlands Administration that an identification for a ship station should be constituted of eight figures (digits) in order to allow all ships to participate. This feeling has been supported by opinions of the CCIR Interim Working Parties 8/3 (on digital selective calling) and 8/6 (on ship station numbering).

It is also the opinion of the Netherlands Administration that a ship statiön identity[1] should not be adapted or artificially curtailed in order to fit into an existing transmission system.

This implies that, given eight-digit ship station numbers[2], a system should be developed in which these numbers can be dialled or keyed by the public network subscribers.

In this paper a system is proposed that enables telephone (and telex) subscribers to dial (or key) the full eight (even nine) digits of a ship station number.

1) ship station identity: The ship's identification $N_1 \ldots N_k$, transmitted on the radio path.

2) ship station number : the number that identifies a ship for access from the public network and which forms part of the international number to be dialled or keyed by the public network subscriber.

2. PROPOSED SYSTEM FOR AN AUTOMATED MARITIME MOBILE TELEPHONE SERVICE

2.1 A "Maritime Switching Centre" (MSC) is introduced in each nationality.

2.1.1 Subscribers of the national telephone network that wish to contact an MSC, have only access to their national MSC. This is realized via the international prefix (P_i) of that country (09 in the Netherlands, 00 in Belgium, 00 in the Federal Republic of Germany etc.), followed by the "country code" 87.
The range 870-879 is allocated to the Maritime Mobile Service. The codes $87S_1$, $87S_2$ and $87S_3$ are used in the Maritime Mobile Satellite Service; the codes $87S_4$ and $87S_5$ be assigned to the Maritime Mobile Service.

2.1.2 Subscribers of the national telex network have access to the same national MSC in a similar way, using the "destination codes" $58T_1$, $58T_2$ and $58T_3$ for the Maritime Mobile Satellite Service and $58T_4$ and $58T_5$ for the Maritime Mobile Service.

2.1.3 Each MSC has, via the existing international telephone network access to the MSC of any other nationality.

2.1.4 Similarly, for telex the MSC of another nationality can be reached by the national MSC via the existing international telex network.

Figure 1 shows a Maritime Switching Centre and its access terminals.

2.2 The arrangement of the MSC (located in the country N)
In this document the arrangement of the MSC and the procedures will be described for shore to ship telephony only.

2.2.1 The MSC is linked with all the national Coast Stations (CS) and Base Stations (BS) by means of fixed connections. (See figure 2.)
This means that MSC_N controls all the transmitting and all the receiving stations employed in the National Maritime Mobile Service.
Inter-MSC traffic is provided via the international telephone network (para 2.1.3).

2.2.2 A computer, as a part of the MSC, has rapid access to a memory containing the ship station numbers of:

2.2.2.1 all ships of the nationality N,

2.2.2.2 ships of other nationality that have more than incidentally contact with MSC_N (these ships are served as if they were of the N-nationality.)

2.2.2.3 ships of other nationality located within the service area of the MSC_N.

Related to each ship station number stored in this memory, the location of that ship, or the identity of the BS_N in which service area the ship is located, is also recorded in this memory. The latter information must be updated continuously, preferably in an automatic way.
This memory will be referred to as "Location Registration Register" (LR).

3. PROCEDURES

If a ship, having the nationality N enters the service area of the MSC of the nationality X1 , she reports to MSC_{X1} via CS_{X1} or via a BS_{X1}.
The MSC_{X1} registers this ship in its LR (para 2.2.2.3).
From that moment on the N-ship is treated as if she were of the nationality X1.
The MSC_{X1} reports to the MSC_N that the N-ship is now registered in the LR of MSC_{X1}. This fact is recorded in the LR of MSC_N, in connection with that ship station number.
If later on that ship enters the service area of MSC_{X2} she reports to the MSC_{X2}. The latter registers the ship in its LR and is served by the MSC_{X2} as if she were an X2-ship.
The MSC_{X2} reports to MSC_N that the N-ship is registered by MSC_{X2}.
This information replaces the previous one in the LR of MSC_N, and, at the same time MSC_N informs the MSC_{X1} that the ship concerned can be dropped out of its LR.
The above procedure ensures that the MSC_N has always a record of the location of the N-ships.

If an N-subscriber wants to contact a ship of the nationality N, and assumes that the ship is located within the service area of the MSC_N, he dials the ship station number, preceeded by $87S_4$.
The dialled ship station number is accepted by an input register at the MSC, where it is checked on nationality and of presence in the LR. If the assumption appears to be correct, the call is routed to the appropriate BS or CS, and the subscriber is charged in accordance with the "national tariff".
If, however, the ship cannot be served by any N-station, the call is diverted either to the manual operated exchange or to an automatic answering device. In both cases the subscriber is informed that if he still wants to contact that ship, he then has to dial anew the ship station number, preceeded by $87S_5$. He will be charged in accordance with the "international tariff".
So in this system two tariffs are considered. If more numbers of the range 870-879 are used for this service, the number of tariffs can be extended accordingly.
In any case, supplementary taxes like coast- tax, may be included in the tariffs.

If the N-subscriber dials the ship station number of a non-N-ship e.g. an X3-ship, using the $87S_4$ access, the MSC_N checks whether this ship is listed in its LR. If so, the same procedure is used as if an N-ship were dialled.
In case the ship requested is not registered in the LR of MSC_N the call is diverted to either the answering device or to the manual exchange. In both cases the subscriber is informed of the absence of the ship in the N-list.
If, nevertheless the subscriber wishes to contact the ship, he has to dial again via the $87S_5$ access. He then will be charged in accordance with the "international tariff".
The MSC_N routes the call to the MSC_{X3}.

If will be clear from the procedure description that it is essential to detect in an easy way the nationality out of the ship station number.

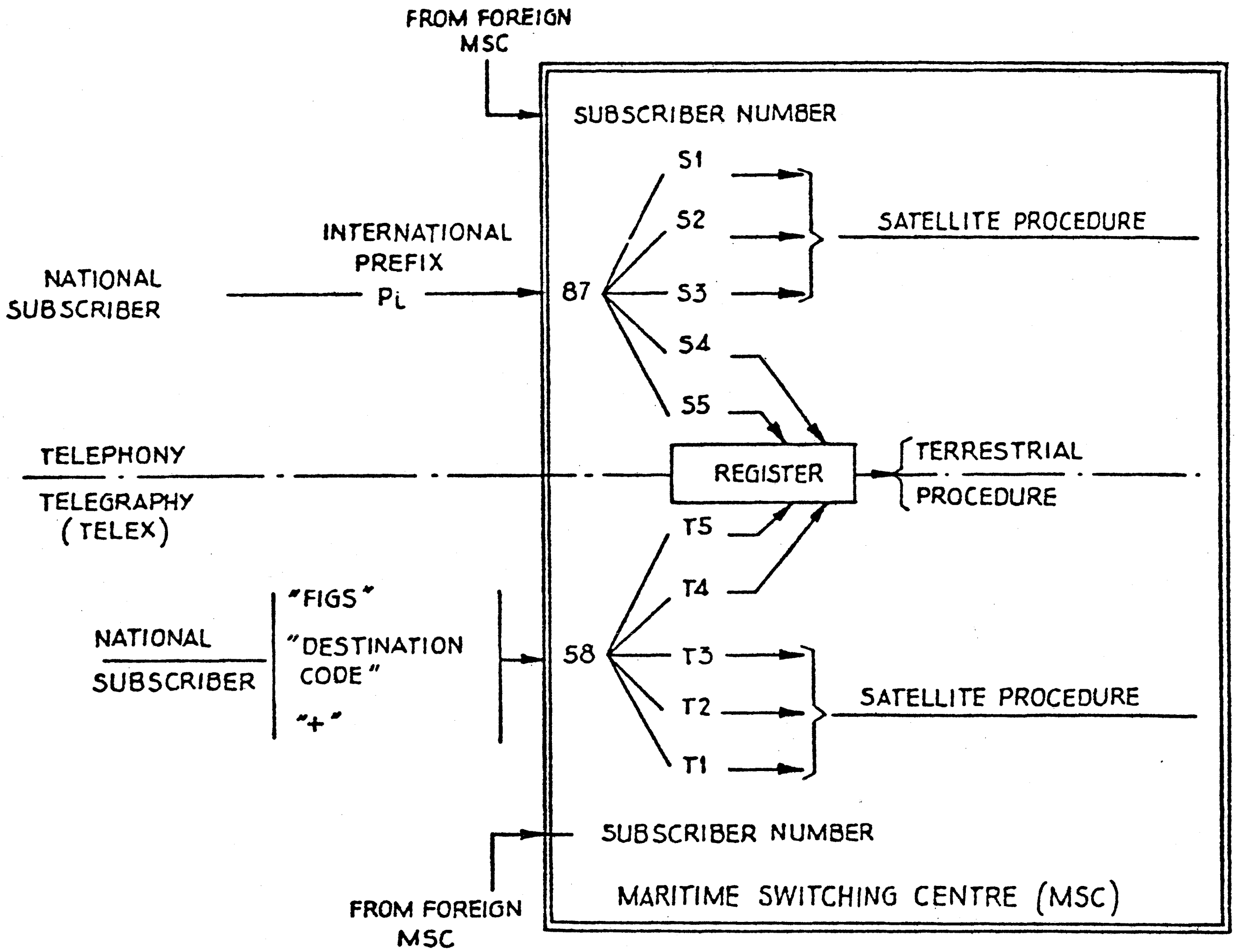

FIGURE 1

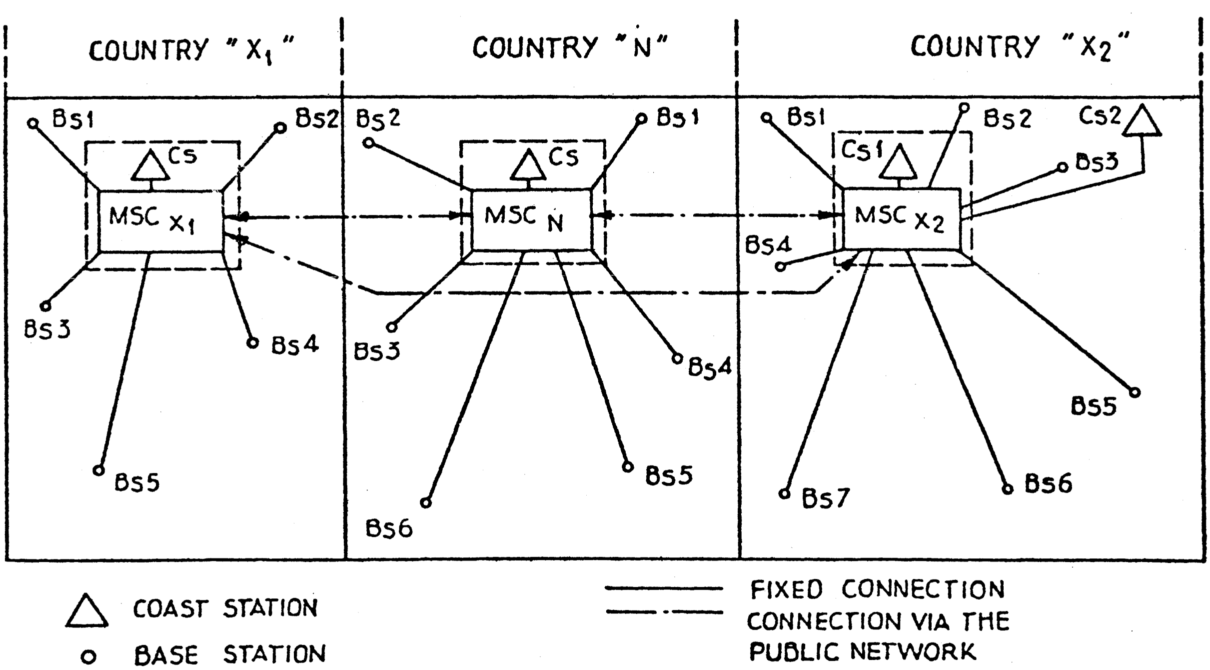

FIGURE 2

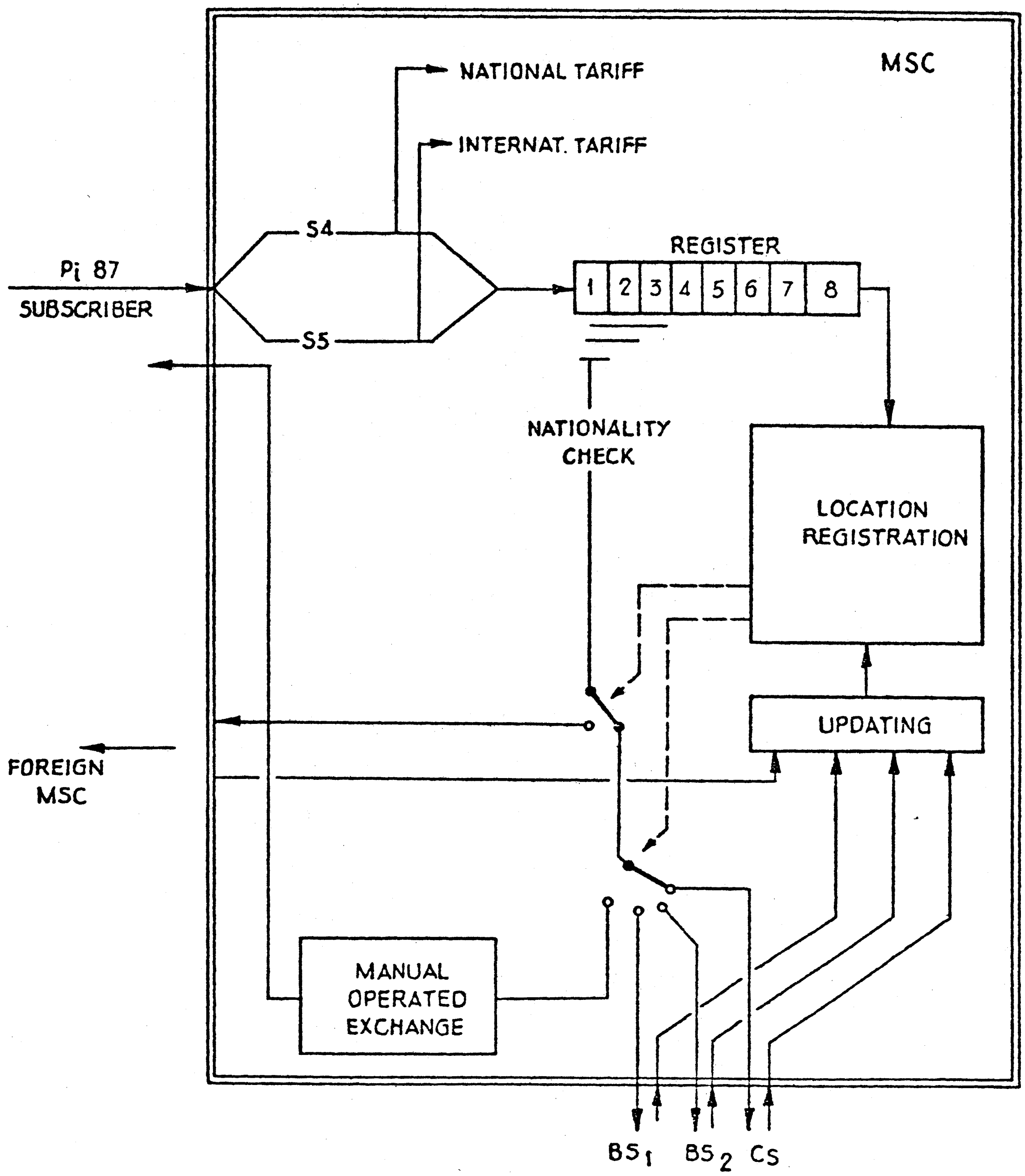
MSC
NATIONAL TARIFF
INTERNAT. TARIFF
S4
S5
REGISTER
1
2
3
4
5
6
7
8
Pi 87
SUBSCRIBER
NATIONALITY
CHECK
LOCATION
REGISTRATION
UPDATING
FOREIGN
MSC
MANUAL
OPERATED
EXCHANGE
BS1
BS2
CS

FIGURE 3

APPENDIX B

DRAFT RECOMMENDATION
SHIP STATION IDENTIFICATION FOR VHF AND SATELLITE MARITIME MOBLE SERVICES

A N N E X

DRAFT RECOMMENDATION

SHIP STATION IDENTIFICATION FOR VHF AND SATELLITE MARITIME MOBILE SERVICES

1. Introduction

1.1 The purpose of this Recommendation is to specify a method by which an internationally unique ship station identification may be assigned to all the ships participating in the Maritime Mobile Services, and to facilitate the introduction of international automatic VHF and Satellite Maritime Services.

1.2 Terminology

The following terms are used in this Recommendation :

a) Maritime Mobile (Terrestrial) Service : conventional Maritime Mobile Services such as the HF Maritime Service and the VHF Maritime Service (as defined in the Radio Regulations).

Maritime Mobile Satellite Service : as defined in the Radio Regulations.

b) Coast station : radio station on land in the Maritime Mobile (Terrestrial) Service.

Shore station : earth station on land in the Maritime Mobile Satellite Service.

c) Ship station identity : the ship's identification $X_1X_2 \ldots X_k$ transmitted on the radio path.

Ship station number : the number that identifies a ship for access from a public network and forms part of the international number to be dialled or keyed by a public network subscriber.

d) Coast (shore) station identity : the coast (shore) station identification $X_1X_1 \ldots X_k$ transmitted on the radio path.

1.3 Basic considerations

The considerations that form the basis of this ship station identification system are :

a) that every ship shall have a unique ship station identity;

b) that the same unique ship station identity should be used in both VHF and Maritime Mobile Satellite Systems;

c) that the same unique ship station identity should be used for all telecommunication services, particularly for radiotelex and radiotelephony;

d) that it is desirable that the ship station number and the ship station identity be the same;

e) that the capacity of the ship station identification system shall be sufficient to admit all ships wanting, or required, tc participate in the various Maritime Mobile Services at present and in the foreseeable future;

f) that access to Maritime Mobile Services via the existing international network in automatic operation should follow the relevant and appropriate CCITT Recommendations;

g) that the ship identity system shall be a numerical system, and should use the full range of decimal digits;

h) that two or three of the digits, $X_1X_2X_3$, of the ship station identity shall indicate the ship's nationality;

i) that there are important differences in national networks that promote different approaches to automation of Maritime Mobile Services;

j) that a numerical assignment Plan should consider current telephone and telegraph network limitations while it permits change to support future requirements.

2. Ship station identification

2.1 Ship station identity [1) 2) 3)]

Ship station identity is established as nine digits. It should be assigned to take into account the implications relating to it in the public switched networks.

$\underline{X_1X_2X_3}X_4X_5X_6X_7X_8X_9$

The initial three digits define the nationality of the ship as indicated in the following sections.

2.2 Ship station number

The ship station number defines the ship station within the public switched network and this information is transmitted to a coast or shore station. In the Maritime Mobile (VHF) Service the ship station number may be different from the ship station identity to relate to national network needs.

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1) Subject to further consideration by CCIR of radio path aspects.
2) A seven digit ship station identity is used in the current generation of Maritime Satellite System.
3) Some international telex centres are limited to 7 digits and the presently used Maritime Satellite System employs only 7 digits for ship identification.

3. Assignment of ship station identification

3.1 Assignment of blocks of numbers

Blocks of numbers should be assigned to countries so that individual Administrations may systematically assign ship station identities within those blocks.

3.2 Identification of ship's geographical region

The first digit of each ship station identity is intended to identify the geographical region to which the nationality (registry) of the ship relates. Only the digits 2 through 7 are used for this purpose to identify easily the world's regions as follows :

2 - Europe

3 - North America

4 - Asia (except South-East Asia)

5 - Oceania and South-East Asia

6 - Africa

7 - South America.

Arrangements may therefore be made to systematically assign a ship station identity to each ship as soon as national blocks are allocated. The digits zero (0), one (1), eight (8) and nine (9) are allocated for other purposes as indicated in the following sections.

3.3 Identification of ship's nationality

Since blocks of the ship station identities would be systematically assigned by country, a ship's nationality can be determined by analyzing the first three digits of its ship station identity.

The digits to be analyzed are called "Nationality Identification Digits" (NID). Examples of the Nationality Identification Digits for ships are given below.

Country	Nationality Identification Digits (NID)		Ship Station Identities
P	231	from to	2 310 00000 2 319 99999
Q	233, 234		2 330 00000 2 349 99999
R	236, 237 238		2 360 00000 2 389 99999
S	240 - 249		2 400 00000 2 499 99999

4. Assignment of nationality identification digits

Each NID represents a discrete capacity assigned according to a plan that relates assigned capacity to ship population. The plan is to be developed by a competent World Administrative Radio Conference (WARC) and administered by the Secretary-General of the ITU.

5. Coast/Shore station identity

The coast/shore station identities may be derived from the pool of the ship station identities assigned to each country.

6. Broadcast calls

$X_1 = 0$ is assigned to indicate a broadcast call to a group of ships having a community of interest. Such calls may be barred in the public switched network and/or at the coast/shore stations. Control of broadcast calls may also be achieved by the use of special broadcast service access to the coast/shore stations.

7. Future expansion of the ship station identification system

$X_1 = 1$ as in the format 1 XXXXXXXX has been reserved for future expansion.

8. Evolutionary expansion of ship station identities as applied to Maritime Mobile (Terrestrial) Services

8.1 The plan permits the identification of ships whose communications requirements are inter-regional, regional or national. The plan is intended to allow the automation of Maritime Mobile Services on public switched networks, where feasible, as the demand for ship station identities increases for the automatic service. This demand is considered in stages defined by the number of digits in ship station numbers required to satisfy automatic communication needs. A minimum number of digits is used for ship station numbers at any given time to permit countries with network restrictions to provide a maximum of automation. Trailing zeros are added to the ship station numbers (received from an automatic network) to form 9-digit ship station identities on the radio path. The $X_1X_2X_3$ digits are shown as Nationality Identification Digits in the following illustration.

Stage	Ship Station Number	Digits on the auto-matic net-work	Ship station identity	Digits on the Radio Path
1	NID $X_4X_5X_6$	6	NID $X_4X_5X_6$ 000	9
2	NID $X_4X_5X_6X_7$	7 *)	NID $X_4X_5X_6X_7$ 00	9
3	NID $X_4X_5X_6X_7X_8$	8	NID $X_4X_5X_6X_7X_8$ 0	9

8.2 In stage 1, those countries that would identify VHF calls and plan to automate VHF in a single stage of subscriber selection would have full access to all ships if they are able to assign 6 digits to ship station numbering in their networks. The plan contemplates mutual cooperation to extend this stage as long as possible by judicious ship station identity assignments to satisfy requirements for automatic VHF in the face of network limitations.

8.3 Additional ship station numbering techniques may be used to expand network access to more ship stations in stages 1 and 2. These techniques permit an extension of the time periods during which stages 1 and 2 apply.

Ship Station Number	Ship Station Identity
8Y $X_4X_5X_6X_7$	$N_yI_yD_y$ $X_4X_5X_6X_7$ 00
9 $X_4X_5X_6X_7X_8$	$N_nI_nD_n$ $X_4X_5X_6X_7X_8$ 0

In this arrangement, the digits 8Y may be 80 to 89 to define as many as ten foreign NIDs (shown as $N_yI_yD_y$) to permit automatic calling of ships of particular nationalities. The coast station would be required to translate a given 8Y to a particular foreign NID. The digit 9 may be used to indicate the Nationality Identification Digits for ships of the same nationality as the network and the coast station. The coast station would be required to translate 9 to one particular national NID (shown as $N_nI_nD_n$). National application of these techniques could be adopted to provide an efficient use of ship station numbers.

*) Due to network limitations, some countries may choose to withhold the first digit of the NID and insert it automatically at the coast station to retain automatic access to all ships whose NIDs have identical first digits (ships of the same geographical area). However, the application of this technique should be avoided if possible to minimize ambiguity.

9. Ship station identity for Maritime Mobile Satellite Service

The international numbering plans would permit up to 9 digits for ship station identity and ship station numbering to be used in association with country codes 87X for telephony and destination codes 58X for telex, where X may indicate ocean area or system.

10. Considerations related to ship station identity assignment

An efficient allocation of ship station identity will permit an extension of the time period in which stage 1 applies. The specific manner in which the optional techniques indicated in Sections 8.1 and 8.3 are applied depend on the needs of a given Administration to achieve an optimum result. Special consideration should be given to the assignment of ship station identities for ships engaged in regional and national traffic so that spare capacity remains available for inter-regional traffic when transition from stage 1 to stage 2 takes place.

Annex

(to the Recommendation)

National network diversity and automation of VHF service

National network numbering and routing requirements provided to satisfy national subscriber population and service needs result in widely varying abilities to support automatic VHF service. The following diverse approaches have been recognized and should be expected.

1. The inability of some networks to carry as few as six digits for ship station number purposes will tend to defer automation indefinitely in some instances.

2. Some countries will find it practical to provide for automation on the basis of six digits for ship station numbering in accordance with the proposed plan in this Recommendation. When seven digits are required (in stage 2) the practice of not dialling the initial digit of the Nationality Identification Digits may be adopted to maintain as much automation as feasible. Refer also to Section 8.1.

3. Some countries may find it practical to use national network numbering to define ship station numbers that are translated to ship station identities at one or more coast stations and perhaps support this with locator services.

4. Some countries may find it practical to use two-stage selection, e.g. in the telephone service a second stage of subscriber dialling with multi-frequency push-button equipment may be already available or provided specifically for subscribers particularly interested in maritime services.

5. Some countries may now, or later, provide for centralized maritime centres that may support automatic location and call routing facilities. The use of such maritime centres would enable the application of ship station numbers of up to 9 digits between countries with such centres.

FORM OT-29 (3-73)

U.S. DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

BIBLIOGRAPHIC DATA SHEET

	1. PUBLICATION OR REPORT NO.	2. Gov't Accession No.	3. Recipient's Accession No.
	NTIA Report 78-7		

4. TITLE AND SUBTITLE
INTERFACING THE AUTOMATED MARITIME MOBILE TELEPHONE SYSTEM WITH THE U.S. PUBLIC SWITCHED TELEPHONE NETWORK

5. Publication Date
Aug 1978

6. Performing Organization Code
NTIA/ITS

7. AUTHOR(S)
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9. Project/Task/Work Unit No.

8. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Department of Commerce
National Telecommunications & Information Administration
Institute for Telecommunication Sciences
325 Broadway, Boulder, Colorado 80303

10. Contract/Grant No.

11. Sponsoring Organization Name and Address
U.S. Maritime Administration
Department of Commerce
Washington, DC 20230

12. Type of Report and Period Covered

13.

14. SUPPLEMENTARY NOTES

15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report summarizes the characteristics of the U.S. public switched network and the maritime radio service, which impact the development of an Automated Maritime Mobile Telephone System (AMMTS). Features and performance parameters which appear desirable to an AMMTS user are reviewed and some basic system concepts capable of satisfying these user's needs are presented. The interface between the public switched network and coast stations serving the maritime community is discussed in detail. Techniques for automatically placing a call to ships whose location is unknown are described. The development of an AMMTS involves a number of issues which may be different in the U.S. than in other countries of the world. The final section of the report defines some issues requiring further study.

16. Key Words *(Alphabetical order, separated by semicolons)*

Maritime communications; automated telephone systems; network interfacing

17. AVAILABILITY STATEMENT	18. Security Class *(This report)*	20. Number of pages
[X] UNLIMITED.	Unclassified	66
[ ] FOR OFFICIAL DISTRIBUTION.	19. Security Class *(This page)* Unclassified	21. Price:

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978 — 778-935/12 REGION NO. 8

USCOMM-DC 29716-P73