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# 1. INTRODUCTION

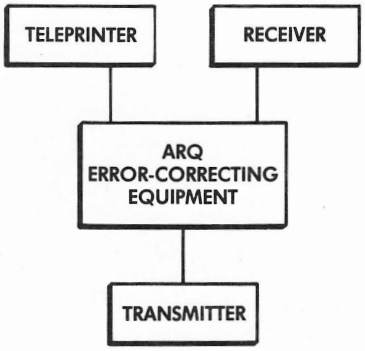
In an effort to improve ship-to-shore communications, ITU for the last two decades has been promoting the direct-printing services. In 1970 the CCIR recommendation 476 was adopted. This recommendation defines the technical characteristics of an error-correcting equipment which requires a return channel for control signals, i.e. a simplex ARQ system. The simplex mode was chosen since it suits shipboard installations, where a duplex system would meet difficulties due to that the available spacing between transmitting and receiving antennas is restricted.

Recommendation 476 also specifies a forward-acting time diversity error-correcting system which can be used for multi-address messages as well as individual messages to mobile stations which may not use their transmitting equipment. Recommendation 476 is amplified by recommendation 491 which specifies the selective call signals required for coast and ship stations.

Equipment built to meet recommendations 476 and 491 has certain drawbacks in that the calling station is not automatically identifying itself. Therefore an additional recommendation on operational procedures was required.

Recommendation 492 defines the requirements for the maritime mobile direct-printing services. This recommendation specifies the operational procedures, the types of prompting required in setting up direct-printing communication between a ship and a coast station. Both manual and automatic operation is foreseen.

Today many coast stations around the world operate direct-printing services. The majority of them operate manual or semi-automatic systems. So far only one fully automatic system is in operation, the MARITEX system, which is operated by sta, the Swedish Telecommunications Administration.




*A minimum equipment configuration for direct-printing may have this form.*

When operating this type of station, the transmitter and receiver are manually tuned to the correct frequencies. The error-correcting equipment is coded with the selective call signal which identifies the station. Prior to establishing contact, the ARQ is coded with the selective call signal of the distant station. When starting the call, the two ARQs establish correct phase relationship, upon which communication can begin on the teleprinters.

The block diagram above applies to both main station and sub-stations. The difference between the two applications lies in that the main station often has access to more powerful transmitters and also to directive antennas. The main station has facilities to switch the teleprinter output into the telex network.

## 2. FROM MANUAL TO AUTOMATIC OPERATION

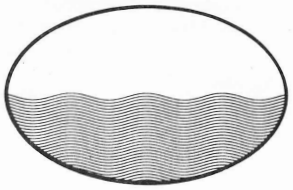
In the coast or main station of a direct-printing network it is possible to multiply the basic equipment and have a number of operators who handle communications. This approach, however, is not utilizing the inherent capabilities of the equipment and furthermore it requires much manpower to operate the system.

In general, one operator can handle two to three simultaneous circuits, but even with efficient operators it is difficult to avoid queues on the radio circuits. Oddly enough, the main effort and the main delays lie in the land telex operation: The desired telex subscriber is very often busy and the links to a foreign country may be heavily loaded, resulting in queue situations on the radio channels. Creating the source material for billing is also a heavy task for the operator.

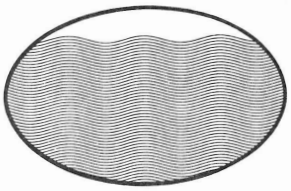
An analysis of the traffic flow in a manual maritime telex network showed that only very few of the messages were exchanged with decision-makers at the teleprinters. The majority of messages were of a telegram or letter type, which were suited for storing and forwarding. The nature of HF radio circuits also favours the store-and-forward method since it is difficult to establish HF radio communication all over the world at any moment. Taking all these factors into consideration it is obvious that an automatic store-and-forward telex system would meet most operational demands in an HF radio network.

A more cost-effective approach, then, would be to connect the basic equipment required for each radio channel to a computer. The computer could then control transmitters and receivers, their associated antenna equipment, the ARQs and the external telegraph circuits, which may be connected to the international telex network or to a national communications center. The result would be a communications network of high efficiency and very short access times.

sta, the Swedish Telecommunications Administration, has designed the MARITEX System along these lines. It has been in operation since 1972 and over the years the system has proven its efficiency and reliability.



*In the MARITEX System, 50 % of the messages reach their destination within 30 minutes and 80 % within 2 hours.*



*This applies to shore-to-ship communications. In the reverse direction, delay times are negligible.*

Today, the system operates 20 simultaneous radio channels and connects via 16 inter-station telex lines to the international telex network. 250 subscribers create 600.000 billed telex minutes per annum.

The average message length lies between 1 and 2 minutes, a result of the

very short access times and also of the structure of the subscribers. The average subscriber exchanges 3 to 4 messages per day. 67% of these go towards land and 33% to ship stations.

The structure of the subscribers has altered over the years. In the beginning only large tankers were considered eligible for a MARITEX installation, but nowadays also very small ships become subscribers. One reason for this may be the high reliability of the MARITEX system, another the ease of operation.

HF telex systems will not be superseded by satellite systems. Even in the future there will be a demand for both services, satellite communications for the modern and efficient high sea ships and HF telex for those who have more modest demands on communications and an eye in the wallet.

## 3. MARITEX SYSTEM PRINCIPLES

The MARITEX system is an HF communications system, primarily designed for maritime networks, but it is also applicable to governmental, diplomatic and military radio networks.

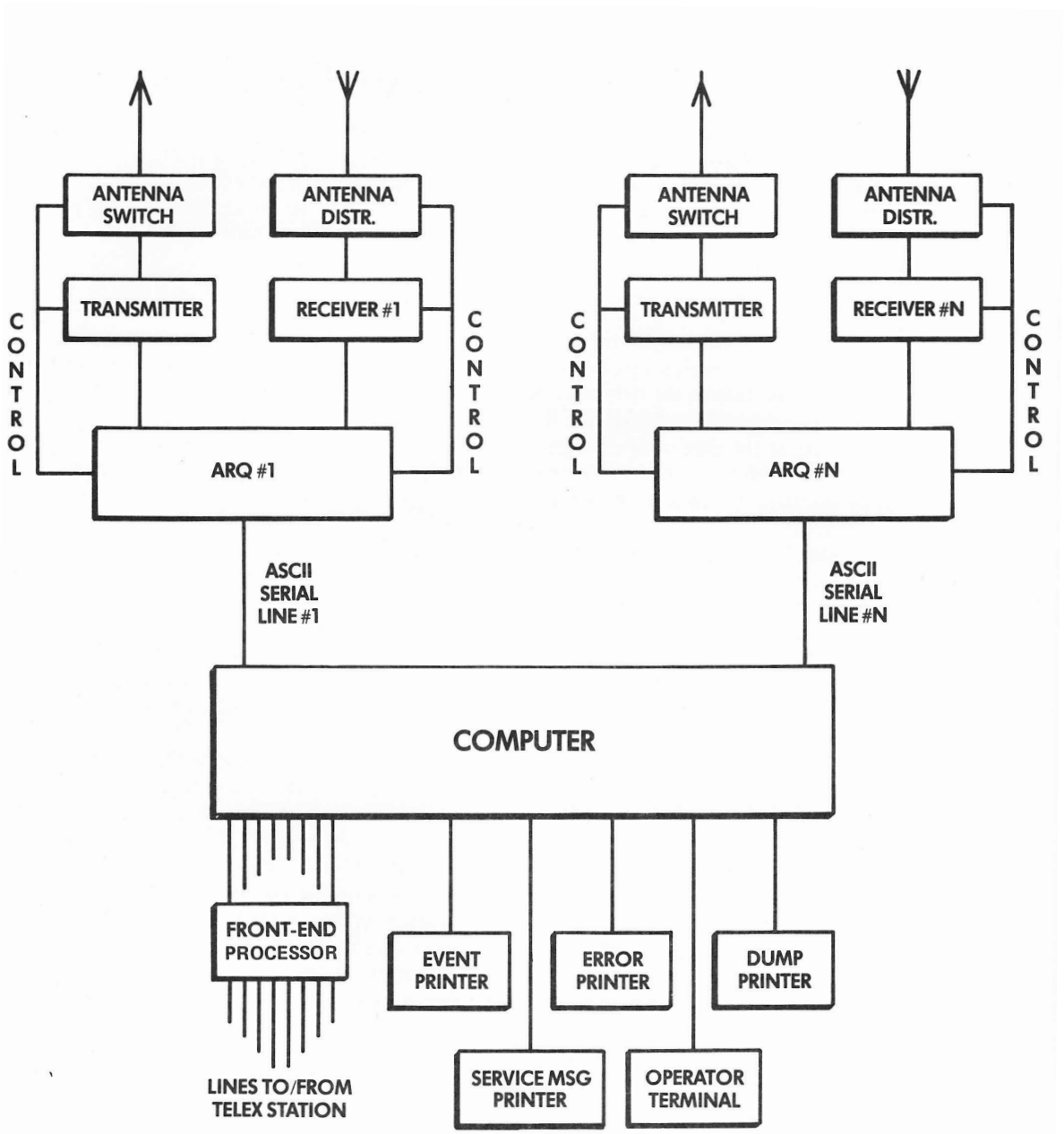
The radio network is star-shaped, with one main station and a number of mobile sub-stations. The network allows only radial communication paths, from main station to sub-station or vice versa. Communication between sub-stations is not recommended.

The main station has a number of radio channels available. The frequencies of the channels are selected to provide adequate coverage at different times of day and at different distances. The frequency plan for the maritime mobile services allocates frequencies in the 4, 6, 8, 12, 16, 22 and 25 MHz bands. A radio channel here is defined as consisting of the basic equipment configuration, i.e. transmitter, receiver and ARQ.

During idle conditions each channel transmits an idle signal, which consists of the first half of the selective call signal, repeated every 450 milliseconds. The idle or free-signal (see Rec. 492) indicates to the sub-station that the channel is free. Continuous watch is kept on the associated receiving frequencies. When a call is detected, the free-signalling is aborted and the communication link is established.

The traffic structure with 67% of the traffic going towards land is mirrored in the watch-keeping. After each transmitted or received message, a pause for watch-keeping is inserted to compensate for the uneven traffic flow distribution.

# Coast station equipment




*MARITEX MAIN STATION BLOCK DIAGRAM*

## 4. MARITEX MAIN STATION CHARACTERISTICS

### Radio channels

A number of radio channels are connected via the ARQ to a computer. Through the unique sta designed ARQs, STARQ M79, the computer is able to control transmitter and receiver frequencies, antenna directions etc.

### Telex interface

Via the telex interface the computer receives and transmits messages from and to the telex subscribers. The telex interface is normally a micro-computer with the main task to translate line levels and to accommodate various protocols in different telex networks.

### Event printer

All events in the system are recorded on an event printer. Whenever a message enters or leaves the system, the event is recorded together with other relevant information.

### Billing and statistics

This information is stored on disc memory. Parts of it are used for billing purposes and other parts for traffic load statistics etc.

### Error printer

Errors or malfunctions are printed on the error printer, which serves as a continuous service log for the system.

### Service messages

Service messages from the sub-station operators are printed on the service message printer. The messages may be of operational or technical nature. Also messages which cannot be routed automatically by the computer are printed here for manual handling.

### Dump printer

Messages which have been stored in the system for a certain period of time without being forwarded are dumped by the system on the dump printer. A dump printout invariably causes manual intervention.

### System terminal

The system terminal gives the main operator access to the system to perform insertions and deletions of traffic.

### Storage

All traffic is stored on disc memory. The actual text of the messages is not printed by the system. Only the event information is available in printed form.

## 5. MAIN STATION FUNCTION

When the telex station places a call to the MARITEX Main Station, the telex interface handles the protocol and forwards the message to the computer, which records the event.

In the computer are stored actual lists of the positions of the sub-stations and also a radio propagation forecast. With the time of day, sub-station position and the radio propagation forecast as decision criteria, the computer selects a radio channel and starts calling. When the called sub-station answers, an identity check is performed, upon which the message is forwarded and the event recorded. If the call fails, it will be repeated. All cails are queued up and repeated in approximately 3 minute intervals, unless the radio propagation forecast prohibits it.

After each outgoing call, the system pauses to receive calls. When a call is detected, an identity check is performed. When the identity of the caller is known, the position list governs selection of directive antennas to improve channel quality.

The received message is stored when complete and until a final identity check has been performed. Then the message is forwarded to its destination via the telex interface and the telex network. The two events are recorded, first, when the message arrives into the system and second, when it leaves the system.

Note that messages are stored in full in the system, prior to transmission. For outbound traffic to the sub-stations this is quite natural, but for inbound traffic to the telex network the reason for storing is that the telex subscriber may not always be free, nor the lines to the country of destination. Storing gives the computer the opportunity of waiting for the connection and also shortens the forwarding time, since transmission can proceed at maximum allowable speed, without interruptions due to bad radio channel performance.

At regular intervals, the computer sets up the radio channels for broadcast transmissions of news, weather reports etc. The information to be transmitted in this way is entered into the system by the main operator at any time prior to transmission.

## 6. SUB-STATION CHARACTERISTICS

A MARITEX sub-station may have different degrees of sophistication.

The basic equipment configuration on page 3 is sufficient in applications where frequency changes are unlikely or infrequent.

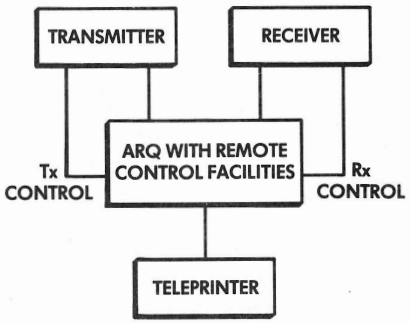
When frequency changes become necessary, a remote-controlled receiver and auto-tuned transmitter becomes compulsory in order to maintain the system demand on access to the sub-station on the optimum frequency.

With remote-controlled radio equipment follows a capability of the ARQ or some other equipment to issue the proper remote control signals.

ARQ equipment built to CCIR Recommendation 476 usually lack remote control facilities, but equipment which meet the demand from automatic telex systems are coming on the market. sta has developed an ARQ, which fully meets and exceeds the demands of recommendations 476, 491, 492 and MARITEX.

The ARQ is designed by the people who designed the MARITEX system. The ARQ is a telex communications terminal designed with emphasis on the operational aspects. It features the following facilities:

- Full keyboard control
- Text editing facilities and 5000 character storage
- Remote control facilities for receiver and transmitter
- 49 preprogrammed frequency pairs arranged in 7 groups of 7 frequencies
- 21 keyboard entered frequency pairs
- 7 default call codes linked with frequency groups
- ASCII or CCITT 2 printer options
- Inbuilt modem
- Automatic operation by means of a special command code which enables the ARQ to transmit messages without operator presence




*The equipment configuration of a sub-station is similar to the basic configuration previously described.*

To the basic equipment a number of functions are added:

- Transmitter and receiver are remotely controlled and the transmitter is auto-tuned
- A channel scanning facility which steps the receiver and transmitter frequencies in recurring sequence
- A character recognition facility, which recognizes the first part of a selcall and may stop receiver scanning when it detects a free-signal (see CCIR Rec. 492) or a call
- The teleprinter answer-back device is coded in the form:

  123456 NAME

  This facility meets the station identification requirements of Rec. 492.
- When the ARQ leaves STANDBY to become MASTER or SLAVE the receiver scanning is stopped and the transmitter is tuned automatically

## 7. SUB-STATION OPERATION

In standby the receiver scans the appropriate radio channels. The operator has the option to select radio channels, but normally the equipment automatically scans all the channels in sequence. The listening period is 5 seconds per channel.

When a free-signal is detected by the ARQ, a stop scan control signal is issued, which may stop receiver scanning. It is stopped for as long as the free-signal is of sufficiently good quality. If the radio channel becomes busy with traffic, scanning is resumed until a new free channel is detected. The absence of a free-signal also prohibits the ARQ to start calling, thus securing against interference with on-going traffic.

During standby periods the operator may prepare traffic to send. The normal method of preparing a message is to punch a paper tape. In the new generation of ARQs, message preparation is better performed with the aid of a semiconductor memory with editing facilities, which eliminates the need for paper tape punch and reader.

### Transmitting messages

When preparation of the message is finished, the operator waits for a free channel and initiates calling. The receiver scanning is stopped, and the transmitter is tuned automatically. When contact is established the MARITEX main station governs the operator from the identity check through the command sequence to transmission of message and finalization. Generally speaking, it is a pushbutton job to transmit a message from a sub-station.

### Receiving messages

When a call is detected by the ARQ, receiver scanning is stopped, the transmitter is tuned automatically and the message is printed by the teleprinter. The MARITEX main station finally checks the identity of the sub-station and signs off. If the connection is broken during transmission the system will call again and transmit the message from the beginning until the final check can be performed. During this entire procedure, the presence of the operator is not necessary.

During broadcast transmissions from the system of press, weather etc, the same procedure applies, apart from that the transmitter is not activated.

### Billing, logbooks

Since a sub-station in the MARITEX system is considered to be a telex subscriber, billing is performed by the main station. Consequently no log-keeping is required at the sub-station from a billing point of view. Itemized invoices are sent to the owner stating the duration, destination, date and cost for each call.

## 8. SUMMARY

The advantages of an automated radio telex system like the MARITEX system are obvious.

*The MARITEX system offers:*

— *Automated two-way operation*
— *Unattended operation on board*
— *Automatic frequency selection speeds message throughput*
— *Efficient frequency utilization*
— *Extremely short message delay times*
— *Access to the international telex network*
— *High privacy*
— *Low investment costs, existing transmitters can be employed*
— *Low manpower requirements*
— *Low running costs*
— *High revenue*