

CHANNEL REQUIREMENTS FOR A DIGITAL SELECTIVE-CALLING SYSTEM

(Question 9/8)

(1982-1986)

1. Introduction

A digital selective-calling (DSC) system could ultimately replace manual watchkeeping on ships and give automatic alerting facilities for all the communications of interest to the ship such as morse telegraphy, radiotelex, radiotelephony etc. Two types of channel will be required: international and national.

- *International channels.* These are used in the direction shore to ship only when a coast station wishes to call a ship but does not know which frequencies are being monitored by the ship. It is considered that these calls will be relatively few. International channels are available to all coast stations.
- *National channels.* These are used when a ship wishes to contact any coast station or a coast station wishes to contact a ship of its own nationality or a ship which it contacts regularly. National channels are associated with particular coast stations. Although the calls can be in both directions current calling patterns suggest that mainly the direction is ship to shore but this could change with an improved service. Experience with the INMARSAT system may give some guidance here.

No national DSC channels are as yet allocated, and the presently allocated numbers of international DSC channels may not be sufficient to support a fully developed DSC system, and new channels will have to be allocated. It is, therefore, important to endeavour to make a provisional forecast for the initial development of the DSC system.

This Report considers the number of calling channels that may ultimately be required for calls other than distress and safety. This information is of value to assist in preparation for the World Administrative Radio Conference for the Mobile Services in 1987.

2. Use of scanning receivers

The use of a scanning receiver leads to a non-zero probability that a call intended for the receiving station is lost due to the decoder being engaged on another channel, usually referred to as the scanning loss. Scanning loss is a function of the number of channels scanned by a single receiver and the loading of the DSC channels, but, as follows from the definition, is independent of the number of calls intended for the receiving station. As a general rule the use of scanning receivers is not to be encouraged as the scanning loss increases channel loading and thus has a cumulative effect. Nevertheless, it must be recognized that the use of scanning receivers may be a necessity on many ships for economic reasons.

As a provisional value for a fully developed system, a single receiver should scan not more than six channels (see Annex I); thus the number of channels that a ship station should be expected to watch is of significant economic consequence. Two cases may be considered:

- minimum of about 6 frequencies, i.e. 1 national and 1 international channels in 3 bands. This would require cooperation of the ship's personnel to select the most appropriate bands at any given time and could increase the traffic load on the international channels due to the limited watch on national channels;
- minimum of about 15 frequencies, i.e. 2 national and 1 international channel in each of the bands 4, 6, 8, 12 and 16 MHz. This would give a more automatic service to the ship's personnel but would require more than one scanning receiver.

3. Assumptions for calculating MF channel requirements

Calculations were based on the following assumptions/data:

3.1 The MF traffic handled by Northern Europe coast stations represents the highest density of MF traffic in the world and meeting the channel requirements for this area will permit satisfaction of the MF requirements for other parts of the world.

3.2 The number of MF communications predicted to be handled in each hour of a typical 24-hour period in 1990 based on the combined traffic of Germany (Federal Republic of), Belgium, Denmark, Norway, the Netherlands, the United Kingdom, Sweden and 50% of the USSR traffic is given in Table I. These figures are assumed to represent the traffic referred to in § 3.1.

Note. — Only 20% of the predicted ship-to-shore radio teleprinter calls are included in Table I since it is assumed that most countries allow ships to use the selective calling system inherent in the radioteleprinter equipment (see Recommendations 476 and 625).

3.3 Duration of a DSC call

3.3.1 The duration of a DSC call from a ship station to a coast station is 5.8 s (assuming a 20-bit dot pattern (see Recommendation 493, Annex I, § 3.4.2).

3.3.2 The duration of a DSC call from a coast station to a ship station is 7.8 s (assumes a 2 s dot pattern).

3.4 A called station transmits an acknowledgement which lasts 5.8 s (assumes no dot pattern). A calling station will repeat a call in accordance with Recommendation 541, Annex II, until an acknowledgement is received.

3.5 The maximum permitted loading of a random access calling channel is 0.1 erlang (according to traffic theory the probability that two or more calls coincide and therefore fail, is 18%). Even for this relatively low channel loading, a second effect, i.e. congestion of a calling channel as a result of repeated unsuccessful calls cannot be neglected. Congestion can only be prevented by requiring a time delay before repeating the transmission of a call sequence. A higher channel loading would also adversely affect the use of scanning receivers (see Annex I and Recommendation 541, Annex II, § 2.1.8.1, 2.1.11 and 2.2.5).

3.6 It is assumed that primarily as a result of imperfect propagation, interfering signals, coincidence with other calls, etc., the transmission of two call or acknowledgement sequences is required for a successful call.

3.7 Ship-to-shore and shore-to-ship calls are made via common paired frequency channels.

3.8 Ship-to-shore and shore-to-ship acknowledgements are made using the same paired channels referred to in § 3.7.

3.9 One paired international channel is used in each of the 500 kHz and 2 MHz bands.

3.10 The traffic handling capacity in erlang for national DSC channels required for each hour is based on the following calculation:

3.10.1 Shore-to-ship

$$\text{Traffic handling capacity (erlangs)} = \frac{\text{Number of calls per hour} \times \text{call duration}}{3600 \text{ (s/h)}}$$

2 (see § 3.6) × 7.8 s (see § 3.3.2)

3.10.2 Ship-to-shore

$$\text{Traffic handling capacity (erlangs)} = \frac{\text{Number of calls per hour} \times \text{call duration}}{3600 \text{ (s/h)}}$$

2 (see § 3.6) × 5.8 s (see § 3.3.1)

TABLE 1 – MF calls and DSC channels required (Northern Europe)
(Based on traffic statistics from Germany (Federal Republic of), Belgium, Denmark,
Norway, the Netherlands, the United Kingdom, Sweden, and the USSR (50%))

Time (UTC)	Shore-to-ship						Ship-to-shore				Combined shore-to-ship plus ship-to-shore			
	500 kHz Morse calls	2 MHz telephone calls	2 MHz teleprinter calls	2 MHz total calls	Total erlangs		500 kHz Morse calls	2 MHz telephone calls	2 MHz teleprinter × 20% calls	2 MHz total calls	Total erlangs		Total DSC channels	
					500 kHz	2 MHz					500 kHz	2 MHz	500 kHz	2 MHz
00-01	4	6	4	10	0.02	0.04	31	27	3	30	0.10	0.10	0.12	0.14
01-02	5	3	3	6	0.02	0.03	11	17	3	20	0.04	0.06	0.06	0.09
02-03	3	9	1	10	0.01	0.04	7	12	2	14	0.02	0.05	0.03	0.09
03-04	4	6	7	13	0.02	0.06	5	14	2	16	0.02	0.05	0.04	0.11
04-05	6	8	2	10	0.03	0.04	14	16	2	18	0.05	0.06	0.08	0.10
05-06	8	7	3	10	0.03	0.04	21	34	4	38	0.07	0.12	0.10	0.14
06-07	13	12	7	19	0.06	0.08	32	54	5	59	0.10	0.19	0.16	0.27
07-08	17	9	5	14	0.07	0.06	41	105	6	111	0.13	0.36	0.20	0.42
08-09	21	33	13	46	0.09	0.20	40	148	6	154	0.13	0.50	0.22	0.70
09-10	28	37	14	51	0.12	0.22	37	146	5	151	0.12	0.49	0.24	0.71
10-11	21	44	19	63	0.09	0.27	34	137	4	141	0.11	0.45	0.20	0.72
11-12	18	36	11	47	0.08	0.20	37	117	2	119	0.12	0.38	0.20	0.40
12-13	17	22	13	35	0.07	0.15	33	117	3	120	0.11	0.39	0.18	0.33
13-14	20	32	14	46	0.09	0.20	33	119	3	122	0.11	0.39	0.20	0.40

TABLE 1 (continued)

Time (UTC)	Shore-to-ship					Ship-to-shore					Combined shore-to-ship plus ship-to-shore			
	500 kHz Morse calls	2 MHz telephone calls	2 MHz teleprinter calls	2 MHz total calls	Total erlangs 500 kHz 2 MHz	500 kHz Morse calls	2 MHz telephone calls	2 MHz teleprinter × 20% calls	2 MHz total calls	Total erlangs 500 kHz 2 MHz	Total erlangs 500 kHz 2 MHz	Total DSC channels 500 kHz 2 MHz	2 MHz	2 MHz
14-15	17	33	7	40	0.07 0.17	36	94	3	97	0.12 0.31	0.19 0.36	2	4	4
15-16	13	28	14	42	0.06 0.18	25	105	4	109	0.08 0.35	0.14 0.32	2	4	4
16-17	17	23	16	39	0.07 0.17	26	91	3	94	0.08 0.30	0.15 0.47	2	5	5
17-18	18	20	6	26	0.08 0.11	27	119	2	121	0.09 0.39	0.17 0.50	2	5	5
18-19	15	27	11	38	0.07 0.16	34	122	2	124	0.11 0.40	0.18 0.56	2	6	6
19-20	12	24	8	32	0.05 0.14	25	107	2	109	0.08 0.35	0.13 0.49	2	5	5
20-21	18	24	9	33	0.08 0.14	25	102	3	105	0.08 0.34	0.16 0.48	2	5	5
21-22	8	19	8	27	0.03 0.12	31	82	2	84	0.10 0.27	0.13 0.39	2	4	4
22-23	9	16	3	19	0.04 0.08	25	50	1	51	0.08 0.16	0.12 0.24	2	3	3
23-24	7	7	1	8	0.03 0.03	22	37	1	38	0.07 0.12	0.10 0.15	1	2	2
Total	319	485	199	684	— —	652	1972	73	2045	— —	— —	— —	—	—

4. Calculation of the required number of MF calling channels

4.1 Based on the assumptions and data given in § 3, the calculations result in the number of national DSC calling channels for each hour given in Table I.

4.2 The maximum number of channels for any hour from Table I is:

3 channels in the 500 kHz band,
8 channels in the 2 MHz band.

4.3 During daylight hours, MF DSC channels used with Northern Europe coast stations have a limited interference range and can be re-used elsewhere in the world.

Although the interference range of MF channels may be greater during hours of darkness it is concluded that the reduced channel loading during such hours compensates for the increased interference range.

5. Assumptions for calculating HF channel requirements

Calculations were based on the assumptions contained in § 3.3 to 3.8 and 3.10.

5.1 Due to different propagation conditions affecting the various HF bands, the lower frequency bands offer a significant possibility of frequency re-use whereas the higher frequency bands, which in principle can be received world-wide, offer less of a possibility of frequency re-use. Sharing factors world-wide, offer less of a possibility of frequency re-use. Sharing factors indicated in Table II require further consideration particularly with regard to information which could be obtained from Report 911 and from Study Groups 1, 5 and 6 and may be changed at a later date.

TABLE II

Band (MHz)	4	6	8	12	16	22
World-wide sharing factors	2	2	2	1	1	1

5.2 HF traffic statistics valid for 1983 from 31 countries (see Note 1) together with predictions of traffic growth or reduction by the year 1990 are estimated to represent 70% of the world traffic in 1990. These traffic statistics indicate peak hour traffic as given in Table III (see Note 2).

Note 1. – Germany (Federal Republic of), Argentina, Australia, Belgium, Canada, Cape Verde, Chile, Cuba, Denmark, Egypt, Greece, Iran, Iraq, Jamaica, Japan, Kiribati, Malta, Mauritius, Mexico, Norway, New Zealand, Netherlands, Portugal, the United Kingdom, Senegal, Singapore, Sweden, Switzerland, Syria, the USSR, Uruguay.

Note 2. – Only 20% of the predicted ship-to-shore radioteletypewriter calls are included since it is assumed that most countries allow ships to use the selective calling system inherent in the radioteletypewriter equipment (see Recommendations 476 and 625).