

RECOMMENDATION ITU-R S.742-1*

SPECTRUM UTILIZATION METHODOLOGIES

(Question ITU-R 49/4 (1990))**

(1992-1993)

The ITU Radiocommunication Assembly,

considering

- a) that interference may impose a limit on the number of satellites which operate in the same frequency band in the same part of the geostationary-satellite orbit (GSO);
- b) that the number of satellites using the GSO for operational purposes has grown and will continue to grow significantly in the next few years;
- c) that frequency band utilization methodologies are considered as a means of reducing inhomogeneity between networks in the frequency dimension;
- d) that the more heterogeneous the types of carriers concerned, the higher are the levels of internetwork interference, and the more complex is the coordination process;
- e) that methods of spectrum utilization can, in some circumstances, increase the likelihood of accommodating additional users;
- f) that the use of frequency band utilization methodologies will lead to the most efficient use of the radio-frequency spectrum and the GSO,

recommends

- 1. that in internetwork coordination one of the following spectrum utilization methodologies should be used as far as possible, depending on their individual practicalities:

1.1 *Band segmentation methodologies*

Spectrum segmentation can be achieved by several methods. The first method is designated as macro-segmentation, where frequency bands are segmented into large blocks, typically many transponder bandwidths wide resulting in only a few segments. Two different techniques for characterizing each of the segments can be used, the first by carrier classification and the second by parameter values. Different sets of rules can be used with each technique. The macro-segmentation method would be most effective where the proportions of different types of carrier or technical parameter values are the same in the satellite networks being coordinated.

The second method of segmentation is micro-segmentation. For this method, the segmentation is based on small blocks, typically the size of a transponder. The micro-segmentation method would be most effective where the transponder plans (bandwidths, polarization, etc.) of the satellite systems, operating in the orbital arc of coordination interest, are similar.

1.1.1 *Macro-segmentation, carrier classification approach*

In this technique standard types of carriers are identified and several classifications are defined. Table 1 shows how 50 different carriers can be identified and placed in one of the following three classes:

- high-density carriers: FM-TV
low-index FDM-FM
- low-capacity carriers: SCPC
low-capacity or low-power analogue and digital carriers

* New version of CCIR Recommendation 742.

*** Former CCIR Question 49/4.

- average carriers: medium- to high-index FDM-FM
TDMA
wideband digital carriers

This last type of carrier is compatible with either of the two former types as regards mutual interference. Thus only the first two types of carrier – high density and low capacity – would have to be segregated under a rational set of spectrum utilization rules: the average carriers can be placed anywhere. To accomplish this, the band allocated (generally 500 or 250 MHz wide) is divided into low-capacity and high-density sub-bands. This can be done by allotting the lower parts of the bandwidth to low-capacity carriers and the upper parts to high-density carriers and only carriers of the assigned class could use the sub-band. The optimum segmentation procedure will depend on the frequency bands in question. Figure 1 shows some of the required separation angles, obtained with the use of this method.

1.1.2 Macro-segmentation, parameter value approach

In this technique a different approach for determining sub-band segments, based on limits on particular values for parameters such as earth-station e.i.r.p., carrier bandwidth and various combinations of the WARC ORB-88 set of generalized parameters (A, B, C and D) are proposed. According to this approach the 6/4 GHz frequency band can be divided into two segments reducing the required satellites spacing to half, relative to the unsegmented case, and with the greatest improvement being achieved on the basis of carrier bandwidth, up-link e.i.r.p., and down-link e.i.r.p. (see Fig. 1).

1.1.3 Micro-segmentation

In this method, bands of the order of a transponder bandwidth are considered for sub-division. A carrier classification approach is used such that sub-bands are identified for use by high-density carriers and for avoidance by low-capacity carriers. In contrast to macro-segmentation, the sub-bands are identified relative to a transponder bandwidth (e.g. 36 MHz) instead of an entire frequency band (e.g. 500 MHz).

TABLE 1

Macro-segmentation carrier classification example

FDM-FM No.	Type		N/V	B_{oc} (MHz)	f_{min} (kHz)	f_{max} (kHz)	Δf_{st} (kHz)	Δf_m (kHz)	Categories		
									LC	AV	HD
1	12	1.3	12	1.13	12.0	60.0	108.5	159.0	x		
2	12	2.5	12	2.2	12.0	60.0	238.9	350.0	x		
3	24	2.5	24	1.96	12.0	108.0	163.4	275.0		x	
4	60	2.5	60	2.25	12.0	252.0	136.5	276.0		x	
5	72	2.5	72	2.25	12.0	300.0	124.5	261.0		x	
6	60	5.0	60	3.96	12.0	252.0	270.1	546.0		x	
7	132	5.0	132	4.45	12.0	552.0	223.5	529.0		x	
8	192	5.0	192	4.51	12.0	804.0	180.0	459.0		x	
9	96	7.5	96	5.87	12.0	408.0	359.8	799.0		x	
10	192	7.5	192	6.40	12.0	804.0	297.2	758.0		x	
11	252	7.5	252	6.74	12.0	1052.0	259.7	733.0		x	
12	132	10.0	132	7.50	12.0	552.0	430.0	1020.0			x
13	252	10.0	252	8.49	12.0	1052.0	357.4	1009.0			x
14	312	10.0	312	8.96	12.0	1300.0	320.0	1005.0			x
15	252	15.0	252	12.39	12.0	1052.0	576.4	1627.0			x
16	432	15.0	432	12.95	12.0	1796.0	400.2	1479.0			x
17	432	20.0	432	17.99	12.0	1796.0	615.8	2276.0			x
18	612	20.0	612	17.70	12.0	2540.0	453.7	1996.0			x
19	432	25.0	432	20.59	12.0	1796.0	727.3	2688.0			x
20	792	25.0	792	22.34	12.0	3284.0	498.4	2494.0			x
21	972	25.0	972	25.00	12.0	4028.0	410.0	2274.0			x
22	972	36.0	972	35.99	12.0	4028.0	796.7	4417.0			x