

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
Request for Declaratory Ruling Removing the)
Commission's Minimum Carrier Tone)
Requirement for OFDM Modulation in the) MM Docket No. 01-145
Multipoint Distribution and Instructional)
Television Fixed Services)

DECLARATORY RULING AND ORDER

Adopted: September 25, 2001

Released: September 26, 2001

By the Chief, Mass Media Bureau:

I. INTRODUCTION

1. The Commission, by the Chief, Mass Media Bureau, acting pursuant to delegated authority, has before it a request for declaratory ruling filed by Cisco Systems, Inc. ("Cisco") pursuant to Section 1.2 of the Commission's Rules, 47 C.F.R. § 1.2. Cisco requests that the Commission amend its rules to eliminate the requirement that a minimum of 256 QAM-modulated carriers be used with Orthogonal Frequency Division Multiplexing ("OFDM") modulation in the Multipoint Distribution Service ("MDS") and the Instructional Television Fixed Service ("ITFS"). For the reasons set out below, we are granting Cisco's petition.

II. BACKGROUND

2. On July 9, 1996, the Commission adopted a declaratory ruling which permits MDS and ITFS stations to use Vestigial Sideband Modulation ("VSB") and Quadrature Amplitude Modulation ("QAM") on a regular basis so long as they meet certain technical requirements. In a subsequent rulemaking, the Commission expanded the list of permissible MDS and ITFS modulations to include Code Division Multiple Access ("CDMA") and

1 Petition for Declaratory Ruling, filed March 13, 2001 ("Cisco Petition").

2 OFDM is a digital emission consisting of multiple carriers within a single authorized bandwidth or channel, each of which is modulated with a portion of the information being transmitted in the bandwidth or channel. The signal modulating each carrier is itself a digital emission, such a QAM. The amplitudes and spacings of the carriers is such that the spectral energy of each carrier is significantly attenuated at the frequencies of each of the two adjacent carriers.

3 Digital Declaratory Ruling, 11 FCC Rcd 18839 (1996).

Quadrature Phase Shift Keying (“QPSK”).⁴ On August 31, 1998, Clarity Wireless, Inc. (“Clarity”)⁵ filed a Petition for Declaratory Ruling requesting that the Commission further expand the list of permissible MDS and ITFS emissions to include OFDM. In support of its petition, Clarity submitted the results of laboratory tests evaluating the technical characteristics of two different OFDM waveforms, one with 256 carriers, each modulated by a 4-QAM signal, and one with 4096 carriers, each modulated by a 64-QAM signal. These tests demonstrated that both of the OFDM emissions complied with the Commission’s spectral mask requirements and would present no greater interference potential than other, previously authorized, digital emissions. On March 19, 1999, the Commission granted the Clarity petition and authorized the use of OFDM, with the condition that a minimum of 256 QAM-modulated carriers must be utilized.

3. In its petition, Cisco requests that the Commission remove the condition that a minimum of 256 QAM-modulated carriers must be used for OFDM. Cisco states that its earlier use in laboratory tests of a lower limit of 256 carriers was meant to generate “worst case OFDM signals whose power spectral density completely filled the spectral mask in the Commission’s rules.” Cisco argues that the use of fewer than 256 carriers should be permitted because the potential for interference from such OFDM signals will be no greater than the interference from OFDM signals using 256 or more carriers.⁶ The ability to use fewer than 256 carriers, Cisco argues, would “allow MDS/ITFS network designers to make important bandwidth and design trade-offs to meet customer bandwidth and cost requirements.” This would occur because of the direct linkage between the number of carriers and the bandwidth occupied by those carriers, *i.e.*, as fewer carriers are utilized, less bandwidth is needed.

4. In response to the Commission’s Public Notice requesting comment on Cisco’s request for a declaratory ruling,⁷ comments were filed by Wireless Communications Association International (“WCAI”), Wi-LAN, Inc. (“Wi-LAN”), and the Catholic Television Network (“CTN”). Reply comments were filed by Cisco Systems. WCAI and Wi-LAN fully supported the Cisco request, citing advantages to the removal of the limitation in the number of carriers permitted for OFDM and urging the Commission to remove this limitation. Wi-LAN also urged the Commission to permit, in addition to QAM modulation of OFDM carriers, Binary Phase Shift Keying (“BPSK”) and Quadrature Phase Shift Keying (“QPSK”) modulation of the OFDM carriers.⁸ CTN, while also supporting removal of the carrier limitation, expressed concerns about

⁴ *Amendment of Parts 21 and 74 of the Commission’s Rules to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions*, 13 FCC Rcd 19112 (1998), *recon.*, 14 FCC Rcd 12764 (1999), *further recon.*, 15 FCC Rcd 14566 (2000).

⁵ Cisco acquired Clarity effective November 2, 1998.

⁶ In a Technical Appendix to their Petition, Cisco cites data evaluating the peak-to-mean envelope power ratio (PMEPR) of OFDM signals with differing numbers of carriers as an indicator of relative interference potential and finds that the PMEPR of a 128-carrier signal is less than that of a 256-carrier signal.

⁷ *Pleading Cycle Established for Comments on Request for Declaratory Ruling to Remove Minimum Sub-Carrier Requirement for Orthogonal Frequency Division Multiplexing Modulation in Multipoint Distribution and Instructional Television Fixed Services*, Public Notice, MM Docket No. 01-145, DA 01-1582 (released June 5, 2001).

the interference potential of OFDM emissions with fewer than 256 carriers, and asked that the removal of the limitation be accompanied by an amendment to the Commission's rules which would, in their view, prevent such interference from occurring.

5. Specifically, CTN is concerned that "lower level QAM spectral energy may concentrate in certain portions of a 6 MHz channel," and that "unless there is a randomizer . . . in the digital encoder, then it is possible in a steady state for the spectral energy to concentrate and increase in amplitude." CTN argues that even if "a lower level QAM signal met the 45 dB D/U co-channel interference ratio in its spread out state, the D/U ratio may degrade to an interference-causing sub-45 dB during steady state video modulation conditions." To remedy this concern, CTN suggests that the Commission adopt one of two requirements for sub-256 carrier OFDM, either: (a) "the proposed transmission meets the 45 dB D/U interference ratio as to all relevant co-channel stations for the worst case digital spectral energy signature;" or (b) "the digital encoder include a randomizer that ensures the spectral energy is spread over the entire channel bandwidth." In reply comments addressing CTN's proposed new requirements for OFDM, Cisco disputes CTN's contention that any new rules are needed, arguing that existing Commission rules already fully address the issues raised by CTN.

III. DISCUSSION

6. We agree with Cisco that no purpose is served by continuing the limitation on the minimum number of carriers which can be utilized for OFDM. The channelization rules for MDS and ITFS permit the use of a very wide range of bandwidths, from tens of kHz to tens of MHz, and it is important that licensees have available to them the flexibility to use the particular digital emissions and bandwidths that meet their operational needs. Removal of the 256 carrier limitation from OFDM would enable licensees to choose from a significantly wider range of bandwidths and data rates than is now permissible with OFDM, *e.g.*, for bandwidths on the order of 50-100 kHz, as few as 4 to 8 carriers may be optimum, whereas for bandwidths on the order of 750 kHz to 1.5 MHz, 64 to 128 carriers may be optimum.

7. With respect to CTN's interference concerns, while we concur that "symbol patterns" may occur with the use of OFDM emissions having fewer than 256 carriers, it is also true that this phenomenon occurs when more than 256 carriers are used and that such a concentration of power in a segment of a wider channel is simply a transient form of the more general occurrence of power spectral non-uniformity commonly associated with some digital emissions. However, we believe that Cisco has adequately demonstrated that this non-uniformity, if and when it occurs, will not have any adverse impact on the potential for harmful interference in MDS and the ITFS systems, in that the range of OFDM emissions which will now be permitted are already fully addressed by the interference protection and power spectral density provisions of our rules. Specifically, all forms of OFDM are subject to the existing rule

(...continued from previous page)

⁸ Wi-LAN's request is partially moot because QPSK modulation, when it was added to the list of permissible emissions in Rule Section 21.905, was considered to be the functional equivalent of the 4-QAM emission. Therefore, we consider that QPSK is covered under the QAM emission for purposes of modulating carriers in an OFDM emission.

requirements for interference protection of MDS and ITFS stations, such as Section 21.902⁹, as well as subject to the existing rule requirements governing emissions with respect to power spectral density, both uniform and non-uniform, such as Section 21.904(e).¹⁰ We therefore are granting Cisco's request to remove the 256 carrier restriction from OFDM and we reject CTN's request that additional requirements be placed on OFDM emissions with fewer than 256 carriers.

IV. ORDERING CLAUSES

8. Accordingly, IT IS ORDERED that under the authority contained in Section 4(i) of the Communications Act of 1934, as amended, 47 U.S.C. §154(i), and Section 554(e) of the Administrative Procedure Act, 5 U.S.C. §554(e), the Petition for Declaratory Ruling submitted by Cisco Systems, Inc. IS GRANTED to the extent specified above. This Declaratory Ruling and Order shall be effective upon its release and shall remain effective pending adoption of rules specifically governing the use of digital emissions in MDS and ITFS in a future rulemaking proceeding. *See* 47 C.F.R. §§1.4(b)(2) and 1.103. Nothing in this Declaratory Ruling and Order shall prejudice the outcome of such a rulemaking proceeding.

9. IT IS FURTHER ORDERED that the staff of the Mass Media Bureau shall send copies of this Declaratory Ruling and Order by certified mail, return receipt requested, to the parties who filed formal comments and reply comments in response to the Commission's June 5, 2001 Public Notice.

FEDERAL COMMUNICATIONS COMMISSION

Roy J. Stewart
Chief, Mass Media Bureau

⁹ 47 C.F.R. § 21.902 sets out the 45 dB co-channel and 0 dB adjacent channel D/U requirements and the -73 dBW/m² flux density contour limit, as well as adjustments in these parameters based on bandwidths used.

¹⁰ 47 C.F.R. § 21.904(e) sets out the procedure for calculating transmitter power for emissions with non-uniform power spectral density. When applied to OFDM emissions, any non-uniformities in transmitted power spectral density arising from "symbol patterns" (*i.e.*, concentrations of power in one part of the occupied channel) or other causes, transient or persistent, must be taken into account in determining permissible power levels and calculating interference in accordance with Section 21.902.