Before the
Federal Communications Commission
Washington DC 20554

In the Matter of	)	
	)	
National Spectrum Management Association and	)	No. ________________
Fixed Wireless Communications Coalition,	)	
Request for Declaratory Ruling on Application of	)	
the Part 101 Spectrum Efficiency Standards	)	

REQUEST FOR DECLARATORY RULING

The National Spectrum Management Association (NSMA)[1] and the Fixed Wireless Communications Coalition (FWCC)[2] jointly request a declaratory ruling as described below.

We request clarification on applying the Commission's Part 101 spectrum efficiency rules to (1) links using Time Division Duplex and (2) links that use two polarizations simultaneously.

A. APPLICABLE RULES

Section 101.141 requires Part 101 equipment to meet minimum standards for "payload capacity":[3]

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1 The NSMA is a voluntary international association of microwave radio/wireless and satellite frequency coordinators, licensees, manufacturers, and regulators. Established in 1984, the Association provides a forum to develop industry guidelines for efficient use and management of the frequency spectrum by the wireless telecommunications community. NSMA provides a linkage between government regulations and industry practice by developing recommendations that streamline and standardize procedures used by the frequency coordination community. For more information, see www.nsma.org.

2 The FWCC is a coalition of companies, associations, and individuals actively involved in the fixed services—*i.e.*, terrestrial fixed microwave communications. Our membership includes manufacturers of microwave equipment, fixed microwave engineering firms, licensees of terrestrial fixed microwave systems and their associations, and communications service providers and their associations. The membership also includes railroads, public utilities, petroleum and pipeline entities, public safety agencies, cable TV providers, backhaul providers, and/or their respective associations, communications carriers, and telecommunications attorneys and engineers. For more information, see www.fwcc.us.

3 47 C.F.R. § 101.141(a)(3)(i).

Frequency (GHz)	minimum payload capacity (bits/sec/Hz)		
	emission bandwidth ≤ 5 MHz	emission bandwidth > 5 MHz and ≤ 20 MHz	emission bandwidth > 20 MHz
3.7-10.55	2.4	4.4	4.4
10.55-13.250	2.4	4.4	3.0

Transmissions in the frequency range 13.250-25.25 GHz must have a bit rate of at least 1 bit/sec/Hz.[4]

In addition, links that use adaptive modulation must

> meet the specified capacity and loading requirements at least 99.95% of the time, in the aggregate of both directions in a two-way link.[5]

B. TIME DIVISION DUPLEX ISSUES

1. Background

Microwave systems generally transmit data between two points in both directions. Frequency Division Duplex (FDD), the older and more common method, transmits simultaneously both ways on different frequencies. A smaller number of microwave systems use Time Division Duplex (TDD), in which the transmitters at each end of the path take turns operating on the same frequency. See Figure 1.

The Commission's spectrum efficiency rules for digital microwave date back to 1981, when only FDD systems were in use (and perhaps a few one-way links).[6] When TDD systems appeared later on, the rules governed them as well. Below, we raise two questions about the rules in relation to TDD.

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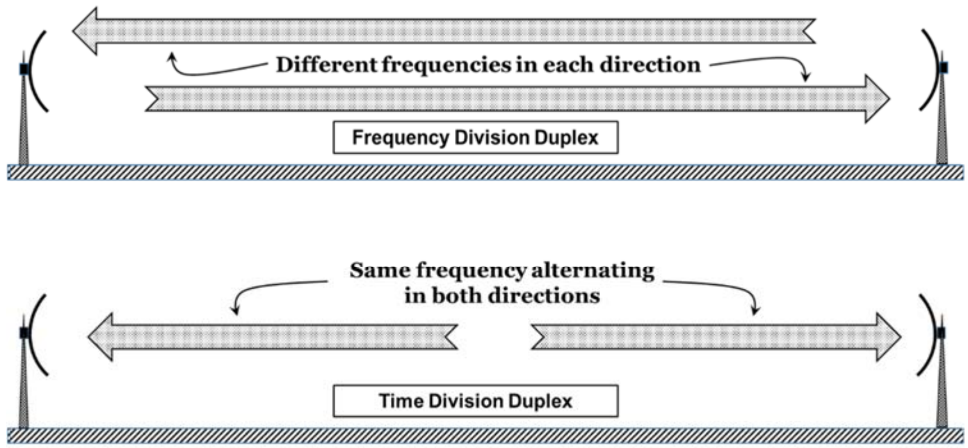
4 47 C.F.R. § 101.141(a)(1).

5 47 C.F.R. § 101.141(a)(3)(ii). Adaptive modulation is a shift to a more robust but slower modulation to compensate for temporary reduction in signal strength due to changing atmospheric conditions.

6 *Amendment of Parts 2, 21, 87, and 90 of the Commission's Rules*, First Report and Order, 86 F.C.C.2d 360 (1981). The initial standards were less demanding than today's.



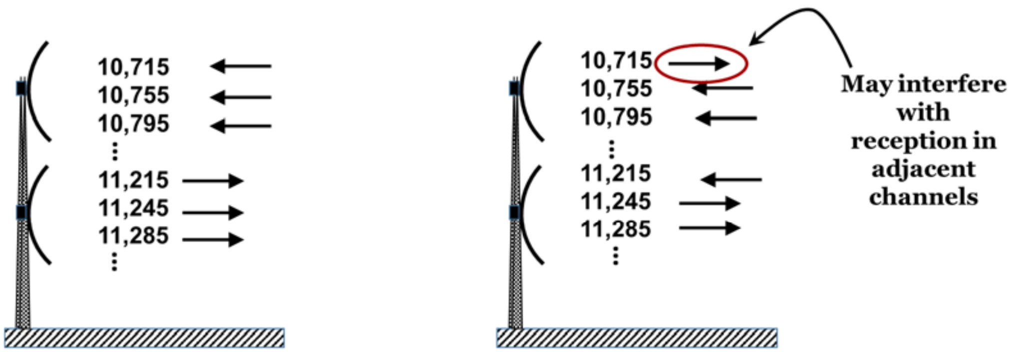
FDD and TDD Compared
Figure 1

At first glance TDD appears to need half as much spectrum as FDD, and with similar modulations, can be expected to carry half as much two-way traffic as FDD. This suggests that TDD's spectrum efficiency should be about the same as FDD's. In fact, however, due to the phenomenon of "bucking," TDD needs at least as much spectrum as FDD to carry half the traffic, and in some situations it needs more, and potentially interferes with many more other stations.

The Part 101 frequency channelization tables designate transmit/receive frequencies in the upper or lower half of each band, individually paired with receive/transmit frequencies in the other half.[7] Frequency coordinators working with FDD systems try to follow the plan—*i.e.*, they try to ensure that all transmitting antennas on a given tower use frequencies in the same half of the band, and all of the receiving antennas on that tower use frequencies in the other half. Figure

[7] The 4 GHz band is an exception: transmit and receive frequencies are interleaved throughout.

2a illustrates this arrangement.[8] Usually it is necessary to maintain the same frequency pairing on other towers within about a quarter-mile to half-mile radius.[9]



Normal Operation
Figure 2a

Bucking Operation
Figure 2b

Occasionally, because of congestion, it becomes necessary to reverse the frequencies for a subset of paths on the tower. This is called "bucking." Figure 2b shows the 10,715/11,215 MHz pair in a bucking configuration.

Microwave receivers, like most others, are sensitive to signals not only in the channels they are tuned to, but to signals in adjacent channels (and to a lesser extent, signals in second adjacent channels). In Figure 2b, the receiver tuned to 10,755 MHz (second entry from the top) is susceptible to interference from the bucking transmitter on the adjacent channel at 10,715 MHz. Interference most often occurs when the signal from the bucking transmitter reflects from a nearby building or signboard into an adjacent-channel receiver on the same tower or one nearby. Typically the reflecting surface is close enough to be within the receiving antenna's "near field," where the usual equations of antenna performance do not apply, so that frequency

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8 Frequencies in Figure 2 are those designated for 30 MHz bandwidth channels in the 10.7-11.7 GHz band. *See* 47 C.F.R. § 101.147(o)(6).

9 See *Mixed High-Low Frequency Plans (Bucks) and Reflection Interference*, National Spectrum Management Association Recommendation WG 03.10.001m, available at http://nsma.org/wp-content/uploads/2016/05/WG03-10-001.pdf

coordinators cannot use mathematical models to reliably predict interference. If the reflective surface is nearby, the reflected interfering signal can arrive at the victim receive antenna at a much higher power than the desired signal. Parties on the same tower with a bucking transmitter usually must conduct live interference testing. Even a system that passes this testing can show interference at a later time, if construction in the area causes new reflections. Because a bucking transmitter threatens other licensees' use of their own channels, frequency coordinators approve them only as a last resort.

Nearly all Part 101 channels are part of a transmit/receive pair.[10] A TDD antenna that conforms to the local channel plan when transmitting from one end of the path necessarily contravenes the channel plan when transmitting from the other end. **Every TDD link bucks existing and future channels at one end or the other.** This greatly increases the potential for interference to links that conform to the local high-low frequency plan. The TDD link thus not only blocks others from using its own channel (as all links do), but also impairs the use of adjacent channels at the bucking end of the link. A TDD link threatens interference to an amount of spectrum equal to two or three times its own radio bandwidth. In addition, the TDD link creates an "orphan channel" by making the other member of its pair unavailable for FDD systems.[11] In total, a single TDD link takes anywhere from two to four channels out of service, with half the throughput of an FDD pair.

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[10] The 4 and 6 GHz bands each have a small handful of unpaired channels. Another small handful, although part of a pair, are designated as available for unpaired use. Even the unpaired channels, however, are adjacent to paired channels and can cause interference if used for bucking operations.

[11] If TDD links occupy both channels of a transmit/receive pair, they will cause bucking on both.

Although a TDD link and half of an FDD pair each occupies a single channel, the TDD link can interfere with many more other stations. Frequency coordinators assess potential interference to and from a “keyhole” shape centered on each tower location. At 6 GHz, for example, the coordinators examine a 250-mile-long, 10-degree-wide sector centered on the azimuth of the main beam, and a 125-mile-radius circle in other directions.[12] The TDD link threatens interference over the circular areas at both ends of the link, and each of its two main beams threatens large areas on both sides of its boresight and far beyond the corresponding receive antenna. Despite its using only one channel, the fact of a TDD link operating from both ends means it potentially causes far more interference than a single FDD station likewise operating on one channel.

TDD systems do not necessarily use spectrum inefficiently, but mixing FDD and TDD systems in the same band and same geographic area does degrade efficiency overall.

2. First Question: Assessing TDD Spectrum Efficiency

The Commission’s spectrum efficiency requirements are specified in bits/sec/Hz. The application to FDD systems is clear. A system that uses, say, two 10 MHz channels, and must achieve 4.4 bits/sec/Hz, must be capable of 2 x 10 million x 4.4 bits/sec, or 88 megabits per second.

To accurately measure spectrum efficiency of a TDD link, while accounting for the total spectrum “real estate” protected by the coordination process, the standard should assess the bit rate not just over the radio bandwidth the link actually occupies, but over the greater radio

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12 The total area assessed for a single 6 GHz station is 53,177 square miles—bigger than 21 states. For details on the procedure *see* C*oordination Contours for Terrestrial Microwave Systems*, National Spectrum Management Association Recommendation WG3.90.026, available at http://nsma.org/wp-content/uploads/2016/05/WG3.90.026.pdf

bandwidth the link makes unavailable to other users—anywhere from two to four times the nominal channel width. Conservatively, the standard as applied to a TDD system should require at least *twice* the bit rate in the rule, multiplied by the nominal channel bandwidth. For example, a TDD system using a single 10 MHz channel for which the rule specifies 4.4 bits/sec/Hz should likewise be capable of 2 x 10 million x 4.4 bits/sec, or 88 megabits per second.

Just as an FDD link must achieve the specified bit rate in each direction independently, a TDD link should have to do the same. The Commission should clarify that a TDD system must be capable of twice the bit rate set out in the rules, in each direction measured separately. Averaging the rates in both directions should not be acceptable.

3. *Second Question: Assessing TDD Loading Compliance*

Links that use adaptive modulation must

> meet the specified capacity and loading requirements at least 99.95% of the time in the aggregate of both directions in a two-way link.[13]

The rule is written for FDD systems, but should apply to TDD as well. The meaning of the word "aggregate" is less clear for TDD, particularly if the channel is operating asymmetrically in time—say, 90% of the time in one direction and 10% in the other. We ask the Commission to clarify application of the rule to TDD: specifically, to state that the link must achieve its specified minimum bit rate 99.95% of the time regardless of direction. By way of illustration: suppose a TDD path connects towers to the North and South. Over any time period it may variously transmit North-South or South-North, or pause between transmissions. The Commission should require the system to achieve the (doubled) minimum bit rate during 99.95% of the entire time period, counting transmissions in both directions. If there are pauses between

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[13] 47 C.F.R. § 101.141(a)(3)(ii).

directions of transmission, the periods of non-transmission must count against the 0.05% outage allowance.

To satisfy this requirement, moreover, transmissions should not only be sent but should also have to be received. The potential for abuse is perhaps most apparent in a point-to-multipoint configuration, where an end point may transmit but be ignored while the hub receives from a different end point. Regardless of the system geometry, a non-received transmission should not count toward the required minimum transmitted bits.

C. POLARIZATION ISSUES

A designer can double the effective capacity of a link by using horizontal and vertical polarizations simultaneously. The present rules are unclear as to whether the minimum bit rates apply to each polarization separately or to the two combined.

Before 2011, the answer was easier. A footnote to the table heading "Minimum payload capacity (Mbits/s)" in Section 101.141(a)(3) then specified "Per polarization."[14] A 2011 rulemaking deleted the footnote,[15] leading to the present ambiguity. Usually regulatees can presume that an agency's removal of a provision reflects a decision that it should no longer be in force. Here, however, the text of the order lacks any discussion of the deletion, leaving its intentionality in doubt. Similarly, the underlying Notice of Proposed Rulemaking made no mention of the change.[16] On the other hand, we have a 2017 email from a member of the

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[14] 47 C.F.R. § 101.141(a)(3) (table n.1) (2010 edition), available at https://www.gpo.gov/fdsys/pkg/CFR-2010-title47-vol5/pdf/CFR-2010-title47-vol5-sec101-141.pdf

[15] *Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul,* Report and Order, Further Notice of Proposed Rulemaking, and Memorandum Opinion and Order, 26 FCC Rcd 11614 at 57 (2011).

[16] *Amendment of Part 101 of the Commission's Rules to Facilitate the Use of Microwave for Wireless Backhaul,* Notice of Proposed Rulemaking and Notice of Inquiry, 25 FCC Rcd 11246 (2010).

Commission staff suggesting that dropping the footnote was not a typographical slip-up, but effected a substantive change. Yet the Commission repeatedly warns that

> [s]tatements by individual members of the Commission staff are not binding on the Commission, as the Commission has specifically held that parties who rely on staff advice or interpretations do so at their own risk.[17]

The present wording of the rule without the footnote—"the payload capacity of equipment shall meet the following minimum efficiency standards"[18]—can reasonably be read as requiring that capacity per polarization.

A different footnote in the pre-2011 version of the rule cut the per-polarization loading requirement in half for links using both polarizations.[19] That provision dates back to 1996, when digital point-to-point microwave equipment was less advanced than it is today.[20] That footnote, too, disappeared in the 2011 revision, likewise unheralded in the NPRM and unexplained in the text of the order.

In the interest of spectrum efficiency, we ask the Commission to clarify that the bit-rate requirements of in Section 101.141(a)(3) apply in full to each polarization—an outcome that will promote spectrum efficiency and is well within the reach of off-the-shelf technology.

D. PROCEDURAL NOTE

The interpretations requested above are consistent with the language of the rules. We expect the Commission to seek public comment on this petition. Unless well-founded and well-

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17 *Roamer One, Inc. and Certain 220 MHz Non-Nationwide Licensees*, Order, 17 FCC Rcd 3287 at ¶ 11 n.26 (2002).

18 47 C.F.R. § 101.141(a)(3).

19 "If two transmitters simultaneously operate on the same frequency over the same path, the [50 percent loading] requirement is reduced to 25 percent." 47 C.F.R. § 101.141(a)(3) (table n.3) (2010 edition) (link provided above).

20 *Reorganization and Revision of Parts 1, 2, 21, and 94 of the Rules to Establish a New Part 101*, Report and Order, 11 FCC Rcd 13449, 13569 (1996).

supported comments divert the proceeding into some novel direction, the Commission can resolve the matter with an order or public notice, without recourse to an APA rulemaking.

CONCLUSION

The Commission should issue the declaratory ruling requested above.

Respectfully submitted,

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