Trimble Navigation Limited
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Technical Justification of Bandwidth Use

03 November 2015

Federal Communications Commission
Office of Engineering and Technology
Equipment Approval Services

Re: Application for FCC ID: KEAADL352, IC: 2368B-ADL352
Model: ADL35-2

Dear Sir or Madam:

Pursuant to § 90.203(j)(8), in Trimble's customer's precision differential GPS systems, a slower data rate (4800 bps and 8000 bps) will provide more spectral efficiency than the standard data rate (9600 bps) over a 12.5 kHz channel bandwidth.

Please refer to the following pages for a statement concerning the spectral efficiency of our system.

Please contact me should there be need for any additional clarification or information.

Best Regards,

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STATEMENT CONCERNING COMPLIANCE WITH SECTION 90.203(j)(3)

Introduction

The KDB Publication 388624 outlines the process for obtaining new equipment authorizations received by the commission prior to the full implementation date of 1/1/2016. This present application falls into this category and thus meets the Commission's Rules on Part 90 transmitters which provides, in pertinent part:

> Applications for new equipment authorizations received by the Commission before the **transition date** (i.e., 12/31/2015) can be granted with a wideband (25 kHz) emission designator as long as the equipment also has a narrowband (12.5 kHz and/or 6.25 kHz) emission designator. Applications for equipment with data rates less than 4800 bps under § 90.203(j) (8) are on the Permit-but-Ask List (refer to KDB Publication 388624) and can only be approved under limited conditions.

The Commission has previously noted:

> [We] will provide manufacturers with additional flexibility to design spectrally efficient transmitters. **The Commission's Equipment Authorization Division may, on a case by case basis, grant type acceptance to equipment with slower bit rates than specified in Sections 90.203(j)(3) and 90.203(j)(5)** of our rules, provided that an acceptable technical analysis is submitted with the application which demonstrates that the slower data rate will provide more spectral efficiency than the standard data rate.[1]

The present application is for the broadcasting of precision differential corrections for GPS, and falls squarely within the scope of this exception. When considered as part of a system, the device in question provides spectrum efficiency and channel utilization far in excess of 4800 bits/sec per 6.25 kHz.

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[1] Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services, 11 FCC Rcd 17676, 17686 (1996) (emphasis added).

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Technical Analysis

Trimble systems transmit one data packet each second from a single source of data to a plurality of receive-only radios. Each packet is up to 4500 bits. At a typical customer's earthmoving construction site, the receive-only radios might include

6 scrapers
3 bulldozers
2 motor graders
2 shovels
2 surveyors
1 supervisor/grade checker

All of these sixteen users are mobile. They move throughout the entire construction site. To perform their respective jobs, each of these receivers must receive greater than 90% error-free packets from the transmitter. The transmissions are one-way. They are not acknowledged. There are no retransmissions. This maximizes spectral efficiency. The received signals must be strong enough to maintain minimum throughput to every mobile receiver or overall site productivity suffers.

To operate in accordance with § 90.203(j) the radio transmitter would have to transmit at least 9600 bps when using 12.5 kHz channels. Our transmitters can and do support this rate (among others). At this rate (assuming line-of-site propagation) a transmitter will cover a circular area with normalized area A.

This radio transmitter also supports 4800 bps data rates. With its state-of-the-art modem, the 4800 bps data rate has 4 dB better link margin than at 9600 bps. This increases coverage to about 2½ A ($10^{4/10} = 2.511...$). The radius of the coverage circle is about 58% larger.

This radio transmitter also supports 8000 bps data rates. With its state-of-the-art modem, the 8000 bps data rate has 1 dB better link margin than at 9600 bps. This increases coverage to about 1¼ A ($10^{1/10} = 1.258...$). The radius of the coverage circle is about 12% larger than at 9600 bps.

In order for a user to cover the area supported by the 4800 bps mode, a system of one transmitter and 3 repeaters occupying three 12.5 kHz channels would be required. This system would allow for an area coverage of 2.827A as shown in the figure below.

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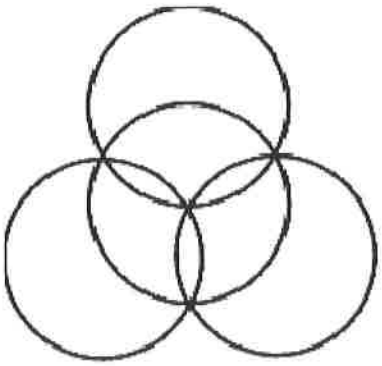

However, since three channels are required to implement such a system, the spectrum efficiency is reduced by one-third.

When we normalize by the coverage area, we get equivalent spectral efficiencies for these four transmitter (Tx) configurations.

Configuration (12.5kHz channel)	Area Covered	Equivalent Spectral Efficiency With Only One Receiver (bps)	Equivalent Spectral Efficiency Per Receiver in 16 Receiver System (bps)
9600 bps single Tx	A	9600	153,600
4800 bps single Tx	2½ A	4800 * 2½ = 12000	192,000
8000 bps single Tx	1¼ A	8000 * 1¼ = 10000	160,000
9600 bps quad Tx (three channels)	2.827 A	9600 * 2.827/3 = 9046	144,736

The third column shows the equivalent spectral efficiency for just one receiver. The calculation of spectral efficiency for a typical system with sixteen receivers is shown in the final column for each configuration.

As detailed in the table above, a typical system installation on a single 12.5 kHz channel can support data rates exceeding 160,000 bits/sec. This performance represents spectrum efficiency far in excess of that required under Section 90.203(j)(3).

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Additionally, compared to conventional two-way systems with acknowledgments and retransmissions, our one-way system is many times more spectrally efficient when there are many receivers (16 receivers to one transmitter in the present case).

Conclusion

We respectfully submit that the Commission spectrum policy is served by calculating the spectrum efficiency of this equipment in terms of an integrated system that incorporates a large number of recipient equipment that use the high precision differential corrections from a single transmitter.