Statement Demonstrating Equivalent Efficiency Under Section 90.203(j)(8)
Neptune Technology Group, Inc., TC# 236440, Inquiry No. 964-655

Neptune Technology Group Inc. ("Neptune"), the holder of various FCC equipment authorizations, hereby demonstrates that Neptune's Meter Interface Units ("MIUs") are spectrally efficient pursuant to Section 90.203(j)(8) of the Commission's rules.[1] Equipment being authorized in Neptune's primary spectrum band must meet a minimum baud rate, also known as a data rate, of 9600. There is, however, an exception to the rule for equipment with a slower data rate that is as spectrally efficient as it would be when operated at 9600 baud.[2]

Neptune is a leading manufacturer of meter reading equipment. The company deploys and operates Advanced Metering Infrastructure ("AMI"), primarily to the water utility industry, having provided over 10,000,000 radio units to the water industry nationwide. Neptune uses one channel in the 450-470 MHz band for fixed operations, which is currently the preferred technology projected for this industry. Neptune has thousands of MIUs installed at homes that can interface with only a few fixed data collectors on a scheduled basis controlled from a central location.

Section 90.203(j)(5) of the Commission's rules provides that "applications for part 90 certification of transmitters … must be capable of supporting a minimum data rate of 4800 bits per second per 6.25 kHz of channel bandwidth." Because Neptune operates on a 12.5 kHz channel, its minimum data rate would be 9600 baud. Neptune believes, however, that the rate its integrated fixed systems currently operate at, 7200, is its optimal baud rate and is also as spectrally efficient in the context established by Section 90.203(j)(8) of the Commission's rules. In this respect, Neptune is similar to Aclara Technologies LLC ("Aclara,"), a company also engaged in AMI. Aclara received authorizations premised on a finding that a similar data rate of 7200 baud, combined with other operating characteristics, provided sufficient spectral efficiency on at least two occasions. *See* FCC ID LLB09010C *granted* Jan. 20, 2010; FCC ID LLB11009X3 *granted* May 1, 2012. Aclara and Neptune provide similar services to water utilities and share many technical characteristics, as explained below and in the attached Technical Appendix.

A. The Commission's "Spectral Efficiency" Exception

The exception to the Section 90.203(j)(5) requirement within the rules, Section 90.203(j)(8), provides:

> The Commission's Equipment Authorization Division may, on a case by case basis, grant certification to equipment with **slower data rates** than specified in paragraphs (j)(3) and (j)(5) of this section, provided that a technical analysis is submitted with the application

[1] 47 C.F.R. § 90.203(j)(8).

[2] This Statement is being submitted as part of an equipment authorization first filed on November 29, 2012.

which describes why the slower data rate will provide more spectral efficiency than the standard data rate.

47 C.F.R. § 90.203(j)(8) (emphasis added). The adoption and existence of Section 90.203(j)(8) provides a clear mandate that approval of equipment operating at "slower data rates" than 9600 baud has been contemplated by the Commission.

Section 90.203(j)(8) was adopted in 1996 as part of a Memorandum Opinion and Order the Commission issued in response to concerns expressed with the Commission's 1995 Order on promoting efficient use of spectrum for private land mobile radio ("PLMR").[3] In response to the 1995 Order, Metroplex Mobile Data, Inc., filed comments seeking an exception to the baud rate requirements in Section 90.203(j). Metroplex, whose systems shared many of the same features as those systems operated by Neptune, believed a system of 0.384 bits per second per Hertz was actually more efficient than the FCC's 0.768 bps standard for some real world applications. Metroplex believed the Commission's decision was arbitrary because "it is a channel data rate and not a throughput data rate."[4] The Commission took these concerns seriously, recognizing that its standard "addresses only one facet of the spectral efficiency of a system."[5] To provide manufacturers with additional flexibility to design spectrally efficient transmitters, the Commission adopted Section 90.203(j)(8).

As discussed above, Aclara has received at least two equipment authorizations based on a finding that its slower data rate of 7200 baud provided more spectral efficiency. Neptune is similar to Aclara in that it uses a single radio attached to each meter, which peridiocally

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[3] *Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services and Modify the Policies Governing Them and Examination of Exclusivity and Frequency Assignment Policies of the Private Land Mobile Radio Services*, 11 FCC Rcd. 17676 (1996); *Report and Order and Further Notice of Proposed Rule Making*, 10 FCC Rcd. 10076 (1995).

[4] Metroplex claimed that if more overhead, forward error correction, interleaving and retries per given bps channel rate are all needed, the efficiencies gained in the channel rate are negated in real throughput of information. Metroplex also noted that the FCC standard data rate would reduce geographic coverage for a given amount of radiation power due to the significant change in signal-to-noise ratios, so additional transmitters or an increase in effective radiated power ("ERP") for coverage of the same geographic area without additional transmission retries will be necessary.

[5] *Replacement of Part 90 by Part 88 to Revise the Private Land Mobile Radio Services and Modify the Policies Governing Them and Examination of Exclusivity and Frequency Assignment Policies of the Private Land Mobile Radio Services*, 11 FCC Rcd. 17676 (1996); *Report and Order and Further Notice of Proposed Rule Making*, 10 FCC Rcd. 10076, 17687, ¶ 22 (1995). The Commission acknowledged that "many factors other than overall bit rate affect the spectral efficiency of a system. For example, Ericsson stated that the most appropriate measure of spectrum efficiency is quantity of communications achieved per unit of occupied spectrum as a function of the geographic area occupied by the signal and the time required to achieve the communications." *Id.* at n.49.

transmits omni-directionally in short transmissions. Data collectors receive and store the transmissions in its range, using backhaul to transmit the data to the utility. Rather than simply achieving spectral efficiency through a high baud rate, both Aclara and Neptune use a high level of frequency re-use, data compression, and other techniques to use a single channel to service numerous users with an effective bit rate as spectrally efficient as 9600 baud. *See* Technical Appendix.

B. Neptune's AMI System is Spectrally Efficient

Under existing rules, Neptune has installed and operated equipment optimized to operate at 7200 baud, a data throughput rate which helps to assure long battery life and meet other system requirements. Neptune operates in this manner today, continuing to add new users to these systems and add news systems as fixed meter reading is implemented by the city and county water utilities Neptune serves.[6] To allow a large number of units to share one channel efficiently, Neptune:

- Sets the transmission time to 120ms or less for the battery operated units. This allows time for thousands of units to transmit on a single channel and an extended battery life since the MIU operates for a shorter period;
- Uses Gaussian Frequency-Shift Key ("GFSK") with a modulation index of 0.5, providing a low Bit Error Rate ("BER"), which reduces the number of re-transmissions necessary. GFSK alters a transmission to narrow its bandwidth, allowing the signal to remain within the emission mask requirements. The frequency shift is the swapping between two frequencies and a lower index indicates a tighter bandwidth, though too low an index can compromise performance leading to a higher BER and a need for more transmissions. Less retries leaves the channel clear for other MIUs to transmit;
- Utilizes various forms of data compression that result in a 25 to 50% reduction in the number of bits sent, depending on the particular packet being transmitted; and
- Is capable of handling 500,000 MIUs, typically the entire population of a water utility district, on a single channel.

As a result of these efficiency efforts, Neptune can operate on one channel in any given area despite an average capacity of 5,000 individual MIUs for each data collector, an average number of MIUs that Neptune attempts to increase, and not decrease, to achieve higher efficiency. As shown in its Technocal Appendix, Neptune calculates a data throughput rate of 21,620 bits per second, far in excess of 9600 baud. *See* Technical Appendix.

[6]The water utilities Neptune serves desire installations that will last for decades because they are intended to be installed unobtrusively and conveniently near the water source of every home and business. For that reason, systems require a battery-powered transmitting meter, a 20-year battery life to match the meter life, a cost effective system, a system with licensed spectrum, and a system that is easy to install and maintain.

CONCLUSION

For the foregoing reasons, Neptune's MIU, as part of its overall AMI systems, is spectrally efficient for purposes of Section 90.203(j)(8).

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Technical Appendix

Technical Analysis

When the system is implemented, an MIU is attached to each utility meter. The MIU periodically transmits meter readings omni-directionally in transmissions lasting under one-tenth second each. Transmissions from different MIUs are independent and uncorrelated. Data collectors are mounted on a nominal 1 to 1.5 mile grid. A collector receives and stores the transmissions from all the MIUs in its range. Each collector periodically transfers the accumulated data to a central computer at the utility office via a cell phone mounted on the collector. The MIU bandwidth is 12.5 kHz, so a strict application of section 90.203(j)(3) would require the equipment to support a data rate of 9600 bits/sec. In fact, to minimize component cost and bit error rate, an individual MIU transmits at rate of 7200 bits/sec. The system achieves spectrum efficiency not through a high bit rate in each individual MTU, but through a high level of frequency re-use achieved by deploying a large number of low-power short range transmitters. As detailed below, a typical large installation of MIUs on a single 12.5 kHz channel can support data rates exceeding 20,000 bits/sec. This performance represents spectrum efficiency far in excess of that required under Section 90.203(j)(3). Where a typical commercial user of private land mobile radio spectrum, such as a delivery service, requires a pair of channels to provide two-way communication with dozens of trucks at most, the MIU is a part of a system that uses a single channel to service millions of users and to carry data representing billions of dollars in annual revenue. This is an extremely efficient use of the spectrum, and is consistent with the Commission's purposes underlying Section 90.203(j)(3).

Neptune's calculation of spectral efficiency on a single channel

Assumptions:

A. A metropolitan area (~2 million people) containing 500,000 meters. This assumes 1 meter per average household of 3-4 individuals, and covers an area approximately equal to that served by a conventional Part 90 base station.
B. 5000 MIUs per collector (500,000 MIUs and 100 collectors.)
C. 4 meter-reading and 4 hourly usage packet transmissions per a day.
D. Each reading transmission contains 350 bits and has duration of 49 milliseconds. Each usage transmission contains 584 bits and has duration of 81 milliseconds.

Calculations:

A. Determine overall system daily data transport:
(500,000 MIUs) * ((350+534) bits in packets) * (4 transmissions per day) = 1.868*109 bits per day

B. Determine equivalent single channel throughput:
(1.868*109 bits per day) /(24 hours*60 minutes * 60 seconds) = 21,620 bits per second on the single channel.

Conclusion:

Overall supportable system spectral efficiency is up to 21,620 bits per second of continuous data throughput. This represents the data throughput handled by a Neptune system covering an area comparable to that served by a conventional base station authorized under Section 90.203(j)(3). 21,620 bits per second is far in excess of the 9600 baud envisioned by Section 90.203(j).