



White space radio for seismic data backhaul

October 2012



Real Time Matters



Memorandum of Understanding

Neul Inc, 440 North Wolfe Road, Sunnyvale, CA 94085, USA

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Background and Purpose of Agreement

Neul's pioneering wide area wireless network technology is specifically designed for Internet of Things (IoT), Machine-to-Machine (M2M), Machine-to-Cloud (M2C) and Rural Broadband applications. Neul's technology operates in the UHF-TV band known as 'white space' and has significant advantages for this type of traffic over existing technologies. These advantages include superior range, capacity and reliability for non line of sight links. As a result Neul technology is particularly suitable for communications in difficult locations.

Wireless Seismic Inc (WSI) has developed a wireless system for collecting seismic survey data. This data is generated during seismic tests by sensor positioned around a test site, often arranged in strings or a grid. Each sensor is connected to a wireless Seismic radio node. Groups of nodes use a proprietary radio mesh system to transmit data to a line Interface Unit (LIU). The LIU back haul data to a central point for collection and analysis. A typical installation might have a few thousand nodes and between 15 and 25 LIUs.

This arrangement allows collected data to be collected and analysed in near real time which is a huge benefit for users. However, it is dependent on every LIU being able to establish a reliable link to the central collection point (often referred to as the "dog house"). Conventional wireless backhaul technology usually requires clear line of sight for a dependable link. It is very common in real installations for there to be at least one, and often more than one, LIU to be in a position that does not have clear line of sight to the dog house. Currently the only solution is to connect these LIUs with fibre. This is inconvenient, time consuming and introduces a potential point of failure.

The ability of Neul's system to deliver reliable, long range connections even when there is no line of sight offers a compelling solution to this problem. Neul and Wireless Seismic have agreed to work together to install a system at a WSI customer site that integrates Neul white space radio technology into WSI LIUs. The purpose of this MOU agreement is to set out a set of mutually agreeable terms for this cooperation and for future work.



Neul Technology and White Space Radio

The Neul system is a wide area wireless network that uses Radio Frequency (RF) in the 'TV white space' (TVWS) parts of the terrestrial TV broadcast spectrum range. Around the world regulators are making these frequencies available license free. White space spectrum is already available in the US, where the initial customer installation will be located.

Neul's technology offers important benefits over other wireless technologies. These include superb non-line of sight connectivity and strong in-building signal penetration. Neul's system is designed as a cellular or star topology with a basestation connected to the Internet at the centre of the network and remote terminals connected to the basestation at distances 10km or more (depending on terrain & conditions). Additional basestations can be added to the network to either increase capacity from a single site or to extend the foot print of coverage. Terminals (CPEs) can associate with any of the basestations on a network that are within range, simplifying network planning.

When used for backhaul in a WSI installation, each WSI LIU device is connected to a Neul CPE radio. One or more Neul basestation radios are installed at the central data collection point. The CPEs connect to basestation radios via white space radio, allowing data from the sensor network to be collected in real time.

Neul basestations are controlled via a cloud based management system so some kind of internet connection is required at the central collection point. However, this does not need to be a high bandwidth connection because it is only used for control and configuration. All of the seismic data stays local. A 3G or low speed satellite would be acceptable.

Working together: Key Principles

Neul and WSI (the Parties) agree to work together according to the following key principles:

- Wireless Seismic will purchase Neul radios, antennas and accessories.
- Wireless Seismic will integrate Neul radio and software technologies with the existing WSI technologies.
- Neul will provide training and support to WSI to assist with this integration. This training may be via email, telephone or face to face meetings.
- Wireless Seismic will sell the combined system, containing both Wireless Seismic and Neul technology, to their end customers. To support this activity Neul grants WSI the right to resell Neul products.
- Neul will, free of charge, provide on-site support for the initial customer installation described in this document. Neul will provide training to Wireless Seismic field crews so that they can complete subsequent installations by themselves.
- Both Parties understand that white space radio is new technology and therefore is less mature than traditional backhaul products. Recognising this Wireless Seismic will ensure that an alternative means of communicating with LIUs can be made available if necessary, for example a fibre connection. Neul agrees to be responsive to any problems that may occur, to avoid the need to use the alternative.

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- Neul agrees, for a period of fifteen months starting on the signing date of this MOU, to refrain from working on any project involving integrating Neul radios with seismic monitoring equipment manufactured by any organisation other than Wireless Seismic.
- Wireless Seismic agrees, for a period of fifteen months starting on the signing date of this MOU, to refrain from working on any project involving integrating Wireless Seismic products with white space radio technology manufactured by any organisation other than Neul.

agrees to and
[Signature]

Initial Customer Project

WSI will identify suitable customer installation for an initial joint project. The aim of the project will be to prove that Neul and WSI's combined technology can reliable wireless connectivity for seismic surveys in challenging environments.

The expected initial customer installation is a network with a total of 1500 sensors each generating data at 12kbps. There will be 25 LIUs, each providing backhaul for 60 seismic sensors. This gives an aggregate backhaul datarate of about 720kbps for each LIU. To meet this datarate requirement and to ensure a prudent margin, Neul recommends that a total of four basestation radios. This will give a ratio of approximately 8 CPEs to each basestation.

The project will be split into a number of phases. The following sections describe these work packages:

Phase 1 – initial integration

Date: October 15th

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Neul and WSI will work together to integrate the Neul system with the WSI management software. This work will be completed at the WSI lab in Houston. It will use the WSI test network there, but with Neul's radio taking the place of the Ubiquiti system currently in use.

At the end of Phase 1, the Neul and WSI systems will be fully integrated, with data coming over white space being displayed and analysed in the normal way by the WSI network management tools.

Phase 2 – initial installation at customer site

Date: October/November

Neul and WSI will install a single basestation at the central collection point of the customer project site.

WSI & Neul will perform a series of test measurements around the site using specialist RF test equipment. These test results will be used to determine the likely performance of the system, including coverage and likely datarate.

Once the initial basestation radio is in place and working correctly Neul and WSI will work together to install a number of Neul CPE devices at chosen LIU locations. These locations will be connected back to the central data collection point via white space radio.

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Neul and WSI will perform tests on the system to ensure that it is working correctly. These tests will include measuring datarate, radio channel conditions and other parameters that affect link reliability determine reliability. Neul and WSI will then run the system with real seismic data, testing its realistic performance.

On successful completion of Phase 2 it will be clear that a single basestation operating alone can connect to and provide backhaul for the required number of LIUs.

Phase 3 – roll out across the entire site

Date: November/December

In Phase 3 Neul and WSI will install sufficient basestation radios to provide backhaul for the entire customer network.

Neul and WSI will perform tests on the system to ensure that it is working correctly. These tests will include measuring datarate, radio channel conditions and other parameters that affect link reliability determine reliability. Neul and WSI will then run the system with real seismic data, testing its realistic performance.

On the successful completion of Phase 3 it will be clear that white space is capable of handling the all the backhaul needs of an entire customer network. This will mark the completion of the initial customer project.

Phase 4 – working together on subsequent projects

Date: December onwards

After the successful completion of the initial customer project Neul and WSI will continue working together on customer projects. These projects will be handles according to the principles outlined in this document.

Pricing for Neul products and services

List price for the Neul Horizon system is as follows:

- Neul Horizon Basestation: \$12,000
- Neul Horizon CPE: \$900
- Neul Horizon basestation management service (delivered via the cloud): \$4000/year
- Neul Horizon CPE management service (fixed CPEs): \$100/year (including WSR database)

Neul considers the engagement with Wireless Seismic to have strategic value and so we are prepared to offer considerably better than standard term:

- On-site support provided free of charge for the integration and initial project.
- A deep discount compared to standard pricing. Please see the associated quote document for details.

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Signed for and on behalf of **Neul Limited**

Signed for and on behalf of **Wireless
Saiam, Inc**

Signature: *James Collier*
Name: J.D. COLLIER
Position: C.E.O
Date: October 24th 2012

Signature: *M.K. Lambers*
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