# Prevent Interference Between Co-Located, Wireless Ethernet Networks with Multi Sync

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## Introduction

This white paper presents technology deployed to create proprietary wireless Ethernet networks that cover thousands of well sites within the Bakken shale in Montana and North Dakota, providing reliable communications for SCADA polls with thousands of devices from a corporate office located 5 states and 1000 miles away. Solutions to common problems encountered in unlicensed wireless networks around the country are discussed.

## Unspoken Risks of Proprietary Wireless Networks

One of the most significant developments in Supervisor Control and Data Acquisition (SCADA) in the last decade is proprietary wireless networking in unlicensed spectrum. Proprietary wireless networks allow oil and gas operators to communicate with assets in the field without relying on phone lines, cable, optical fiber or even cellular service. Operators can monitor and react to live events across thousands of well sites from the corporate office with complete control of the communication channel, without relying on the spotty service of cellular networks and buried coaxial cable.

While the benefits of proprietary wireless networks are well known in the oil and gas industry, what is less known is their performance with overlapping networks. Walk down the aisle of an oil and gas trade show and ask about the impact of Radio Frequency (RF) noise in unlicensed 900 MHz and 2.4 GHz spectrums around the country. The unlicensed frequencies have become the “Wild West” in established oil and gas formations because no permitting from the FCC is required for the installation. The very first wireless networks installed 20 years ago can no longer communicate because of the noise from so many other wireless networks in the area.

The balance of this white paper presents the first-hand experience of overcoming the interference in unlicensed spectrum for a large network in the Bakken shale in Montana and North Dakota.

## Common Network Architecture

The architecture for this system is the same as many other SCADA networks around the world. At the corporate office there are secure servers running SCADA polling software Cygnet and XSPOC. Petroleum engineers in the corporate office use these applications to monitor production and dispatch work when conditions require. Cygnet and XSPOC are set to poll all sites 3 times every hour and to send queries and commands to field equipment.

Multiple high-speed microwave links act as a high-speed transmission line across 5 different states. In this case Cambium Networks microwave radios are used. The high bandwidth and low latency links of Cambium radios offer the ideal technology to send data long distances very quickly.

In North Dakota and Montana, the high-speed microwave links connect to Point-to-Multipoint Ethernet networks. The high-speed microwave links terminate at routers and switches in communication sheds at the base of tall communication towers. Each of these towers in Montana and North Dakota has 3 Ethernet radios configured as Point-to-Multipoint Access Points. The Ethernet Point-to-Multipoint Access Points provide Ethernet connectivity to the well pads. There are thousands of well pads.

At each well pad there is a Xeta9x9-E 900MHz Ethernet radio. The Xeta9x9-E radio is one device with 2 embedded radios. The first embedded radio acts as an Ethernet Point-to-Multipoint End Point. This Ethernet connection links the site to the tower. It provides Ethernet connectivity to the site and allows TCP/IP polling from Cygnet in the corporate office to a Programmable Logic Controller (PLC) and flow meter on the well pad in North Dakota and Montana. Petroleum engineers in the corporate office 5 states away can communicate with and configure each and every Xeta9x9-E radio, PLC, and flow meter. The second embedded radio in the Xeta9x9-E radio is configured as a Serial Point-to-Multipoint Master.

The last link in the network is a Xeta9-SB radio. The Xeta9-SB radio is a Serial Point-to-Multipoint Slave radio used to connect Serial devices on the well head. In this network there are up to 5 Serial Slave radios at a single pad. This is consistent with many other industries where older and low cost equipment commonly use Serial interfaces, regardless the availability of Ethernet connections.

The logistics of managing a wireless network with up to 15,000 wells are complicated. While the record keeping of serial numbers and site lists is a manageable task, proper configuration of the networks is critical to ensuring optimal performance and reliability.

## Multi Sync Eliminates Adjacent Network Interference

Early in the deployment of the system, the engineers at the corporate office expressed some dissatisfaction with the reliability of communication with the field equipment. Specifically, the devices in the field failed to respond to Cygnet and XSPOC SCADA polls more often than not. Also, the management of the devices was a challenge since Ethernet communications to the well head was not reliable.

The Technical Support team reviewed the network diagnostics and found that Multi Sync was not enabled. Multi Sync is a feature designed to synchronize all radios in a wireless network to a common time. In this network, the goal is for the 3 Access Points on each tower to transmit at the exact same time but on different frequencies. Likewise, the same 3 Access Points on each single tower are to receive data from remote radios at the exact same time but on different frequency. This prevents one Access Point from broadcasting a signal at the exact same time that another Access Point attempts to receive and decode a very weak signal from a distance End Point.

Additional troubleshooting tools were used to further understand the communication challenges. Specifically, Network Diagnostics, an enterprise software application for monitoring the health of wireless networks, confirmed a high noise reading across the networks.

Slot Diagnostics is another tool in radios that engineers can use to analyze communication at the RF level between radios. Metrics about every single RF slot showed that radios that should have good signal levels were not even acknowledging RF packets.

To resolve this issue, a 1 Pulse Per Second (1PPS) signal from a GPS receiver was connected to the Point-to-Multipoint Ethernet Access Point to synchronize all radios in the network. New configurations for the radios with Multi Sync were chosen and deployed.

Immediately, Ethernet communication across the entire field improved. End Point radios which previously would not communicate could be accessed quickly. Ping times from the corporate office dropped. Radio configuration web pages loaded quickly and were much more responsive. The engineers in the corporate office were very pleased with the improved reliability and performance.

## Simultaneous Terminal Sessions Support Multiple SCADA Polling Hosts

Despite the improvements in throughput and system responsiveness obtained with Multi Sync, the Cygnet and XSPOC polling hosts were still reporting errors.

There were 2 types of errors reported most commonly by Cygnet and XSPOC. One of the errors was a "socket connect failure". This meant Cygnet or XSPOC could not even communicate with the radio to create a terminal session. Looking into specific sites with "socket connect failure" revealed sites without power, sites with a rig on, or manual shut down for other service reasons. The second error was "no response." The "no response" failure demanded further investigation and analysis.

Both Cygnet and XSPOC were supposed to connect to the terminal server running on the Xeta9x9-E radios. A schedule was created so that every 20 minutes one or the other polling hosts would poll the entire field. Upon connecting to the terminal server running on the Xeta9x9-E, Cygnet and XSPOC would send data from the terminal session to the serial network created by its second embedded radio. It was expected that Cygnet and XSPOC would close the terminal session upon completion.

Investigating the network traffic using Wireshark, a software application to inspect Ethernet data, revealed that Cygnet and XSPOC were not always closing the terminal session properly. Transmission Control Protocol (TCP), layer 4 of the OSI networking stack, expects a specific sequence of events to close a session. For an unknown reason Cygnet and XSPOC were not always completing the termination sequence correctly. There were missing packets from the termination sequence.

Rather than requiring changes to Cygnet and XSPOC, the software engineering team added the capability to support multiple simultaneous terminal sessions, creating a solution that would benefit all users. The first test bed of 5 radios with the new software showed a 95% polling success or better. Finally, the Cygnet and XSPOC polling hosts showed tremendous improvements in network speed, responsiveness and low latency. There was no need for the end user to change Cygnet or XSPOC polling settings.

## Adaptive Software Overcomes SCADA and Radio Frequency Challenges

All XetaWave radios now ship with the latest software that includes Multi Sync and multiple terminal sessions. The lessons learned in dealing with noisy RF environments and multiple SCADA polling hosts now benefit all XetaWave radio users.

Ask yourself how much of this impacts your SCADA network: How do my overlapping networks avoid interference? Will my SCADA network allow me to add another polling host? Will I have to optimize my polling software for my network?

If the answer is "I don't know" to either of these questions, then your network is susceptible to the failures noted above.

## Future Enhancements

Since the challenges described in this white paper, XetaWave's software engineers have added many other new features and optimizations. If you thought you needed separate wireless networks for Ethernet and Serial communications, think again. Call XetaWave and find out the latest trends in optimizing network performance and reliability.