Wireless vs. Cable

Industrial facilities have always relied on their miles of cable to communicate between the control room and the other components on their network. Cable continues to be a reliable choice in the majority of applications today; however, the needs of a facility inevitably change. Managers are seeking greater control and functionality of their process and the existing network in a facility may need to extend to include additional points in remote sites or hazardous areas. Cable may not be the appropriate or cost-effective choice to accommodate these needs.

Wireless technology is not, of course a new concept for the industrial sector, but lately, it has been experiencing tremendous growth as manufacturers incorporate license free radio modems into their I/O strategies for dependable, cost-effective data communication solutions.

As the application needs of facilities change, the desire for sophisticated features and greater control will continue to fuel the growth and capabilities of wireless technologies. With their versatility and robust capabilities, wireless strategies have become a major contender against cable.

The sophisticated wireless strategies that were once deemed too expensive and only available to government or military institutions are now within easy reach of the process control engineer. In fact, they may actually offer greater functionality and cost less than cable, especially in the long term.

Regardless of cable or wireless, there are obviously various expenses associated with both. However, unlike cable, wireless strategies are not buried in trenches or under buildings, and subjected to the environmental elements (water, earth, weather, etc.) that can hinder performance, or sometimes render a network useless. The costs for maintenance, retrenching and cable replacement, as well as downtime and the loss in production as retrenching and reconfiguration occur, can be severe.

Because wireless modems operate in the license free band ranges of 902-928MHz and 2.4-2.4835GHz Industrial, Scientific and Medical (ISM) spread spectrum band, there are also no licensing fees, lines to lease, or usage fees required. Should a problem arise, many wireless modems maintain self-diagnostic capabilities to prevent errors. A wireless modem can identify and correct the situation quickly to reduce costly downtime.

Implementing wireless modems, engineers are no longer limited by distance, terrain, or hazardous environments. Engineers can access areas where it is impossible, dangerous, or simply not cost-effective to run cable, so communication can extend beyond buildings, mountains, and other obstacles without the need to install cable. Safety is also enhanced because wireless modems reduce the need for personnel to make unsafe, inconvenient, and costly visits to remote or hazardous locations.

The Wireless Network Module (WNM)

Moore Industries' NET Concentrator System® (NCS) Process Control and Distributed I/O Network, was specifically designed for the most demanding applications. The optional Wireless Network Module (WNM) provides wireless functionality to the NCS, and can effectively extend a facility's existing digital communication infrastructure, without costly wires, leased lines, and ongoing visits to remote locations.

This bi-directional, spread spectrum wireless module employs Spread Spectrum Frequency Hopping technology, 128-bit AES (Advanced Encryption Standard) encryption, 32-bit CRC (Cyclic Redundancy Check) error protection and ARQ (Automatic Resend Query) to provide robust and secure, communications. The Spread Spectrum Frequency Hopping technique ensures reliable, noise and interference immune, license-free wireless communications. Available models will interface Ethernet or MODBUS RTU networks, and operate in the ISM frequency bands ranging from 902-928MHz and 2.4-2.4835GHz.

Ethernet

The WNM interfaces Ethernet communications seamlessly and reliably. The WNM transceiver's Ethernet port is a standard 10/100Base-T connector which will accept either a straight through or crossover Ethernet cable. There are two Ethernet WNM models available from Moore Industries.

The first WNM module was designed for data communications in the 902-928MHz license-free band,

and has a rated range of up to 30 miles (48km). The second Ethernet WNM module operates in the 2.4 to 2.4835GHz license-free band and has a rated range of up to 15 miles (24km), with both modules using highly-directional antennas and with a direct line-of-sight RF path. Ethernet models have a selectable RF data rate of 1.1Mbps or 345Kbps.

Serial

The serial version of the WNM supports MODBUS RTU and will communicate to devices via RS-232, RS-422 or RS-485. The RS-232 port is a standard female DB9 connection. RS-422 and RS-485 communications take place through a custom five pin terminal connector supplied with the radio. Both full and half duplex RS-485 communication is supported.

Two serial WNM models are available. The first was designed to operate in the 902-928MHz license-free band with a rated range of up to 30 miles (48km). The second serial WNM model operates in the 2.4-2.4835GHz license-free band and has a rated range of up to 15 miles (24km). Both serial models boast user-selectable RF rates of 230kbps, 172kbps, 115kbps or 19.2kbps, and superior sensitivity for ultra data integrity data rates of 230.4kbps: -106dBm, 172kbps: - 108dBm and 19.2kbps: - 116dBm (all three at 10-6 BER). Full duplex operation at data rates up to 230kbps provide the fast response times needed for polling communications.

Intelligent Frequency Hopping Spread Spectrum

Moore Industries' WNM utilizes Frequency Hopping Spread Spectrum (FHSS). FHSS is a very robust technology, with little influence from noises, reflections, other radio signals or other environment factors. The FHSS method transmits data using signals which rapidly switch a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver.

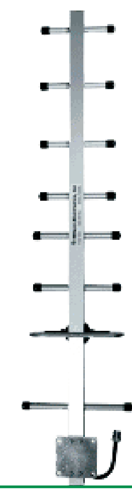
This technique offers many advantages over a fixed frequency transmission. Because the signal is spread over a number of frequency channels, it is highly resistant to interference from other signal sources. It is also more secure since it is difficult to intercept the transmission unless the pseudorandom sequence is known. FHSS transmissions can share a frequency band with many types of conventional transmissions with minimal interference. The FHSS signals add minimal noise to the narrow-frequency communications, and vice versa. As a result, bandwidth can be utilized more efficiently.

The WNM can be configured to operate on one of several 'Network Channels'. Each channel uses a different frequency pattern which allows multiple networks to coexist using the same frequency band in the same geographic area.

As wireless technologies continue to evolve, this method will be an even more important consideration as facilities seek to install multiple wireless networks at their facilities.

Yagi Antenna

A more efficient antenna for longer distances is the Yagi antenna. Also referred to as a Yagi-Uda after its Japanese inventor, this planar antenna is composed of an array of linear wires or rods arranged parallel to each other. One rod or wire in this array is the driven element which is connected directly to the transmission line. The wire or rod positioned toward the rear of the Yagi is called the reflector and all remaining rods or wires are called directors. The antenna transmits electromagnetic field energy in the direction running from the driven element toward the director. Adding additional directors to the array will ultimately increase the forward gain. Yagi antennas will send and receive signals in a concentrated, unidirectional pattern, and are most commonly used in communications with frequencies above 10MHz.



Omnidirectional Antenna

Omnidirectional antennas feature a plug and play installation and are an ideal choice for short ranges. This antenna broadcasts along a 360 degree plane, so a direct alignment with a receiver or another antenna is not necessarily required. The omnidirectional antenna radiates and receives equally well in all horizontal directions; however, the signals sent or received by omnidirectional antennas will be hindered by buildings and other obstructions between the antennas.

Antenna Selections

Omnidirectional and Yagi are two of the primary antenna types commonly used in wireless networking to receive and transmit radio frequencies across a network. The WNM comes standard with an omnidirectional "whip" antenna which is typically used for bench set up and testing. To extend the range of the WNM, use an external antenna in place of the standard whip antenna.

Configuration Modes

When integrated with a NET Concentrator System (or similar) distributed control and I/O strategy, WNM modules can be operated in Point-to-Point (Figure 1) and in Point-to-Multipoint (Figure 2) architectures.

Each WNM network includes a Master WNM module. The Master can be set to communicate with just one, or multiple, WNM modules configured as Remote modules.

WNM modules can also be configured as Repeaters to relay signals when a direct line of sight does not exist between a Master and Remote modules, or to significantly extend the transmission distance allowable within a WNM network (Figure 2). There can be an unlimited number of WNM Repeaters per WNM network.

"Smart Switch" Delivers Robust Peer-to-Peer Ethernet Networks

When set in Smart Switch Ethernet (SSE) mode, the WNM automatically establishes the most efficient path for data packet transmission. It determines whether to broadcast direct to a single radio, to some radios, or to all radios in the network, on a packet-by-packet basis (any node to any node). The WNM's "Smart Switch" capability delivers fast and highly reliable network performance.

Figure 1. *Point-to-Point Mode*

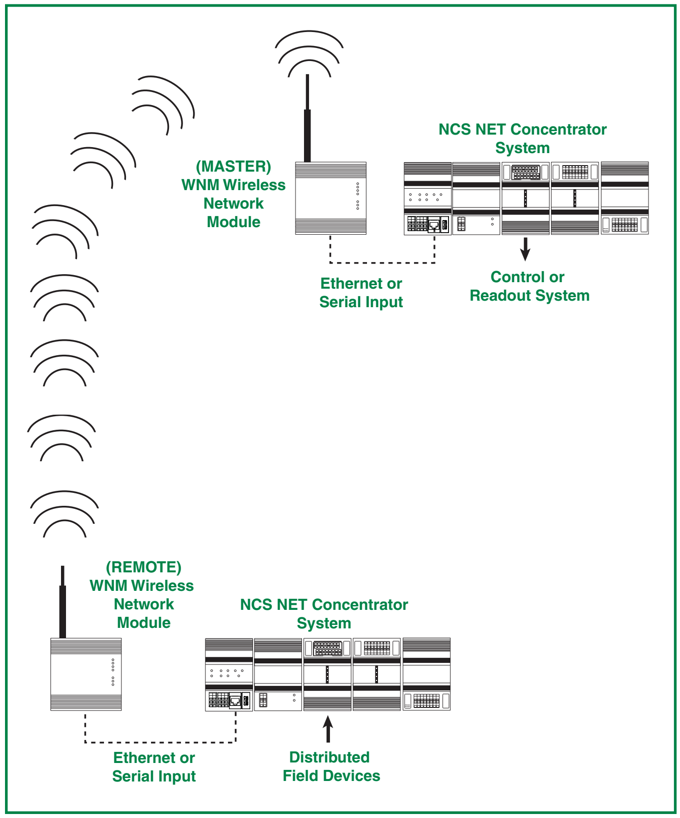
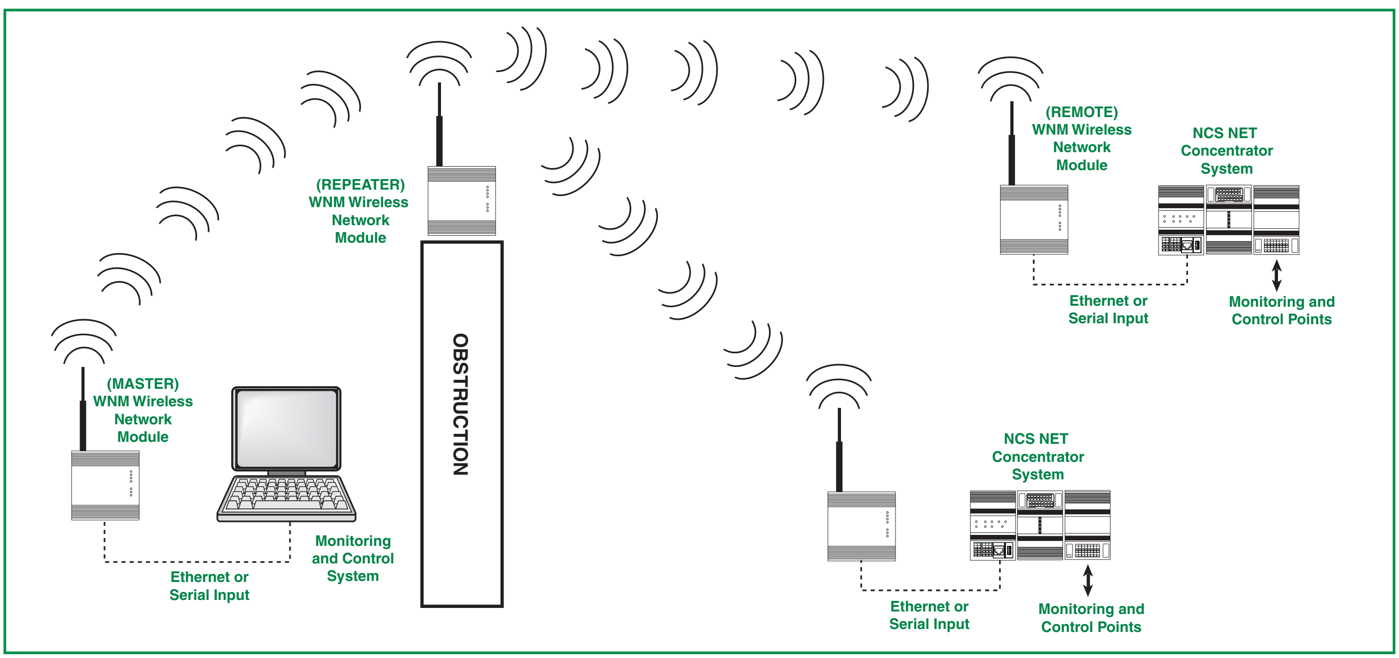


Figure 2. *Point-to-Multipoint Mode*



Wireless Possibilities
WNM Wireless Network Module

From simple plant floor monitoring, to complex networks, spanning miles over rugged terrain and connecting remote substations, Moore Industries' WNM offers an appealing solution for numerous process applications. Facilities are no longer limited by the restrictions of cable. They can increase the reach and functionality of their control system, without disrupting their current infrastructure, or incurring the expenses imposed by cable.

Glossary of Terms

Attenuation
Loss of signal power/strength in a transmission, usually as a result of distance, atmospheric conditions, or antenna design.

Director
One or more straight rods or wires placed in front of the driven element on Yagi antenna array that is slightly shorter than ½ wavelength. The more directors, the greater the gain.

Driven Element
Straight rod or wire on a Yagi antenna that is the equivalent of a center-fed, half-wave dipole antenna.

Error Correction
Signal coding that can detect errors at the receiver.

Error Detection
Signal coding that exposes discrepancies by analyzing received data against specific guidelines.

Frequency Hopping Spread Spectrum (FHSS)
A method by which a data signal spreads out over different frequencies in a random pattern and is returned to the original bandwidth at the receiver. The incoming signal is less susceptible to noise and less likely to interfere with other surrounding signals.

Gain (Antenna Gain)
The ratio of the output amplitude of a signal to the input amplitude of a signal. The higher the gain, the better the antenna will receive and transmit a signal. Gain is expressed in decibels (dB).

Line of Sight
State in which no obstructions exist in the direct path between a transmitter and receiver.

Omnidirectional Antenna
Antenna that radiates a flat, non-directional, 360 degree signal.

Point-to-Point
Configuration in which direct communication is limited to specific senders and receivers.

Point-to-Multipoint
Network configuration in which a Master communicates separately with a number of Remotes.

Radio Frequency (RF)
Electronic waves used for wireless communications, approximately 50kHz to 3GHz.

Reflector
Straight rod or wire placed behind the driven element on a Yagi antenna array that is slightly longer than ½ wavelength.

Repeater
A network component that receives a digital signal and sends this signal on to another device, extending the distance of a wireless system, or to bypass obstacles in the line of transmission.

Yagi Antenna
A high gain antenna that sends and receives signals in a concentrated, unidirectional pattern.