

# Straight Talk about Wireless for Traffic Applications

by Randy Ferras and Jeremy Hiebert, ENCOM Wireless Data Solutions Inc.

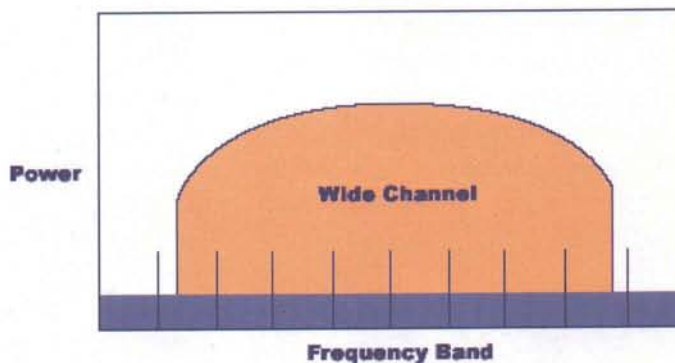
Wireless technology has proven to be a very reliable and cost-effective way to provide communication between any number of traffic control or monitoring devices. Because wireless solutions save time and money by overcoming the distance, disruption and topographical problems of hardwire, interest in wireless technology has increased substantially. It is important to understand some basic facts about wireless communications.

This brief article offers some straight talk about what one should know to make informed choices when selecting appropriate wireless products for traffic applications. There is much to consider when looking at implementing a wireless system; it is not simply a matter of taking a radio that may be designed for another purpose and making it work in a traffic application. Specific wireless products have been designed for traffic monitoring and control applications, and there are reasons why these specialized products can deliver robust, reliable, and cost-efficient wireless connectivity in real world conditions. Some basic matters to consider in selecting your wireless system include: (1) choosing the best technology, (2) reliability and immunity to interference, (3) 900 MHz versus 2.4 GHz, (4) the value of radios designed for industrial applications, and (5) what it means for wireless products to be specifically designed for traffic and what to look for in some typical wireless traffic applications.

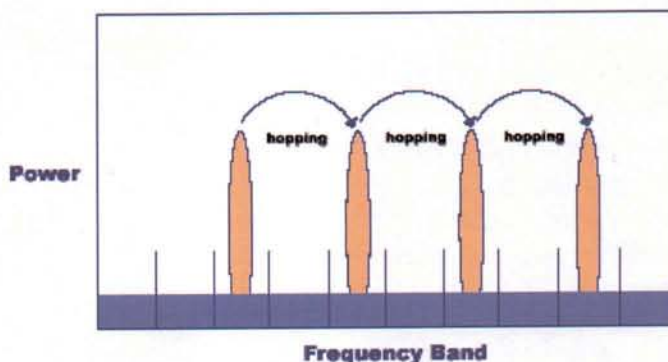
## Choosing the best technology:

One of the first steps in choosing the correct wireless product for your traffic application is deciding on FHSS (Frequency Hopping Spread Spectrum) or DSSS (Direct Sequence Spread Spectrum). One must first understand the basic technology on which Spread Spectrum is based. Spread Spectrum is a wireless communications technology where the signal is spread across the available frequency band. Spreading the data across the frequency spectrum greatly increases the bandwidth (the amount of data that can be transmitted at one time), and makes the signal more resistant to noise, interference, and eavesdropping. Simply put, the transmitter takes the input data and spreads it in a pre-defined method. As well, each receiver must understand this pre-defined method and de-spread the signal before the data can be interpreted. There are two methods to perform the spreading: FHSS and DSSS. Frequency hopping spreads the signal by 'hopping' the narrow band signal as a function of time. Direct Sequencing spreads the signal by expanding it over a broad portion of the radio band.

Example of  
Direct Sequence Spread Spectrum Signal (DSSS)  
• Fixed Frequency Channel



Example of  
Frequency Hopping Spread Spectrum Signal (FHSS)  
• Hopping Frequency Channel



## Reliability and immunity to interference

In choosing between these two types of technologies, one must consider which would be more reliable in the 'non-licensed' environment. The FCC has allocated three 'non-licensed' frequency bands (called the ISM bands) in the United States for spread spectrum communication. The bands are 902-928 MHz, 2.400-2.4835 GHz, and 5.7525 - 5.850 GHz. Wireless devices must co-exist within these three radio bands allocated by the FCC. Consequently, a wireless system must be able to send and 'hear' the signal above the din of competing radio signals and other transmissions in the allowed bands.

The basic operation of DSSS radio technology presents some inherent reliability limitations and concerns. A DSSS system uses a wide frequency channel in which to transmit and receive information. One can see that operating with a wide frequency channel makes DSSS

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vulnerable to interference: an interfering signal with a frequency near the DSSS radio's frequency can block the receiver, rendering the radio inoperable. In contrast, a Frequency Hopping Spread Spectrum radio does just what the name implies: it 'hops' from frequency to frequency over a wide band. Therefore FHSS presents the real advantage of being highly immune to interference, as it is always changing RF channels. This technology also offers further interference immunity because it allows for a large number of user-selectable RF channels as well as a large number of different 'hop patterns'. It is clear that FHSS is a very robust technology, strongly immune to interference and able to operate very effectively in the real world, non-licensed environment. This resistance to interference also allows end-users more flexibility to co-locate several radios or systems; ideal for urban and suburban settings.

(Note that the wide frequency channel limitation of DSSS is something to be concerned about even more when using DSSS technology in high speed Ethernet radios. This is because high speed capacity requires higher bandwidth (i.e. wider frequency channels), but DSSS has few alternate frequency channels to use when interference is encountered.)

### **Selecting a radio frequency: 900 MHz versus 2.4 GHz**

The two most-used radio frequencies in the ISM band are 902-928 MHz and 2.400-2.4835 GHz (commonly called 900 MHz and 2.4GHz). Due to early use (and misuse) of low quality non-licensed products in the early 1990's, today there is a great misperception regarding which of these two frequencies is better to use. This can be cleared up with a few simple facts.

Physics tells us that the lower the frequency, the more robust and better penetration the RF signal will have. This rule applies to total distance achieved, loss through RF accessories (i.e. cables, lightning protection) and total loss through space.

As well, many wireless devices have been manufactured to operate in the wider 2.4 GHz band. The 2.4 GHz band is now shared by many wireless devices such as garage door openers, indoor wireless LANs, hospital monitoring equipment, retail bar code readers and even cordless telephones, to name just a few. As thousands of these devices crowd the 2.4 GHz band, the 900 MHz band has become - and will continue to become - less congested. So not only is the 900 MHz band a more robust frequency to use, (because, remember, the lower the frequency the more robust and better penetration the RF signal will have), it is a better choice both for today and for the future.

### **The value of using radios designed for industrial applications**

We are all hearing a lot of talk these days about high speed wireless Ethernet applications. Wireless Ethernet radios were originally developed for a computer, which means this wireless technology has originally been designed to be used in indoor local computer networks: in a stable temperature environment, with ready power supply, and for short distance high speed uses. Some vendors are taking these indoor high speed Ethernet radios outdoors for use in traffic applications. People are finding that although they can get the system to work, it is often at additional unforeseen cost. To realize the promised high speed of the Ethernet radio, they have to spend more on infrastructure to overcome the indoor design specs of such radios. For example, to accommodate the temperature specs of a radio designed for indoor use, they may have the added expense of air-conditioned or heated cabinets to house the radios.

As well, the typical RF power output is low (150 milliwatts), which means large directional antennas may be required to compensate for this low output power level. These large dishes may require expensive installation and reinforced mountings. The Ethernet radio's power requirements may also be greater than what a practical solar power application can provide, necessitating some means of providing reliable electrical power to the devices, which can be a very costly endeavor and why solar power friendly devices are an important consideration.

### **A Ferrari engine on bicycle tires: the truth about speed specs**

Sometimes, purchasing high-speed-but-designed-for-indoors Ethernet radios is like discovering the Ferrari you purchased has bicycle tires. You will be able to achieve the potential speed of the engine, but only after meeting the additional costs of tires and suspension, because a high speed engine alone is not enough; every part of the car must also be capable of supporting that speed. Without the rest of the infrastructure system, it's a Ferrari on bicycle tires; sure, you've got high speed specs, but you can only go 5 miles per hour (and only a few yards). Do not be seduced by the high-speed specs of an Ethernet radio that brings with it hidden infrastructure costs. There is more to total performance than just speed specifications. Wireless products designed expressly for traffic applications, although their speed specs may appear slow, work very efficiently in real-world conditions and actually outperform and are much more cost-effective than the Ferrari-on-bicycle-tires.

## What it means to be specifically designed for traffic applications

Optimally designed traffic radios will work with all major traffic controllers and detectors. They are backwards compatible for seamless expansions of existing hardwire systems with wireless inter-connections. They are multi-function radios: each radio in the system can be configured to function as a Master, a Remote, a Repeater or a combination of Remote and Repeater; only a single radio is required for any of these functions. They accommodate multiple interfaces into systems (RS232 / Ethernet / 2 or 4 wire FSK copper). They are industrial strength, with temperature and power specifications for real world outdoor deployments. They employ FHSS technology for anti-interference capabilities. They may be shelf, pole, or rack-mounted and come pre-programmed. They are quickly and easily deployed.

## What to look for in some typical wireless traffic applications

### Interconnect applications

Examples of this type of application include replacing and/or extending existing copper and fiber, or dealing with the problem of broken buried copper wire. When selecting a wireless product for this type of application, look for a device that can be easily integrated into an existing system. Radios with a 2 or 4 wire FSK port will allow the end-user to directly tie the radio into the existing infrastructure, effortlessly replacing defective copper lines, and allowing the system to be upgraded without disruption. For fiber applications, traffic radios provide an effective and economical wireless connection between remote intersections and a fiber backbone or ring. Fiber optic cable need not be run to every intersection within a system. If the radios are available in various styles – shelf, rack card, and pole mount – this will keep installation flexible and costs low. High quality FHSS technology will decrease interference and increase reliable throughput.

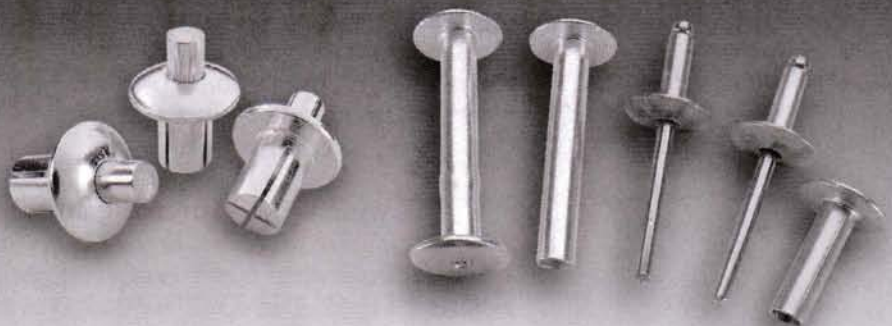
Why is wireless ideal for this application? It is non-disruptive, imposes a low impact to the environment, is easily deployed, and is a low-cost alternative to expensive hardwire installation. For example, trenching costs in New York City are currently \$150 per



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linear foot. Wireless cost savings also come via the elimination of leased line costs. Our clients have found that typically, the cost to install a wireless system is 40% of the hardwire installation costs for an equivalent system.

### Remote On/Off Control and Signs

Fire hall pre-emption, where a signal can be sent from the fire hall to hold traffic lights red as the emergency vehicle is dispatched, is an application of on/off control. Another application is school zone flashers, where the control of the flashing signs can be given to the local school.

Look for bi-directional radio confirmation capabilities, where the transmitting device can send a signal back to the fire hall to confirm the traffic signals are in fact activated and the emergency vehicles can proceed safely and quickly. Consider a radio that does not require a new cabinet but can be installed on the back of school zone flasher signs.

### Detection Applications

Many roadways have stretches that are prone to accidents, due to weather conditions for instance. Detectors can be integrated with traffic systems to send a variable text message to advise approaching

drivers of current accidents or road conditions.

For wireless detection applications, look for products that offer connectivity and the ability to integrate with magnetic loop, radar, or video detectors. Immediate signal verification is desirable to allow the sending device or person to confirm the data message was actually received and displayed at the receiver sites. The devices must be rugged and work in severe weather conditions. Note that traffic designed radios provide a high speed method to transmit information from multiple transmitters to one receiver, and are well-suited for detection applications.

### Ethernet Applications

Examples of Ethernet wireless in traffic include video detection and video surveillance to a control room monitoring traffic flow. As pointed out earlier, look for more than high speed radio specs. The Ethernet radios must be suited to rugged outdoor use, and not bring with them hidden infrastructure costs. Wireless Ethernet is ideal for large network applications because it offers a standard protocol. As opposed to serial-based systems, which, because they are timing-driven, are limited to exist as pockets of twenty or thirty devices, wireless Ethernet allows for mass control.

### Stay informed

Wireless products specifically designed for traffic monitoring and control applications are providing flexible, dependable, and robust connectivity in many localities today. As with any technology, it can be a challenge to keep up with the rapid emergence of wireless applications and to foresee all costs. We hope this brief article has helped to identify some points to consider when selecting appropriate wireless products for traffic applications.

ENCOM Wireless Data Solutions Inc. manufactures a complete line of industrial-strength spread spectrum wireless products for many applications, including Traffic Monitoring and Control (Intelligent Transportation Systems). All ENCOM products include:

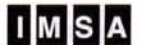
ControlPAK™, the most comprehensive radio programming and diagnostic software in the traffic industry. Learn more about ENCOM and the possibilities of wireless at:

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The authors welcome discussion of these concepts. Please contact them at:

[encom@encomwireless.com](mailto:encom@encomwireless.com)



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## We Have Come A Long Way!

On a recent trip to Meriden, Connecticut I discovered that they had refurbished the old traffic tower that controlled all the downtown traffic. A police officer would be stationed in this and would change the light manually. It is quite an interesting structure and probably very unique.

The following is taken from the plaque at the site of the tower:

*Meriden's Traffic Tower. Erected on September 21, 1925. Meriden's Traffic Tower was an innovative traffic control device designed to provide safe travel for the vehicles and pedestrians in the growing city. The unique character of the tower quickly made it a local landmark and a symbol of the city.*

*The traffic towers original location was in an area rich in historical significance for Meriden and Connecticut. One of the earliest colonial roads ran through the area that is now downtown Meriden and Connecticut's first stage coach ran from New Haven to Hartford passing near the site. In later years this route began U.S. Route 5.*

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