More Straight Talk About Wireless - Wireless ON/OFF Control and Monitoring, Part 2

By Ken Szgatti, President, ENCOM Wireless Data Solutions

Direct Contact-Closure Transfer
Many articles have been written on the history, operational characteristics and installation methods of Spread-Spectrum Wireless Radiomodems for data transfer. The technology available today, in most cases, is proven and reliable. When all is said and done, though, the end result of most of these articles (and real world installations), is a wireless link capable of transferring only the serial data provided by other devices, providing an RS232 port at either end of the link. You may have been considering wireless as a cost-effective, reliable solution for an application where cabling, for whatever reason, is not a viable option. Your challenge, though, is that your application is not serial data based, you have no RS232 ports to interface to. What if you just need to turn things on and off remotely, or need the accurate transfer of contact closure information from remote detection devices?

The Evolution of Integrated RF Control
An obvious evolution in wireless is to create an RF based device with on-board monitoring and control functionality, allowing direct connection to external status I/O (pushbutton switches, relays, flashers, etc.) without having to add on external processing equipment, such as PLC’s. How? By replacing the RS232 serial data port (the standard interface on all Spread Spectrum radiomodems), with on-board parallel I/O capabilities, and adding the intelligence to allow these devices to manage their own operation. For many traffic monitoring and control applications, this technology permits the direct connection to, and wireless transfer of, single or multiple contact closures. These status transfers may be one-way, real-time (typically for detection monitoring), or two-way, with confirmation capabilities (typically for remote control and monitoring). Contact closure inputs at one end of the wireless link are replicated as open-collector, or relay-outputs, at the other. The end result? Simple, cost-effective, specific wireless solutions that look and operate as multi-pair communications cables, without the physical limitations of hardware.

Real-Time Remote Detection Applications
The ability to wirelessly transfer multiple contact closures directly, in real-time, over considerable distances, opens up a world of possibilities, especially in remote detection applications. Why is real-time performance necessary, though? In high speed, high volume and high occupancy detection applications detector output timing considerations become a major concern. In high speed, high occupancy situations, detector status outputs are very rapidly generated, and, depending on the length of vehicle, can be of very short duration. Any wireless equipment utilized in these applications must be able to accept and accurately transfer “worst case” status data. High frequency pulses (high speed vehicles), and variable pulse widths (varying vehicle lengths) all must be handled transparently by the Wireless transmitter, while minimizing time delays of its own, all for 8 or more status channels simultaneously. How are these real-time status transfers accomplished?

Parallel Interface Technical Considerations
The Wireless transmitter parallel interface consists of a number of independent status input lines (typically 8), directly feeding an on-board microprocessor. The status of all inputs are scanned by the microprocessor, their conditions constantly updated. This parallel data is processed, and then converted into a data stream easily transported by radio. Error checking and forward error correction instructions are added at this point, and then the bit stream is fed to the RF transmitter. As our goal is to attain one-way, real-time performance from the wireless link, the RF transmitter section is operated continuously enabled, minimizing keying delays. An 8 millisecond (average) end-to-end transfer delay is introduced by the RF link, due to transmitter channel-hopping and associated receiver resynchronization. This delay, when combined with the status input update time, produces an end-to-end system latency (time from change of status of a transmitter impact to a corresponding status change in a receiver output) of typically 20 milliseconds, more than fast enough to be considered real-time by the associated ITS application. Now that we have a basic understanding of how it works, how do we apply this technology to common, real-world applications?

Wireless Mid-Block Loop Detector Application

Fig. 1 shows a pair of Mid-Block Loops, installed a considerable distance upstream from an existing controller cabinet. Typically, a length of multi-conductor “home run” cable would be installed between the loop location and the loop amplifiers located in the intersection controller cabinet. In many cases this may not be cost effective, due to the distances involved, cable installation costs or technical considerations. The wireless solution consists of standard loop detector card(s) installed in a Wireless Loop Transmitter Package, installed at the remote loop location. Loops are connected to the Wireless Loop Transmitter Package, and real-time status information from the detector card outputs is transmitted back to the intersection controller cabinet, where a corresponding Wireless Status Receiver is located. These status receivers, typically provided as detector rack cards, are direct replacements (pin for pin) for standard loop detector cards, allowing “plug and play” installation. Status outputs from the receiver cards are routed to the appropriate controller input via the standard rack wiring. With a good RF path between
the transmitter (mid-block location) and receiver (intersection controller) locations, the new loops, for all intents and purposes, appear hardwired to the controller. Installation is simple, quick and above ground, with only a source of power required at the mid-block location. Gone are the headaches, technical issues and cost of trenching and ducting long runs of cable, as well as gaining the ability to configure and test loop functionality directly at the loop location, by a single person.

Remote Video Detection Application

In some remote Video Detection installations, hardwiring the cameras directly to the Video Detector cards located in the intersection controller cabinets may be impractical, due to the distances involved. To eliminate the cabling requirements, some applications have transmitted raw video from remote cameras wirelessly back to their Video Detector cards located in controller cabinets. While this cable replacement approach may seem reasonable, there can be a serious downside. The transmitters used are usually very low powered RF devices, transferring a wide bandwidth analog video signal. This combination makes initial installation and setup critical, especially in areas of high RF congestion. Should more than one camera be located in the same area, interference from co-located transmitters is a very real possibility. If these wireless video links from the cameras degrade due to interference or poor radio paths, the quality of the raw video supplied to the Video cards may not be good enough to allow the detectors to process properly, leading to unreliable or intermittent status outputs to the controller.

To eliminate this potential issue, instead of wirelessly transferring the raw video between cameras and their detector cards, the detector cards may be relocated close to the camera location, and cabled directly to the cameras. This provides the detector cards the high quality video they require to process with maximum accuracy. In this case, the Video Detector cards would be installed into a Wireless Loop Transmitter Package, which houses the equipment, and provides power and interfacing to the status inputs of the embedded wireless status transmitter. The status outputs from the Video Detectors are transferred, in real time, to corresponding Wireless Status Receivers plugged into in the detector racks at each intersection controller cabinet. The end result is a remotely located Video Detection system that appears, to its associated controller, to be hardwired.

Fig. 2 shows a mid-block Video Detection application, with 2 cameras monitoring 8 lanes. Camera 1 and its Video Detector card provides detection zones 1-4, eastbound, with its status outputs connected to inputs 1-4 of the Wireless Loop Transmitter Package. Westbound lanes are detected as zones 5-8 of Camera 2 and its Video Detector card, and are fed to inputs 5-8 of the Wireless Loop Transmitter Package. The continuously transmitted RF signal, carrying status information for all 8 zones, is broadcast to Wireless Status Receiver cards installed in the controller cabinet detector racks for both the east and westbound directions. Receivers at each intersection decode, and make available all 8 detection zone outputs simultaneously. Receiver status outputs, on a per detection zone basis, are mapped to their appropriate controller inputs as dictated by the system requirements, (In this case, outputs 1-4 are interfaced to the eastbound controller, outputs 5-8 are interfaced to the westbound). This scenario allows the placement of Video Detection cameras anywhere, without cable length limitations.