Wireless Ethernet Streamlines Pomegranate Production

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One of the world's largest suppliers of fresh pomegranates and producer of pomegranate juice is located in northern California. In this northern California production facility an update to their automated bin delivery system has greatly increased production, through fewer down times, of a very time sensitive product.

Figure 1: Fresh Pomegranates

Pomegranates (Figure 1) are one of the oldest cultivated fruits on earth. Historical evidence suggests that man first began planting pomegranate trees sometime between 4000 B.C. and 3000 B.C. Although Pomegranates grew in the wild before the dawn of agriculture, they were one of the first five domesticated crops along with olives, grapes, figs and dates.

In northern California, the picking season for fresh pomegranates runs from early October through the middle of November. These delicate fruits must be hand picked to avoid damaging the internal arils (seed casings) filled with the pomegranate juice. From the time the pomegranate is picked, the fruit is very vulnerable and must be treated and stored quick to avoid spoilage. With a very limited picking season and great volume of fruit, the processing is done in a 24 hour operation in the fruit packing warehouse. During this most critical stage for the fresh fruit, all automated system's must operate reliably or the year's fruit crop will be lost.

Process Unlimited in Fresno, California was hired to update the automated bin delivery trolley system. This bin delivery system moves the fresh fruit throughout the warehouse to the various processing stations and is the heart of the packing system. The original bin delivery system used an elaborate combination of track I/O devices to control each trolley's movement. This I/O based system required considerable maintenance every season and after three seasons of unreliable operation, the plant had to consider an update. The new trolley system not only would need to be more reliable, but would also require each trolley to have autonomous operation in network and accept controls from a central processor. These new "smart trolleys" could be removed or added to the system as required without disruption of the overall production.

The old trolley system was removed and replaced by independent smart trolleys controlled by a central control PLC and HMI computer. Each of the twenty four (24) trolleys can move independently along the large processing facility track (Figure 2) and their position, status and task is monitored by a local Rockwell Automation MicroLogix controller. This entire system is controlled by a centrally located Rockwell Automation ControlLogix processor that monitors and sends the positioning, route and status information to each of the trolleys.

Figure 2: Automated Bin Delivery Track

The only way to control this complex network is to maintain continuous contact from the Central PLC to each one of the smart

trolleys. Each trolley follows a route through the large indoor packing facility, under walkways and between packing machines (Figure 3). The only practical means for communication in this environment was wireless. The speed of the trolley's movement and number of trolleys in the network required a very high-speed, high-bandwidth communication system that could only be accomplished with the latest generation of wireless Ethernet hardware.

Figure 3: Walkways Covering Delivery Track

Rockwell Automation has a third-party referencing program that allows them provide a complete solution for industrial applications called the Encompass™ program. Many Encompass wireless vendors were tested for this application but the ESTeem 195Eg, 2.4 GHz wireless Ethernet modem was found to provide the best coverage area with the highest data rate. The ESTeem 195Eg has a 1 Watt output power and 54 Mbps throughput that worked well for the trolley application's difficult RF environment.

ESTeem Wireless Modems was requested to help design the wireless network for the trolley system. After the ESTeem hardware was tested and selected for this application, an on-site radio survey was completed to determine the best location for the Master PLC's ESTeem and any required repeater sites. Through this on-site analysis of the system and signal strength testing, it was determined that a central 195Eg at the master location and four (4) repeater sites on the corners of the trolley pathway (Figure 4) would allow overlapping coverage to all areas of operation. The overlapping coverage of the repeater sites would provides redundancy in the network. If one of the repeater sites were ever to loose power the other repeater sites could still provide radio coverage to that area. All areas throughout the difficult RF pathways were tested to ensure constant radio coverage with the Central PLC. Each phase of the radio integration was an excellent example of how to design a reliable wireless network.

Figure 4: ESTeem Repeater Location

Phase 1 – Design and Hardware Testing

Process Unlimited and the customer conducted a design review of the proposed wireless network prior to conducting any on-site testing. They reviewed the specifications for each wireless Ethernet network, contacted the vendors and conducted evaluation testing for each product. Once the wireless hardware was selected they proceeded to the testing phase.

Phase 2 – On-Site Radio Survey

Once Phase 1 design was completed, all trolley travel locations in the network needed to be physically tested with the hardware that will be installed at the site. Site survey testing included measuring receive signal strength, RF background noise and data transmission efficiency. The purpose of this testing is to confirm the initial wireless design and also make any site adjustments if an on-site problem is identified. For example, it was determined that although all remote areas could be reached from a single centrally located ESTeem 195Eg in the building, four additional repeater sites allowed for overlapping coverage to eliminate a single point of failure. ESTeem Wireless Modems presented a formal site survey report with all the testing information and installation plan to Process Unlimited.

Phase 3 – Installation/Commissioning

After the radio design plan was evaluated and accepted, Process Unlimited and ESTeem completed the installation of the wireless hardware and performed a site commissioning using the same testing techniques uses during the radio site survey. The testing was conducted on the installed hardware and the results should be equal or greater than the values tested during the site survey.

The purpose for all this extensive testing is that the wireless network is providing the "backbone" for all communications in the automated trolley system. If any wireless link is unreliable then all devices connected to that link will also be unreliable. A properly designed, installed and tested wireless network can be as reliable as any cabled communication system.

The ESTeem 195Eg on each of the trolley cars were placed in a mode of operation specifically programmed for mobile applications called the client mode. This client mode allows the 195Eg to change between the Master and Repeater sites based upon the receive signal strength for the best radio link. The 195Eg monitors all available wireless links and selects the link with the highest RF data rate. This client mode feature and overlapping radio coverage provided the constant wireless Ethernet communication required of the network.

The same ESTeem 195Eg wireless modem is used as the base, repeater and client modem for the trolleys which greatly reduces spare hardware requirement. The only difference between locations is software programming. Another advantage of the 195E series wireless modems is their ability to be directly mounted in an outdoor or industrial environment. The 195E wireless modems are housed in a NEMA-4 rated case that is a great advantage in the food processing industry that require wash down.

The wireless trolley system upgrade has operated for over two seasons without interruption or system failure. The packing process reliability has been greatly enhanced saving the customer both time and money in no network down-times. The unique automated bin delivery system designed by Process Unlimited and the customer, using off the shelf controller and wireless hardware, is an excellent example of how ingenuity and vendor partnership programs can solve unique problems.