Theme Park Attraction Uses Wireless Control

A radio frequency network consisting of ESTeem wireless modems interfaced to Allen Bradley PLC's was found to be an effective solution for communications between mobile Ride Vehicles and a Master Control Station (MCS) at a major theme park boat ride attraction. The MCS at the attraction consists primarily of Allen-Bradley PLC's, and it is responsible for the ride control, special effects control, animation control, show lighting/audio, facility power control and monitoring, and operations and maintenance interface. Eight of the PLC's used in the attraction are located on Ride Vehicles which move unchained throughout the attraction in water. The communication link between the MCS and these Ride Vehicle PLC's is the primary focus of this article.

The attraction is themed after a tour boat company which gives guided tour boat rides around some of the sights of the area. Self propelled Ride Vehicles transport the park guests through the attraction in a man made lagoon. As the guests travel through the attraction, they encounter many complex special effects and animated figures.

Allen Bradley equipment was specified by the owner due to its proven reliability in other attraction in the park, park technicians familiarity with the equipment, and existing spare parts inventories. These considerations made the cost difference of the Allen-Bradley equipment and other manufacturers PLC's insignificant to the MCS design team.

The design required the RV's to move throughout the attraction automatically. The speed profiles, motion profiles, collision avoidance, and operator interface needed to be controlled automatically. The only operator interface required on the RV's are dispatch requests and emergency respond commands. Due to this requirement, a communication link to the land based MCS was required. The MCS monitors the location of all of the Vehicles and directs traffic as the attraction operates. After researching the requirements of the Ride Control System, it was determined that a Radio Frequency communication would be the most practical solution.

To determine the best radio modems for the network, several modems were researched and tested. The ESTeem wireless modems were selected primarily due to their compatibility with the Allen Bradley protocol, the ability to initiate a message from any network source, and their overall reliability. By using the ESTeem modems, communications can be initiated from any station on the RF Network, allowing the MCS base station to receive an emergency message from any RV without waiting to be polled (Report by Exception). This was particularly important because an immediate response to an emergency condition is critical to the safety of the passengers and the collision avoidance system.

The MCS base station for the RF network is an Allen-Bradley PLC 5/40. The PLC 5/40 was selected primarily due to the number of configurable communication channels, processing speed, and memory capacity. The number of communication channels was significantly important, as it allowed the PLC to communicate to remote racks and Panel View on a one channel, data highway to other land based PLC's on another channel, and dedicate independent data highway channels for each of the Radio Frequency networks. This limited the amount of traffic on the modem communication data highways to only the radio transmissions on that frequency.

The Ride Vehicles are controlled by Allen-Bradley PLC 5/12's. These processors control the motion of the RV, operator interference, audio control system, on board special effects and the communication of the RV to the Base station. The RV's communicate with the MCS via a KE Module and an ESTeem Model 95 Wireless Modem.

The RF network was divided into two separate frequencies to reduce the amount of traffic on each frequency. The system utilizes a maximum of eight RV's, thus four RV's are assigned to each frequency. The ESTeem radios use a packet burst, carrier sense multiple access (CSMA) communications protocol. Allen Bradley PLC's communicate to the modems via KE Modules. The PLC communicates with the KE Module via message instructions in the PLC ladder logic. A message instruction is used to Read or Write a block on memory from one PLC to another. This block of information is transferred to the local modem and then sent to the designated remote modem on the RF...
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The remote modem then passes the information to the remote KE Module and then to the remote PLC. The base station uses a polling method for normal communication to all RV’s on the RF link. Status information is continuously shared between the Base Station and the RV’s every few seconds. The polling method is programmed to allow a small amount of time between polling RV’s to receive a message from a RV. In the event of an emergency on the RV, the RV instantly initiates a message to the MCS (Report by Exception). The MCS then determines how to respond to the situation. In addition to the normal polling and the report by exception, the MCS also utilizes a “Fast Update” method of communication where it immediately sends an emergency command as fast as possible (no time between messages, and minimal information) to each of the RV’s in operation. This allows the MCS to immediately stop all the RV’s in an emergency situation at virtually the same time.

In all radio modem applications it is important that a radio site survey be conducted. The radio site survey will determine if other RF emitters and noise sources are present which could cause interference to the system. Electronic Systems Technology (EST) performed a site survey at this attraction and ran the ESTeem modems with an in-house test program to determine how the system modems would perform at this particular site. The survey also served to determine the proper type and location for the antennas. EST also recommended operating frequencies for the modems, appropriate cables, and installation instructions.

Some of the important lessons learned in this application are as follows:

- The Status information shared over the RF link needs to be consolidated and prioritized in both PLC’s in order to minimize the time of the transmissions. By prioritizing the information, critical information can be easily sent without the overhead of unnecessary information.
- Polling the remote PLC’s during the normal operation stabilizes the communication system. Alloting time between transmissions allows the "Report by Exception" method to send critical information as soon as the frequency is clear of any other transmissions.

- It was found impractical to monitor or program a remote PLC via the ESTeem modem network while the system was in operation. The programming software sends the data as fast as the ESTeem can transmit it and does not allow sufficient time to share the RF with the rest of the system.
- The type of cable and cable connections were critically important for the reliability of the link. The unusually harsh and violent conditions of the equipment in this attraction tended to deteriorate standard cable connections and antennas. As long as the cables, connections, and antenna connections are solid, the link has proven very reliable.

If the above recommendations are considered in the preliminary design stages, the ESTeem wireless communication network will be trouble free and have a minimal start-up time. This theme park attraction is a good example for describing how a complex wireless network should be designed. The ESTeem Wireless Modems and the Allen-Bradley PLC’s have proven to be a reliable cost effective solution to a complex, fully automated theme park attraction.