Deploying a Fire & Gas monitoring system for an LPG storage plant

MCL CONTROL

1.- Summary

This application note shows how to successfully deploy a Wireless WiFi based Fire and Gas (F&G) monitoring system for an onshore gas processing and storage plant, using MCL Control's WiFi Sentinel (WFS-1000) Universal Serial Converter and WiFi Solar powered Micro "RTU".

The performance indicators presented in this note are based in statistics collected from an actual implementation of WFS-1000 on a Liquefied Petroleum Gas (LPG) storage plant.

This application note applies to WFS-1000 models 10-01, 10-02 and 10-03.

2.- Justification of Wireless Systems for F&G monitoring

In a gas processing and storage plant F&G detectors are placed in pumps, LPG spheres, LPG bullets, truck loading, bottling facilities, etc. Covering these zones with conventional wired F&G detection systems, even in a small plant, involves significant wiring installation costs since distances from the sensors to the F&G gas panel are typically in the order of thousands of feet of cable. Also many F&G sensors power consumption, limits the wire length to prevent voltage drops beyond the manufacturer requirements. In addition, long wire runs are prone to failures due to electromagnetic interference in cables that may lead to false signals or induced voltage that might damage input circuits in the F&G control panel, which in turn calls for surge and transients protection devices, circuit isolators, and safety barriers increasing even more the initial cost (CAPEX) and the operational cost (OPEX), and increment the number of point of failures, thus reducing the system availability.

In applications where the sensors are deployed in a spread open area, and when there is line of sight between the access point and the different locations where the F&G sensors are installed, the use of WiFi sensors network seems to be suitable. To power each group of sensors and the WiFi transceivers, solar cells, battery charger, and deep cycle lead acid batteries can be used.

Installation cost are dramatically reduced because for each group of sensors neither power supply nor signal wires from control room are required. Each F&G zone is protected by a junction box equipped with an external solar panel, batteries, charger, and WiFi Sentinel (WFS-1000) with or without additional I/O.

3.- Wireless system requirements

The requirements for the wireless F&G systems proposed by the end user are:

- Response time from activation of any F&G detector to alarm in control room: < 10s (Ref.: NFPA 72).
- Report of any detected failure, including communication failures and battery state, preventing the alarming of fire and gas events to the control room: < 200s (Ref.: NFPA 72).
- 24 hours of backup battery (secondary power) under normal load.
- 5 minutes of backup battery (secondary power) under full load.

In addition to the above mentioned requirements, the following will apply:

- Standard 4-20 mA signals from the Fire and Gas detectors are to be used to interface to the wireless transceivers.
- Wireless transceivers shall be able to detect currents from the sensors between 0 to 4mA to allow reporting of diagnostics from the detectors.
- Wireless transceivers shall accept Inputs from Manual Alarms Call station (MACs) featuring line supervision with end of line resistors to discriminate real alarms from broken field wiring.
- Wireless transceivers shall allow the activation of visual and sound field devices like beacons and sirens.
- The systems shall be expandable by adding I/O in each zone.
- Communication protocols shall be open and widely used.
- Wireless technology shall be based on proven and widely used open standards.
- Field devices shall be suitable for the electrical area classification where it will be installed as per NFPA 70.
- Wireless communication shall be based on an unlicensed band.
- Wireless technology shall include security features to minimize cyber-attack.
- Wireless communication shall have availability figures above 99%.

4.- Proposed WiFi Sentinel solution

Figure 1 shows the architecture, based on WFS-1000 series, to fulfill above mentioned requirements.

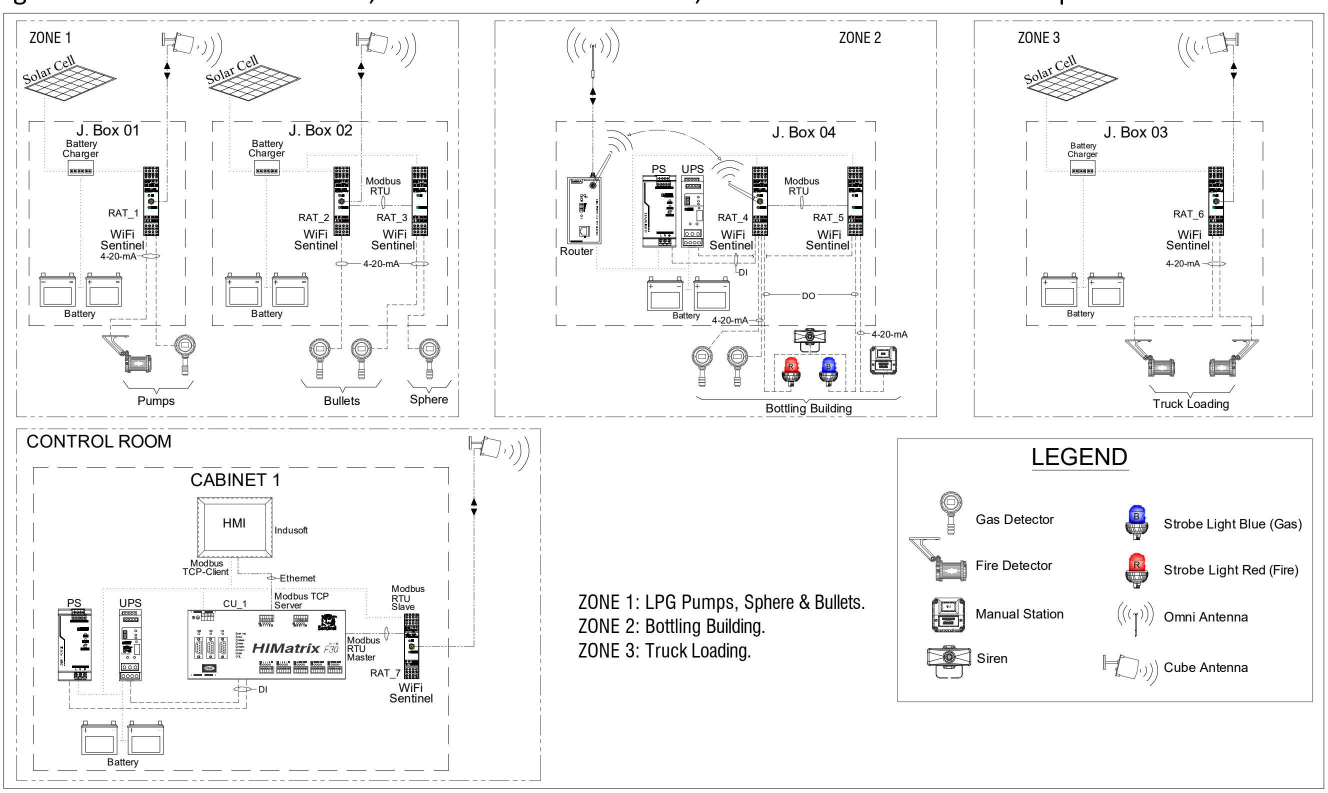

Figure 1.- WiFi Sentinel System Architecture

In above sample architecture (taken from a real project), there are three detection zones, each one having one or more WFS-1000 devices. For example, in zone 1, there are three WFS-1000, two of then (RAT_1 and RAT_2) are equipped with a WiFi radio and a directional antenna, and the third (RAT_3) is an I/O expansion of RAT_2. Each WFS-1000 can accommodate up to two 0 – 20 mA inputs from F&G detectors, one discrete input, and one discrete output.

Although WFS-1000 features an embedded lead acid battery charger, in this sample application it is not used due to its limited capacity up to 3W; instead, an external battery charger with proper capacity was used.

Each WiFi Sentinel (WFS-1000) along with the battery charger, lead acid batteries (24 Vdc), terminal blocks, circuit breakers, an antenna lightning protector is installed inside a Junction Box properly selected for the environmental conditions and electrical area classification.

Each Junction Box (JB) is installed near the top of a 10m pole; also solar cells and directional antennas are installed on the top of the pole. Fire detectors can also be installed on each pole. Gas detectors are wired from its location to the Junction Box (See Figure 2).

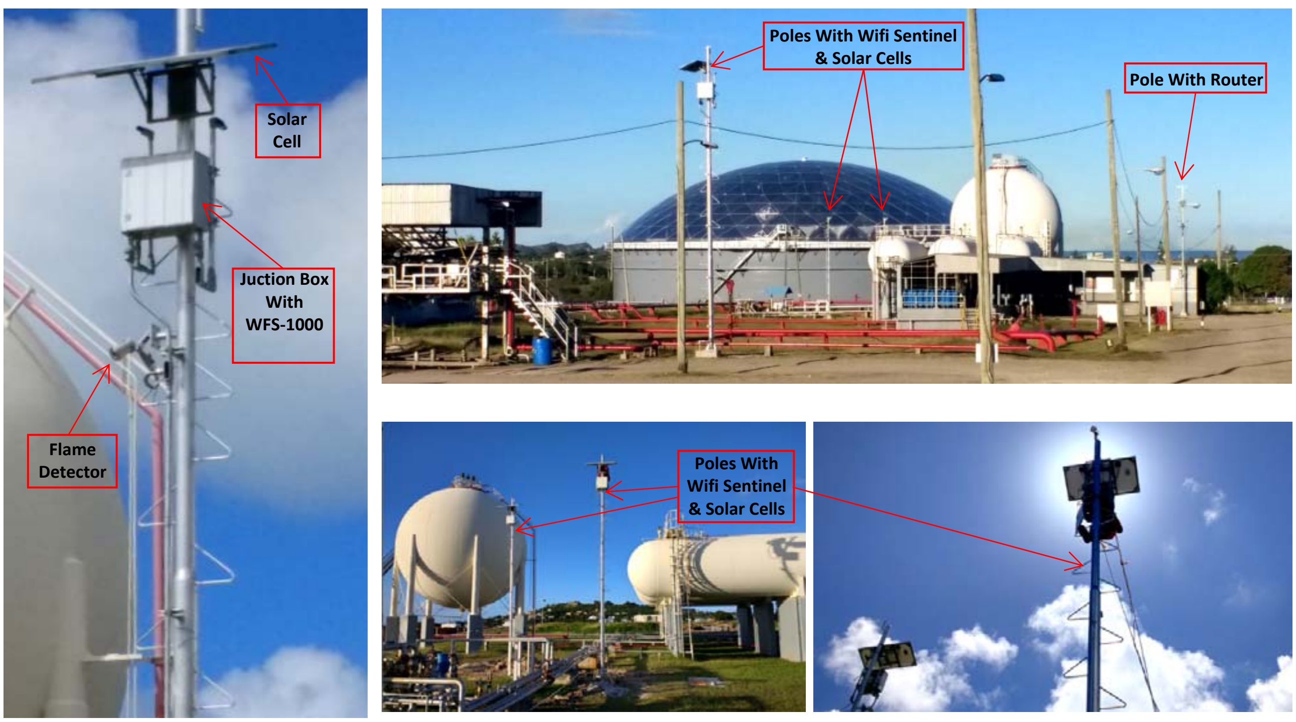

Figure 2.- WiFi Sentinel in a real application

Each WiFi Sentinel is connected to a directional antenna aimed to the omni-directional antenna of the industrial grade WiFi Access Point (AP).

At the control room, there is a safety related HIMA's Himatrix Programmable Logic Controller (PLC) running the F&G detection system logic. This PLC is connected via Modbus TCP to an Operator's panel running a F&G Human Machine Interface (HMI). From this panel the operator can supervise the status of each zone, register alarms, diagnose the complete system, and inhibit zones.

Engineering studies has to be previously performed to select antenna gain, location and height, to determine link budget and to guarantee Line Of Sight (LOS), and a free of obstacles fresnel zone to minimize interference and WiFi signal fading (see figure 3).

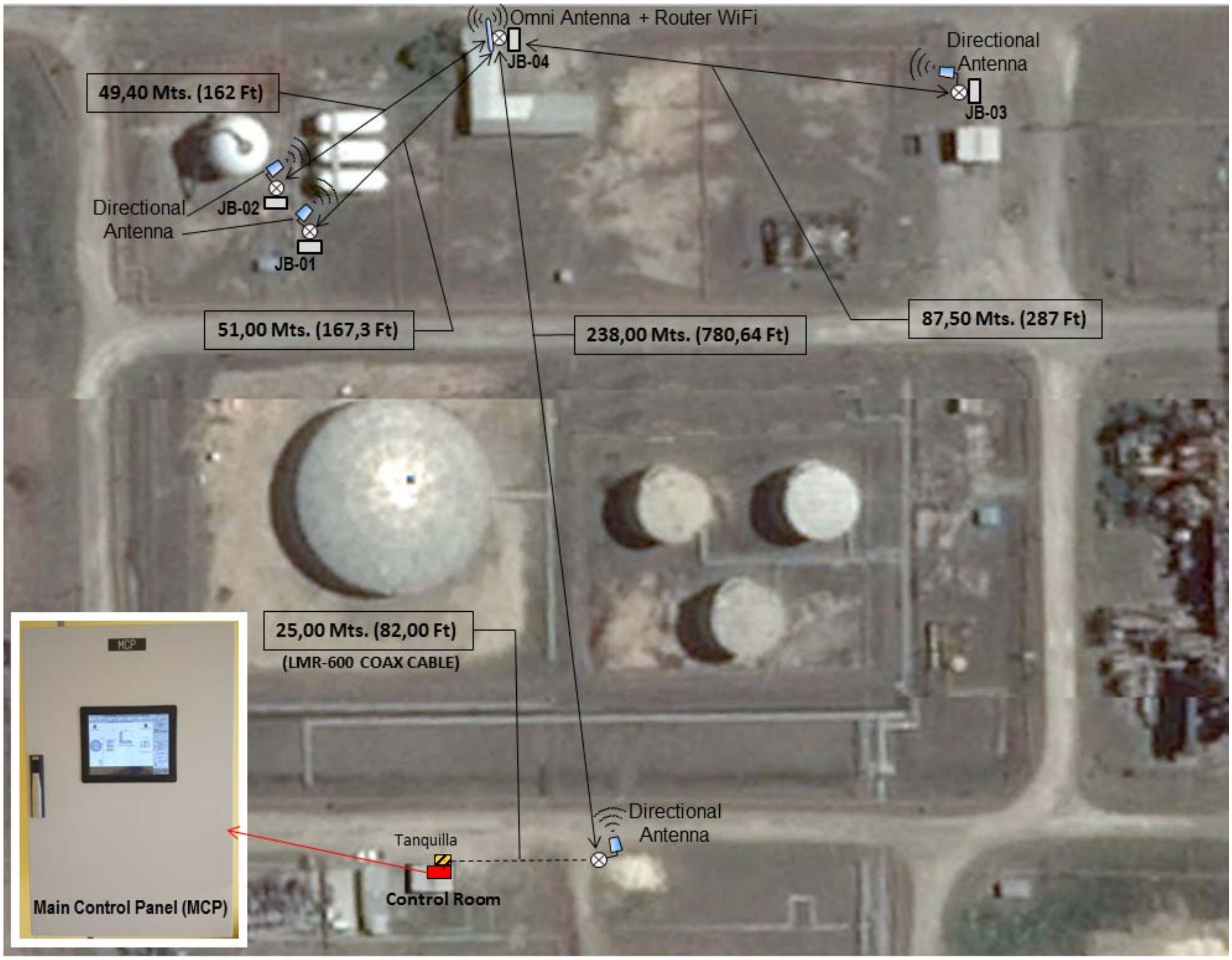

Figure 3.- WiFi Sentinel deployed on field

The PLC works as a Master Terminal Unit (MTU), and the protocol used to communicate with the WFS-1000 working as Remote Terminal Units (RTU) is Modbus RTU. There is one WFS-1000 (RAT_7) connected to the Master PLC (Himatrix F30 in this example) via RS-485 channel at 38,400 bits per second (bps), and several WFS-1000 (slaves) deployed on field. The Modbus RTU query requested by the MTU is retransmitted wirelessly by the WFS-1000 (RAT_7) to the other WFS-1000 (Slaves) in the field. Each WFS-1000 must have a unique Modbus RTU slave address, only the one matching the query address responds to the MTU. The response received by the WFS-1000 (RAT_7) is retransmitted via the serial channel to the MTU.

Each WFS-1000 radio must have a unique IP address. The WiFi network is managed by a WiFi Access Point (Router), consequently all WFS-1000 must be connected to the same WiFi Network to communicate each other. The WFS-1000 working as a master send an UDP broadcast message having the Modbus RTU query, all the WFS-1000 in the field receive the message, and the one matching the proper Modbus RTU address respond via WiFi to the WFS-1000 master sending an UDP message with the response to the WFS-1000 master. The response message IP address must match the WFS-1000 master IP address.

4.- Performance figures

The system performance was measured under the following conditions and configuration settings.

System conditions and settings:

- Number of RTUs (WFS-1000): 6
- Number of RTUs (WFS-1000) equipped with WiFi Radios: 4
- Modbus RTU communication baud rate: 38400 bps
- Modbus RTU scan time: 1 second
- Modbus RTU timeout: 500 ms
- Modbus RTU retries: 5
- Number of gas detectors: 6
- Number of fire detectors: 3
- Number of MACs: 1
- Number of strobe lights: 2
- Number of sirens: 1
- Maximum distance between any remote device and the WiFi Router: 238 m (780 ft)
- Maximum distance between any remote device and the control room: 325 m (1067 ft)
- Worst case Link Margin: 28 db
- Poles height: 10 m
- Time to declare a communication error: 15s (< 200s requested by NFPA 72)

Based on the above mentioned conditions and settings, the system Key Performance Indicators are:

System performance:

- Scan time (all remote devices under no communication errors): 1s
- Average scan time (all devices under average communications errors): 3 s (< 10 s requested by NFPA 72)
- Maximum time a remote device was observed disconnected from the network (not responding): less than 50 seconds
- Wireless link worst case availability for any remote device: 99.6%

Based on measured performance and configuration settings the proposed system complies and exceeds the typical F&G monitoring system requirements, proving that Wireless F&G monitoring systems are a valid alternative to conventional wired systems.

MCL CONTROL

International Office
13652 Breton Ridge Drive, Suite A, Houston, Texas 77070, USA
Toll Free: 888-563.0941, Ph: 281-469.6634, Fax: 281-469.0172
mclcontrolusa@mclcontrol.com

Latin America Office
Av. Principal de Los Ruices Centro Empresarial Los Ruices, Piso 3, Ofic. 308
Caracas 1071, Venezuela, Ph: 58-212-238.2996/2581. Fax: 58-212-232.1223
mclcaracas@mclcontrol.com

Web Page
www.mclcontrol.com