vMonitor Wireless Sensors Enhances Pipeline Safety and Efficiency

Client: PEMEX GAS AND PETROQUMICA BASIC

Wireless sensor network provides a dependable automation solution in record time and under budget.

Pemex Gas y Petroquimica Basica, PGPB, is the division of the Mexican National Oil and Gas Company that is in charge of transporting the gas and basic petrochemicals across the country. PGPB has efficiently managed their vast network of pipelines with a control center located in Mexico City and has a large portion of the pipeline integrated into their SCADA system, however, they have never had any information about the operational conditions of their pipelines that transport the basic petrochemicals including propane, ethane, methane, heavy crude and light crude between the processing centers, which comprise a total of about 900 Km of pipelines.

As a first step, PGPB wanted to be able to properly manage this vast network, which required rapid access to remote data such as gas pressures from all sectioning and transport valves across the network. Operators in the control room were to be able to monitor status and operating conditions of the pipeline and monitor pressure trends to help them detect any anomalies and possible compromise of this theft prone and highly dangerous pipeline network.

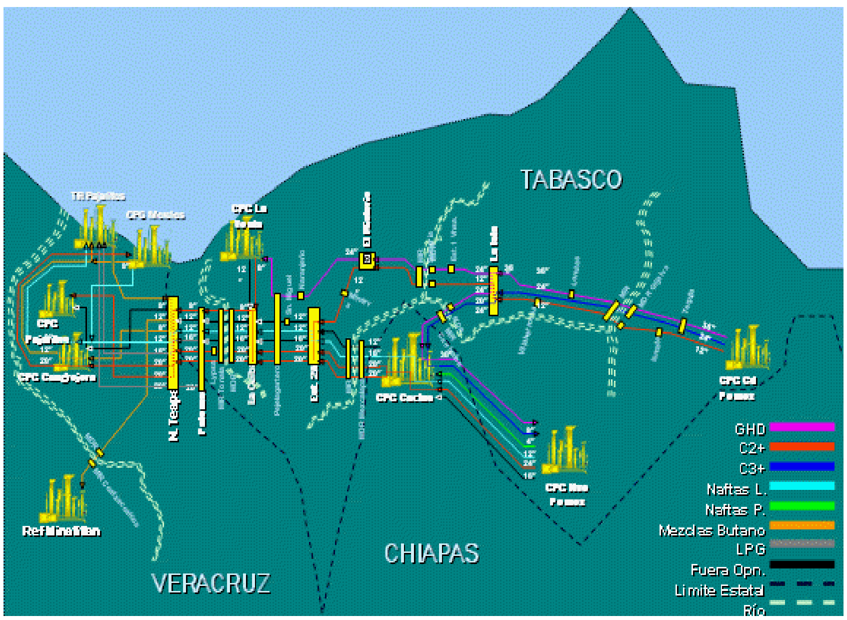


Figure 1. PGPB pipeline Network for transportation of basic petrochemicals between processing centers

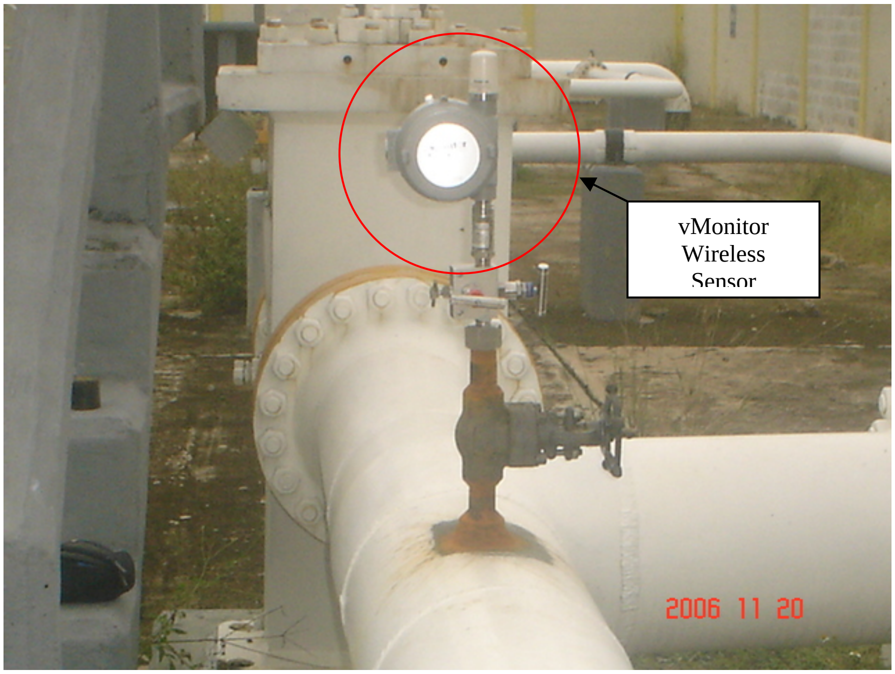
Pemex original project schedule was 4 months. However, due to contractual delays, the schedule was compressed into 8 weeks to install and integrate the whole pipeline totaling 31 stations across the entire length of the pipeline, which includes a large scope of civil and electromechanical activities. This was indeed a major challenge for vMonitor to deliver a turn-key system in such a short period.

Pemex Challenges and vMonitor Solution

In the implementation region, PGPB was faced with several challenges when installing automation hardware. All power sources such as solar panels or battery banks, even copper cables, were stolen and in many cases instruments were cannibalized and deemed non effective.

On integrating the SCADA, PGPB has a SCADA system operating on a UHF/Microwave backbone with the polling engine supporting only BSAP and Pemex Modbus Protocols. Pemex Modbus is an extension of standard Modicon Modbus with support for Historical and flow data.

To address the first challenge, vMonitor was up to the task by providing a low profile explosion proof enclosure with the full assembly painted in the same color as the pipeline, making the equipment look like part of the piping. The equipment is completely autonomous, operating from an internal battery pack that according to the specifications and the design, would last six months with the wireless sensor transmitting every 5 seconds. This self sufficient wireless design eliminated the need for any type of wiring, which usually gets stolen.



For the second challenge, vMonitor developed the stack for the Pemex Modbus protocol in one week. Tests of the protocol revealed one small issue that was resolved over night resulting in a 100% response from the remote sites when interrogated from the SCADA.

Logistics and the distance to be covered by the installation teams posed another challenge. The pipeline extended over three operating regions in three states in South East Mexico. vMonitor dealt with this challenge by providing multiple teams up to four during some phases of the project; each independently tackling one geographic region to optimize travel times and minimize transportation delays.

Communications - The Essential Link

A key element of any SCADA system is the communications network reliability. Without it means delayed or inaccurate responses to system response and reporting, which can result in inaccurate operating state of the pipeline and safety being compromised. PGPB had a well designed SCADA communications backbone consisting of Point to Multipoint Master UHF Towers installed alongside the pipeline network with each master site covering a diameter of about 80-100 Km of pipeline. Each one of these UHF towers was linked with the Main Control Room in Mexico City with a point to point Microwave network. Such network provides PGPB a secure and redundant link with an independent communications channel for each Master site, which in turn has improved the overall polling cycle and optimized the performance of the whole communications network.

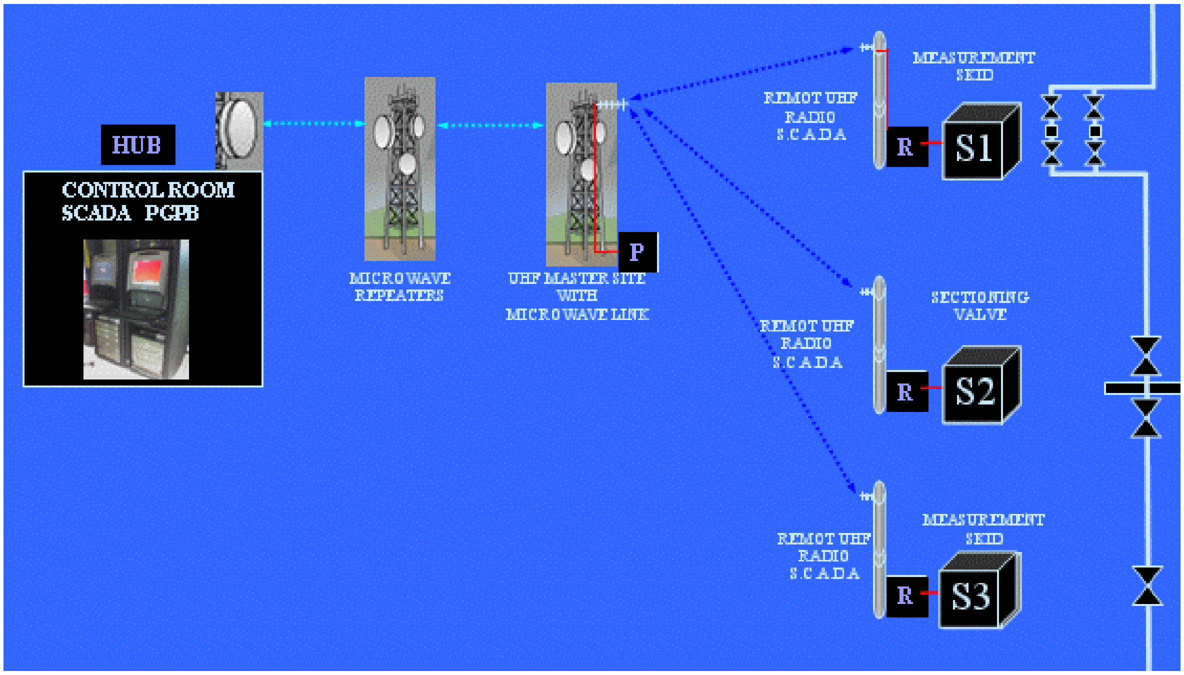


Figure 2. PGPB current UHF/Microwave communications backbone

Architecture Overview of Wireless Sensor Network and Data Flow

Typical wireless sensor architecture operates as follows:

- Multiple numbers of wireless sensors create a single mesh network reporting to one Gateway.
- A Point-to-Multipoint Gateway in the center of this mesh receives messages from all wireless sensors registered with the corresponding Gateway.
- The Gateway maps data from wireless sensor messages into their relevant registers according to their ID.
- The Gateway is serially connected to the UHF radio network.
- The SCADA Polling engine gets data from the Gateway utilizing the UHF/Microwave communications backbone network.

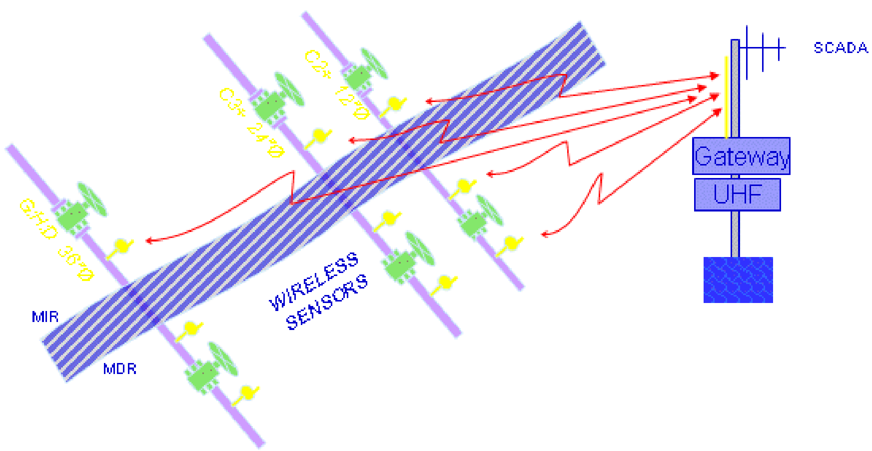


Figure 3. Wireless Sensor Network Data Flow

Data Flow

Operation of the system begins with the collection of data. Wireless sensors installed on the pipeline acquire measurement information such as pressure, and converts this data into electrical signals suited for transmission over the radio channel. The wireless sensors push data (Transmit) once every 30 seconds, which was adopted after evaluating the SCADA system polling cycle providing a one year battery pack life, to the Gateway.

vMBus-XMP Package **vMBusX-MPBattery Pack** **vMBusX-MPElectronics Side**

Figure 4. Wireless Sensor packaging

The Gateways are scanned (polled) once per minute by an associated UHF base station and then send their data at that time. When the base station receives the data, it is relayed to the Main Control Room in Mexico City via the point to point microwave network.

In addition to receiving remote data, the network can also be used to direct commands to a particular remote station. This will be most useful in the second phase of this project planned for this year whose scope will cover control of solenoid valves to control the sectioning valves for security in case of leaks or anomalies that has caused numerous HSE incidents in the past.

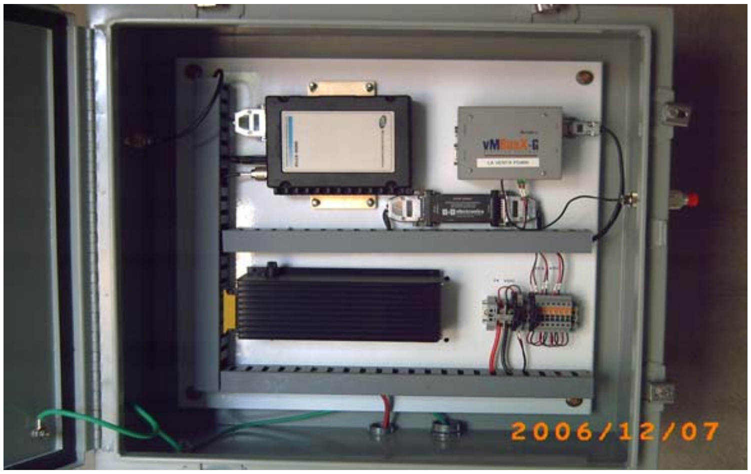


Figure 5. Typical Gateway panel installed inside the communications shelter

Managing the Network

Besides the operating state of the pipeline network, vMBus system provides several diagnostics information to facilitate operations and to guarantee data integrity. Each transmitted message from the wireless sensor includes a battery voltage reflecting the real voltage of the battery pack providing power to the wireless sensor. This register will provide PGPB operations the advantage of planning maintenance trips to sites with low battery level and being proactive in maintenance issues rather than reactive and waiting for the sensor to stop reporting before replacing the battery pack.

On the Gateway side, each ID registered with the corresponding Gateway has an auto incremental register labeled “Time since last message” which increments in seconds until a new message is received at which point it resets to zero and starts incrementing again. This register ensures PGPB the integrity of their data and guarantees information about the operation of the wireless sensor. Control Room operator can quickly look at the TSLM register below the pressure value to ensure that this is within the limits of reporting time.

Diagnostics data is important to PGPB, because it allows close monitoring and configuration of the network—including sensor status at the remote stations—without the need to personally visit sites to make minor changes. With over 600 Km of pipeline to manage, frequent site visits would be time consuming and cost prohibitive with tremendous HSE exposure.

Conclusion

This article has given an overview of how wireless is being used to improve the safety and efficiency of an extensive pipeline network. Industrial wireless solutions, such as the vMBus system described here, are now a practical reality and are being used by many organizations to replace older, less flexible systems. New developments in wireless sensors continue to unfold, and will no doubt play a key role in the telemetry networks of the future.