“Satellites to Samplers”
The Development of Remote Telemetry for an Automated Storm Water Sampler Network

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Figure 1. Typical landscape on the Pajarito Plateau. Staff maintaining a remote telemetry unit (RTU) at the southeast corner of LANL are visible on the right.

Introduction

The surface water program at Los Alamos National Laboratory (LANL or the Laboratory) evaluates storm water discharges on the Pajarito Plateau in northern New Mexico under an EPA National Pollution Discharge Elimination System (NPDES) Individual Permit (IP). The landscape is rugged, as shown in Figure 1, and many monitoring locations are difficult to access due to topography and security restrictions. IP monitoring locations, shown in Figure 2, are widely distributed throughout the 39 square miles of the Laboratory and pose a challenge for routine inspections and retrieval of storm water samples.

In 2014, the surface water program began collaborating with ISR-3 (Space Data Systems) to apply technology developed for satellites to environmental operations. A circuit board, shown in Figure 3, was adapted to communicate with automated samplers to transmit information to a central base station. Real-time information is now available from remote monitoring locations throughout the Laboratory without costly and time-intensive site visits.

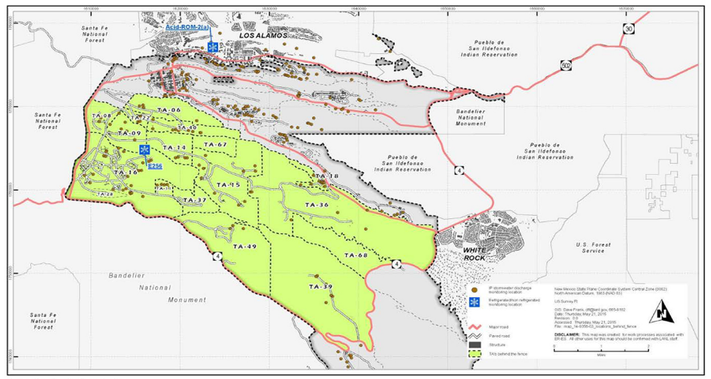

Figure 2. Map of IP monitoring locations at LANL

Many monitoring sites are located in remote sections of LANL and are not associated with current industrial activities. In addition, numerous monitoring locations are located within restricted areas (shown green in Figure 2), where access is tightly controlled and thus often inaccessible for equipment maintenance and sample retrieval. Site visits are further complicated by the topography and hydrological characteristics of the Pajarito Plateau. A functioning RTU network will alert the program staff when samples have been collected or when maintenance is required, ensuring LANL compliance under the IP.

The Telemetry System

The circuit board is equipped with a microprocessor able to bundle data and perform operations as programmed, and is equipped with a radio chip or satellite modem interface, allowing multiple ways to send information. Figure 3 shows the board itself and the RTU package (node) mounted on an ISCO automated sampler. Each automated sampler equipped with telemetry talks to its nearest neighbor, the signal hopping from location to location until it reaches the base station, or home: node number 1. Telemetry system architecture is shown in Figure 4.

Information is displayed on a graphical user interface (GUI) on a desktop computer showing the status of every location. The sampler alarms whenever it attempts to collect a sample or when there is a delay in communication. Figure 5 is a screenshot of the GUI, taken October 12, 2016.

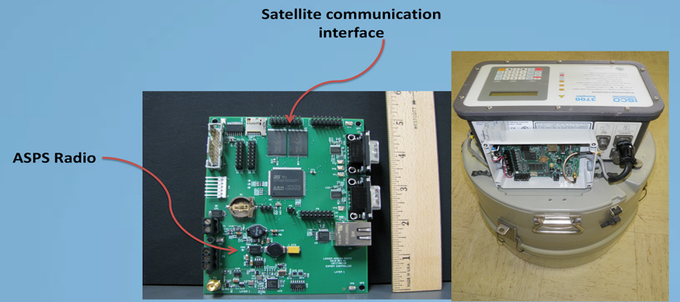

Figure 3. Satellite telemetry board modified for environmental monitoring and mounted on an ISCO automated sampler. Features include:

- Low power radio with ~1-km range, 414-MHz industrial, scientific, and medical (ISM) frequency
- Mesh networking for multi-node communication and data transfer
- Link to commercial satellite for data transmission
- Hardware addressable up to 256 nodes (monitoring locations)
- Flash Memory – configurable secure digital input/output (SDIO) Socket, 16-32 GB
- Standard interfaces
  - Ethernet
  - Serial and serial digital interface (SDI)
  - General purpose input/output (GPIO)

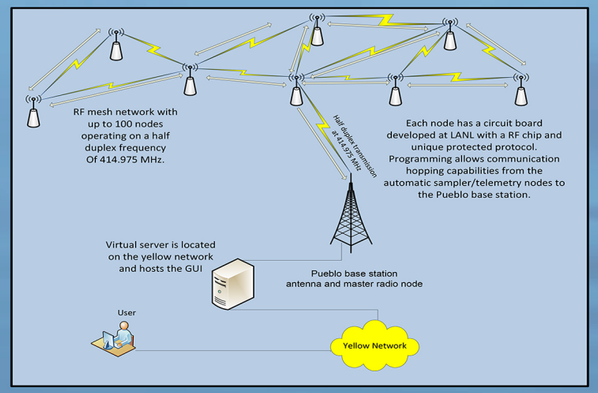

Figure 4. Architecture of the RF mesh telemetry storm water sampler network.

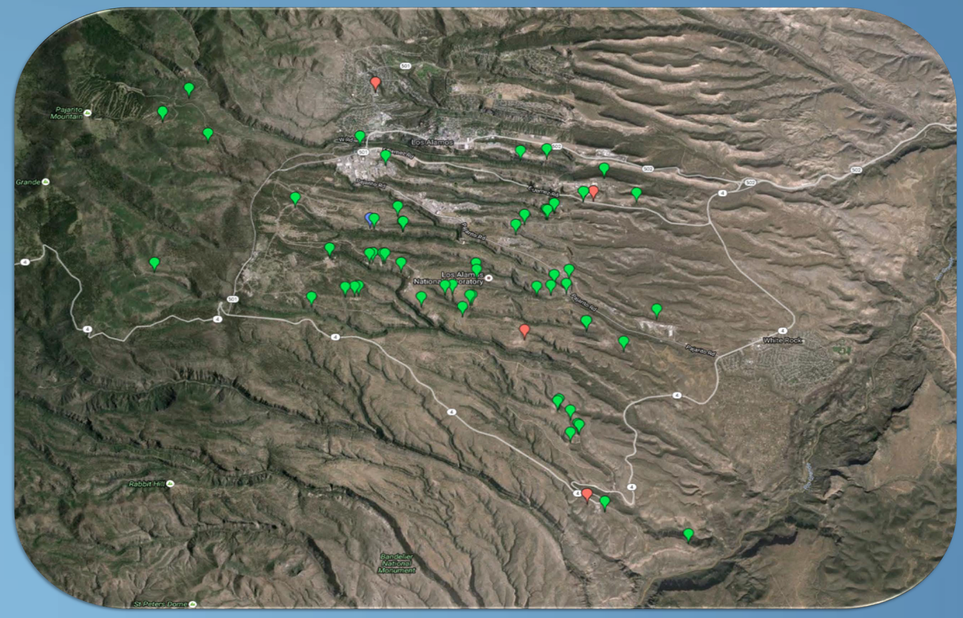

Figure 5. GUI with typical messages for different RTU locations in 2015

- Blue balloons indicate that a sample event has occurred (see center left).
- Red balloons indicate a communication lapse.
- Green balloons indicate a station is fully operational.