Proof of concept;

Cost reduction capability of FlexSCADA Q5 series as a SatCom gateway device

Background to the issues.

There are many providers supporting satellite network communications to needed sites in remote areas. Historically these orbiting networks were considered very expensive to implement and maintain yet they allowed end-users to connect to the outside world (and back) at sites that are often too remote to be connected through more common methods such as cell towers, point to point radio, microwave or wireless broadband networks. This study allows us to look at ways to optimize the use of satellite network communications in a way that for some applications can significantly reduce communications costs (depending on the provider and contracted billing methods used), as well as reduce ground-based infrastructure costs.

It should also be noted that some sites with ‘remote area’ characteristics can potentially be located near or even in modern populated areas of the country – nevertheless they fall into traditional terrestrial based network infrastructure ‘dead zones’ (be it cell or broadband services), and many dead zone sites are also often off-grid (no utility power available). No matter if the site is an off-grid public park in the middle of a large city, a gas pipeline going through the countryside or a remote mountainside reservoir/dam monitoring station, the common ideal theme is that many of these locations can see up to the sky, as sky facing is a requirement of all communication with satellites.

When one looked at the historical ‘awareness infrastructure’ needed at remote sites using satellite communications-based strategies, a long chain of ground-based equipment was crucial to support the original mission. The mission; typically, data gathering, situational operations monitoring and alarm notification for an off-site manager or team. The chain, often sensors, connected to data loggers, connected to power management equipment, and power supplies (to power everything in the chain) to then communications modems (or radios) that could transmit and receive via antennas that often also need power to communicate with the satellite. And again, within a historical perspective, the communications would often be a constant 24/7 active profile (meaning constantly communicating back and forth with a satellite via a ground-based satellite communications modem required at the site). One can see how the dollars could quickly add up...

Today, thanks to gateway systems such as the FlexSCADA Q5 and Q5Pro, the historical awareness chain can be condensed bringing higher efficiencies to both the operations as well as in reducing costs. A FlexSCADA can be very a near complete gateway device; power supply, remote diagnostic system and a form of true monitoring and control known as SCADA - *Supervisory control and data acquisition*. In this strategy the FlexSCADA remote telemetry unit (RTU) also replaces data loggers, and communication routing gear and could also act as a smart timing device for power preservation (even fuel conservation in some cases). The mission’s awareness infrastructure now can be as simple as; sensors, a FlexSCADA Q5 (the gateway device), Batteries and a Satellite Communications modem and antenna. A true ground base reduction in equipment, and through power management, far less power being used – again all factures resulting in cost savings while gaining system longevity and sustainability.

As would be expected at any remote site, especially those that are running only on batteries, power quality and availability is crucial. By reducing the mission's awareness infrastructure to bare minimum, it increases operational viability and sustainability and also reduces (again) cost. With this in mind we must note that by design the FlexSCADA Q5 is an ultra-low power consumption (<0.6W) device that can be installed into any professional system to allow a user to monitor and control a site remotely. All FlexSCADA Q5 series RTUs are also desert and arctic rated – again truly designed for use at remote sites.

The FlexSCADA device inputs allow numerous awareness connection points and even shared data acquisition from other smart devices such as advanced battery systems, PV Charge controllers, ultrasonic anemometer-based weather systems, traditional voltage-based sensors, Modbus sensors, and other devices with a modern signal output - all to be viewed in one single platform. The control of radios, modems, power systems, Genset or Fuel Cell starter contacts (often dry contact based), and other devices (with a normally-open or normally-closed circuit control) can be toggled via the FlexSCADA onboard relays and change the state at will. These functions can be done manually, or through the onboard JavaScript based logic. This is important as in principle the easy to configure FlexSCADA logic code could be written in such a way that one would no longer need transmit and receive to the satellite via the ground base modem on a 24/7 basis. Instead, a remote site could still be fully aware 24/7 of alarm conditions and gather data 24/7, but without having to constantly transmit awareness status reports. This strategy would allow savings on 1. Power draw from the SatCom Ground Station Modem (often a large power draw component), and 2. The amount of communications data that is transmitted as well as the duration of those transmissions (as within many SatCom contracts, less communications duration and less data typically results in lower SatCom use costs). It should be noted that in very hot climates the decreased need for power can result in less batteries being used – which means less cost when replacing battery banks. Battery bank replacement in very hot climates is frequent and expensive – so part of the case study will be to see how small a battery bank needs to be to stay operationally sustainable.

Case Study

Objective: 1. to monitor and maintain a remote access site through FlexSCADA and X2nSAT-Satellite communication. This will be proof of concept for system compatibility.

Objective: 2. If the FlexSCADA proves to be a compatible gateway device for SATCOM based ground stations, we will then explore cost savings from a. component reduction, b. power consumption reductions and c. reductions in battery bank size – by starting with the bare minimum battery bank and only increasing it if the system fails due to energy storage issues.

Remote site details (all components listed above are mounted to a mobile trailer (2000 lbs. GVWR)):

- Two (2) DC115-12 Deep Cycle AGM batteries connected in series for 24VDC available power
- Four (4) SunWare 4265 solar modules capable of 48 Watts per panel
- Two (2) Eco Energy solar charge controllers S5-24V
- One (1) FlexSCADA Q5Pro
- One (1) FlexSCADA BME-680 Environmental Sensor
- One (1) MCE-TEMP3M Temperature Sensor
- One (1) VWind-420 Wind Speed Sensor

- One (1) 1.2M parabolic antenna dish
- One (1) UHP-1000 TDMA/SCPC Satellite Router
- Access to a Geosynchronous Satellite and related services – provided by X2nSAT

Narrative: The mobile Satellite Communications Trailer (SCT) was built and deployed throughout a test region. After initial configuration of the satellite link through the modem, the trailer was able to change locations, re-establish a communication link, provide on-site analysis for given periods of time, and proceed to change locations again. The process can be broken into four distinct phases.

Phase 1 –Set-up and build

The four (4) SunWare solar panels produced power to the two (2) DC115-12 deep cycle AGM batteries, which were connected in series. The batteries and charge controllers were installed into a weather tight enclosure mounted towards the rear of the trailer, while the supporting electronics (Q5, satellite modem) were built into a pelican style case and mounted in front of the battery compartment. Satellite dish connections extended inside of the electronics box and connect to the satellite modem through watertight glands. The satellite modem's power was connected to relay channel 1 of the FlexSCADA Q5 device. Data connection to the satellite modem is through a standard Ethernet line into a laptop computer.

Phase 2 – Initial Configuration

Initial alignment was challenging the first time. Certain tools are helpful (such as an angle finder), as well as mobile apps. A geosynchronous satellite was assigned (by X2N) based on the location of the remote test site. After verifying proper satellite coordinates to be aiming the dish at, the dish was maneuvered for proper orientation in relation to the satellite. The azimuth and rise positions were the first to be oriented, and need to be as close as possible to the proper numbers. Adjustment of the feedhorn (position) was the most critical. If the feedhorn was in the wrong position, the dish and modem never achieve a proper lock-on. After initial pointing direction through the modem, a discussion with X2N was required for the final fine-tuning to achieve optimum signal reception. Once the satellite dish is receiving optimal signals, the entire assembly is ready to be placed into operation mode on site.

Phase 3 – Operation Mode

The laptop connection to the satellite modem was removed after configuration, and replaced by connecting the FlexSCADA Q5 to the satellite modem. The Q5 was configured prior to deploying with a relay-timer power function. Relay #1 would power up for a given length of time (30 minutes) and then power off for a different length of time (4 hours). This allowed the device to boot, establish communication lock on with the satellite, and transmit data over to the FlexSCADA cloud service. It also opened a direct link to the public IP address of the webhost (protected via secure passwords). This direct link to the webhost was only available when the satellite modem was active, Webhost load time was much slower than a typical ethernet connection (over 600 ms ping response time). Data was visible on the user configured dashboard after the modem was actively transmitting over the FlexSCADA cloud network. This limited the power drain caused by the modem (approximately 1.1A when on). With limited solar charging available (testing done during December, a month with low solar potential), it was important to maintain a healthy state of charge on the batteries. However, the Q5 continued to monitor and record all data at the site, and could transmit the data once connected to the network.

Phase 4 – Transit Mode

The entire trailer is portable enough to be hitched to a vehicle and moved to a new location within a relatively short period of time. The satellite dish needed to be properly secured for travel, which impacted the alignment at each site. At the new site, the alignment process was very similar to the initial alignment. It was not necessary to call X2N after each movement unless signal quality was too low to achieve proper lock-on. The lock-on and quality of signal will both be visible on the satellite modem. Proper alignment still requires connection from the satellite modem to a laptop.

Once the mobile SCT ground station was on-site and active, the data transmission continued along the predetermined timer function. The need for a direct link to the webhost was rare as the key readings and instrumentation was visible through the FlexSCADA cloud. The programming of alarm trigger points for low-voltage was set, as well as an extended loss of transmission alarm. This allowed the mobile SCT to send back vital information and limit the battery consumption. The SCT was able to maintain an average battery state of charge of 25.71VDC while only consuming an average of 0.25A throughout the month of December. Even with the low ability to utilize solar charging, the mobile ground station's batteries were able to maintain throughout.

The most difficult part of the process came during phase 2 – initial setup. Pointing the dish requires a 'soft-hand,' and can be frustrating when unable to achieve a lock-on. The test location meant that the elevation (up/down) of the dish put it at 16°, which was almost horizontal. However, even slight variations in this could hinder the success rate of the lock-on. Initial setup was done in a controlled environment. In subsequent remote sites tests (after moving the SCT to other locations) we were able to enable communications with the satellite without calling X2nSAT technical support for fine tuning, however it is hard to say what the success rate would be in a truly typical 'remote' and off-grid installation – especially with a large (1.2m) parabolic dish.

Final Conclusions

The FlexSCADA proved to be an excellent gateway device. We were able to monitor and maintain a remote access site through FlexSCADA and X2N-Satellite communication back to our headquarters from any of the three test sites.

The 6-month study also allowed us to prove the concepts and cost savings from a. component reduction, b. power consumption reductions and c. reductions in battery bank size (no larger battery bank system was ever needed to maintain operational sustainability).

As for operational challenges, the biggest drawback came in the form of 'final dish configuration' (fine tune pointing). It can be difficult in a controlled environment, hence in highly remote areas, the installation may have a higher level of difficulty. One weakness discovered in our study was the limitation of needing to call X2nSat for the final fine tuning (as a SOP) where there is no phone coverage. This may necessitate the use of a satellite phone, which can be costly and time-consuming, however we believe other Sat antenna pointing technology may replace this "technical service" step in the future. We are working with the experts at X2nSat now to overcome such limitations in the future.