A Mirrored Telematics-SCADA System using Global System for Mobile Communications and Short Message Service

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All around the world, telematics technologies have been opening a new branch of research in several fields that may include agriculture. Particularly, new approaches to measure physical variables such as temperature, humidity, and others, have been commonly added as part of automatic systems to acquire, transmit and store data. However, most experimental agricultural fields are located in rural areas, where the communication services such as General Packet Radio Service (GPRS), High-Speed Packet Access (HSPA), or Long Term Evolution (LTE) are not available. A new Telematics-SCADA System is proposed in this work in order to avoid the communication problem that appears in regions where only the infrastructure and protocols of the Global System for Mobile communications (GSM) are offered by cell phone companies. The current trend in agricultural measurements is toward the use of any kind of sensor, without taking into account the electronics, resolution, accuracy or communication protocols. Thus, the implementation of a general telematics-SCADA system is the ideal solution to monitor and control remotely in real time, the state of any experiment even one running in rural areas, without internet connection. In general terms, the proposed system consists of the following: First, a physical computing board with embedded software and hardware is used to interact with and respond to the analog world, by using specialized sensors. Second, a GSM board is used to connect with the cell phone base station. Third, a display to graphically visualize and monitor the physical variables in real time is used. Fourth, a remotely mirrored SCADA system is built and fed with the measured data and transmitted through the GSM-SMS protocol. Experimental results show that it is possible to measure and monitor physical variables remotely by using the GSM-SMS protocol and the cell phone infrastructure in rural areas without a typical internet connection.

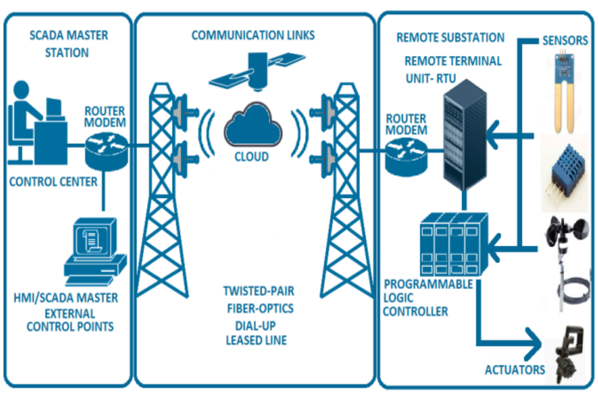

Figure 1. Typical SCADA system.

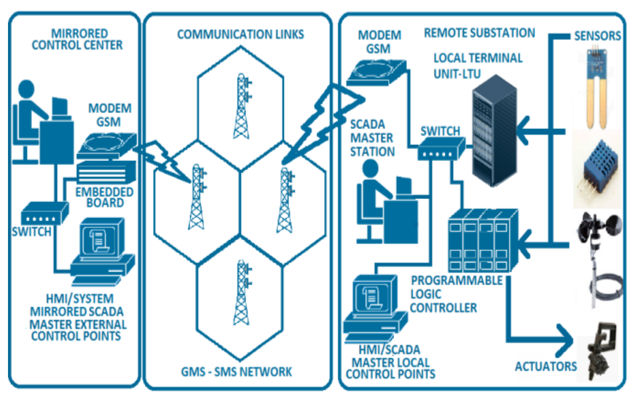

Figure 2. Proposed mirrored SCADA system.

Figure 1 illustrates a typical SCADA system that consists of three main blocks: The remote substation, the communication links, and the SCADA master station. The substation can

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identify sensors, actuators, programmable logic controllers (PLCs), embedded boards, or data acquisition devices. The architecture is based on the strategy that sensors and actuators are directly connected to the PLC, or to the remote terminal unit (RTU), that can be a desktop computer with hardware to acquire data. The RTU is connected to a router or modem device as an interface to the internet. Thus, the communication between the SCADA master station and the remote substation can be achieved by using any communication technology such as fiber-optics, wireless point to point, or satellite communication (any internet connection). Finally in this architecture, the operation of the SCADA system is only available remotely, demanding a good quality of service (QoS) of the internet connection. Even if this architecture holds good features such as human machine interaction, and multiple external control points; other aspects such as local master station, and master local control points are still missing in the design of the SCADA system. Considering the above, Figure 2 illustrates the mirrored telematics-SCADA system that is proposed here. The advantage of this architecture is that the master and master control points are copied identically both locally and remotely from the substation. Moreover, this system can operate in regions without internet, by using the GSM-SMS technology.

The operation of the Mirrored Telematics-SCADA system is based on cell phone infrastructure already installed by communication companies that usually guarantees a huge coverage area. Additionally, rural areas have the capability to support SMS service because it uses the signaling channels that do not demand complex infrastructure to interchange user data such as GPRS or EDGE. Figure 3 illustrates the proposed telematics-SCADA framework. The system is capable of managing up to 4096 substations with 10 sensors or actuators with 8 bits of resolution. The framework was designed considering the following aspects: ID Substation (12 digits), ID Sensor/Actuator (4 digits), DATA (8 digits), and 8 digits of Hamming code (linear error-correcting code) to detect up to two-bit errors. Thus, the length of the framework is 140 digits that correspond to the typical SMS number of ASCII symbols accepted by a single message. In addition, the system is bidirectional between mirrored control centers, and remote substations. Finally, all data are updated each minute, but could be faster depending upon the availability of the cell phone infrastructure.

Figure 3. Proposed telematics-SCADA framework.

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