

DATA COMMUNICATION FOR SCADA WIND ENERGY SYSTEM

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Abstract: A SCADA system is a common process automation system which is used to gather data from sensors and instruments located at remote sites and to transmit and display this data at a central site for either control or monitoring purposes. The collected data is usually viewed on one or more SCADA Host computers located at the central or master site. A real world SCADA system can monitor and control hundreds to hundreds of thousands of I/O points. A typical wind energy system SCADA application would be to monitor the energy production of every generator, the quality of electrical energy, and other parameters required by the energy production process.

The paper present two solutions for wireless data communications at SCADA wind energy system based on radio modem and cellular network.

Keywords: SCADA, Internet, radio modem, cellular network, analog, digital, communication, wireless

1. INTRODUCTION

SCADA systems allow complex monitoring of the distributed processes. Today the SCADA solutions include the wireless communication between system components. The paper describes the wireless SCADA solutions for wind energy systems.

There is typically another layer of equipment between the remote sensors and instruments and the central computer. This intermediate equipment exists on the remote side and connects to the sensors and field instruments. Sensors typically have digital or analog I/O and these signals are not in a form that can be easily communicated over long distances. The intermediate equipment is used to digitize then packetize the sensor signals so that they can be digitally transmitted via an industrial communications protocol over long distances to the central site. Typical equipment that handles this function are PLC's (**P**rogrammable **L**ogic **C**ontrollers) and RTU's (**R**emote **T**erminal **U**nits). These devices employ de facto standard industrial data communication protocols such as Modbus, AB-DF1, and DNP3.0 to transmit the sensor data. Typical physical interface standards are Bel 202 modem, RS-485 & RS-232.

The SCADA Host is usually an industrial PC running sophisticated SCADA MMI (**M**an **M**achine **I**nterface) or HMI (**H**uman **M**achine **I**nterface) software. This software is used to poll the remote sites and store the collected data in its centralized SQL or Oracle databases. Logic can be configured in the SCADA Host software that then monitors and controls plant or equipment. The control may be automatic, or initiated by operator commands.

Data acquisition is accomplished firstly by the RTU's or PLC's scanning the field inputs connected to the RTU / PLC. This data is usually collected at a polling rate configured by the operator. The number of sites determines

the polling rate, the amount of data at each site, the maximum bandwidth of the communication channel and the minimum required display and control time. Once the data has been acquired at sent to the SCADA Host, the MMI software will scan the acquired data (usually at a slower rate.) The data is then processed to detect preset alarm conditions, and if an alarm is present, an alarm message will flash on the operator screen and added to an alarm list.

The operator must then acknowledge this alarm. There are 3 common types of data collected:

- Analog - used for trending
- Digital (on/off) - used for alarming
- Pulse (i.e. revolutions of some kind of meter) - accumulated /counted.

The primary operator interface is a set of graphical screens that show a representation of the equipment being monitored. Real-time data is displayed numerically or graphically as changing bars, circles, lines or other shapes over a static background. As the acquired data changes in real-time, the bar, circle, line or other representative shape is updated. For instance, an analog level increase may be displayed as a lengthening of the representative vertical bar or a valve graphic may look open to represent that it is open.

A typical MMI will have a nested tree structure of many such screens, usually with the many overview screens on the first page with the most relevant data displayed. There are then links that go to other pages. Users can easily configure the type of I/O point, communication protocol driver, and polling rate, alarm thresholds and notifications, trend process data as well as configure the User and Operator screens.

Next generation SCADA MMI software such as NETSCADA include all these functions in one convenient easy to use and cost effective package and also have seamless internet integration enabling many clients to securely view the collected data anywhere on the internet. A flexible SCADA Host can easily expand to handle additional future remote sites and I/O points.

SCADA communications can employ a diverse range of both wired (lease line, dialup line, fiber, ADSL, cable) and wireless media (licensed radio, spread spectrum, cellular, WLAN or satellite). The choice depends on a number of factors that characterize the clients existing communication infrastructure. Factors such as existing communications infrastructure, available communications at the remote sites, data rates and polling frequency, remoteness of site, installation budget and ability to accommodate future needs all impact the final decision.

In complex SCADA architectures, there can be a variety of both wired and wireless media and protocols involved to get data back to the central monitoring site.

SCADA systems differ from DCS's (Distributed Control Systems) which are generally found in plantsites. While DCS's cover the plantsite, SCADA systems cover much larger geographic areas. Often SCADA Systems are required to interface to a plantsite DCS if there are remote sensors, instruments or motors and pumps that must be controlled/monitored by the plantsite DCS.

Certain types of applications like those in Oil & Gas, Electrical & Water Utilities, Water & Wastewater and Environmental Monitoring inherently require SCADA communications because of the remoteness of the assets (i.e. Oil wells, water wells, and generator stations).

Furthermore, due to the remoteness many of these often require the use of wireless communications. In these cases, the traditional solution is to add a radiomodem stage to the standard SCADA architecture.

Next generation wireless SCADA equipment such as BenteK Systems 900-MB or SMX-900 or UNICON IP offers another level of integration by placing the wireless communications and RTU functionality together in the same package.

In addition to this higher level of integration, next-generation SCADA equipment such as the UNICON IP also support TCP/IP, UDP or other IP based communications protocols as well as strictly industrial protocols such as Modbus TCP, Modbus over TCP or Modbus over UDP all working over private radio, cellular or satellite networks. The UNICON IP can act as an Ethernet Serial gateway to enable older legacy serial equipment to connect to TCP/IP networks. Coupled with Host software such as NETSCADA, this enable implementation of powerful IP based SCADA networks over mixed cellular, satellite systems and landline systems.

Due the wind energy system characteristics: geographic distribution of the wind generators, the connection of RTU's stations difficulty due of the environment matter, necessity of the connection at central station, the wireless SCADA system is the desired system.

This paper describes two possibilities for wireless SCADA system data transmit: using the radio modem or the cellular network.

2. RADIO MODEM USED IN SCADA SYSTEM

The proposed structure with radio modem of the wind energy generators SCADA system is shown in figure 1.

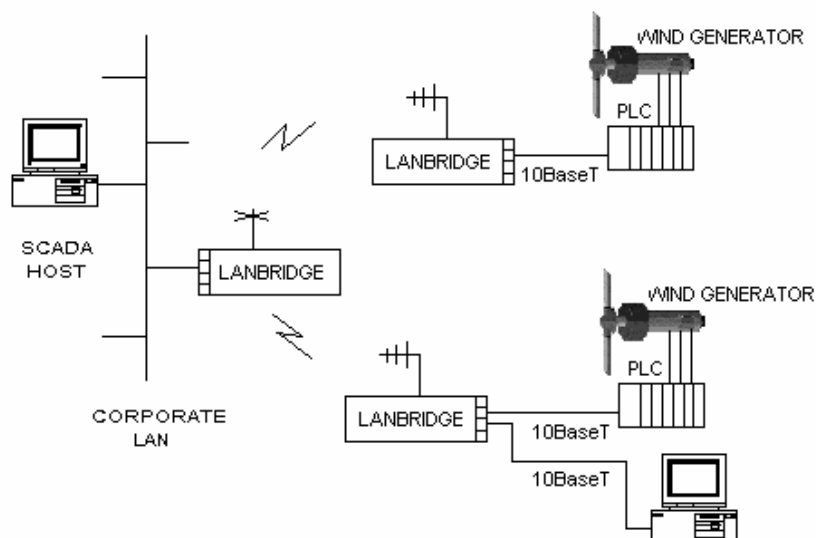


Figure 1. The proposed structure with radio modem of the wind energy generators SCADA system.

The main characteristics of the BENTEK SCADALink 900-MB radio modem is shown below:

- License-Free 902-928 Mhz Frequency Hopping Spread Spectrum
- -105 dB Receiver Sensitivity
- 20 Mile Range using Low Cost YAGI Antenna
- 1 Watt TX power
- Ethernet 802.3 Compliant
- 4 Port Hub: UTP, RJ45
- 115 KBits/sec.

- Point-to-Multipoint Operation
- Store-and-Forward & Roaming
- Serial / Ethernet Gateway Option
 - connect Serial Devices transparently to TCP network
 - connect Modbus Serial Devices(RS232/RS485) to Modbus TCP ethernet network
 - Access Remote Serial Port via TCP, UDP
- Temperature Range: -40C to 85 C
- Wide Voltage Range: 9 - 26 VDC

SCADALink 900-MB products are designed for industrial applications. Every effort has been made to ensure that data over the link is secure and fail-safe. In addition to CRC-16 error checking, a number of self-checking features have been implemented.

A special output on all SCADALink 900-MB transceivers (LINK) indicates the status of the radio link and provides a fail-safe means of shutting down remote equipment in the event of a failure in the link.

These devices are virtually immune to interference since they provide the interference and range benefits of a narrow band receiver while utilizing the entire 902 - 928 MHz band. The radio frequency hop pattern is pseudo random in nature and each frequency is used for 65 msec before hopping to the next one. This hop sequence repeats approximately every 4-sec.

3. CELLULAR NETWORK USED IN SCADA SYSTEM

The cellular technology has an extensive development in the past years. The cellular Internet network technology known a large development in speed and extent.

The SCADA system using the cellular telephony is shown in figure 2. The UNICON IP technology is used.

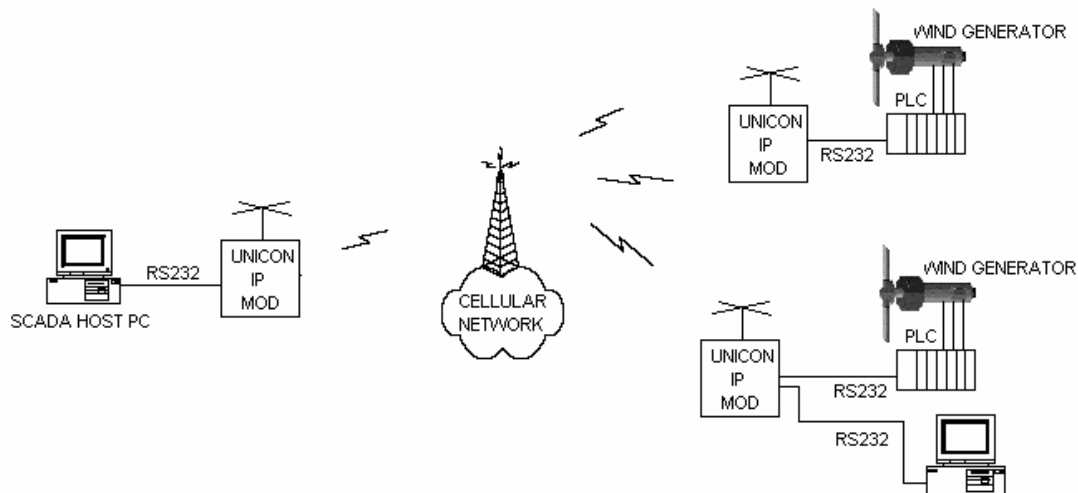


Figure 2. The proposed structure with cellular technology of the wind energy generators SCADA system.

The main characteristics of the UNICON IP technology is shown below:

- Operation on IDEN RF Cellular Network (NEXTEL, SouthernLinc, Telus)

- Transparent Serial Communication
- 3 Serial Ports (1 RS232/RS485, 2 RS232)
- TCP, UDP Addressable IP Ports
- Modbus TCP Gateway
- Modbus Multiplexer
- Wide Temperature Range (-45 to 60 Deg. C)
- Wide Input Voltage (9-30VDC)
- Panel Mount
- Terminal/Telnet Configuration
- Local Diagnostic - RSSI Display

The solutions for SCADA over cellular networks is used to poll individual wind generator or as a bridge to a customer are existing network of private radios.

Alternatively, a cellular modem can be used as a repeater enabling the Host to monitor an existing private radio network.

4. CONCLUSIONS

The paper present two solutions for wireless SCADA system used at wind energy system.

The first solution, radio modem data communication is a Wireless Ethernet Bridge and provides cost effective long distance Ethernet connectivity for industrial applications. This application connects Ethernet enabled PLC's and RTU's to host computers via wireless Ethernet.

Remote monitoring is used where it advantageous for equipment and facilities to continuously monitored for measurement, control and alarm purposes. The term "Remote" is relative.

The SCADALink UNICON IP Gateway is a Multiport Industrial Terminal Server designed for SCADA and Automation Applications requiring Serial Connectivity over LAN/WAN and Internet Networks.

The IP Gateway enables Serially connected PLC's, RTU's, SCADA hosts, Flowcomputers, Data loggers and Radiomodem systems to be accessed from a LAN/WAN network. Unique features such as multiple host connections and simultaneous TCP, UDP and Modbus TCP ports give it flexibility and scalability in automation and SCADA applications.

UNICON IP technology can be used effectively by companies or institutions with multiple offices and cellular coverage to their remote assets. The Internet provides the means to network the multiple offices together while wireless cellular technology provides the means to access the multiple remote assets. By exploiting the Cellular Providers infrastructure, the combination of Internet and Cellular gives such a company an effective, reliable, wide area SCADA system without having to incur the traditional high capital cost associated with erecting radio towers.

UNICON IP technology can be used for SCADA communications over IDEN to reach all remote sites and to one hub site which can provide a first mile link (hub) to existing legacy SCADA Point-to-Multipoint radio systems. This enables an IP-enabled host residing on the Internet or a private Intranet to communicate with legacy wireless SCADA systems.

After determining that coverage is available in the area, the cellular provider provisions the UNICON IP with a static IP address. This IP address can be private or public depending on the particular Cellular Provider.

After that, the user simply needs to configure the unit to meet the specific requirements of each remote site... programming the RTU, Modem or Alarming features as required. After initial software configuration, all additional configurations can be done remotely via Telnet.

The both presented applications can use the Internet network for data presentation and monitoring.

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