

WIRELESS CONTROL OF AN INDUSTRIAL SERIAL NETWORK WITH ARDETEM PECA 300 SIGNAL ANALYSERS

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Abstract: Industrial serial networks communicate with master systems through serial ports. If we want to have a remote control for this type of applications, we can use RS232-RS485 converters. This solution limits the distance of the link to 1.2 km. Further so, these communications don't have high speed because it is difficult to control the E/R amplifiers of the converter. We can accomplish remote control and monitor without these limitations using the possibility to transmit information over Ethernet networks (LAN, WLAN and WAN).

In the paper we use virtual ports and a bi-directional Serial-Ethernet Redirector implemented in the computer and in the wireless Access Point like a client-server application, for control and monitor of a SCADA application with ARDETEM PECA 300 signal analyser.

The software is transparent for the SCADA application and converts the communication protocol in UDP Datagram and vice-versa.

Keywords: Process Control, SCADA Applications, Wireless Control

1. INTRODUCTION

The term SCADA (Supervisory Control And Data Acquisition) typically refers to systems where a central master or PLC master communicates to multiple RTUs (Remote Terminal Units). The SCADA host will perform centralized alarm management, data trending and operator display and control. With SCADA architecture, the host communicates to the RTU via protocol data communications.

In this paper the SCADA application is made for monitor and control an industrial network with ARDETEM PECA 300 signal analysers. For remote control a Serial-Ethernet Redirector is used implemented in the computer and in the Wireless Access Point like a Client-Server application.

The server application runs on the Access Point. The serial network is connected to Access Point's serial port. On the computer we have a client program, which can use a virtual port, a shared port or a real port to connect to the target system. In the case when we use a virtual port, these ports have to be connected by software to communicate one with another. The SCADA system is connected to one virtual port, and the client program of the Serial-Ethernet Redirector is connected to the other virtual port. If we use a shared port then the two applications can open the same serial port, and if we use a real serial port for each of the two applications then they have to be interconnected with a null-modem cable.

2. THE SCADA APPLICATION

The ARDETEM PECA 300 signal analyser is designed to measure, monitor and control all parameters in an electrical network (RMS value, power factor, frequency, energy, harmonics). The analyser can display 15 parameters to choose among a list of 90. The analyser display 3 measures simultaneously on 5 pages. This equipment can be used on all types of electrical networks: single phase, 3-phase balanced, with or without

neutral, 3-phase unbalanced, with neutral with or without current measuring transformers, and voltage measuring transformers.

The device is fully programmable by means of the front panels keys, and allow saving steadily a measured parameters list, and their date and hour. In the paper the analysers is used in 3-phase unbalanced without neutral electrical network. The PECA is fitted a 2 wires RS485/RS422 converter. For communications the analyser uses a subset of MODBUS protocol.

The SCADA program is made in *LabWindows/CVI* from *National Instruments*. The protocol and syntax for the device's commands uses ASCII characters.

The request of the Master and response of the Slave is presented in fig. 1[1]. MODBUS functions used:

- Function 1: reading of N bits (only made of 8 bits packs);
- Function 3: reading of N words;
- Function 6: writing of 1 word;
- Function 7: quick reading of the PECA's running diagnostic mode;
- Function 15: writing of N bits (only made of 8 bits packs);
- Function 16: writing of N words;

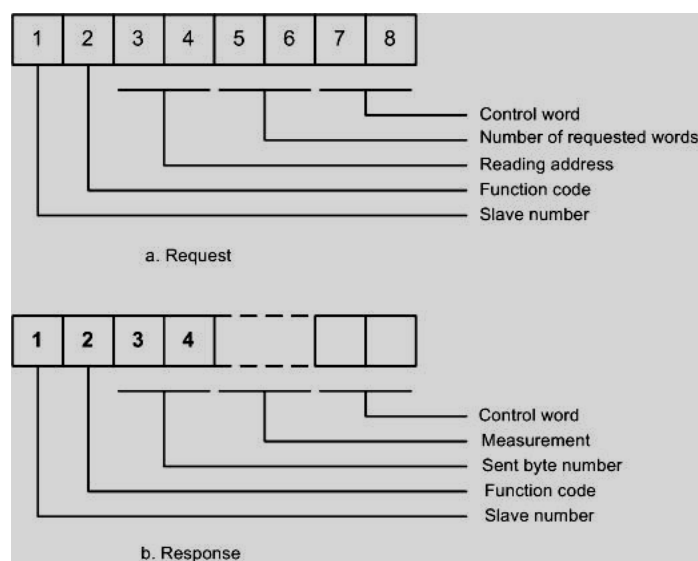


Fig. 1. The MODBUS protocol

The main window of SCADA application is shown in fig. 2. In this window a canvas control is used to draw a bmp image of front panel of ARDETEM PECA 300 analyser. Three numerical controls are used for display 3 measures, one button for choosing which parameters are displayed and LEDs for looking displayed parameters.

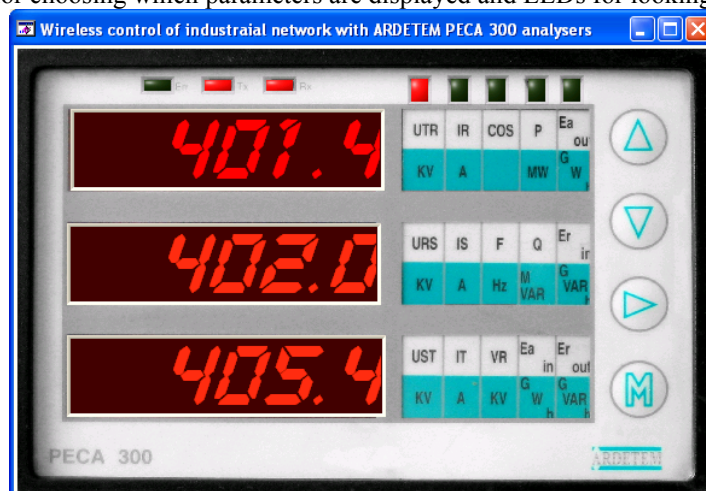


Fig.2. User interface of SCADA application

The timer control is used to initiate a MODBUS RTU transaction. The timer control generates an event at a 2 s time interval. This event is sent to the *callback* function. In the callback function the master sends the request with function code 3 and receives the Slave response. The response is parsed and then displayed in user interface controls.

3. SERIAL-ETHERNET REDIRECTOR [2]

The general structure of the serial-Ethernet redirector has as a model the client-server one. The server application runs on the Access Point. The serial device or the serial network is connected to Access Point's serial port. On a computer with the developing system we have the client program, which can use a virtual port, a shared port or a real port to connect to the target system.

In the case when use virtual ports these ports have to be connected by software to be able to communicate one with another. The development system of the PLC, or the SCADA system is connected at a virtual port, and the client program of the *serial-Ethernet redirector* is connected at the other virtual port.

If we use a shared port then the two applications can open the same serial port and if we use a real serial port for each of the two applications then they have to be interconnected with a null-modem cable.

The application architecture is shown in fig. 3.

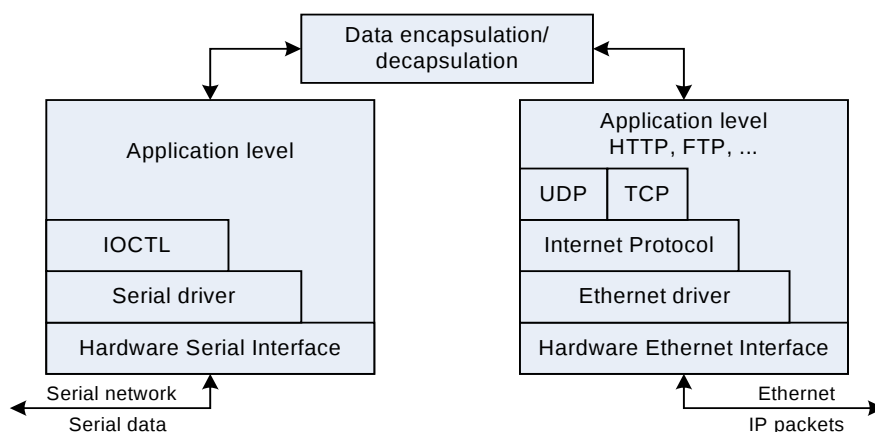


Fig. 3. The application architecture

For communicating in Ethernet network we use API socket and the program code is portable on any operating systems that respects POSIX standard and implements the TCP/IP protocol stack.

There are two protocols used in socket programming: TCP (Transmission Control Protocol) and UDP (User Datagram Protocol), that are actually a relay of the protocol IP (Internet Protocol) to be able to communicate in the TCP/IP network.

The UDP protocol is best to be used in the case of small packages send. This protocol doesn't require establishing the connection before the transfer of the UDP datagrams and the receiver doesn't have to confirm each received package. Because the UDP datagrams don't have a complicated header with the sequence number of the package this protocol is faster and the information transfer is more efficient.

The UDP protocol using broadcast datagrams, which can address device groups from a network based on the one-to-many, many-to-one or many-to-many model. The UDP is not oriented on the connection, it doesn't require establishing the connection before the data transfer.

The UDP protocol is configured using *IP address* and *Port Number* for the communication and for the serial *port speed, parity, number of data bits* and *flow control* must be set.

The main characteristics of the *serial-Ethernet redirector*, which has the functions of an Access Point [3], where the clients can connect through wireless network:

- HTTP web server;
- Web based configuration system;
- FTP, DHCP, Telnet servers;
- 802.1x RADIUS Authenticator;

- WEP encryption 64/128 bits;
- WDS – Wireless Distribution System;
- ACL – Access Control List.

4. POSSIBLE APPLICATIONS

In the first application the host system with the SCADA application is connected to the serial network that is going to be controlled and monitored. The suggested *serial-Ethernet redirector* of the serial data flows on the Ethernet, shown in fig. 4 uses two virtual ports interconnected or a shared port for the SCADA application and redirector. In this case, the SCADA application stays unmodified, like in the case in which they were directly connected to the serial network. The data flow sent on the serial network reaches wireless network, then is received by the AP and redirected towards the ARDETEM PECA 300 analysers using RS232-RS485 converter.

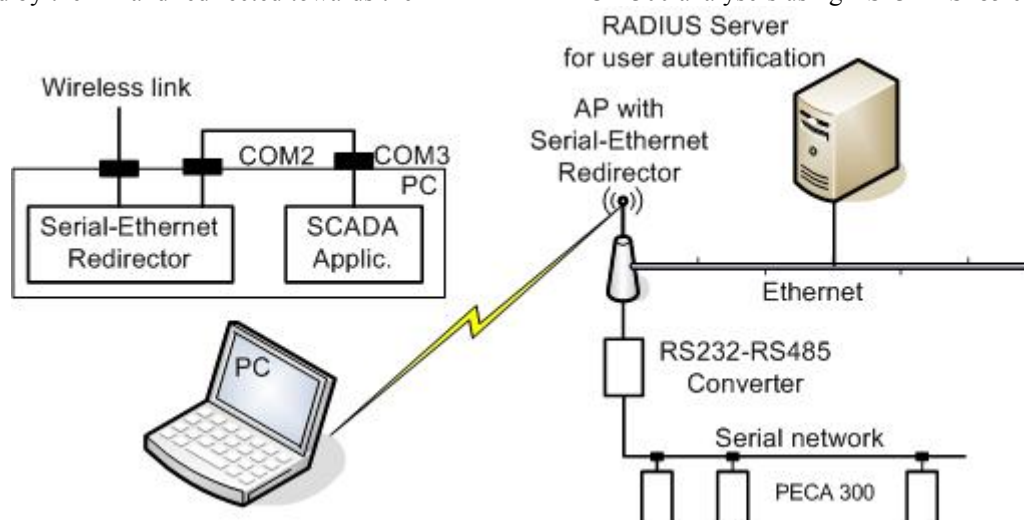


Fig. 4. Remote monitoring system

For the client system a *serial-Ethernet redirector* program was implemented in *LabWindows/CVI*, using the RS-232 and Win32 SDK library functions, which have the same architecture as in fig. 3.

The user interface of the *serial-Ethernet redirector* client program is shown in fig. 5[2]. Using this program we can configure the serial and the Ethernet interfaces. Activating the debugging module there will be shown the transmitted “→” and received “←” messages in the textbox.

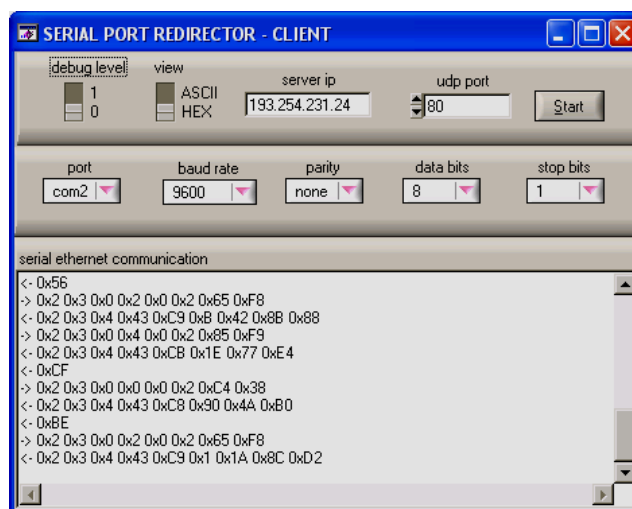


Fig. 5. The user interface of the client *serial-Ethernet redirector*

Another example of using the *serial-Ethernet redirector* is when the SCADA application is interconnected through INTERNET with the INTERNET Server. Using an AP that runs the redirector the program can to link with PECA devices. The structure of this system is shown in the fig. 6.

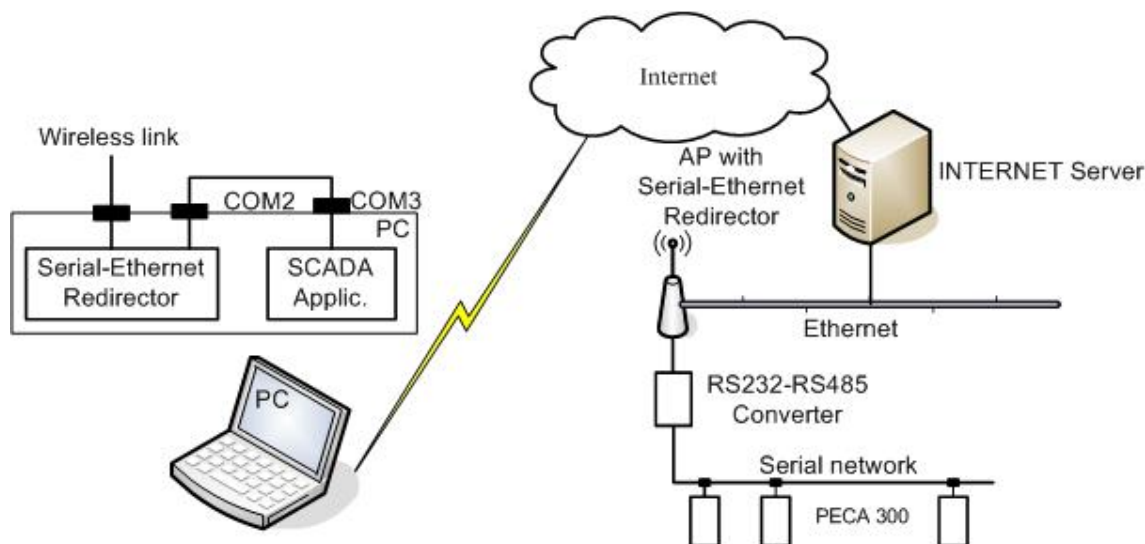


Fig. 6. Remote monitoring using INTERNET

5. CONCLUSIONS

The data generated by the programming or monitoring environment that get to the serial port of the computer are encapsulated in UDP datagrams and transferred on the network. The Firmware from the Access Point implements the TCP/IP stack, allowing to receive Ethernet data and their transfer in the serial data, that reach the serial or PLC network. The PLC answers with a confirmation message or a request message that reaches the Access Point and is encapsulated in the UDP datagrams and transferred on the network. These data are received by the computer and redirected by the client package program to the serial port (virtual, shared or real port). From the serial port the programming or monitoring environment receives data.

In general, latency means the interval of time between application of a stimulus and detection of a response. In networking, latency means, the amount of time it takes a packet to travel from source to destination. Together, latency and bandwidth define the speed and capacity of network. In our tests, the *serial-Ethernet redirector* device required, on average, 20.4 milliseconds.

This *serial-Ethernet redirector* can be used to access from the network any device because it is independent from the communication protocol, which is faster than the commercial products implemented with the TCP protocol. This is an easily configured solution and used with debugging and visualization possibilities of the transferred packages.

The presented solutions were tested on various serial networks like: the serial network RS-485 of the ICP-CON company with a serial I-7000 modules and the *FieldPoint* serial network from *National Instruments* company with a *FP* modules.

A special application was developed for loading and debugging from the distance of the programs in the PLC 2xx Siemens, that don't have an Ethernet communication module.

Here are some of the main characteristics of the monitoring and control system:

- Allows the rapid design of applications for monitoring and control applications;
- Changes in the configuration files can be made using any text editor;
- Uses a small amount of memory allowing the development on embedded systems of reduced hardware features;
- The development costs are reduced;
- The changes occur only in the client side software and do not require special programs on the Access Point;
- It does not depend on the operating system and protocol;

- Can be used to develop virtual laboratories.

The monitoring and control system was tested successfully on platforms EMBI4 with an IDT processor RC32334 from Embedded Wireless GmbH, SL-5354 with IDT RC32438 from Senao and Q5 with AMD AU1500 designed by Q-Networks [3, 4].

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