

UTILIZING OF THE GSM/GPRS TECHNOLOGY IN MONITORING OF THE DISTRIBUTED TECHNOLOGICAL NETWORKS

Paper presents new possibilities of developing Supervisory Control and Data Acquisition (SCADA) System for the distributed technological network. Application of the novel data transmission medium such as SMS messages and GPRS transmission via GSM mobile phone network enables creating both reliable and cost-effective systems. Also previously used data transmission methods, like a low power radio transmission or cables are presented in the paper. It was shown, that all methods of data transmission should be taken into consideration in designing the effective supervisory control and data acquisition system.

ZASTOSOWANIE TECHNOLOGII GSM/GPRS W MONITORINGU ROZPROSZONYCH SIECI PRZEMYSŁOWYCH

W referacie przedstawiono możliwości zastosowania nowoczesnych mediów transmisji danych w systemach monitoringu i sterowania rozproszonych sieci przemysłowych. Zastosowanie nowoczesnych rozwiązań, takich jak wykorzystanie komunikatów SMS lub transmisji GPRS przez sieć GSM umożliwi stworzenie skutecznych i tanich systemów automatycznego nadzoru urządzeń technologicznych. Także tradycyjne metody przesyłania informacji, takie jak transmisja radiowa czy kablowa, zostały przedstawione i omówione w referacie. Zalety i wady wszystkich przedstawionych środków transmisji danych powinny być uwzględnione w fazie projektowania przemysłowych systemów monitoringu i sterowania.

1. INTRODUCTION

Many different types of the technological networks should be permanently supervised by the service team. In such a case proper operation of, for example, the water or wastewater stations can not be checked rarely, such as two times per week, by service personnel. Due to the high costs of the malfunction of the devices in such technological station service personnel should be informed about malfunction of the technological network as soon as possible.

To enable permanent supervision of the technological network distributed at the large area special, computer based supervisory control and data acquisition (SCADA) system

should be applied. The simplified structural scheme of such monitoring system is presented in Fig. 1.

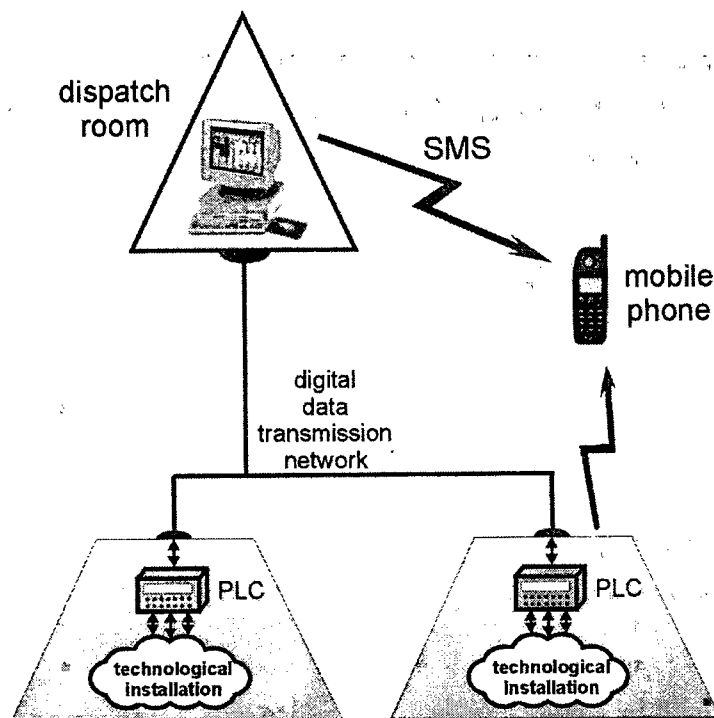


Fig. 1. Simplified structural scheme of the computer based supervisory control and data acquisition (SCADA) system

In such solution critical objects of the technological installation are equipped in programmable logic controller (PLC). Such controller, with proper measuring transducers, measures technological parameters of the object (such as temperature, pressure or flow) and control operation of the devices such as pumps or valves. Moreover programmable logic controller enables digital data transmission from the technological station to the dispatch office. As a result SCADA systems create very important opportunity of taking personnel away from the hazardous or arduous area of the technological network. Moreover in computerized systems all parameters of the process may be observed and remotely changed by personnel. Moreover technological data may be archived and analyzed with using of the statistical process control tools. For this reason economical profits of modernization activities might be objectively verified.

2. DATA TRANSMISSION IN THE SCADA SYSTEM

Effective and reliable method of the data transmission is one of the most important problem in design of remotely controlled, computer based SCADA system. One should also note, that for typical industrial applications data transmission does not have to be very fast, but should be unfailing. For these reasons medium of the data transmission, as the most sensitive part of the SCADA system, should be selected very carefully [1].

To chose proper medium of the data transmission designer should decide, if all data must be transmitted permanently, or only information about malfunction of the technological network should be received by service team as soon as possible. In a case, when it is acceptable, that only short and rare messages would be sent to the service team, transmission via the mobile phone network (GSM) or by the ordinary telephone network can be utilized [2]. In the case of both mediums, such transmission can be realized automatically, with specialized modules mounted on the technological stations. The simplified scheme of transmission via GSM network information about malfunctions of the technological station is presented in Fig. 2. Presented solution was applied in the PIAP-GSM monitoring system, developed in the Industrial Research Institute for Automation and Measurements.

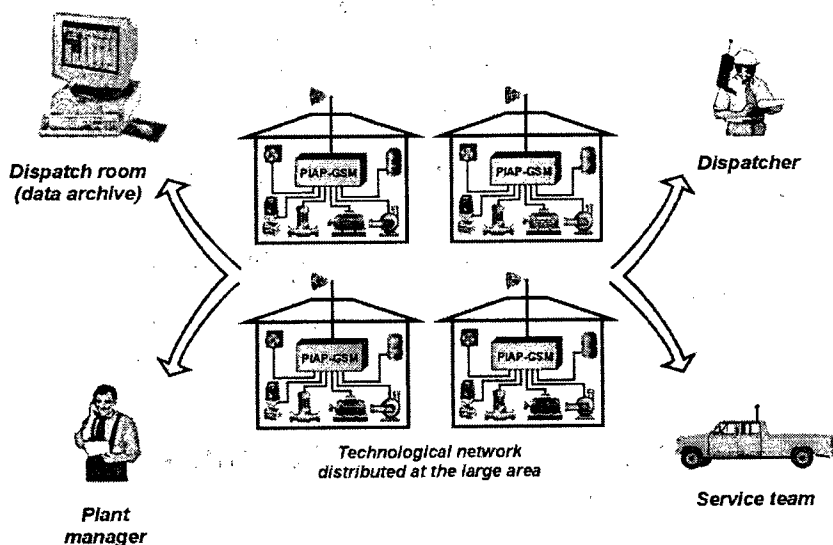


Fig. 2. Schematic diagram of transmission (utilizing SMS messages) of the information about malfunctions of the technological network distributed at the large area [3]

The most important opportunity created by the SMS data transmission is the possibility of automatic sending of the messages on practically unlimited distances. Moreover such method is also cheap. From practical point of view it is also very important, that information is sent directly to the personnel responsible for the proper operation of the technological network. As a result one does not have to organize dispatch room. For this

reason, such solution enables significant decreasing of the running costs of the technological installation.

One should note that transmission of the information about faulty operation of the technological network can be also realized automatically via the ordinary telephone network. But in this case dispatch room should be organized, if information is transmitted digitally. On the other hand also via ordinary telephone network information can be transmitted directly to the service team. In such a case voice synthesizer should be utilized. But this solution is much less reliable than transmission via GSM network due to the fact, that member of the service team must be near the stationary telephone.

In a case of SCADA systems, which operate in the real time, one should provide possibility of permanent data transmission. In such a case utilizing SMS or telephone data transmission is very costly. For this reason, other mediums of the data transmission should be used. The traditional medium of transmission, such as transmission via cable, leased telephone-line or low power radio transmission, have both its advantages and disadvantages.

From practical point of view transmission via cable is unreliable. First of all cable lines are very often incidentally damaged or stolen. Moreover, during the thunderstorms, electrical impulses may be induced in cable lines. Such impulses may damage transmission devices or even be hazardous for the personnel. For these reasons effective cable line must not be longer than few hundred meters.

Utilizing leased telephone-line has the same disadvantages as cable transmission. Moreover in a case of malfunction of the leased telephone-line owner of the SCADA system must wait, until the defect of a data transmission medium will be repaired by the authorized personnel.

Transmission utilizing low power radio can be successfully applied when distances do not exceed few kilometers. Moreover this limit can be significantly decreased in the town's area. When higher power of radio transmission is required, special license for such transmission must be obtained. In such a case user of the radio transmission based SCADA system must incur the costs of both license and special project required for license application. Moreover these cost must be also incur when any changes in the data transmission system topology is made due to the fact, that in such a case new license and new project is required

3. NEW POSSIBILITIES CREATED BY THE GPRS TRANSMISSION VIA GSM NETWORK

Newly lunched service called GPRS (General Packet Radio Transmission) is a break through solution in data transmission via GSM network. The most important feature is charging not time of handled connection but the amount of transferred data. Next new feature is possibility of connection "one to many" instead "peer to peer" which was only available in traditional systems. Next advantage comparing with traditional CSD (Circuit Switched Data) mode used in e.g. telephone modem connection, is a no need of proceeding a long and complicated procedure of data channel establishing.

The above mentioned features create new possibilities of utilize GPRS transmission in industrial telemetry and telematic applications where data is transmitted relatively rarely in small amounts.

3.1. Principles of the GPRS transmission

With GPRS, the information is split into separate but related "packets" before being transmitted and reassembled at the receiving end. Packet switching means that GPRS radio resources are used only when users are actually sending or receiving data. Rather than dedicating a radio channel to a mobile data user for a fixed period of time, the available radio resource can be concurrently shared between several users. General idea is showed in Fig. 3 below.

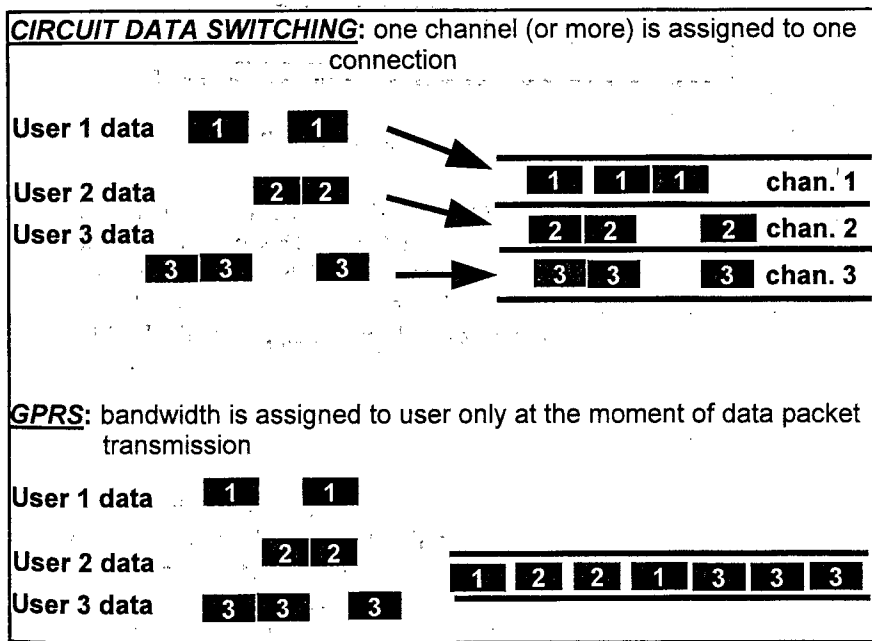


Fig. 3. Comparison of CSD and GPRS transmission

3.2. Protocol description

In order to access GPRS network are to be used PPP (point to point protocol). This protocol is dedicated for transporting multi-protocol datagrams over point-to-point links and internet as well. PPP encapsulates datagrams what allows to transport packet protocols like IP, IPX. In 7 layer OSI model PPP protocol corresponds with data link layer what is shown in Fig. 4 below.

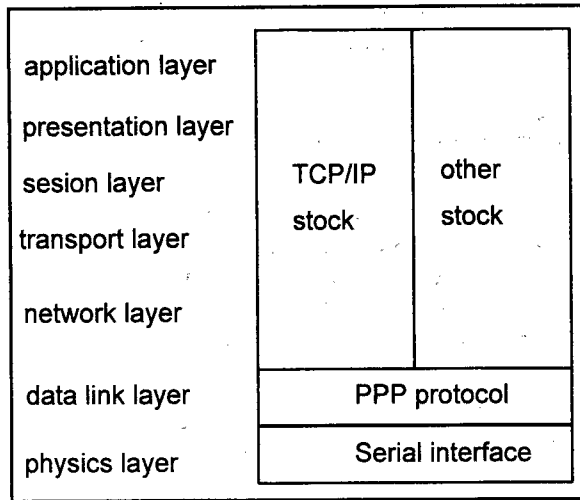


Fig. 4. Protocol PPP and TCP/IP

Industrial serial protocol like e.g. Modbus should be divide into packets and encapsulated by PPP protocol to transport via GPRS. This makes impossible to use industrial control devices like PLC an widely available GPRS terminals (DTE). Specialized converters are necessary at this moment. But in close future most of industrial measuring and control devices will be equipped with TCP/IP an PPP protocols.

3.3. GPRS and Internet

GPRS as a service of GSM operator (GPRS bearer) is a kind of subnet of the Internet called APN (Access Point Name). It means that it's possible to design e.g. telemetry system based only on GSM operator transmission infrastructure – remote nodes and central station are members of the same subnet. Disadvantage of this model is fact that transmitted data is charged twice: first time when a remote node transfers data to APN, second time when the same data is transferred from APN to central station (e.g. Dispatch Station).

In mixed model based on GPRS and Internet transmitted data is charged only once by GSM operator. Transfer between APN and Internet is free.

The overview of simply telemetry system is shown in Fig. 5 below.

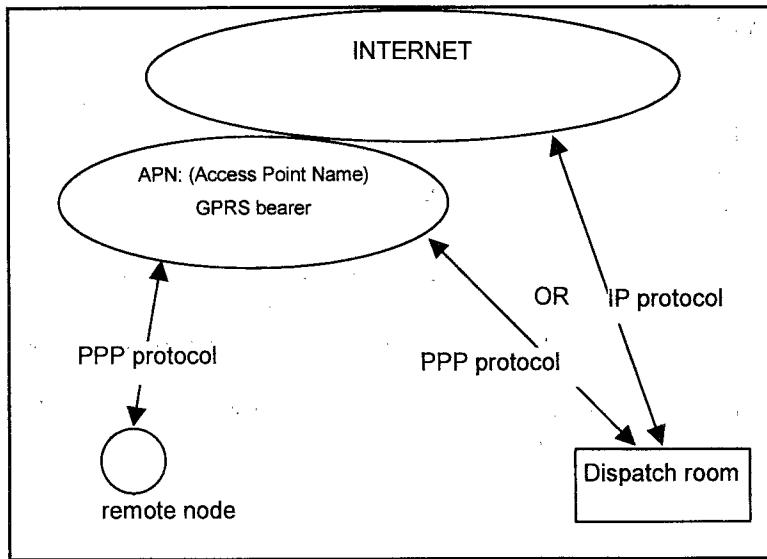


Fig. 5. Schema of the simple telemetry system with GPRS transmission

4. CONCLUSION

All methods of data transmission should be taken into consideration in design of the effective supervisory control and data acquisition system. But new data transmission media create possibilities significant of running-cost reduction.

Utilizing SMS messages gives possibility of creation of the open monitoring system without dispatch room. This method of data transmission should be used if only information about malfunction of the technological network should be receiving by service team.

On the other hand the GPRS service makes GSM network ready to be utilize as a wireless data transfer solution for telemetry/telematic systems especially distributed system on a wide area, urban areas etc. What makes a real change comparing to CSD transfer is much lower cost in case of permanent connection and relatively small amount of data transferred. At this moment there is not possible to integrate smoothly industrial standard equipment and GPRS data transmission terminals – special converters are necessary, although authors are sure that in very close future this problem will disappear because of further development of industrial equipment based on standard widely used protocols like PPP and TCP/IP.

LITERATURE

- [1] A. J. Simonds "Data Communications and Transmission Principles" MacMillan Press, London 1997
- [2] K. Wesołowski "Systemy radiokomunikacji ruchomej" WKŁ, Warszawa 1998
- [3] R. Szewczyk „SMSy w gospodarce wodociągowej” Rynek Instalacyjny 6 (2001) 69
- [4] Official web sites of polish GSM operators : PLUSGSM, ERA, PTK
- [5] T. Parker, M. Sportack „TCP/IP Księga eksperta” Helion, Warszawa 2000
- [6] P. Lesiak „Inteligentna technika pomiarowa” Wydawnictwo Politechniki Radomskiej, 2001
- [7] B. Zieliński „Bezprzewodowe sieci komputerowe” Helion, Warszawa 2000
- [8] Cisco GPRS White Paper