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# DATA TRANSMISSION FROM SEISMIC STATIONS VIA NETWORK AGNES USING GSM-GPRS TECHNOLOGY

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**ABSTRACT**
Global System for Mobile Communication (GSM) is frequently used for data transmission from seismic stations because it allows an easy realization of data connection from field observation points where metallic telephone line isn't available. Communication channel is established as a dial-up connection. As a GSM communication adapter either separate GSM modems or modems integrated to some standard mobile phone are used. Data are transferred through GSM network the same as voice digital signal using service Circuit Switched Data (CSD), but the priority of data is lower. Therefore data rate fluctuates according to the load of GSM network and theoretical value of 9.6 kbps (14.4 kbps Eurotel) is achieved rather rarely. Moreover, this way of data transfer is expensive with regard to a high price of CSD service. To reach low-cost access to Internet from mobile phone the GSM network was supplemented by General Packet Radio Service (GPRS). The GPRS technology allows usage of associated free channels of CSD system and data packet switching technology for data transfer. It allows users to stay continuously connected to the Internet. Data rate is theoretically higher on CSD, in practice it considerably depends on network loading. The main advantage is that GPRS user pays only for the amount of transferred data, not for online time per-minute.
In the paper principles of GPS, GPRS and telemetric data transmission using GPRS are briefly described. System of seismic data transmission from PCM3-EPC apparatuses with the help of virtual private network (VPN) AGNES, operated by company Conel Ltd. in the GPRS T-Mobile network, is tested in the Institute of Geonics AS CR. Communication adapters (which convert PPP protocol to RS232 protocol), the CGU02 Intelligent GPRS modems (Conel Ltd.) and communication software pcAnywhere are used. Our experience obtained during the trial operation is discussed.

**KEYWORDS:** seismic data transmission, GSM, GPRS

## 1. PRINCIPLE OF CSD SIGNAL TRANSMISSION IN GSM NETWORK

Skeleton drawing of GSM-GPRS network is demonstrated in Fig.1. The GSM network is cellular-based. Territory is covered by base transceiver stations (BTS) and individual mobile stations (MS) situated within their working radius communicate with them. Every operator of GSM network has allocated number of operational frequencies in 900 MHz or 1800 MHz band that are more divided to 200 kHz separated 8 channels. Operational frequencies of adjacent BTS are different. The BTS on the identical frequency don't interfere each other because their distances are greater then their signal coverage.

Mobile station tunes-up itself on one of the 8 channels of relevant BTS and periodically transfers digital data packets containing digitally coded 4.615 ms long intervals of analog signal (voice or data) together with service characters which are necessary for GSM network operation. Individual MS communicate with BTS in time division multiplex of 0.577 ms intervals (timeslots).

A number of BTS communicates with BSC (Base Station Controller), which furthermore communicates with switchboard MSC (Mobile Switching Center). MSC builds-up a communication channel in accordance with the telephone number of called MS, i.e. transfers data only through BTS on whose area caller and called MS are located (bold arrows on Fig.1). Communication channel exists during the whole connection time regardless of whether useful data are transferred in timeslots or not (e.g. both participants of talk are silent). That is why the price of CSD is proportional to the time of connection. The GSM network includes further units HLR, AuC, VLR and EIR (Home Location Register, Authentication Center, Visitor Location Register and Equipment Identity Register), which contain information on individual MS, check justification of required services and charge connection. The CSD communication with different networks (metallic, other GSM operators) is realized through MSC.

GSM modems are used as an MS for the CSD data transmission. These modems convert input data to the GSM data packets. From the user's point of view the GSM modems appear to be standard AT-compatible analog modems. They can be designed as special accessories (e.g. Siemens TC35 Terminal) or they are components of mobile phone and built-in module, respectively. The GSM modems use standard

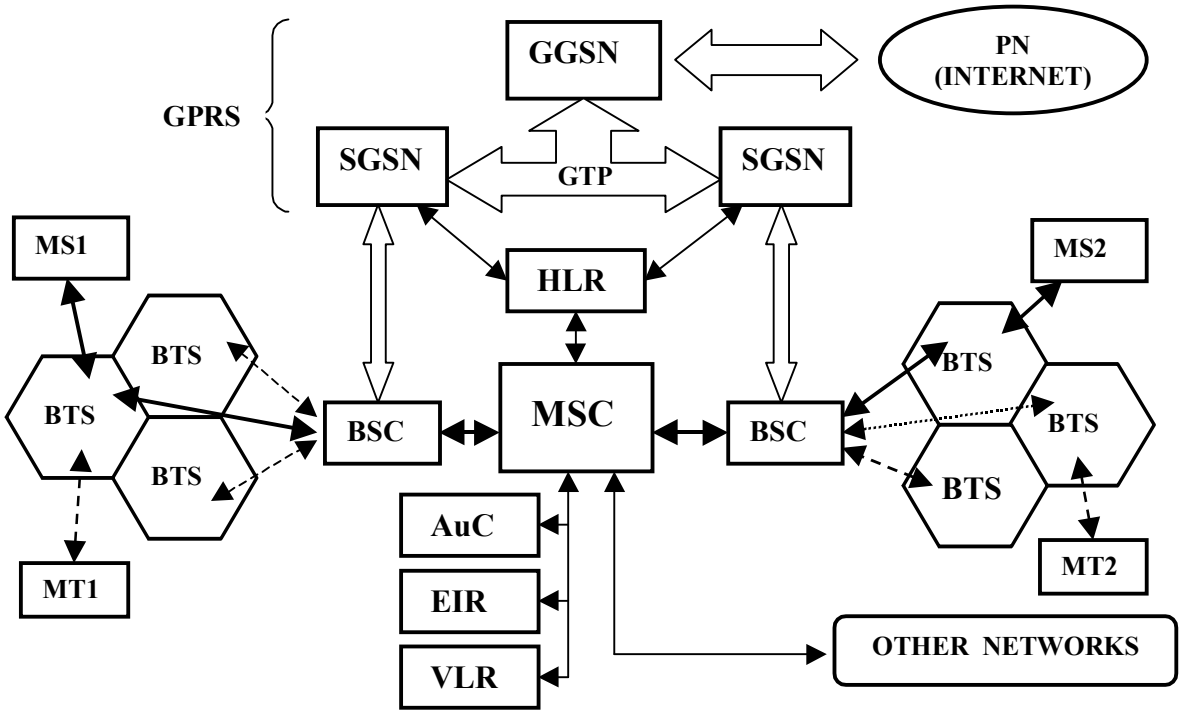


**Fig. 1** Simplified flow chart of GPS–GPRS network

data compression protocols as a rule. They can communicate with modems in metallic telephone network, too. The CSD data rate is limited by the data rate in timeslots of the GSM network to 9.6 kb/s in networks T-Mobile and Oskar. The Eurotel operator uses fewer amounts of service bits in timeslots that is why it reaches data rate of 14.4 kbps. The GSM network is designated for telephone calls especially therefore due to intelligibility of call the priority of "voice packets" is greater than priority of "data packets" and "data packets" are delivered with delay at period of high network loading. That is why effective data rate declines and price for transmitted data rises.

The Eurotel operator provides service HSCSD (High Speed CSD), which is based on association of several (up to 8) timeslots. According to the number of associated timeslots rises maximum data rate, but effective data rate fluctuates according to GSM network loading, too. A disadvantage of the HSCSD is the charge assessment according to connection time and the need of special modems.

## 2. GENERAL PACKET RADIO SERVICE (GPRS)

General Packet Radio Service (GPRS) is a packet-based wireless communication service that provides data rates from 56 up to 114 kbps and continuous connection to the Internet for mobile phone and computer users. The GPRS is based on principle of packet switching. Packets are equipped with IP address and transmitted to destination analogous to letters in envelope.

For the GPRS, the GSM network is updated of the several nodes SGSN (Serving GPRS Support Node) and one GGSN (Gateway GPRS Support Node) through which the GPRS communicates using GTP (GPRS Tunneling Protocol) with external packet networks (PN), e.g. with the Internet. As soon as the mobile data terminal (MT, e.g. MT1 and MT2 on Fig.1) is within reaching distance of the GSM network it logs in SGSN and immediately now on it is capable to communicate. The GPRS data terminal is "always connected", but until it doesn't transmit data it doesn't load the GSM network. Association of 2-8 free timeslots is used to achieve higher data rate (downlink, up to 114 kbps). Data rate from MT to the GSGN is limited to 14.4 kbps (uplink). Effective data rate of GPRS transmission is very variable due to variation of probability of presence of defined number of free timeslots at the same time. Transmission can be completely stopped for limited time (GPRS delivery time). The GPRS doesn't guarantee integrity and correctness of delivered data packets, this function must be ensured by communication software.

The main advantage of the GPRS is that the price is not for online time per-minute, but for the amount of transferred data. Typical usage of the GPRS is WAP. The GPRS interface is implemented into most of modern mobile phones and the GSM modems. Architecture and function of the GSM-

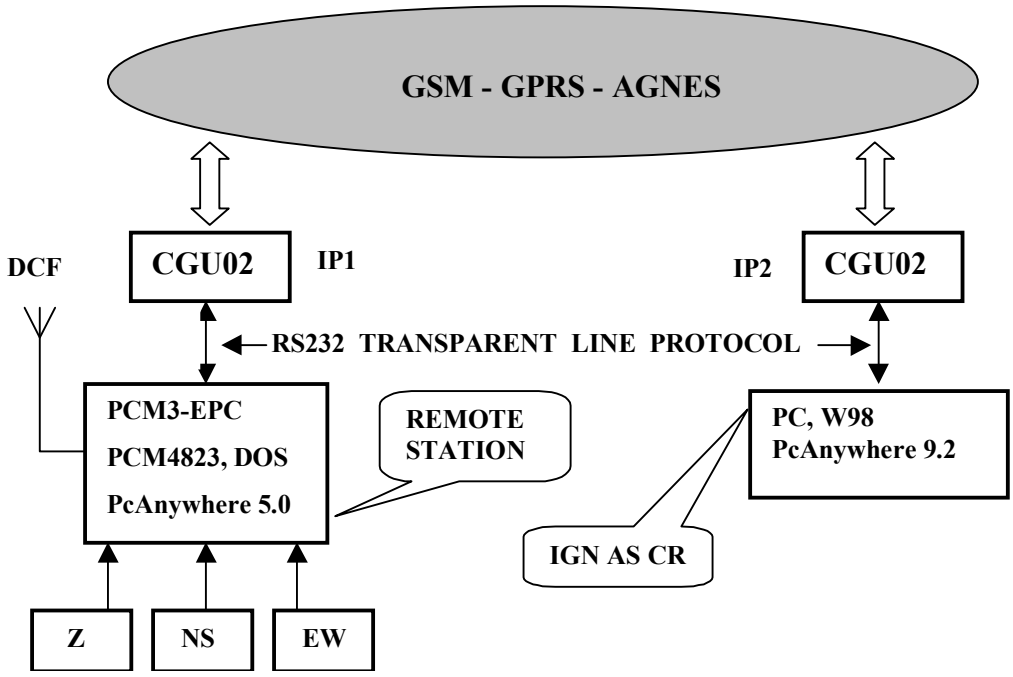


**Fig. 2** Flow chart of trial GSM/GPRS seismic data transmission

GPRS network are in detail described in a lot of papers, e.g. on www.pcsvet.cz/komunikace/site.

### 3. EXPERIMENTAL SEISMIC DATA TRANSMISSIONS BY MEANS OF GPRS

At present, we use the CSD service in the T-Mobile network for data files transmission from 6 remote seismic stations to the IGN AS CS (Kaláb and Knejzlík, 2002). Low data rate and high expenses inspired us to check out the possibility to take advantage of the GPRS. From the user's point of view is the implementation of telemetric connection by means of the GPRS more complicated than dial-up CSD connection. The problem is that the SGSN assigns to MT dynamic IP address by default (likewise provider of dial-up connection to the Internet). Therefore two mobile terminals cannot simply communicate in the GPRS with each other. Communication protocol PPP that takes control of data transmission between MT and SGSN isn't a part of common communication programs. This problem can be solved by the way that GPRS operator facilitates to create selected provider private access point, e.g. area of fixed protected private IP addresses, inside them individual mobile terminals are able to communicate with each other (Virtual Private Network – VPN). Private IP addresses are inaccessible from other networks. As the communication devices for GPRS-VPN special GPRS terminals, that convert PPP protocols to common RS232/485 protocols, are used. The creation of VPN inside of GPRS requires specialized knowledge in the branch of telecommunications, and therefore is facilitated to specialized subject only.

We had the possibility to check chances of seismic data transmission through VPN AGNES (Advanced GPRS NEtwork System), operated by company CONEL ltd. in GSM-GPRS network T-Mobile (Müller, 2001, www.conel.cz). The AGNES system enables data transfer between arbitrary data points within this network. Communication is realized through CGU02 modules, which convert PPP protocols to common RS232/485 protocols. The AGNES system enables direct communication between long distance systems with quick response and high safety of transferring data.

The CGU02 consists of the GSM-GPRS module (Embedded module) and the control microcomputer, which ensures communication in the GPS-GPRS network, services of user interfaces and service functions. Module CGU02 has three serial ports and one with direct attachment input/output peripheral. All ports may be configured independently to specific protocol (ARNEP UI, MODBUS, S-BUS, Transparent LINE and AT modem). Chosen protocol is preseted by CONEL Ltd. to the leased SIM card for the CGU02.

We had lent 2 pieces of the CGU02 configured for mutual communication (Transparent LINE protocol, RS232, data rate 19.2 kbps). Trial data communications were carried out with seismic station instrumented by recording apparatus PCM3-EPC. Flow chart of experiment is presented in Fig.2. Recording apparatus PCM3-EPC is equipped by

single board computer PCM4823 (Knejzlík and Kaláb, 2002). As a communication program pcAnywhere 5.0 configured as the Host computer was used (www.symnatec.com). Communication program pcAnywhere 9.2 was used in the IGN AS CR. Serial ports of both computers were stetted to the regime "direct connect" (19.2 kbps, no parity, HW hand-shake). Connection was started in host computer by receiving two characters CR (Generally used DCR is setted on high level after logon to GSM-GPRS network immediately).

Following experience was obtained:

- Usage of VPN AGNES (or some different VPN) facilitates realization of GPRS connection considerably. The CGU02 moduli are able to communicate through VPN AGNES in moment of turning-on. The VPN AGNES ensures integrity and correctness of delivered data packets.
- Connection can be established by pcAnywhere of different releases. Connection is reliable. Large data files (order MB) were reliably transferred in regime "Data Transfer". Such large files weren't possible, as a rule, to transmit by CSD due to breakdown of connection.
- Theoretical maximum data rate through AGNES network is 13 kbps (Müller, 2001) by reason of mean data rate of transmitted data must be equal received data rate when mobile terminals communicate with each other within the AGNES network. Effective data rate fluctuates considerably according to GSM network. We have observed data rate from 0.1 kbps to 1 kbps, but signal transmission was stopped for few seconds from time to time, too. That is a standard situation in the GPRS because guaranteed data packet delivery time is in seconds due to the lowest priority of GPRS packets in GSM network (up to 6s, according to standard GPRS). Moreover, the CGU02 contains buffer, whereof data are transmitted after filling and/or after the lapse of defined time. Communication software mustn't evaluate such interrupts of data stream as timeouts!
- The GPRS is useful for data transfer in the pcAnywhere mode "File Transfer". It is difficult to work on remote computer (Host PC) in the mode "Remote Control" due to very variable delay of keyboard response and occasional breaks of data stream. Critical situation occurs when connection is lost during file transmission, e.g. when one computer is switched-off, because pcAnywhere (release 5.0 for DOS especially) doesn't fit for this type of operation. Using proper communication software and battery backup of both computers will solve this problem. In Windows or Linux environment GPRS direct connection of computers will operate reliably, we suppose.

## CONCLUSION

The simplest description of GSM-GPRS network operation is presented in the paper to make possible to explain the difference between CSD and GPRS data transmission. At present, the CSD seismic data files transmission from 6 remote seismic stations is used in the IGN AS CR. The GPRS data files transmission was tested using virtual private network AGNES in T-Mobile GSM network. Using of VPN AGNES and preprogrammed data terminals CGU02 considerably facilitates the usage of GPRS technology. Gained experience proves advantages of GPRS technology, reliable transfer of large data files and comparatively low price especially (the lowest GPRS tariff 0.03 Kč/kB, T-Mobile), while a disadvantage represents higher price of terminals CGU02.

## ACKNOWLEDGEMENT

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