

# Mobile Measurement System On Demand – by PDA Or GSM Mobile Phones

Roman Malarić<sup>1</sup>, Tarik Mutapčić<sup>1</sup> Damir Ilić<sup>1</sup>

<sup>1</sup>Faculty of Electrical Engineering and Computing, Zagreb, Croatia

**Abstract-** This paper describes the procedure in which the widely available PDA device or even more common GSM mobile phone can be used for on demand control of the distributed measurement system with the Internet connection [1-4]. With the use of new mobile Internet technology, measurement can be initiated and controlled anytime and anywhere. This mobility approach of the measurements is limited only by the availability of GSM signal from the base station. Once established, the connection between the operator (located away from the PC running as a measurement system controller) can be used in many different ways, from sending commands to PC or instrument, to control measurement process and receiving the measurement data on GSM or PDA device.

## I. Introduction

In today's information age, PDAs and smart phones have become essential tools, making them very interesting in many disciplines such as measurement, education, service, development, etc. (Figure 1). Mobility measurement is the ability to get a information on demand just in time. Real time two way point to point data communication can be useful for a wide range of remote applications like remote control of various processes. The PDA and GSM devices are useful for remote control applications because of its mobility, light weight and accesability of wireless communication in remote areas. The second generation (2G) of mobile phone system is called Global System of Mobile Communication (GSM), which uses entirely digital communication, and thus offering the possibility to use it for transmission of measurement data. It is mainly used in Europe, but similar systems are used in USA, Asia and elsewhere. The use of mobile phones for data transmission was enhanced with the introduction of General Packet Radio Service (GPRS) in GSM. To establish the communication link all the components in the system must have data transmission capabilities, along with the voice transmission. The systems that use the PDA/GSM mobile phone for data communication technique already exist, but all of them to our knowledge are using some specially designed hardware on the receiving end, which acts as interface to the PC that controls the measurement system. This is usually done by using GSM modem or connecting mobile phone to the computer with IrDA link, Bluetooth link or RS-232C cable.

However, there is another possibility, and that is to use the e-mail communication. In this way there is no need for additional hardware at receiving end, and also PDAs with e-mail capabilities can be used as well. It is the cheapest but also the most convenient way of communication. By using the Short Message Service (SMS) the GSM can send up to 160 characters in length to another mobile phone, but also to e-mail users using the SMS to e-mail service offered by some providers. There are two features of SMS that are important to the control of measurement process, First, the messages can be delivered to the user during a phone call, and second, there is an option for sending delivery report to the sender.



Figure 1. The universality of PDA and GSM devices

## II. On-Demand communication between the controller and PDA or GSM

To establish the e-mail communication between the PC that controls the distributed measurement system and the operator, PC must have the Internet connection, and the GSM phone or PDA must also be able to send e-mails. Most of the GSM operators have the GSM - e-mail gateway available to its customers. The only restriction is that the length of SMS messages is maximum 160 characters long. This can be overcome easily by sending or receiving several SMS messages one after another. However, this is usually no problem if the communication protocol is chosen conservatively by using some sort of protocol between PC and GSM/PDA. The whole system is based on a single computer acting as a server. In addition, the server does not need to have any additional hardware, such as GSM modems, but only valid e-mail account and working internet connection of any kind. The e-mail client software on the server computer does not have to have any special features. Freely available *Outlook Express* is a good choice, but other software can be used as well. Therefore, almost any computer can act as a server. The e-mails that are sent to the users are free, including the SMS/e-mails sent to the user GSM phone using e-mail to SMS gateway. The only payment to the GSM provider is made when user sends the SMS/e-mail to the server. The server software is composed of a number of different modular components. The server must perform several tasks:

- check the e-mails regularly for upcoming instructions from operator
- check the identity of the operator for security reasons after e-mail is received
- interpret instructions from the SMS/e-mails
- execute the measurements if the instructions are correct
- send the e-mails to the operator with the measurements results

## III. Controlling measurement instrument - example

The main task is to define the communication protocol between the operator and the PC. Table 1 shows the communication protocol used to remotely control digital voltmeter. The operator can change the setup of the voltmeters by sending simple commands using predefined codes. It is also possible to send predefined setup modes (p1, p2 and p3) which are used to change several voltmeter properties at once, simplifying the task for the operator.

Setup	Code	p1	p2	p3	Allowed values
Voltmeter ID	i	1	1	1	1-2
Number of measurements	m	1	3	5	1-100
Range	r	10	10	10	0.1;1;10;100;1000
Number of power line cycles	n	5	10	20	5-100
Number of samples	s	1	10	10	1-100
Time between samples	t	0.2	0.5	1	$\geq 2 \cdot (NPLC/50)$
Time before measurement	m	0	0	0	0-10
Autocalibration		no	no	no	yes, no
Reading no.	a	1	1	1	1-10000

Table 1. Communication protocol for controlling voltmeters

For example, the command line in the SMS message or e-mail first defines one of the three predefined setups, and then the operator can choose any one of predefined values that he/she wants to change. All commands have to be separated by semi colon. For example, the command "i1;p1;m10;n10;s3;yes;" means that the measurement setup values defined by p1 are chosen for voltmeter designated as DV1, except that the total number of the measurements are changed from 3 to 10, that NPLC is changed from 5 to 10, number of samples from 1 to 3, and that auto calibration routine will be performed before the measurement starts. In case that any of values sent by the SMS deviates from allowed values, the measurement is not performed, and the computer sends the SMS with the error message. In addition, the operator can ask the results of the measurement at any time, by using the code 'a', rather than waiting the end of measurement to receive the average readings and standard deviation of the measurement. The codes and the application can be modified easily to add any command, that operator wishes to include in the system. The flow chart of the basic system functions are shown in Figure 2.

As anybody can send the e-mail to the PC, a system must be able to filter the the emails and to have some sort of authentication. The filtering can be done by checking the sender's e-mail address or if tighter security is needed by applying the password protection. The filtering can be easily done by most of the e-mail programs themselves, and the e-mails from the operator are then placed in specially designated operator's folder. A specially designed VBScript program checks periodically (time period is operator defined) if there is a message in the operator's folder. If present, it must be decoded by specially programmed interpreter. The message in the e-mail must have no errors or values outside predefined ranges to be considered as valid. After the message has been interpreted, the operator is immediately notified by automatic email response about the result of the interpretation. If the message is considered valid and commands interpreted correctly, the operator will also receive one or several emails about the measurement results.

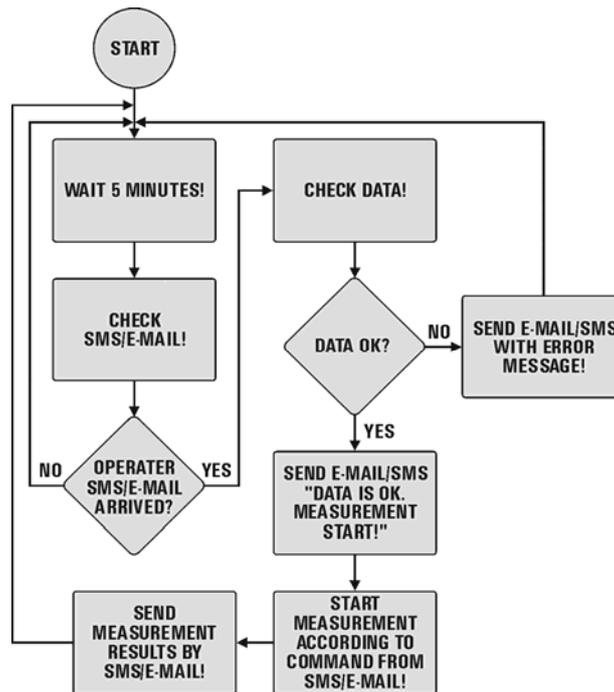


Figure 2. Flow chart of the communication between PDA or GSM and controller (PC)

#### IV. Conclusions

The application that offers remote communication on demand between the control computer and the operator using simple protocol and GSM phone or PDA device has been realized. The operator can have full control of the measurement process with only the readily available GSM phone or PDA anytime and anywhere and the control computer that only needs to be connected to the internet with e-mail capability. Mobile measurement service described in this paper can be easily implemented in other areas, like MDS (monitoring - diagnosing - servicing) for industrial purposes, home automation, patients status monitoring in hospitals, or M-learning or expanded to include different instruments in more complicated measurement system.

#### References

- [1] C.E.Lin, L.Chih-Ching, H.An-Sang, W.Chih-Chen, "A real-time remote control architecture using mobile communication", IEEE Transactions on Instrumentation and Measurement, vol.52, Issue 4, Aug. 2003, pp.997-1003.
- [2] K.Chih-Zeh, "GPRS/GSM Mobile Navigator for the intelligent transport system (ITS)", Exploring Innovation in Education and Research, Tainan, Taiwan, 2005
- [3] A.Roversi, A.Conti, D.Dardari, O.Andrisano, "Collaborative and distributed laboratories for remote measurement: concepts and technical challenges", WSEAS Transactions on Circuits and Systems, vol.3, Issue 3, May 2004, pp.444-452.
- [4] J.Sabina, S.Uwe, T.Christian, "Collaborative Working Environment for Virtual and Remote Experiments in Nanoscience and Nanotechnologies", Berlin University of Technology Germany, 2006