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Distributed Measuring Systems Based on Wireless Networks

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Abstract: *Notion distributed system isn't exactly new, and despite there are other meanings for this association, we join it mostly with systems distributed in space. So basically these are systems deployed around large area. Origin of such systems is closely bound with computer networks. And as wireless attribute is more and more often appearing in connection with computer networks, so are distributed systems getting more interconnected with wireless data transmission. The pressure on utilization of wireless forms of communication is growing every day, no matter if we are talking about mobile systems, where other form of communication is almost impossible, or about classical systems in buildings, workshops and alike. Even here, the mobile form of communication has indisputable benefits. If we omit power cables, then of course the most obvious advantage is the absence of wiring and problems linked with it. Even where the wireless communication is not necessary it often simplifies given solution. Therefore this paper is dealing with analysis and proposal of such wireless distributed systems, specifically empathizing on measuring systems working on larger area.*
Final model has been created at laboratories of Department of Control Systems and Instrumentation VŠB – Technical University of Ostrava and is funded by FRVŠ grant

Keywords: *measurement, wireless, networks, GSM*

1 Introduction

As the title of this paper stays, this based is aimed on distributed measuring systems, particularly systems distributed over larger areas with relatively large number of nodes. We are also talking about systems using wireless technologies there are many advantages these technologies offer comparing to wired ones. Other issue is, that as this project is meant to help during teaching lessons for students it must be synoptical enough for them, to learn something about wireless networks, data analysis and storage etc.

2 Choosing the right wireless technology

According to type of applications we want to dedicate this work to it is necessary to mark out which characteristics are most important for us and how they will affect the application, as there are a lot of different wireless standards and devices which are using them.

We declared that we are specifically empathizing on measuring systems working over large area. If we take this into account it is practically impossible to use Bluetooth or ZigBee based solutions, even though they are meant for technical applications, as their range is too short.

The next option in line is some of the Wi-Fi family of standards. The range is better here, but there is still one significant problem as they need direct line of sight and the range is still somehow limited.

The problem of Wi-Fi is partially solved by Wi-Max technology as the range is increased notably and direct LoS is not required (although it is reducing the range if there is no LoS). But this standard is relatively new one and solutions based on this standard are still not properly tested and quite expensive.

Last technology to mention is GSM (using GPRS for data transfer). The situation is bit different here. Unlike the others it is cellular and so we need network of base stations. But we don't need to build this network as it is already established by Mobile operators so the infrastructure is already created. This is a big advantage, but we still need to realize that it has also disadvantages. GPRS is using only free channels and so even if some mobile operators offers possibility of dedicated timeslots or channels none of them are operating in Czech Republic and so in the worst imaginable situation the actual connection speed can even go to zero. This situation is not probable, but still possible. So the solution similar to what we want to set up is only suitable for transfer of small data volumes within relatively long time intervals.

Although we are aware of its limitations which are severe, we decided that GSM is the right choice for us, as it satisfies most of our needs.

[SMYTH, P; SCOURIAS, J.]

3 Shortly about GPRS

GPRS is a mobile data service available to users of GSM mobile phones. GPRS is different from CSD connection. In CSD, a data connection establishes a circuit, and reserves the full bandwidth of that circuit during the lifetime of the connection. GPRS is packet-switched which means that multiple users share the same transmission channel, only transmitting when they have data to send. This means that the total available bandwidth can be immediately dedicated to those users who are actually sending at any given moment, providing higher utilization where users only send or receive data intermittently.

Packet-switched data under GPRS is achieved by allocating unused cell bandwidth to transmit data. As dedicated voice (or data) channels are setup by phones, the bandwidth available for packet switched data shrinks. A consequence of this is that packet switched data has a poor bit rate in busy cells. The theoretical limit for packet switched data is approx. 160.0 kbit/s (using 8 time slots and CS-4). A realistic bit rate is 30–80 kbit/s, because it is possible to use max 4 time slots for downlink. The maximum data rates are achieved only by allocation of more than one time slot in the TDMA frame. Also, the higher the data rate, the lower the error correction capability.

GPRS speed is a direct function of the number of TDMA time slots assigned, which is the lesser of what the particular cell supports and maximum capability of the mobile device expressed as a GPRS Multislot Class (Table 1).

Table 1. GPRS Multislot Classes

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5

Transfer speed depends also on the channel encoding used. The least robust (but fastest) encoding scheme (CS-4) is available near the Base Transceiver Station while the most robust encoding scheme (CS-1) is used when the Mobile Station is further away from the BTS. Using the CS-4 it is possible to achieve a user speed of 20.0 kbit/s per time slot. However, using this scheme the cell coverage is 25% of normal. CS-1 can achieve a user speed of only 8.0 kbit/s per time slot, but has 98% of normal coverage.

4 Storing the data

If we take into account what typo of data we are working with when talking about measuring stations network it definitely leads us to conclusion, that this data must be stored using relational database system as there will be lot of information with similar structure. Now there are some important parameters which can make things more difficult. Firstly, it is the time between measurements. The amount of data in one entry is usually not very high, but if we are reading the value for example ten times in a second for 24 hours a day the amount of information may rise. Second problem is, that there could be hundreds or thousands of sensors from which we are taking the data. This is why conventional database systems are sometimes not enough for industrial purposes. And this is also the point where industrial database systems can take advantage. Again we went through the possibilities and Industrial SQL came out at first place, as we can work with standard SQL Server and its tools and than easily transfer it to iSQL.

[Industrial SQL Server]

5 GSM Controller

First step in realization of this project is to create a measuring system (or measuring station to be precise). This station is based on GSM controller GB 060 511T by LEVEL.

This controller is combining GSM communicator with programmable controller. It contains eight binary independently programmable inputs/outputs. It is also possible to connect analog inputs using Dallas bus. Dallas bus has only one wire to which all external units are parallel connected to. Maximum number of such units is ten. Under normal circumstances this bus is usable only for thermometers or ID key readers, but by using external unit for analog inputs we can use any analog input between 4-20mA or 0-10V. Each external unit includes two current and two voltage inputs.

Standard serial interface RS232 is used for communication with superior computer with remotely controlled device with RS232 output for modem transmission and it provides reading and writing of configuration, reading of measured values and identification data, reading of reported events memory – Report, connection of distant devices with RS232 using GSM to local PC and connection of printer for printing incoming SMS messages.

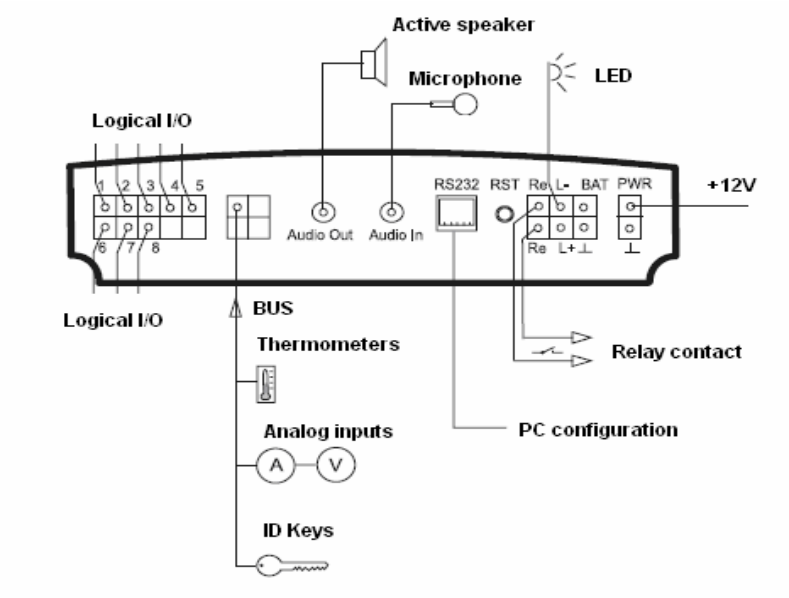

Figure 1 – GB 060 511T schematic

GB 060 has an internal registry enabling storage of 3000 entries such as measured values and information about device state. CP saves report using interface Microsoft Windows ODBC (Open database Connectivity), which can be used to access the data with various database software. Data can be transferred using RS232, by means of GPRS connection or by sending SMS messages. Triggering of actions is event driven by default but it is possible to change this easily to time driven or query driven.

There are several defined events which can trigger required action. These events are:

- Activation of binary input
- Analog input limit violation
- ID key signing in or off
- Regular time period (there are two timers)
- Incoming control SMS
- Incoming call from number in list

Triggered actions could be::

- Allowing group
- Allowing action
- Set output
- Save to report
- Lowered power consumption
- Sign off ID key
- GSM call with listening or beep signal
- GSM data connection using GPRS
- Start timer

End call

[FARANA, R.; GSM, GPRS dohled technologií]

6 Concept of the model

As it was said earlier the measuring station also works as a model for students. Basic model composition consists out of GB 60 511T itself and three blocs.

First block provides the measuring itself as it reads analog values from external sensors. It consists from a switch, signal LED diode and external unit for analog inputs. After switching on internal timer is started and controller reads values from sensors connected to external unit for analog inputs with certain time period. These values are then saved into report. Whether this is active or not is signalized by LED diode.

First block is simplified heating model consisting from thermometer and signal LED diode. There are two limit temperatures set in the controller which are turning on or off the heating symbolically represented by LED diode.

Third block is model of safeguarding the station consisting from ID key reader, correed relay, signal LED diode and ID keys. Whole model is inside a metal case. Opening of the case is detected by correed relay. If the case is opened without deactivating the alarm with ID key in next ten seconds the alarm represented by LED diode is set off and it also dials to a given phone number.

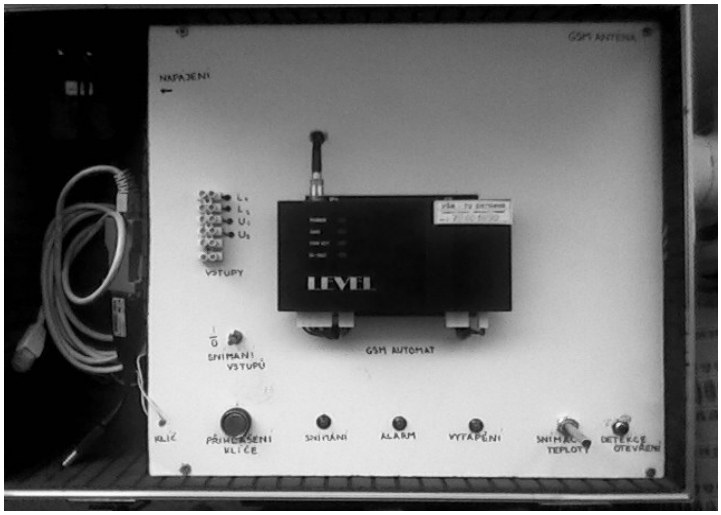

Figure 2 – Measuring station model

7 Conclusions

This model has been created at laboratories of Department of Control Systems and Instrumentation VŠB – Technical University of Ostrava and is funded by FRVŠ grant. Over the last months the practical work was done while setting up the measuring system with GSM controller. These efforts led to creation of operational system, which is momentarily in a stage of testing. We are also still working on storage of the data, as we want to incorporate the possibility of analysis and interpreting the trends.

8 References

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