Wireless communication with intelligent buildings using GSM network

Veselin Obradović, Jovo Karišik, Borislav Odadžić

Abstract — **In order to achieve more effective and more efficient control of systems in "intelligent" buildings, authors propose using GSM network, as more accessible, namely SMS and MMS messages, for communication between administrator and the system, in cases when there is no 24 hours presence of staff in the controlled building.**

Key words — **Intelligent buildings, GSM, MMS, and SMS.**

I. Introduction

IN regular buildings there are various systems that are in use (central heating, fire and security alarms, etc.), as well as different electrical appliances that are totally isolated from each other. On the other hand, intelligent buildings have the infrastructure that enables mutual communication of those systems and devices, so that, for e.g. security system can turn on and off exterior lights, lock doors, etc.

Most intelligent buildings monitor or control more units, or control more than one system in the building, offering more efficiency, than it is possible for separate systems. Some sort of network or integrated information system is required in order to consider a building "intelligent". Its "intelligence" is based on central logic that, according to the information received from systems/sensors to which it is connected and conditions defined, control those systems performing changes in the building.

Beside network and intelligence, a must have part of the intelligent building is a large number of sensors. Sensors are not only numerous in quantities, but also in kinds. Radio-frequency identification (RFID) tags are used for tracking objects and individuals throughout the building. There are motion sensors based either on optical detection (infrared or laser) or on acoustical detection. They are not only used for security systems, but also to monitor cessation of occupancy of an area in order to extinguish unneeded lighting. Also, there could be a wireless sensor network used to cooperatively monitor environmental conditions as temperature, loudness, vibration, pressure, etc. Of course, there are more simple sensors as rain sensors, daylight sensors, liquid level sensors, power consumption sensors, etc. Usually, input from all (or most) of this sensors can be monitored through some sort of central console.

Some of most common systems are those for monitoring and controlling temperature and humidity in rooms, security systems (security cameras, burglary, fire and other alarms, access control), monitoring power supply (which also turn on backup power supply if necessary), etc. Central logic has conditions and parameters for expected problems and situations, but, under the certain conditions, there is always need for human decision and supervision, which is not a problem when there is 24 hours-a-day staff presence in the building. But, if that is not the case, most of the intelligent building systems (IBS) enable remote control using web interface. But, what happens in the case when access to the internet is not available to the authorized personnel?

This paper explains system of remote control and monitoring, using almost omnipresent GSM network, which is realized by the authors. Global System for Mobile communications is the most popular standard for mobile phones in the world. It is available on every continent and in almost any country in the world. GSM is cellular network, meaning that a mobile phone connects to it by searching for cells in immediate vicinity. It operates in four different frequency ranges: most common is 900MHz/1800MHz and mostly used in Americas 850MHz/1900MHz. The key difference of GSM from its predecessors is that it uses higher digital voice quality. It supports from its very first commercial specification (in 1991) the SMS standard. Later improvements of the standard (in 1997) introduced GPRS – a mobile data service. GPRS is packet switched thus allowing that multiple users share the same transmission channel in contrast to CSD – Circuit Switched Data where a connection establishes a circuit, reserving full bandwidth of that circuit during the lifetime of the connection. GPRS can be used for services such as Wireless Application Protocol (WAP), Multimedia Messaging Service (MMS), and for Internet access to services such as e-mail and World Wide Web (WWW). Although most of the modern cellular phones support web browsing using GPRS, web content, at least when web interfaces for intelligent building control is concerned, is not suitable for small screens on the cellular devices.

These are the reasons why we propose this system, where using SMS (Short Message Service) messages, queries and instructions are sent, and intelligent building responds to them with graphical display of requested data using MMS (Multimedia Messaging Service) messages. MMS is standard for telephony messaging that allows sending multimedia objects (images, audio and video) and

Veselin Obradović, B.App., Technical faculty "Mihajlo Pupin", Zrenjanin, Serbia (e-mail: hogar@cg.yu).

Jovo Karišik, B.Sc., ProMonte, Podgorica, Montenegro (jovo.karisik@gmail.com).

Prof. Ph.D. Borislav Odadžić, Technical faculty "Mihajlo Pupin", Zrenjanin, Serbia

not only text as SMS. A MMS message is collection of several media files described in a Extensible Markup Language (XML) document. The XML document is of SMIL type (Synchronized Multimedia Integration Language).

In the second part of the paper, used software and hardware will be discussed, while the third part explains explicit realization of the system.

II. Hardware and Software Used

Siemens MC35i Terminal (fig. 1) was used for connecting the IBS to the GSM network. It is dual-band GSM/GPRS terminal, with voice, data, SMS and fax communication capabilities.

Fig. 1 Siemens MC35i Terminal

This device is connected to the computer using RS-232 interface. GSM operator mini SIM card is inserted in it as well. MMS sending is supported with MM1 protocol (MMS over GPRS).

Software was developed using Java 6 programming language under Eclipse version 3.2, along with jSMS Java API for sending and receiving SMS and MMS messages.

Java, a programming language originally developed by Sun Microsystems in 1995, today is mostly available under GNU General Public License. The most important feature of this programming language is its portability or platform independence. This means that programs written in Java must run similarly on any supported hardware platform and operating system – one should be able to write the program once, compile it once and run it anywhere. This is achieved by compiling Java language code into Java bytecode (simplified machine instructions specific to the Java platform) and then running this semi-compiled code on a virtual machine – a program written in native code for the host platform that interprets and executes the bytecode.

Eclipse is open-source software development platform written primarily in Java. It is a Java IDE (Integrated Development Environment) consisting of Java Development Tools (JDT) and compiler (ECJ). The basis for Eclipse is RCP – Rich Client Platform. In order to provide the functionality on top of the RCP, Eclipse employs plug-ins, and this is in contrast to some other applications where functionality is typically hard coded. This approach allowed using Eclipse as development platform for other programming languages as C or Python, with telnet applications and even with database management systems.

III. Accomplished Solution

A. Experiment conditions

This solution was developed in experimental conditions, that is – it is not developed in real intelligent building, but in a simulated environment. As the idea of the experiment was to demonstrate communication using proposed method, using simulated environment was acceptable. Intelligent building environment was simulated using PC compatible computer, a couple of web cameras and a thermo sensor. Also, function of controlling systems/devices was simulated in software, represented with images of switches, changing their position from "off" to "on".

Apart from previously mentioned equipment, Nokia N80 cellular phone was used for sending and receiving SMS and MMS messages. For the purpose of capturing screen content of mobile phone for this paper, Mobiola Screen Capture software was used – which enabled having better image quality than when using digital camera.

B. Idea

In brief, the idea was that using certain commands, via SMS message, instructions are sent to central logic of intelligent building, based on which the logic would perform certain actions, informing sender on status of action (instruction received, action in progress, action succeeded, action failed). Performed actions in the experiment were: sending information on state of certain sensor (SMS) or diagram of fluctuation in time (MMS) and sending photo of current video from certain security camera. Data flow is shown in the figure 2.

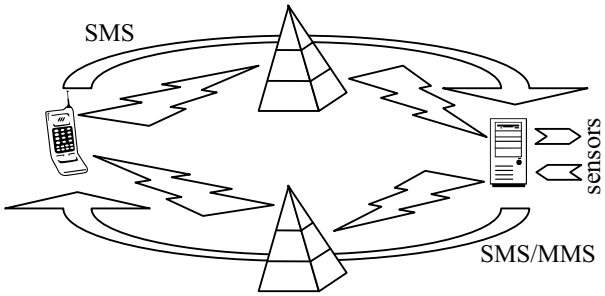

Fig. 2 Diagram depicting data flow between user and intelligent building

It is clear from previously stated, IBS responds to certain commands using SMS and on other using MMS messages, giving graphical representation of temperature fluctuation, or image from security camera.

Apart from replying to commands, IBS would also send warnings (alarms) using SMS or MMS to authorized users (depending on the situation). For security reasons, IBS would receive instructions only from previously defined phone numbers followed by password (in case that cellular phone was stolen).

C. Realization

According to what was stated so far, appropriate communication system was created. In experimental conditions, temperature from sensor was monitored in equal time intervals, as well as video from two web cameras, acting as security cameras. Temperature sensor data was recorded in the database, thus simulating real system.

Upon receiving appropriate SMS messages, the computer (simulating IBS) would reply either with current temperature sensor reading (using SMS), or would send MMS containing graph of temperature fluctuation in time. Since experimental software was not developed too sophistically, there where no option to choose time period for the graph, but the temperature fluctuation during the last hour was displayed (fig. 3).

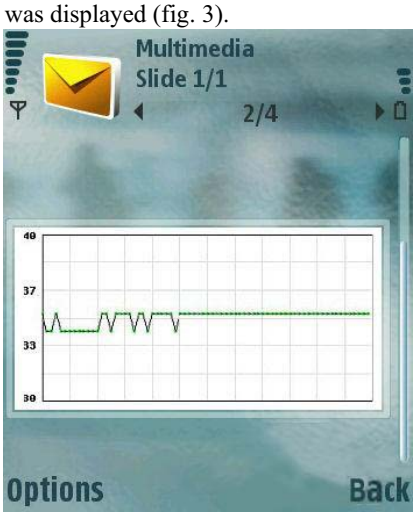

Fig. 3 MMS received by client's cellular phone displaying temperature fluctuation on targeted sensor.

Similar to this, sending SMS message with appropriate instruction, the computer replied with MMS message containing current image from targeted security camera video, along with the date, time and camera identification (fig. 4).

Fig. 4 MMS received by client's cellular phone displaying current image from targeted security camera.

Beside the above mentioned, experimental software contained sub-routine that graphically simulated control of certain devices by IBS upon receiving appropriate instruction codes by SMS message.

It is important to note that, due to lower price of a SMS message compared to price of a MMS message, authors tried to use SMS messages as often as possible, in order to achieve lower exploitation costs.

IV. Conclusion

There is no doubt that intelligent buildings are important, and that their importance will significantly grow in the future for numerous reasons. Some of them include health monitoring and timely health assistance, crime prevention, improved energy rationalization, work efficiency improvement, pollution reduction, etc. Therefore the need for advanced and more accessible communication between these systems and their users/administrators is clear.

With the method proposed in the paper, authors believe that they have demonstrated an efficient way of remote communication between IBS administrator and system itself. Efficient in many ways, including cost efficiency (simple solution, involving minor adjustments in existing systems, low cost of exploitation, mostly using already existing equipment), staffing efficiency (it is possible to monitor system without continuous staff presence), availability efficiency (GSM network is most widely spread network), etc.

This solution is not only usable for intelligent buildings, in business environment, but also in smart homes – where its benefits are numerous as well. It is easy to imagine advantage in turning boiler or central heating on, one or two hours before arriving back home from some trip – convenient, energy saving, cost effective. It enables to randomly turn on and off devices in the house in order to scare away possible burglars, etc.

Literature

[1] Zhang Yong-Qiang, Zhao Ji-Chun, Wu Ning, "Design and Realization of Embedded Image Transmission System Based on GPRS," *circa*, p. 39, International Conference on Computational Intelligence for Modeling Control and Automation and International Conference on Intelligent Agents Web Technologies and International Commerce (CIMCA'06), 2006

[2] Scott B. Guthery, Mary J. Cronin: Mobile Aplication Development with SMS and the SIM Toolkit. McGraw Hill (Telecom Professional). 2002.

[3] Gwenael Le Bodic : Mobile Messaging Technologies and Services SMS, EMS and MMS. John Wiley and Sons.

[4] http://www.objectxp.com/products/jSMS/

[5] https://pia.khe.siemens.com/index_wireless_modules.products_solutions.products_systems.terminals.mc35i_terminal-14274.htm

[6] http://www.eclipse.org/

[7] S. Faruque, Cellular Mobile System Engineering, Artech House Boston-London

[8] R. Prasad, CDMA for Wireless Personal Communications, Artech House Publishers Boston – London

[9] Milan Janković, Borislav Odadžić, Razvoj korisničko orjentisanih servisnih platformi u rezidencijalnom okruženju.