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SHAHID M. ZUBAIR
Dept. of Telecommunication, Atria Institute of Technology, ASKB Complex, Anandnagar, Bangalore – 560024, Karnataka, India, shahidmzubair@gmail.com

NIKHILA RAMESH
Dept. of Telecommunication, Atria Institute of Technology, ASKB Complex, Anandnagar, Bangalore – 560024, Karnataka, India, nikhilaramesh08@gmail.com

DIVYASHREE G
Dept. of Telecommunication, Atria Institute of Technology, ASKB Complex, Anandnagar, Bangalore – 560024, Karnataka, India, divyashree730@gmail.com

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SHAHID M. ZUBAIR[1], NIKHILA RAMESH[2] & DIVYASHREE G[3]

[1,2,3]Dept. of Telecommunication, Atria Institute of Technology, ASKB Complex, Anandnagar, Bangalore – 560024, Karnataka, India
E-mail : [1]shahidmzubair@gmail.com, [2]nikhilaramesh08@gmail.com, [3]divyashree730@gmail.com

Abstract - In India and many developing and under-developed countries, providing internet facility to many school-going students is still a far-fetched concept. Also, in places like DRDO, DRDL and ISRO campuses, where internet is blocked due to security reasons, lack of internet causes many problems even to those who have blocked it. In places where natural calamities have struck or in warzones where the attacker has taken down the internet infrastructure, contacting loved ones through social forums or just accessing basic internet facilities is impossible. In this paper, which is based on our project, we propose a new system which circumvents the internet architecture by using GSM infrastructure to access internet services, albeit on a reduced scale. This can be done by using a GSM Modem interfaced to a microcontroller (NXP in this case.) The command sets of each service offered in the system are integrated in the source code. The GSM Modem is controlled through AT Commands and sends SMS messages to access internet services and receives information in the form of SMS messages. All subsystems in the module are interfaced to the microcontroller.

Keywords- *GSM Modem; NXP Microcontroller; AT Commands; GSM Architecture; GSM Modem.*

I. INTRODUCTION

Internet usage in today's era has gone up by leaps and bounds. The rise of social networks has fuelled its growth in recent times. The need for communication and the hunger for knowledge has stimulated this rise. With the advent of 3G and 4G technologies, internet access has become fast and widespread. New wireless standards have allowed Wi-Fi users to have lightning fast speeds and long range. An estimated 2.28 billion people use internet worldwide today.

All these technologies, however, will be useless if there is no internet service available. No matter how advanced a device is or which generation it belongs to, it simply won't work if the internet architecture in an area breaks down or does not exist. If we venture out to rural areas in developing countries like India, chances are we won't be able to access even the most basic of internet facilities. This is because there is no internet service provider (ISP) in these areas. The internet infrastructuredoes not exist in these areas as it is not considered as profitable.

Internet was the major driving force in the popular uprisings in the Middle East recently. Protests were organized via social networking sites like Facebook and Twitter. Thus, it is no surprise why during wars, the aggressor always looks to take out or cripple the internet infrastructure of the defender. In such cases, there is no way for the populace of the defender, both local and foreign, to be in touch with their families through internet.

As good internet can be in this modern age, it also poses risks when it comes to security and confidentiality. Due to its widespread use, attacks on unsuspecting users have become frequent. The victim, however, may not be just a passive user. Many governmental and military agencies have been victims of cyber attacks in the past. Some agencies, to prevent such attacks, are prepared to let go of the benefits of internet for security and block it in their premises. Such agencies include ISRO and DRDO. Such measures have, of late, reduced their efficiency as there can be no substitute to the services offered by internet in terms of pure intellectual power.

There can be many other scenarios where lack of internet access poses many problems. Hence, there is need to develop new technologies which can provide internet access in such remote areas. In our project, we attempt to create one such technology which circumvents the entire internet infrastructure to access a limited number of internet services.There are three levels of internet access: 1.Full-internet, which can be accessed through laptops and PCs. 2.Mini-internet, which is accessed from tablets and smart phones. 3.Micro-internet, which is accessed using other mobile phones. As we go from full to micro level internet, we see that the scale of the devices reduces and the number of internet services offered also reduces. In our project, we introduce another level of internet, called Nano-internet, through which we offer a limited number of internet services on a reduced scale with respect to both size and cost.

II. SYSTEM ARCHITECTURE

The system being developed uses fairly low-cost components. The idea is to access internet services using a GSM modem through SMS messages. Figure 1 showsthe block diagram of our system which shall henceforth be called as 'Nano Internet System' or

simply NIS. Our goal is to create a low-cost device which can access internet in remote areas and provide a meaningful number of services. The input and output devices are a 4x4 keypad and a 16x2 LCD display respectively. The service requests are handled by the microcontroller. The microcontroller used is NXP P89V51RD2, manufactured by NXP. We use a SIM300 GSM modem to send and receive text messages from the NIS.

Since the GSM modem works on a TTL serial interface, we use a MAX232 IC which converts signals from a RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits.The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals.

The 4x4 keypad is used to give input to the NIS. It consists of 16 keys. It is interfaced such that it works like the alphanumeric keypad of mobile phones i.e. rapidly pressing a key will input a different letter, number or symbol. Other features like moving through the menu have also been interfaced to the keypad.

The NIS uses a menu-based system. All the services offered in the system are displayed in the menu. The user should select the desired service and use it. The menu is hard-wired. Hence, to change it, the entire source code has to be upgraded. This is one of the disadvantages of the system as it does not provide a real-time menu because it cannot be changed in real-time.

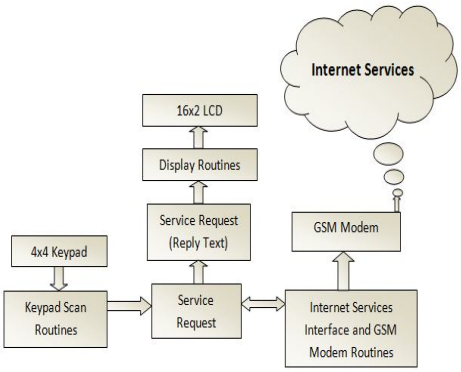

Figure 1. NIS block diagram

The internet interface is the source code. Each service offered has its own command set which has to be integrated into the source code as a separate function. The integrated command set must be in the form of AT commands which are to be sent to the GSM modem. A complete discussion on AT commands and their use in NIS is done in subsequent sections.

The source code is written in embedded C language. Currently, testing and troubleshooting is being done using the µVisionKeil and Flash Magic software. Hyper Terminal is used to interface the GMS Modem to the PC to test each service and GSM modem routines.

A. Internet Services Offered

A number of internet services can be accessed by sending SMS. Figure 2 shows some of them. However, not all of them can be used without at least a partial use of the internet architecture. Also, some of them cannot be accessed in some countries. Thus, the services which can be provided in the NIS differ in different areas. Hence, the system must make optimum use of services provided by global service providers (SPs) like Google.

The system we designed made use of a number of Google services provided by its Google Labs service. Now, many services which are provided by independent SPs are provided in the NIS.

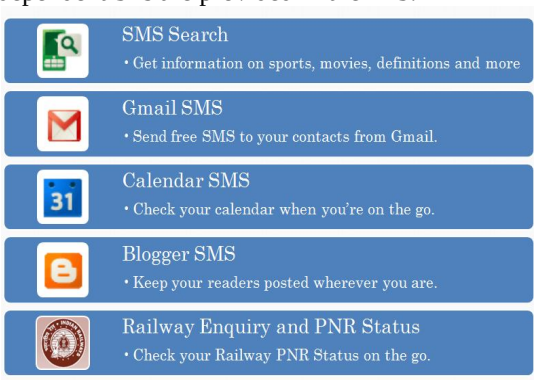

Figure 2. Some of the services offered in NIS

Each service has a command set of its own. This command set includes the form of the text message to be sent to perform different functions provided in the service. It also includes the number to which the text message has to be sent. This number differs for different geographical areas. For example, the number to use the Google SMS Search service differs in India from the one in USA. Thus, the NIS has to incorporate different source codes based on different geographic locations and include an option in the menu which lets the user decide the geographic location he/she is in.Alternately, we can use just one source code for all regions by suitably altering the different criteria for different regions based on the region selected by the user. Thus memory requirements of the source code can be kept to a minimum, although this would not pose any problems as the NXP P89V51RD2 has 64kB of flash memory and 1kB of RAM. Additional memory can be added by using an EPROM.

The command sets of each service must be incorporated in the source code in the form of AT commands which are used to communicate with the GSM modem. AT commands are dealt with in the next section.

B. GSM Modem and AT Commands

Table I Some SMS Atcommands Used Innis

Command	Description
AT	Check if serial interface and GSM modem are working.
ATE0	Turn echo off, less traffic on serial line.
AT+CNMI	Display new incoming SMS.
AT+CPMS	Selection of SMS memory.
AT+CMGF	Select the input and output format of SMS messages.
AT+CMGR	Read new message from a given memory location.
AT+CMGS	Send message to a given recipient.
AT+CMGD	Delete message.
AT+CSMS	Select message service.
AT+CMGL	List messages.
AT+CMSS	Send message from storage.
AT+CMGW	Write message to memory.

The GSM modem can be used by sending AT Commands to it. AT is an abbreviation for 'Attention Terminal' or 'Attention Telephone.' They are also called Hayes AT commands because they were introduced by Hayes Communications[x].

There are various AT command sets available for different purposes. The command set differs for different modems. A command set is available for each modem. The command set for a modem may include all or any combination of the call control, data card control, phone control, computer data card interface, service, network communication and SMS commands. For our purposes, we make use of the SMS commands along with some other basic commands.

Table I shows some of the basic SMS AT Commands used in NIS. Each command has a different syntax. For example, to send to send a message, AT+CMGS is used with the syntax:

AT+CMGS = "<Number>" <Enter>
<Service_command><Ctrl+z><Enter>

On execution of this command, the service command entered is sent to the specified number. The service command can be any command included in the command set of a service or it can be a text message which the user wants to send to a particular number.

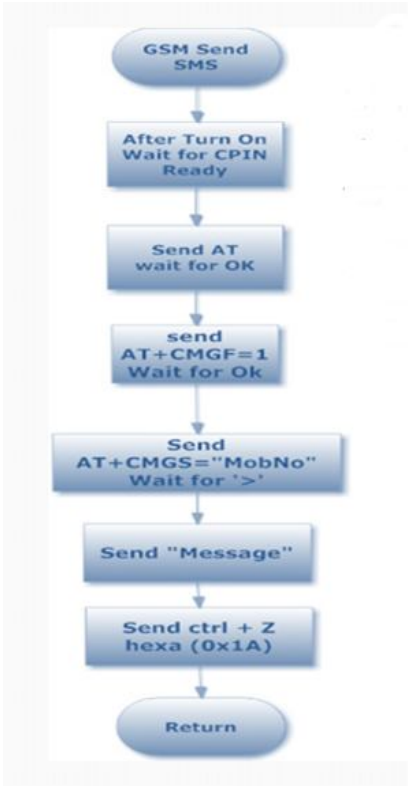

Figure 3. Flow chart to send a message using the GSM modem

Figure 3 shows the flow chart to send a message. After each AT command is sent to the GSM modem, the microcontroller waits for the modem to send an acknowledgement. The GSM modem can work in two modes:

- PDU mode
- Text mode

In the PDU mode, reading and sending SMS is done in a special encoded format. This compressed format saves message payload and is default in most modems. However, the PDU mode supports very few SMS AT commands. Hence, in NIS we use the text mode where reading and sending SMS is done in plain text.

C. NXP P89V51RD2 Microcontroller

The NIS device uses an NXP P89V51RD2 microcontroller. A key feature of the P89V51RD2 is its X2 mode option. The design engineer canchoose to run the application with the conventional 80C51 clock rate (12 clocks permachine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twicethe throughput at the same clock frequency. Since internet access is measured in terms of the speed with which it is accessed, we can use the X2

mode to decrease the send/fetch time of SMS in the system.

Apart from this, the microcontroller has a 64kB flash memory and a 1kB RAM. This will prove to be useful when a large number of services are provided to users in almost regions. The In-System Programming (ISP) feature will also allow us to reprogram the system at any stage of its development under software control. Thus, the capability to update the source code makes a wide range of applications possible.

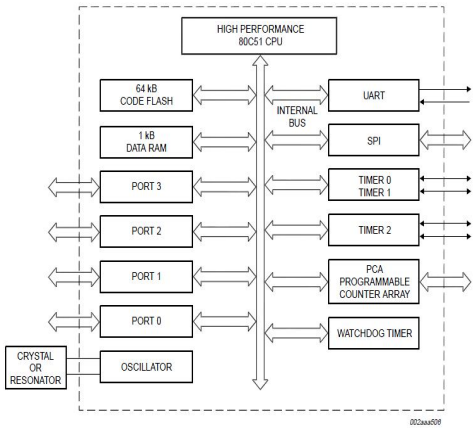

Figure 4. P89V51RD2 block diagram

The microcontroller used is also In-Application Programmable (IAP.) This allows the flash program memory to be reconfigured even when the program is running i.e. the program can be changed when the device is in the middle of an operation like sending an SMS.

As Figure 4 shows, the microcontroller provides three 16-bit timer/counter. The requirement of timers in NIS is critical. In a scenario where the GSM does not respond, we do not want the microcontroller to wait for a reply indefinitely. Hence, a timer is used to perform a time-out operation to re-perform an operation or show an error message on the display. Thus, the microcontroller will not enter a state where it will wait for an event to occur forever. This can also be done for other scenarios where time-out operation is necessary.

The ports P0 to P2 are used to interface different subsystems. The port P3 has pins for serial input and output, external interrupts and external data memory read/write strobes. It also pins for external count input for timer/counter 0/1.

III. WORKING OF NIS

Figure 5 shows the flow data in the NIS. The 4x4 keypad is used to input the data to the NIS. The input will include the selection of the service from the menu by the user. The menu is displayed on the 16x2 LCD display. It will consist of a complete list of the services offered by the system. The services offered will differ for different regions. The input will also include a function of the service. For example, while using the Calendar SMS service, different functions such as requesting scheduled events for the current day, next day or the next scheduled event.

All the input data is received by the microcontroller which, from the source code, generates and sends a service request to the GSM modem. In figure 5, the service request generator/receiver is the microcontroller. The internet services interface is the source code which has the command sets of all the internet services offered in the device in the form of AT commands. When the service request is sent from the microcontroller to the GSM modem, it is in the form service-command-incorporated-AT-command. The GSM modem performs the desired function and sends an acknowledgement to the microcontroller.

The GSM modem receives data in the form SMS messages and sends it to the microcontroller. The microcontroller then displays the received message on the 16x2 LCD display. But there is problem in this operation. If we use services like SMS Search, the reply consists of not just the search but also unwanted text like ads. This unwanted text can be present in any part of the SMS, the start, end or somewhere in the middle. This calls for a modification in the source code to include a text processing function. This function should analyze the received text, detect unwanted text and remove it before it is displayed.

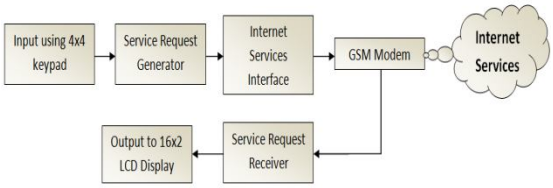

Figure 5. Flow of data in NIS

The fact that the content and position of unwanted texts in the received message is always the same for a particular service makes it a little easier to write such a text processing function. If the content of the unwanted text is always the same, a simple if-else instruction will form the text processing function. If the position of the unwanted text is always the same, the system can perform a function to only display the rest of the message. The job becomes easier if both the content and the position of the unwanted text are the same.

Some services do not require an input from the keypad. They are received when the SP sends an SMS. An example is the Bangalore-specific service provided by the Bangalore Traffic Police. This service informs the user of the roads in the city which he/she should avoid due to traffic jams. The messages

from this service are received at pre-destined times or when an arterial road is jammed. On an average, 4 messages are received per day. This is only an example and there many other services which fall under this category. The user will have an option to allow or block such messages as there are many messages from the network provider which one may wish to avoid.

IV. RESULTSCONCLUSION AND FUTURE ENHANCEMENTS

All the services are accessed by circumventing the internet architecture. The cost of accessing is virtually zero as internet data rates are avoided. The only charges one may incur are those of the SMS service. If the user has an SMS pack, this cost will also be removed. Thus, the only potential cost for the user would be the cost of the device itself, which, considering the low cost components being used, will not be high. Thus, our goal of creating a low-cost system which can access internet services without directly accessing internet is achieved.

Today's world requires technologies which enhance our experience of the web. Technologies like 4G and standards like IEEE 802.11ac Wi-Fi Protocol greatly expand the scope of the net. But what if the backbone on which these technologies, the internet infrastructure provided by ISPs, breaks down some day and pushes the world back to Stone Age? There must be an end-of-the-world insurance policy that will keep the world from breaking apart during such an apocalyptic event. NIS is one such effort to provide this policy. Though not complete and in no way final, it is a step forward towards achieving that ultimate technology which can provide cheaper access to internet for everyone. The bubbles left by ISPs where internet access is not possible have to be filled up and NIS is the way forward now.

It is obvious that this system is not complete. Thus, it has no future without it being enhanced. Many enhancements have been discussed and adopted or dropped. The main let-down in this system is the display and the keypad, the two main subsystems with which the user interacts. In future, the 16x2 LCD display can be replaced by a 128x64 LCD display or even an LED display. This would pave way for images and videos to be available in the system. Of course, there must be a service which offers them.It also requiresmuch advancement in GSM technologies and policy changes (read SMS cap) in the way SMS messages are delivered.

Many services like sending e-mails, accessing Facebook and chatting on Gmail are on hold due to different problems which can only be overcome when there are massive policy changes in India. However, they can be easily accessed in other countries. Such hurdles, when overcome, will clear the road for many such interactive services to be used in the system, making NIS a truly cutting edge system which provides the most popular web services without accessing the internet directly.

REFERENCES

[1] Kenneth J. Ayala, The 8051 microcontroller, USA, WP Company, 1991.

[2] I. Scott MacKenzie and Raphael C.W. Phan, The 8051 microcontroller, 3rd ed. USA, Prentice Hall, 1999.

[3] Thomas W. Schultz, C and the 8051, 4th ed. USA, PageFree Publishing Inc, 2004.

[4] Nicola Pero, SMS Messaging Applications, USA, O'Reilly Media, 2009.

[5] Atmel Corporation,Application Note, ATMEL: AVR323 Interfacing GSM Modem [Online], Available: http://www.atmel.com/Images/doc8016.pdf

[6] Developer's Home. Introduction to GSM / GPRS WirelessModems [Online], Available:http://www.developershome.com/sms/GSMModemIntro.asp

[7] Google. Google Services [Online], Available: http://www.google.com/mobile/sms/

[8] Philips Semiconductors, P89V51RD2 Manual [Online], Available: http://www.keil.com/dd/docs/datashts/philips/p89v51rd2.pdf

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