Hello guys have you ever thought of building a telephone yourself? Telephone and radio are some of the very important and early discoveries in electronics. There is a lot of information on the net about radio in fact you can see all types of DIY radio circuits both receivers and transmitters but very little about the DIY telephone circuits that you and I can have some fun with.

In a hi tech world we find ourselves today, we wonder about so many things especially in the field of electronics. This is because many things happen that we cannot see example; electron flow, electrical signals, computer programs just to name these few. Fortunately, the effect of it all is always very visible and useful

In this post am going to show you how to build a **VOIP (Voice over IP)** phone using very cheap components. To achieve our goal, we will design the **soft phone (Office com)** and a **hard phone** then we will use **MECAM SIP** protocol to communicate with someone on your **LAN (Local Area Network)** or even with me through the internet.

TELEPHONE BASICS

From a basic point of view, a telephone circuit is very simple. With a microphone and speaker you can do a closed circuit telephone as shown in fig1. `

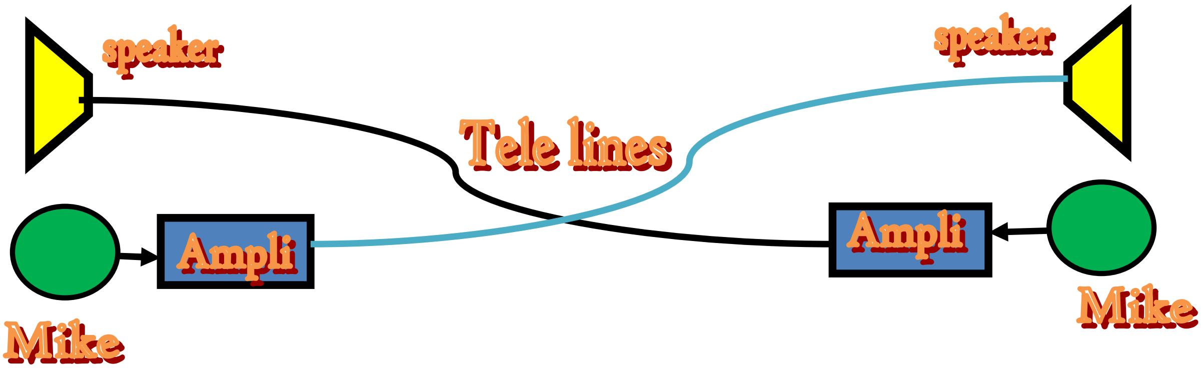


Figure 1 basic telephone principle

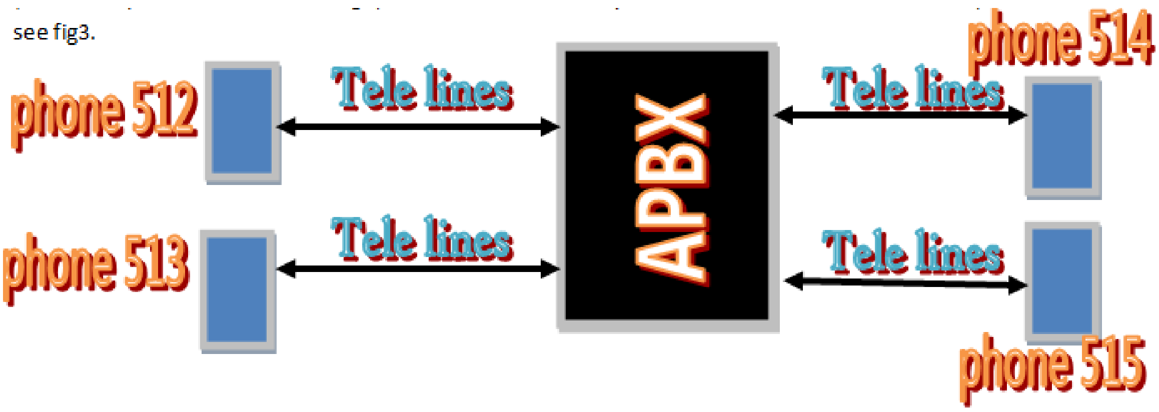
The illustration above will works fine if implemented but a real telephone of today should at list have the following basic functions;

- ALERT a phone should ring when there is an incoming call or SMS
- DIALER a phone should have a way of connecting to other phones on its network
- SMS a phone should be able to send and receive text messages

Well I know you will ask me what about multimedia and internet connectivity? Well let me remind you that today what we call phones are not actually phones they just look like phones. As a matter of fact they are some kind of mobile computers and are also called smart phones, Android phones etc.

From fig 1, you can easily add a ringer in other to alert the other party when you wish to talk with him. Now let's consider a situation where you need to add more phones so you can communicate say in your small business structure. In other to connect many phones you will be in need of an APBX (automatic private branch exchange) which will automatically route the calls based on number a plan see fig2.

Figure 2

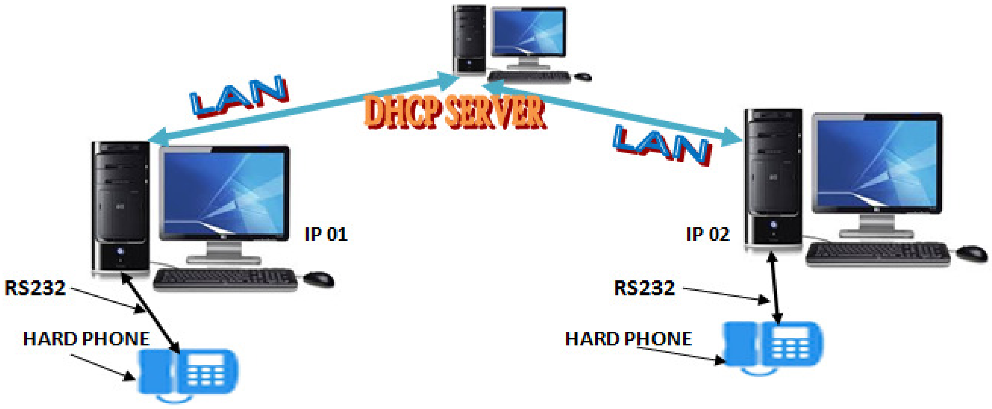


The above principle (fig2) in telecom is called **circuit switching** here relays are used to create full duplex lines for the phones to communicate. Realizing the PBX will be a bit complicated for a simple DIY project I know many will not like to do that so let's explore another option.

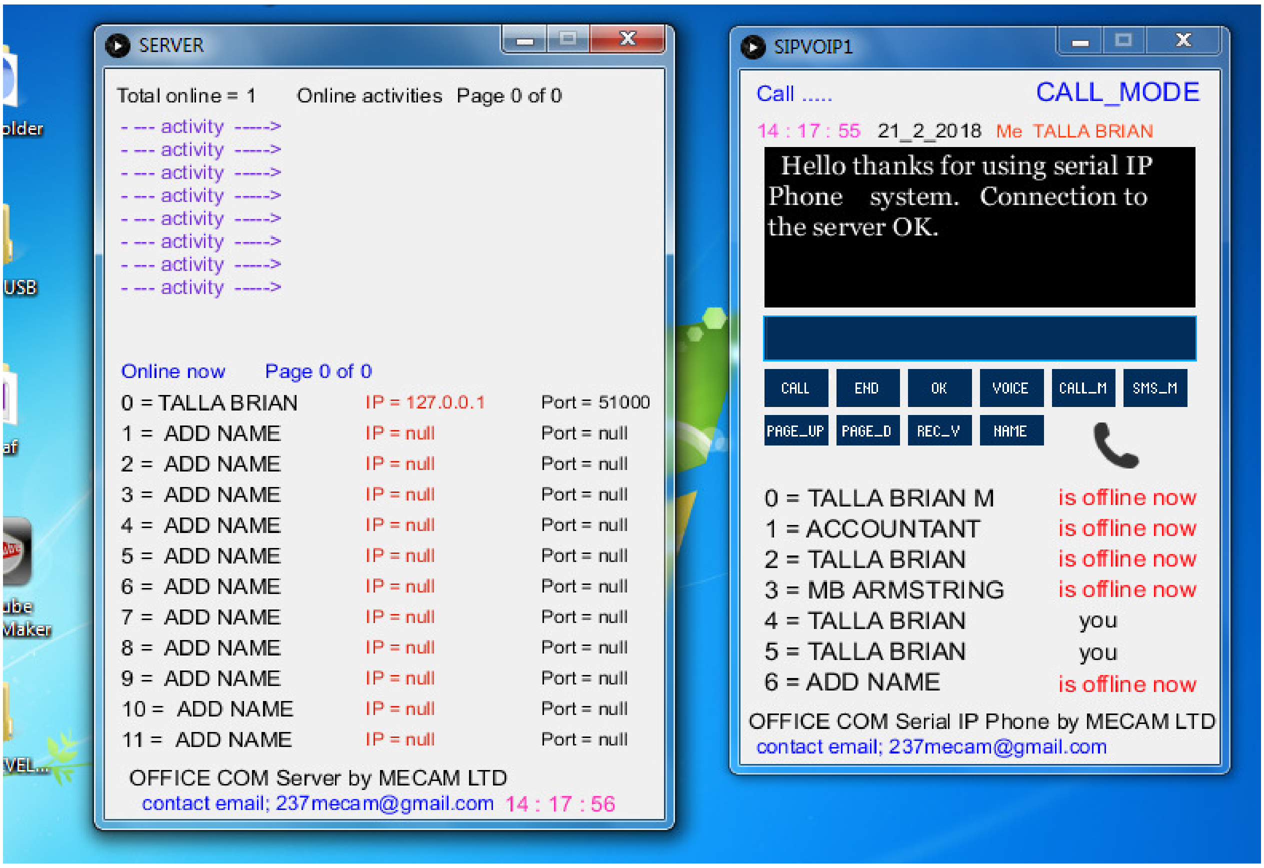
VOIP (Voice over IP)

THIS IS AN APPROACH DEVELOPED BY MECAM LTD

Figure 3



Voice over IP is a packet switched telephone technology which uses the internet protocol (**TCP IP**) to send and receive audio packets. Contrary to circuit switch, packet switch is software complicated and requires a microprocessor capable of implementing the TCP IP stack. You don't have to worry about all the hi tech soft phone application I have already developed it for you and it will be available for download along with the instruction on how to install. Those of you who are interested in its source code let me know but it's written in processing (a Java based IDE) which you can download **for free.** Below are screen shoots of the PC applications. Server, phone in call, voice and SMS modes respectively.



SERVER

```
Total online = 1      Online activities  Page 0 of 0
- --- activity ----->
- --- activity ----->
- --- activity ----->
- --- activity ----->
- --- activity ----->
- --- activity ----->
- --- activity ----->
- --- activity ----->

Online now      Page 0 of 0
0 = TALLA BRIAN      IP = 127.0.0.1      Port = 51000
1 =  ADD NAME        IP = null           Port = null
2 =  ADD NAME        IP = null           Port = null
3 =  ADD NAME        IP = null           Port = null
4 =  ADD NAME        IP = null           Port = null
5 =  ADD NAME        IP = null           Port = null
6 =  ADD NAME        IP = null           Port = null
7 =  ADD NAME        IP = null           Port = null
8 =  ADD NAME        IP = null           Port = null
9 =  ADD NAME        IP = null           Port = null
10 =  ADD NAME       IP = null           Port = null
11 =  ADD NAME       IP = null           Port = null
```

OFFICE COM Server by MECAM LTD
contact email; 237mecam@gmail.com 14 : 17 : 56

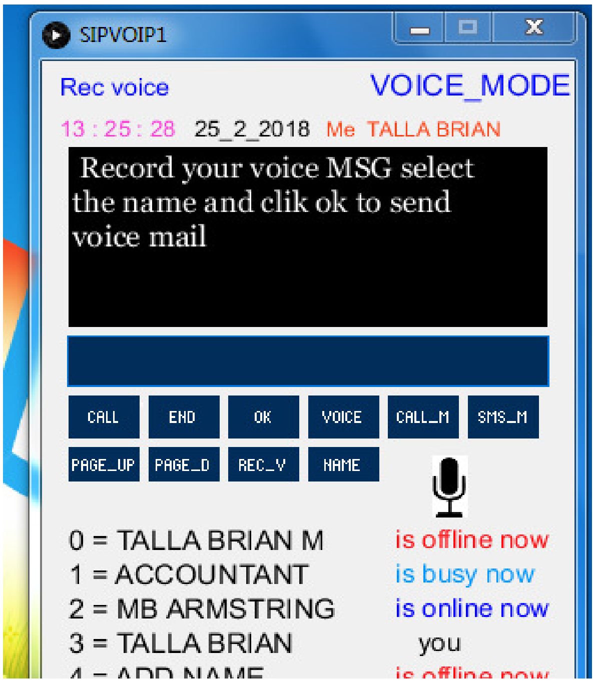
SIPVOIP1

```
Call .....                          CALL_MODE
14 : 17 : 55   21_2_2018  Me  TALLA BRIAN
```

Hello thanks for using serial IP Phone system. Connection to the server OK.

```
0 = TALLA BRIAN M        is offline now
1 = ACCOUNTANT           is offline now
2 = TALLA BRIAN          is offline now
3 = MB ARMSTRING         is offline now
4 = TALLA BRIAN             you
5 = TALLA BRIAN             you
6 = ADD NAME             is offline now
```

OFFICE COM Serial IP Phone by MECAM LTD
contact email; 237mecam@gmail.com

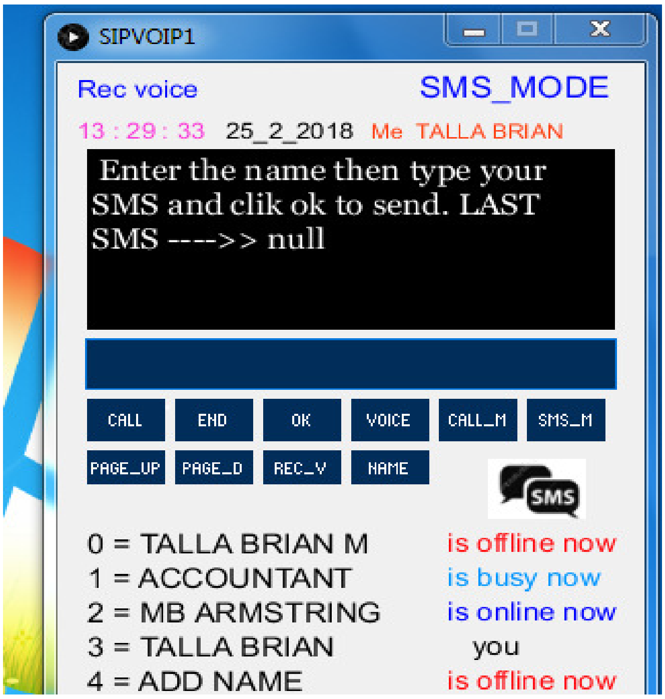


SIPVOIP1

```
Rec voice                       VOICE_MODE
13 : 25 : 28   25_2_2018  Me  TALLA BRIAN
```

Record your voice MSG select the name and clik ok to send voice mail

```
0 = TALLA BRIAN M        is offline now
1 = ACCOUNTANT           is busy now
2 = MB ARMSTRING         is online now
3 = TALLA BRIAN             you
4 = ADD NAME             is offline now
```

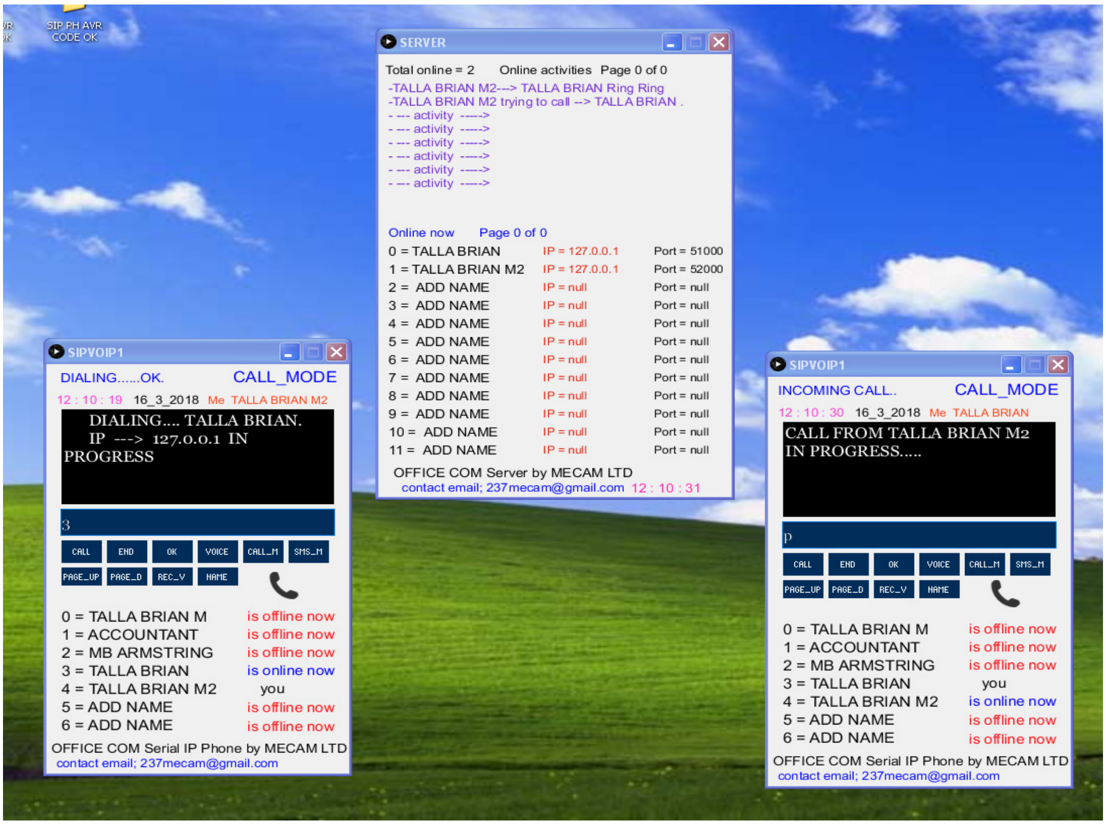


SIPVOIP1

```
Rec voice                       SMS_MODE
13 : 29 : 33   25_2_2018  Me  TALLA BRIAN
```

Enter the name then type your SMS and clik ok to send. LAST SMS ---->> null

```
0 = TALLA BRIAN M        is offline now
1 = ACCOUNTANT           is busy now
2 = MB ARMSTRING         is online now
3 = TALLA BRIAN             you
4 = ADD NAME             is offline now
```

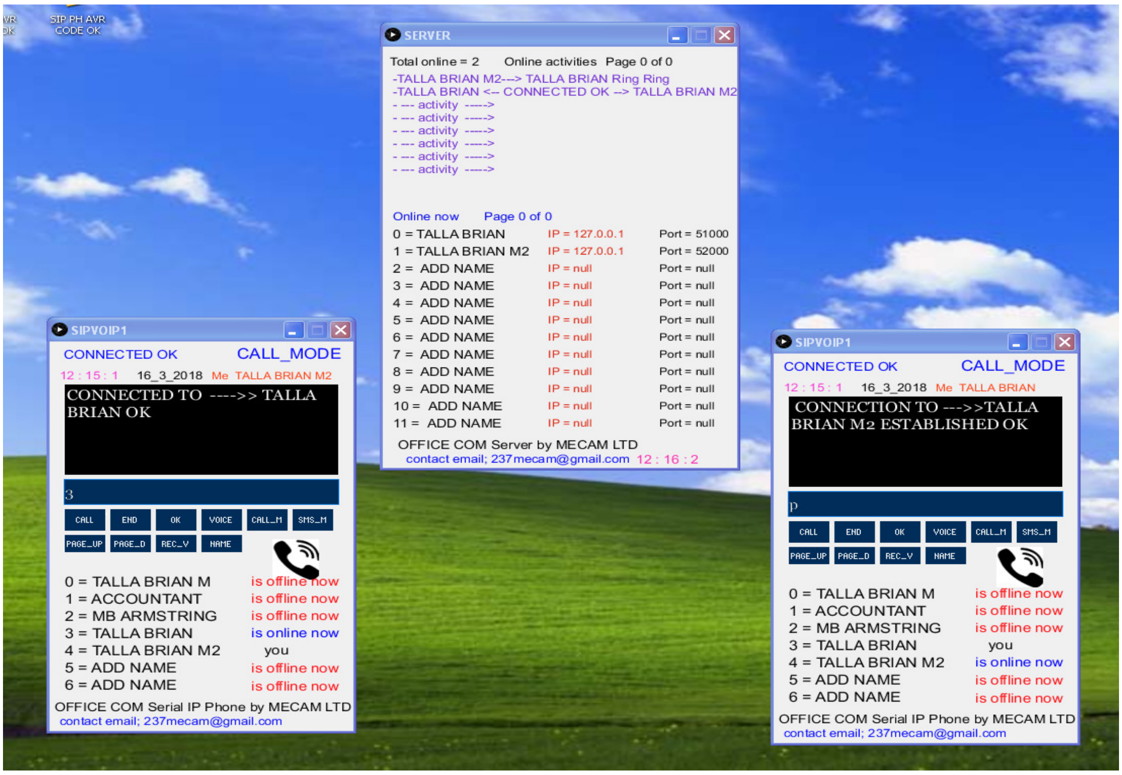


```
SERVER
Total online = 2      Online activities  Page 0 of 0
-TALLA BRIAN M2---> TALLA BRIAN Ring Ring
-TALLA BRIAN M2 trying to call --> TALLA BRIAN .
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->

Online now      Page 0 of 0
0 = TALLA BRIAN        IP = 127.0.0.1        Port = 51000
1 = TALLA BRIAN M2     IP = 127.0.0.1        Port = 52000
2 =  ADD NAME          IP = null             Port = null
3 =  ADD NAME          IP = null             Port = null
4 =  ADD NAME          IP = null             Port = null
5 =  ADD NAME          IP = null             Port = null
6 =  ADD NAME          IP = null             Port = null
7 =  ADD NAME          IP = null             Port = null
8 =  ADD NAME          IP = null             Port = null
9 =  ADD NAME          IP = null             Port = null
10 =  ADD NAME         IP = null             Port = null
11 =  ADD NAME         IP = null             Port = null
 OFFICE COM Server by MECAM LTD
  contact email; 237mecam@gmail.com  12 : 10 : 31
```

```
SIPVOIP1
DIALING......OK.                      CALL_MODE
12 : 10 : 19   16_3_2018  Me  TALLA BRIAN M2
   DIALING.... TALLA BRIAN.
   IP  ---> 127.0.0.1  IN
PROGRESS
3
0 = TALLA BRIAN M             is offline now
1 = ACCOUNTANT                is offline now
2 = MB ARMSTRING              is offline now
3 = TALLA BRIAN               is online now
4 = TALLA BRIAN M2              you
5 = ADD NAME                  is offline now
6 = ADD NAME                  is offline now
OFFICE COM Serial IP Phone by MECAM LTD
 contact email; 237mecam@gmail.com
```

```
SIPVOIP1
INCOMING CALL..                       CALL_MODE
12 : 10 : 30   16_3_2018  Me  TALLA BRIAN
CALL FROM TALLA BRIAN M2
IN PROGRESS.....
p
0 = TALLA BRIAN M             is offline now
1 = ACCOUNTANT                is offline now
2 = MB ARMSTRING              is offline now
3 = TALLA BRIAN                 you
4 = TALLA BRIAN M2            is online now
5 = ADD NAME                  is offline now
6 = ADD NAME                  is offline now
OFFICE COM Serial IP Phone by MECAM LTD
 contact email; 237mecam@gmail.com
```



```
SERVER
Total online = 2      Online activities  Page 0 of 0
-TALLA BRIAN M2---> TALLA BRIAN Ring Ring
-TALLA BRIAN <-- CONNECTED OK --> TALLA BRIAN M2
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->
- --- activity  ----->

Online now      Page 0 of 0
0 = TALLA BRIAN        IP = 127.0.0.1        Port = 51000
1 = TALLA BRIAN M2     IP = 127.0.0.1        Port = 52000
2 =  ADD NAME          IP = null             Port = null
3 =  ADD NAME          IP = null             Port = null
4 =  ADD NAME          IP = null             Port = null
5 =  ADD NAME          IP = null             Port = null
6 =  ADD NAME          IP = null             Port = null
7 =  ADD NAME          IP = null             Port = null
8 =  ADD NAME          IP = null             Port = null
9 =  ADD NAME          IP = null             Port = null
10 =  ADD NAME         IP = null             Port = null
11 =  ADD NAME         IP = null             Port = null
 OFFICE COM Server by MECAM LTD
  contact email; 237mecam@gmail.com  12 : 16 : 2
```

```
SIPVOIP1
CONNECTED OK                          CALL_MODE
12 : 15 : 1   16_3_2018  Me  TALLA BRIAN M2
CONNECTED TO ---->> TALLA
BRIAN OK
3
0 = TALLA BRIAN M             is offline now
1 = ACCOUNTANT                is offline now
2 = MB ARMSTRING              is offline now
3 = TALLA BRIAN               is online now
4 = TALLA BRIAN M2              you
5 = ADD NAME                  is offline now
6 = ADD NAME                  is offline now
OFFICE COM Serial IP Phone by MECAM LTD
 contact email; 237mecam@gmail.com
```

```
SIPVOIP1
CONNECTED OK                          CALL_MODE
12 : 15 : 1   16_3_2018  Me  TALLA BRIAN
 CONNECTION TO --->>TALLA
BRIAN M2 ESTABLISHED OK
p
0 = TALLA BRIAN M             is offline now
1 = ACCOUNTANT                is offline now
2 = MB ARMSTRING              is offline now
3 = TALLA BRIAN                 you
4 = TALLA BRIAN M2            is online now
5 = ADD NAME                  is offline now
6 = ADD NAME                  is offline now
OFFICE COM Serial IP Phone by MECAM LTD
 contact email; 237mecam@gmail.com
```

CALL MODE IN ACTION

Now it’s time for us to start our project.

1 PC applications (soft phone and server)

Things needed

- Pc with hardware serial port
- PC must be on a local area network(LAN)

1 hard phone

Things needed (main components)

- Atmega 16 AVR MCU
- Max232
- 11mhz crystal
- JRC
- PCB
- RS232 cable
- A telephone heard set
- 5v 1Amp power supply
- Three push buttons
- Three LED’s

SUMMARY OF OPERATION

As was seen on fig3 above, this project is based on **UDP**(User Datagram protocol) which obviously cannot run on the **ATmega16 MCU** so this MCU sends digital audio samples to the PC, sends commands, receive commands, receive audio data from the PC, play back audio data using PWM module, monitor push buttons and controls indicator LED’s . All of these functions have been achieved successfully with a clock speed of 11 MHz. it sounds impossible but its true it’s quite challenging as you have to dig right dip into handling **time critical events** on the

MCU and the PC. This platform will be small to explain the complete operation of this **VOIP approach by MECAM SIP (Serial IP Phone**) please don't get confused with **Session Initiation Protocol**.

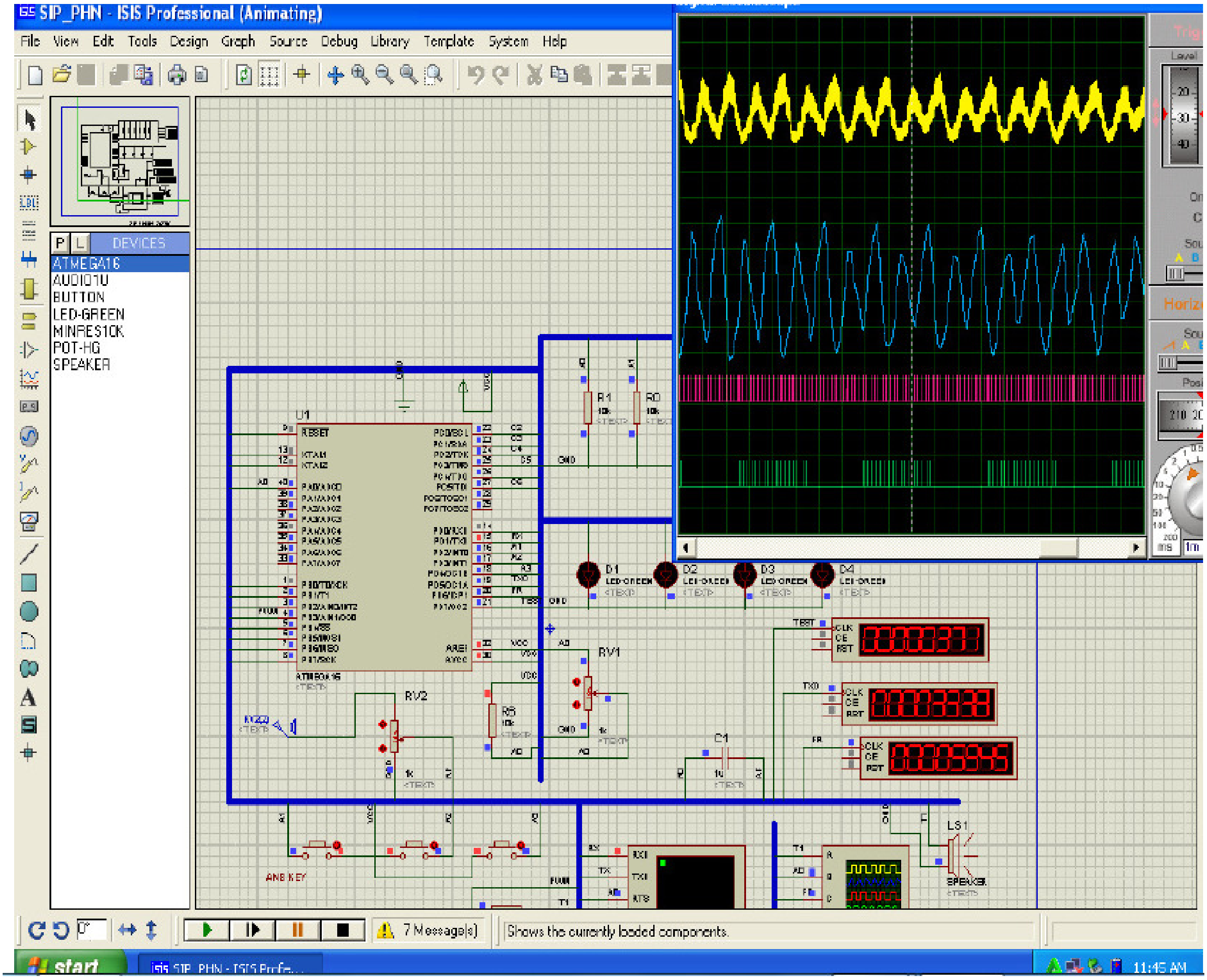
CONFIGURATION

To carry out this experiment you need at list two computers connected on a LAN (Local Area Network). One PC will host the server and office com SIP (serial IP Phone) applications the other PC will host the other SIP phone all the Phones are connected to the PC through the serial port. You must edit the phone name dot text file found in you download as follows;
1 change the IP address to that of the PC
2 change the IP of the server to that of your current server's IP (the IP of where you installed the SIP server)
3 it is important that the SIP server run on port 50000 to avoid interference from other UDP communications.
4 don't care about the phone book it will be given by the server so the server must run first before the phones so that the phones can get their current phone books.

After editing this file you can now run the application the information being displayed will guide you how to use it.
You will see those that are online and can now communicate with the using the various modes have fun with it and feel free to contact us for any issue thanks. Watch our YouTube at channel mecam for more details and you may request for the project download at 237mecam@gmail.com thanks.

SIMULATIONS AND TESTING

Simulation of the hard phone on proteus

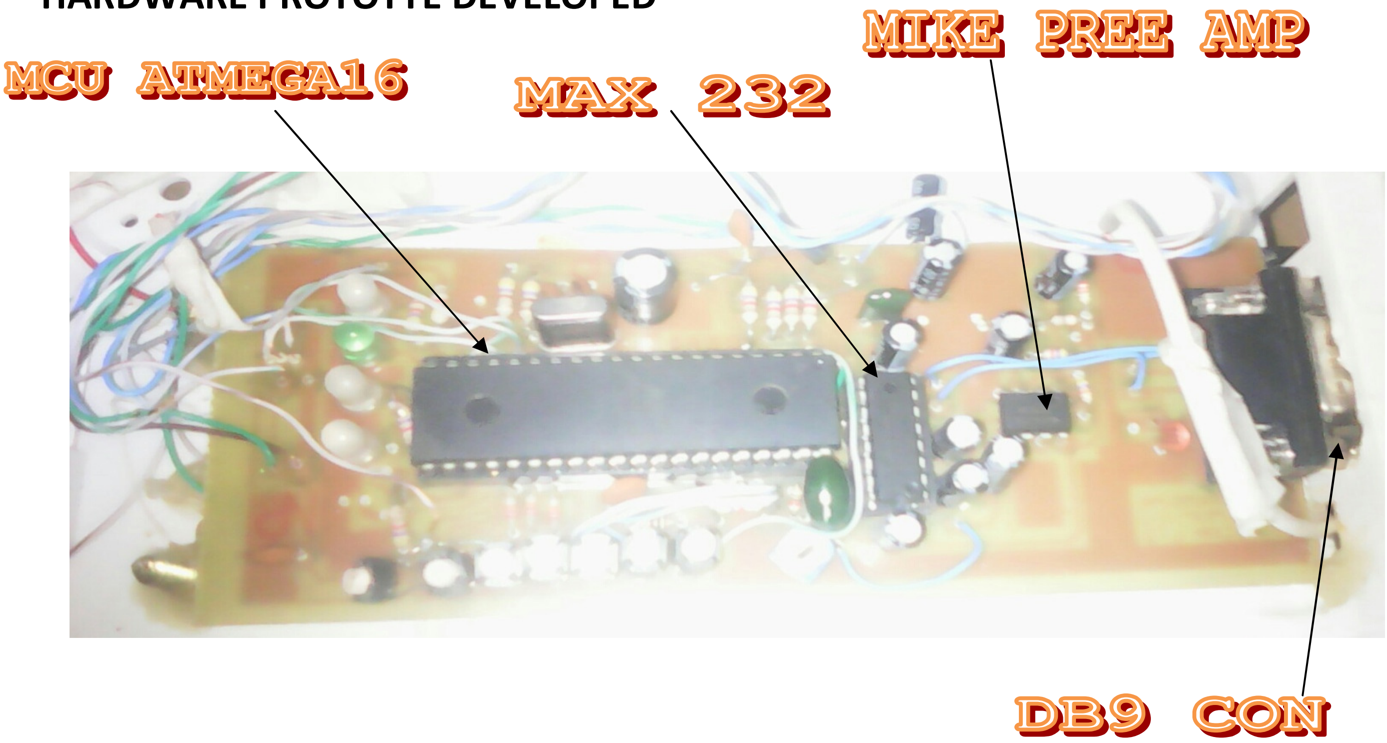


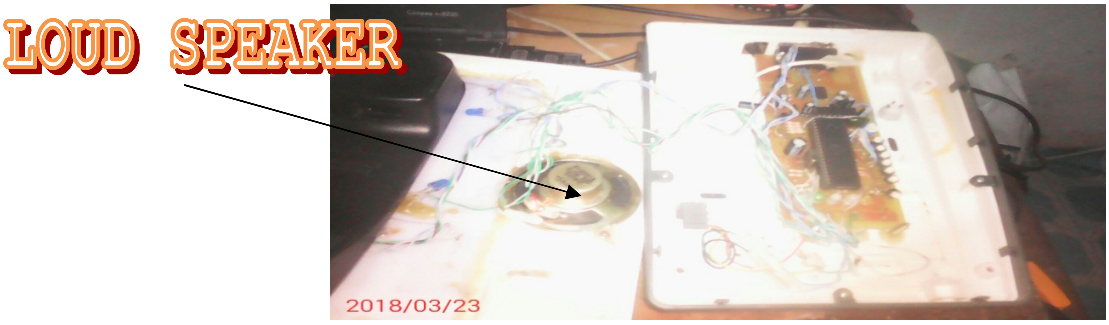
Shows the currently loaded components.

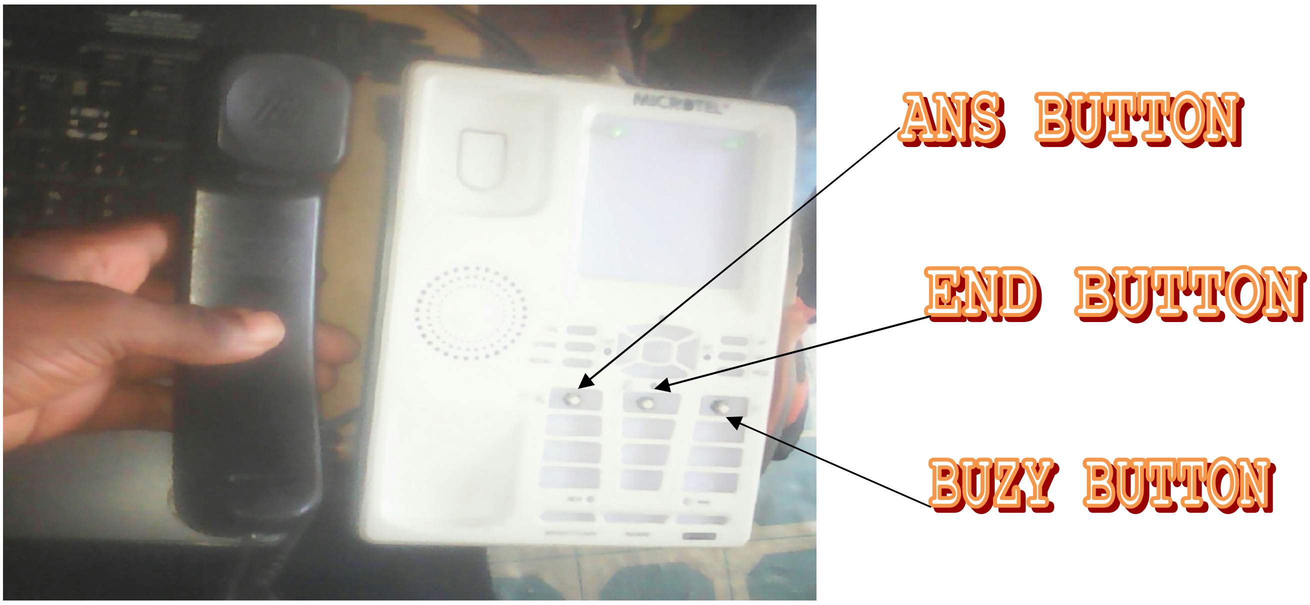
7 Message(s)

- Blue trace on the scope = the original speech signal
- Gray trace on the scope = the sampling frequency
- Yellow trace on the scope = filtered PWM speech signal from the MCU
- Green trace on the scope = silence detection
- Simulation with MCU running at 8Mhz

HARDWARE PROTOTYE DEVELOPED







SHOWING SOFT AND HARD PHONES

The above photos are just a few we could post for now a video demo of this project will soon be available. If you are interested in realizing this project please email me at 237mecam@mail.com your comments, critics and support will highly be appreciated thanks.

Engr Talla Brian Monde founder and CTO of Microelectronic Engineering Cameroon(MECAM)

Mr Mbariko Armstrong CEO MECAM