DESIGN OF PABX SYSTEMS USING BOARD COMPUTER

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***Abstract*—In this paper, we investigated designing Voice over Internet Protocol (VoIP) applications using a single board computer (SBC). Business VoIP is another aspect of this protocol which is found to be very convenient and profitable in the recent past and the present. This paper discusses a system developed with the use of VoIP in a simpler aspect, a prototype that could be used as a communication method between a couple of IP phones or PCs with VoIP enabled software with the use of raspberry pi. It also scrutinizes the advantages and disadvantages of VoIP and some aspects of VoIP applications as well.**

Keywords - Voice over Internet Protocol; VoIP Applications; Raspberry pi applications

I. INTRODUCTION

With the development of technology, the telephone network has become the major communication method all over the world. Most of the Private companies depend on these telephone network as they cannot exists without it. Therefore, many of them have decided to carry out their own telephone service. So that they could manage their own calls internal to the company. Currently voice telephony over mobile cost service provider such as GSM or Using IP service provider at a cheaper cost [1][2].

Voice over Internet Protocol (VoIP) is a method of communication that allows you to make phone calls over a broadband internet connection instead of normal telephone lines commonly known as the Public Switched Telephone Network (PSTN) that we use every day at home or in the office [3]. Unlike PSTN circuit-switched network, the packet-switched network is used in VoIP networks as the name implies, a packet-switched network transfers 'packets' or chunks of data from the sender to the receiver.

A packet-switched network can be more advantageous than a circuit-switched network because different routes can be used each time a chunk of data is sent, therefore data can still reach its destination in network failure situations. In a circuit-switched network, once the circuit connection has failed, the destination becomes unreachable. Additionally, with packet-switched networks only useful data is sent and received and only the necessary bandwidth is used. In the case of a paused conversation in the packet-switched network, no data is sent, and no bandwidth is utilized. Basically, VoIP uses the internet to communicate with other IP phones which must have an internet connection to all the phones, or some can use VoIP using traditional landline where we have to pay for the service. Also, some VoIP services required additional computer or a special adapter [4] [5] [6].

This technology is one of the most popular communication which can communicate from anywhere in the world. The number of service providers is increasing rapidly so it becomes one of the reasons for getting cheaper VoIP technology comparatively with others. Not only on business companies but also VoIP is being used in residential and domestics nowadays [7] [8].

The rest of the paper is organized as follows. **Section II** analyzes the related work, based on VoIP technology usage and its surroundings. Then **Section III** presents a system overview. **Section IV**, then discusses the designs and how the system is implemented. **Section V** then presents the results and conclusions that can be taken with the obtained analysis. **Section VI** gives a final overall conclusion to this system.

II. RELATED WORKS

Several contributions have been made on applications with VoIP and Raspberry pi, such as Raspberry pi clustering for VoIP communication [9], implementing VoIP using Raspberry pi as a server [10] etc. Few of those work is explained below.

Ashwini S. Gawarle has completed her research to design a free voice calling system using raspberry pi and she has reached her objectives of making a voice call when there is no network coverage and to make a free voice call without a sim card. She has used a raspberry pi, a router and an SD card while using software like Asterisk and PuTTY software to connect with mobile phones and has also used the Zoiper app to connect PC's. She has concluded saying that the VoIP technology can be of great advantage as per the cost factor and as there is no need for a network [1].

The parallel computing algorithm MPICH have been experienced in a Raspberry pi cluster for VoIP applications in the research conducted by M.W.P Maduranga and H.M.M Perera. They have set up two experimental setups using a single Raspberry Pi board and set up a cluster using three Raspberry Pi boards. Multiple simultaneous VoIP calls have been generated and CPU performance was analyzed based on the number of calls. It has been observed that CPU utilization had dropped dramatically when clusters are used [9].

Another research has been conducted with the objectives of developing a system which is cost effective and which utilizes the VoIP communication in embedded system. Here session initialization protocol (SIP) had formed the channel of

transmission in the system. Thus, a system had been developed by using open source free ware software and it is a cost-effective system that uses the basic VoIP as communication support and runs on small embedded hardware as its server [10].

A research on portable voice communication system on Raspberry pi has been conducted, using Asterisk as the software implementation of private branch exchange (PBX) with a Raspberry pi in LAN. Here Asterisk powers IP PBX frameworks, VoIP portals, gathering servers, and thereby at the end of the research they have gained many objectives such as a web app simple to oversee, sound video conferencing, remote IP telephone gadget with a low support cost [11].

III. System Overview

The system comprises of a Raspberry pi 3 for the interconnection of the IP phones and to control their services, the IP phones that need to be connected for the use of clients, necessary wires to connect all devices and a common Wi-Fi connection.

Fig 1: Raspberry pi 3

Along with IP phones, PC's can also be connected to this system, with the use of VoIP service, and the conclusions and reports with regard to the system can be obtained through the FreePBX.

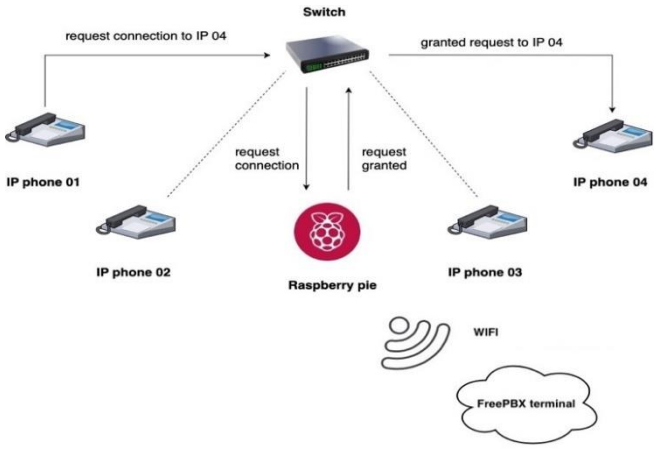

Fig 2: Overview of the system

IV. Designs and Implementation

First, we need to install FreePBX to the raspberry pi, a separate OS that enables VoIP in it, and then give a static IP address to the raspberry pi (not compulsory but easier if did). Then we need to setup the IP phones through the FreePBX terminal with the IP address given to the pi, giving the phones separate names so that it is easier to identify each and giving the IP phones static IP addresses so they won't change when the network is disconnected and connected again (For assurance). We can also use this PABX system with PC's by using a software that gives the VoIP service over calls (e.g. ExpressTalk), install it in your PC and set it up with the IP address of the Raspberry pi, so that you can call any phone or PC that is connected to the pi and the same network. One thing that we should also do, is give a common reference number to the connected devices so that any device could call another using this reference number. This number should also be given during the setup process.

V. Results and Analysis

After setting up the complete system with IP phones, PC's and the raspberry pi, we can make calls to any connected device by using the given reference number. It is also possible to make a few simultaneous calls (we tried 5 during tests), using this VoIP service through the raspberry pi. It is also possible to view the analysis and summaries through the FreePBX portal. We can view the network usage, the CPU usage, memory usage and many more using this same FreePBX terminal. This system gives a very clear channel or route from one device to another with the VoIP service through the raspberry pi, but it slightly reduces when the number of devices connected is raised to more than 5 or 6 devices.

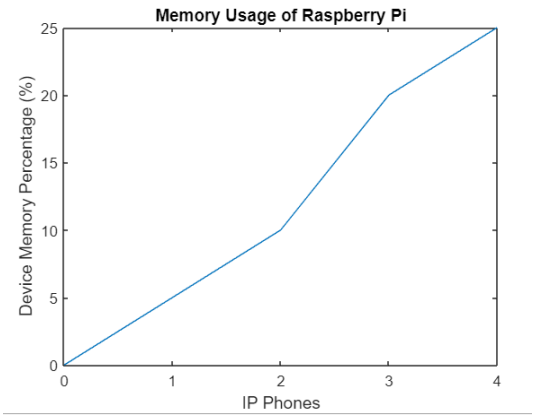

Fig 3: Memory usage of Raspberry vs the No. of IP phones

The above figure depicts how the memory usage of the Raspberry pi differs with the number of IP phones used. As it displays, we can see that even with 4 IP phones connected to the Raspberry pi, it occupies only about 25% of the total memory of it. Therefor we can conclude that at least 5 IP phones can be very easily connected with a single Raspberry pi at one time. We also got the statistics of CPU, memory, disk and network usage while the systems running on 2 or 3 IP phones.

Displayed in the below graphs is the network usage of the Raspberry pi, while a call is ongoing. There are 2 ends for the

network usage as the transmitter end and the receiver end of the Raspberry pi, where the Raspberry pie is the intermediate agent of every call. As we can see in the graphs, the amount of network used in approximately 40 seconds of a call is around 45 KB/s to receive and around 120 KB/s to transmit which are insignificant in a larger scale. On this scale we can approximate the usage of network for a call of around 1 minute, to be less than even 1 MB/s which brings huge advantages in a larger scale.

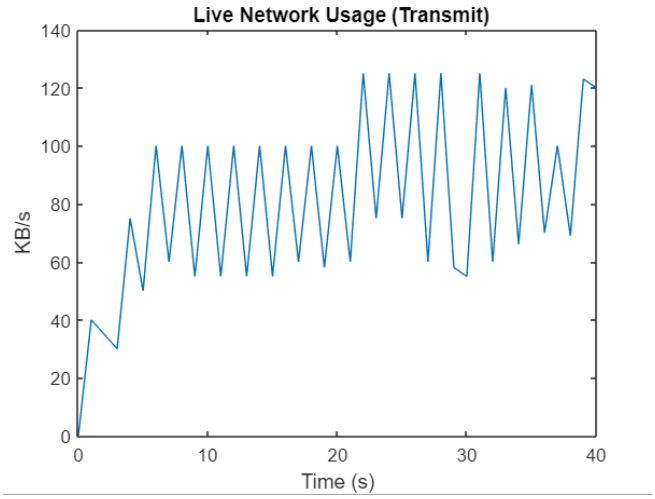

Fig 4: Live network transmission of the raspberry pi vs the time

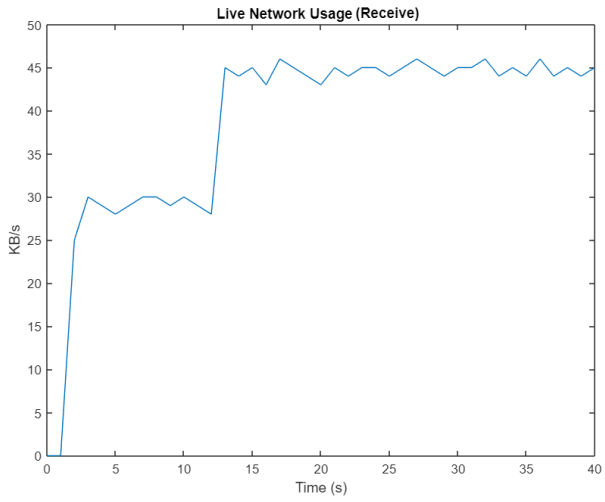

Fig 5: Live network receivance to the raspberry pi vs the time

VI. CONCLUSION

VoIP or Voice over IP allows users to make phone calls over LANs (local area networks) or the internet. This modern technology is capable of converting analog voice signals into digital packets of information. These packets can then be sent over the internet, allowing for conversations to take place anywhere in the world where an internet connection is available. You may likewise hear it referred to as IP telephony, internet telephony, broadband telephony, or broadband phone service. Business VoIP also is growing in use worldwide. While the technology has countless advantages, it also has its share of disadvantages. Advantages include the huge potential savings and greater scalability of systems. One disadvantage is that it requires a reliable internet connection with high bandwidth availability. Although VoIP involves the transmission of digitized voice in packets, the telephone itself may be analog or digital. The voice may be digitized and encoded either before or concurrently with packetization. Therefor the system we have developed can be deduced as a very basic yet a comprehensive call system with the use of FreePBX with Voice over IP, where only a microscopic amount of network is used during calls and it can be concluded as a very useful system that comes along with many advantages and benefits

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