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Next Generation Networks based implementation of eFax Services

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Abstract: The aim of electronic Fax (eFax) services is to allow sending and receiving of faxes through the internet. Our implementation involves development of a Fax server which when included in the IP (Internet Protocol) cloud can help Next Generation Networks (NGN) provide eFax services to its customers. We have implemented a HylaFAX enterprise server which is a telecommunication system for the UNIX environment supporting conversion of fax calls from fax machines to TIFF/PDF format and vice versa. The HylaFAX server is connected to an Asterisk PBX via an IAX channel. Its online interface is through AVANTfax which is a GUI for our server. The server communicates with Group 3 fax machines running T.30 and T.4 along with V.XX modulation schemes connected through Asterisk. It can also connect devices which work on the ITU-T recommendation of real-time FoIP T.38. The complete solution allows users to send/receive faxes to/from other fax numbers through an open source online interface AVANTfax. The solution presented has the capability to integrate with Next Generation Network.

Keywords: AVANTfax, Next Generation Networks (NGN), eFax system

1. Introduction

T.38 protocol was devised in 1998 to permit fax to be transmitted over the IP networks [1]. It is an ITU recommendation for allowing transmission of fax over IP networks in real time. In the late 90s, VoIP, or Voice over IP, began to gain ground as an alternative to the Public Switched Telephone Network. However, because most VoIP systems are optimized for voice rather than data calls, conventional fax machines worked poorly or not at all on them due to the network impairments such as delay, jitter, packet loss etc.

eFax is a value-added service of next generation networks which allows sending and receiving of faxes through email [2]. User aiming to send eFax is simply required to login to an online interface with login-account first. Then afterwards, the attached fax is sent to the fax number followed by a domain (such as: 1233455433@efaxdomain.com). Once someone sends a fax to an eFax number which is just like an ordinary fax number, it is forwarded to the concerned address. Existing Public Switched Telephone Network (PSTN) are utilized during the whole process. The main aim is to solve the transition from the fax communication on the legacy networks to the networks of the future such as internet. In order to provide advanced high data rate services, almost all of the services provided to customers need to do a shift to IP network. Fax has remained an ignored service since its limited use worldwide, but it still remains a service in use.

The rest of the paper is organized as follow: Section II describes the Related Work. Section III describes our Implementation. Section IV presents the results and Section V concludes the paper.

2. Related Work

The Fax technology is relatively outworn, and it is still extensively being used. The published work is limited to theoretical concepts rather than a practical approach. The researchers in [3] discussed a Real-time system implementation for Multicast Fax using IP Network. It provides the ground-basic concepts regarding the Fax over IP (FOIP), Transmission of Fax over multiple nodes, and Issues concerning the FOIP. In addition to that the signal flow is also presented in detail. Ref. [4] presents a Web Based Fax Server for

Home and Small Business Use and a practical approach for implementing a Fax Server using RISC embedded microprocessor with a built in fax modem and using a SENDFAX and RECVFAX scripts. However, our approach is slightly different since we are using Open Source Software Solutions and two different models with results compared in a graphical form. A SIP/T.38 Implementation in [5] uses 3 different network models to carry fax and data traffic and the results in terms of Delay and Link Utilization are compared. [6] Presents the concept of Internet Based Mail Fax Gateway Technology and is perhaps one of the earliest papers on the concept of internet based fax. It discusses the technology of Internet gateways with emphasis on the Intranet-based email fax gateway solution.

3. Implementation

The aim is to make use of open source software solutions in order to develop an application server responsible for sending/receiving fax. The objective is to perform the extra processing required at the core in order to provide efax services to end user. The design of our server revolves around three Linux based open source solutions:

- Asterisk
- Hylafax
- Avantfax

Our design involves two different network models:

a) DAHDI/ASTERISK interface to connect legacy fax machines with our network.
b) ATA/ASTERISK interface to connect future devices with T.38 Fax support to to our network.

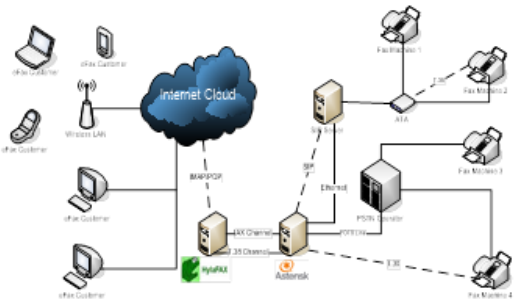

Fig. 1. Network Model for complete eFax Solution.

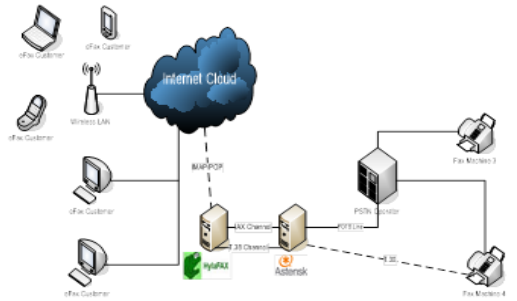

Fig. 2. The DAHDI/Asterisk Network Model.

4. DAHDI/ ASTERISK Model

DAHDI (formally known as Zaptel) stands for Digium Asterisk Hardwar Device Interface. It is an open source Device Interface Technology that is used to control Digium and other Legacy Telephony Cards. Figure 2 shows the Network Model for this scenario. The Foreign Exchange Office (FXO) Card is a telephony card with a port capable of receiving an analog line. The FXO Card is placed in the Server running both HylaFax and Asterisk. DAHDI comes in two packages i.e. DAHDI Linux and DAHDI tools. The details of each package are discussed in further section.

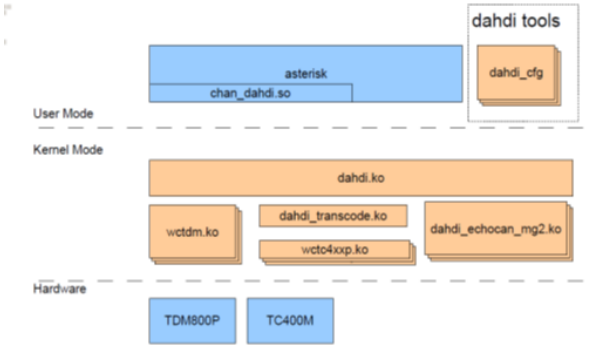

Fig. 3. Linkage of the two modes with hardware.

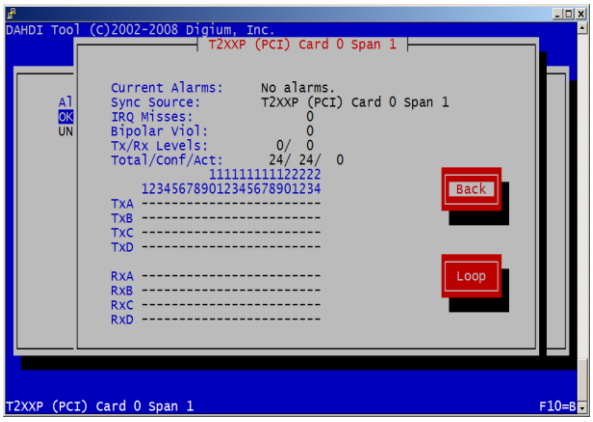

Fig. 4. Graphical Front End

a) DAHDI Linux

The DAHDI Linux contains a set of Kernel modules which need to be compiled before installing the DAHDI tools package. These Kernel modules link the User Mode to the Hardware. The kernel mode acts as intermediate between the two. DAHDI Linux part consists of the System Header files and Kernel Modules.

Figure 3. Linkage of the two modes with hardware.

The DAHDI tools consists of Configuration files and various commands for User Mode:

I. DAHDI_TOOL
II. DAHDI_TEST
III. DAHDI_MONITOR
IV. FXOTUNE

DAHDI_TOOL

Graphical front end for viewing spans on a system as shown in Figure 4.

DAHDI_TEST

Used for troubleshooting and qualifying platforms.

DAHDI_MONITOR

Used to record pre and post echo cancelled data on tx and rx directions of a DAHDI channel.

FXOTONE

Can dramatically reduce echo on analog lines.

FXO Card

The FXO Card used in implementation is a single port card similar to 56K Modem but with software compatibility for Asterisk. FXO card is linked with Asterisk using DAHDI.

Steps for Interfacing an FXO Card with the DAHDI:

- Compiling the kernel.
- Changing the configuration files.
- Configuring an Inbound Route.
- Configuring an Outbound Route

1. ATA/ ASTERISK Model

The second model comprises of an Analog Telephony Adapter which is directly connected to a SIP Server. The Adapter basically acts as a gateway between the Internet Cloud and the PSTN Network. The SIP Server communicates with the Asterisk Server via the SIP Protocol. Figure 5 shows the Network model.

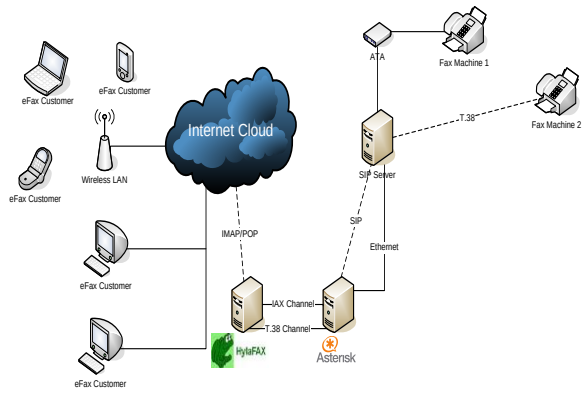

Fig. 5. The SIP/T.38 Network Model

An old fax machine connected directly to the SIP Server communicates via tha T.38 Protocol while another fax machine is connected to the SIP Server via the ATA.

5. Results

Using the DAHDI Configuration we were able to send and receive faxes to and from the PSTN Network. Using different sizes of files to determine the Network Latency. A file size of up to 7.2MB (Image File in TIFF Format) was successfully sent and received on the other end.

Figure 6 shows the file size-time relationship (size in Kbs on y-axis and time in seconds on x-axis) obtained with the network model employing a FXO card. This fax was sent from an old fax machine and received on AvantFax interface. The Graph clearly shows that the size-time relation is almost linear. Increasing the size of file increases the processing time. It takes time to adjust the skew for a large file.

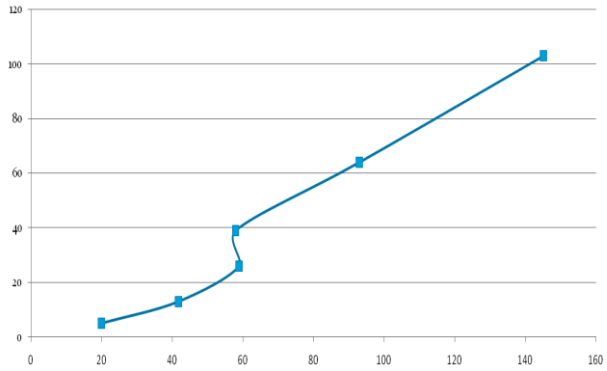

Figure 6. Size-Time Relationship for an Outgoing Fax

Figure 7 shows the sent fax size versus the time. The fax was sent from the AvantFax interface and received on the old fax machine. The Figure 7 depicts that by increasing the file size, the time increases exponentially in the beginning and then almost linear relationship between the size and time. Comparing the graph with the incoming fax, it is certain that the outgoing fax takes more time then the incoming fax. This shows the processing delay of the server during the outgoing fax. Other factors include the Network Congestion at the time the fax was sent and other delays at each node in the Network.

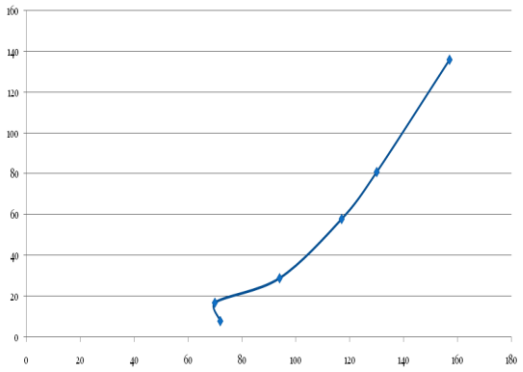

Figure 7. Size-Time Relationship for an Incoming Fax

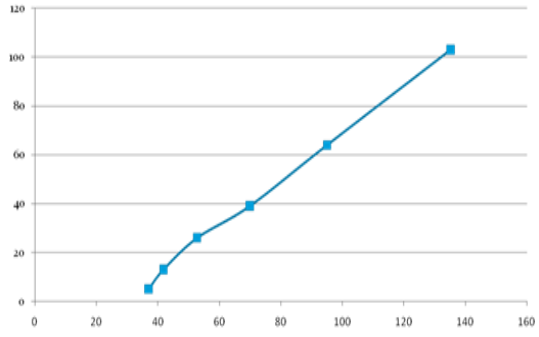

Figure 8. Size-Time Relationship for an Incoming Fax

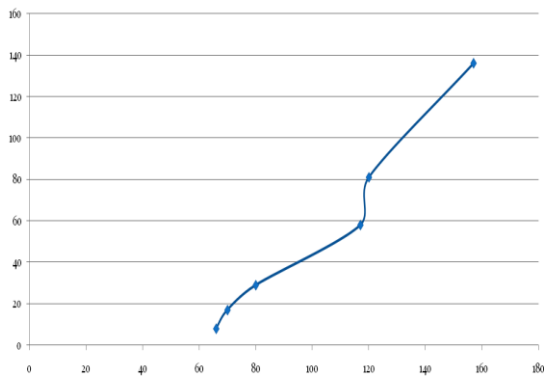

Figure 9. Size-Time Relationship for an Outgoing Fax

Using the SIP/T.38 Network model, the results obtained improved probably because the fax machine was connected by the server via the Analog Telephony Adapter (ATA). This may have reduced the Network Delay that was involved in the DAHDI/FXO Implementation. Figure 8 and 9 shows the Incoming and Outgoing Fax graphs (using the SIP/T.38 Network Model) respectively.

6. Conclusion

As the world is converging towards NGN there is a need to add various Value Added Services (VAS) in NGN. Efax is one the value added service of NGN. Fax is not becoming obsolete; it is the fax machine which is becoming obsolete. Old fax machines are still in use so eFax is aimed at integrating the old fax machines with NGN. With efax a customer can enjoy the fax service without worrying about inks, paper jams, missing important faxes etc. Since the user can send/receive faxes from anywhere in the world, provided he has an internet access. This brings mobility to the service of fax, as the customer does not have to worry about the fax machine any more. It also reduces the cost of buying a whole new fax machine. With efax a customer pays a fixed monthly amount and enjoys the service of fax. Furthermore the efax server can easily integrate with any Next Generation Network. With this integration it is possible for any NGN based company to provide the service to its customer by deploying an efax server.

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