This **Technology Guide** is one in a series of topic-focused Guides that provides a comprehensive examination of important and emerging technologies.

This series of Guides offers objective information and practical guidance on technologies related to Communications & Networking, the Internet, Computer Telephony, Document Management, Data Warehousing, Enterprise Solutions, Software Applications, and Security.

Built upon the extensive experience and ongoing research of our writers and editorial team, these Technology Guides assist IT professionals in making informed decisions about all aspects of technology development and strategic deployment.

techguide.com is supported by a consortium of leading technology providers. Vovida Networks has lent its support to produce this Guide.

Visit our Web site at **www.techguide.com** to view and print this Guide, as well as all of our other Technology Guides.
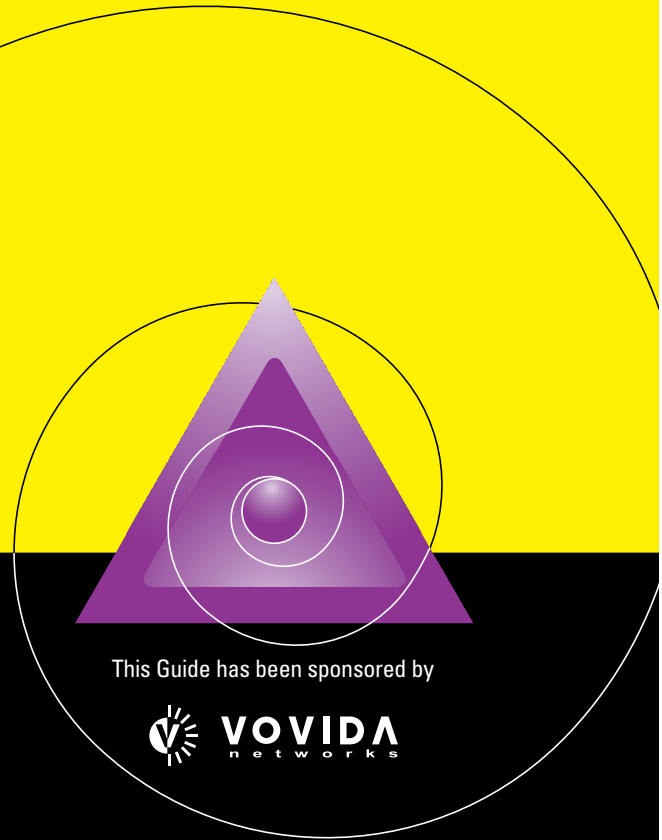
This is a free service.

Vovida Networks'
VoIP On Linux

produced and published by

techguide.com

visit www.techguide.com™

This Guide has been sponsored by

VOVIDA
networks

Table of Contents

About the Editor…

Jerry Ryan is a principal at ATG and the Editor-in-Chief of techguide.com. He is the author of numerous technology papers on various aspects of networking. Mr. Ryan has developed and taught many courses in network analysis and design for carriers, government agencies and private industry. He has provided consulting support in the area of WAN and LAN network design, negotiation with carriers for contract pricing and services, technology acquisition, customized software development for network administration, billing and auditing of telecommunication expenses, project management, and RFP generation. Mr. Ryan has been a member of the Networld+Interop Program Committee and the ComNet steering Committee. He holds a B.S. degree in electrical engineering.

Abstract

VoIP (Voice over IP) is a new technology that enables telephone communication over packet switched networks such as the Internet using the Internet Protocol (IP). Internet Service Providers (ISPs), Application Service Providers (ASPs), Local Exchange Carriers (LECs), and Inter Exchange Carriers (IXCs) may all desire or need to implement this technology in order to gain or retain a competitive edge by offering an array of new services to their subscriber base.

Vovida Networks' VoIP solution provides call control plus switching and advanced feature capabilities that run on the Linux operating system, which allows it to be easily ported to any Unix based system. Although there are some misconceptions about the viability of using Linux for mission critical projects and there are questions about the effectiveness of an open source solution, both analysis and experience has shown these doubts to be unfounded. Linux's high reliability combined with the low or nonexistent licensing cost of open source are key business reasons to seriously consider the Linux operating system in the VoIP context.

In addition, the culture of openness and rapid development that surrounds Linux and open source solutions are additional reasons for choosing Linux for mission critical applications. When VoIP is implemented on a Linux platform, it is supported by a rich operating system that is under continuous development and debugging by talented programmers and developers who willingly share their solutions with the rest of the community.

This white paper reviews the advantages of Vovida's particular VoIP solution, focusing on the contributions of the Session Initiation Protocol (SIP), Linux, and the open source solution.

Introduction

Vovida Networks is a global provider of communications software. The Vovida Open Communication Application Library (VOCAL) enables advanced telephony features, applications and services to be rapidly and effectively deployed on converged datacom-telecom networks in carrier and service provider environments. Among these advanced services is Voice over IP.

Voice over IP (VoIP) is a new technology that replaces the traditional hardware switches and other legacy telephony equipment (Figure 1) with software switches and voice communication protocols, transmitting voice via the Internet's own IP protocol. VoIP is vital, according to some analysts, to the continued existence and profitability of Internet Service Providers (ISPs), Application Service Providers (ASPs), Local Exchange Carriers (LECs), Inter Exchange Carriers (IXC). For purposes of this paper, hereafter "Service Providers" will be used to collectively refer to this group. Providing voice communication over the Internet is one of the key capabilities that will enable these providers to take advantage of the next generation of product offering opportunities.

```
        ┌──────┐
        │ SS7  │
        └──────┘
┌──────────────────────────────────┐
│ ┌────┐   ┌──────────┐   ┌────┐    │
│ │    │   │  CALL    │   │    │    │
│ │    │   │ CONTROL  │   │    │    │
│ │Line│   └──────────┘   │Line│    │
│ │Card│                  │Card│    │
│ │    │   ┌──────────┐   │    │    │
│ │    │   │Time Slot │   │    │    │
│ │    │   │Interchange│  │    │    │
│ └────┘   └──────────┘   └────┘    │
└──────────────────────────────────┘
```
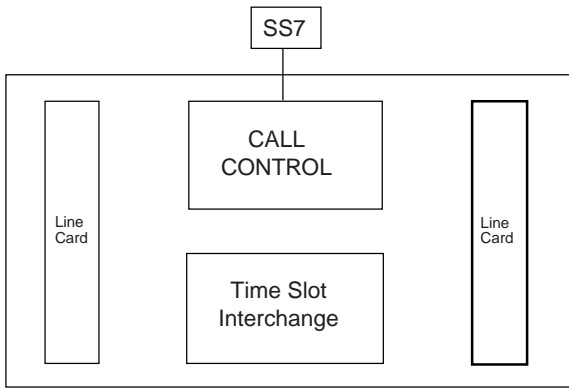
Class 5 Switch
Monolithic, i.e. Lucent

Figure 1 — Vertically Integrated, Proprietary, Circuit-Based Switch

In a typical VoIP-enabled office environment, an end user initiates a call by picking up a phone, which may be an old style analog device or a new style digital phone, or even a headset, plugged into an Ethernet card. Once the user dials the number, whether by keying it on the phone or by using telephony application software on the computer, a routing server looks to see if the phone number is in its database and connects the call. If the call is to someone outside of the network, the routing server routes the call to a gateway device that acts as a portal to the Public Switched Telephone Network (PSTN) for call completion.

The Vovida family of products is developed on open source, IP-centric, communications software that provides packetized voice, video and data traffic over converged datacom and telecom networks. The core software resides in an industry standard Intel-based server. By integrating Vovida software, Service Providers can build flexible, customized communica-tions functionality for the specific needs of their subscribers.

Vovida has chosen Linux, an open source version of Unix, as the operating system for its VoIP platform. Unix has been widely accepted by Industry as the preferred operating system for high reliability systems and applica-tions. Linux has evolved out of Unix, leveraging the inherent stability and reliability with an improved perfor-mance-to-price ratio based on open source contributions from a wide development community.

The foundation of VoIP is the communications protocol selected to handle the telephony connectivity and switching functions necessary to place calls over an IP environment. Vovida is an industry leader in utilizing Session Initiation Protocol (SIP) - it is non-proprietary, flexible and simple to implement and manage.

It is the combination of a robust Linux operating system and a scalable architecture based on the SIP protocol that makes Vovida Networks' VoIP solution the solid choice for new network implementations.

Convergence: The Telephone and The Computer

The rapid growth of the Internet and the industry surrounding it is almost legendary. In the mid-nineties, telephone and cable companies sparred over which could provide the fastest and most reliable service with the most content and ISP's have become caught up in this struggle. The result is sometimes the collapse of small ISPs, or dwindling profits for larger ones as they try to establish strategic but ultimately losing partner-ships with one side or the other.

New Services Offer Competitive Edge

The business of providing Internet connections has become so competitive that the ability to provide new additional services may make the difference

between success and failure. Content, many say, will be the name of the game. ASPs certainly are poised to take advantage of this opportunity with innovative features and services, while LECs and CLECs come at it from the other end, already providing telephone service and trying to integrate Internet access with it. The development of Voice over IP (VoIP) gives these companies new service alternatives to offer their customers. While many of the previous items that brought telephony and computers together were new types of hardware, this step in technological evolution is a matter of software and protocols.

VoIP and the Network Service Provider Marketplace

VoIP comes about at an opportune time, in particular for the ISPs that need to find ways to expand and enhance services to their customer base. Conversely, the relatively new ASP community also needs to incorporate some traditional telephony services along with their new service paradigm. VoIP offers both of these segments the opportunity to expand their service offerings.

Traditional PSTN (Public Switched Telephone Network) providers also need to take VoIP seriously. Without deploying VoIP, they could be left without the ability to compete for telephony services. They could be relegated to merely managing their leased line data infrastructure and reselling network capacity to faster moving competitors.

One reason that LECs feel competitive pressure today is that their business has traditionally been expensive to break into - the costs of equipment, software, and the man-hours necessary to deploy and maintain an infrastructure were too prohibitive for all but a few big players. But today ISPs and ASPs already have the necessary networking apparatus to compete in a VoIP market. This levels the field with all of the different Service Providers competing to put together their own VoIP solution and packaging structures.

As VoIP protocols and services mature, telephony and data traffic will merge completely on the network. Customers will have more choices about telephone services, because VoIP will open up the playing field for all types of telephony providers.

The VoIP Environment

VoIP, as its name describes, works over any data network using the Internet Protocol (IP). This enables the relatively easy deployment of new services and telephony features - everything from web-based control of the phone system to providing long distance service to homes and offices. To build this effectively, providers need a reliable operating system upon which to put their new services.

Linux as a Solution

Enter the new kid on the computing block - Linux. Linux is an open source derivative of the Unix operating system. Its user base has grown dramatically in recent years and it has a strong foothold with home users, business enterprises and service providers. Linux provides an alternative to the proprietary Windows NT and Solaris systems.

Linux grew up in conjunction with the open source and free software movements that evolved during the 1990's. The general purpose of these two movements is to provide software that includes source code for the people who download or purchase it. Once they have the code, the user can then modify it as needed and even share these changes with the rest of the community by integrating it into an application or system package. In many ways this is the main strength of the open source movement. Every person who wants access to the source becomes another developer added to the debugging process.

Vovida Networks' VoIP Solution On Linux Meets Business Objectives

One business decision that every computer services provider must make is the choice of operating system on which to build their services. After all, computers are tools, and a smart company utilizes the best tools for each project. Linux is a tool that makes a great deal of sense for a company that wants to implement network services, including VoIP. It is an operating system with which many service provider administrators are already familiar.

Benefits of Linux

There are several cost benefits to using the Linux operating system: wide vendor support, limited licensing costs, and wider choices.

Wide Vendor Support

Because it works on a wide range of hardware, implementers are not forced to buy equipment from one particular vendor or even from one of a short list of vendors. Information about what products and services are compatible with the Linux operating system is continuously updated and is available for review and evaluation. Manufacturers, especially of server equipment, are eager to assure users that their hardware is on those lists.

If a device is not currently supported, the manufacturer is likely to have an idea of when it will be. And if not, there are other manufacturers on the list that do make comparable equipment supporting the desired application or service. A person needs only to look in one of the Linux magazines available on the newsstands to see the wide range of hardware, software, and services supported by Linux.

Limited Licensing Costs

An equally large cost concern is the price of the software used to run the service. This cost can balloon if expensive licensing structures are put into place. Those who need to serve a large customer base or have a large development staff discover that the cost of licensing alone can far exceed the price of the hardware.

Wider Choices

The beauty of Linux as an open source operating system is the avoidance of vendor lock-in. Users can choose either to go or not to go with the vendor for their support and custom programming solutions. The user has the option of doing its own custom work, or hiring one company for support, and yet another for custom programming work. The programming could even be done in-house. If anything, having competition for support and satisfying custom needs causes the vendor to offer better service than those who know the customer has nowhere else to go.

When only the company that provides the original solution can make any repairs, upgrades, or alterations, the user is dealing with the problem of vendor lock-in. This is one of the most frustrating aspects of proprietary software, especially when the vendor has sub-par service or if the user needs are greater than those of the provider's typical client.

The Open Source Community

Another factor that makes open source so desirable is that the entire community has access to the code. In the case of the freely downloadable VoIP software from Vovida Networks, anyone with the desire and

expertise who wants to do so can submit patches and suggestions to help debug and improve the base package. Although it is difficult for those who come from the world of proprietary software to understand why people might do this, it is commonplace in the open source community.

Often, the motivation that drives many in the open source community is to get the recognition of their peers. To be known as the person who found and fixed an elusive bug, or who donated a particularly clever piece of code is enough for many people. Typically, anyone who contributes to the code is listed there - and perhaps, as well, on a Web site acknowledging contributions. If it seems unlikely that some people might participate in the open source community only so that they can be acknowledged as a contributor to a major package, keep in mind that there are advantages to being on a software contribution list. Being listed amongst the bug fixers or feature donators is résumé material, and useful for drumming up custom programming, consulting, and support business.

This encourages robust and flexible software, since the moment that anyone discovers a problem, they can turn around and look for a solution themselves. If the discoverer does not have the knowledge or talent to fix the bug, he or she can point it out to the vendor or post the issue to the Internet, often on the vendor's own Web site. Someone else will fix the problem quickly. Sometimes it even becomes a race to see who can do it first and best.

Involves Hardware and Software Vendors

Open source encourages more than just the general community to get involved. Many hardware and software vendors search out those who are making their own solutions compatible with the new package and provide code and drivers to make sure that it works properly with their own systems as well. This policy makes sense as the market fragments. Cross-compatibility will be important for those wanting to broaden their own customer base. The consumer wins as well. When a number of packages all support the same hardware and can talk to each other, the vendor can worry less about being locked into specific product combinations and more about which one is the most efficient and best meets the client's needs.

No Proprietary API's

Vendors aren't the only ones who can add to the code. Downloading an open source solution allows any developer to add new features to the software. These features do not have to be small improvements that merely interface with a primary product. A Service Provider, vendor or business partner can develop its own code to add new VoIP features on top of what is already there. There are no proprietary Application Program Interfaces (API's) with vague specifications standing between the user and a solidly integrated solution. Instead, the user gets an API as well as the direct ability to look at the source. This factor is one of the primary attractions for companies to utilize open source products.

Community Contributions

One technical advantage of implementing VoIP on Linux is the access the user has to a wide base of professional programmers who are used to having their code examined by the greater Linux community. This creates a group of people who are serious about putting together good, clean code without ugly and embarrassing shortcuts and hacks. While these programmers are useful for helping to debug code, the main reason they are of interest is in developing a list of additional services. Without unwieldy API's in the way, a good programmer or programming team can seamlessly integrate new components with the original

source code. This makes for a far more efficient end product than one in which only the user has a limited ability to plug new functions into the base package. The user can also go directly to Vovida to get additional programming done if they do not have access to their own programming team, or prefer to get the work done by the solution provider.

Vovida Networks' VoIP Solution

What works best from the business angle, however, does not always work best from the technical point of view. At the end of the day, one cannot retain customers without a reliable system. This means that the developer needs a solid operating system, high-end hardware, and robust software. The Vovida VoIP solution provides the scalability, reliability and performance to effectively deliver converged voice and data applications on the data network.

Vovida Open Communication Application Library

The value in tomorrow's communication switching solutions lies at the intersection of three different software domains: an IP based architecture for call signaling and control, a feature creation platform for development of innovative IP-based features, and an Operation Support System to allow one to manage, control and bill for these features. The Vovida Open Communication Application Library (VOCAL) is a SIP based "softswitch" running on distributed Linux servers, built to offer the following values: Highly scalable, reliable, redundant architecture; feature and service creation; and, an Operation Support System.
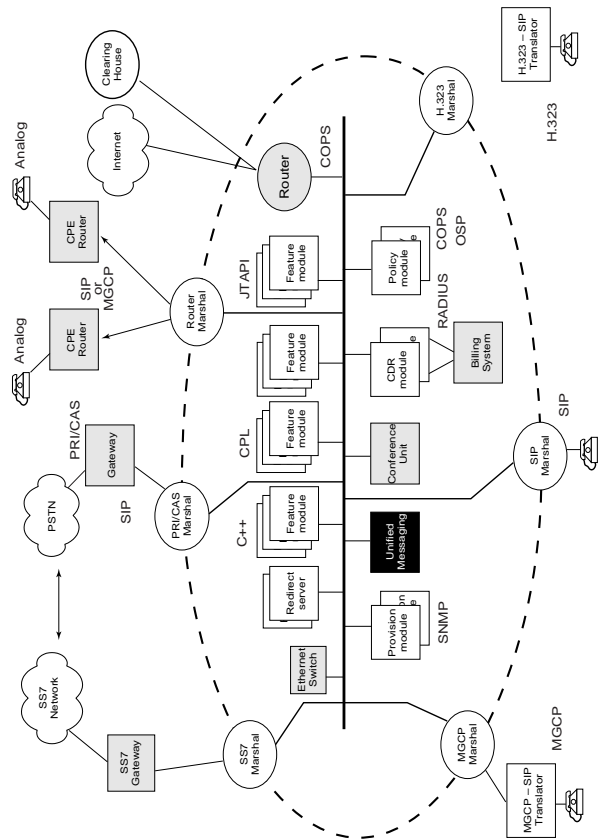
Figure 2 — System Architecture

Highly Scalable Reliable Redundant Architecture with No Single Point of Failure

The Vovida Open Communication Application Library uses the Session Initiation Protocol (SIP) as the core signaling protocol. SIP is a very lightweight, highly scalable VoIP signaling protocol. Based on a peer-to-peer structure as opposed to traditional telephony master-slave architecture, SIP provides the system a highly flexible and modular structure that will scale easily and simply by adding additional servers or software modules. The system also offers multi-

protocol translators to allow H.323 and MGCP based endpoints to connect into the SIP based architecture. Interoperability with these industry accepted, open standards will provide the maximum system flexibility for the types of gateways, endpoint and network devices that the system can connect together into an integrated network.

Feature and Service Creation

The Vovida Open Communication Application Library will offer a subset of existing CLASS telephony features, including Call Forward, Transfer, Caller ID and others. This is viewed, however, as just a place to start. The feature creation modules act as development platforms, allowing 3rd party developers, business partners and service providers to develop their own features with simple, standard scripting languages. This gives the user the power to develop customized applications based on his or her unique business needs and ideas.

Operation Support System

The Vovida Open Communication Application Library gives one the capability to manage and control a converged IP network. This includes the ability to provision and monitor network elements, authenticate subscribers, and track billing information. In addition, the system offers a web-browser interface to the provisioning system, so a subscriber could have the power to enable or change his or her own features and services.

Telephony Capabilities

Vovida Networks' VoIP software supports full CLASS 5 telephony service. The softswitch architecture consists of a series of modules. The main (redirect) server module handles basic issues such as mapping phone numbers to locations and routing calls. In fact, the user can have more than one redirect and

proxy server if the network load requires it; or they can be added later. The CLASS 5 feature functionality comes from the Open Services Creation Platform server module itself.[1]

Open Source Signaling Protocol

Vovida offers open source implementations of MGCP, RTP, SIP and H.323 Annex F protocols:

MGCP — Open Source MGCP is a protocol used for controlling Voice over IP (VoIP) Gateways from external call control elements. MGCP is the emerging protocol that is receiving wide interest from both the voice and data industries.

RTP — Open Source RTP is a protocol used to carry streaming real-time multi-media data over IP Networks.

H.323 Annex F — Open Source H.323 standards provide a foundation for audio, video and data communications across IP-based networks; H.323 Annex F, a subset of H.323, provides protocol detail to address Simple Endpoint Types (SETs).

SIP — Open Source SIP (Session Initiation Protocol) is an application-layer control protocol that can establish, modify and terminate multimedia sessions or calls. These multimedia sessions include invitations to both unicast and multicast conferences and Internet telephony applications. SIP can be used in con-junction with other call setup and signaling protocols.

Gateway Module

A Gateway module is a doorway to a third party gateway, which converts voice information to and from IP packets. This module is compatible with the industry standard Signaling System 7 (SS7). Any third party gateway that is compatible with SS7 can interface with this module.

---

1 To assist the customer in development, Vovida Networks offers the Open Telephony Applications Platform Library and the Open Services Creation Platform for those who want to develop custom applications to interface with the Vovida Networks products. OSCP uses the Call Programming Language (CPL), which is quite similar to C++.

Server Module

The Operations Support System server module provides Web-based system administration capabilities. This module lets the user add subscribers, specify which customers get access to which features, add new modules to support existing hardware or add software modules. Since the interface is based on a typical web browser, with easily understood functions the potential for error is less and training time reduced.

Billing Server

Also, rather than trying to integrate billing into the main server or the feature server, The Vovida approach lets each module do what it does best. The Billing Server stores Call Detail Records (CDR's) for each call so that the user can plug in a favorite third party billing system, import the data, and easily generate invoices. Finally, there is the voice mail module, which provides voice mail service and can integrate with third party voice mail solutions.

Packet Based Switching

One of the major changes from the current telephony norm to VoIP is packet-based switching. Traditional telephone traffic travels along dedicated lines. But VoIP has to share bandwidth with other Internet traffic, some of which is small, but some of which is bandwidth-intensive. Furthermore, not all IP packets travel along the same route. Although one of the advantages of IP is that data is broken into packets and transmitted along whatever direction seems most efficient at that moment, this introduces unplanned problems with synchronizing voice traffic in a smooth and continuous stream. Unfortunately, this can make voice traffic unbearably choppy and jagged.

Benefits of SIP

Various organizations are working to overcome these problems. But while this work is progressing, many organizations are settling on SIP as the primary protocol for a purely VoIP solution. Vovida took this fact into consideration when it chose the Session Initiation Protocol (SIP) instead of H.323 or MGCP (Media Gateway Control Protocol). There are a number of issues that make SIP the superior choice for this type of application. One of these is that SIP is a focused protocol. It deals exclusively with telephony issues. By its very nature it is more straightforward than a protocol such as H.323, which is a suite of protocols that supports audio-visual conferencing as well as telephony. MGCP is more of a direct competitor to H.323 than to SIP, and tries to be everything to everyone, though it was created after H.323 and incorporates a number of improvements.

H.323 and MGCP both support telephony functions in a similar manner to the way that it is handled now by the phone companies on their circuit switched networks. While this may be the most efficient method for doing it on a dedicated network, it is not the most efficient method on a packet-switched network that has to share bandwidth with other traffic types. SIP, on the other hand, was initially designed specifically to support telephony data across IP networks. This is an improvement over the traditional way of doing things and enables a solution that is more appropriate for the medium. SIP's distributed architecture handles load surges and service interruptions efficiently in the distributed model of IP communications.

The more straightforward a protocol is, the simpler it is to implement. The easier it is to put into use, the more likely it is that each company's individual implementation of it will work properly with other implementations. Complex protocols are prone to indi-

vidual interpretation problems and can make it difficult for applications all using the same protocol to talk to one another.

However, even though Vovida Networks' primary VoIP software is the SIP-based softswitch, it also includes both H.323 and MGCP marshals (acts as a software interface to different types of hardware and endpoints) to ensure that the service providers are able to support all of their customers appropriately.

Security

It is also difficult to discuss the Internet without bringing up the issue of security. No one can escape the fact that there are people out there trying to break into computer networks. Whether they want to use these systems to steal telephone time, leave some kind of mark there, or just look around and see what's there, the fact remains that no production system on the Internet should be left unsecured. Fortunately Vovida Networks' VoIP solution includes a SIP-based firewall for security needs.

Conclusion

In today's quickly changing computer services world, one thing is rapidly becoming clear. Computer and telephone technologies are merging. If the ISP, ASP, LEC, or CLEC does not integrate these two services and do it soon, their competitors may leave them behind. One way to maintain an edge in this market is to use a Linux-based solution. The hardware, software, and licensing benefits easily make Linux tempting. This operating system's sturdy performance and the tendency for open source software to produce robust, reliable code makes the Vovida Open Communication Application Library solution a serious contender in the VoIP market.

NOTES

NOTES

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

NOTES

NOTES

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

NOTES

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____