NUNTIUS

Broadband - Infrastructure & Options

White Paper

Carter Horney

for

Nuntius Systems, Inc.

13700 Alton Pkwy., Suite 154-266

Irvine, CA 92618

Phone: 949.295.0475

Web: www.nuntius.com

VOICE OVER PACKET APPLICATIONS

IP telephony will account for 10% of total North American packet telephony revenue by 2004 – a market forecast to grow to $34 billion.

VoIP over Cable

The underlying technology of broadband cable is relatively simple. Cable providers set two TV channels aside for data traffic, one downstream to the home or office and one upstream to the Internet. Within the upstream path is the Cable Modem Termination System (CMTS) that passes incoming Internet Protocol (IP), synchronous optical network (SONET) or ATM traffic to the Hybrid-fiber coaxial (HFC) cable of most providers. At the customer premise is a cable modem that converts the stream into an Ethernet or Universal Serial Bus connection (USB) to the PC.

Implementation and installation of cable modem technology has become easier for the cable provider because of the data over cable service interface specification (DOCSIS) standard, developed over the past four years by the industry and accepted by the International Union (ITU) in 1998. The first DOCSIS modems became available for the 1999 holiday season.

There are now more than three million cable-modem subscribers in the United States and Canada, which represents only 6% of the 48 million homes for which the service is now available and less then half of the 100 million North American cable homes "passed". This also represents an increase of 1.2 million subscribers during the first months of the year 2000.

Many cable operators are upgrading their facilities to provide two-way capability. They are using this capability to provide high speed Internet Protocol Data Services as per ITU-T Recommendation j.83, " Digital Multi-Program Systems for Television, Sound and Data Services for Cable Distribution". These operators are expanding the capability of their delivery platform to include telephony. The proposed “Audio Codec Requirements for the Provision of Telephone Service over Cable TV Networks using Data modems” is one of a series of recommendations designed to achieve this goal. It specifies that audio codecs be used in the provisioning of telephone services over cable TV distribution using IP technology (that is, IP Cable Phone service).

The IP Cable Phone architecture contains three networks: the cable modem hybrid finer/coax (HFC) access network, the managed IP network and the PSTN. The CMTS provides connectivity between the cable modem HFC access network and the managed IP network. Both the signaling gateway (SG) and the Media Gateway (MG) provide connectivity between the managed IP network and the PSTN. The Cable modem HFC access network provides high-speed, reliable and secure transport between the customer premise and the cable head-end. This network may provide all cable modem capabilities including quality of service. The cable modem HFC access network includes: the cable modem, multimedia

terminal adapter (MTA) and CMTS. The managed IP network serves several functions. First, it provides interconnection between the basic IP Cable Phone functional components responsible for signaling, messaging, provisioning and QoS establishment. In addition, the managed IP network provides long haul IP connectivity between the other IP managed IP and cable modem HFC networks. The managed IP network includes a: call management server (CMS), announcement server (ANS), several operational support systems (OSS) back-office servers, SGs, MGs and Media Gateway Controller (MGC).

The proposed Network Call Signaling Protocol for the delivery of Time Critical Services over the cable modem is based upon the Media Gateway Control Protocol (MGCP) version 1.0. It was the result of merging the simple gateway control protocol (SGCP) and the IP device control (IPDC) family of protocols. The recommendation provides a network-based call-signaling protocol necessary to establish connections. It describes a profile of an application programming interface (API) called the media gateway control interface (MGCI) and a corresponding protocol called media gateway control protocol (MGCP) for controlling voice-over-IP embedded clients from external call control elements. The profile is described in this document as the network-based call signaling (NCS) protocol. An embedded client is a network element that provides two or more traditional analog access lines to a VoIP network, or possibly one or more video lines to a VoIP network. Embedded clients are used for line-side access and have line-side equipment (such as analog access lines with conventional telephones associated with them, as opposed to trunk gateway).

Cable operators have made a strong effort to roll out telephony over cable, and have reported about 300,000 US subscribers. The North American cable operators (through their R&D arm, Cable Labs) have been working for two years to develop a full suite of protocols for IP telephony over cable. These protocols are called Packet Cable. Together with the updated DOCSIS 1.1 specification for cable modems they provide a comprehensive approach for overcoming the quality of service issues in the " last mile." Prototype systems now being deployed by cable operators are based upon the draft PacketCable specification. Systems passing Cable Labs certification tests, will appear next year, first by cable operators new to cable telephony, and then by the large operators (especially AT&T Broadband and Cox) which have to-date used circuit-switched telephony over cable.

CENTRAL OFFICE SWITCH SOLUTIONS

Worldwide there are 1.3 billion PSTN lines growing to 1.5 billion lines in 2004. Assuming a 10% worldwide voice-over-packet conversion rate there will be 150 million VOIP lines by 2004. As legacy voice networks grow obsolete, carriers are moving to replace Class 4 and Class 5 switches with packet-based Central Office switches ——referred to as IP switches.

AT&T, Deltathree, Dialpad.com, GRIC Communications, IBasis, ITXC and Net2Phone are all service players in the voice over IP market. When it comes to delivering voice-over IP to small businesses, the adoption rate tracks closely with the uptake of broadband access deployments.

Company	Second Quarter Financials	VoIP Service Offerings
AT&T	Overall $16 Billion in revenue.	Through Concert, it buys and sells VOIP minutes in 8 countries. Through a Net2Phone trial it offers customers 1000 minutes of free PC-to-phone calls.
Deltathree	Revenues of $8 Million, a gain of $6 Million over Q299	International PC phone calling, e-commerce services, calling cards.
Dialpad.com	Secured a $17 Million loan in April	Free IP phone service. Had 8 million registered users in 8 months of service.
GRIC Communications	Revenues of $7 Million, up 293% from Q299.	Provides value added IP services, platform to service providers, as well as multiple IP services to end customers
IBasis	Revenue was $13 Million a 276% increase from Q299.	Its global IP telephony network delivers voice, fax and advanced hosted communications to global carriers
ITXC	Revenues were $19 Million at 302%, or $14 Million increase from Q299	Calls itself the " service providers" service provider for IP telephony. Operating in 63 countries.
Net2Phone	Net revenues of $19 Million, more than double the $9 M of Q299	PC- to-phone, computer-less IP telephony service for phone or fax, Corporate/SOHO IP telephony, voice-enable e-commerce solution, Web-based call back service, and an IP telephony-powered shopping portal.

Today, sending voice calls in digital form using Internet protocols is becoming mainstream —– and being sought after by many. There are a dozen companies offering various flavors of phone calls over the Internet (or at least using internet protocols), options that involve PCs or nothing more than a regular phone, and Fortune 500 customers who have joined the hackers and consumers as customers. AT&T, once the monopoly that built the copper wire-based switched network in America, invested $1.4 billion in Net2Phone, a leading voice over-IP company.

For most companies in the business, the goal is simple: carrying voice calls over the internet or private networks that use the same technology is a vital piece of the endgame in which audio, video and data are all carried on a single network.

It is estimated that, industry wide, about 2 percent of all calls placed this year will be Voice-over-IP; by 2004, that will grow to 20 percent. That may not seem like much of a market until you realize that on one day this year, AT&T handled 327 million calls.

When it comes to delivering voice over IP to small business, the adoption rate is paced by availability of broadband access. That is because handling even a single call will require a minimum connection speed, and having the data line handle the bulk of the business phone traffic requires at least a DSL or cable

connection. Only one percent of the homes or businesses had a broadband connection as of the end of 1999, approaching 1 million subscribers.

Net congestion is the largest inhibitor to quality. One primary goal for providers is to get closer to the ISPs points of presence. Large companies have investments in legacy phone systems, PBX equipment, phones and the like. Getting a company to junk it an install new generations of voice-over-IP PBXs and related equipment takes time. But already on the market are products that connect what looks like ordinary phones to IP networks. IP PBX equipment and "gateways" linking existing PBXs to IP networks are becoming available.

Fujitsu, Tellabs (Salix), Nuera, Cisco, Lucent, and Convergent Networks are among some of the earliest High-Density Carrier Class Gateway solutions. Enterprise/Carrier Class Gateway equipment solutions are being offered by companies such as Clarent, Accelerated Networks and Multitech Systems. Furthermore, the Remote Access Concentrator market is evolving into a multi-media smart port gateway. Each port supporting a range of media types. These ports support Voice, fax and data capability.

VOICE-OVER-DSL

DSL is catching up with cable modem subscriptions. Today, cable enjoys about 4 million subscribers versus a million DSL subscribers. DSL subscribers are expected to grow to 8 million by 2002. DSL service for business is attractive, at about $50 to $250 per month, one-tenth the price of a T-1 line.

DSL offers speeds up to 7 Mbps upstream but most small businesses are content with a 384 kbps symmetrical service. Although that is far less than a T1-line rate of 1.5 Mbps, the price performance ratio has proven to be a cost affective alternative. DSL comes in a variety of flavors but is primarily available in two forms. Asymmetrical DSL (ADSL) is targeted at residential users, where only high-speed downstream rates are required. Symmetric DSL (SDSL) is designed for business customers who need faster upstream and downstream speeds in the 144 kbps to 2.4 Mbps range. *SDSL requires exclusive usage of the phone line, while ADSL can be shared with an analog phone line.* Until recently, DSL rollout was slowed by the availability of DSL access multiplexor hardware in central offices and availability of trained technicians and customer service workers to install them. In the past year, significant progress has been made towards lowering the DSLAM cost and installation times. Many local telephone operators have been faced with the time consuming tasks of straightening out their copper cable plants that place many users out of range. Most of the carriers have targeted the metropolitan cities. High demand is leaving many prospective subscribers on hold.

Most DSL service carriers have dropped there rates by about 15 percent during the first half of 2000. While prices have dropped, costs remain high compared to

dial-up and cable modem subscriber rates. ADSL prices are expected to match cable rates as infrastructure and network scale match cable's rollout in 2001.

SBC Communications and Quest (old US West) had more than 190,000 subscribers by the end of 1999. SBC hit the 200,000 mark in the first quarter of 2000; and Verizon (Bell Atlantic and GTE) hit 80,000 subscribers, 50,000 signed on in the first quarter of 2000. The CLECs are struggling now to keep pace with the larger ILECs. Among the largest broadband DSL CLECs are Covad Communications, Northpoint Communications Group and Rhythms NetConnections with nearly 100,000 subscribers in 1999. The CLECs have targeted the small and medium sized businesses that are in need of broadband Internet access. At the end this years first quarter, ILECs had about 600,000 DSL subscribers (85% residential and 15% business). The CLECs had 180,000 subscribers (15% residential and 85% business).

The CLECs are anxious to boost their subscriber base. One way is by adding more value to their network investments, CLECs hope that wide spread acceptance of voice-over-DSL will propel them to profitability. CLECs are attracted by the margins they can obtain by offering as many as 16 lines of voice over an unbundled loop that costs them no more than $20 per month.

Equipment vendors in the surging DSL market stand to profit from the soaring DSL subscriber growth. Major DSL vendors include Cisco Systems, Lucent Technologies, Motorola, 3Com, Copper Mountain, Paradyne and Efficient Networks. The DSL market encompasses a wide variety of products, including chips, modems, DSLAMs and voice/data splitters. The major modem chip suppliers include Centillium, Conexant, GlobeSpan, Lucent and Virata.

One of the hottest markets is the Integrated Access Data (IAD), or residential gateway, market segment. Accelerated Networks, Integral Access and Vina are among the early startups active in this market. Although veterans such as Cisco Systems and 3Com through an alliance with Copper Mountains is also active. The IAD is typically located on the customer premises and performs the task of integrating multiple traffic types over a single access line. IADs come in various configurations, but all perform the same basic function: multiplexing voice and data traffic streams intro IP flows over DSL.

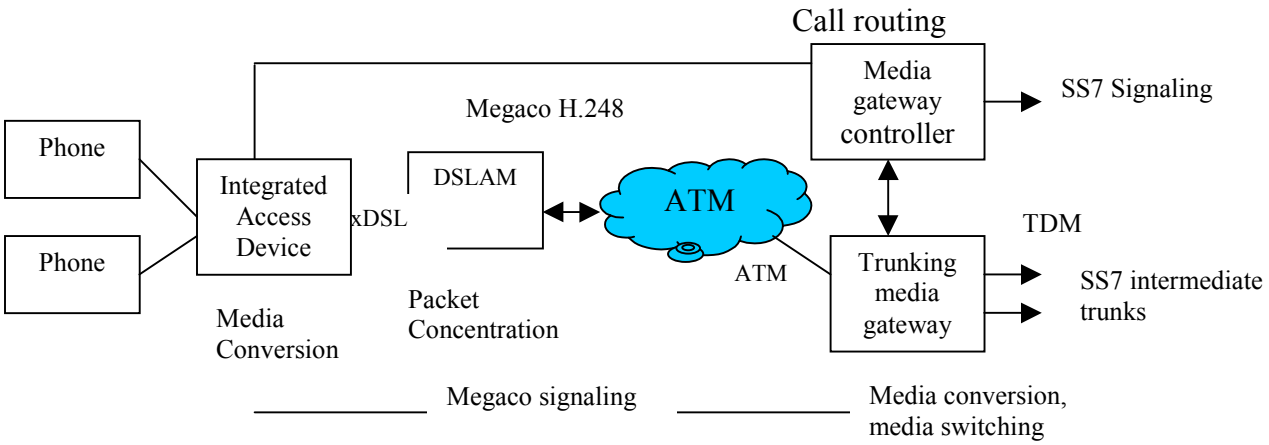
DSL technology will be used to deliver ATM to homes and small-to-medium-sized businesses in order to provide voice, DSL data and other broadband services.

VoDSL is a value-added broadband service that complements DSL data transport capability and allows for multiple voice lines and data to be simultaneously transmitted over a single copper wire. VoDSL is rapidly becoming a key DSL application, with service revenues expected to reach $9 billion in 2003.

Broadband voice-over DSL gateways are available from General Bandwidth, Jetstream, Tollbridge and Coppercom. Newcomers offering unique concepts for integrating voice and data aggregation in the customer premise region include Avial Networks, Broadband Gateways, RC Networks and Woodwind Communications.

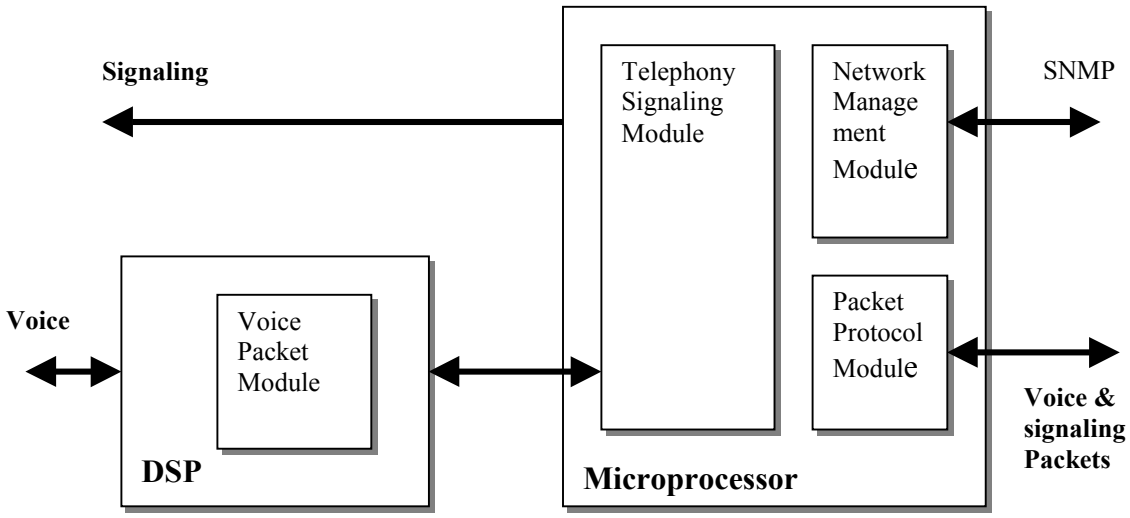
Voice-over broadband gateways use GR-303 interfaces to communicate directly to a Class 5 Circuit Switch. It takes in traffic packaged in ATM cells from IADs that talk ATM Adaptation Layer 2, or use BLES proxy to take in IP traffic based on MGCP or SIP signaling protocols. Broadband Loop Evaluation Service (BLES) protocol has been endorsed by both the ATM Forum and the DSL Forum as a way of providing voice-over DSL using ATM cells. Incumbent and CLECs are using BLES as a transition to native IP based packet voice-protocols.

There are two primary elements to the VoDSL architecture. A voice-gateway, located in the central office, converts the packet voice back into PSTN circuits for the Class 5 Switch. An IAD (residential gateway) located in the customer premise, connected to a DSL line capable of converting 16 analog voice telephony lines to digital packet form.



Making It Work

Two major types of information must be handled in order to interface telephony equipment to a packet network —– voice and signaling information. Voice over packet software interfaces to both streams of information from the telephone network and converts them to a single stream of packets transmitted by the packet network.



Voice over Packet Software Architecture

In voice over packet, there are many classic DSP algorithms (e.g. echo cancellation, speech compression, voice activity detection, DTMF detection and generation). There are also many system tasks involving non-DSP networking standards (G.711 compression/decompression, interleaving and de-interleaving T1/ E1, and proprietary bit-serial PCM data, packing and unpacking ATM streams according to AAL1, AAL2, or AAL5, creating and receiving IP/UDP/RTP headers, encrypting and decrypting information.

The story is similar in other applications. For example, the ADSL (G.DMT) data pump requires DSP algorithms like FFT and equalizers, but also includes many algorithms that are very inefficient on traditional Microprocessors and Digital Signal Processors: Reed Solomon coding, byte interleaving, CRC, self synchronous scrambler, constellation generation and complex bit-packing per tone. Behind the data pump, the rest of the ADSL solution requires ATM processing, HDLC processing (PPP), and IP header processing as well. Below are the categories of software available developed by Nuntius Systems.

- Voice Packet Software: This software, typically runs on a DSP, prepares voice samples for transmission over the packet network. Its components perform echo cancellation, voice compression, voice activity detection, jitter removal, clock synchronization, and voce packetization.

- Telephony Signaling Gateway Software: This software interacts with telephony equipment, translating signaling into state changes used by the Packet Protocol Module to set up connections.

- Packet Protocol Software: this software process signaling information and converts it from telephony signaling protocols to the specific packet signaling protocol used to setup connections over the packet network (e.g. Q933 and Voice over Frame Relay). It also adds protocol headers to both voice and signaling packets before transmission into the packet network.

- Network Management Software: This software provides the voice management interface to configure and maintain the other modules of voice over packet systems. Most management information is defined in ASN.1 and complies with SNMP syntax.

The Microprocessor is generally responsible for moving voice packets and adapting the generic headers to a specific Voice Packet Protocol that is called for by the application, such as Real-time Protocol (RTP), Voice over frame Relay (VOFR) and Voice Telephony over ATM (VTOA). The microprocessor also processes signaling information and converts it from supported telephony signaling protocols to the packet network signaling protocol (e.g.H.323 (IP), Frame Relay or ATM signaling.

About Nuntius
Nuntius Systems is focused on developing software for the communications industry. With specialization in Voice-over-Packet processing applications, Nuntius' software bridges voice and high-speed data networks by compressing voice traffic into efficient ATM or IP packets. The result is an efficient end-to-end optimized software solution for next generation Voice-over ATM Gateways, Voice-over-IP Gateways and Wireless equipment manufacturers and chip set suppliers.

Manufacturers of communications products, DSP's and Microprocessors rely on Nuntius Systems for the software that powers their equipment in the rapid convergence of voice, fax and data traffic over broadband data network movement.