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Product information begins on page 2.

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We also invite you to contact us with your questions directly at: info@ascend.com

Ascend

WHITE PAPER

Building Cost-Efficient and Reliable Voice Over IP Services



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1. Executive Summary

The telecommunications landscape is undergoing immense changes. Data traffic has caught fire, experiencing 20% a year growth in the face of ISPs scrambling to build infrastructures capable of handling the capacity. Even three years ago, it was unthinkable to combine voice and data onto a single network. However, there are compelling reasons as to why the traditional voice and data infrastructure walls are starting to crumble.

- Two physical networks cost significantly more to build and maintain
- Staffing requirements are separate and costly
- New applications take advantage of a single voice and data network
- Long distance charges are \$4 million a year for an average Fortune 500 firm

Most organizations are staring at next year's budget, faced with accomplishing more network services, despite no increase in funds. Combining voice and data networks is a step towards relieving those budgetary pains. Voice over IP is emerging as a viable alternative to long distance intra-company charges.

Ascend's MultiVoice™ for the MAX™ is the first product to offer a complete voice over IP solution that guarantees quality of service, from the access point to the core network. Ascend is the only company who can make this claim because of the complete integration of MultiVoice with the MAX access switch and Ascend's Frame Relay and ATM core switching products. Using MultiVoice, ISPs and carriers can generate new revenue by offering their customers high quality voice services.

2. Introduction to Voice over IP

In the past several years, the network landscape has changed dramatically for corporations and service providers. To compete in the future, ISPs and carriers will have to address several factors in order to provide consolidated voice and data services;

1. **Global competition**—Businesses are no longer competing against other local businesses in their own market. Companies from around the world are offering competing products and services. To differentiate themselves from the competition, companies have begun to implement different communication strategies.
2. **World-wide customer base**—Companies are now able to reach into countries around the world to support global customers, partners and employees.
3. **Fast customer service**—Organizations are looking for more effective ways to acquire any new customers and retain existing ones. In order to do this, it requires timely response to customer information requests and problems.
4. **Increased data traffic**—According to Frost and Sullivan, data traffic has been increasing at 20% a year, while voice is at a constant 3%. With e-mail and database access applications being used extensively across the Internet, carriers and ISPs will need to provide a network capable of supporting such large volumes of traffic.
5. **Remote access**—Telecommuting is now mandated in some states, and is projected to increase to 30 million workers by the year 2000. Remote workers need access to the corporate network, which means carriers and ISPs will need to offer low-cost, secure, mobile connectivity service.

Data traffic is king in enterprise networks, and Internet service providers (ISPs) and carriers are re-tooling their offerings to support integrated voice and data — especially over the enormously popular Internet. The goal today is to let voice traffic ride for free — or close to it — by integrating voice calls over existing IP services. The Voice-over-IP (VoIP) trend is quickly becoming a mainstream business strategy.

According to Jeff Pulver, publisher of The Pulver Report, "1998 will be the year that more enterprise users move to virtual private networks (VPNs) and start adopting voice over network technologies." The economics of network consolidation are driving many carriers and user organizations to consider what would have been politically unthinkable in telecommunications and data communications departments just a few years ago — voice and data on the same network. Users and carriers have spent billions creating separate facilities tailored for voice and data.

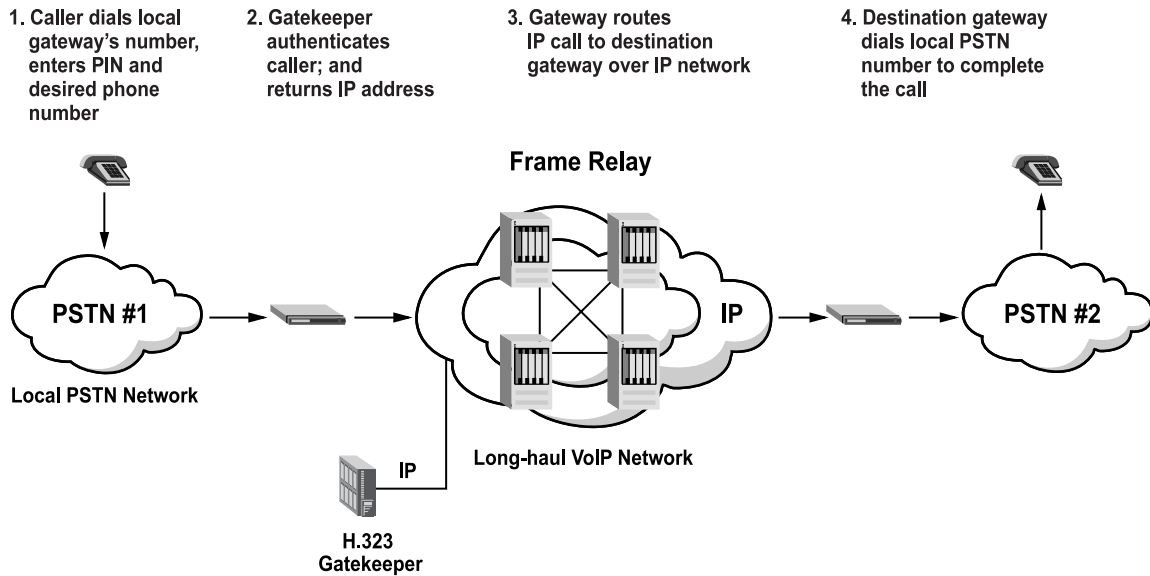


Figure 1 – Long-haul Voice Over IP net uses local exchange providers to deliver calls the last mile.

The emergence of public and private IP services on the Internet means customers, suppliers and business units worldwide can now use data networks to carry voice services. VoIP products based upon the International Telecommunications Union's H.323 multimedia standards provide the underpinnings for transmission of real-time, high quality, voice over IP packet over networks such as the Internet, and private intranets and extranets.

Internet telephony has evolved rapidly since its birth in 1995. Originally, the idea was to enable computers to place telephone calls. Today, VoIP allows users to "piggy-back" voice calls on a data connection across the Internet, or private intranets. This means a separate, circuit-switched 64k line is not needed for voice calls. For corporations with large intra-company voice and fax volumes, VoIP represents a 50% reduction in long distance charges.

VoIP holds great promise for forward-thinking companies. Ascend Communications, Inc.'s objective to provide customers with leading networking products that support widespread use of real-time packet voice applications via the Internet, intranets and extranets.

Cost savings potential

Ascend's Internet-based VoIP solution allows ISPs, Competitive Local Exchange Carriers (CLECs) and other carriers to pass on considerable savings to end-users. For example, an early VoIP success story focuses exclusively on public gateway services. Australian businesses and other consumers use OzEmail's gateway-based VoIP service for domestic calls at 10 cents per minute — a 70% savings over public carrier Telestra's best rate.

For the enterprise class user, VoIP corporate gateways can save a bundle. A business with heavy traffic between two or more offices can install gateways at each site and ferry traffic over the Internet. For example, a gateways between Boston and Paris, carrying two hours of traffic per day will cost 40% less than AT&T's 35 cents/minute.

The economics of VoIP become especially compelling for carriers who currently operate separate voice and data networks. Ascend's carrier-class VoIP offerings enable service providers to reap considerable savings by operating a single network — thereby eliminating the requirement for different equipment, services and staff resources to manage separate facilities.

3. The Market Opportunity – Overview

Ascend's entry into the VoIP market with its MultiVoice product line signals a rare opportunity for network service providers and enterprise users to add high-quality, real-time voice transport services to their existing IP backbone infrastructures.

For service providers, including ISPs and CLECs, Ascend is opening up an enormous market. The 1998 revenues for VoIP are projected to top \$245 million, however according to a 1997 Frost & Sullivan market research report, sales are expected to balloon by a whopping 149% annually to \$1.89 billion spent by the end of 2001.

Internet Telephony Market Revenue Forecast

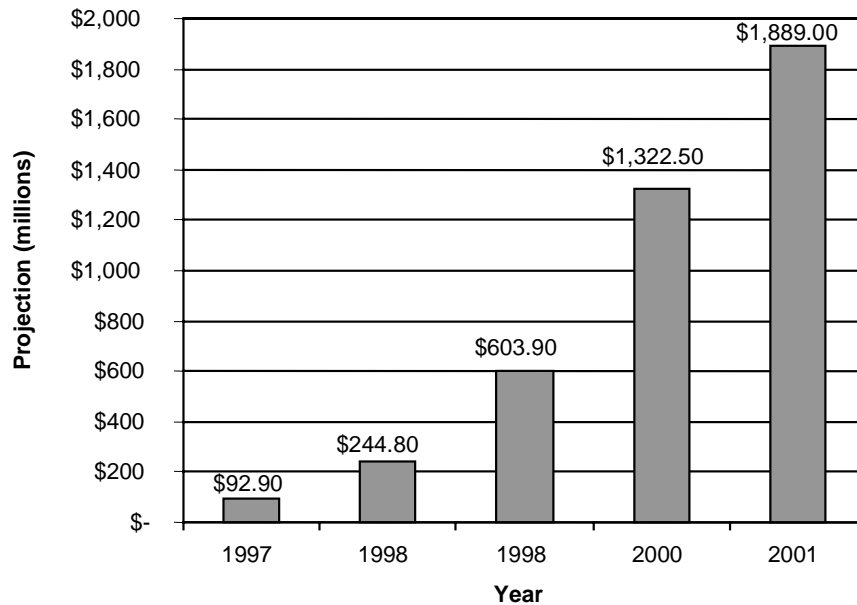


Figure 2 – Source: Frost & Sullivan, Inc. "Worldwide Internet Telephony Products," 1997

Despite high growth, in the short term VoIP isn't likely to unseat basic business telephony service. VoIP market revenues will still pale compared to the \$475 billion spent on basic telephony services in 1997. For network managers pressed with the reality of flat budget growth for net services, VoIP is an attractive means of leveraging existing network investments.

According to market researcher International Data Corp, by 1999, 60 million PC users will be making calls over the Internet. Probe Research reports that by 2002, data lines will carry 18.5% of all domestic phone traffic. InfoTEST International estimates that 25% of the world's phone calls will travel across the Internet within 12 years. This represents an \$85 billion dollar market, based on last year's market estimate of \$475 billion for basic telephony services.

Ascend is uniquely positioned to assist service providers by offering worldwide VoIP services. Ascend's MultiVoice products open a new world of applications to users and carriers. VoIP can be integrated at the application level using the same IP infrastructure for both voice and data applications. Ascend's core network frame and ATM switching products also provide the networking technology required to support real-time applications such as voice. Using Ascend's "Absolute" Quality of Service (QoS) core network technology, toll quality voice can be provided across a switched IP backbone network.

4. VoIP Benefits

Voice over IP provides ISPs, competitive LECs (CLECs), carriers and enterprise class users with enormous benefits that can provide any organization with a strategic edge over its competition.

End user benefits

MultiVoice is ideal for deployment of VoIP services in private networks. MultiVoice enables customers to leverage their existing packet networks by using spare capacity to carry voice between internal private branch exchanges, and beyond into the Public Switched Telephone Network (PSTN).

Network managers can consolidate voice and data requirements into a single, reliable, remote access platform, thereby reducing the cost of supporting parallel platforms.

MultiVoice gives enterprises the flexibility of bypassing a PSTN in the event PBX trunks are choked with traffic. This means calls can be routed through a MultiVoice Gateway onto the company intranet when voice T1 connections are at full capacity. The traffic flows across an IP network using spare capacity that that doesn't cost extra.

If small branch offices are deployed across the country, or within a region, MultiVoice lets you consolidate the voice and data traffic onto a single link connected to headquarters. Many organizations today are already connecting small branch or remote offices using Frame Relay. As a result, it, makes sound business sense to route internal voice traffic over the same line.

ISP/CLEC benefits

MultiVoice products can open entirely new avenues for organizations that previously relied on data-only applications.

Additional revenue streams from new and existing clients

The ability for an ISP/CLEC to carry voice alongside data opens up entirely new revenue streams. ISPs can furnish clients with new types of customer service applications — where both voice and data are integrated for the customer service representative. While browsing the Web, customers can click an icon to open up a packet voice channel to a vendor's customer service center.

Maximize network investments

MultiVoice enables carriers and ISPs to build a single backbone network integrating voice and data. Carriers can now compete against cut-rate telephone service by offering tiered pricing and service along with their standard PSTN. One price for circuit-switched calls and another price for packet-switched calls.

Introduce transaction billing to your customers

Carriers and ISPs can use MultiVoice to implement a rate structure based on cents-per-minute, instead of a flat rate pricing model. This means carriers and ISPs can charge for actual bandwidth usage instead of unlimited access—a pricing model that constrains ISPs today.

Deepen customer relationships

MultiVoice creates opportunities for carriers and ISPs to offer better, more comprehensive services beyond the customer's firewall. This translates to more revenue by providing more customized solutions based on each customer's individual voice and data needs. Using MultiVoice client-centered applications, carriers and ISPs can keep loyal customers from being lured away by competitive commodity providers.

5. Overview Of Voice Over IP Components

Ascend's VoIP solution is called MultiVoice for the MAX. The MultiVoice solution consists of the MultiVoice Gateway and MultiVoice Access Manager. These two components work in tandem with Ascend's industry-leading switch products to equip ISP, carriers and enterprise organizations with the high-quality services necessary to support end-to-end calling between telephone endpoints on different PSTNs, or between a PSTN and a VoIP equipped PC on an IP network.

VoIP gateways bridge voice traffic from circuit-switched telephony networks to a packet-switched IP-based network such as the Internet. These gateways intercept incoming telephone calls, compress the signal using voice and data compression techniques, and packetize them for transport across the Internet. At the far-end of a call, the gateway also takes IP-encapsulated voice packets and readies them for hand-off to the remote PSTN. Both operations can occur simultaneously, making it possible to support full duplex, or two-way communications.

MultiVoice Gateway

Ascend's MultiVoice Gateway provides an interface between the PSTN and an IP-based network that enables voice calls to hop on and off the packet network. It does this by:

- Terminating PSTN interfaces (T1, PRI, E1, etc.),
- Supporting codecs which provide voice compression to reduce network bandwidth demands
- Using DMTF tone detection/generation to emulate PSTN functions
- Supporting the ITU-T H.323 protocol stack for phone-to-phone communications over IP net
- Teaming with the MultiVoice Access Manager to establish and terminate VoIP calls

The MultiVoice Gateway combines a MAX WAN access switch, MultiVoice DSP slot cards and the MultiVoice Gateway software. Initially, MultiVoice Gateway will support phone-to-phone H.323 operations, provide ample telephony and packet network interfaces, offer voice codec support, as well as support for private networks. It will also provide DTMF detection/generation and hybrid-line echo cancellation.

MultiVoice Access Manager

Ascend's MultiVoice Access Manager¹ is server-based software that works in conjunction with the MultiVoice Gateways to provide network address translation functions for connecting voice calls over an IP network. The MultiVoice Access Manager accomplishes this by:

- Managing a "zone" or set of Gateways that support the H.323 protocol standard
- Providing address translation from standard national and international telephone numbers to IP addresses, and vice versa
- Authenticating users and performing gateway registration

Initially, the MultiVoice Access Manager will support Microsoft Corp.'s Windows NT 4.0 (Unix support will follow soon), include an ITU-T H.323 compliant Gatekeeper implementation, and performs phone-to-phone address translation. MultiVoice Access Manager also comes with a Web-based administration interface and support for PIN-based user authentication.

¹ Ascend's Voice Access Manager is known as a "Gatekeeper" in ITU-T H.323 terminology.

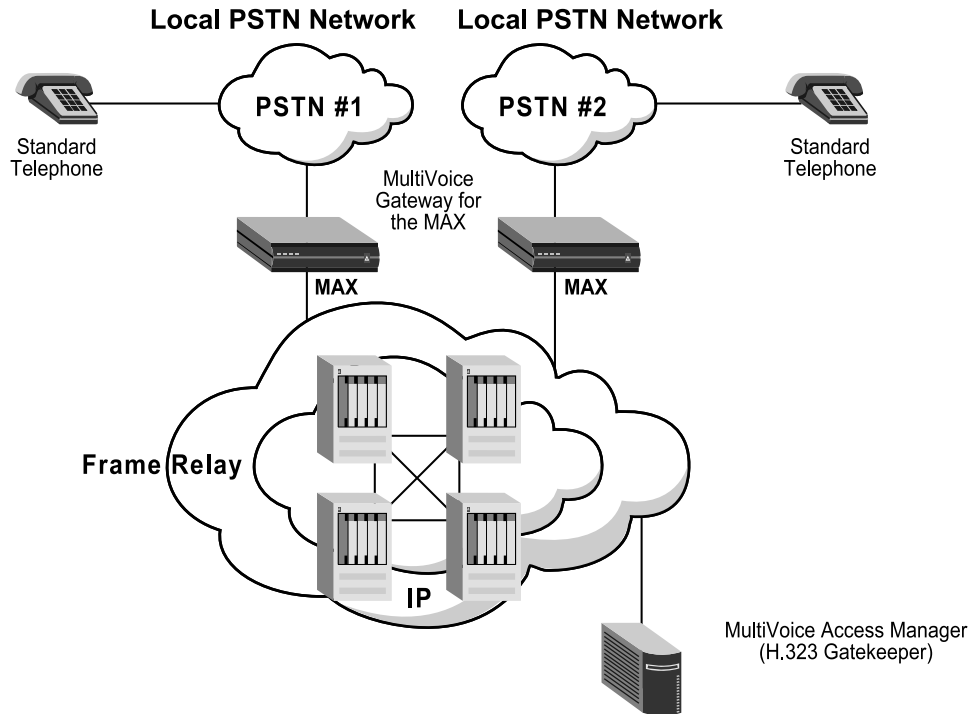


Figure 3 – Location of MultiVoice Gateway and MultiVoice Access Manager in a VoIP net.

Quality of Service

Together, the MultiVoice Gateway and MultiVoice Access Manager provide a solid foundation for VoIP services. Ascend intends to add a core networking feature that guarantees toll quality calls over MultiVoice networks. The feature, called "Absolute" QoS, will ship as an enhancement to Ascend's IP Navigator. IP Navigator is software that can be used in conjunctions with Ascend's core frame relay and ATM switches that allows IP routing in a switched core network. When MultiVoice is combined with a switching core running IP Navigator, the Absolute QoS capability establishes end-to-end toll quality VoIP service.

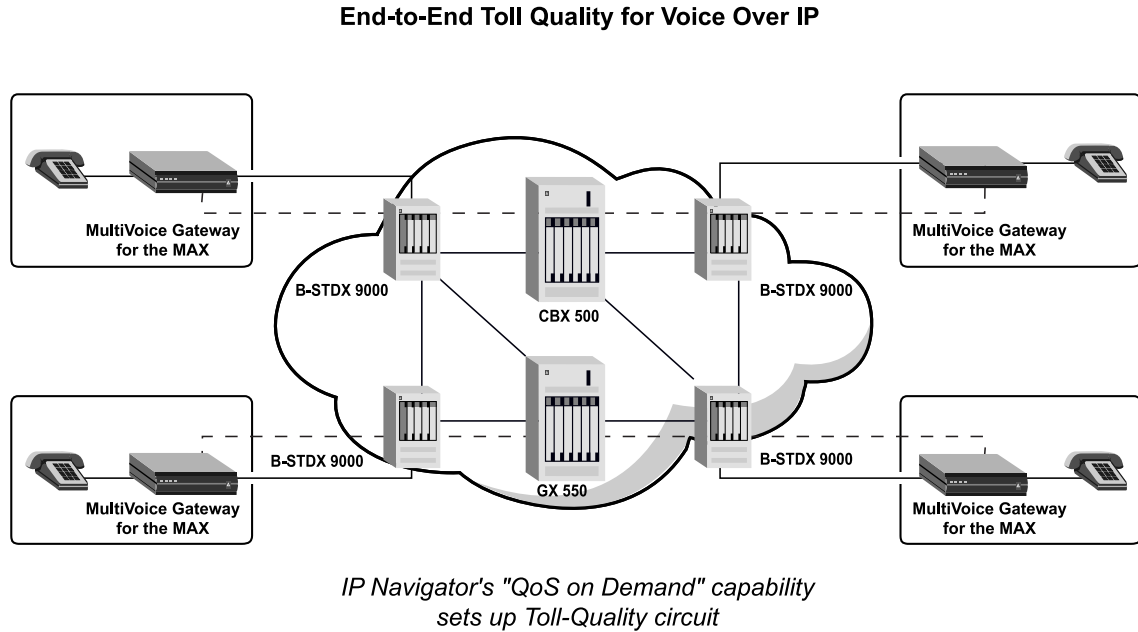


Figure 4 – In this Absolute QoS application, IP Navigator sets up end-to-end toll quality SVCs to carry VoIP calls.

6. How MultiVoice and IP Navigator Provide Absolute QoS

MultiVoice receives a multiplexed voice stream (TDM) from a PBX and converts it into a VoIP packet voice stream. MultiVoice also sets the Type of Service (ToS) byte in the IP header to a specific value indicating to the core network the presence of voice packets within the IP stream.

IP packets then go to a switched cloud running IP Navigator via a V.35 or Ethernet interface. The Absolute QoS capability looks for packets in the IP stream with a specified ToS byte value (the same value generated by MultiVoice for its voice packets). When the voice packet is detected, IP Navigator checks to see if a Switched Virtual Circuit (SVC) exists between the source and the destination. If an SVC already exists between the source and the destination, packets are transmitted automatically over that SVC.

If no SVC is present, IP Navigator creates a connection with the appropriate end-to-end characteristics required for giving voice packets a lower delay (higher priority) than normal data traffic. Unlike routed networks, the SVC also reserves bandwidth between the source and the destination to support real-time voice communications. This SVC setup is very similar to the current PSTN, with one fundamental advantage: Once bandwidth is reserved in the PSTN, no other application can use it, in the case of IP Navigator the bandwidth can be shares with lower priority data when voice connections are idle.

MultiVoice also offers "best efforts" voice delivery service and a relative QoS service. These features will work across non-Ascend networks, providing a QoS level second only to Ascend's Absolute IP QoS feature.

Smart tips for buyers

A key benefit of the MultiVoice Gateway is that it supports higher density PSTN interfaces and trunk lines than competing products, giving customers much better cost of ownership over the product's life. In addition, existing Ascend customers also can re-deploy their existing MAX 4000-based platforms to provide VoIP services within an existing IP network.

7. Application Examples

A MultiVoice network can support many different applications in public and private networks. But there are four key application focuses that carriers and users will want to first address.

Basic Public Long Distance Service

Long distance service is ideally suited for ISPs and CLECs that operate extensive domestic or international packet backbone networks. In this application, the Network Service Provider (NSP) supports voice and data over the same packet network, relying on interfaces to local PSTN facilities to deliver the last segment of a voice call. Voice and data services travel over a single, integrated, managed IP backbone composed of Ascend's switching products and the MultiVoice platform. For traditional NSPs, this opens up new untapped revenue streams from network infrastructures that previously supported only data. ISPs can adopt a usage-based billing model and begin to wean users from a flat monthly fee for unlimited service.

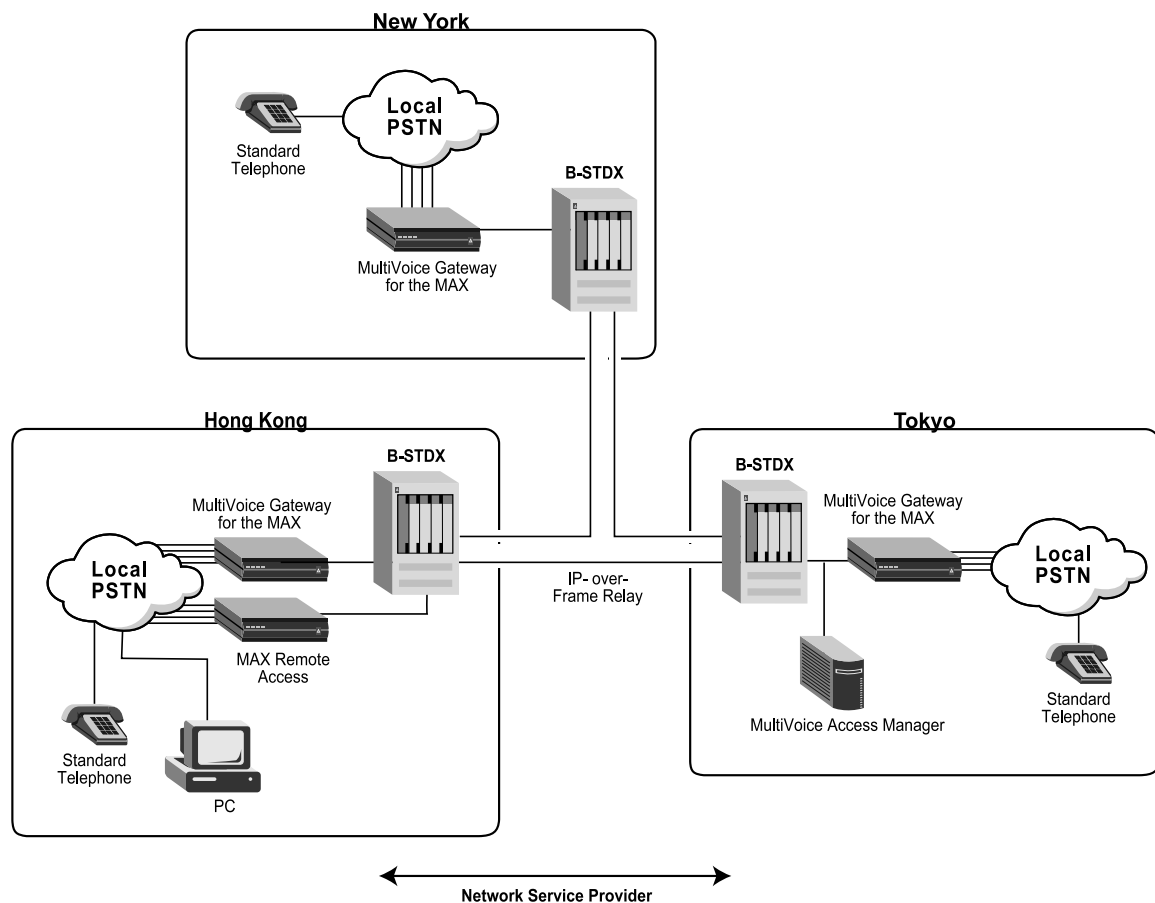


Figure 5 – Integration of voice over existing IP facilities supports basic public long distance service.

Local 800 Service for Customer Service Applications

ISPs and other NSPs can lower their internal operational costs incurred for customer service by publishing a local customer service telephone number associated with nearby points of presence locations. Ascend MultiVoice Gateways transport voice traffic across the Internet to a centrally located customer support center. ISPs are then able to avoid pricey long distance charges.

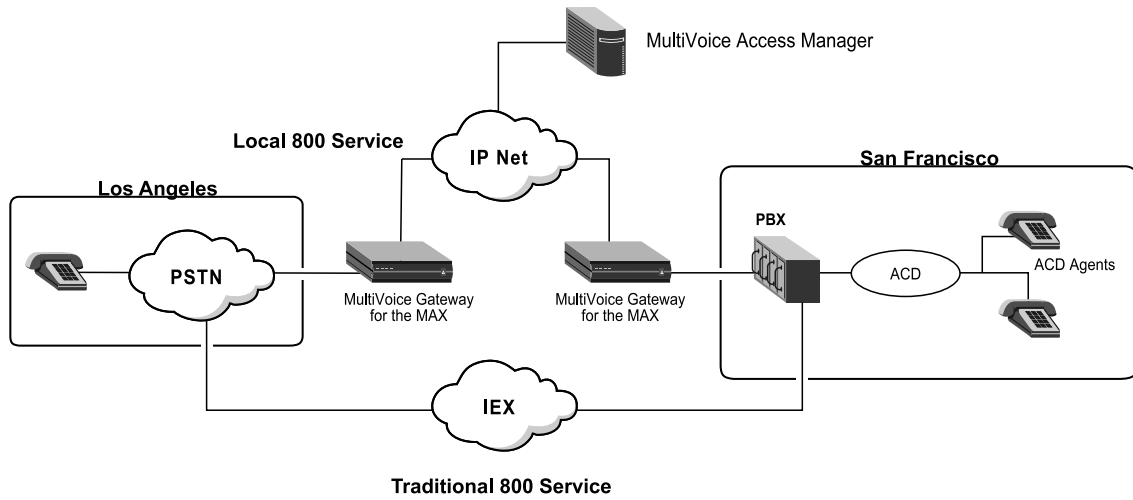


Figure 6 – NSPs can deploy VoIP at local POPs to siphon 800 traffic from the PSTN and route it over less costly IP services.

Point-to-Point PBX Trunk Extension

Enterprise-class users can leverage their existing IP packet networks to carry voice traffic between PBXs stationed across the organization. MultiVoice Gateways effectively become the front-ends that converts voice traffic for travel across an IP backbone. Ascend MultiVoice even makes it possible to set priority frames that guarantee better Quality of Service (QoS) which offset delay and enhances voice quality.

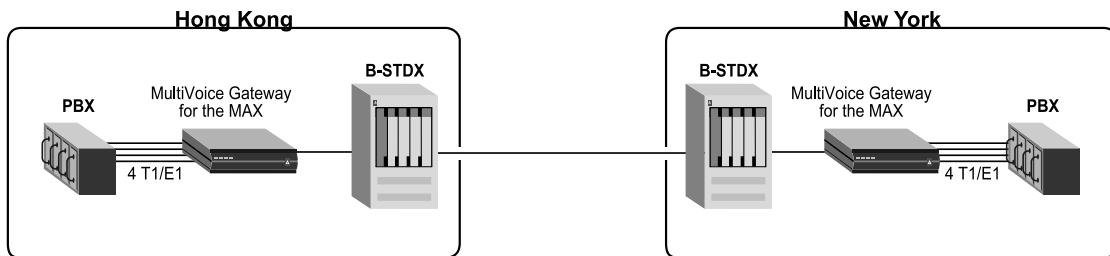


Figure 7 – MultiVoice can be used to link PBXs at different locations.

PBX Trunk Intraflow Across Routed IP Networks

Ascend's MultiVoice platform can provide an alternate route for voice calls across a managed IP network. When all public network trunks between two PBXs are busy, users can "Dial 8" to route calls via a MultiVoice gateway across a company's IP network, thus, reducing the number of inter-PBX trunks required to handle traffic in the busy hour.

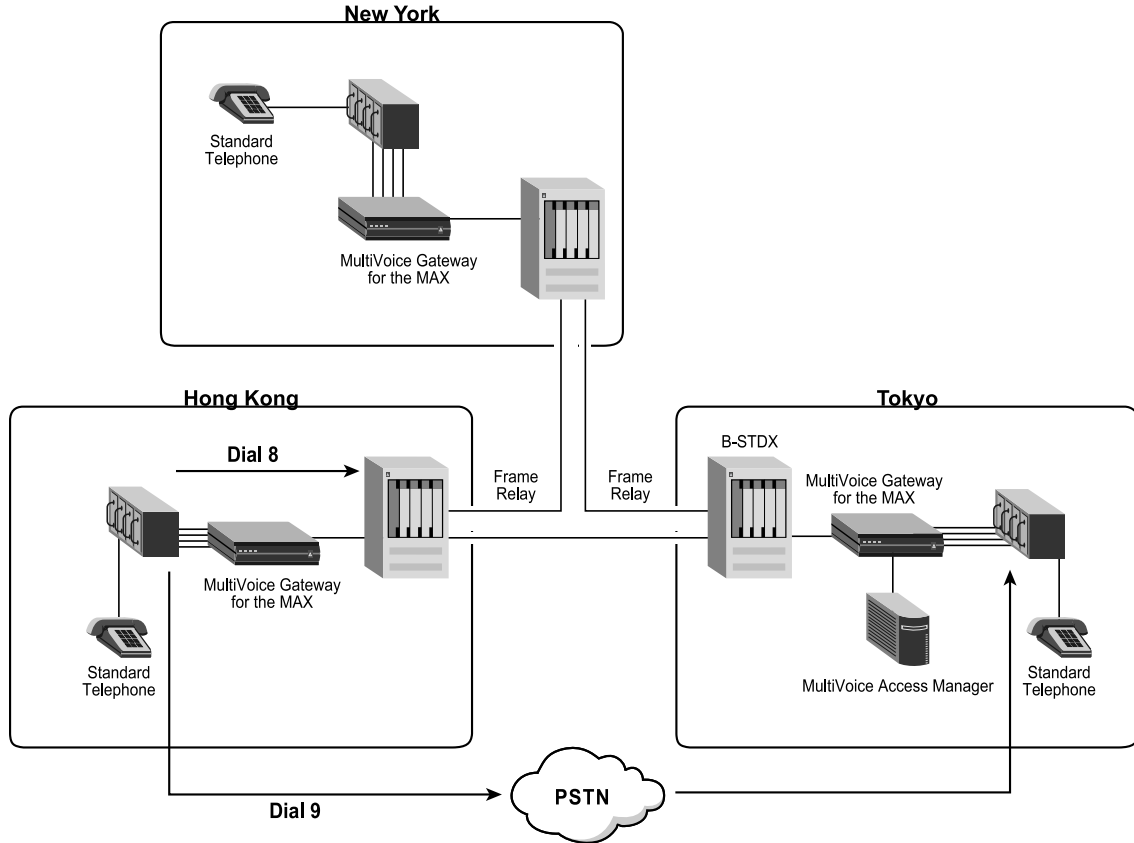


Figure 8 – MultiVoice can route voice traffic over an IP network to ease congestion on PBX trunks.

Integration of Voice with PC Applications

In addition to the four key applications already discussed, the MultiVoice products can also be used to deploy VoIP applications that support PC users.

MultiVoice, for instance, will support off-net calling to on-net VoIP clients. PC users attached to a company's intranet or IP network can receive voice calls to their workstations from callers attached to the PSTN. VoIP clients on an IP net can place calls to one another via the packet network.

Ascend's MultiVoice even enables Web surfers to handle voice calls. For example, if a Web surfer's phone line is connected to the internet and someone tries to contact him or her, they would normally get a busy signal. With MultiVoice, the call is forwarded to a MultiVoice Gateway where the call is routed to the recipient's PC via the same internet connection used to access the internet. In effect, the original phone-to-phone call is transformed into a phone-to-PC call without the caller doing any additional work. The Web surfer already is paying for the call to the service provider local POP. The benefit is two fold; ISPs can receive additional revenue from Internet connections already in use, and PSTN carriers can complete calls that otherwise would ring busy.

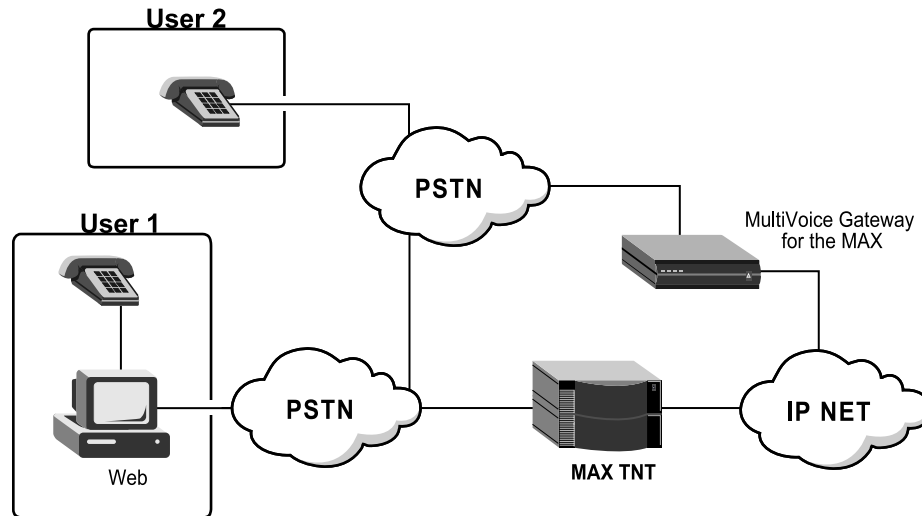


Figure 9 – MultiVoice enables a regular phone user to complete a voice call to a PC user via an IP network.

Phone to PC applications holds remarkable benefits for retailers, and other customer service-oriented businesses with on-line Internet catalogs. Consider that a prospective customer is browsing a company Web page, or catalog, and wants additional information. A customer can click an on-screen icon which transparently launches a “soft” phone, setting up a call through the IP network to the company’s customer service center. The possibilities for Web-enabled ACD applications are infinite.

8. How to Contact Ascend

To find out more information, including implementation details on Ascend’s MultiVoice product, see one of the following:

- Call Ascend at 1-800-621-9578 (option 3) in the U.S. For international questions call 1-510-769-6001.
- Visit the Ascend Web site at <http://www.ascend.com>. (Under “Products”, Ascend offers additional information on MultiVoice for the MAX).

9. Web Resources

The Internet's World Wide Web holds a vast amount of additional information prospective VoIP users may wish to examine. Here's a sampling of sites to explore:

<http://www.pulver.com/>

This is home to the most comprehensive Web site with information about Voice over IP. Here there's info on H.323 and other standards, links to the Voice over Networks Coalition, info about The Pulver Report, an on-line newsletter about voice over network technology, and info about conferences and moderated newsgroups.

<http://www.von.com/teleph.html>

For VoIP advocates looking for info about Internet telephony products or info about the H.323 standard, this is the site to use.

http://www.imtc.org/i/about/i_bckgnd.html

Learn about vendor efforts to standardize on VoIP components and technologies by tapping into the VoIP Forum's site.

http://www.tcm.hut.fi/Opinnot/Tik-110.551/1997/seminar_paper.html

An April 1997 paper authored by two professors at the University of Helsinki which provides a fairly in-depth technical review of the H.323 standard for voice transmission over TCP/IP and other widely used audio coding standards and recommendations.

<http://www8.zdnet.com/pcweek/opinion/0818/18just.html>

PC Week Online looks at the planning that must go into any Voice over IP implementation.

<http://www.nwfusion.com/netresources/0630feature.html>

This online site for Network World newspaper offers a bevy of news reports from the last year about VoIP announcements. Plus a June 1997 full-length feature story, "IP Calling," provides an assessment of the issues and early products that make up the VoIP market.

<http://www.internetwk.com>

InternetWeek's Web site contains a flurry of news stories regarding recent VoIP announcements.



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