SIP Trunking: Enabling Wideband Audio for the Enterprise
Executive Summary

Installing SIP trunking on an enterprise's network can facilitate the transition to an all-IP environment, leading to new services and productivity improvements. Benefits of transitioning to an IP environment include easier delivery and integration of presence information, as well as enabling a wide range of technologies, such as VoIP, instant messaging, file transfer, application sharing, white-boarding, and video conferencing. SIP trunking enables the enterprise to streamline processes, enhance delivery, and thus achieve better productivity. And, when coupled with the cost benefits of eliminating PSTN lines, the benefits of SIP Trunking are even more compelling.

One of the technologies enabled by SIP trunking is the use of wideband audio, also known as “HD Voice.” Wideband audio provides a higher quality voice transmission than narrowband audio and thus creates more natural sounding speech over a phone line.

This white paper focuses on how an enterprise with SIP trunking can use wideband audio for internal communications, communications with other enterprises, and communications with mobile users to create a better user experience. Also, this white paper discusses some of the equipment needed to support wideband audio, and finally looks at the likely next step as uses for wideband audio spread to include wideband audio conference calls.
# SIP Trunking: Enabling Wideband Audio for the Enterprise

## Table of Contents

- Introduction .................................................................................................................. 2
- SIP Trunking Architecture ........................................................................................... 2
- Wideband Audio ........................................................................................................... 3
  - Wideband Audio Codecs. ........................................................................................... 3
  - Headsets and Handsets ............................................................................................... 4
  - VoIP and Wideband Audio ........................................................................................ 4
- Wideband Audio Conferencing ..................................................................................... 6
- Summary ......................................................................................................................... 7
- For More Information ..................................................................................................... 8
Introduction

SIP trunking, a real-time IP communications service offered by Internet Telephony Services Providers (ITSPs), extends VoIP connectivity outside the enterprise by using the same connection as the internet connection. A SIP trunk is primarily implemented as a set of concurrent call sessions routed over the IP backbone of an Internet Service Provider (ISP) by an ITSP. The ISP and ITSP may be one and the same provider, or an ITSP may leverage third-party ISP IP backbones and enterprise broadband connections to deliver the service.

As a converged voice and data service, SIP trunking does the following:

- Eliminates the need for PSTN lines
- Allows call paths based on enterprise needs and which can be easily added or removed as needs arise
- Results in measurable cost savings for the enterprise
- Delivers a fast Return on Investment (ROI) for the switchover to IP

By deploying SIP trunking, an enterprise benefits from a feature-rich environment that uses its installed IP-PBXs to communicate over IP within the enterprise; and outside the enterprise, service providers can use SIP trunks to connect to the PSTN.

This white paper presents a brief overview of SIP architecture, and then focuses on one of the technologies enabled by SIP trunking, wideband audio, also known (and referred to here) as “HD Voice,” with emphasis on its advances and how it can be used by an enterprise for internal communications, communications with other enterprises, and communications with mobile clients.

Note: For an introduction to SIP trunking and the benefits it can bring to an enterprise, see SIP Trunking: Deployment Considerations at the Network Edge (see “For More Information”).

SIP Trunking Architecture

Figure 1 shows an example of a high-level view of a SIP trunking architecture in a VoIP environment. In this architecture, the service provider provides the IP-to-PSTN and SS7 network capabilities.
SIP Trunking: Enabling Wideband Audio for the Enterprise

By using a SIP trunk for voice and data connectivity services, the enterprise can consolidate its connectivity options, move to IP, and save money all at the same time. In this way, an enterprise using SIP trunking can access a vast range of IP services, such as wideband audio, media storage, conferencing, and “cloud computing services,” such as Communications as a Service (CaaS).

Wideband Audio

Wideband audio (50 Hz to 7,000 Hz) provides a higher quality voice transmission than traditional narrowband audio (300 Hz to 3,400 Hz) because it extends the frequency range transmitted to the remote side. This creates a better overall experience for the remote user because on the phone it:

- Makes it easier to recognize voices
- Makes it easier to distinguish the sounds of fricatives, such as s, z, and f
- Fades or cuts out background noise
- Provides more natural sounding speech

Figure 2 shows the amplitude versus frequency for a 30 second sample of audio. It depicts the differences between wideband audio and the G.711 narrowband audio frequency ranges, demonstrating the level of extra information the wideband signal can depict.

![Figure 2. Wideband Audio versus Narrowband Audio](image)

Wideband Audio Codecs

To use wideband audio, voice data is coded differently than for narrowband audio, which means a move away from codecs such as G.711. Many wideband audio codecs are in use today, with most aimed at a different type of connectivity and vying to become the “de-facto standard” codec for specific applications. Some wideband codecs are proprietary and others are standards based. Some proprietary codecs, including Skype’s SILK, have been made available and/or been licensed royalty-free, enabling a broader field of application, and creating the possibility that the codec(s) will be incorporated into third party applications and devices.
Table 1 describes four widely used wideband audio codecs.

<table>
<thead>
<tr>
<th>Codec</th>
<th>Description</th>
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| G.722 | • Original wideband audio codec that first described the characteristics of wideband audio (50 to 7,000 Hz)  
• High-quality speech applications, including wideband VoIP  
• Royalty-free  
• Manufacturers make phones that support G.722 |
| AMR-WB | • An ITU-T standard speech codec, now codified as G.722.2  
• Jointly developed by Nokia and VoiceAge  
• First standardized by ETSI/3GPP in December 2001  
• ITU-T approved as the G.722.2 recommendation in January 2002  
• Applications include teleconferencing and voice-over-packet  
• Mandatory standard codec for wideband speech in GSM and Wideband Code Division Multiple Access (WCDMA) networks  
• Included in the CableLabs PacketCable 2.0 specification |
| RTAudio | • Microsoft® adaptive wideband audio codec used by Microsoft® Office Communications Server  
• Use is growing as the number of deployments of Office Communications Server in enterprise networks increases |
| SILK | • Skype’s wideband audio codec that replaced the Sinusoidal Voice Over Packet Coder (SVOPC) codec  
• Royalty-free license made available in March 2009  
• Other devices and applications can implement SILK in non-Skype devices  
• July 2009, Skype submitted the SILK codec description and payload formats to the Internet Engineering Task Force (IETF)  
• March 2010, Skype submitted updated SILK codec descriptions and source code to the IETF |

Table 1. Widely Used Wideband Audio Codecs

Headsets and Handsets

When deploying wideband audio in the enterprise, choosing the right equipment for the end user is an important consideration. To support wideband audio, headset/handset equipment must support the relevant codec and have enhanced acoustics in the form of microphone and speaker capabilities. IP-PBXs and SIP phones are increasingly supporting wideband audio as a standard. Manufacturers are incorporating wideband audio into their SIP Phones, and mobile device manufacturers are incorporating wideband audio into their mobile phones.

VoIP and Wideband Audio

SIP trunking capabilities enable the deployment and use of wideband audio for communication within an enterprise, communication between enterprises, and communication between enterprises and mobile phones.

Communication within an Enterprise

With SIP trunking, wideband VoIP is possible when connectivity is internal to the enterprise. This type of internal communication can take place within one branch office or between two branch offices via the enterprise network or via Peer-To-Peer (P2P) connectivity over the internet using a service such as Skype. In these various situations, codec-related issues are usually rare because the same codec is usually used throughout the communication.
SIP Trunking: Enabling Wideband Audio for the Enterprise

Figure 3 depicts an example of the use of wideband audio between two enterprise branch offices.

Communication between Enterprises

When connecting to another enterprise, control over the remote end’s codec use is lost if the two enterprises support different codecs. In such a situation, either a transcoding function is needed to convert between the different codecs (such as RTAudio to G.722), or both ends must default to a common narrowband codec.

If the connection between enterprises runs through an internetwork of service providers using IP peering, and the network supports wideband audio (HD Voice), then maintaining end-to-end HD Voice communications is possible. A number of companies provide this service, thus enabling seamless internetworking and interoperability between fixed and mobile networks.

Figure 4 depicts an example of the use of wideband audio between two enterprises that support different codecs.

Figure 3. Internal Communication with Wideband Audio

Figure 4. Enterprise to Enterprise Communication with Wideband Audio
SIP Trunking: Enabling Wideband Audio for the Enterprise

Enterprise to Mobile Communication

Although wideband audio has been slower to roll out on wireless networks than on wireline networks, some mobile carriers are beginning to provide this service, and other mobile network providers are running trials.

One difficulty using wideband audio on mobile networks is that wideband audio is being rolled out as “islands” that lack wideband audio connectivity outside of the provider’s network. Businesses desiring to provide the same type of connectivity across wireline and wireless calls will likely create more demand and thus increase efforts to improve this technology.

One example of enterprise to mobile communication occurs when a user’s mobile phone uses a SIP-based VoIP applet and broadband access, rather than its voice connectivity, to communicate with an enterprise over wideband audio. In such an instance, a transcoding capability is required to connect the AMR-WB mobile section of the call to other codecs (typically G.722) on the enterprise-side of the call. In this situation, IP end-to-end connectivity costs less than voice connectivity, especially for roaming mobile users.

Another example occurs when a mobile phone user communicates with an enterprise using voice connectivity. In such an instance, the transcoding operation can be located either at the service provider end of the SIP trunk or at the enterprise end of the SIP trunk. Locating the transcoding function at the enterprise end allows the enterprise to control the transcoding function. For this example, the enterprise can limit the transcoding function to translating to and from the codec it uses internally. Locating the transcoding function at the enterprise end gives the enterprise the flexibility it requires for selecting equipment and communications systems that enable the use of wideband conferencing systems with different types of endpoints.

Figure 5 depicts an example of the use of wideband audio between an enterprise and mobile user when the communication occurs over broadband.

Figure 5. Enterprise to Mobile User Communication with Wideband Audio

Wideband Audio Conferencing

As uses for wideband audio spread, the likely next step will be to have conference calls be wideband, followed by the desire for conferences to support multiple types of codecs, thus supporting as many different endpoint types as possible. In this situation, locating the transcoding capability in the enterprise network means limiting the number of potential transcode operations for an audio path, thus causing as little degradation of quality as possible. Figure 6 shows an example of the potential of transcoding and conferencing with different end points.
The SIP trunking gateway can provide an end-to-end interoperability function using transcoding to support completing wideband audio calls when two or more end points have dissimilar codecs terminating in different networks.

**Summary**

The implementation of SIP trunking on an enterprise’s network facilitates the move to an all-IP environment, which offers many possibilities for new services, such as wideband audio. Because wideband audio extends the frequency range transmitted to the mobile user on the remote side, it provides a high quality voice transmission that can enhance the user experience.

Wideband audio is starting to become more mainstream as service providers continue the move from trial to deployment. Although wideband audio is being rolled out as “islands” that lack wideband audio connectivity outside of the service provider’s network, it is expected that this situation will eventually improve, as businesses drive the need for the same type of connectivity across wireline and wireless calls.

Service providers that offer SIP trunking control the interfaces from their network to fixed and mobile networks, and because of this control, they can offer additional services, such as wideband audio, that span their network and the fixed/mobile networks. Enterprises that purchase SIP trunking services can also purchase wideband audio services, and they can reap benefits by using wideband audio for communication within the enterprise, communication with other enterprises, and communication with mobile phone users.

**A Note on AMR-WB**

Using AMR-WB resource in connection with a Dialogic* product does not grant the right to practice the AMR-WB standard. To seek a patent license agreement to practice the standard, contact the VoiceAge Corporation via [http://www.voiceage.com/licensing.php](http://www.voiceage.com/licensing.php).
For More Information

For more information on HD Voice, see:

http://www.dialogic.com/technologies/hd-voice.htm

For more information about SIP and SIP trunking, see:

