MegaPath A Fusion Company

WHITEPAPER

VOICE SERVICES

QUALITY OF SERVICE AND TECHNOLOGY

OVERVIEW

MegaPath offers everything you need for a complete, unified Hosted Voice system that supports a single office or multiple locations nationwide including broadband connectivity, IP phones, calling plans, advanced calling features, and Unified Communications tools. For best possible performance, using a MegaPath circuit with MegaPath Voice will deliver end-to-end Voice Quality of Service.

MAINTAINING VOICE QUALITY OF SERVICE

As business managers look for innovative ways to cut costs and improve workflow efficiency, VoIP services frequently become a viable option and lead IT managers to think about the quality and reliability of voice services. One of the biggest components in choosing a reliable voice provider is determining how that vendor will maintain QoS.

MegaPath's Voice Quality (VQ) technology solves the problems of reliably sending voice services. By prioritizing voice traffic at all the constraint points of Wide Area Network (WAN) links between MegaPath and customers, MegaPath is able to provide a high-quality and reliable service. This is done by smoothing traffic at the traditional bottlenecks:

- Toward the customer WAN
- Through use of router prioritization

MegaPath addresses the issue of customer WAN circuit congestion with a variety of techniques. Outbound voice traffic from the customer is protected with the use of an Application Layer Gateway (ALG)—which is used to manage traffic flow from the customer to the network—that is capable of ensuring that voice traffic receives priority through the LAN router. Additionally, MegaPath edge routers are configured to prioritize voice traffic more favorably than data traffic when crossing the WAN link to our customers, frequently, the largest and most common bottleneck. Finally, the MegaPath network connects directly to all the voice network equipment through private interconnects, so no voice traffic destined for the PSTN is passed over a third-party network or any public peering points. This ensures consistent quality voice service.

THE BUILDING BLOCKS OF VOICE QUALITY TECHNOLOGY

Historically, there have been two major fields of thought regarding maintaining Quality of Service for IP networks: Differentiated Services (DiffServ) and Integrated Services (IntServ). The primary difference between DiffServ and IntServ is how they deal with the problem of resource allocation. MegaPath's Voice Quality technology is based upon the DiffServ model.

IntServ very closely resembles the way the PSTN works. An attempt is made to reserve capacity from end-to-end; if the reservation is successful, it delivers the service. MegaPath ruled out IntServ as a viable option for two reasons: signaling and economics. For IntServ to essentially guarantee that resources will be available from end-to-end, the call must be able to be set up end-to-end. The Resource Reservation Protocol (RSVP) was created to address this problem.

In an IP network without end-to-end signaling—such as that which RSVP provides—maintaining the guarantee that IntServ requires is difficult. While access networks—such as MegaPath—could deploy RSVP, it would also have to extend the protocol all the way through partner networks that provide the IP to PSTN gateways. Today, such cooperative examples of inter-provider signaling for purposes of traffic prioritization are nearly nonexistent. Additionally, IntServ essentially recreates a circuit switched network on top of a packet switched network, which removes a lot of the statistical multiplexing benefits of the packet infrastructure. This overlay quickly erodes many of the benefits of a converged network.

The primary advantage of DiffServ is that it doesn't require a signaling protocol. DiffServ does not attempt to move data from end-to-end, but rather on a per-hop basis. Because the statistical multiplexing characteristics of the packet network are not eroded, MegaPath considers the DiffServ model to be a better vehicle for implementing converged services across a single broadband connection.

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DEMYSTIFYING IP VOICE

Fundamentally, there are two main concepts in any sort of DiffServ infrastructure:

- **Classification.** Takes place on the ingress to the domain and, ultimately, is an attempt to identify and mark the traffic so it can be mapped into the correct per-hop behavior
- **Scheduling.** Essentially, allocates resources so priority data is treated as such

Before any sort of per-hop behavior can be applied to a packet, it must be classified. For MegaPath Voice customers, both the core routers and Voice Application Layer Gateway (ALG) perform classification. MegaPath's core routers classify traffic coming from its voice gateways and then mark the headers so the voice per-hop behavior can be queued appropriately through MegaPath's network. Any voice traffic that is converted to IP is considered to be in the voice per-hop behavior.

Once the voice signal is classified as packet-carrying voice data, MegaPath protects it from regular data flows. The ALG shapes the traffic that is sent across the WAN circuit before it arrives at MegaPath's network. It is important to note that ALL traffic must be passed through the ALG for it to have the desired effect of scheduling the voice traffic before data traffic.

The other area where scheduling comes into play before a packet is sent down a client's WAN circuit is on the MegaPath edge router. Also called an access router, the edge router sits at the periphery of a network, in contrast to a core router, which is in the middle of a network. Edge routers and core routers are somewhat relative terms, but may also indicate that different vendors or models of equipment are being used.

All are routers, but of different size and capacity. They may have been built from Application Specific Integrated Circuits (ASICs), which are optimized for different tasks. The Edge/Access router is where the customer aggregation takes place.

The default configuration for the MegaPath edge router's scheduler divides all network traffic equally. This includes buffer capacity, as well as how frequently a packet can be transmitted through the interface. For example, if we have an access service with 100 Mbps with 1000 customers bound to it, then each customer will be serviced 1/1000th of the time and have 1/1000th of the buffer pool available. In this case, everyone is treated with classic best-effort forwarding.

With MegaPath VQ, we have defined four per-hop behaviors, so the customer now has the following four differentiated behaviors:

> Network Internet routing protocols
> Voice—Packets from MegaPath gateways
> OnNet—Packets from MegaPath address space
> OffNet—Packets from the Internet

There are four different per-hop behaviors for every client that is VQ-enabled; each behavior is modified from the default case for maintaining differnt service levels. To preserve the quality of voice conversations, the most critical behaviors are voice—the valued resource to be protected—and OffNet, the large volume of traffic competing for resources.

An earlier reference was made that if 1000 users were attached to a given aggregation circuit, each would have access to 1/1000th of the resources. Should one of those users subscribe to MegaPath's voice service, then the scheduling frequency is no longer completely equal, due to the protective mechanisms that exist to defend the voice traffic:

	Non-Voice User	Voice User
Voice	---	Strict
Data	1*	1*

The numbers reflect the frequency at which the interface scheduler will look at each client interface to see if there are any packets awaiting transmission. The asterisks in the data row indicate that while the amount of scheduler resources that are allocated to the clients for data starts out the same, there are variables that play into the period in which the scheduler will visit the client interface, as well as the amount of data that is permitted to be sent.

One of the artifacts of handling voice packets with strict priority is that the exact frequency with which the scheduler visits the client interfaces for data transmission is no longer as predictable. This is because the real-time nature of voice requires that it receive priority queuing, which then introduces a bit of randomness in the frequency that the data queues are serviced.

PER-HOP BEHAVIOR ANALOGY

Imagine that you are a student going on a field-trip from Seattle to Washington, D.C. Because of the distance involved, flying is the obvious choice. At school (a non-DiffServ-enabled network), everyone is equal; so when it comes time to board the bus for the airport, everybody lines up and files in one by one. Getting off the bus and heading into the main terminal is the same—the bus empties in the same order that it filled: First In, First Out. Of course, now that you are not on school property (a DiffServ-enabled network), things are slightly different for some travelers.

Several travelers have frequent flier miles to get an upgrade to business class—a different behavior aggregate that triggers an entirely different per-hop behavior. At the ticket counter, people flying business class are in a MUCH smaller line (lower latency). Here, the ratio of airline agents to assist business class travelers vs. those flying economy is much more favorable (scheduler weighting). In the economy section, the lines are long and there are many directional ropes to traverse (larger buffer capacity).

The voice over the loud speaker announces, “Last call for boarding flight DCA_1776 at gate J4.”

At this point, it is quite possible that travelers with business class tickets are already at the gate area or on the plane because they were processed through the lines much more quickly. Travelers flying with an economy ticket may miss their flights due to having to wait in line for so long (packet loss, similar to old world order TTL expiration). In this case, those with economy tickets have no choice other than to look for a later flight (re-transmit). In MegaPath’s view, queues at the airport are very similar to the DiffServ model, particularly when considering the elasticity of resource allocation. Travelers may have noticed that the helpful airline attendants working with business class customers will assist those in economy if they are otherwise unoccupied. The same can happen in DiffServ, where resources from one per-hop behavior can be “borrowed” from another if there is a momentary surplus.

THE COMPLEXITIES OF BUSINESS IP VOICE

In an office setting, it is possible for the IP data from one phone handset to go directly to another without passing through a voice gateway. As a result, multiple classification possibilities exist. In addition, there are times when a packet’s per-hop behavior will change as it passes through the system.

An Application Layer Gateway (ALG)—a packet-shaping device—is required at the edge of the customer’s LAN on the business’s premises to help protect the customer’s voice traffic. An ALG’s primary responsibility is to perform call admission control to help ensure that adequate resources exist from end-to end in order to sustain calls. If adequate resources are available to sustain the voice call end-to-end, then the call goes through. If there are inadequate resources, the user gets a fast-busy signal.

The ALG knows how many active calls are in progress. All of the phones register themselves with the ALG, and the ALG is in their forwarding path; it is also configured with a specific number of calls that the provisioned network should be able to sustain. With these two pieces of information (number of active calls in progress and number of calls configured), MegaPath can determine if a call has a chance of going through. In the event that a new call pushes the call capacity over the limit, the ALG can disrupt the signaling. In this situation, the caller gets a busy signal of sorts, but the quality of the existing calls that are being forwarded through the ALG is not degraded.

Ideally, the network would never drop a packet and the customer would only want to use the circuit for voice traffic. However, customers usually want to converge their infrastructures to run both voice and data over the same links. The ALG does not have the ability to control non-voice-based traffic that is inbound to the customer's location. It cannot fully prioritize traffic entering the customer's LAN in a fully converged voice and data environment. This is where the MegaPath edge router comes into play.

Three possible sources/destinations from which the voice/data traffic can flow are shown in the table below. Under the Receiver section of the table, notice the actual scheduling behavior of the traffic. Note: There are three receiver options.

The acronym expansion and definitions used in the table are as follows:

> **PSTN:** Public Switched Telephone Network (voice)

> **OnNet:** An IP address that is within MegaPath's address blocks

> **OffNet:** An IP address that is NOT within MegaPath's address blocks

Sender		Receiver	
	PSTN	OnNet	OffNet
PSTN	N/A	Voice	N/A
PSTN	OffNet	OnNet	OffNet
PSTN	N/A	OffNet	N/A

The table below displays MegaPath's relative scheduler weights. As before, the numbers represent the relative frequency that a particular queue is serviced. For the OnNet and OffNet division that occurs for the voice user, in the absence of one classification of data traffic, its resources can be borrowed by the other non-voice traffic class.

	Non-Voice UserVoice	User
Voice	---	Strict
OnNet	---	.66/1*
OffNet	1*	.33/1*

In business voice scenarios, the network of classification is as follows:

> MegaPath core routers classify traffic coming from the Voice Gateways and mark the header in such a way that the voice per hop behavior can be acted upon through MegaPath's network. (PSTN ≥ OnNet)

> The ALG classifies voice traffic based upon registration. (Voice ≥ MegaPath across the backhaul)

> The MegaPath edge router rewrites the IP precedence bits based upon the source and destination of the packet header. If both are within MegaPath's Classless InterDomain Routing (CIDR) space, then the packet is given the behavioral aggregate for OnNet. Otherwise, it is considered OffNet.

Scheduling looks like:

> The ALG sends voice traffic ahead of data traffic. (Voice ≥ MegaPath across the backhaul)

> The MegaPath edge router maps all packets based upon their behavior aggregate into the appropriate traffic class and, by extension, queue.

BUILDING BLOCKS OF QUALITY OF SERVICE

Many VoIP providers tout a high-quality voice experience over the Internet, but they neglect to inform potential customers that the traffic is quickly handed off to the public Internet, where it is susceptible to jitter and packet-loss—which translate into echo and static that make for a low-quality caller experience.

True Quality of Service depends on the following factors:

> **Bandwidth.** This is a leading vactor affecting voice quality in VoIP. Additional factors include packet loss, jitter or delay characteristics, latency leading to echo and whether full end-to-end QoS is applied. The bandwidth of the circuit should be based on the quantity of calls to support, the codec used, and the amount of bandwidth desired for data traffic. At MegaPath, we can sell business class connections with our voice service. This allows us to guarantee the clarity of the call and to actively monitor the quality.

> **Equipment.** The VoIP equipment you use can greatly impact call quality. Poor quality equipment typically has the lowest price, but not always. Therefore, it is highly recommended to have as much information as possible on a router or IP phone before investing in it. Read reviews and discuss the equipment in forums. Various professionals—regardless of industry—regularly say, "Use the right tool for the job." VoIP is no different. You might choose the best equipment in the world, but will experience problems if it is not designed to meet your specific needs.

> **Phone Frequencies.** The frequency of your IP phone may cause interference with other VoIP equipment. Some people using 5.8 GHz phones were able to rectify interference problems by changing to a lower frequency (2.4 GHz, for example) phone.

> **Compression: The Codec Used.** VoIP transmits voice data packets in a compressed form, so that the load to be transmitted is lighter. The compression software tools used for this are called codecs. Some codecs are good, while others are not considered optimal because each codec is designed for a specific use. If a codec is used for a communication need other than that for which it is meant, call quality will suffer.

SUMMARY

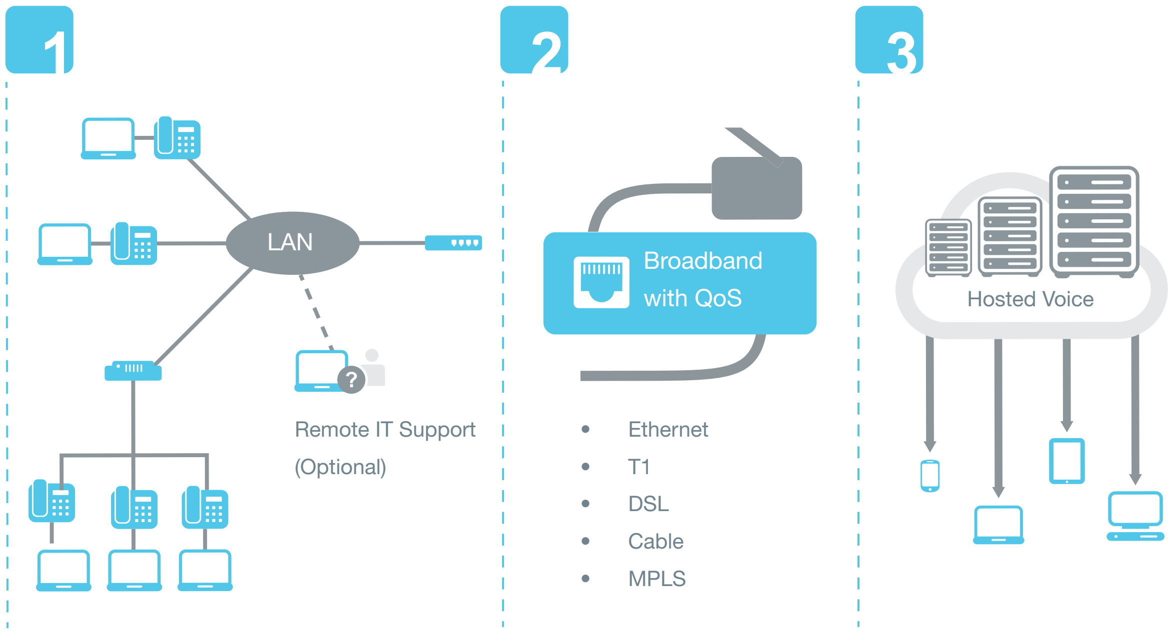
With MegaPath QoS, there's no need to invest in large amounts of additional bandwidth to ensure high-quality VoIP conversations. With QoS—even when there are large spikes in network usage or circuits are congested—you can rest assured that your voice traffic will be given priority.

Offering a diverse set of advanced features, choice of installation options, 24/7/365 customer care, and industry-leading reliability, MegaPath may have what you're looking for in a voice and Unified Communications solution.

> Leading, award-winning VoIP platform with 99.999% voice network availability, the best in the industry.

> Over 50 calling features to enable mobility, productivity, and collaboration.

> MegaPath Hosted Voice can be purchased as a stand-alone solution—customers bring their own broadband—or as a fully integrated Voice and Data solution with guaranteed Quality of Service (QoS).



- Flexible install options. If you need to get up and running quickly, you can opt for self-install and get your phones within 7 days, the industry's first installation SLA backed by service credits. Or if you'd rather have us perform the installation, you can choose a fully managed installation with dedicated project management.
- Free customized training for a smooth transition. Live user and admin training, plus on-demand recordings.
- True quality of service and HD voice for excellent call quality
- Comprehensive Unified Communications (optional service) helps companies support collaborative mobility by providing voice & video calling, IM and Presence, and online conferencing (including desktop sharing and guest access via web browser), integrated into a single application available on virtually any device.
- Get voice, broadband, security, and cloud services from one provider, with one bill and one call for support for all your locations.

NEXT STEPS

Visit www.megapath.com/voice to learn more, or contact a MegaPath Business Consultant today at 877-611-6342.