NetLink Technologies, Inc.
White Paper

VoIP and Quality, a System, Not a Product…

May 2008

3589 Sagamore Parkway N.
Suite 240
Lafayette, Indiana
www.netlink-tech.com

What this paper is…

This is a personal, non-exhaustive overview of the factors which, I feel, most dramatically, place VoIP service quality at risk. It's not hardware or service-centric; there's no endorsement of any particular vendor or manufacturer; no specific carrier services are recommended above those of another.

It is a discussion, primarily directed at the Small(er) business owner, with a single or multiple site organization. It's presented in as non-technical a fashion as possible, and is intended to address the perception that has contributed to the slower than anticipated acceptance of VoIP into the Small Business community.

It is a reflection my opinion of where VoIP is today (a little about where it has come from), where it's headed, and what you need to be aware of – especially from the perspective of assessing service quality - before leading your Small Business Enterprise into that future.

Introduction…

In its simplest, VoIP is the transmission of voice communications over any data network utilizing the TCP/IP protocol, including the Internet.

VoIP is here to stay… it's not some flashy, technologic fad that will disappear in the next six months. It is, in fact, the very future of telecommunications, and it represents a significant departure from the PSTN (Public Switched Telephone Network) we have enjoyed for the past one hundred thirty years.

VoIP is about transmitting voice communications across the same types (even the same) networks we have been using to transmit data for more than two decades. It's about Packet Switching, TCP/IP, and the Internet.

It is a means of digitizing voice communications, just as we do other forms of information, routing it, storing it, massaging it, and delivering it in the form we need it, where, and when it is needed. It's about cost containment and reduction; productivity improvement; and improved customer/client, vendor/supplier collaboration.

It's about limitless potential, and it's about change… and the fact that change is not always embraced by everyone.

Perception becomes reality…

Since its invention and patenting in 1874, the telephone (and ultimately) the PSTN has had more than 130 years to evolve, develop, and redefine itself. Every component has gone through

countless iterations, upgrades, and improvements designed to make it the most reliable, secure, and taken for granted resource available to the business community today.

This national resource has gone from copper wires, to microwave towers, to intercontinental satellite telecommunications, and everything in between. It's migrated from manual switchboards, to step by step switches, to crossbar, to ESS and Digital switching Central Offices. It's gone from one company, to The Bell System, to Divestiture, and back again… and it has witnessed a re-definition of what telecommunications is, and who its providers are, with cable companies (Comcast, Insight) providing residential voice services, and AT&T providing movies and other entertainment services, to name just two.

In the end though, what other device do we have so much confidence in as the telephone? When we lift the hand set, we hear the expected dial tone. When we dial a telephone number, we expect to be flawlessly connected to the intended party we have dialed. When we dial 911, we expect help to be just minutes away. When we answer an incoming call, it's not uncommon to recognize the calling party, simply from the sound of their voice.

This single device extends to us an unprecedented performance standard. When we need it; it is always available (or nearly so). I can think of no other tool -- the lights in my office; my calculator, pens, paper, computer; and certainly not our company's internet connection -- that comes anywhere near the reliability and performance standards, that we have legitimately grown to expect of the telephone network.

Along with this performance level, however, has also come an end-user who is extraordinarily sensitive to performance quality… (or rather, one sensitive to and intolerant of any deviation from what we have grown to expect).

Though VoIP has been available and generally accepted by the enterprise since the mid to late 1990's (VoIP was experimented with as early as the 1970's), and is widely accepted throughout Western Europe; there remains a perception - a pervasive concern within the Small Business community, especially - that the actual quality of voice carried as data over a VoIP network, is some how inferior to that of traditional telecommunications. To some degree, this may be residue of early Internet voice users who often tried to connect and transmit voice via unstable, unpredictable, low bandwidth, saturated, residential grade internet connections (and with often inferior hardware, as well).

For the record, this perception that VoIP voice quality is somehow, intrinsically inferior, simply cannot be substantiated.   There is no reason to expect any deviation in quality simply because of the packet switching characteristics of an IP Network.

It's only as strong as its weakest link…

We've all had experiences with data networks of one form or the other. We've had good experiences and bad. There are known characteristics of a data network that must be taken into consideration; levels of quality must be engineered into the infrastructure; but VoIP makes no demand that we somehow lower our expectations regarding voice transmission quality.

If you remember our definition of VoIP - the transmission of voice communications over any data network utilizing the TCP/IP protocol, including the Internet - it's probably time to concede that definition has generally grown to mean "especially the Internet."

With the proliferation of cheap (in some cases, free) internet voice services; the widespread promotion of Vonage and other Cable-based residential services; and with the fact that the Internet may be the only generally available network paralleling the PSTN… many have concluded that VoIP has to be carried via the internet. Frankly, that's not completely accurate – VoIP can be carried across any IP network including Private IP, Frame Relay, ADSL, etc.

Factors affecting quality, however, also can apply to these other forms of IP networks. It's my belief that our individual experiences make it a bit easier to understand if we confine our discussion to Internet.

When many of us were first introduced to the Internet, it was through services like Prodigy and AOL; CompuServe; and others. Access was a subscription based service, utilizing a telephone connection, and initially connecting at a dialup speed of 14.4Kbps. Later, speeds were to increase to 28.8Kbps; 56K over dialup modems; then to 1.5Mbps, to 7Mbps, or even faster, via ADSL or Cable connections. In general, our experience (and enjoyment) with internet access was directly related to the speed at which we could connect… with Bandwidth.

Just as bandwidth directly affected our Internet browsing experience, it leads the list of factors to consider when considering those that affect quality of the VoIP experience. Simply, bandwidth is the "size of the pipe" that connects your company's network to the rest of the world. Assuming all factors to be equal …the bigger the pipe, the greater its ability to carry data before experiencing a loss of quality. But here's the rub, all factors aren't equal.

Just as an oversubscribed ISP (more users and collective demand, than can be carried by THEIR connection to the Internet) could impact the quality of your internet connection; just as an inferior modem; just as your service provider's hardware infrastructure or connection to the internet itself could impact YOUR browsing experience, it follows, your total experience will only be as good as that provided by its weakest component.

Physically, not every local area network (LAN) is created equally. Some are "do it yourself" models, where a friend of a neighbor's cousin, "works with computer networks" and will install your cable infrastructure for little more than a pizza and a subscription to the beer of the month club. Some have improper wiring, poorly terminated, extending beyond the realistic reach of

twisted pair cabling. Or those that are evolutionary, having been constructed over years without a plan or even a clear understanding of the destination of the project.

These types of IP Networks (LANS) are subject to serious performance flaws and leaks, and should not be relied on to carry voice communications internally, let alone, across publically available facilities. Regardless of the size of the pipe, it is likely that a VoIP experience in this environment will fall very short of expectations.

Contrary to the opinions of many, there really are differences between the switching and routing capabilities of different manufacturer's products. If that wasn't the case, everyone would buy an $80 router instead of a $2000 router (or more), and Cisco would be out of business. Some have more memory, or a more powerful processor; other were specifically designed and optimized to work within an integrated voice and data environment, others are simply, inexpensive.

We all have seen how hardware improvements have added enjoyment to our personal computing experiences. It is essential to understand that higher quality hardware is likewise, one of the fundamental ingredients in a solid, dependable, scalable, high quality VoIP infrastructure. It is equally important to understand that even the best pipe cannot compensate for sub-standard hardware dependence.

Not every telephone system is capable of VoIP communications. Many in service today, have been in place for 10 or more years; nearly pre-dating the general availability of VoIP itself. It is as unfair to expect those devices to be able to perform, as it is to expect the earliest PC to run today's high-end, and graphics intensive software applications.

Today, available to virtually every sized business customer, are premise based VoIP enabled systems from manufacturers like Avaya, Cisco, and Nortel… the world leaders in premises based VoIP CPE (Customer Provided Equipment). In addition, an array of hosted solutions, requiring little to no hardware is also available from respected providers like AT&T, Verizon, and Qwest.

But again… it's about the WEAKEST Link, and in my opinion, that's about the characteristics of the physical connection your company chooses to attach your VoIP system to the internet… it's about your internet connection, and Jitter, Delay, and Latency.

When best effort isn't good enough…

I admit "enthusiastic ignorance" when it comes to the details of circuit switching (traditional PSTN technology); as opposed to packet switching (the methodology by which data is transmitted across a Data Network). However, at least a basic technologic foundation is necessary in order for us to understand our differing tolerance for errors which occur in data and voice communications. .

With Circuit switching, a connection in the form of a dedicated path is established between two devices – from the telephone, over copper wires, to and from Central Offices and Toll Centers, again over copper wires, to the party we intended to call – which, once established, is used for the duration of the message.

The communication path is selected from among many; is established and maintained, until terminated by the parties; and ultimately gives us the ability to create communications between many separate devices. This is the switching technique used by the Public Switched Telephone Network (PSTN).

In a Packet Switching Network, no specific path is used for data transfer. Instead, the message is divided into smaller, well defined segments called packet*s* and sent over the network. Information regarding the routing of the message is embedded in the packet themselves and left to intermediary hardware devices within the network (routers, switches, etc.)

As a result, packets are often transported over different routes, combined or broken apart, as might be required in order to get them efficiently from one point to another.   At the receiving end, data is read from the packets and reassembled to form the original message.   This is the switching technique used by virtually all Data Networks, including the Internet.

Far more differences between these two switching methodologies exist, but the point that needs emphasis with regard to its impact on VoIP is that…

- Voice communications carried over the PSTN enjoys the luxury of being carried, in an uninterrupted fashion, from one end of the circuit to the other.
- Data -- including digitized voice -- carried via a packet switched network, is broken into multiple parts, switched and routed over multiple different routes, and then reassembled at its destination.

Three characteristics of a packetized network, all of which CAN impact the effectiveness of data delivery, must be taken into consideration. Enter the evil triplets… Jitter, Delay, and Latency.

- Jitter is the variation in the time between packets arriving at the destination, caused by network congestion, timing fluctuations, or route changes.
- Delay, on the other hand, is the amount of time it takes for a signal to be transferred across the path.
- Finally, Latency is a synonym for delay, and describes how much time it takes for a packet to get from one point to another.

As often as I've heard the terms, as often as I look at the definitions, I'm still not sure I understand the distinction between the three. But that's not important.   What is important is the knowledge that data transmitted over a packet switched network is subject to DELAYS.

We also need to understand that voice communications occurs in real time; that delays are most likely a bad thing… and that packets containing voice information therefore require priority handling by the network.

 As we know, the PSTN was designed and perfected to carry voice traffic. But in a packet switched network, everything appears as homogenous data. That means in order to insure the quality that we as users demand, resources of the network must be 100% committed to the transport of voice packets immediately, and on demand. If not, the sound quality of the voice traffic could be significantly degraded.

In contrast, however, data transport is extremely tolerant of variations in network performance levels. When packets containing an email are dropped, the missing information is simply resent; when an end-user encounters an additional 500 ms of delay in loading a web page, it's a non event. Can you imagine a telephone conversation where you're forced to repeat yourself every three or four sentences, just to be understood?

Tools used for simple internet browsing, email, and other data based services, no longer can be expected to provide the necessary quality we demand for voice communications. ADSL, and other similar services originally intended to provide a low cost, residential Internet experience have proven to be unacceptable for VoIP applications due to a complete lack of Voice Quality of Service (QOS). Cable connections (residential in nature) because of the common practice of over-subscription, the lack of QOS, and because they are prone to service interruptions, have less than desirable performance track records. Satellite and other non-terrestrial modes of communications, because of their natural tendency to delay transmissions (propagation), also appear to be unacceptable as a means of voice transport.

Dancing with the one that brought you…

Within the Carrier/ISP world are three levels (Tiers) of providers, Tier 1, 2, and 3. In general, Tier 1 Providers own their entire network, or have peering arrangements with other Tier 1 Carriers to exchange services where necessary (they do not purchase facilities or services). Tier 2 providers, on the other hand, may be very large organizations, in and of themselves, but at some level, are required to purchase facilities and services from a Tier 1 provider. Providers within the Tier 3 category purchase all facilities and services from Tier 1 and 2 providers.

One of the more obvious qualities of this hierarchical structure is the inescapable conclusion that Tier 3 providers are more subject to "breakage," market volatility, service outages, adverse service offerings due to financial performance (or the lack of it), and other factors.   Another concern is the size of the provider itself; its geographic reach, and the redundancy of the network itself. A single Fiber connection to a Tier 1 or Tier 2 provider (though offering significant bandwidth) is still, a single connection, and a single point of failure. Unfortunately, most Internet Service Providers are Tier 3 providers.

Tier 1 providers, (AT&T, Verizon, Qwest, and others) are today's names for many of the same companies that got us here in the first place. AT&T is today's version of Ameritech (Indiana, Michigan, Illinois, Wisconsin, and Ohio Bell Operating Companies), SBC, and Southwest Bell. Verizon; the combination of GTE, and Nynex, MCI and UUNet, and Qwest represents a union of Mountain Bell, US West, Pacific Northwestern Bell. These companies, or at least their predecessors, are the same entities responsible for the development of the PSTN, and the incredible quality we have grown to take for granted. Who better than these same companies to lead the development of VoIP as an alternative voice transport?

With a Tier 1 provider you know they don't resell someone else's service – their guarantees are their own, the responsibility and liability their own. They have spent, and continue to spend BILLIONS of dollars expanding the reach and capability of the network; they have built in unparalleled redundancy, minimizing the likelihood and impact of service outages and promoting rapid disaster recovery; the networks themselves are often enhanced to provide integrated anti-spam, virus protection, and other security services. They provide dynamic bandwidth allocation, providing you with more or less bandwidth depending upon your needs at any single point in time.

In short, they are the "phone companies" of the past, working today to provide an IP network as robust, failure proof, and as secure as that to which it is most often compared. Many would argue they have already accomplished their objective.

Conclusion…

The reality is that we have significantly different performance expectations (and thresholds for tolerance) for data compared to voice traffic. In general, data networks operate under what is often referred to as "best effort" standards that don't set any end-user expectations. On the other hand, we expect voice communications to be a pristine experience. When it comes to delivering the expected level of voice reliability, availability, security and quality, "best efforts" are clearly not enough.

Another reality is that VoIP is here to stay. It isn't going away, and will only get better and better, ultimately offering capabilities that we haven't thought of yet.

It is the future of telecommunications, it's available to all, and it should be evaluated by every business, regardless of size, as to the potential for profit improvement within your own organization.

It is an asset to be developed, customized, continually evaluated, and protected by integrating the best components possible within the constraints of a budget.

As I hope we have begun to demonstrate, VoIP is more a system, than a product. It is truly more than the sum of its parts… It's cabling, switching and routing; hardware and software; it's the integration of a premises based or hosted VoIP telephone system; and it is about high quality carrier access to the internet. Each of these components must seamlessly integrate with one another in order to assure the same level of quality we have come to expect and demand.

_____

[i] NetLink Technologies is a Microsoft Certified Solutions Provider – Partner, specializing in the design; installation; support and maintenance of Windows Networking solutions for the Small to Midsized Business client. In addition, they are both an Avaya Small Business Partner, as well as a Cisco Select Business Partner, with concentrations in the voice, voice over IP, and data communications needs of the Small Business Client.

NetLink Technologies also, through contractual arrangement, represents the services of more than 50 Carrier service products and services, including: AT&T, Verizon, Qwest, Sprint, and others.

They can be reached at (765) 742-2420, or via the internet at www.netlink-tech.com

The author is President of NetLink Technologies, Inc., and has more than thirty years experience with Telecommunications, Data Communications, Data Networking and Internet products and services. He may be reached via email at tbrown@nltch.com.