

Peer-to-Peer Voice for Business

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Executive Summary

Peer-to-Peer architectures can be used in a variety of business scenarios. Voice is one of the business applications where the peer-to-peer model can offer many benefits such as reducing deployment costs and increasing flexibility and recoverability. From a small business to small branches of a large enterprise, peer-to-peer voice can be used to rapidly deploy fully featured phone systems without the added cost of an IP PBX. In larger environments businesses will be able to achieve benefits from a combination of both approaches, the peer-to-peer model and the centralized IP-PBX model, by matching the right level of functionality and cost to address the needs of different locations..

Introduction and history of P2P

The term “Peer-to-Peer” (P2P) refers to a network paradigm of de-centralized nodes (the “peers”) communicating directly with each other, without the use of a central server as an intermediary.

A network architecture can be referred to as peer-to-peer if the nodes participating in the network are symmetrical: They fill the role of client and server. Additionally in a peer-to-peer network there are no central servers acting as intermediaries between peers. Of course, there is no bright line separating a “pure” P2P model from a “pure” client-server model. Between the two, there is a range of models incorporating elements of peer-to-peer and client-server.

P2P networks are not a new development – the concept led to the development of the Internet. Prior to the Internet, computer networks were primarily modeled on the master-slave model requiring a powerful central computer. ARPA developed the Internet to ensure a high level of “survivability” of the network and to remove the need for central nodes, which created single points of failure. In the Internet Protocol, there is no concept of “client” or “server” per se, and the protocol itself does not impose a centralized or a de-centralized design.

Some of the earliest examples of large-scale computer networks were, in fact, peer-to-peer models. USENET, a group discussion protocol created in 1969 and still very much alive today, is an early example of P2P networking. Mail Transfer Agents (MTAs) based on the SMTP protocol also form a P2P network: There is no “central” mail server on the Internet. All mail servers are treated equally and communicate with each other as peers in a loosely connected, self-assembling mesh network.

Since the advent of Napster, peer-to-peer networks have been (incorrectly) associated with piracy and file sharing. Ironically, Napster required central servers and therefore was not a pure P2P architecture. Napster, however, brought the concepts of P2P and the term P2P itself into popular culture. It would be a shame if P2P was forever associated with illegal activities, as the underlying principles that make P2P suitable for piracy and file sharing are just as well suited to creating extremely robust large-scale self-assembling networks for other uses.

What underlies the increased adoption of the P2P model in networked applications? Firstly, the bandwidth available at the endpoints of the network has been increasing at a near exponential rate. Secondly, the processing power of the endpoints has been increasing according to Moore’s law—allowing system designers to incorporate more and more functionality. Finally, the P2P model allows features to be added to the endpoints without the need to upgrade the entire network. This is also the characteristic that makes the Internet Protocol so successful. For all of the above reasons we expect that many business applications will incorporate P2P characteristics in the future.

How does P2P work for voice?

One possible use of the peer-to-peer paradigm is in the domain of voice communications.

Traditional “Plain Old Telephone Service” (POTS) is a highly hierarchical system where calls are aggregated into larger and larger switching systems from the local level all the way to the international switching nodes. With the advent of IP telephony, things have changed. Much of the intelligence originally located in switching centers has migrated to the phones. An analog phone is a very simple device with very few parts and almost no “intelligence” other than the ability to ring and generate DTMF tones. An IP phone by comparison contains more processing power than most early “supercomputers”. Furthermore, a typical IP phone is capable of many of the session management functions that used to reside in central-office switches.

In an IP telephony network, the functions of the traditional central office or PBX systems are incorporated in a server. This server provides telephony switching support as well as the value-added voice services such as automated attendant, conferencing, call forwarding, etc.

Therefore, we can see that modern IP telephony systems are a blended model of the traditional centralized telephony of POTS, and the de-centralized model of the Internet where intelligence is pushed to the endpoints. In fact, the predominant protocol for

Voice over IP, the SIP protocol has quite a few P2P capabilities. Even though most IP telephony systems do not take advantage of these features, SIP-based phones are able to operate without servers, initiating connections to each other directly. Even in a “centralized” IP telephony system, after the call session is established the actual voice traffic travels from one phone to the other directly, without the use of a server. Even value-added features, such as conferencing and presence, can be implemented in SIP in a peer-to-peer mode without the use of a server. At this point, it is important to disambiguate the concepts of VoIP, which is a set of protocols, and IP Telephony, which is a complete telephony system using an underlying VoIP transport. While the protocols that implement VoIP have P2P features, the IP telephony systems rarely use these features.

An implementation of IP telephony modeled on peer-to-peer principles pushes even more intelligence to the endpoint. Under such a model, there is no need for a central server. Many functions, such as voicemail and conferencing do not reside in a central location, but rather are distributed amongst the phones. The phones themselves contain all the functionality needed to create an IP telephony network. In addition, voicemails, configuration information and presence information are stored in multiple phones rather than a central server removing the single point of failure of a centralized approach.

One of the few components that must remain centralized in a P2P telephony system is the gateway to the POTS network. The P2P phones must use the POTS gateway to connect to phones outside the P2P network. The gateway itself can be located on-premise or hosted by a service provider. With a hosted gateway, deployment of the P2P telephony network reaches the ultimate level of simplicity: plug any phone into any Internet connected network and you can start making calls. To add another user, buy a new phone and plug it in to the network.

In a P2P model, mobility, simplicity and recoverability are built into each and every phone of the network. All of the characteristics of the network emerge from the collaboration of the phones without the need for complex network architectures, high-cost redundant servers or specialist to configure everything.

Benefits of P2P voice

There are many benefits in adopting a P2P model for IP telephony:

- ⊕ Reliability : Because of the absence of a single point of failure, a decentralized telephony network offers higher reliability. As the phones communicate with each other directly, even for the switching and session-management functions, the aggregate reliability of the network is much greater. For example, if any part of the network is disrupted, only the phones within that part of the network are affected. The other phones continue to operate without any problems.
- ⊕ Mobility : The endpoints of a P2P voice system can be moved without re-configuration to any part of the network. This makes it easy to rapidly deploy phones for new offices or move phones in the case of a disaster.

- ⊕ Disaster Recovery : Not only does the P2P telephony network survive small disruptions because of the lack of a single point of failure, but it can also be quickly re-constructed at a recovery site in the case of a more serious problem. This makes it a lot easier for IT and voice administrators to put together a disaster-recovery plan. Furthermore, the disaster recovery itself will be simpler since much of it can be executed by the end-users (the owners of the phones) without the need for technical experts.
- ⊕ Easier Deployment and Management : One of the characteristics of P2P networks is that they are self-assembling. When a P2P telephone node is plugged in to an IP network it will discover the “cloud” of IP phones and configure itself to join the cloud. This feature makes it much easier to deploy P2P phones. In many cases the deployment can be done by the non-specialist end-users. Since the added-value features are also in the phone and not at a central switch, the phones can also be much easier to manage. A simple Web interface on each phone can be all that is needed to configure the network.
- ⊕ Scalability: A P2P telephony system is also extremely scalable. With an initial configuration of just two phones, the startup cost is low. But since each phone provides resources to the network, even while it consumes resources itself, the network can scale very well. Scalability is in fact the key characteristic of the P2P model which contributed to the explosion of file sharing in the late 1990s.
- ⊕ Modularity : Since each phone contains all the necessary functionality, “deployment” becomes as simple as plugging a phone into an IP network. This means that the initial cost of setting up a network is very low, allowing companies to literally “throw” a few phones together to create ad-hoc ephemeral networks on demand. A large company can build a departmental or temporary phone system in minutes, while a small business can have a state of the art telephone network for the cost of a few phones. Finally, this level of versatility does not negate scalability. That same small business can grow their phone system one phone at a time until long after the word “small” applies to them.

Potential disadvantages of P2P voice ...and how to resolve them

Today’s enterprise is becoming increasingly de-centralized through globalization, outsourcing, teleworking and other transformational trends. Yet it remains still highly centralized in many ways. Organizationally, geographically and legally, enterprises are top-down organizations. So while a decentralized network offers substantial benefits there are some potential drawbacks. Some telephony activities need to be centralized. For example, in many organizations all calls are centrally logged and sometimes recorded for regulatory compliance purposes. In a strictly decentralized P2P telephony model, such activities may be somewhat more difficult. This is not a flaw in the P2P model but rather a mismatch between the P2P telephony model and the structure of an enterprise.

Solving these problems is straightforward. Between a purely centralized model and a purely decentralized model, there is a near infinite range of possibilities. IP telephony is already a mix of the POTS paradigm and the Internet model, as it has to co-exist and interoperate with POTS. By combining P2P features with the IP-PBX model we can get benefits from both. Depending on the nature of a company, ranging from a small business to a global enterprise, there may be any number of approaches with more or less de-centralization.

So while compliance, auditing and network partitioning will be difficult to do in a consumer level P2P telephony network, these features can be designed in an enterprise suitable P2P telephony network by combining the best of P2P with the best of the IP-PBX approach.

Combining P2P and IP-PBX for the best of both worlds

Which functions should reside in the endpoint and which in a central server? This question is at the heart of the design of any IP-based telephony system. In the POTS world, the answer was to locate the vast majority of the functionality (and the value) in the switches. By comparison, in a modern IP telephony network many of these functions are now located in the endpoints (the phones). Although it may appear that the eventual conclusion of this trend is that all the functionality moves to the endpoints, this would likely result in over-engineered and complex phones, much as the other extreme involved an over-engineered and complex network. One of the advantages of IP telephony, however, is that the phones are flexible computers. This means that the right balance of functionality may be negotiated by the phone itself. For example, a peer-to-peer style phone can continue to rely on its own built-in applications but could link to a centralized server that provides advanced-routing capabilities to efficiently connect to other peer-to-peer phones in other locations or to headquarters communication systems. Effectively, the balance between centralized and decentralized operation can shift based on external circumstances.

By creating a mixed model, therefore, we can more closely match the needs and structure of an enterprise without sacrificing the benefits of the de-centralized P2P model.

Benefits for Industry Sectors

Each business will have its own requirements and special circumstances when it comes to telephony systems. In this section we will examine various types of businesses and how they can benefit from P2P telephony.

Small and medium sized business can greatly benefit from the flexibility and lower startup cost of P2P voice. For a small business a “traditional” PBX is relatively expensive, since the costs of the central resources are shared among few users. IP telephony has reduced the entry barrier, but even an IP-PBX may be costly for a small business. The real cost, however, comes from the installation, configuration and maintenance. These activities require a high level of expertise if one is installing an

analog PBX or an IP-PBX. The ability to build and grow the system in a plug-and-play fashion removes the need for highly skilled technicians and brings state-of-the-art telephony within the reach of even the smallest business. Using a hosted solution for POTS or SIP trunking, small businesses can start with only the cost of a single phone per user. Furthermore, as the business grows, the system can smoothly scale up.

One of the challenges facing medium and large companies is the small regional office. Equipping a regional office with all the communications necessities can be very expensive. And while connection costs for DSL and T1 have dropped to very affordable levels, PBX costs are still very high. In essence this places limits on the minimum viable size of a regional office. With P2P voice, however, the regional office can start with a few phones and minimal startup cost. A P2P solution scales down to the teleworker level or up to larger offices with many phones. In the large enterprise the same model can be used to equip temporary or new offices requiring rapid deployment. A combination of the peer-to-peer model and the centralized IP-PBX model can help businesses match the right level of functionality and cost to address the needs of their different locations.

Financial Services

Financial-services organizations have very distinct communications needs. Because the industry is highly regulated, there are stringent requirements for auditing and compliance. At the same time, financial-services companies are at the forefront of globalization and are often highly distributed organizations with many small regional offices. Disaster recovery is a challenge for small offices and the need for business continuity often places a minimum limit on the size of an office. Since the P2P model uses self-assembly and auto-discovery, the disaster recovery can be as simple as “pick-up and go.” Effectively, the end-user of each phone either can move his or her phone or arrive at a secondary location and install the new phone himself or herself. No special skills are required to re-build the telephony network and therefore the resilience and recoverability of the network is increased.

Retail and services

Retail organizations operate on razor-thin margins. In this environment, not all employees have desk phones (or even desks). In many cases, IT staffs set up phones in common areas as “stations” without a specific owner. Also, small retail locations may only require one or two phones at most. So the cost of using a traditional PBX is disproportionately high for many such environments. P2P telephony offers the ability to deploy just a few phones and to use WAN connectivity to route all calls. In addition, standard retail-store features, such as auto-attendant, can be supported, again by the phones themselves, in a peer-to-peer environment. For larger retail environments, these phones can be combined with a central IP-PBX for additional scalability. Another key consideration is the speed of deployment. Some retail companies have to manage almost explosive growth. A certain specialty coffee retailer for example may need to open two to three new stores every week just to maintain growth. In this scenario, phone deployments can represent an unacceptable delay. So the retailer is faced with a dilemma: state-of-the art telephony at a slow pace, or POTS lines for speedy deployment.

P2P resolves this dilemma by offering the best of both worlds, with plug-and-play deployment and a fully featured communications platform.

Conclusions and recommendations

The peer-to-peer model fits very naturally in IP telephony. Companies can discover many benefits in adopting a peer-to-peer model, where each phone contains all the functionality needed to create a fully-featured telephony system. Reduced deployment costs and simplified “plug-and-play” installation will appeal to small businesses. In small branches of larger organizations, peer-to-peer voice will complement existing IP-PBXs in headquarters. This mixed model which provides flexibility to deploy the right solution to match the needs of different locations utilizing the best mix of local or central intelligence. Nemertes Research recommends that companies examine the benefits of peer-to-peer telephony, despite the negative connotations of the term “P2P”. If you look beyond the infamy of file sharing you will find that peer-to-peer is a flexible and natural architecture for fully connected networks such as the Internet and for applications such as telephony.

About Nemertes Research: Founded in 2002, Nemertes Research specializes in analyzing the business value of emerging technologies for IT executives, vendors, and venture capitalists. Recent and upcoming research includes Web services, security, IP telephony, collaboration technologies, and bandwidth optimization.

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