Voice LAN Networking

S 38.126 Course Assignment

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ABSTRACT

In this paper we discuss the Voice LAN technology Networking as well as its potential business values that will be delivered to the end users. The core idea of Voice LAN Networking technology is to merge company's telephony network and traditional computer network into one efficient single network. The deployment procedure is to use company's LAN networking system to transfer voice data, treat voice as just another form of data, offer more services and applications to the end user on a single simple networking system. The reasons and advantages of the technology are analyzed. Possible scenarios are recommended to transfer from PC/Telephony networks to Voice LAN/WAN networks. No one can predict the exact road map of this new technology. However the voice LAN technology with its obviously great value added features to the customer has big potential in the market and technology development. In the near future we will be able to see digitized voice data melted into the LAN data stream.

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1. Introduction

The Voice LAN Networking is a LAN-based voice networking technology. An outgrowth of Computer Telephony Integration (CTI)[1], the Voice LAN networking market has experienced a renewed level of interest during the past year as multimedia technologies have risen to the forefront of the applications "hot" list. In this paper we try to discuss the significance of LAN-based voice systems, especially as they relate to the evolution of private branch exchange (PBX)[2] [3]technologies.

We try to look at the market without focusing on any specific vendor architectures, avoiding linking a still-emerging technology with any specific products. Where vendor references do occur, they are intended to illustrate examples of different technologies that have been devised to support the migration of the PBX into the (Local Area Network) LAN[4] environment.

As this technology is still emerging, and extremely undefined in a broad market sense, it is very difficult to delve into all of the specifics. This paper will examine the mechanics of Voice LAN technologies as well as a discussion of the value of Voice LAN technologies and how an end user might anticipate the emergence and deployment of Voice LAN products within his own business environment.

2. The need for Voice LAN technologies

One might easily argue that the most perfect form of communications between any two people is direct, face-to-face, verbal communications. This type of interaction eliminates most misunderstandings brought on by interpretations of words, and lets each person fully utilize the tremendous power of the human brain in both expression and comprehension. After all, verbal communications is much more than mere words; it is phrasing, inflection, cadence, facial expression and body language. Unfortunately, communications in the business world is often forced into less-than-perfect modes of operation. Memos, letters, and e-mail dominate, and bring with them the limitations of printed communications.

For most business people, the telephone is still the next best thing to being there, although eventually, video technologies will become the preferred mechanism. Until that time, however, voice is where it's at. The idea of providing the best level of voice communications is the heart of Voice LAN technology. As both vendors and end users have developed and implemented high-performance data networking systems, we have often overlooked the improvement of voice communications. Further, we have not yet begun to fully leverage the strength of integrating voice and data communications within the LAN environment, although the benefits could be phenomenal.

There are many potential benefits:

- The ability to blend voice and data messages into a single "conversation" between multiple users.

- The ability to edit a document with voice annotations.
- The ability to route and broadcast voice messages, as we now manipulate e-mail and traditional file sharing.

These potential capabilities can be translate into business applications such as:

- Integrated phone/PC systems for the office to improve call tracking.
- Enhanced call forwarding with document attachment to improve customer response-time for customer service call processing centers.
- Increase in productivity through the addition of interactive "white boards" that use both voice and on-screen charts shared by all participants for conference calls. So called video conference.[5]
- Enhanced automated telephone response systems for retrieval of data information via a telephone.
- Improved corporate communications and training through the use of broadcast voice/data messaging.

It is in these applications that we find "Voice LAN" technologies; it is much more than just CTI (computer telephony integration), it is found in any application or system that attempts to blend voice and data together in an integrated manner using the LAN infrastructure as a common transport mechanism.[6]

Of course, the excitement surrounding voice and data integration goes far beyond the LAN itself. Even with the abysmal performance that it offers, users are lining up for the applications required to receive broadcast video and radio transmissions across the Internet, such as RealNetwork.[7] And in perhaps the most unusual voice over LAN application, some providers plan to offer low-rate long-distance calling across the Internet, such as VocalTech.[8]

2.1 Business requirements

The business community itself has helped to create the demand for an integrated media solution where voice and data communications are united in a single network and applications environment. Business relies upon communications. The strength of communications can often define the strength of the corporation. Linking voice and data communications can allow the corporation to offer a wider range of services and improve efficiency for many existing applications.

From a different perspective, the ability to integrate voice and data systems into a single architecture can also help to simplify the overall network infrastructure, resulting in cost savings and improvements in the overall bottom line.

2.2 Previous trials on voice and data integration

The idea of integrating voice and data is not new, in fact, the business community has seen the value of this for many years, only to be limited by the ability of technology to

work in a cost-efficient manner. Many of the early attempts were ill-fated from the very start. For example, the data PBX was an early attempt that suffered from the growing bandwidth demand of personal computers. While the data PBX was ideal at supporting low-speed data connections, it lacked the performance that users demanded and received from Ethernet and Token-Ring[9] networking technologies.

More recently, many PBX manufacturers attempted to bring the LAN world into the PBX environment by integrating LAN interfaces into the PBX architecture. However these products too failed to take hold in the market for several reasons. While still lacking support for integrated applications (i.e. unified voice/data interface and desktop), these LAN/PBX systems often were unable to provide the increased level of technology support that mainstream LAN hub vendors were able to provide. Further, most organizations were hesitant to put their hot and growing LAN systems under the control of PBX and voice team.

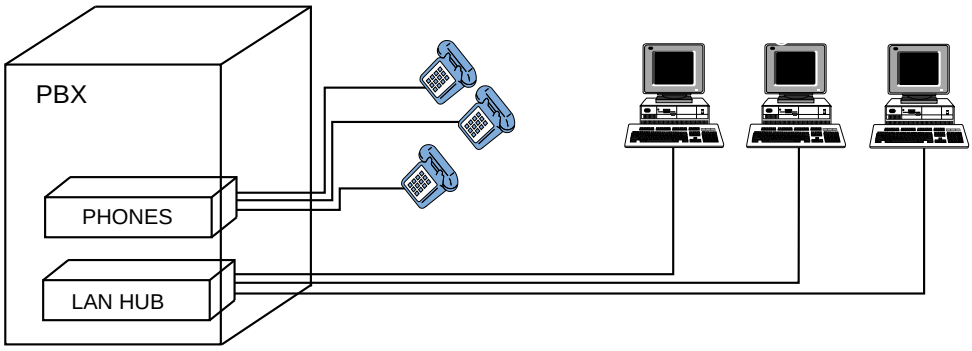

Figure 1. Traditional LAN integration within the PBX

Clearly, the issue of voice/data support has not been addressed successfully in the past. Fortunately, the network and applications industries are now at that point where most of these issues can be addressed. There have also been tremendous improvements in LAN infrastructure technologies, such as improved latency, higher-bandwidth, non-blocking connections, and the ability to provide prioritization or class of service (CoS) or quality of service (QoS)[10] through new LAN switching and cell-based Asynchronous Transfer Mode (ATM)[11] [12] [13] switching. Without LAN switching, we would not be able to achieve the low-latency and non-blocking environment required for voice communications on the LAN.

2.3 Voice LAN Standards

Within the Voice LAN and CTI product areas, there are a number of standards that are being used to drive voice into the LAN. Many of these standards apply to other technologies and are merely being used by Voice LAN and CTI vendors as a convenient way to bring their technology to market. The key factor here is that these standards exist at all. During prior attempts at integrating voice and data, there was a lack of standards that forced vendors into mostly proprietary implementations.

From a physical network perspective, Voice LAN products are being designed to operate over existing networking technologies, such as the IEEE 802.X LANs, ATM, ISDN and Q.931 specifications.[14] [15] From a management perspective, SNMP (Simple Network Management Protocol)[16] [17] has become the management protocol of choice for not only data-oriented LAN products, but for voice PBX systems as well. This, coupled with some vendor specific management tools in the NOS (Network Operating System) arena from vendors such as Microsoft and Novell who have also developed "standardized" applications programming interfaces (API) in the form of the Telephony API (TAPI)[18] and the Telephone Services API (TSAPI)[19], has helped to bring the management of voice and data applications together.

The industry has also lined up in support of a new physical interface, the Universal Serial Bus (USB)[20] being driven by Intel for the connection of phone-sets to PC's. From a pure applications perspective, traditional standards such as MPEG[21] and H.320[22] (for video/image compression) and ADPCM (for voice compression)[23] are at the core of the "voice/video as data" technology discussion.

Of course, not all of these standards are currently available. ATM, as an example, is fairly well defined from a hardware perspective and can be used to pass packetized voice between different LANs or between call servers and LAN-based handsets. However, the specification for native support of voice over ATM is still in the development stage, forcing many vendors to either limit their products or rely on temporary proprietary solutions when ATM is present in the customer site.

There is also ongoing work in the ATM Forum to develop variable-bit-rate (VBR)[24] technologies for better support of voice over an ATM link. VBR would enable flexible allocation for voice traffic - a point that is critical for the success of Voice LAN since users cannot afford to nail-up fixed portions of their network for voice-only support. There are also some discussions involving the use of virtual LANs (VLANs)[25] to define calling groups within a LAN.

3. Advantages of Voice LAN technology

Before any user should consider implementing any new technology, there must be a firm set of business reasons. These reasons can typically be grouped into three different areas: improved management support, improved applications support, and lower costs.

3.1 Management features

Often overlooked in the discussion of new applications and network technologies, network management is one of the most significant issues in networking today. For Voice LAN technologies to be accepted by the user community, voice-oriented management must be both consistent with traditional network management and not result in additional management overhead.

3.1.1 Single management team

Many organizations have, during the past 20 years, been forced to create multiple network support organizations. The first, and oldest, is typically responsible for traditional voice PBX and low-speed data support. Often referred to as the communications group, this team has seen its control over the network reduced to managing aging PBX systems and controlling building wiring plant.

The second organization is the LAN-oriented inter-networking team, responsible for LANs, hubs, bridges, routers and switches. It is this group that has rapidly grown from a small management team to the dominant network support group within most organizations. On top of these management teams we find the applications support groups.

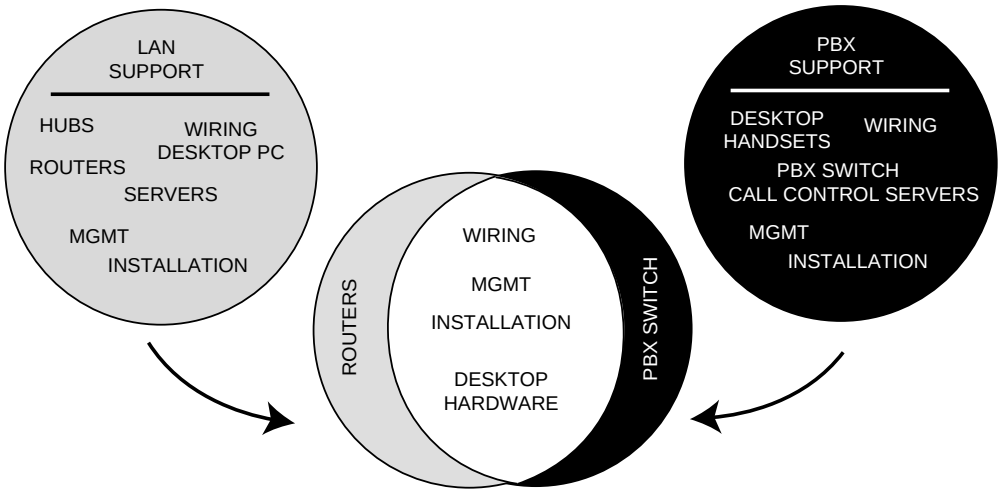

Figure 2. Overlap of LAN and PBX support functions

One of the prime values of Voice LAN technologies is the ability to integrate these voice and data support organizations into a single team. This results in a single group responsible for managing the network “infrastructure” which is now focused on providing LAN support only. The requirement to manage a separate voice network is removed as Voice LAN technologies are implemented on the LAN. Further, the applications support group function can be expanded to include as an application the Voice LAN technologies as well. Again, we see the inclusion of previously stand-alone PBX management becoming a part of overall application management.

What makes this work is the relationship of voice to data technologies. Here we have the fairly static voice application team being integrated into the high-performance data networking environment. This integration is very different from the “mergers” that were attempted in the past between the voice and data management teams. This is also consistent with the direction that the Voice LAN and CTI technologies are following in respect to the LAN: most vendors are focused on migrating the PBX itself to a LAN-server model where voice processing functions are supported by LAN application servers, rather than the merger of the PBX and the LAN.

3.1.2 Improved support

By migrating the voice and data networking worlds together, we can see that overall network support can be simplified and improved. Rather than building and maintaining two separate networks. We can now focus our resources to build a common network infrastructure, a single high-performance switched network that supports both voice and data systems. The beauty of this arrangement is that the burden of adding voice to the LAN network is negligible. Voice communications are easily supported by today's high-performance switching systems with little or no impact on traditional data applications. Unlike the early days of networking when data rode for free on the voice network, we now have voice riding for free on the data network.

3.2 New Applications/Features

The second area of improvement for Voice LAN technologies involves new applications and enhanced features. If we examine the current voice support infrastructure, we find that there are several important limitations that have prevented voice applications from evolving as rapidly as their data counterparts. Perhaps the chief limitation is the telephone handset itself.

3.2.1 Value of PC-based communications

Today's telephone sets are extremely limited in form and function. First, we have the limited key-set of the phone. There are clearly limitations to such a restricted keypad, and attempts to add additional keys and components have been met with little or no success as costs have risen and additional functions have competed directly with data-oriented applications. For example, there have been several attempts in the past to include data-terminals with small micro-processors into telephone handsets. One of the key features that these devices offered was the ability to act as a remote terminal for dial-access, a function that has now fallen directly into the domain of the remote PC. Another important application was the addition of the on-line phone list. However, this market has been dominated by PC-based address books that offer much more flexibility and function sets, not to mention integration with other standard word processing and calendar packages.

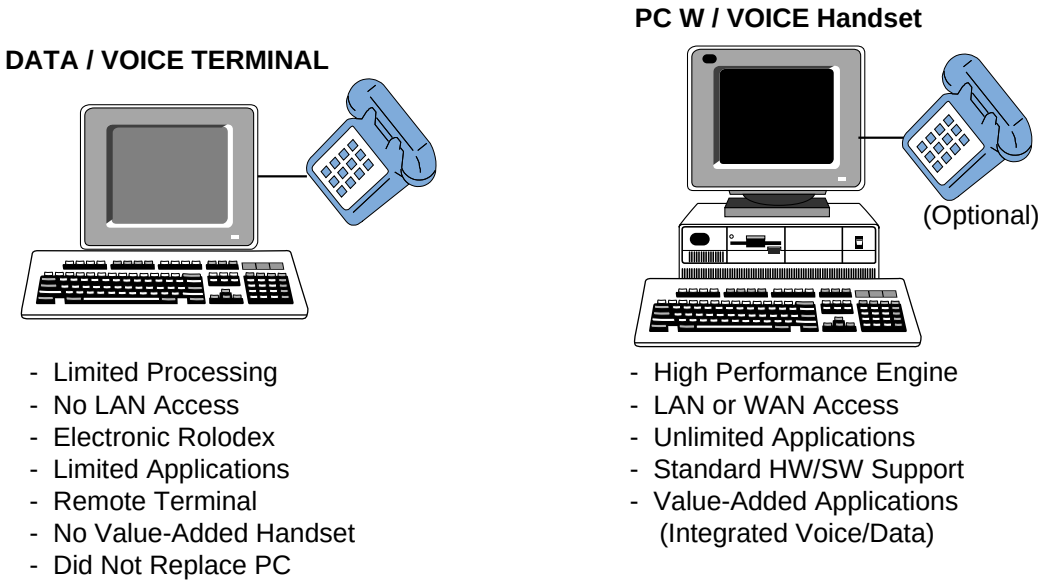

Figure 3. Comparison of Data/Voice terminal with PC/Voice Handset

In many cases the limitation of the voice handset is a result of the lack of an integrated computer or standardized processing capabilities. While it does not make sense to integrate a computer into a phone, it does make sense to integrate the simple functions of a telephone handset into today's powerful PC platforms. The software programmability and availability of inexpensive voice interfaces for the PC have made it the ideal replacement for the aging telephone handset.

3.2.2 Voice/Data application integration

Once we bring voice communications into the PC platform, a number of opportunities are presented. Key to all of these is the notion that voice within a PC or a network for that matter can be treated as just another form of information or data. Thus, any type of processing that could have been done for data files can also likely be accomplished for voice information or files. For example, the PC is ideal for storing v-mail (voice mail)[26] messages, with its increasingly cheap memory and improved sound capabilities. In a broader applications environment, the PC platform offers the ability to translate between e-mail and v-mail. The ability to annotate data files with voice comments already has begun to use in some entrepreneurial startups. And the ability to hold conference calls either voice only or combined voice/video/data has been a big hit at industry conferences as the demonstration of multimedia technology.

3.2.3 Enhanced call processing capabilities

From a networking perspective, the ability to combine voice and data packets within the same infrastructure has several benefits as well. Aside from the obvious ability to consolidate costs and management (single network vs. dual networks), there is the opportunity to take advantage of the routing and switching capabilities of the traditional LAN that are not available in most PBX-only environments. For example, with a

distributed switching backbone within a campus, there is no PBX-like single point of failure, allowing calls to be rerouted throughout a campus to the appropriate destination. Voice servers can be deployed optimally throughout the organization to offer better service and facilitate the merger of voice and data on an applications level (i.e., sending a data file along with a voice message through an integrated voice/data server). Only recently has the LAN reached the performance and up-time characteristics necessary for this type of function.

Moving beyond the basic desktop dialing programs that have been around for the past decade, many users have begun to weave this technology directly into their business applications. For example, applications that control, record or track telephone solicitation calls are in hot demand.

Now that we have brought the PC into the picture, we also have opened up the door to improved call processing capabilities. Telephone operators can now record voice conversations and embed them within product orders or customer files. Call tracking systems can now be greatly improved without having to rely on a single point of failure. On the horizon we even see the ability to integrate Virtual LAN (VLAN) technologies with call processing systems to improve the way that calls are routed through the network.

3.3 Cost savings

For a new technology to survive beyond the infant stage, there must be a compelling cost. There are three main areas that can be identified as common to most forms of Voice LAN systems, all within the implementation and operations arena .

The first cost savings is derived within the physical LAN/campus network. As mentioned earlier, the bandwidth of the campus network (a dedicated 10 Mbps to the desktop) has far exceeded the requirements of the voice network (which is a mere 64 kbps). By consolidating the voice and data network infrastructures, we can eliminate the often aging voice wiring infrastructure.

The second major cost savings area is in improved utilization of WAN (Wide Area Networks)[27] access links. While many consider that the local campus bandwidth is essentially free, the WAN connection is certainly one of the most costly segments of any network. This is especially true for large distributed firms such as retail, insurance or financial firms. There have been many attempts in the past to consolidate voice and data via multiplexing solutions, but very few have been able to provide the level of improved utilization that users were seeking. By integrating the voice traffic directly with LAN data traffic at the source, improved link utilization can be achieved. As a side note, most of the firms that operate in a largely distributed manner run heavy transaction processing systems that would benefit extremely from the application integration of Voice LAN and data systems discussed earlier. For instance, an insurance agent will be able to voice annotate a claim, or a bank teller being able to record a verbal transaction with a funds transfer record.

The third cost savings area involves savings due to the simplification of the management support structure. By treating Voice LAN applications as just another form of data on the network, management staff can be consolidated and better cross-trained for overall applications support. Removing the requirement to have two separate trained staff, one in voice and one in data. This can improve the leveraging of trained staff and also help to remove corporate management redundancies in managing the network/voice management teams. By combining the two systems together, we eliminate the requirement for multiple management platforms (i.e., an SNMP-based LAN system and a proprietary PBX system). This can not only reduce hardware costs, a factor for many small to mid-sized organizations, but can also consolidate and leverage training and support costs as the PBX becomes another SNMP-managed device on the LAN.

Figure 4. Cost savings

An additional area of potential cost savings can be found in the migration from proprietary PBX hardware to a standardized PC-based server platform. This is noted as a "potential" savings, however, since it is difficult to take into account the costs of the call control software that would be required to complete the system (server + software = PBX). It is likely that some PBX vendors will use this software component to offset revenue lost from the move to a server-based platform, possibly negating the cost savings. This is not unexpected, nor is it unique. Similar pricing shifts from hardware revenue to software revenue have occurred in other markets where vendors have abandoned proprietary hardware platforms in favor of standardized PC or server hardware, often becoming primarily software vendors and leaving the hardware components to the commodity manufacturers.

4. Integration of Voice LAN products

As with any new technology being deployed in the network market, there is going to be a period of time during which the new technology is transferred into the market. This is especially true for Voice LAN products that are not only new, but also bridging a gap between existing PBX technologies and a new PC-enabled voice environment.

4.1 Physical Integration

The current state of physical Voice LAN integration varies considerably depending upon the orientation of the Voice LAN vendor. The three main vendor camps moving into Voice LAN are the traditional equipment vendors i.e., PBX, host computing, the NOS vendors and independent applications vendors. As expected, each of these vendor groups has a tendency to favor their own market perspective, forcing the unsuspecting end-user to evaluate different vendor strategies on an uneven playing field.

	PBX Vendors	NOS Vendors	App Vendors
Goal	Integrate PBX with LAN & Servers	Provide Voice APIs and Server Support	Develop Voice-Based Applications
Focus	Infrastructural	Mgmt/Control	Desktop Applications
Outlook	Must Work With Nos and App Vendors to Offer a Complete Solution	Will Likely Not Move Beyond Small Apps or LAN Server	Currently Limited to Small APPs Only
Complexity	High	Moderate	Moderate/Low

Table 1. Voice LAN integration market

Perhaps the farthest along in terms of product development is the combination of NOS vendors and independent applications vendors. By working within the framework of existing NOS capabilities, many vendors are beginning to release new Voice LAN products that address a wide range of applications niches. By focusing on small applications, and leveraging existing platforms, these products have achieved a relative state of completeness, at the expense of product complexity. Because the basic attachments to PCs that are often lacking in product richness or functionality as a complete phone system.

The PBX manufacturers are also still working on the integration of Voice LAN systems into the LAN network environment. The initial thrust of their efforts has been focused on taking existing PBX components, breaking them apart from the PBX-mold, and inserting them into various network-intelligence configurations. In this model, the LAN becomes an extension of the PBX control mechanism (i.e., use the LAN as a bus-extension for passing information between PBX components). Thus we have the phone handset being integrated into the PC or into the LAN hub/switch. The PBX call switching matrix has become a separate and distinct server on the network, and the PBX control mechanism yet another server within the network. However, this level of integration is not yet fully functional in that there is often special hardware that is required for the system to operate, or more commonly, there is no value-added applications that are enabled by this configuration.

The big issue in Voice LAN technologies is not likely to remain physical for long. As technology continues to develop, the issues of physically integrating Voice LAN

technologies into the LAN will be resolved. The completeness of voice servers, for example, will quickly evolve to compatibility with standard LAN data servers. Voice switching systems or call control software should also move onto standard LAN servers in relatively short order.

The merger of telephone and PC technologies is also progressing rapidly. For the small applications vendors, the challenge is to integrate higher-quality systems into the workstation while increasing overall network functionality. Currently these systems are limited to specific applications and have not yet begun to address the full "PBX-replacement" market demand.

The PBX vendors, in contrast, have a very different issue. The ability to function as a virtual PBX within the LAN environment is already there for most Voice LAN vendors. What is missing in addition to a more LAN-server focus on the call management and switching systems is the integration of the PC and telephone handset. Most systems today require special hardware components to connect telephone handsets into the LAN environment, in some cases bypassing the PC. That should improve considerably as the integration of voice and data packets improves within the network and as the telephone function is integrated directly within the PC.

4.2 Drawbacks of the technology

As mentioned earlier, the ability of a PC to mimic a telephone handset is within the grasp of current technology. The issue of support here is more one of market demand rather than technical ability. While there are many advantages to merging the PC and handset, there are also some limitations. Specifically, if the PC is a portable computer, the phone goes away when the PC is placed in the briefcase and carted away. The old "power-down" button needs to be erased from the PC for the phone to operate.[28] What is likely to succeed is a blend of integrated dedicated devices that allow PC mobility for those users that require it while still providing value-added functionality.

4.3 Management Integration

The ability to manage Voice LAN applications in a traditional data LAN environment often depends on the type of integration that has taken place. For most of the NOS/application products, the integration of management is relatively straight-forward, as the application is managed via traditional application tools. Of course, the challenge for these vendors is relatively simple as they are addressing specific applications only, and not the overall integration of a complete PBX into the inter-networking environment.

For the PBX manufacturers, making the move to Voice LAN technologies has a much more complex management requirement. On the one hand, there is the wholesale migration of previously stand-alone management tools to a LAN-centric platform. At the same time, these vendors must deal with the segmentation of PBX components into stand-alone devices, each of which must be managed independently while retaining some semblance of unity as a complete system. This may be difficult as various

management functions are absorbed by different, existing, devices. NOS-based, or server, management tools will likely take responsibility for managing voice servers. Similarly, a new management requirement (control of software-based handsets) needs to be created and managed - potentially by both PC-based applications and system - wide Voice LAN management tools.

4.4 Management Support

Beyond the initial physical and logical integration of Voice LAN technologies comes the critical task of managing the managers. Rework the previously standalone voice and data management teams into a single, voice/data-literate group.

As with the merger of any type of management teams, the merger of voice and data groups will cause some discomfort as these groups have traditionally been viewed as antagonistic, rather than synergistic. However, this merger is more of an assimilation of the voice group into the data group, rather than a replay of the voice vs. data debates of the 1980's.

Many organizations that have successfully combined the two management teams have done so with cross-training; educating the voice team on LAN and data applications while educating the LAN team on voice fundamentals. This type of training has become essential for groups that are tasked with managing many of today's emerging multimedia applications where both voice and data are considered "data."

Since Voice LAN traffic is really just another form of data traffic. It is similar to data-oriented multimedia. Manage small Voice LAN applications should be no different from new multimedia systems that the support groups are already being introduced to on a limited scale. If, however, the application is a wholesale migration from a fixed PBX to a decentralized Voice LAN system, then the issue becomes more complex.

Many of the initial Voice LAN implementations targeted at total PBX replacement will use existing PBX hardware. This forces the support group to be extremely knowledgeable on traditional PBX management and operations procedures. In some early Voice LAN and CTI implementations, this level of complexity has served to keep the voice and data sides of the management staff somewhat separate, forcing a migration of technology as well as management group structures.

5. Voice LAN Migration Scenarios

It is always difficult to predict the complete development and implementation schedule of any new technology. In the analytical community, the predictors of technology are placed in a situation of having to reconcile anticipated product development plans with anticipated market demand, often also resulting in an ever-changing "shift" in their predictions. Thus, it is very difficult to predict exactly how this new technology will be received, or deployed, in the market. This is extremely evident with Voice LAN technologies.

As we discussed earlier, there are not only technology factors at work here, but also social factors in the way that workers and businesses will embrace a shift from telephone-based communications to voice-based LAN communications. We will have to think of the desktop PC as a phone, not to mention all the new value-added integrated voice/data forms of communications that will be enabled. Some people will probably insist that the handsets be kept on the desktop for simple function use.

Within these constraints, however, we can see a fairly logical path from the existing PBX model to a decentralized Voice LAN model, based on what appears to be the easiest path to merge voice and data technologies in the LAN environment.

Step 1: Distributed PBX model

The first stage of Voice LAN deployment will focus on breaking apart the existing PBX model and using the LAN as a simple transport vehicle for packetized voice between the telephone handset and the centralized PBX switching system. Most vendors will continue to use their existing ADPCM and low-bit-rate (32k, 16k, 8k, 4k) compression techniques, which due to a lack of standardization will likely limit the implementation of multi-vendor Voice LAN systems on the physical level. Voice packetization will also continue to be proprietary since there are no firm standards here yet for voice to frame/cell and will likely require vendor specific hardware to provide the LAN interface into the network.

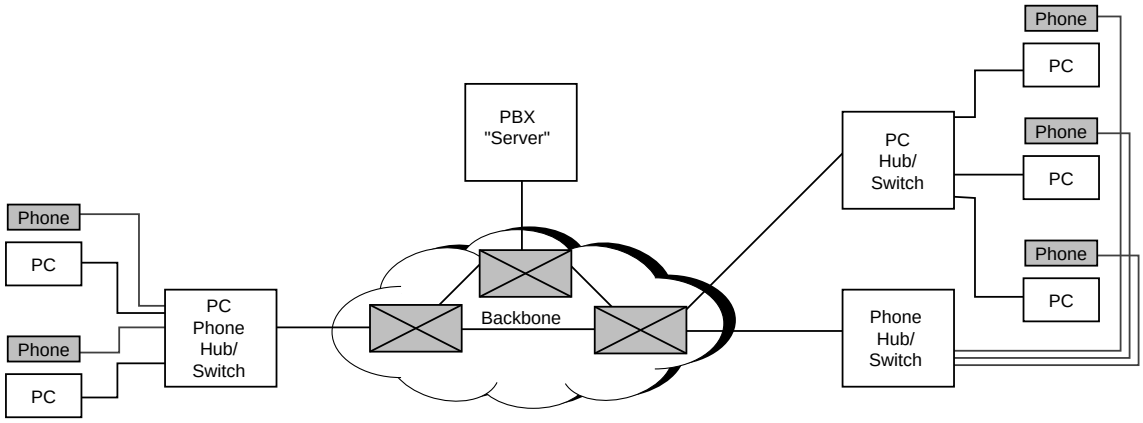

Figure 5. Initial distribution of PBX in a Voice LAN environment

Under this initial deployment scenario, there is little real integration of the handset and the PC, and certainly not any value-added applications on the PC.

Step 2: Voice servers and integrated voice/data PCs

The next logical step in Voice LAN deployment is to integrate the telephone handset and the PC hardware. As mentioned previously, there are many logistical reasons why this may not make sense for many Voice LAN users (i.e., lack of mobility of the PC). However, it seems that vendors will make this leap relatively quickly since it is required to provide true value-added applications support. To support those users that have integration issues with this step, we anticipate that vendors will continue to offer a

stand-alone handset option and over time work on solutions that provide a work around to the mobility issue. One possible solution involves the use of wireless technologies that would allow the PC and handset to be de-coupled on demand while maintaining a high-level of functionality.

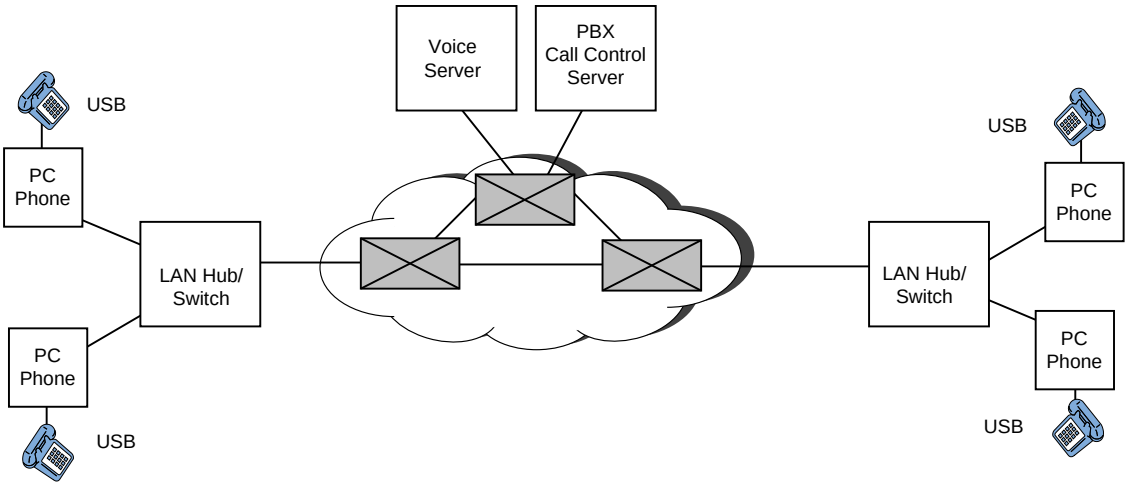

Figure 6. Addition of USB capabilities and integrated voice/data PCs

The interface utilized for the PC/telephone integration will likely be the USB interface, providing the first real opportunity for users to utilize components from different Voice LAN vendors at different points within a network for instance one vendor for control functions and one vendor for handsets.

As the deployment of voice-oriented devices matures in the LAN, vendors will begin to migrate from existing PBX-based hardware to open standard PC server platforms, reworking their features and functions into PC-based applications.

There are some products, especially in the smaller Voice LAN niches, that have already hit the market. Such as LANphone® developed by Telecom Finland and Oy LM Ericsson AB,[29] and Quicknet Inc.[30] these products are primarily designed to support focused applications only, and not the voice infrastructure market that we see the larger PBX and system vendors attacking over the next few years.

Step 3: Voice LAN in the WAN

For any networking technology to survive as an infrastructure technology (i.e., ubiquitous support throughout an organization for the majority of users), it must be able to play in the wide area network (WAN)[31] as well as the LAN. As the technology behind Voice LAN products matures, the ability to build an integrated voice/data WAN connection will become available. Again, it is important to note here that we are not just talking about a mixed voice/data system, but rather an integrated desktop environment where the PC provides both voice and data services and the LAN/WAN infrastructure provides integrated voice/data transportation.

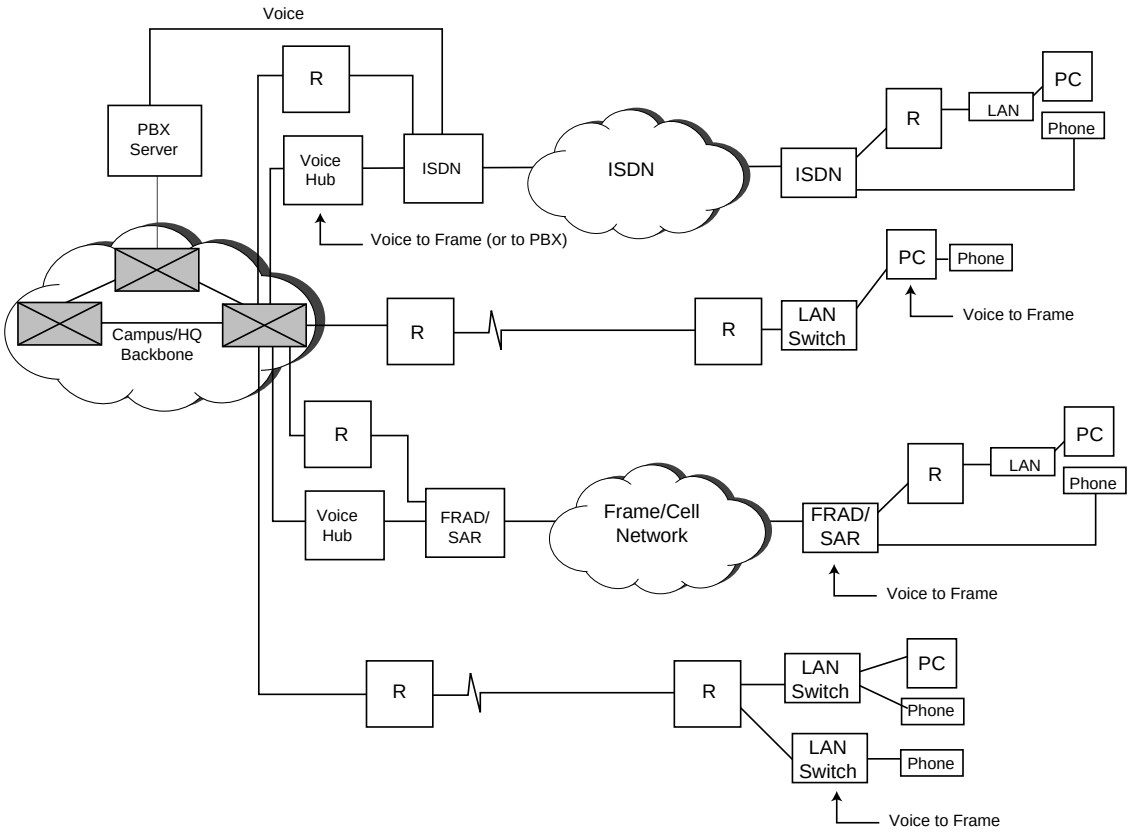

Figure 7. Possible Voice LAN/WAN scenarios

It is likely that WAN-enabled technologies will begin to appear soon, provided that certain technical issues can be resolved. In particular, there is a major issue surrounding the ability of a router based WAN to provide the necessary performance characteristics (i.e., prioritization, latency, etc.) to support voice applications. In the traditional network model for integrated voice/data WAN connections, voice could be guaranteed a level of service by either the dedicated bandwidth or by the pass-through capabilities of the router (giving priority to a particular interface or data stream). However, when the voice communications is nothing more than another "data" packet coming off the LAN, the issue of prioritization becomes more difficult. If the packet can be associated with a particular protocol, there is a chance that prioritization can occur. However, if that protocol is IP and the rest of the network is also IP, prioritization is unlikely.

Perhaps the most promising vehicle for providing a high quality of network service for Voice LAN systems can be found in another still-emerging network technology: Virtual LANs. Given that LAN switches and routers will likely provide prioritization based on VLANs assuming that VLANs can be identified by a standardized mechanism, such as the 802.1 VLAN[32] working group proposals, it would seem a logical step to associate Voice LAN traffic with a particular VLAN identifier. This could also end up being an ideal method for routing of Voice LAN traffic throughout the enterprise network.

6. Conclusions

Perhaps the biggest issue surrounding any type of voice/data integration within the LAN is one of migration strategy. It is accepted that the trend within the LAN is towards the replacement of shared-media frame-based networks (i.e., traditional Ethernet and Token-Ring) with switch-based networks, initially switched Ethernet and eventually cell-based LANs based on ATM technology. This physical hardware trend is ideal for supporting Voice LAN applications since it allows the network to offer the performance requirements necessary for real-time voice communications on the LAN (low, fixed latency in a non-blocking environment).

On the desktop, there is the unmistakable trend towards higher-performance computing and the implementation of multimedia graphics systems. This level of desktop support is very important to the success of Voice LAN technologies since one of the biggest reasons for merging voice and data on the network is to facilitate improved business communications through enhanced applications. Without the growth in desktop processing capabilities, this would not be possible.

Given that the network and the desktop are moving to a mode of operations where voice/data integration is both possible and beneficial, the question becomes when will the user community embrace this new model? Much of this will depend upon how fast user organizations are willing to change the way they operate their businesses and how fast they are willing to change the services they offer to their users and/or customers.

When contemplating the implementation of Voice LAN technologies, whether that means a simple voice-based email system, an integrated voice/data desktop or even a full CTI-based system, network planners must keep in mind that any new implementation must be supported by the networking technology, accepted by the end-user base, and be justified as a sound business investment. For most users, this will translate into a long-term migration from the traditional “voice separate from data” networks to an integrated voice/data network involving the gradual implementation of stand-alone Voice LAN and CTI applications first, followed by the integration of the complete PBX infrastructure into the traditional LAN and extended campus network.

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