Telephony Over the LAN

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1. Executive Summary

This is the most challenging time in history to be a network manager. One aspect of this period of unprecedented challenge is the relentless increase in business pressure. This increasing business pressure usually translates into stringent requirements for network managers. Typically included in these requirements is the dictate to both support the current suite of applications while also providing new functionality. This new functionality can include facilitating new client server applications, enabling increased revenue generation via expanded call center operations, and supporting Intranet deployment.

The primary constraint inhibiting network managers from responding to these requirements is the limitation on both their budgets and their staff. Specifically, the vast majority of network organizations are limited to single digit budget increases and flat headcount. Hence, the challenge for network managers is to provide a rapidly increasing set of network services without a significant increase in resources.

There are a number of techniques that companies can utilize to successfully meet this challenge. One of these techniques is outsourcing. For example, J.P. Morgan recently announced that it was going to outsource a major component of its IT infrastructure to an alliance of vendors in a deal valued at more than $2 billion over seven years. Another technique to meet this challenge is for managers to restructure their traditional approaches to providing network services.

One non-traditional approach to providing network services that offers tremendous potential for improvement is carrying voice over the Local Area Network (LAN). This approach primarily appeals to managers who realize that while the voice network is not functionally broken, it is economically broken. For example, in the vast majority of corporations the local voice and data networks have disparate infrastructures; e.g., people and hardware. Having separate infrastructures for voice and data traffic limits efficiencies and drives up the cost of providing network service. Network managers who are upgrading their LANs have the potential to carry voice on that LAN and reduce the cost of providing voice service by approximately 55%.

A secondary reason that network managers are interested in carrying voice over the LAN is that this approach offers the potential to move the development of call center applications away from the current Byzantine approach to an efficient, client server approach. Hence, whether they are motivated by reduced cost or added functionality, network managers who are upgrading their LANs should do so in a way that facilitates carrying voice traffic.

2. The Embattled Network Manager

2.1 The Challenges

This is the most challenging time in history to be a network manager. Two of the forces driving this period of unprecedented challenges are the relentless increase in business pressure as well as the continued development of new networking technologies. In particular, companies are under increasing, global pressure to improve their profitability. This usually translates into a set of stringent requirements for the network manager. Typically included in this set of requirements is the dictate to:

- support both existing as well as new, and often unpredictable applications
- facilitate new styles of computing, such as those based on the client server model or those involving image, or multimedia
- provide Internet access
- support Intranet deployment
- enable increased revenue generation via expanded call center applications

In addition to the business pressures, there is a broader set of Local Area Network (LAN) technologies either currently available or under development than at any previous time. While having a broad set of technologies to choose from presents certain opportunities to network managers, it also presents some significant challenges. In particular, network managers must aggressively control which LAN technologies get deployed in their networks or else they will fail at their jobs. They will fail because, as will be detailed later in this paper, there is a direct correlation between increased network complexity and the number of LAN technologies, protocols, Network Operating Systems (NOSs), network management systems, and vendors there are in the network. Hence, in order to be successful, network managers must resolve two goals that are often in conflict. The first goal is that in order to manage network complexity, network managers must carefully choose a limited set of technologies to deploy in their network. The second goal is that

they must choose technologies that can support the continually expanding set of business requirements.

2.2 The Constraints

While network managers have to respond to increasing business pressures as well as evaluate and potentially deploy new technologies, they have significant constraints. One of these constraints is the network manager's budget. Strategic Networks Consulting has surveyed numerous groups of end users relative to the expected changes in their budgets over the next twelve months. The responses of these groups, which are summarized in Table 2.1, has been remarkably uniform; i.e., the great majority of end user organizations are expecting single digit budget increases.

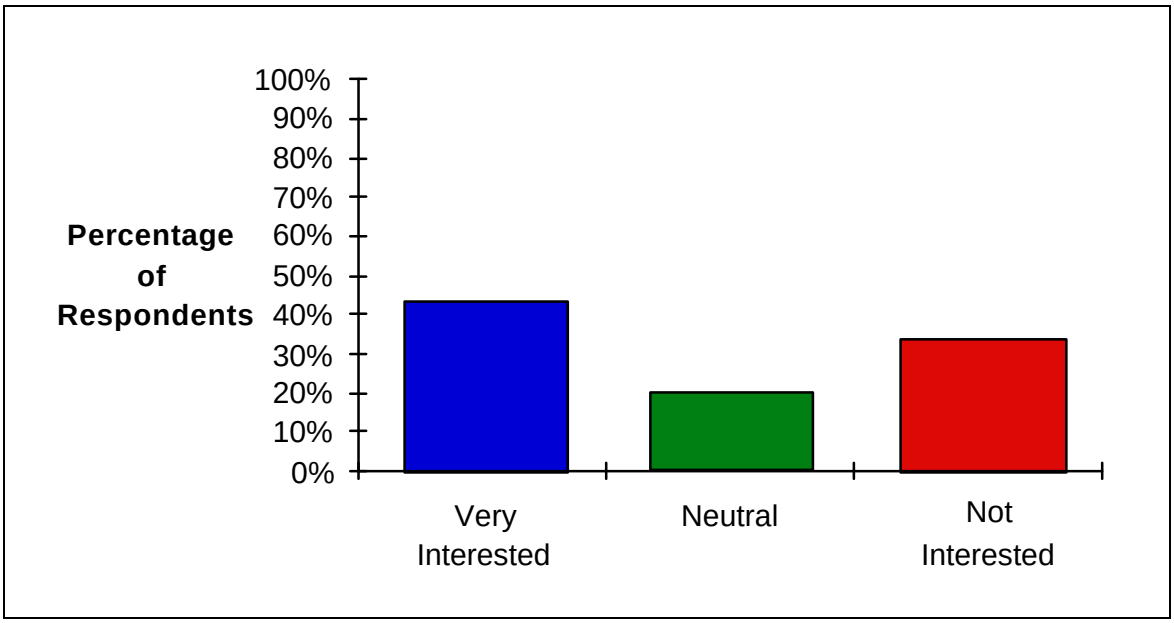
Forecasted Change in Budget	Typical Range of Respondents
Decrease	5% - 10%
Single Digit Increase	80% - 90%
Double Digit Increase	5% - 10%

Expected Change in Network Budgets as Reported by Multiple Survey Groups
Table 2.1

A second constraint faced by network managers is headcount. There are two manifestations of this constraint. The first is that many companies have a difficult time attracting, training, and retaining skilled network professionals. A second manifestation is that many companies are under what appears to be a permanent headcount freeze for support functions. As one client of Strategic Networks explained "I can sign for $100,000 of capital, but I can not add a single person to my organization".

3. A Planning Methodology

While carrying voice on the LAN is a relatively new concept, there is considerable interest in it from leading edge network managers. For example, in April 1996 attendees at a LAN switching tutorial at NetWorld+Interop were asked to indicate their interest in carrying voice over the LAN. Figure 3.1 summarizes their responses.



Seminar Attendees Interest in Telephony over the LAN
Figure 3.1

As can be seen from Figure 3.1, the single most common response from the seminar attendees was that they were very interested in carrying voice over the LAN. However, the challenge these managers now face is to create a solid business case that documents why their LAN upgrades should be done in a way that allows for the integration of voice and data. To assist with this task, Strategic Networks Consulting suggests the following planning methodology.

I. A description and quantification of the current network environment(s)
II. An identification of the forces driving change

III. The determination of the viable alternatives
IV. An identification of the criteria which should be used to choose between alternatives
V. An analysis of each alternative based on the identified criteria
VI. The creation of a recommendation and next steps

4. The Current Environment

For the most part, the prevalent techniques used to carry voice and data traffic in the local environment are highly functional. The key management issue is that the current disjoint approach to providing voice and data service increases cost and limits the ability of network managers to offer new voice applications. A reduction in both the network cost as well as the time to deploy new services are two of the reasons why many corporations deployed integrated wide area networks in the late 1980s. They are also two of the primary reasons why there is continued interest by many leading edge companies in outsourcing some or all of their Information Technology (IT) organization.

4.1 Technologies and Organizations

Voice and data traffic are notably different. For example, business voice traffic is characterized by:

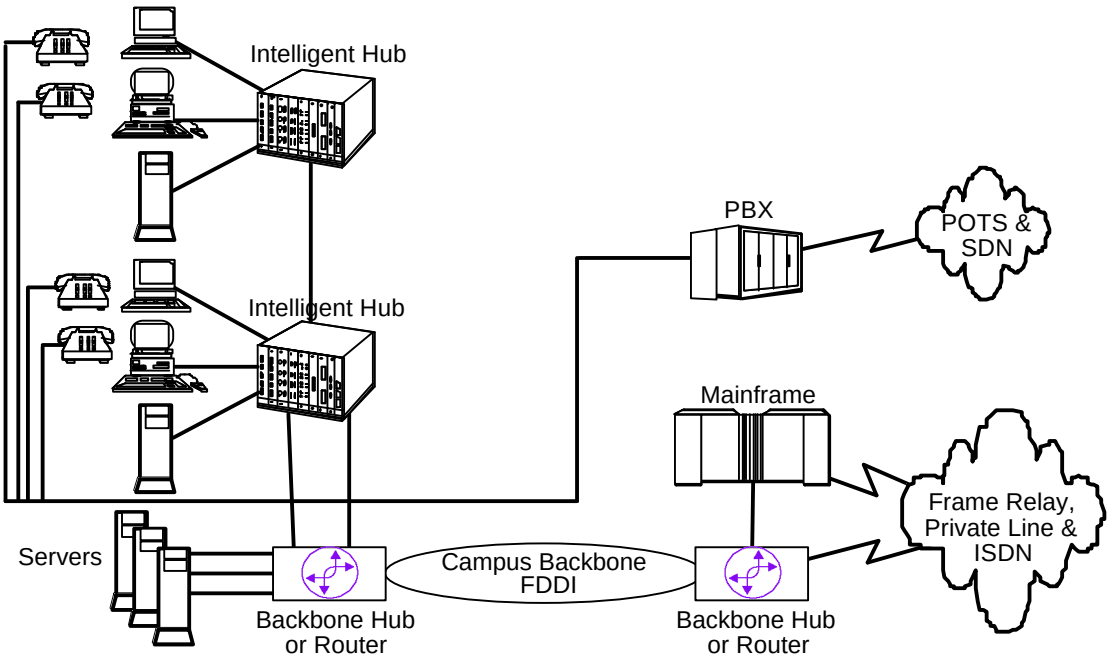
- an average holding time of approximately 3 minutes
- standard encoding schemes (PCM, ADPCM) requiring either 64Kbps or 32Kbps of bandwidth
- user expectations for highly uniform, very low, end-to-end delay
- well established design rules predicated on the probability of completing a call
- user expectations for extremely high reliability

Data traffic is characterized by:

- holding times that range from a few seconds to several hours
- bandwidth requirements that range from a few thousands of bits per second to megabits per second
- user expectations for somewhat uniform, moderate end-to-end delay
- ad hoc design guidelines predicated on providing no more than an acceptable amount of delay
- user expectations for high to extremely high reliability

Based in part on these divergent characteristics, different technologies have been developed to carry voice and data traffic.

Figure 4.1 depicts the typical data and voice network infrastructures at a corporate site. Throughout this paper, these infrastructures will be referred to as the Legacy LAN and the voice network respectively. The key aspect of Figure 4.1 is not the various pieces of network hardware; e.g., routers, hubs, PBXs. The key aspect of Figure 4.1 is that there are separate and distinct network infrastructures to carry voice and data traffic. In addition, in order to support these disparate network infrastructures, most corporations have voice and data organizations that are themselves quite separate and distinct.

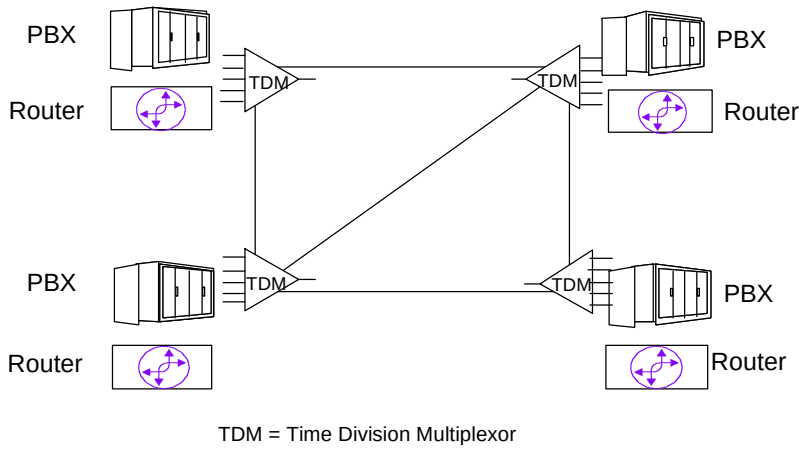


Today's Voice, Data, and Video Network Infrastructure
Figure 4.1

4.2 The Integrated Wide Area Network (WAN)

Deploying a single network to carry voice and data traffic is nothing new. In the late 1980s, many corporations deployed a wide area network infrastructure as depicted in Figure 4.2. This integrated network was capable of carrying voice and data traffic and was deployed for two reasons. The first reason was to reduce cost. These

cost savings resulted from both the relative economies of T1 circuitry as well as the reduction in the costs associated with having separate groups of people planning, designing, implementing, and managing multiple transmission networks. The second reason corporations deployed integrated WANs was to reduce the time to deploy new service.



Integrated Wide Area Network
Figure 4.2

4.3 Outsourcing

One way that many IT organizations manage to meet expanding business requirements with virtually fixed resources is to outsource part or all of the network. The term outsourcing first became well known in 1989 when Eastman Kodak outsourced the majority of its IT function to IBM and Digital. That deal called for IBM and Digital to provide both main frame data center and network services to Eastman Kodak respectively. As part of that deal, IBM and Digital acquired Eastman Kodak's IT infrastructure, including the people and equipment who had previously been performing those IT services.

Since 1989, the majority of outsourcing deals have been more selective than the Eastman Kodak deal. In particular, instead of outsourcing a

major component of their IT function, many companies have chosen to outsource one or more individual functions, such as network installation, or operating the help desk. However, the Eastman Kodak type of outsourcing still occurs. For example, in May 1996, J.P. Morgan announced that it was going to outsource major pieces of its IT infrastructure to an alliance of vendors in a deal valued at more than $2 billion over seven years. The alliance is comprised of Computer Sciences Corporation, Andersen Consulting, AT&T Solutions, and Bell Atlantic Network Integration.

Below is a summary of the primary reasons organizations outsource.

I. Reduce the cost of providing service
II. Gain access to skilled resources
III. Free up staff and management resources to perform other tasks
IV. Reduce the time to deploy new services
V. Improve the quality of service provided

5. The Forces Driving and Inhibiting Change

As outlined in section 2 of this document, network managers must provide a rapidly increasing array of network services while being constrained to single digit budget increases and flat headcount. While outsourcing is one way to potentially manage these forces, another way in which network managers can be successful in this environment is to be able to cut the cost of providing existing services and use those savings to fund the provision of future services. However, in order to cut the cost of providing existing services, network managers need to be able to quantify those costs. To facilitate this, Strategic Networks has conducted extensive research into the cost of LAN ownership. We have also worked with TEQConsult to quantify the cost of providing building and campus voice services.

5.1 Cost

5.1.1 The Cost of Network Ownership

As detailed in Table 5.1, the Strategic Networks model of the cost of network ownership is comprised of three primary components. They are:

- Capital Equipment

  The cost of the hardware and software purchases directly related to operating the network

- People

  The total (salary plus benefits) cost of the people assigned to plan, design, implement, and manage the network

- Facilities

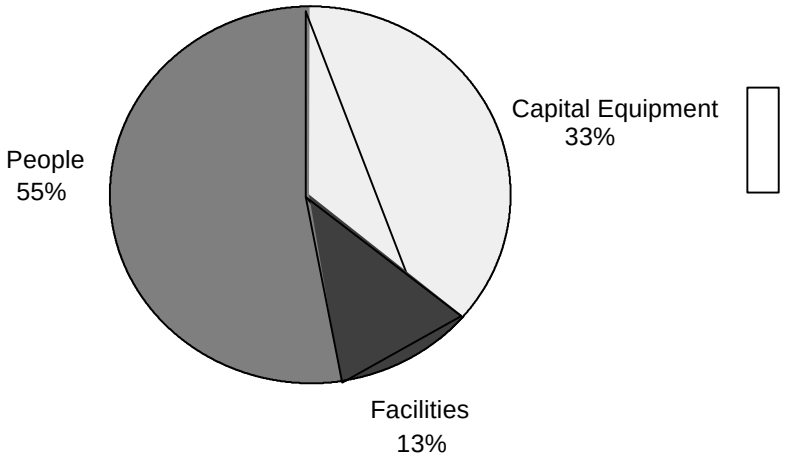
  The costs of the cable plant, office space, hardware and software maintenance and utilities necessary to operate the network

Capital	People	Facilities
PBX	Network Design	Wiring/Cabling
Hubs	Network Configuration	Equipment Maintenance
Routers	Help Desk	Software Maintenance
Servers	Operational Support	Floor Space
Network Interface Cards	Address Management	Power
Network Management Hardware and Software	Implementation	Air Conditioning
Remote Access Hardware and Software	Moves/Adds/Changes	Wide Area Network circuits (if applicable)

Primary Components of the Network Cost of Ownership
Table 5.1

5.1.2 Cost of LAN Ownership

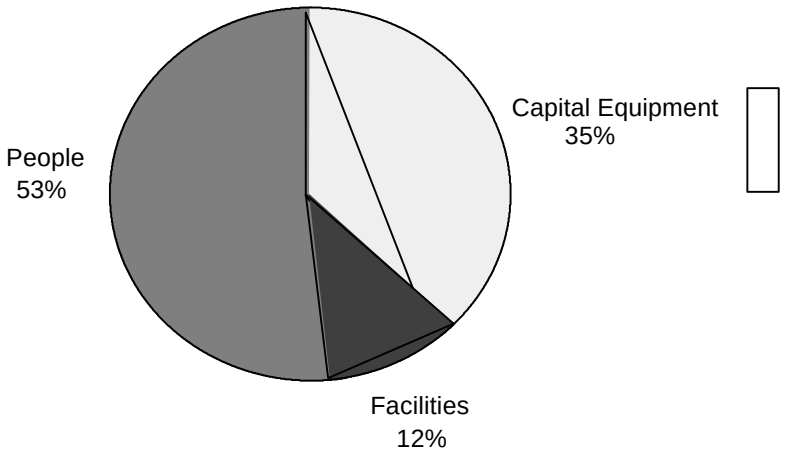
As shown in Figure 5.2, the people costs are the dominant contributor to the cost of a traditional LAN. The capital equipment cost is the second most important component of the total LAN cost while the facilities costs are relatively insignificant. However, network managers planning their network upgrades need to realize that there are two industry trends that will further accentuate the percentage of the cost of LAN ownership attributable to people. The first of these industry trends is that over the next few years the cost per LAN support person will rise notably faster than either the capital or the facilities cost. The second trend is that over the next few years corporations will continue to increase both the number of networked desktops and networked applications. In order to maintain service levels, this will necessitate additional support headcount.



LAN Cost Components
Figure 5.2

5.1.3 The Cost of Building and Campus Voice

As shown in Figure 5.3, the cost profile associated with providing building and campus voice services is remarkably similar to the cost profile of providing LAN services. In particular, the people costs are the dominant factor. The equipment costs are the second most important component of cost, and the facilities costs are relatively insignificant.



Cost Profile for Providing Building and Campus Voice Services
Figure 5.3

5.1.4 Network Complexity

Understanding what percentage of the cost of providing voice and traditional LAN services is attributable to people, capital, and facilities is certainly a first step to managing those costs. However, it is just as important to understand the factors that drive up the bottom line cost of providing those services. Research performed by Strategic Networks has shown a strong positive correlation between the complexity of a network and the cost of running that network.

There are a variety of factors that make up the complexity of a network. These factors can be categorized as complexity drivers, and include the number of:

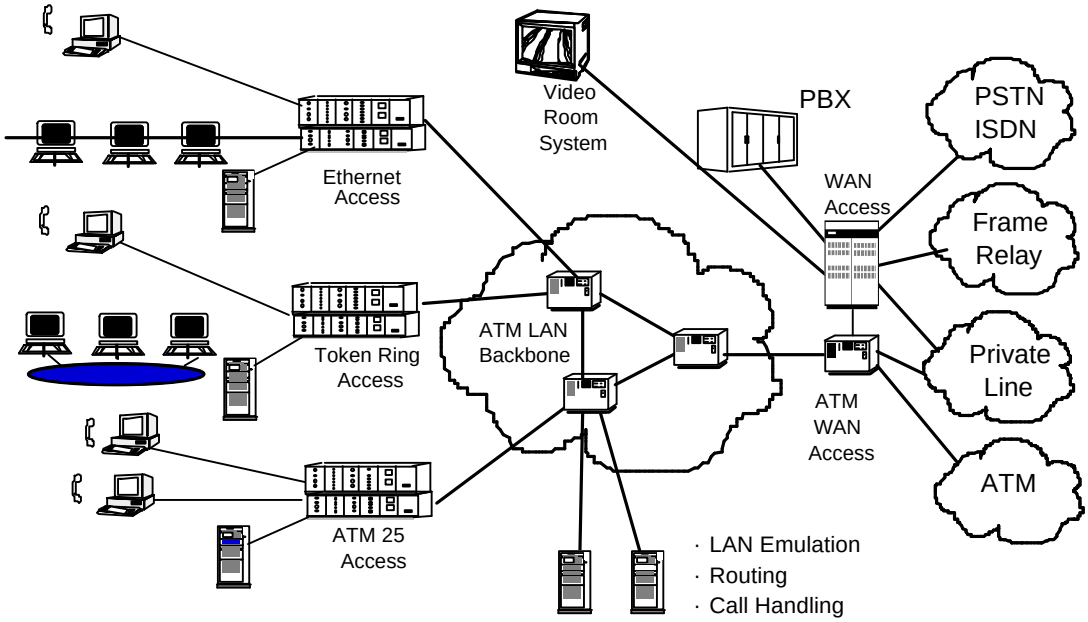
- LAN technologies
- Protocols
- Network Operating Systems
- Network Management Systems
- Vendors

Each complexity driver is composed of two parameters: initial cost and steady state cost. The initial cost is the resources consumed for the learning and installation of the complexity driver; i.e., a new LAN technology. The steady state cost is the resources consumed to maintain the network after the installation of the new functionality.

As the complexity of the network increases there is a ripple effect which originates with the support staff. This is particularly troublesome since people costs are the biggest budget items associated with running a local voice and data network. The immediate impact of the increased complexity is increased operational strain and reduced buying power. However, as will be described in the next section, by deploying an integrated LAN, network managers will reduce their steady state network complexity.

5.2 The Integrated LAN

Just as network managers deployed integrated WANs in the late 1980s in order to reduce cost, leading edge network managers are looking at integrating voice and data on their LANs to cut cost. Figure 5.4 depicts one LAN architecture that can support this approach.



Integrated LAN Architecture
Figure 5.4

It should be noted that while Figure 4.1 shows a Private Branch Exchange (PBX) to process voice calls, a number of vendors have begun to migrate away from that approach. In particular, some vendors have begun to move away from providing a proprietary PBX to process voice calls to an approach where call handling is done on one or more servers with open interfaces. In affect, this marks the beginning of the migration of voice call processing away from a proprietary mainframe to an open, client server model.

Whereas the primary characteristic of Figure 4.1 was how disparate the voice and data infrastructures are, Figure 5.4 depicts a network with a common infrastructure. Since this integrated LAN architecture has fewer network elements than the disintegrated LAN architecture, network managers who adopt the integrated LAN architecture will lower the steady state cost of providing local voice and data services.

5.3 A Cost Comparison

5.3.1 The Building and Campus Network Costs

It is insightful to quantify just how much the integrated LAN architecture can reduce network cost. Towards that end, Table 5.1 contains the annual costs for the Legacy LAN and the Legacy Voice Network. These were computed by Strategic Networks and TEQConsult, respectively. More detail can be found in the Appendix.

In order to estimate the annual cost of the Integrated LAN, the following was done:

- The cost of the network hardware was estimated based on the current street prices
- It was assumed that the facilities costs for the Integrated LAN would equal that for the Legacy LAN
- The people costs for the Integrated LAN were estimated to be 20% higher than the Legacy LAN for the first 18 months of deployment

In order to estimate the annual cost of adding voice to the Integrated LAN, the following was done:

- The people costs were computed assuming that the voice support staff can be cut in half
- The hardware costs assume that servers take on the role once held by PBXs
- The facilities costs also assume that servers take on the role once held by PBXs

	Legacy LAN	Legacy Voice Network	Integrated LAN	Incremental Voice
People	$581	$320	$639	$160
Hardware	$298	$211	$382	$74
Facilities	$136	$68	$136	$24
Total	$1,015	$599	$1,157	$258

Annual Cost of Local Networking Options
Table 5.2

The primary conclusion to be drawn from Table 5.2 is that if network managers have deployed a LAN infrastructure similar to that depicted in Figure 5.4, the cost of adding voice to that network is approximately 55% less than the traditional way to deploy voice.

5.4 Enabling New Applications

In addition to reducing the cost of providing network services, the deployment of an Integrated LAN infrastructure will facilitate the rapid deployment of new applications. These new applications include:

- the conversion of electronic mail (email) message to voice mail messages enabling them to be more easily retrieved by mobile employees
- voice annotation with a text document
- interactive voice/data editing capabilities such as electronic white boards with simultaneous voice

5.5 Barriers to Change

Strategic Networks believes that network managers looking to deploy an Integrated LAN will encounter resistance, both technical and otherwise. One technical objection is the level of sophistication and market penetration of some of the key enabling technologies. For example, in 1993 both Microsoft and Novell introduced Applications Programming Interfaces (APIs) to enable interaction between LAN

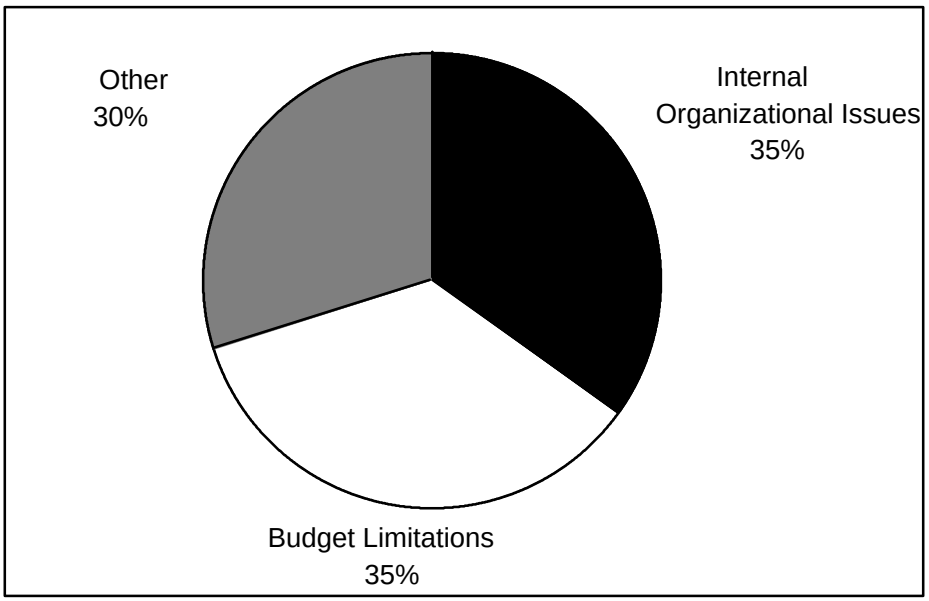
servers and PBXs. The products from both Microsoft and Novell, Telephony API (TAPI) and Telephony Services API (TSAPI) respectively, translate commands from a PC into commands for a PBX. While both of these products had limited initial marketplace success, the demand for them is increasing significantly.

Another technical objection will center around the servers' inability to provide the level of reliability required by voice traffic. However, while we understand and agree with this argument in the current environment, we think the environment is rapidly changing. More specifically, both server hardware and software are becoming increasingly reliable. This increasing reliability is being driven by the reliability requirements for data networks that are rapidly approaching those for voice networks. Based on this, we believe that the reliability issues of servers will soon be moot.

In order to better understand the non-technical barriers that corporations face in evolving their networks in general, Strategic Networks surveyed a wide selection of network managers. The results of that survey are found in Figure 5.5. The results of the survey are quite interesting in that the respondents identified that there were two primary forces inhibiting change.

One of the primary forces limiting change, budget limitations, is quite easily understood. As was detailed in section 2.2, the vast majority of network managers are constrained by single digit budget increases. However, it was somewhat disturbing that the second force, organizational issues, carried equal weight with budget constraints.

Figure 5.5 presents a clear message to network managers considering deploying an integrated LAN architecture. Specifically, organizational issues are one of the two primary forces inhibiting network change of any type. Combining a voice and a data organization will meet enhanced resistance. Hence, network managers looking to deploy integrated LANs need to carefully manage this integration.



Forces Limiting the Evolution of Corporate Networks
Figure 5.5

6. Alternatives, Criteria, and Analysis

For the purpose of this analysis, it is assumed that the network manager is upgrading the LAN and intends to deploy frame and cell switching in a manner similar to that depicted in Figure 5.4. As such, the question is whether or not the manager should integrate voice traffic over that LAN infrastructure.

While integrating voice over the LAN has a definite appeal, network managers know from experience that many heralded network technologies and architectures fail in the marketplace. Because of this, network managers need to develop a cautious, but not cynical, approach to the evaluation of new technologies and network architectures. To assist in evaluating the likely success of a new technology or network architecture, Strategic Networks has constructed a set of evaluation criteria. These criteria were developed by analyzing the reasons why various network technologies of the last fifteen years either succeeded or failed in the marketplace. As such, we believe they will serve as a good indicator of the success of emerging network technologies.

Those evaluation criteria are listed below, along with our analysis of how they apply to the integration of voice on top of the LAN infrastructure of Figure 5.4.

I. Does this solve a problem people want to solve?

   This answer to this is a strong yes if the problem is broadly defined as lowering the cost of network services and reducing the lead time to develop new applications. The answer is a strong no if the problem is narrowly defined as changing the way voice services are delivered.

II. Is this the first way to solve the problem?

   No, there are other solutions; i.e., outsourcing.

III. If this is not the first way to solve the problem, is it notably better than the alternatives?

Yes, by reducing the fundamental cost structure of provisioning local voice and data services, LAN integration offers a higher potential upside than merely moving the provision to a third party. In addition, many companies initial experiences with outsourcing have not been that positive; i.e., Eastman Kodak recently re-outsourced its network to IBM's ISSC organization.

IV. Is the level of technical sophistication appropriate for the problem being solved?

Yes

V. Is it a long term solution?

Yes

VI. Are all the relevant technology pieces in place?

No, but they are rapidly falling into place.

VII. Will it take a major effort to implement?

No

VIII. Are there any non-technical risks that are significant?

Yes, an organization's natural resistance to change is a significant risk.

7. Summary and Recommendation

In these challenging times, network managers need to think creatively about ways to lower cost and provide enhanced network services. For most companies, real progress in this area will not occur by making minor changes to the existing infrastructure. What is required is a fundamental restructuring of the traditional approaches to providing network services.

One non-traditional approach to providing network services that offers tremendous potential for improvement is carrying voice over the Local Area Network (LAN). While this is a relatively new concept in the LAN, it is a familiar concept in the WAN. To network managers who are upgrading their LAN infrastructure it offers the potential to reduce the cost of providing voice service by roughly 55%.

Strategic Networks recommends that network managers looking to upgrade their LAN infrastructure should proactively do so in a way that allows for the integration of voice and data traffic. In order to develop a deployment timetable, these managers need to also closely monitor the refinement of the key technology enablers; i.e., server reliability, APIs. Finally, in order to ensure a successful deployment, managers need to prepare their organizations for changing responsibilities.

Appendix

Cost Model Assumptions

- The hardware for the voice network was depreciated over five years
- The PBX pricing included standard software operating features, but did not include features such as Automatic Call Distribution (ACD) and voice messaging
- The PBX pricing was for a system with five hundred stations
- The hardware for the LAN was depreciated over three years
- Half the desktops were served by ATM25 and half were served by dedicated Ethernet
- An adequate in-house cabling system (wiring, distribution frames) was in place