resource guide

Ascend

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videoconferencing for the corporate enterprise

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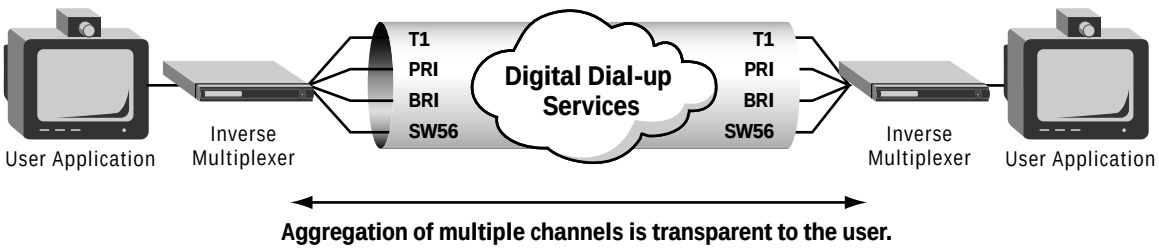

A Resource Guide for Videoconferencing, Telecommunications and Datacommunications Managers

ASCEND

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1. Executive Summary

This resource guide provides background information on the application of Bandwidth on Demand solutions in videoconferencing networks. Videoconferencing, telecommunications, and datacommunications managers, as well as business and functional managers and users of videoconferencing throughout the organization, can use the information in this guide to support their activities in planning new videoconferencing facilities and upgrading existing facilities.

Today's videoconferencing networks range broadly in both architecture and capabilities. All videoconferencing environments, however, involve a combination of several technologies — endpoints in conference rooms or on desktops, public or private network transport services, and network equipment which typically provides switching, gateway and multipoint bridging functions.

Specifying the appropriate mix of technology is critical for successful implementation of videoconferencing. Network designers must carefully consider and balance the operating cost and service quality provided by various technology options.

Market research shows that most organizations have a variety of videoconferencing applications requiring different levels of service quality. Network bandwidth has the most significant impact on video and audio quality, and it carries the greatest long-term cost in a videoconferencing network.

Bandwidth on Demand provides network managers and users with the means to address specific quality requirements using the appropriate mix of network bandwidth and cost — all on a conference-by-conference basis.

This resource guide will assist readers in better understanding the quality-cost trade-off and how Bandwidth on Demand fits into the picture. It provides planners and implementers the information they need to effectively integrate Bandwidth on Demand into a videoconferencing network. A basic overview of the technology and several scenarios describing ways in which user organizations are successfully employing Bandwidth on Demand are also presented.

2. Quality: Critical to Successful Videoconferencing

For many years, organizations around the world have been using videoconferencing technology to dramatically improve communication links among widely dispersed facilities. Historically, videoconferencing managers have dealt with the issues of quality in their videoconferencing networks.

Today, research shows that user perceptions of conference quality have a major impact on the utilization and value of videoconferencing in the enterprise. In particular, higher quality video can have a substantial impact on the usability and effectiveness of videoconferencing [see Figure 1]. Some users report that they are more productive in videoconferences with higher quality video. Many users also feel that videoconferencing can be used in a broader range of applications when the video quality is higher. Physicians, for example, can take advantage of outstanding video quality to effectively utilize medical images (CAT and MRI) in telemedicine applications. And, clients of an ad agency who are involved in a videoconference to remotely preview a new television spot will settle for nothing less than sharp images and smooth motion quality. High quality is a basic requirement for these applications and others that involve intense visual content.

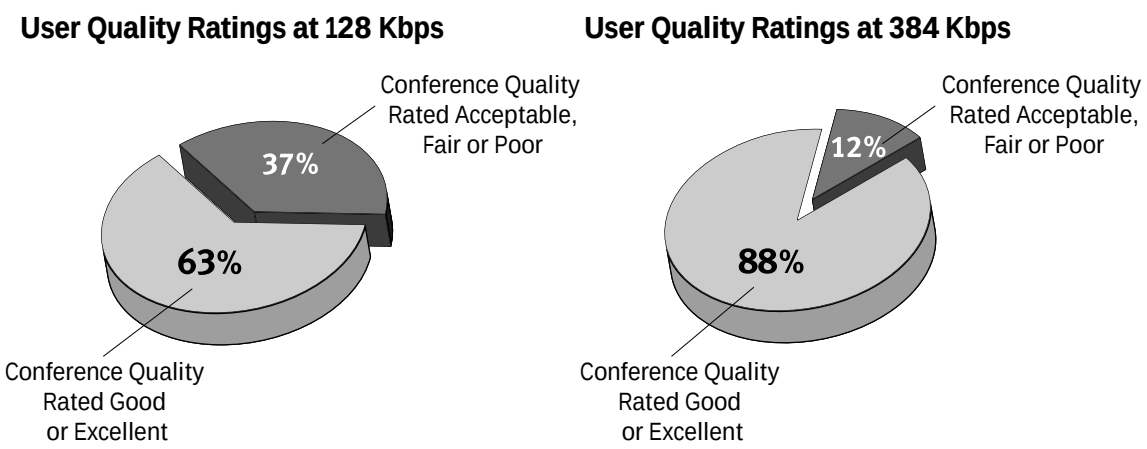

Figure 1 — User surveys show that quality delivered at higher data rates meets more user application requirements.

The factor that most affects conference quality is network bandwidth. Higher bandwidth networks permit videoconferencing connections to operate with smoother motion video, improved audio fidelity and lower end-to-end delay. These three characteristics are the most critical to overall conference quality.

Using leased lines and other wideband dedicated networks, early generations of videoconferencing solutions delivered outstanding conference quality — with some trade-offs. A large number of these networks, which typically operate at data rates of 768 Kbps or higher, remain in use today. High reliability, ease-of-use and consistently high video quality are hallmarks of these legacy networks. There are, however, significant disadvantages to these architectures. Typically, they are very costly to operate

and they do not provide easy access to “off-net” sites. As demand for videoconferencing grows, expansion of these networks comes at a high price.

Low bandwidth videoconferencing using switched network, with operating rates of 112 or 128 Kbps, has emerged as a very cost-effective alternative to the dedicated network approach, and has taken off rapidly in the past seven years. With the advent of ISDN Basic Rate Interface services offering 128 Kbps transmission rates at affordable prices, many organizations are finding that a large number of conferencing applications do not demand the video quality levels delivered by the high-end solutions. Casual meetings from desktop to desktop, group status meetings among peers and a wide range of other ‘working’ meetings are being successfully operated at 128 Kbps. Operation at these lower data rates permits broader usage and acceptance of videoconferencing in the enterprise, and effectively removes operating cost as an inhibitor to growth.

While the cost and connectivity advantages of low bandwidth ISDN videoconferencing are quite apparent in many applications, video quality delivered at 128 Kbps is clearly not adequate for an important set of highly interactive and visually oriented meetings.

Emerging from the experience of users of both high and low bandwidth videoconferencing approaches is the need for a flexible solution that can deliver any level of bandwidth needed to meet specific application requirements.

3. Bandwidth on Demand

Current Technologies Allow Management of Both Quality and Cost

Bandwidth on Demand technology was developed specifically to meet the needs of a variety of applications requiring dynamic allocation of network bandwidth. When used in videoconferencing networks, Bandwidth on Demand permits users and managers to optimize conference quality and cost by choosing the bandwidth that will be used on a conference-by-conference basis.

Bandwidth on Demand gives user organizations the flexibility of getting the dial-up bandwidth they need, when they need it, while paying only for the bandwidth that is used. Using Bandwidth on Demand, organizations can take advantage of dial-up services that have usage-based pricing rather than paying fixed monthly charges for dedicated bandwidth which may not be utilized around the clock. Videoconferencing traffic requires substantial bandwidth, but not all the time. Therefore, it does not present a steady load to the network. Figure 2 shows the wide ranging bandwidth requirements of a typical videoconferencing network. With Bandwidth on Demand technology, network transport costs are incurred only when videoconference meetings are taking place.

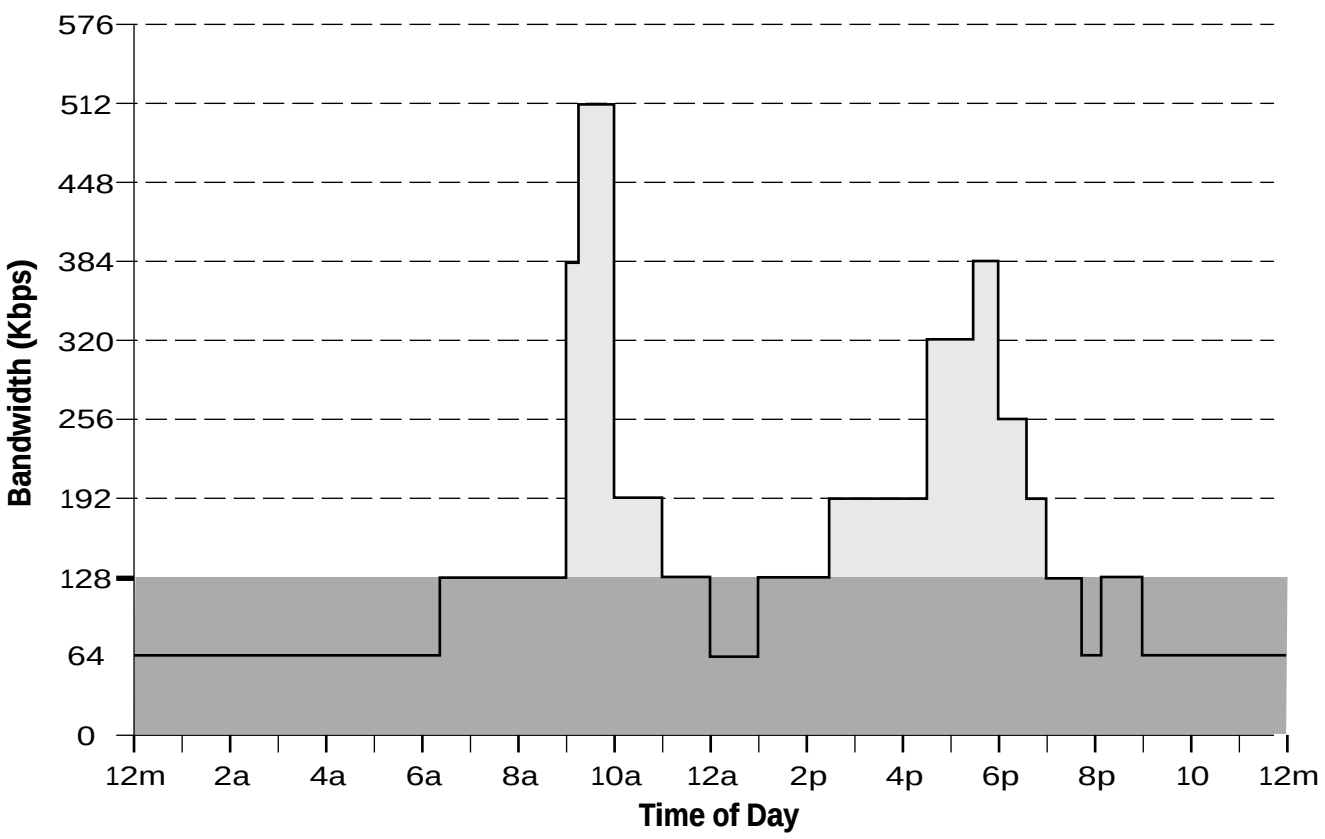

Figure 2 — Dramatic variations in videoconferencing traffic load make Bandwidth on Demand an attractive option.

How Does Inverse Multiplexing Work?

In order to establish a high-quality end-to-end Bandwidth on Demand connection, inverse multiplexers perform two critical functions:

- ***Call Set-Up and Control:*** *The inverse multiplexer that is initiating a call first dials a single number at the remote location. The answering IMUX responds by sending back a list of local dial numbers for all of the required B-Channels. Upon receipt of the list of numbers, the calling IMUX dials the remaining circuits needed to establish the call.*
- ***Synchronization:*** *After all the B-Channels needed for the Bandwidth on Demand call have been connected, the inverse multiplexers at both ends of the call synchronize and reorder the data channels that are being received. This process is necessary to compensate for the diverse paths and resulting delays that are introduced in each of the separate data streams.*

Bandwidth on Demand allows the addition of bandwidth in small increments to achieve a desired total connection bandwidth. This is an ideal solution for videoconferencing, as quality levels improve rapidly when bandwidth is increased from 128 Kbps to about 512 Kbps. Conference cost also increases in proportion to the bandwidth used. For example, a one-hour videoconference held at 384 Kbps over ISDN network will be three times as costly as the same call operated at 128 Kbps. Today, most organizations that are using fixed bandwidth solutions are operating at 128 Kbps, 384 Kbps or 768 Kbps. With Bandwidth on Demand however, organizations have much more flexibility. They have the option of using and paying for the specific bandwidth required for a particular meeting. Because organizations using Bandwidth on Demand have the ability to choose any bandwidth, they can easily utilize any or all of the traditional data rates mentioned above. In addition, they are beginning to experiment with other rates, such as 192 Kbps, 256 Kbps and 768 Kbps to meet specific cost and quality objectives.

Critical to making Bandwidth on Demand a viable approach is the availability of a range of flexible ISDN services from telephone companies around the world. These services make bandwidth available in increments of 56 Kbps or 64 Kbps. Each telco-provided 64 Kbps increment is called a B-Channel. ISDN services are able to deliver 64 Kbps bandwidth increments in groups of two or 23. Groups of two B-Channels are called Basic Rate Interface (BRI) services, while groups of 23 B-Channels are delivered as Primary Rate Interface (PRI) services. D-Channels carry the signaling and control information needed to manage the flow of data over the B-Channels. See Figure 3.

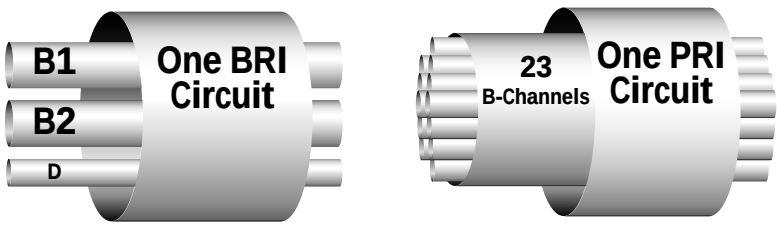

Figure 3 — ISDN services deliver bandwidth flexibility.

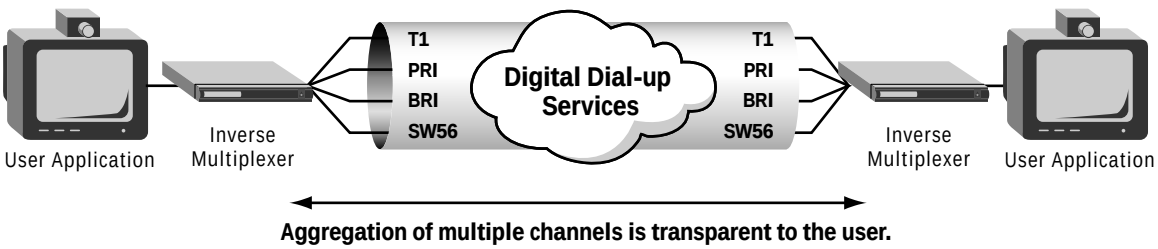

Figure 4 — Bandwidth on demand leverages flexible dial-up services.

An inverse multiplexer (IMUX) [Figure 4] is used to combine bandwidth increments for use in Bandwidth on Demand applications. In a videoconferencing application, one port of the inverse multiplexer connects to the videoconferencing system. The other port(s) are connected to the ISDN network. When specifying a Bandwidth on Demand solution for an entire videoconferencing network, each site may require a different form of ISDN access. Some locations may require inverse multiplexers that connect to BRI while others will be connected to PRI. Regardless of the type of local network connection, these sites will be able to communicate with one another transparently.

Basic Bandwidth on Demand Connections

In the simple example shown in Figure 5, two videoconferencing systems are equipped with Bandwidth on Demand capability. Both sites use three BRI lines for ISDN network access. Each line provides two 64 Kbps B-channels for a total available bandwidth of six channels or 384 Kbps. The IMUX chosen for this application is specifically designed to connect to the network using multiple BRI lines.

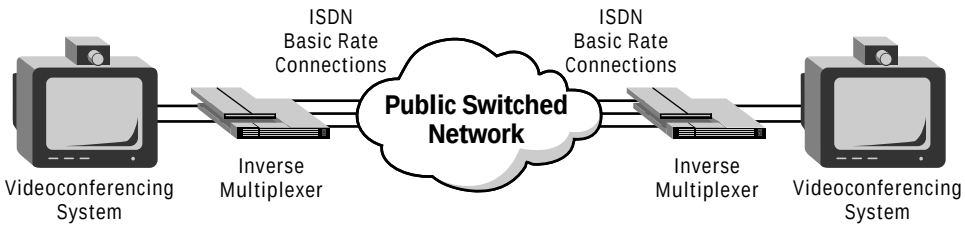

Figure 5 — A Bandwidth on Demand connection using multiple ISDN basic rate lines.

The Bandwidth on Demand example in Figure 6 uses Primary Rate ISDN lines at both locations instead of Basic Rate services. Six B-channels are available on the PRI circuits connecting to the IMUX equipment at both locations. This system is functionally identical to the first example. Videoconferences can be established at any data rate from 64 Kbps to 384 Kbps.

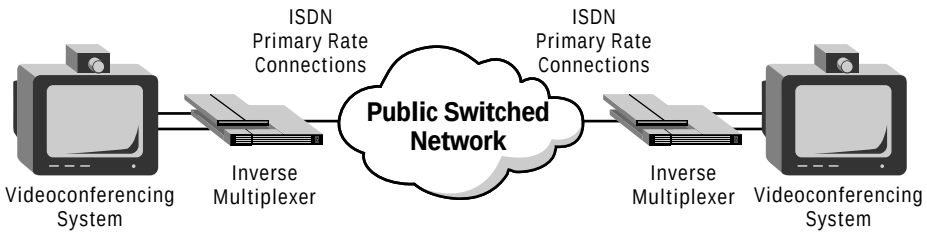

Figure 6 — A Bandwidth on Demand connection using ISDN Primary Rate services.

The final example depicted in Figure 7 shows the flexibility of the ISDN solution. Each location has access to six B-channels for videoconferencing. One location uses BRI for network access while the other uses PRI. These locations can communicate with each other seamlessly using this Bandwidth on Demand configuration.

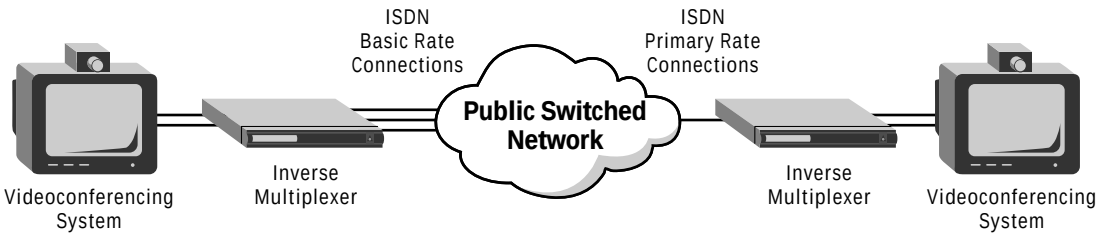

Figure 7 — A Bandwidth on Demand connection using a combination of Basic Rate and Primary Rate services.

Real-world videoconferencing networks are, of course, more complex than these point-to-point connections. Bandwidth on Demand technology can be integrated into all parts of today's sophisticated videoconferencing networks. Figure 8 shows how Bandwidth on Demand technology is applied in a videoconferencing environment that incorporates a variety of endpoints, switching equipment and a multipoint bridge.

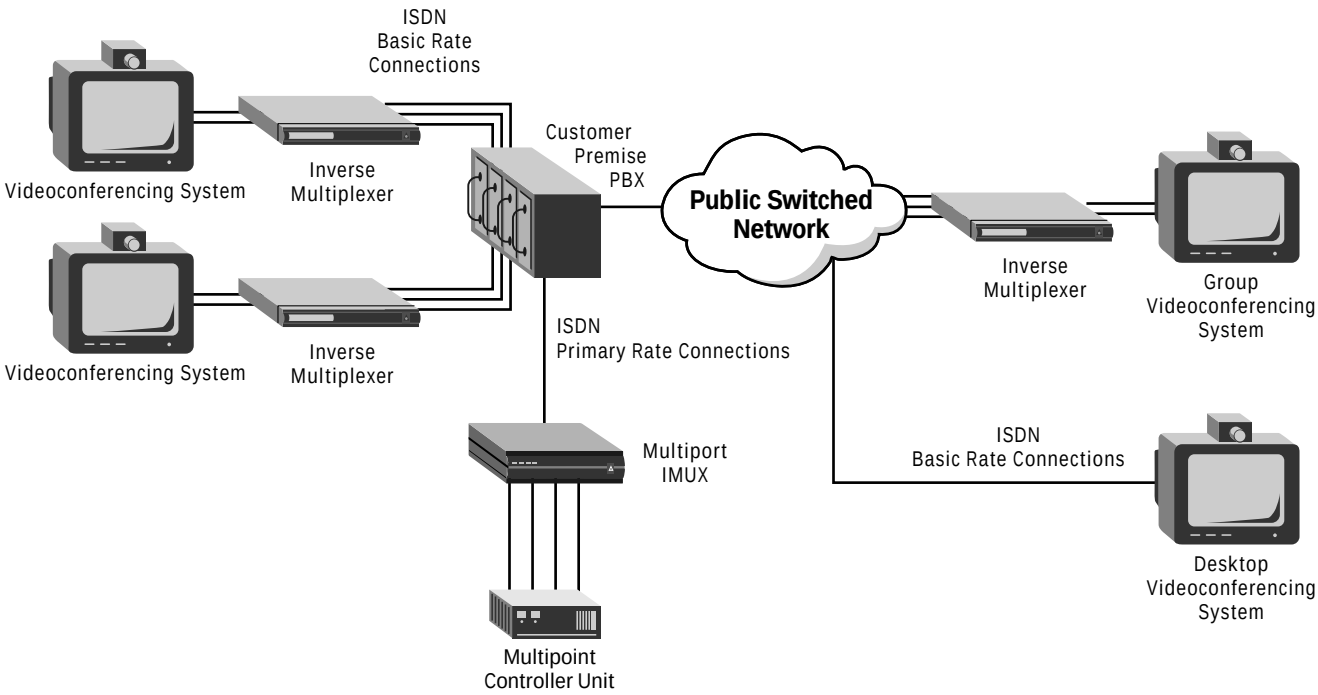

Figure 8 — A real-world videoconferencing network utilizing Bandwidth on Demand.

Note that this network includes one desktop videoconferencing system which does not support Bandwidth on Demand, and is capable only of operating at a lower data rate — 128 Kbps. This system is, however, able to communicate with all the other systems in the network, but only at the 128 Kbps transmission rate.

4. Designing a Bandwidth on Demand Solution

As network architect for your organization, you must carefully consider the strategy you will employ when incorporating Bandwidth on Demand into your plans for enterprise videoconferencing. To implement the best Bandwidth on Demand solution for your company, you'll need to focus on two key areas:

- User application requirements
- Equipment selection

Determining User Application Requirements

You should consider the following when determining your network requirements.

You will want to:

- *Build your Bandwidth on Demand videoconferencing network to meet the specific needs of your organization*
- *Understand your organization's meeting profiles and user expectations.*
- *Plan to integrate Bandwidth on Demand into existing videoconferencing facilities. You should be able to upgrade most of the videoconferencing equipment in your network.*
- *Take advantage of the most cost-effective network options available in each location.*
- *Whether you choose a centralized or decentralized approach, design your Bandwidth on Demand network so it can be effectively managed.*

Your final network design will be driven primarily by the applications it must support. Make sure you fully assess the application needs of your organization. Some of the most important areas you should cover are described in the following sections.

Meeting and Participant Profiles and Expectations

By far, the most important research you will do before specifying the details of your Bandwidth on Demand approach is an investigation of how your user community uses or plans to use videoconferencing in the organization. You'll need to discuss the issues of quality and cost with a representative subset of your current and prospective users. Determine which applications will benefit most from operating at higher data rates, as well as those that can be handled most satisfactorily and cost-effectively at lower bandwidths.

Videoconferencing Equipment Mix

Consider the following questions when determining the appropriate product mix:

- What videoconferencing equipment is currently deployed in your organization?
- Are you using group systems in your conference rooms?
- Are desktop videoconferencing systems being used extensively?
- Given the applications you need to support, which of these endpoints will require the flexibility of Bandwidth on Demand?

Endpoint and Multipoint Bridge Locations

Geographic equipment location is a very important factor in your network design. First, you will need a complete list of the countries in which you wish to install inverse multiplexing equipment. Additionally, you will need to know the types and costs of network access that are available at each of the locations. This information will be required as you select the appropriate vendors and configuration for your inverse multiplexing equipment.

Technology Management Approach

How do you plan to manage the videoconferencing equipment throughout your network? Will you be managing from a central location or from the local sites? Your decision about management strategy will drive you to look for a number of important management features in your inverse multiplexers.

Choosing the right IMUX equipment helps ensure successful implementation.

Don't forget to look for these key features:

- *Hardware and software compatibility with your videoconferencing equipment*
- *Support for the BONDING interoperability standard and high performance extended modes*
- *Certification for operation in each of the countries where you have videoconferencing sites*
- *Ease-of-use features for end users — like simple dialing*
- *Ease-of-use features for network managers — remote access for call set-up and diagnostics*
- *Quality products delivered in high volumes by established vendors*
- *Service and support local to each of your videoconferencing facilities*

Selecting Inverse Multiplexing Equipment

Once you have determined the basic application requirements of your videoconferencing network environment, you can begin to assess the various vendors and product alternatives.

Compatibility with Videoconferencing Equipment

Each inverse multiplexer you connect must be compatible with the local videoconferencing endpoint or multipoint bridge host port. Most videoconferencing equipment can be configured to connect to an inverse multiplexer (or other network interface device) using V.35, RS-449/422 or X.21 data ports and RS-366, V.25bis, X.21 or control lead dialing.

Manufacturers of Bandwidth on Demand solutions can provide you with a list of the videoconferencing equipment that has been tested with their inverse multiplexing products.

Interoperability and Standards Support

In 1990, the Bandwidth on Demand INteroperability Group (BONDING), an industry-sponsored standards organization, introduced a standard for manufacturers to follow in implementing Bandwidth on Demand products. Today, all manufacturers of IMUX equipment design their products with the BONDING standard as a minimum specification. This ensures that all Inverse multiplexers can connect to one another, regardless of manufacturer.

Tested compatibility with the BONDING specification is critical for reliable connectivity. You should assume that your videoconferencing network will be used to communicate with sites using inverse multiplexers from a variety of manufacturers. Be sure to ask for BONDING test results and statements of compatibility from every inverse multiplexer manufacturer you consider.

Some inverse multiplexer manufacturers support only portions of the BONDING specification. For videoconferencing applications, it is important to ensure that BONDING Modes 0, 1 and 2 are fully supported.

Extended modes of operation are available from some manufacturers. These proprietary modes can provide performance exceeding that of the BONDING specification. These modes of operation, however, cannot be used when interoperating between inverse multiplexers made by different manufacturers. Standardizing on a single Bandwidth on Demand manufacturer for your entire videoconferencing operation will allow you to take advantage of the benefits of an extended mode of operation for all your internal videoconferences and with external locations utilizing inverse multiplexers from the same manufacturer.

If your strategy includes the use of a public service bureau for multipoint bridging, you will need to determine what equipment they are using to support Bandwidth on Demand videoconferences. If they do provide Bandwidth on Demand services, they will certainly support BONDING operation, at a minimum. They may also support extended mode operation. If so, you may want to note which proprietary protocols they can support and keep this information in mind as you choose your vendor for Bandwidth on Demand.

What is Homologation?

Public network operators and government agencies everywhere in the world strive to ensure that only safe and compatible equipment is connected to their local networks. Government agencies normally require that a specific set of tests be performed by manufacturers before their equipment can be certified for connection to the public network. Connecting equipment to the network without these certifications is a violation of local law. It also introduces substantial risks of network failure.

Homologation is the process manufacturers use to gain the certifications needed for operation of their products in every country around the world. It is a country-by-country process, involving both technical testing and governmental application activities. Equipment must be individually tested and certified for operation in every country where it will be sold and installed.

Homologation is a lengthy and expensive process. User organizations should ensure that their IMUX equipment vendors have made the necessary investment in homologation. At a minimum, they must verify that the equipment they purchase has the certifications needed for operation in all countries where videoconferencing using Bandwidth on Demand will be installed.

Compatibility with Local Telecommunication Networks

Every inverse multiplexer in your videoconferencing network will be connected to some form of public or private network. Several important factors involving the network connection will drive your choice of inverse multiplexer. Because you may be taking advantage of different network access options at each site, you will need to develop individual requirements for each inverse multiplexer in the network.

First, you need to determine the hardware interface required for connection to the network you have chosen. Typically, your network access interface choices will be ISDN BRI, PRI, T1/E1 or SW56. You may also have to choose between 2-wire and 4-wire services and whether or not a Channel Service Unit (CSU) is required for your configuration. Inverse multiplexers can be connected directly to public network or to your internal PBX, DACS or other switching equipment.

If your network access point is a direct connection to the public network, you will also need to ensure that the inverse multiplexer equipment you are connecting is fully homologated and certified for operation on the local network. Suppliers of Bandwidth on Demand equipment can supply you with the list of countries in which their products have been homologated.

Ease of Use for End Users

Depending on your approach to call set-up, you may or may not be placing responsibility for dialing in the hands of your end users. If you have decided to encourage users to establish their own calls, you will want to ensure that the process is as simple as possible.

Many manufacturers of inverse multiplexers have programmed their products to respond to special dialing sequences generated by the videoconferencing equipment. These dialing sequences provide ‘encapsulated’ call set-up information to the inverse multiplexer. In addition, many of the major manufacturers of videoconferencing equipment have preprogrammed these dialing sequences into their operating software. All this extra effort on the part of the manufacturers has been done to reduce the complexity of dialing for the user.

When you discuss your Bandwidth on Demand requirements with a potential vendor, it is important that you identify the videoconferencing equipment that will be used at each endpoint and ensure that simple dialing mechanisms can be used to initiate videocalls. Your users should never be required to enter more than two or three additional keystrokes to establish a multichannel Bandwidth on Demand videoconference call.

Ease of Use for Network Managers

Remote management of networks employing Bandwidth on Demand capability is an important consideration. If you plan to deploy inverse multiplexers around the world and manage them from a central location, you must carefully select a product family that incorporates a set of easy-to-use management tools. You should be able to quickly dial into any remote system to establish a call, perform diagnostics or to download new configurations and software updates. Tools for remote management of inverse multiplexers range from limited and cumbersome command line environments to powerful and easy-to-use menu-driven interfaces. When specifying an inverse multiplexer solution, look for loopback testing and Call Detail Reporting (CDR) capabilities. These features will dramatically simplify the management of your Bandwidth on Demand facilities.

Quality and Reliability

You will want to do everything you can to ensure that your network operates consistently and reliably. There are a few things you can do in the equipment selection process to ensure that your network will be as reliable as possible. You should plan to standardize on a single manufacturer for all inverse multiplexing requirements throughout your network. Manufacturers spend most of their testing resources ensuring interoperability amongst their own products. You can further reduce the risk of interoperability problems by making sure that all of the inverse multiplexing equipment you install in your network is loaded with the same revision level of software. Try to avoid having a mix of new and old software in your network. These steps will help to ensure that videoconference connections among your own locations are as successful as possible.

What can you do to achieve high connection success rates when communicating with the outside world? To ensure maximum reliability when connecting with external locations, there is one an additional factor you can take into account during the vendor selection process. Try to choose an established vendor that has a large installed base of inverse multiplexers in the videoconferencing application. In doing so, you benefit in two ways. If the vendor has been successful in deploying Bandwidth on Demand solutions for videoconferencing, you can be sure that many interoperability issues have already been identified and addressed. Larger vendors also have the resources to address new issues as they arise. Additionally, when you connect with an external location that has Bandwidth on Demand capability, it is quite likely that you will be connecting with another product manufactured by your own supplier of inverse multiplexers!

Service and Support

Like all the other equipment in your videoconferencing network, inverse multiplexers need to be properly installed and maintained. As you evaluate potential suppliers of inverse multiplexing equipment, be sure to consider their service and support capabilities available local to each site in your network. You will want to put a service strategy in place that keeps your equipment current and always in service. The larger suppliers of inverse multiplexing equipment have extensive networks of qualified service and support outlets around the world.

5. Avoid a Few of the Most Common Videoconferencing Pitfalls

Think About the Whole Network — Not Just the Components

Your videoconferencing network will be much more successful in the long term if you think like a network architect. From the beginning, be sure to consider how all your systems and network equipment will work together. Focus on interoperability and flexibility. You'll want to be able to add new locations to the network without modifying existing facilities.

Test Everything — On a Regular Schedule

Network configurations can change. Your network service provider might install new Central Office (CO) equipment or software. These changes could affect your ability to make successful video calls. Even your own equipment set-up could be modified. Users sometimes make changes in set-ups to address immediate problems. Unfortunately, these changes can make videoconferencing connections less reliable. Be sure to check equipment set-up at all sites on a regular basis.

Use Your Resources Efficiently

Videoconferencing requires expertise in a variety of areas. Be careful about which functions you choose to perform internally and those you choose to outsource. Your best bet is to focus your own staff on operations management and planning for the future. Unless your videoconferencing operation is very large, you should seriously consider outsourcing many of the minute-to-minute tasks involved in keeping the network operational. Look at outsourcing for scheduling and reservations, equipment maintenance and multipoint bridging. You'll find that the service providers can deliver outstanding service quality for most of your videoconferencing applications.

6. Videoconferencing Using Bandwidth on Demand

Share Network Bandwidth Within a Facility

When multiple systems are located in a single facility or Bandwidth on Demand is required for a multipoint bridge, use of a multiport IMUX is appropriate. These devices combine multiple Inverse multiplexers into a single chassis. They have several advantages over the use of individual IMUX units, including lower cost per IMUX, smaller space requirements, and most importantly, the ability to share network bandwidth amongst multiple IMUX ports. This approach reduces both network access charges and equipment cost in many videoconferencing networks, as compared to the use of multiple network connections and independent IMUX units.

Keep Call Setup Simple

Make every videoconferencing system as easy to use as the telephone (or easier). Choosing a location from a menu or dialing a one or two digit speed dial numbers is the most you should ask your users to do when they set up their own videoconference connections. Complex dialing sequences turn users off. Don't make call set-up a nightmare that your users will try to avoid.

Establish Several Videoconferencing Service Levels

Bandwidth on Demand gives you a new dimension of flexibility. Unfortunately, with flexibility comes additional complexity. You should work hard to limit the complexity of your videoconferencing service offering. When you bring your Bandwidth on Demand videoconferencing capabilities on-line, be sure to establish a set of two or three service levels. There is no need to offer your users the ability to choose from any more than a few bandwidth options. Start with 128 Kbps, 256 Kbps and 384 Kbps service levels and adjust them based on user feedback.

Give Senior Executives the Best

When your organization's senior executives use videoconferencing, they can easily be your most effective proponents of the technology. Make their experience a satisfying one. Run their videoconferences at 384 Kbps or higher.

Secrets to Success with Bandwidth on Demand

- *Use multiport IMUX equipment to share bandwidth within a facility and achieve maximum network-utilization and efficiency.*
- *Keep dialing simple for users. Simple, preprogrammed dialing sequences can eliminate unneeded complexity.*
- *Use no more than three standard service (bandwidth) levels. Avoid the temptation to give users unlimited flexibility.*
- *Expose your senior executives to an outstanding videoconferencing experience — always run their conferences at 384 Kbps or higher.*
- *Measure user satisfaction and cost efficiency. Drive performance to exceed expectations.*

Measure, Measure, Measure...

You are bringing Bandwidth on Demand capabilities into your videoconferencing environment for specific reasons. You are focusing on delivering appropriate levels of conference quality while aggressively managing operating costs. How will you know if your efforts are paying off?

Take the time to measure both quality and cost-efficiency. First, and most importantly, ensure that your user community is experiencing the conference quality levels that they expect for their applications. Conduct a user satisfaction survey. Interview a few key users. And, plan to carefully compare the costs of network services that you incur after installing your Bandwidth on Demand solution with the cost levels prior to making the change.

With this kind of information in hand, you will be able to proactively and effectively manage the performance of your network to meet the real conferencing needs of the organization.

7. User Scenarios

Scenario One: Regional Health Care Provider Expands Videoconferencing Network Beyond Distance Learning Applications

The Multiband Product Family

Multiband™ bandwidth-on-demand controllers are used for videoconferencing and other applications with fluctuating bandwidth needs such as backup and disaster recovery, distance learning and telemedicine. At their core is Ascend's industry-leading inverse multiplexing technology, a method of combining multiple switched channels into a single high-bandwidth data stream for speed as needed.

- ***Multiband VSX BRI*** *— a scalable inverse multiplexer that supports a single application over one to four ISDN BRI lines.*
- ***Multiband VSX T1*** *— a scalable inverse multiplexer that supports a single application at speeds ranging from 128 Kbps to T1/PRI.*
- ***Multiband Plus*** *— an inverse multiplexer that supports multiple applications over two T1/PRI.*
- ***Multiband MAX*** *— offers the most powerful Multiband solution and includes an inverse multiplexing card, SNMP management and the option to upgrade into a full MAX WAN access switch with support for extensive remote networking capabilities. The Multiband MAX family includes the 1800,2000, 4002 and 4004.*

Application Overview

A regional healthcare provider serving the midwestern US operates a high-bandwidth, eight-site videoconferencing network primarily for the purpose of remote training of medical professionals. Their typical distance learning applications involve use of videoconferencing to deliver half-day sessions focused on training of physicians on new medical procedures. These sessions usually originate from an amphitheater located in a major medical teaching facility within the healthcare system. Videoconferences are conducted point-to-point between a local audience and a second, remote location, which is usually a classroom environment accommodating 50 to 100 attendees.

Videoconference-based training has been extremely well-received throughout the healthcare system. Participants at the remote sites are quite satisfied with the quality of the training they receive using videoconferencing. The network is highly utilized, and there are many requests for expansion. Some hospitals not yet equipped for videoconferencing are interested in taking advantage of the training opportunity. People are beginning to think about accessing training material from locations outside the region. And, medical professionals at remote sites currently on the network are requesting new services in the area of telemedicine — like remote access to specialists and consultants.

Word of the success of videoconferencing is spreading throughout the organization. Many new applications for the technology are being proposed, requiring additional sites to be equipped.

The IT organization is very excited about the opportunity to expand the use of videoconferencing, but is concerned about the associated cost of delivering high quality conferencing in such a large number of new applications and locations.

Current Technology Approach

The entire videoconferencing network currently operates over a web of T1 lines amongst the major facilities. All conferences are run at a data rate of 768 Kbps. Bandwidth is allocated using a Digital Access Crossconnect Switch (DACS). All conferences are operated point-to-point.

Situation Analysis

The IT management group recognized that a broad range of new application requirements were emerging. New sites needed to be brought on-line. Current videoconferencing quality levels needed to be maintained for the existing training applications and for the proposed telemedicine applications. New, more frequent applications for videoconferencing within the administrative side of the organization had to be addressed — but at a much lower cost level! The entire network needed to be "opened" for connection to the outside world.

After analyzing its changing application requirements, this organization found that without a dramatic change in its approach, it would never be able to respond to demand and equip new facilities with cost-effective videoconferencing capabilities.

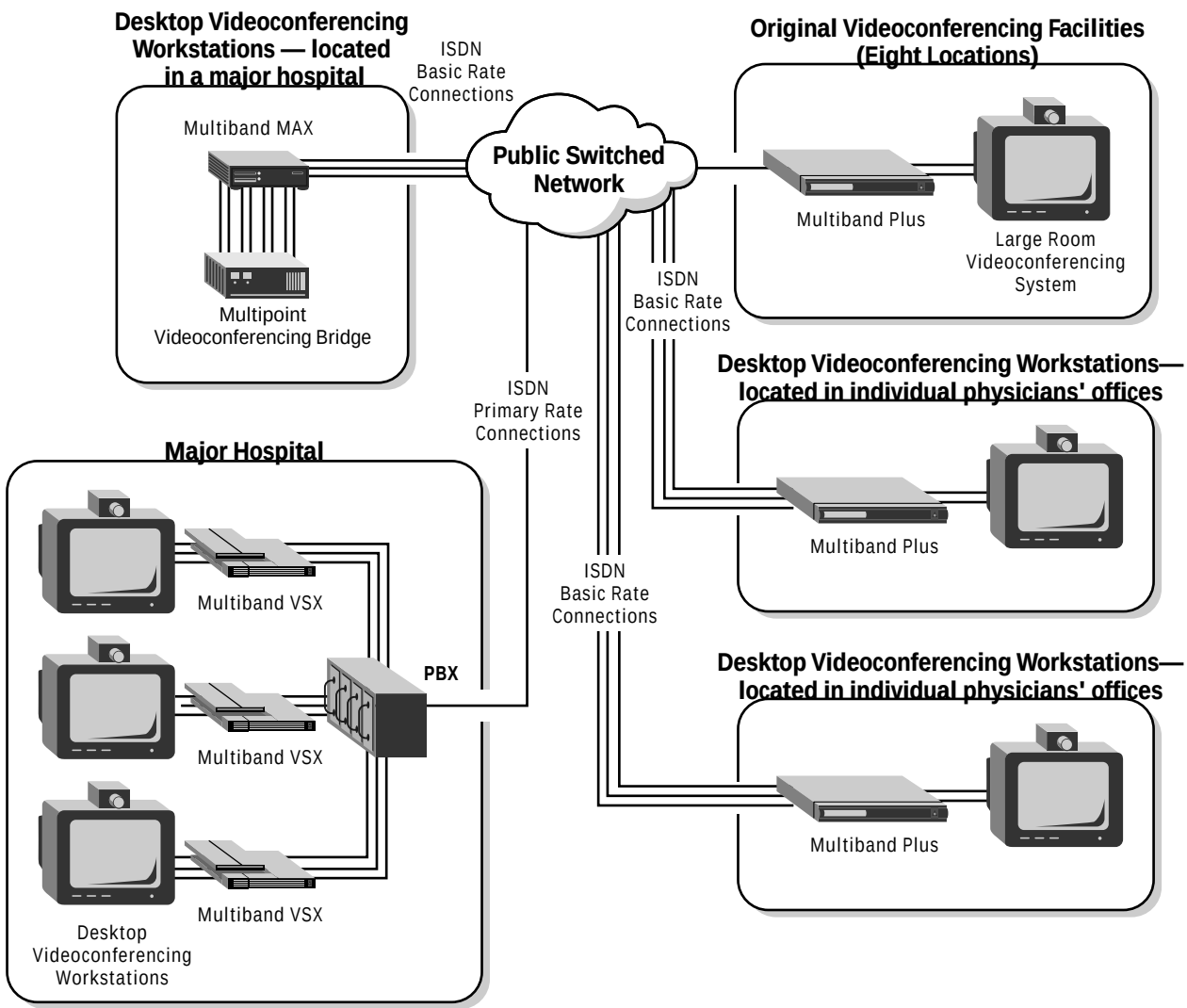

Figure 9 — Regional health care videoconferencing network.

Bandwidth on Demand Solution

The range of strategic uses of videoconferencing within this health care organization was dramatically increased through use of the Ascend Multiband product line. The organization opted to completely eliminate the use of leased lines for videoconferencing. As shown in Figure 9, all existing locations moved to a combination of ISDN PRI access and inverse multiplexing, enabling communications amongst all internal locations as well as many external locations which were previously unable to access the private network. A whole new network of 50 desktop systems was deployed to physicians' offices throughout the region. These systems connect using one, two or three 128 Kbps Basic Rate ISDN lines. Multipoint bridging capabilities were added to the mix through use of a public bridging provider equipped for Bandwidth on Demand.

The training sessions that were originally driving the use of videoconferencing in the organization are now being run at exactly the same bandwidth and quality level as they were when they were operated in the private network environment. They have been improved, however, in two ways. Remote audiences are no longer restricted to a single site. Multiple sites can be trained simultaneously through the use of multipoint conferencing. Additionally, new training material is being provided from a variety of external sources. These content providers were previously inaccessible from the private network.

Physicians throughout the region are taking advantage the conveniently located desktop units to conduct remote consultations with specialists located in the system's major hospitals. They choose a low-bandwidth or high-bandwidth connection depending on the level of visual content required to support the discussion.

New applications in general management and administrative areas of the health care network are being developed. These applications are operated at 128 Kbps and 384 Kbps. In the private network environment, these applications would have been cost-prohibitive.

Scenario Two: Major Financial Institution Develops Videoconferencing Network for Global Communications

Application Overview

The CEO of one of the world's largest global banking institutions uses videoconferencing for a variety of meetings, including monthly communication meetings with the bank's senior executives at 25 major locations around the world. A total of more than 550 high-ranking bank executives attend these meetings with the Europe-based CEO. The communication meetings normally last about two hours.

Meeting participants at the remote locations find the quality of the videoconference to be less than satisfactory. Poor motion quality and hollow sounding audio are frequently mentioned problems. The net result is declining attendance at the remote locations and a pervasive feeling within the bank that videoconferencing cannot deliver the level of communication quality that is needed to conduct the bank's business.

Current Technology Approach

The bank's videoconferencing network consists of 25 rooms of varying sizes. The five largest rooms are auditoriums handling up to 250 people. They are equipped with audio/visual booths, large projection screens and customized videoconferencing systems. Most of the other rooms are medium to large conference rooms handling 10 to 75 people. The videoconferencing systems in these conference rooms are roll-about units with large monitors. The five large rooms have access to leased T1/E1 lines and ISDN BRI lines, while the other rooms have access only to BRI services. Executive level point-to-point calls are linked using the leased lines. All other meetings, including the monthly communication meeting, however, are held at 128 Kbps using the BRI lines at all locations. A 32-port multipoint bridge is located at the bank's headquarters office. Network is supplied to the bridge via two PRI lines. All of the bank's multipoint calls are run at 128 Kbps.

Situation Analysis

The CEO's monthly communication meeting is the bank's internal showcase for videoconferencing. In fact, it is the first exposure that most of the bank's executives have to videoconferencing. How can the executives who participate in this meeting at the remote locations be expected to begin to employ the technology in their own departments if they are dissatisfied with their initial experiences with videoconferencing?

Participants' comments about poor video and audio lead to the conclusion that the quality level of the videoconference at 128 Kbps is simply not satisfactory for the communication meeting. Operation at a higher bandwidth should improve user perceptions of quality quite substantially.

Bandwidth on Demand Solution

The bank decided to deploy Ascend inverse multiplexers into its network at all sites and at the multipoint bridge. Their new videoconferencing network is shown in Figure 10. Two new BRI lines were added at each conference room location, and additional PRI lines are "borrowed" from the bank's voice and data network to support operation of the multipoint bridge during the monthly communication meeting.

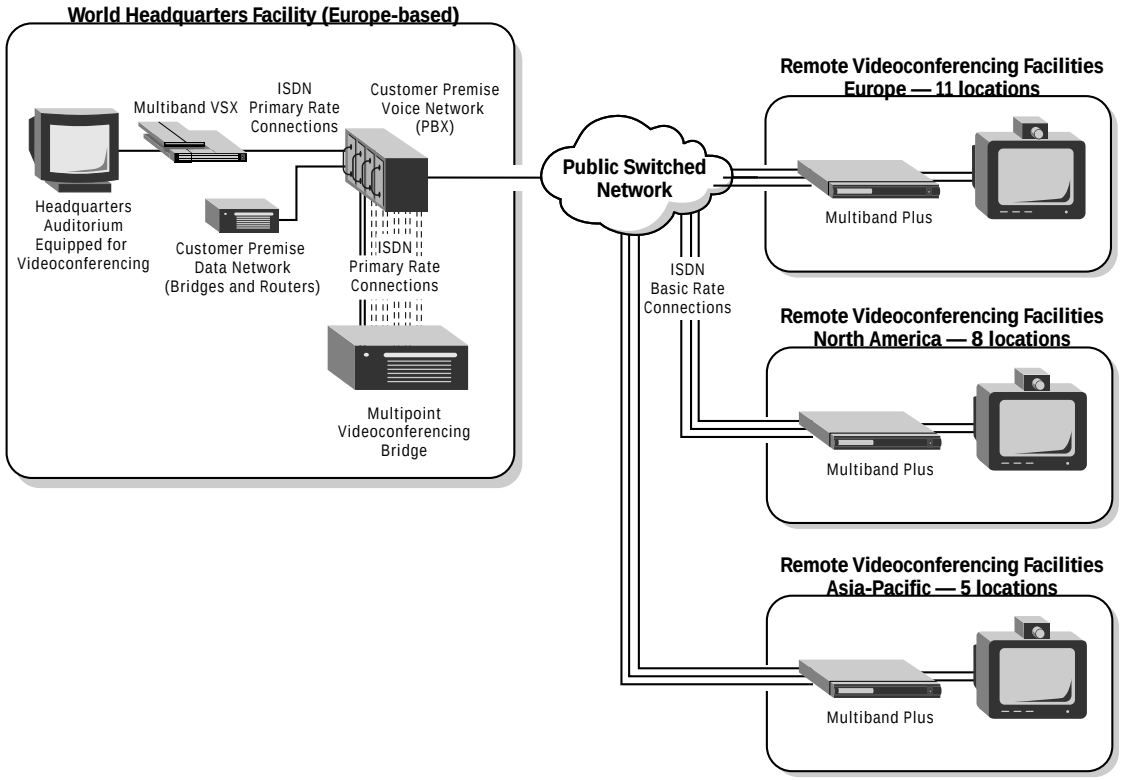

Figure 10 — Global videoconferencing solution using Bandwidth on Demand.

Multiband Plus and VSX products with multiple BRI connections were installed at each videoconferencing site. At the multipoint bridge, four PRI interfaces were added to permit physical connection to the network. To enable the multipoint bridge to operate using Bandwidth on Demand capabilities, the bank purchased an inverse multiplexing software option for the bridge.

The bank also instituted a two-tiered videoconferencing service structure. Service Level I is a high quality (384 Kbps) operating mode, while Service Level II is a low cost (128 Kbps) mode. The monthly communication meetings are run using Service Level I. Managers who set up their own meetings can choose between Service Level I and Service Level II.

The results of the network upgrade were immediate. Attendance at the remote locations increased dramatically. Participants note that they are now able to remain focused on the meeting for its full duration because the video and voices are clearer. Some participants mention that they feel less fatigued at the end of the two-hour session.

Internal efforts to promote the use of videoconferencing are being well-received. Executives have begun to realize that videoconferencing can meet many of their communication objectives. They are also pleased to know that they can choose from two Service Levels to manage cost and meet their specific application requirements.

8. Glossary

2-wire/4-wire
A physical interface for 56 Kbps DS0 connections. Interface will be either 2-wire or 4-wire. This specification is required for proper configuration of an inverse multiplexer that will be connected to switched 56 Kbps services.

Algorithm
Compression algorithms are the mechanisms by which wideband audio and video signals are converted into lower bandwidth data streams for transmission over digital networks. These algorithms form the core of videoconferencing technology.

Audio Fidelity
Quality of audio as measured in terms of frequency range and distortion. Aggressive compression of audio signals can introduce lower frequency response and higher distortion levels. Using higher bandwidths for videoconferencing permits audio to be transmitted with higher fidelity.

Bandwidth
Measured in thousands of bits-per-second (Kbps), bandwidth is the rate at which data is transmitted over a digital link. For purposes of videoconferencing, useful bandwidth ranges from 112 Kbps to 1,536 Kbps.

Bandwidth on Demand
Technology developed to allow the combination of multiple low-bandwidth channels to achieve higher bandwidth on an as-needed basis.

Basic Rate Interface
A 128 Kbps switched digital service using ISDN technology. Provides two 64 Kbps B-channels and one 16 Kbps D-channel

B-channel
Also called a Bearer channel, the B-channel is used to carry information across an ISDN connection.

BONDING
BONDING represents the Bandwidth on Demand Interoperability Group. An industry standard developed to ensure interoperability of inverse multiplexers from different manufacturers.

BRI
See Basic Rate Interface.

Call Detail Reporting
Logging and reporting of calls made to and from an inverse multiplexer or other network device.

Call set-up
Initialization of a videoconference call. The process of connecting endpoints to one another or to a multipoint bridge. Involves dialing, negotiation of operating modes and establishment of a video and audio connection.

CDR
See Call Detail Reporting.

Channel Service Unit
A device used to connect endpoint equipment to switched 56 Kbps digital network services.

Compression
Technique used to transmit video and audio signals over low-bandwidth digital networks. See algorithm.

Control lead dialing
A lead (typically DTR) on the data connector which transitions to initiate a call through the data connection equipment (i.e. the inverse multiplexer).

CPE
See Customer Premises Equipment.

CSU
See Channel Service Unit.

Customer Premises Equipment
Telephone or network equipment located within the facilities of a telephone company customer, but owned and maintained by the customer. Videoconferencing systems, inverse multiplexers and other types of network access equipment are CPE.

DACS
Digital Access Crossconnect Switch

Data rate
See bandwidth.

D-channel
A channel carried by all forms of ISDN service which allows control information to be transmitted over the link. D-channel signaling allows equipment at each end of the link to remotely determine various line and equipment configurations.

Dedicated network
Permanent network connections between fixed locations. Dedicated networks are built using leased lines, which carry fixed prices. They are designed primarily for full-time operation.

Desktop videoconferencing system
A videoconferencing system designed for individual use from a business desktop. Usually provided as an add-on to a personal computer consisting of a camera, microphone, speakers, compression software and hardware for connection to the network.

Diagnostics
Software programs that allow troubleshooting of equipment. Diagnostic programs may be operated local to the equipment being analyzed or from a remotely located workstation.

Distance learning
The process of delivering training and education programs to remotely located students. Involves the use of technologies such as videoconferencing, audioconferencing and data collaboration. Distance learning is commonly applied in corporate training and higher education environments.

E1
See T1.

Endpoint
A videoconferencing endpoint refers to the equipment used in a local environment to transmit and receive video, audio and data from one or more remote locations. See desktop videoconferencing system and group videoconferencing system.

End-to-end delay
The time from the moment a word is spoken to the time it is heard at the far end of a videoconferencing connection. Compression and decompression in the videoconferencing endpoints introduces the most substantial component of videoconferencing delay. Large end-to-end delays make videoconferencing uncomfortable for the meeting participants. Operation at higher data rates tends to reduce end-to-end delay.

Extended mode
Operating modes for Bandwidth on Demand applications that utilize enhanced features provided by individual manufacturers. These modes sometimes allow for higher reliability and better performance. They are, however, limited to connections between inverse multiplexers produced by the same manufacturer.

Group videoconferencing system
A videoconferencing endpoint system typically used in a conference room environment. Group systems range from small, self-contained, roll-about units to larger, fully-customized rooms. These units are frequently equipped with Bandwidth on Demand capability.

Homologation
The process manufacturers of network access equipment use to ensure that their products are compliant with local regulations certified for operation in all countries around the world.

IMUX
See inverse multiplexer.

Interoperability
The critical ability for a network interface to properly connect with equipment located remotely. Interoperability is ensured through standards and through extensive testing by manufacturers.

Inverse multiplexer
A device used to aggregate multiple data channels to achieve an as-needed high-bandwidth capability. Used extensively in videoconferencing applications.

ISDN
Integrated Services Digital Network. A worldwide digital network offering wide area networking services ranging from 64 Kbps to 1,536 Kbps in 64 Kbps increments. Service pricing is based primarily on actual usage levels. See Basic Rate and Primary Rate.

Kbps
kilobits per second. Thousands of bits-per-second. See bandwidth.

Leased line
An individual connection used in a dedicated network. Usually purchased as a dedicated T1, E1 or 56 Kbps connection. See dedicated network, T1 and E1.

Modes 0, 1, 2
The operating modes defined in the BONDING specification. Support for all three modes is required for most videoconferencing applications of Bandwidth on Demand.

Multipoint bridge
A network device which allows three or more locations to participate in a single videoconference. Instead of connecting to one another, each site establishes a connection to the multipoint bridge. The bridge performs two primary functions. It mixes audio so that all sites can be heard, and it switches video from one site to another.

Multiport IMUX
Combines multiple inverse multiplexers into a single chassis. A multiport IMUX is cost effective in situations where network needs to be shared amongst multiple videoconferencing systems in a single facility.

NT-1
A network device used to terminate an ISDN Basic Rate line. The interface on the telephone company side of the NT-1 is a 2-wire connection called a U Interface, while the side connecting to the customer premise equipment is a 4-wire interface called the S/T Interface. The NT1 may be a stand-alone device or it may be built into some network interface equipment.

Off-net
Term used to describe a location which is not on a private or virtual private network.

On-net
Term used to describe locations that are accessible without going off a private or virtual private network.

PBX
Private Branch Exchange. A PBX may be used to deliver network services to videoconferencing systems located within a facility or campus. The PBX must be able to support ISDN BRI or PRI to the internal videoconferencing locations.

Point-to-point
A direct connection through a public or private network from one videoconferencing system to another.

PRI
See Primary Rate Interface.

Primary Rate Interface
A 1,536 Kbps switched digital service using ISDN technology. Provides 23 64 Kbps B-channels and one 64 Kbps D-channel. Primary Rate services are delivered over T1 or E1 physical interfaces. See T1 and E1.

Public multipoint service bureau
A service provider who owns and operates multipoint bridging equipment. These services provide multipoint bridging on a usage basis. Bridge operators of this type are located around the world and offer a range of features and capabilities in their service offerings.

Remote management
The ability to perform routine troubleshooting, maintenance, diagnostics and system software updates by modem from a remotely located workstation.

RS-366
A standard dialing protocol supported by most videoconferencing systems. Typically used in conjunction with V.35 data connections to connect a videoconferencing system to an external network interface such as an inverse multiplexer. This is the most popular means of connection used in the United States.

RS-449/422
A physical interface specification used to interconnect videoconferencing data ports to a variety of network equipment. Frequently used in dedicated network environments without dialing requirements.

S/T interface
The 4-wire connection used to connect ISDN Basic Rate network interface equipment to the customer premise side of an NT-1. See NT-1 and U interface.

Speed dial
A mechanism supported by videoconferencing systems and inverse multiplexers that simplifies the dialing of a multichannel Bandwidth on Demand videoconference call. Eliminates the need for independent, sequential dialing of multiple phone numbers.

Switched network
Network environment in which endpoint equipment is able to selectively connect with a variety of far-end locations from a single network access point through the use of dialing protocols. Switched networks used for videoconferencing are typically public networks built and maintained by telephone companies. Switched networks also include virtual private networks and private customer premise facilities (PBX) in which dial-up capabilities are available.

T1
A physical interface designed to deliver 24 independent 56 Kbps data channels with in-band signaling. T1 lines are typically used to deliver dedicated services or ISDN Primary Rate switched services. T1 is the standard interface used primarily in the United States and Japan. E1 is the equivalent interface used in other parts of the world, particularly in Europe.

Telco
Telephone company. Switched digital services, including ISDN, are available from all major network service providers around the world.

Telemedicine
The practice of medicine using telecommunications technologies to interconnect remotely located physicians and patients. Involves the use of technologies such as videoconferencing, audioconferencing and data collaboration. Telemedicine is applied in a variety of forms — including consultations between physicians to actual remote examinations of patients.

U interface
The 2-wire interface between an NT-1 and an ISDN Basic Rate line provided by the telephone company. See NT-1 and S/T interface.

V.25bis
A standard dialing protocol supported by most videoconferencing systems. Typically used in conjunction with V.35 data connections to connect a videoconferencing system to an external network interface such as an inverse multiplexer. This is the most popular means of connection used in the United States.

V.35
A physical interface specification used to interconnect videoconferencing data ports to a variety of network equipment. Typically used with RS-366, X.21 or V.25bis dialing interfaces.

Videoconferencing
A means of full-motion video and audio communication involving the use of compression techniques and transmission over wide area digital network connections.

X.21
A standard dialing protocol supported by most videoconferencing systems. Typically used in conjunction with V.35 data connections to connect a videoconferencing system to an external network interface such as an inverse multiplexer. This is the most popular means of connection used outside the United States.

Videoconferencing for the Corporate Enterprise

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