2. ISDN - A Decision Maker's Perspective

This section of the Catalog is intended for business decision makers. If you need to decide about investing in a new communications capability, then this chapter is for you. It provides the tools to decide whether ISDN offers the telecommunications services you need to solve your business problems at a reasonable price. Technical details are left for Section 3. The focus here is on the business decision to use ISDN. The approach is to look at the components of a "feasibility study" that a business might make when considering the opportunities offered by this technology. Taking the enterprise's perspective, an example "feasibility study" is presented for two popular applications - telecommuting (or work-at-home), and videoconferencing.

An important long term issue is interoperability - how well different systems (built by different manufacturers) work together, this topic is covered in Section 2.3. Section 2.4 presents the NIUF's report on cost justification, for use as a reference.

2.1 Work At Home Feasibility Illustration

Suppose a company is exploring the opportunity to have some of its employees work at home, or telecommute electronically to the office. To make its decision, a company might prepare a feasibility study. This section outlines the components of just such a study.

The Opportunity

A growing number of organizations are considering work at home as an option for their employees. Social, economic, and environmental changes are spurring interest in the ability to "telecommute" via computer between home and the office.

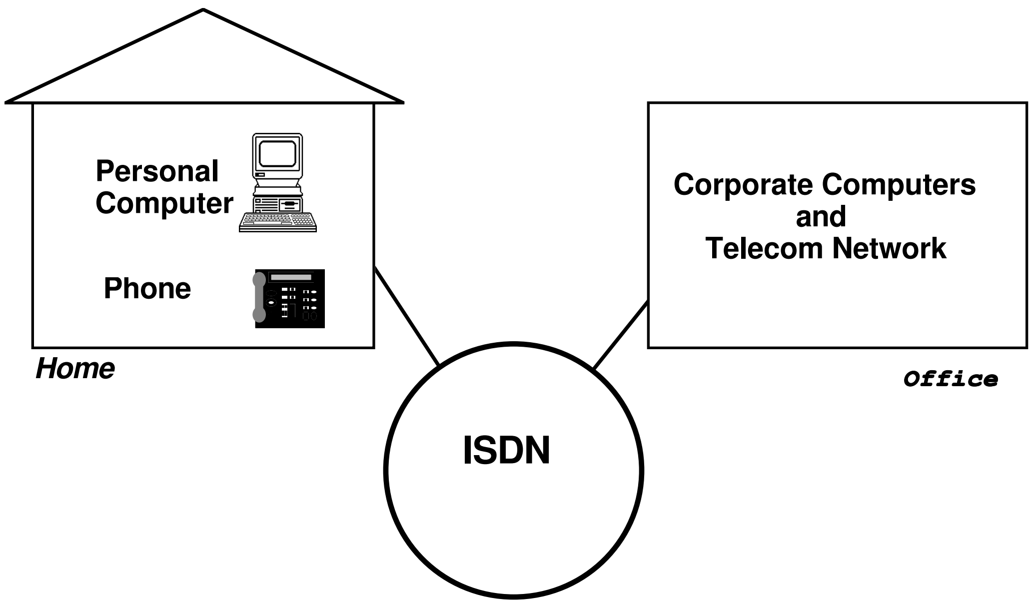
The growth in telecommuting is a result of the need to:

- Reduce air pollution in sprawling urban and suburban settings. New regulations mandate that companies support programs to help reduce the number of cars on the road.

- Support the personal needs of people who need flexible hours to care for children, elderly parents and other family members.

- To let knowledge workers - consultants, programmers, lawyers, teachers - work at home evenings, weekends, during bad weather, or when not traveling; to save time, and contribute more.

The telecommuter needs to access the company's host computers for electronic mail and access national information services. While at home, each uses the telephone extensively. They each need conferencing, and the ability to forward calls to the corporate voice mail system, and calling number identification for screening incoming calls.



Premises Equipment (Phones, terminals, applications, and corporate computers) are under company control.
The company establishes service requirements, to be met by ISDN, under the telecommunications service provider.

Business Requirements

Looking at their business environment, the company would identify potential participants, and evaluate both personal and corporate requirements necessary for the success of the project. For example:

- Provide easy-to-use, transparent communication between home and the people and information resources of the organization
- Support both voice and data communications
- Provide the same telephone features at home as at the office, including voice messaging, conferencing
- Maintain network security
- Keep employees "in the loop" with respect to ongoing activities, changes in the business, etc.

- Improve or maintain productivity: for work at home to be a success, the productivity of those who work at home should improve, and the overall productivity of the work group should not decrease, as judged by the participants, their management, and their clients.

To learn more, the Bibliography (Section 6) includes references on Telecommuting.

Technical Options

ISDN, and the office equipment that it can support, are well suited to answering this set of communications needs. Technical solutions are presented in Section 3. (See solutions 3.1.1, through 3.1.4, and 3.1.19 through 3.1.22.) Some of the available equipment is described in Section 4.

Depending upon the size of the organization, contact the local telephone company's business sales office to check on the availability of ISDN in the area.

Benefits and Costs

In this part of the study, the benefits of telecommuting are assigned a value, based on measurements, quality assessments, and the experience of the organization. The costs of implementing the solution are estimated, as illustrated below:

1. Hard/Soft Benefits:

    - improved productivity for 23% of the affected personnel*

    - reduction in time/dollars required for travel of 18%, thereby increasing the effective wages of employees

    - faster service/improved accuracy of 12%

    - increased customer satisfaction of 7%

2. Costs (including non-recurring, monthly and pay-back period):

    - Home equipment increases this year's Cost of Capital by 3.5%.

    - Legal Fees increase 5% in year one for work-at-home agreements.

    - Management time increases 10% in year one to setup work-at-home personnel procedures.

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* The numbers shown are hypothetical, and are not based on any actual study.

- installation charges, usage fees, basic service charges, user training add non-recurring costs of 9% of the yearly MIS budget.
- equipment, long distance charges will add 12% to the yearly MIS expense budget.
- with discounted cash flow of 8% the payback-period is 36 months using the foregoing intangible benefit credits.
- No tangible costs are eliminated or avoided in year one.

The reader can compare the above illustration with the extensive list of potential benefits and costs of ISDN-based solutions as presented in Section 2.4.

Based on anticipated costs and benefits, the decision maker can evaluate whether the proposed opportunity is cost effective.

Decision Analyses often encompass uncertainties, for example:

- Does the company want to be a leader/follower on the Clean Air Act?
- Will employees be productive in the work-at-home environment?
- Does the remote access compromise our office systems security?

Next Steps

The organization decides to conduct a six month pilot program with three employees to test the feasibility study. Depending upon the size of the organization, the next step would be to:

- Consult with in-house technical staff in either, or both, the computer and communications areas.
- Consult a third-party telecommunications provider or consulting company.

Further information on example solutions, services, and products are covered in Sections 3, 4, and 5.

2.2 Video And Multimedia Conferencing Feasibility Illustration

A college explores the opportunity to provide some coursework electronically between main and satellite campuses and between campus and corporate sites. To make the best decision, the college will prepare a feasibility study. This section outlines the study.

The Opportunity

A growing number of educational institutions are exploring videoconferencing as an option for providing distance instruction. As in the previous feasibility study, social, economic, and environmental changes provide the impetus to add this form of conferencing to existing instructional options.

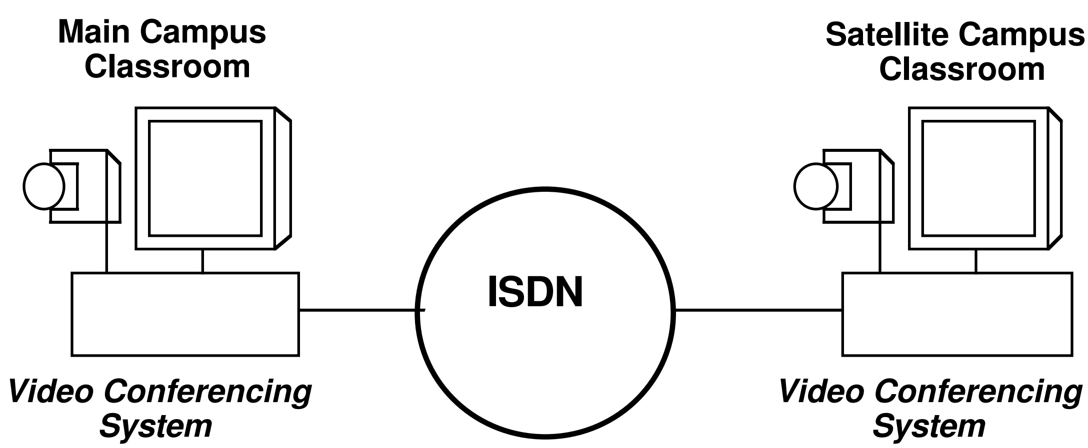
The college needs to respond to the need to:

- Reduce air pollution in sprawling urban and suburban settings. New regulations mandate that companies support programs to help reduce the number of cars on the road.

- Distribute scarce or unique instructional resources and expand collaboration with sister institutions.

- Establish satellite campuses to expand student populations served as an alternative to reduction in force (RIF).

The instructor/student needs access to "face to face" classroom meetings, to the college's host computer, campus network, file servers, and print services, and library/information resources.



Institutional Requirements

As they inspect their campus environment, the college needs to identify one or two academic disciplines, potential faculty participants, potential courses and evaluate individual and college requirements necessary for the success of the project. For example:

- Easy-to-use videoconferencing solutions between campus and satellite campuses (or corporate satellite sites), as shown in the figure above

- Support for voice, video, and data communications

- Provide the same "face to face" atmosphere and ability to use audiovisual facilities for the instruction, e.g., computer, laser disc, CD ROM, and overheads

- For distance instruction via interactive videoconferencing to be a success, the overall quality of the instruction should be deemed equal to an on-campus in person classes by the faculty, students, and the administration. Additionally, this option should be seen as an opportunity to increase the number and type of courses offered.

Technical Options

ISDN, and the videoconferencing options that it can support, are well suited to answering this set of conferencing needs. Technical solutions are presented in Section 3. See solutions 3.1.9 through 3.1.11, and 3.3.5 through 3.3.8. See Section 4 for product information, and Section 5 for additional technical information on video communications.

Call the local telephone company's business sales office to ascertain the availability of ISDN in your area and the area of the satellite campuses.

Benefits and Costs

The college assigns a value based on measurements both subjective and objective and the experience of the organization. The costs of implementing this solution are estimated, as illustrated below:

1. Hard/soft Benefits:

    - improved productivity for 30% of the faculty/students affected *

    - reduction in time/dollars required for student travel to campus or faculty travel to satellite campus of 50%

    - ability to serve wider audience of students of 14%

    - increased student customer satisfaction of 15%

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* The numbers shown are hypothetical, and are not based on any actual study.

- courses and information resources could be available to all students without regard to geography, distance, resources, or disability.

2. Costs (including non-recurring, monthly, and pay-back period):

   - Satellite campus equipment increases this year's Capital Equipment costs by 6%.

   - Installation charges, usage fees, and user training add non-recurring costs of 7% of the yearly media center budget.

   - Long distance charges will add 15% to the yearly academic computing/continuing education expense budget.

The reader can compare this illustration with the extensive list of potential benefits and costs of ISDN-based solutions as presented in Section 2.5.

Based on these anticipated costs and benefits, the decision makers can evaluate whether the proposed opportunity is cost effective.

Next Steps

The college decides to conduct a semester-long pilot program with three faculty teaching three courses from one academic department to test the feasibility of this solution.

- Consult with in-house technical staff in telecommunications, media, and academic computing areas.

- Consult a third-party videoconferencing provider or consulting company.

Further information on example solutions, services, and products are covered in Sections 3, 4, and 5.

2.3 The Status of Interoperability

Investment in new services for enterprise applications may reveal the need to introduce long-term viewpoints as part of one's immediate decision. ISDN technology is evolving, leading to multi-media access and integration of services, interfaces and networks. This section introduces general technical trends toward interoperability that decision makers may consider as part of their analysis of ISDN.

Some of the long-term benefits of interoperable solutions include:

- The ability to communicate with others using integrated voice, data and video

- More product choices

- Flexibility
- More competition
- Barriers to entry for developers are based on performance and quality
- Lower prices

The drawbacks to interoperability can include extended development cycles, because of the standardization process, or multi-vendor conformance testing.

A study of long-term trends and benefits are separate from the solutions in the NIUF Catalog. However, some of the long-term factors that are relevant to the maturing ISDN state-of-the-art are depicted in the following items in general terms.

2.3.1 Compatible End Systems that use ISDN

The compatibility of the end-systems that connect to ISDN for moving voice, data, and video is of paramount importance in the long run. Today however, many products are incompatible, and will only work with equipment from the same company. There are a variety of standards in use now, which are growing in importance and are escalating the number of multi-vendor compatible implementation agreements. The following topics highlight the degree of compatibility that a customer can achieve today with ISDN.

Compatible Multiplexing

Many applications require more bandwidth than a single B channel at 64 kbps can provide. For example, depending on user requirements, videoconferencing can run on ISDN at 128 kbps (2 x 64), or higher (n x 64) combinations. Similarly, to send information, a router with a high speed serial interface will need to split its data stream over multiple lower speed channels and to forward information, it will recombine these separate lower speed channels back into the original. The function of splitting and combining is referred to as inverse multiplexing.

There are several ways to create a single multiplexed wideband channel from multiple 64 kbps channels. (Section 5.1.9 presents additional details.)

- The end-systems can provide inverse multiplexing. In this case, the communicating systems must implement a compatible inverse multiplexing protocol. In the United States, the major manufacturers of inverse multiplexers all support a common specification, referred to as BONDING, for the Bandwidth ON Demand INteroperability Group. Bonding has been implemented and tested among these companies.

- The network can provide "N x 64" services. In this case, the end-system requests the channel size it needs from the network when setting the connection. N x 64 services are referred to as SWF-DS1 (for "switched fractional DS-1"), or Multirate ISDN . Multirate is part of the Primary Rate Interface in National ISDN 2. If using SWF-DS1 , inverse multiplexing functionality is not necessary. (A connection to the PRI is still required, for example, through a PBX or multiplexer.)

- Some end user equipment may use multilink procedures to provide communications at rates greater than 64 kbps. This technique involves establishing multiple 64 kbps (or 56 kbps) circuit data links across the network and sending independent units of data (packets) over the links without recombining and reordering them into a higher bandwidth data stream at the network layer. This technique works well for applications which can handle the potentially out-of-order packets at a higher layer. Multilink procedures are becoming common in LAN connectivity products. There is a discussion of the interoperability efforts of LAN product suppliers in Section 2.3.3.

Compatible Rate Adaptation

Rate adaptation is the process of adapting lower rate data streams to the 64 kbps ISDN B-channels. For example, IBM and compatible personal computers can connect to ISDN through their serial port, just as they would connect with a modem. If the PC hardware has a maximum data rate through the port at 19.2 kbps, but the ISDN circuit-data connection runs at 64 kbps, there is an engineering problem, how do you rate adapt 19.2 kbps within 64 kbps, and what does the resultant data look like? In order to work together, the CPE at each end of the connection must adjust their rate adaptation protocol - use the same mechanism for normalizing the flow of data in a sea of incoming bits.

Both standard and vendor proprietary rate adaptation procedures are available. The standard procedures that are must commonly used with ISDN are V.120 and V.110. DMI, T-Link, and Telrad are examples of vendor proprietary procedures in use today.

Compatible Multimedia Systems

For videoconferencing to take place over phone lines, the conferencing systems at each site must work together to perform a variety of tasks:

- Video and audio input and output

- Video signal compression, coding and decoding
- Audio signal compression, coding and decoding
- Multimedia call control
- Separating the components of the multimedia signal (audio, video, and data) into subchannels
- Splitting and recombining the packaged information to/from multiple 64 kbps channels - inverse multiplexing

The H Series defines international standards for all these aspects of a conferencing system. ANSI standards corresponding to the H series are in draft form.

All major videoconferencing system companies have announced support for the H-Series. However, many manufacturers have proprietary solutions available as well. Users need to check with manufacturers to find out which products interoperate.

There are additional video and imaging encoding standards. JPEG (for Joint Photographic Experts Group) is an international standard (from ISO) for still image coding. JPEG is used in desktop multimedia still image systems. MPEG (for Moving Picture Experts Group) is an international standard for motion video coding. MPEG is suited for one-way transmission, and runs at 1.5 Mbps. Since it is one way, it is not widely applied for conferencing.

JPEG and MPEG codecs are implemented on chips for use as components in multimedia systems. Signals encoded through these standards are treated as "data", and can be transmitted over ISDN in that fashion.

2.3.2 National ISDN

Beginning in 1992, telephone companies and network switching system manufacturers committed to provide standard ISDN services. This commitment is called National ISDN. National ISDN specifies the way that telephones and computers - Customer Premises Equipment (CPE) - communicate with the ISDN network. The National ISDN agreements ensure that each central office switch operates in a standard way, providing a uniform interface to CPE. With National ISDN conformance, a phone, for example, will work on any type of National ISDN switch and will interwork with the analog public network.

For some customers without National ISDN, such as those who began using ISDN before 1993, there can be some minor variations in the service they receive, depending on the brand of central office switch that provides their service. These variations can affect CPE configurations, but generally, these customers can place ISDN calls to other ISDN customers, as well as to analog phones.

National ISDN 1

National ISDN is being deployed in phases. National ISDN 1 (NI-1), the first phase, provides a uniform implementation of the Basic Rate Interface, key supplementary services, and switch-specific PRI. NI-1 equipment will be compatible with newer NI phases.

NI-1 was showcased at TRIP '92, a nationwide demonstration, in November of 1992. Most major local telephone companies now offer National ISDN 1 service. Services that are switch-specific, pre-standard ISDN, are also still supported by some service providers. A Special Report from Bellcore, SR-NWT-002102, *ISDN Deployment Data,* presents detailed (NPA-NXX based) information from individual LECs on their planned deployment of ISDN. It contains information about planned SS7 deployment, and it includes some Interexchange Carrier (IXC) planning information for interconnection between exchanges.

National ISDN 2

National ISDN 2 is the second set of implementation agreements between service providers and switching system manufacturers. It extends the features that are available in a uniform way across switches from different manufacturers. The major additions are a uniform Primary Rate Interface (PRI), and uniform service feature operation. Most service providers plan to deploy National ISDN 2 initially at the end of 1993, with general availability in 1994. National ISDN 1 products will migrate to National ISDN 2 without change, as will the compatible operation and interworking permitted by NI-1.

National ISDN 3

National ISDN 3 is the planned third step in the introduction of uniform ISDN services. The included features will be finalized in '93 with general availability in '95. An increasing level of features will complement the prior features while providing increased uniformity, compatibility and interworking of end-to-end NIUF Catalog Solutions.

2.3.3 Internetworking

The prior sections looked at compatible solutions using only ISDN, this section considers connecting different "subnetworks". In general, internetworking is the problem of enabling different incompatible subnetworks to perform together to provide a harmonious end-to-end transport backbone for the access of the "compatible" devices that we explored in Section 2.3.1. Several important open approaches to internetworking with ISDN are considered here.

TCP/IP and ISDN

TCP/IP is a Transport Layer protocol and stands for Transmission Control Protocol/Internet Protocol. The TCP/IP model is a widely used set of protocols for computer communications. TCP/IP is used on the Internet, a government supported international network connecting colleges, research institutions, corporations, and individuals, and on many multivendor campus and corporate data networks. The Internet Engineering Task Force (IETF) defines protocols in the TCP/IP world.

The IETF is currently working on protocols for carrying IP datagrams on ISDN. Specifications are complete for carrying IP datagrams on X.25 and ISDN packet data. The group is currently formalizing the method for carrying IP datagrams on ISDN circuit-data.

OSI and ISDN

Open Systems Interconnection (OSI) is the name of a collection of international standards for computer communications. The federal government has endorsed OSI, and has established as a goal that federal agencies purchase computer communications systems that use OSI protocols. Specifications for federal government OSI protocols are established in OSI Implementation Agreements and Profiles. In the United States, important profiles are GOSIP, the GOvernment Open Systems Interconnection Profile, and IGOSS, the Industry/Government Open Systems Specification. The OSI implementation agreements and profiles include interworking with D channel packet-data and B channel packet-data.

An ISO Draft International Standard is complete for sending datagrams over circuit data on the B channel. When standardized, work will proceed on implementation agreements and inclusion in the GOSIP and IGOSS.

ISDN-LAN Bridges and Routers

Routers and Bridges are generally used to connect together smaller subnetworks to build larger enterprise-wide internets. For ISDN, bridges are often used to provide access for a single user to the enterprise network. Several companies make bridges and routers for ISDN. Today, most will only operate if connected to another half bridge from the same manufacturer.

Major manufacturers of ISDN-LAN Bridges and Routers are working on an interconnection standard. The manufacturers plan to demonstrate interoperability based on guidelines proposed in the NIUF.

2.3.4 Interoperable Applications

Interoperability means that applications can work across dissimilar sub-network protocols and media, i.e. LANs, MANs or WANs.

The keys to interoperability are standards and implementation agreements - industry agreements that are publicly disclosed, which specify how some aspect of how information systems communicate with each other. Ideally, each standard solution is implemented by a variety of vendors.

The forward vision of interoperable solutions that encompass applications, services, and multi-media is a continuing challenge to the telecommunications industry as a whole, including ISDN and its users. The long-term benefits that result from interoperable solutions are numerous, and are outside the scope of this catalog. However, the NIUF has been dedicated towards these goals from its inception in 1988. The following topics are pivotal in order to achieve interoperable, portable and seamless application networking over ISDN services and protocol platforms.

The Annex presents additional information on the activities of the NIUF.

North American ISDN User's Forum (NIUF) Profiles

An NIUF Application Profile defines, in functional terms, a user's requirements for an application. Products that meet the profile specification use consistent hardware, software and service interfaces (specified by the profile) to guarantee the way in which the product behaves.

By meeting the profile, products from different vendors can work together, that is, interoperate across an intervening network. The scope of profiles can encompass applications, including application protocols. A Profile is the equivalent of a set of NIUF "blue prints" which must be "realized" with a particular set of service provider "bill of materials" in order to fulfill the user's networking expectations. All vendors who want their products to comply will answer the detailed questions posed in the profile. These "conformance" responses must be verified by the external behavior of their products to assure open, interoperable applications.

NIUF work on the following profiles is nearing completion. They will be stable specifications based on completed standards when implementation agreements are completed by the NIUF.

- Secure voice mail
- Engineering workstation interface
- Data conferencing--point to point (i.e., between two people)
- Data conferencing--multipoint (i.e., between more than two people)
- Unified message notification (e.g., to light the lamp on a phone from any messaging system)
- Building controls (for heating, lighting, security)

- Incoming call management (customer service agents)
- Messaging and answering
- ISDN telephone workstation integration
- Remote agent (customer service agents).
- ISDN station event recording.

After profiles are stabilized, vendors who choose to do so can begin the process of conformance toward interoperable applications.

Application Software Interfaces

Given Application Profiles that may ensure the interoperability of multi-vendor products, the remaining question is the degree of compatibility of the underlying vendor's features or platforms, etc., which each employs as "subsystems" within their "interoperable" product. Early on, the NIUF recognized that users' investments in premise devices or equipment would become rapidly obsolete as each vendor changed their subsystem or product interface specifications--whether caused by the adoption of different hardware, software, features or standards.

The NIUF also recognized that each vendor's BRI terminal interface - enabling end-user interplay with the provider's ISDN services - was different, not because of ISDN protocols or electronic interfaces; but, because of vendor-specific hardware and/or software, adapters, drivers, or function libraries. In the performance of the CPE-to-ISDN communications, these proprietary CPE-to-ISDN convergence mechanisms were vital in order to provide an efficient end user programmable ISDN service interplay.

The result of the NIUF's endeavors to produce one unified set of CPE-to-ISDN "convergence mechanisms" is called the Application Software Interface (ASI). The reader will find more technical-oriented overview material on ASI in the ANNEX.

2.4 Additional Information - A Generic Model for ISDN Cost Analysis

This section presents the report of the NIUF Cost Justification Working Group, "A Generic Model for ISDN Cost Analysis", February, 1993. The complete report is available from the NIUF Secretariat. This report is intended to help the decision maker conduct a cost/benefit analysis of ISDN for their situation by providing a framework for evaluation.

I. Introduction

In evaluating the use of ISDN in a business setting, users should compare the costs and benefits of their present method of operation with ISDN. The users will then be empowered to fiscally decide whether ISDN makes sense for their particular situations.

The benefits of an ISDN BRI line generally increase with the more applications serviced by a single BRI. Break-even results will vary as a function of costs and savings per application. Users are encouraged to analyze their individual applications based upon their unique costs and benefits and work with their sales representatives in each telephone company to determine which costs would apply. Users should also incorporate cost/benefit elements over a realistic system life cycle, typically five to seven years, to obtain an accurate view of lifetime system costs.

II. Checklist for Cost Analysis Elements

A checklist has been developed which indicates the general elements which should be considered, in these categories: hard and soft dollar benefits, costs eliminated or avoided, costs of ISDN, and soft benefits. Users are encouraged to quantify "soft" dollar savings as well as actual costs and benefits of ISDN. While these checklists include the typical costs and benefits associated with ISDN, users should consider their particular implementation and situation to include all other potential costs and savings. Since multiple applications will decrease the cost/performance ratio, users should determine the incremental costs/benefits of add-on applications, as well as the ratio for the initial application. The checklists shown in Figure 1 indicate potential costs and benefits of ISDN.

Figure 1: ISDN Cost/Benefit Checklists

Hard/Soft Benefits

Faster data rates compared to modems

New telephone set and terminal functions

Access to packet data transfer

Transparent Switch/Automatic Call Distributor networking

Calling number identification

Intelligent access and call control

Faster call set-up and disconnect

Reduced time in call answer/forward

Increased call completions

Reduced queuing

Reduced agent keystroke time

Faster information access

Increased customer satisfaction

Improved data accuracy

Reduced time/dollars required for travel/messenger service

Improved productivity

Network-wide call management service

Costs of ISDN (including one-time, monthly)

New wiring (if necessary)

Wiring design and certification (if necessary)

Contract termination charges (as applicable)

Network termination equipment

Telephone sets and office equipment (Terminal Adapters, etc.)

Training (users, technicians, MIS)

Basic service and usage charges

Installation charges

Special services charges (tie trunks, etc.) (if necessary)

Costs Eliminated/Avoided

Service charges

Equipment

Cabling

Salaries

Floor space

Environmental costs

Electrical

Maintenance

Moves and changes

III. Cost Analysis Spreadsheet - Generic Model

A generic spreadsheet has been developed based on the NIUF checklists which incorporates elements of standard financial analysis. Users should perform this analysis for both the present method of operation and ISDN to obtain the most accurate view of the incremental costs and benefits of ISDN. This spreadsheet is included in the ANNEX, Section A.8. Similar models have been developed by other organizations. For more details, see the complete report (available from the NIUF Secretariat) and the Bibliography.