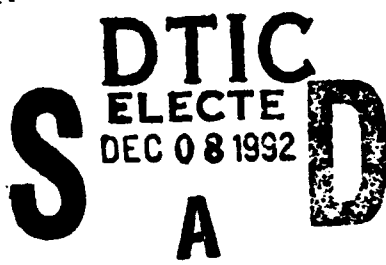


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Public reporting burden for gathering and maintaining this collection of information, in Davis Highway, Suite 1204, A		se, including the time for reviewing instructions, searching existing data sources, tion. Send comments regarding this burden estimate or any other aspect of this ers Services, Directorate for Information Operations and Reports, 1215 Jefferson Paperwork Reduction Project (0704-0188), Washington, DC 20503	
1. AGENCY USE ONLY		2. REPORT TYPE AND DATES COVERED	
1992		THESIS/DISSERTATION	
4. TITLE AND SUBTITLE Implementing ISDN: A Case Study of the U.S. Legion		5. FUNDING NUMBERS	
6. AUTHOR(S) Herbert H. Oakes, Jr., Captain			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AFIT Student Attending: University of Colorado		8. PERFORMING ORGANIZATION REPORT NUMBER AFIT/CI/CIA- 92-092	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFIT/CI Wright-Patterson AFB OH 45433-6583		10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release IAW 190-1 Distributed Unlimited ERNEST A. HAYGOOD, Captain, USAF Executive Officer		12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)			
 DTIC ELECTE DEC 08 1992 A D 92-31044  012200 209px			
14. SUBJECT TERMS		15. NUMBER OF PAGES 207	
		16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

Title: IMPLEMENTING ISDN: A CASE STUDY OF THE U.S. LEGION

Author: HERBERT H. OAKES, JR., Capt, USAF, 1992

Number of Pages: 207 (including title page, table of contents, etc.)

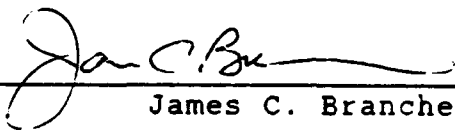
Degrees awarded: Master of Science in Business Administration/
Information Systems and a Master of Science in
Telecommunications.

Institution: University of Colorado, Boulder CO.

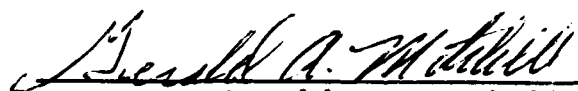
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DTIC QUALITY INSPECTED 2

This thesis for the Master of Science degree by
Herbert H. Oakes, Jr.
has been approved for the
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Implementing ISDN

Thesis directed by Assistant Professor James C. Brancheau

The lightning-fast pace at which new technology is being introduced is incredible. Today's managers are finding it increasingly difficult to evaluate all of the latest innovations. They are finding it even more difficult to successfully implement any of them. Integrated Services Digital Networks (ISDN) is a technology that has been around for a long while, but it is only now being evaluated and implemented in significant numbers. This thesis discusses some of the key implementation issues that affect the deployment of ISDN in a corporation.

The research is split into three sections. The first section covers the technology aspects of ISDN. It also discusses some of the current issues and misconceptions regarding ISDN. The second section provides an in-depth case study of a Department of Defense (DOD) organization. It covers their organizational structure, procedures, communications plans and also includes some employee interviews. The last section analyzes the case study. First the findings are summarized, then the DOD agency's ISDN implementation is examined using the innovation diffusion theory.

The final analysis is that ISDN, if implemented correctly, can be an effective solution for some problems. It cannot fulfill all communication requirements (regardless of what the promotional hype has led people to believe), but it can satisfy many of them.

Dedication

To my wife Kathy,
I couldn't have made it without you.
I love you.

DISCLAIMER

The views, opinions, and/or findings herein are those of the author and do not necessarily reflect those of the U.S. Department of Defense or any other official governmental office. This document should not be construed as an official Department of Defense position or policy unless so designated by other official documentation.

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Implementing ISDN: A Case Study of the U.S. Legion

by

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A thesis submitted to the
Faculty of the Graduate School of the
University of Colorado in partial fulfillment
of the requirements for the degree of Master of Science
Management Science/Information Systems
1992

Chapter 1

Introduction

Few things have had as much effect on the shape and conduct of business (and our lives) as the recent advances in telecommunications. Telecommunications has shrunk the world into one large community. A single manager can now effectively manage several different divisions all over the world. Telecommunications links give her the up to date information that she needs to make decisions and then disperse directives to the appropriate people. In other words, telecommunications provides the reins of Command.

Demand for telecommunications has been growing as rapidly as the demand for computers. As technology in both of these industries advances (particularly the chip and data storage technologies), the demand grows even more¹. The existing analog telecommunications infrastructure could not meet the mass requirements of modern organizations. Some large companies required data rates of 100 or more megabits per second (mbps). The best analog connectivity provides is advertised at about 19.2 kilobits per second (kbps), although most testing indicates actual throughput of only 8-10kbps.² Telecommunications professionals knew that current analog

¹ Carroll Frenzel, Management In The Information Age. (Under contract to Boyd & Fraser Publishing Co., 1991), Chapter 5, p.4.

² Rick Maiden, Data Applications In An ISDN Environment. (Telecommunications Thesis, 1989), p.4.

systems could never meet these high throughput demands and envisioned a digital infrastructure instead; hence, the birth of ISDN.

The Integrated Services Digital Network (ISDN) is a project sponsored and controlled by the Comite Consultatif International Telephonique et Telegraphique (CCITT). They define ISDN as follows:

A network, in general evolving from a telephony Integrated Digital Network, that provides end-to-end digital connectivity to support a wide range of services, to which users have access by a limited set of standard multipurpose user interfaces³.

As this definition implies, ISDN is many things. In a nutshell, ISDN is an advancement to the local telephone loop that allows both voice and data to be carried over the same twisted pair. It is a fully digital network where everything is in a digital form. Voice, data, and video are all seen as bit streams by the switch. Therefore, everything can be multiplexed together and transported over the same transmission media and equipment⁴.

³ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.2.

⁴ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.4.

What Is ISDN?

Imagine coming into work and turning on your computer. All the necessary files needed for the day are automatically downloaded from the main corporate database in another state. Then as you are reading the E-mail, a message on the computer says your wife is calling.

While talking to your wife, another message pops up and states that your district manager is on the phone and wants to discuss yesterday's sales figures. You put your wife on hold as you discuss the topic with your boss augmenting the discussion with interactive graphics.

As you finish the conversation, your computer pops up two more messages. One states that your wife had to go and will call later. The second states that a call from a pesky salesman was automatically rejected. While all of this is going on, you have received a facsimile which is automatically being routed to your laser printer to make a hard copy. You also got an integrated voice and data mail message. As you listen to the message the accompanying data comes up on your screen, "Bob, as you can see, our sales did not meet the projections. I think we need to increase our advertising." ⁵

While this scenario may sound idealistic and futuristic, it could be a reality with the implementation of ISDN. More

⁵ This scenario was adapted from a Byte magazine article Duncanson and Chew, "The Ultimate Link?," Byte, July, 1988: p.278.

than 75,000 ISDN lines already exist today throughout the world. ISDN is here, and the capabilities listed above and the products to implement them are either already on the market, or on the drawing board.

Problem Statement

ISDN is a technology that has been around and advertised for several years, but is only now being implemented in any great numbers. There are many misconceptions about ISDN and the users are confused on where and how to use it. The problem is to identify the communications requirements that ISDN can fulfill and then successfully implement it to solve those requirements.

Thesis Purpose

The purpose of this thesis is to identify some key factors that will help successfully implement ISDN. The thesis will examine the technology and its current state of deployment in the United States. It will also examine in-depth the ISDN implementation of one organization and attempt to identify what they did right and wrong.

Method

This thesis is part of the Emerging Technologies Research Program at the University of Colorado. The objective of this program is to identify the critical success factors that a manager needs to control to successfully implement a particular technology.⁶ To do this, each member performs an in-depth case study of an organization that is implementing their chosen technology. Eventually, when enough case studies have been performed, the Emerging Technologies Research Program will have sufficient data to draw accurate conclusions on how to successfully implement a technology.

I chose to do a case study on a military organization which I refer to as the "Legion." Information for the case study was gathered from three sources: Interviews, a planning meeting, and company publications (e.g. regulations, pamphlets, manuals, reports, etc). Except for one telephone interview, all of the interviews were conducted face to face.

The case study revealed many problems that organizations face when implementing an interactive media technology. It indicates that unless an implementation plan is designed to

⁶ Dana J. Barnes, Bonnie K. Buckland, and James C. Brancheau, Methodological Issues in Emerging Technologies Research: Experiences and Recommendations, Hawaii International Conference on System Sciences faculty working paper (September 1991), p. 1.

deal with the unique issues technologies like ISDN present, it will fail.

Thesis Organization

Chapter 2-4 provide details on the ISDN technology and the organizations that govern it. Chapter 5 presents the current state of ISDN deployment in the United States. It also discusses some of the difficulties involved in marketing ISDN. Chapter 6 describes the research methodology used in performing the case study. Chapter 7 provides some background on the Legion and their procedures. Chapter 8 details the Legion's ISDN implementation. Chapter 9 summarizes and analyzes the data from the interviews. Chapter 10 compares the Legion's ISDN implementation to two models of innovation diffusion. Chapter 11 concludes the thesis and provides my thoughts on how to successfully implement ISDN.

Chapter 2

ISDN and Its Standards Organizations

ISDN is not a specific technology or service, but rather a set of international standards that describe the advanced digital networking capabilities that will be available on the public telephone network. The CCITT and its member groups have worked to adopt international standards for ISDN to give it the ability to interconnect anywhere around the world. The following are some of the principles the CCITT developed for the ISDN standards⁷:

- 1.1 The main feature of the ISDN concept is the support of a wide range of voice and non-voice applications in the same network. A key element of service integration for an ISDN is the provision of a range of services ... using a limited set of connection types and multipurpose user-network interface arrangements.
- 2.2 ISDNs support a variety of applications including both switched and non-switched connections. Switched connections in an ISDN include both circuit-switched and packet-switched connections and their concatenations.
- 1.3 As far as practicable, new services introduced into an ISDN should be arranged to be compatible with 64kbps switched digital connections.
- 1.4 An ISDN will contain intelligence for the purpose of providing service features, maintenance and network management functions. This intelligence may not be sufficient for some new services and may have to be supplemented by either additional intelligence within the network, or possible compatible intelligence in the user terminals.

⁷ "Integrated services digital network (ISDN), recommendations of the I series." CCITT Red Book, Vol. III, Fascicle III.5, Recommendation I.120, p.27.

- 1.5 A layered structure should be used for the specification of the access to an ISDN. Access from user to ISDN resources may vary depending upon the service required and upon the status of implementation of national ISDNs.
- 1.6 It is recognized that ISDNs may be implemented in a variety of configurations according to specific national situations.

When fully implemented ISDN will enable many services to be provided to customers. The following are some of the applications ISDN will offer or enable:⁸

a. Circuit-Switched Data: The simplest data application over ISDN is circuit-switched connectivity using a B-channel (described later). This is similar to using a plain old telephone service (POTS) line, where the user seizes a line via a modem, and the line would remain seized for the duration of the call. The main advantage of ISDN over POTS in this service is the data rate. An ordinary ISDN line can support a data rate of 64kbps where an ordinary POTS line can only support a data rate of about 9.8kbps.

b. Packet-Switched Data: This application can use either B-or D-channels (described later). The information is grouped into packets which are individually addressed. These packets are routed through the central office and use whatever path the intelligent network considers best at that time. This will help keep high capacity lines from sitting idle between sporadic bursts of

⁸ Fred R. Goldstein, ISDN in Perspective. (Addison-Wesley Publishing Company, 1992), pp.97-120.

use. Packet switching also allows a user to have multiple connections over a single channel.

c. Central Office Local Area Network (LAN):

Several PCs can be "hooked" together via ISDN to serve a number of purposes (for example sharing a laser printer or communicating over E-mail). LANs via ISDN have an advantage over traditional LANs because they use existing telephone wires (i.e. no coaxial cable). However, for applications that require greater than 64kbps speed (e.g. CAD workstations) ISDN, currently, is not appropriate.

d. Multiplexing: Up to eight terminals can be multiplexed onto a single ISDN Basic Rate Interface Line.

e. Modem Pooling: There is a necessity to communicate outside of the ISDN world. To do this, modems are required. The number of modems required, however, can be minimized by putting them at the Central Office. This enables many users to share the modems for both outgoing and incoming connections.

f. Enhanced Call Management: ISDN enables the user to handle calls more efficiently. Some of the better known services in this category are automatic number identification (ANI), conference calling, call hold, call transfer, call forwarding (unconditional, on no answer, or on busy), and multilevel precedence and preemption.

g. User-to-User Information Signaling: This allows the users to pass brief messages via the D-channel. For example, say a caller was put on hold. He could send a

brief message to let you know how urgent the call was, or he could say that he would call later.

h. Voice Quality Improvements: the 64kbps rate could allow a much greater bandwidth to be passed (about 7KHz). While this may not mean much on a normal conversation, it would vastly improve special applications such as speakerphones.

i. Simultaneous voice and Data: With the BRI, two users can view the same image and converse on the contents. For example, say a customer calls her broker. Through ANI, the broker automatically knows who she is and pulls up her file on the computer. The broker could then send pertinent information and graphs to the customer and discuss why she should buy a particular stock.

j. Telefax 4: This service allows Group 4 Facsimile machines to transmit documents at 64 kbps. It can provide four levels of resolution, 200X200, 240X240, 300X300, and 400X400. This service is much faster than normal facsimile machines. In fact, the printing typically takes longer than the transmission.

Developing ISDN so that it can perform all of this functionality is not an easy or quick task. It has taken the scientists and engineers many years to create the technology that allows ISDN to operate. In addition to the technical aspects of ISDN development, there have also been political aspects. Many different organizations from different countries had to negotiate and agree on what ISDN should do,

and how it should do it. The following discussion describes some of the processes and organizations that developed ISDN.

ISDN Standards Organizations

The development of ISDN standards, like any standardization effort, is as much a political process as it is a technical process. There are many organizations with their own (and sometimes conflicting) agendas. They each try to influence the ISDN international standards in a way that best meets their own personal requirements. All of these inputs get thrown together and hashed out until eventually form the final ISDN standards. This section presents some of the key organizations and their processes that influence the evolution and deployment of ISDN.

International Telecommunications Union (ITU): The ITU has been around since 1865. It is an international organization headquartered in Geneva with 157 member nations. It is a United Nations government treaty organization, and only national governments may be members. However, private agencies (e.g. AT&T) and scientific organizations may participate in many of the proceedings.⁹ The ITU is responsible for regulating, planning, coordinating, and

⁹ Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications, (Prentice-Hall Inc.), p. 158.

standardizing international telecommunications. Their objectives are as follows:¹⁰

- a. Maintain and extend international cooperation for the improvement and rational use of telecommunications.
- b. To promote development of technical facilities and their efficient operation, so as to improve telecommunications services; increase usefulness, and make them more available to the public.
- c. Harmonize the actions of nations in attainment of these goals.

Originally, the process of adopting recommendations was fairly lengthy. It started when one of the ITU's subcommittees provided an initial draft recommendation. It was then debated and researched for about four years. At the end of four years, the ITU either accepted or rejected the recommendation or put it back into committee for another four years. Fortunately, they have speeded this process up to about two years by cutting out some of the unnecessary steps. Regardless of which method, the final decision to adopt is usually by a majority vote at what is called a Plenary Assembly. But, since the ITU recommendations are non-binding, a country does not have to accept any of the recommendations. This can be a problem for international interoperability. It often leads to many awkward solutions

¹⁰ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 14.

to interface with countries that did not choose to implement the international standard.¹¹

CCITT: The CCITT is a permanent committee of the ITU. This is the principal organization responsible for developing international ISDN standards. CCITT recommendations focus on the end-to-end performance, interconnection, and maintenance of the world's telephone, telegraph and data communications networks.¹²

The goal of the CCITT is to produce recommendations. These recommendations are formally adopted (or not) at the Plenary Assemblies. The CCITT ISDN Recommendations that were adopted in 1984 are printed in the I-Series recommendations which are incorporated into volume III of the CCITT "Red Books". The recommendations that were approved in 1988 are in the CCITT "Blue Books".

The U.S. member on the ITU and CCITT is the Office of International Communications Policy, Bureau of Economic and Business Affairs, U.S. Department of State (DOS). When deciding on CCITT policies, the DOS has an Executive Order to confer with both the Federal Communications Commission and the National Telecommunications and Information Administration (NTIA). The NTIA is an Executive Office organization and provides the President's views on how CCITT

¹¹ Fred R. Goldstein, ISDN in Perspective. (Addison-Wesley Publishing Company, 1992), pp.97-120.

¹² ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 17.

policy should be guided. More and more, the DOS also confers with the private sector via organizations like the Exchange Carriers Standards Organization.¹³

International Organization for Standardization (ISO):

The ISO is a non-treaty voluntary organization dedicated to the development, coordination, and promulgation of international standards.¹⁴ The ISO is comprised of the national standards bodies of all countries. This body should be the organization which best represents the interests of their respective country. The United States' (U.S.) member of the ISO is the American National Standards Institute.¹⁵ The ISO collaborates with the CCITT on ISDN (and other standards) to help assure that the users' needs are met.¹⁶

Federal Communications Commission (FCC): The FCC is the U.S. governmental agency that is responsible for telecommunications regulation. It is this agency which is primarily responsible for overseeing ISDN evolution in the U.S.¹⁷ The FCC is an independent regulatory agency that reports directly to the Congress. Basically, as long as it

¹³ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 36.

¹⁴ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 20.

¹⁵ Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications, (Prentice-Hall Inc.), p. 164.

¹⁶ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 20.

¹⁷ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p. 34.

is within their scope of responsibility, the FCC can make their own laws and anyone in the U.S. that deals with any type of communications media must follow their regulations on communicating. Some of their responsibilities include the following:¹⁸

- a. Authorizes companies to provide common carrier services.
- b. Prescribes technical criteria for telecommunications systems and the rates that AT&T can charge.
- c. Certifies that equipment complies with FCC standards.
- d. Helps determine U.S. positions on international telecommunications issues.

American National Standards Institute (ANSI): ANSI is a non-profit organization that acts as a focal point for nationally coordinated voluntary standards. Its members include companies, trade associations, technical societies, labor organizations, consumer organizations, and governmental agencies. In addition to aiding U.S. standardization, ANSI represents the U.S. in the ISO and the International Electrotechnical Commission (IEC). ANSI publishes standards after they have been approved by standards bodies like the Institute of Electrical and Electronic Engineers. ANSI then uses these standards in their roles on the ISO and the IEC.¹⁹

¹⁸ Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications, (Prentice-Hall Inc.), p. 164.

¹⁹ ISDN Sourcebook, (Information Gatekeepers Inc., 1991), p. 34.

Institute of Electrical and Electronic Engineers (IEEE):

IEEE is a well known U.S. professional organization. It holds many conferences on ISDN and publishes ISDN information in their IEEE Communications Magazine. Much of the IEEE information and guidance was and is used in developing the ISDN standards.²⁰

North American ISDN Users' Forum (NIU): The U.S.

standards organizations noticed a lack of user involvement in the development of ISDN. To encourage user participation in creating ISDN standards, the NIU was formed. The goals of the NIU are as follows:²¹

- a. To promote an ISDN forum committed to providing users the opportunity to influence the developing ISDNs to reflect their needs.
- b. To Identify ISDN applications, develop implementation agreements and to facilitate their timely harmonized implementation.
- c. To solicit user, product provider, and service provider participation in this process.

²⁰ ISDN Sourcebook, (Information Gatekeepers Inc., 1991), p. 45.

²¹ ISDN Sourcebook, (Information Gatekeepers Inc., 1991), p. 46.

Chapter 3

Narrowband ISDN

Narrowband ISDN (N-ISDN) is considered to be any of the ISDN interfaces or channels at rates of PRI or below. For the purposes of discussion, N-ISDN technology and capabilities are split into three parts. The first part discusses the ISDN reference configuration and architecture. This provides the overall structure of the ISDN network and describes the network interfaces. The second part details the ISDN protocols. This section shows how the ISDN network operates and communicates. The last part describes the common channel signaling system which is used by the customers to control and setup their calls.

ISDN Reference Configuration and Architecture

The ISDN architecture can be split into three major parts:²²

a. Interexchange Network (IEN): The IEN is the backbone of the public switched network. It includes the physical and logical components which connect the originating central office (CO) to the destination CO. The IEN provides a pipeline for customer information exchange. There are two

²² Hermann J. Helgert, Integrated Services Digital Networks, (Addison-Wesley Publishing Company, 1991), p.21.

types of IENs: Circuit switched networks and packet switched networks.

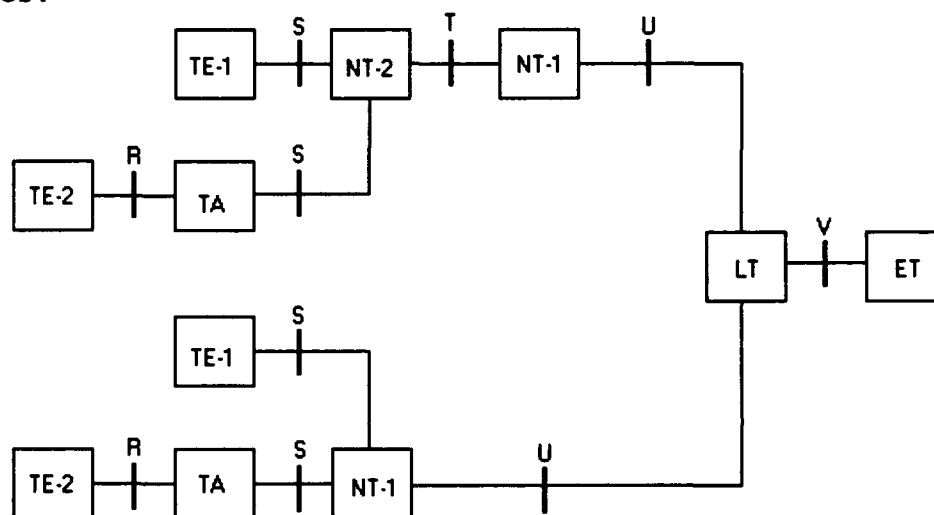
b. Common Channel Signaling Network (CCSN): The CCSN is used to signal, manage, control, and maintain the ISDN network and the rest of the public switched telephone network. Like the IEN, it also extends from the originating CO to the destination CO. Through the CCSN, the customer can apply sophisticated control to their connections while they simultaneously exchange user data. The CCSN will be discussed later.

c. Subscriber Access Network (SAN): The SAN extends from the CO to the end user. It has three basic portions. The customer premise portion includes those things that are under the direct control of the user. The local loop portion is the physical line that connects the CO to the customer portion. Finally, the Local exchange termination (LET) provides the logical termination point for the local loop.

SAN Configuration

To aid ISDN standardization, the CCITT has clearly defined a reference configuration (Figure 3.1). There are variations of this (e.g. combining the NT-1 and NT-2), but this is the basic one. There are many purposes to defining this reference configuration. First, it helps delineate the responsibilities between the network and the customer. Second, it splits the design into manageable pieces so that

manufacturers can design cost efficient equipment. Third, it defines the interface requirements so that manufacturers can build the equipment however they want (internally) as long as what they design can communicate with the defined ISDN interface. Finally, the division of entities allows each piece to evolve separately without disrupting the other pieces.²³



Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.23.

Figure 3.1 ISDN Reference Configuration

There are two main parts to the reference configuration: Functional groups and reference points. The Functional groups describe the capabilities of the SAN. Each of these usually corresponds directly to a particular piece of equipment. Their definitions are as follows:²⁴

²³ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.23.

²⁴ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.269.

- a. Exchange Termination (ET): This is part of the CO and provides functions such as signaling insertion and extraction, frame alignment, etc.
- b. Line Termination (LT): This is where the local loop is physically terminated in the CO. It performs tasks such as power feeding, loop back signals, baseband generation, etc.
- c. Terminal Equipment Type 1 (TE-1): This is an end user piece of equipment (e.g. phone) that complies with ISDN standards for an "S" interface. It performs tasks at all seven levels of the OSI reference model.
- d. Terminal Equipment Type 2 (TE-2): Same as TE-1 except that it does not comply with ISDN standards (e.g. RS-232) so it has to work through a terminal adapter.
- e. Terminal Adapter (TA): This converts TE-2 outputs to TE-1 outputs and visa versa. It works at OSI layers one, two, and three and is needed to interface TE-2 equipment with an ISDN network.
- f. Network Termination Type 2 (NT-2): This includes functions of OSI layers one, two and three. These functions include switching and concentration. It usually corresponds to a public branch exchange (PBX) or a Local Area Network (LAN).
- g. Network Termination Type 1 (NT-1): this is the boundary between the customer premises equipment (CPE) and the public network. In the U.S., the NT-1 is owned by the customer. It performs at OSI layer one and does tasks like baud rate conversion, four to two wire conversion, timing, power transfer, etc.

The CCITT also defined several reference points. These points describe how the different functional groups interface with each other:²⁵

²⁵ ISDN Sourcebook. (Information Gatekeepers Inc., 1991), p.6.

- a. The "R" interface is between TE-2 equipment and the TA. It could be any non-ISDN interface like an RS-232 interface, or an X.21, or an analog phone signal, etc.
- b. The "S" interface is an all digital interface which connects TE-1 and TA equipment to either of the network terminating groups.
- c. The "T" interface connects the NT-2 and the NT-1.
- d. The "U" interface is between the NT-1 and the local loop.
- e. There are several types of "V" interfaces. They define the internal CO ISDN interfaces.

Channels and Customer Interfaces

Two key components of the ISDN standards are channels and customer interfaces. The channels are the "conduits" through which the information flows. The customer interfaces are the grouping of channels that the telephone companies will provide (i.e. sell) to the users.

Channels: One of the most important facets of ISDN is the flexible allocation of bandwidth. While it is flexible, the allocation is constrained to pre-defined channels with fixed bandwidths (see table 3.1).

Table 3.1 Customer Interfaces

Channel	Purpose	Bit Rate
B	Bearer services	64kbps
D	Signaling and packet mode data	16kbps (BRI) 64kbps (PRI)
Ho	Six B-channels	384kbps
H1	All available Ho channels H11 (24B) H12 (30B)	1.536mbps 1.920mbps
H2	Broadband ISDN (proposed) H21 H22	32.768 mbps 43-45mbps
H4	Broadband ISDN (proposed)	132-138.240mbps

Source: Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.30.

The D-channel carries signals (e.g. dialing information) between the user and the network.²⁶ These signals describe the characteristics of the service the user is requesting (e.g. voice, data, data rate, etc.). Since it is unlikely that the entire channel is needed for signaling, the extra bandwidth can be used for the user's packet data. The D-channel operates at either 16 or 64kbps depending on the access interface (described later).

The Bearer-channel or B-channel is used to carry the user information.²⁷ No service requests from the user are sent on this channel. The B-channel always operates at 64 kbps and can be used for both circuit switching and packet switching applications.

²⁶ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.30.

²⁷ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.31.

The H-channels also carry the users information, but at much higher rates than the B-channel (see previous table). Broadband ISDN standards will define channels with even higher bit rates.

Customer Interfaces: The above mentioned channels have been grouped together to define standard ISDN interfaces. These interfaces provide the means for users to gain access to the network. Thus far, there are two interfaces defined (the Basic Rate Interface, BRI, and the Primary Rate Interface, PRI) and some loose guidelines for additional interfaces dealing with broadband requirements (described later).

The BRI is made up of two B-channels and one D-Channel, giving the user a total data rate of 144kbps. This interface will mainly be used in three ways:²⁸

- a. Provide ISDN connectivity between a residential user and the central office.
- b. Provide connectivity between the user and the central office in a small business environment, usually through a Centrex service.
- c. Provide connectivity between the user and an ISDN PBX in the business environment.

The PRI has a number of possible configurations. The most common in the U.S. is made up of 23 B-channels and one D-channel, giving the user a total data rate of 1.536mbps. Some H-channels can be superimposed on the PRI. This

²⁸ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.33.

flexibility would allow the business user to reallocate bandwidth to meet their immediate needs.

ISDN Layer Protocols

The ISDN protocols are a set of rules that govern the way ISDN operates. They were developed to comply with the lower three levels of the Open Systems Interconnection (OSI) Reference Model. Since these ISDN protocols are intended to define standards for the D-channel (user-network interfaces), there are no counterparts for the OSI four through seven²⁹. The following are the three ISDN layers:

- a. Layer 1 (physical layer): Describes the physical connection between the terminal equipment and the network. The connection is synchronous, serial and full duplex. It can be point to point or point to multipoint. The B and D-channels share the physical line by using time division multiplexing.
- b. Layer 2 (data link layer): This contains procedures to ensure error free communication over the physical link and defines the connection between the user and the network. It also defines rules for multiplexing multiple terminal equipment on a single channel.

²⁹ Gary Kessler, ISDN. (McGraw-Hill, Inc., 1990), p.65.

c. Layer 3 (network layer): Spells out the user network interface and signaling messages used to request services from the network.

Layer One

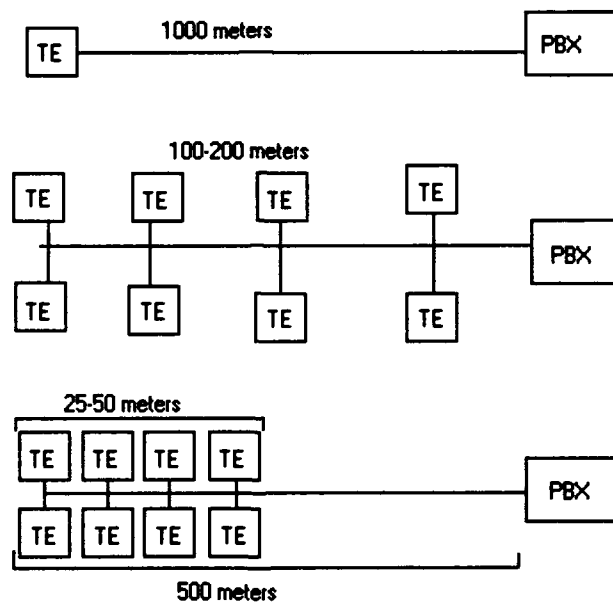
Generally speaking, the physical layer is responsible for passing the bits. The customer gets access to the physical layer either at the S or T reference points. Layer one performs at least the following:

- a. Multiplexing the channels to form the BRI or PRI interfaces.
- b. Encoding information for transmission.
- c. Activating and deactivating the circuit.
- d. Power feeding.
- e. Checking maintenance and performance.
- f. Performing D-channel contention procedures when a single D-channel is shared by more than one terminal.

BRI Layer One

There are two portions of layer one for the BRI: From the TEs to the NT-1 (customer portion) and from the NT-1 to the CO (CO portion). From the NT-1 to the customer, communications takes place over four wires. Several configurations are possible, each with their own distance limitations (see Figure 3.2). These distance limitations are

no problem to the average home, but they can easily be exceeded in a large building complex. To get around this, many corporations place several remote switching terminals in strategic locations or they put NT-1s near every user (see Figure 3.3). The distance limitation on a BRI U loop is 18,000 feet. There is no distance limitation on a PRI loop because it uses repeaters.



Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Pub. Co, 1991), p.23.

Figure 3.2 Possible TE configurations

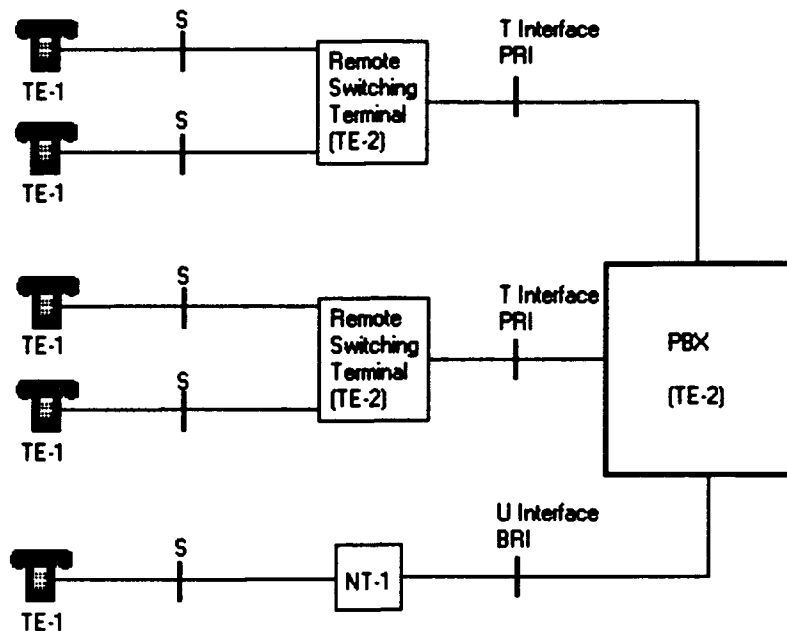
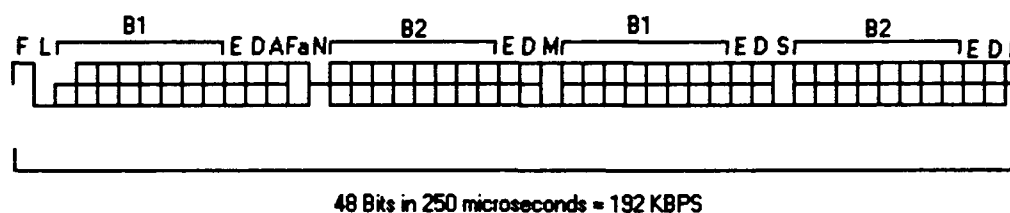


Figure 3.3 Alternate configurations

Power Supply: There are three options for supplying power to the end user's terminal equipment. Power can come from a local source (e.g. battery or commercial power), from the NT units, or from the central office over the U loop.³⁰ The most likely source will be the first option; however, this can cause a problem. The majority of ISDN phones will use a 110 volt outlet for local power. If a customer's power is lost, they lose their phone service as well. (The current POTS system provides power to the analog phones from the CO. Hence, local user power outages do not cause loss of phone service.) When vendors start supplying rechargeable batteries with the phones, this problem should go away, although the phones will be larger and will cost more.

³⁰ Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications. (Prentice-Hall Inc.), p. 92.

Customer Portion BRI Framing: At the physical layer, the users' information is grouped into frames. The frame from the customer TE is illustrated in Figure 3.4. The following lists the functions of the different bits:



Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p. 94.

Figure 3.4 BRI Frame

- a. The B1 and B2 bits are for user information on the B-channel.
- b. The D-Bits are for signaling and user information on the D-channel.
- c. The F bits provides frame synchronization. The A bit is for activation/deactivation.
- d. The M bit allows the user to identify frames that form a multi-frame.
- e. The L bit is used to get the average DC on the line to zero volts.
- f. The E bit is used to handle D-channel contention.
- g. The remaining bits are left for future expansion.

Customer Portion BRI Line Code: The line code from the TE-1 or TA to the NT device is known as pseudoternary. One bit of user information translates to 1 baud (line symbol). Zeros are pulses and ones have no voltage. To maintain the average line voltage at zero (or else the line transformers will become saturated), the polarity on the zeros is

alternated (e.g. +3v, -3V, etc). On frames where there is an even number of zeros, the voltages cancel out, so there is no problem (the L bit becomes a one). When there is an odd number of zeros, the L bit is used to counteract the voltage of the odd zero (the L-bit is set to zero).³¹

Frame alignment is accomplished through a bipolar violation in every 48 bit frame. The first two bits (F and L) are zeros. The next zero (either in the user data or the Fa bit if no zero occurs in the user data) has the same polarity of the first L bit (e.g. -3V, -3V). Hence, there is always a bipolar violation in the first fourteen bits of a frame.

D-Channel Contention: The ISDN standards allow for up to eight TE-1s or TAs to share a single BRI. Since the user must request a B-channel, there are no collision problems. If the line is busy, then they are denied access. The D-channel, however, is more like a LAN. Anyone can access it at anytime. Hence, there needs to be some kind of contention resolution procedure. Basically, these procedures work as follows:³²

a. If a terminal does not want D-Channel access, it transmits ones (zero voltage).

³¹ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.322.

³² Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.102.

b. A terminal that wants access must monitor the D-Channel and count 8-11 ones (depending on their priority) before they can transmit their message. There is no way to get this many ones in user data because of bit stuffing (discussed later). If they count the correct number of ones, then the terminal can begin transmitting.

c. Occasionally, two or more terminals try to transmit at the same time. This is where the E bit is used. The E bit transmits back to the users everything that is transmitted on the D-channel (like an echo). Once a transmission is started, a terminal compares the E bits to what it was transmitting on the D-channel. As long as the bits match, the terminal continues to transmit. As soon as there is a disagreement, the terminal that detects a difference stops transmitting and goes back to monitoring the D-channel. This works, because in ISDN, zeros kill ones. If one terminal transmits a zero when another transmits a one, the zero goes through, the one is lost. Hence, in the D-channel contention algorithm, the station that first transmits a one when the other transmits a zero loses.

CO Portion BRI: Physical layer procedures have to change from the NT-1 to the CO. One of the key limiting factors the engineers had to consider when creating the ISDN standards was the local loop. From the CO to the average consumer, there is only one pair of twisted copper cables. On average, the signal has to travel over these cables for up to 18,000 feet without any signal regenerators. This

severely limits the data rate that a user can transmit. In order to maximize the user data rate for the BRI, the ISDN standards call for a coding change at the NT-1. First of all, the NT-1 strips off all of the overhead and leaves only the B and D bits. It then adds twelve of its own overhead bits which makes the BRI data rate 160kbps from the NT-1 to the CO (144kbps user data and signaling and 16kbps overhead). Besides reducing the overhead, the NT-1 also performs a baud rate reduction. The U.S. uses an encoding scheme called 2B1Q. This scheme takes two bits and encodes them into one quaternary symbol. A quaternary symbol is a pulse that can take on four discrete values (i.e. +1V, +3V, -1V, -3V). Some other functions the NT-1 performs are as follows:³³

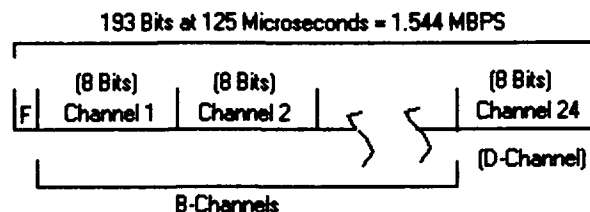
- a. Scramble the signal to reduce the crosstalk and co-channel interference.
- b. Convert from four wire to two wire and visa versa.
- c. Balance the signal to help reduce noise.
- d. Provide loop backs and other functions for maintenance purposes.

PRI Layer One

The physical layer of the PRI is much simpler than the BRI. It can only work point to point from the TE to the NT;

³³ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.286.

hence, there is no D-channel contention. The U.S. PRI frame is illustrated in Figure 3.5.



Source: Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications, (Prentice-Hall Inc.), p. 103.

Figure 3.5 PRI Frame

It has 23 B-channels, one D-channel, and one framing bit. (However, to reduce the costs on D-channel access, many vendors allow 10 or more PRIs to share a single D-channel. This also allows many PRIs to have 24 B-Channels.) It is no coincidence that the PRI is similar to the DS-1 format. The U.S. adopted this format rather than the European ISDN standard (256 bit frame at 2.048 mbps) so that it would be cheaper for the COs and customers (who have already heavily invested in T-1 technology) to switch.

One of the big advantages of PRIs over DS-1s is that PRIs do not use bit robbing. In DS-1s, the eighth bit of every channel on every sixth frame is used for signaling purposes.³⁴ Hence each channel can only support 56 kbps. ISDN has no bit robbing, so each channel has access to 64 kbps of clear data.

³⁴ Roger L. Freeman, Telecommunications System Engineering. (John Wiley & Sons, Inc), p. 391.

There is no baud rate reduction or cutting of bits on the PRI as there is on the BRI. Instead, the PRI uses four wires and periodic repeaters to assure the data arrives at the CO unharmed. (This method would not be cost effective for a BRI.) The PRI has its own encoding scheme. Here, the ones generate a pulse (alternating polarity from +3V to -3V) and zeros are coded with zero voltage. To insure timing recovery at the receiver, no more than seven zeros in a row are allowed. If eight zeros do occur in the user data, then a bipolar violation is substituted for the eight zeros (this code is known as Bipolar Eight Zeros Substitution or B8ZS).³⁵ This is another advantage over DS-1s because the user is unrestricted in the data she sends. The network automatically makes the necessary changes.

Twenty-four PRI frames are grouped together into a superframe. The framing bits for frames 4, 8, 12, 16, 20, and 24 provide multiframe synchronization. The framing Bit for 2, 6, 10, 14, 18, and 22 are used for a cyclic redundancy check. Finally, the framing bits from all of the odd frames are used for maintenance purposes. Not much capacity goes to waste in a PRI frame.

³⁵ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.111.

Layer Two

The primary mission of layer two (the data link layer) is to provide error free communications between peer layer three entities. The ISDN protocol that performs this function for the D-Channel is called LAP-D (for packet switched connections on the B-channel, it is LAP-B). LAP-D is defined in CCITT Recommendation I.441/Q.921³⁶.

Data Link Primitives: To perform its mission, layer two invokes primitives (similar to computer commands) to provide services to layer three and to request services from layer one. There are four classes of service primitives that LAP-D uses which are illustrated in Figure 3.6:

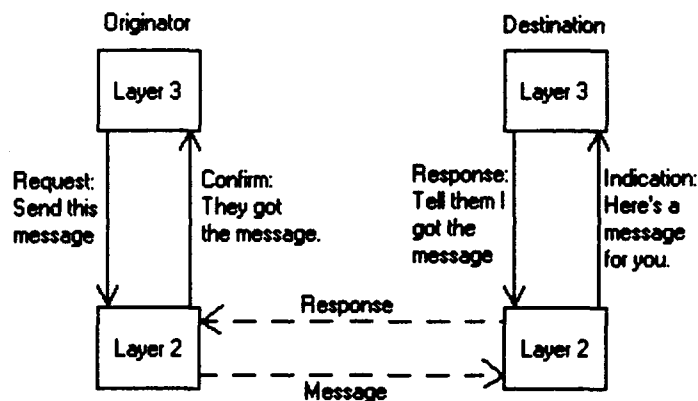


Figure 3.6 Primitive communications

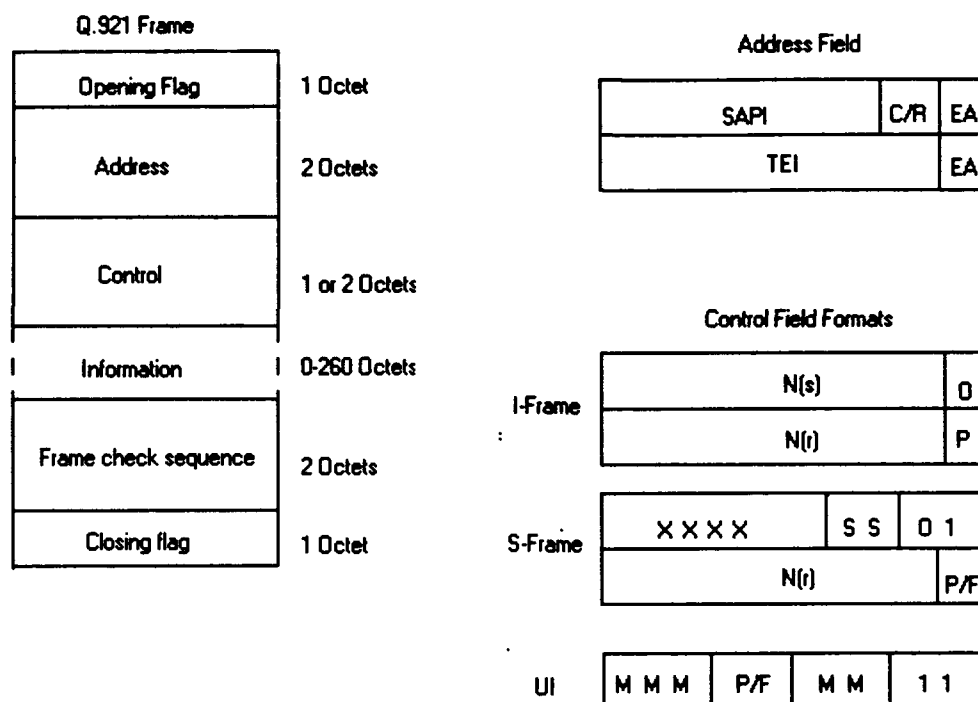
- a. Request: A service user (e.g. layer 3) invokes this primitive to request a service from the data link (e.g. send this message).
- b. Indication. The layer two entity uses this primitive to notify its customer that something has arrived (e.g. here is a message for you).

³⁶ Fred R. Goldstein, ISDN in Perspective. (Addison-Wesley Publishing Company, 1992), pp.158.

- c. Response: The receiving layer three uses this primitive to acknowledge the indication.
- d. Confirm: This primitive is used to relay the response to the originating layer three entity.

Data Link LAP-D Frame: Peer layer two entities communicate back and forth by exchanging LAP-D frames. The format of these frames is in Figure 3.7. The flag marks the beginning and end of a frame. In LAP-D, the flag pattern is 01111110. Receivers use this pattern to synchronize on the beginning and end of a frame. Since the LAP-D frame has a variable length, a receiver cannot know where the end of a frame is until it detects the end delimiter flag. If the flag pattern happens to occur on the inside of the frame, it would cause an error. To avoid this problem, LAP-D uses bit stuffing. If the sending data link layer counts five consecutive ones within the user data, it automatically stuffs a zero after the fifth one. This way the flag pattern cannot occur by accident. If the original data had five ones and a zero, it is not a problem. A zero is still stuffed after the fifth one; hence, yielding a sequence of five ones and two zeros. When the stuffed frame arrives at the destination, the receiver removes all zeros that follow five ones; thus, reconstructing the original data.³⁷

³⁷ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.138.



Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.137.

Figure 3.7 LAP-D Frames

The address field is used to target a service user on a particular terminal located at the other side of the physical connection. The destination terminal is addressed using a terminal endpoint identifier (TEI). The service access point identifier (SAPI) targets the service user. TEIs can have a value from 1-127 (zero is reserved for broadcast mode) and can be assigned manually by the user, or automatically by the network. The advantage of the automatic TEI assignment process is that the network will ensure that no two terminals sharing that interface will have the same TEI. Thus far, the CCITT has assigned four SAPIs. Number "0" is used for call control procedures that manage the B-channel. Number "16" is

for X.25 packet communications on the D-channel. Number "63" is used to exchange layer two management SAPIs (e.g. TEI assignment). Finally, number "1" is for Q.931 user-to-user packet communications. "32-62" are reserved frame relay services.³⁸

LAP-D Frame Types: To denote the three different types of LAP-D Frames, the control field has three formats:³⁹

a. Information transfer frame (I-Frame): The I-Frames carry the user data. Flow control and error control information is piggybacked onto this frame. N(s) is the sequence number of the I-frame being sent. N(r) is the number of the next frame the entity expects to see from the other side. This number also acknowledges the receipt of all frames up to and including N(r)-1. The P/F bit is the poll final bit. It is used to solicit a response (Poll) or respond to a request (Final).

b. Supervisory Frames (S-Frames): The S-Frame also provides flow control and error control information. The S bits tell the other side that the receiver is ready to accept I-frames; or the receiver is not ready to accept I-frames; or the receiver requests retransmission of all frames starting with N(r).

³⁸ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.360.

³⁹ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.143.

c. Unnumbered Information Frames (UI): Mostly, the UI is used to establish, maintain, and release a connection. The M bits identify the type of UI and its function.

LAP-D Flow Control: It is through the control field that ISDN exercises flow control. LAP-D employs a sliding window, modulo 128, go-back-n flow control algorithm. In this protocol, each frame has a sequence number from 0-127, and the transmitter has a window size of 127. This means a layer two entity can send 127 frames without getting an acknowledgement, starting with the number of the last frame acknowledged. As the transmitter receives acknowledgements, it advances its window and can send more frames. When errors occur (e.g. frame lost or garbled), the transmitter simply retransmits the frames starting at the last frame acknowledged plus one.⁴⁰

Sample LAP-D Procedure: The following is an example of how LAP-D procedures work. This particular case deals with establishing multiframe acknowledged operations (MFAO)⁴¹:

- a. Layer three on the initiating side sends a data link(DL) establish request primitive to its DL.
- b. The initiating DL puts the request into a UI frame called Set Asynchronous Balance Mode Extended (SABME) and transmits it to the other side.
- c. If able to enter MFAO, the destination DL responds with a UI response message to the originating DL which states it is willing to establish MFAO.

⁴⁰ Andrew S. Tanenbaum, Computer Networks, (Prentice Hall, 1989), p. 229.

⁴¹ MFAO is the mode of operation ISDN enters when exchanging information (I-Frames) over the D-Channel.

- d. At the same time, the Destination DL informs its layer three (via a DL establish indication primitive) that MFAO is established.
- e. The originating DL receives the UI response and informs its layer three entity (via a DL establish confirm primitive), that the MFAO connection it requested is ready.
- f. The two sides are now ready to send I-frames containing user data.

Layer Three

ISDN layer three (network layer) uses the D-channel for connection control, supplementary services control, user-to-user signaling, and user information transfer. The specific protocol is CCITT I.451/Q.931.⁴²

Functional and Stimulus Terminals: All Layer three information is encapsulated into protocol messages. These messages are generated by a communications device (e.g. phone) and inserted into the information field of a LAP-D I-Frame or UI Frame. An end user generates these protocol messages from his TE-1 or TA. These terminal devices can be one of two types: A functional terminal (FT) or a stimulus terminal (ST). An FT is an intelligent device that can interpret and manipulate the entire I-451/Q.931 protocol. The network does not need to know much about the FT's capabilities. It just relays the messages to the user and lets the FT interpret them. The FT provides the user with a

⁴² Pramode K. Verma, ISDN Systems Architecture, Technology, and Applications. (Prentice-Hall Inc.), p. 134.

lot more capabilities than the ST, but it is also more expensive. The ST is a much simpler device. It generates and responds to only a simple set of stimulus commands that do little more than relay an action (e.g. off hook, ring, busy, etc). The big advantage of the stimulus terminal is cost, they are much cheaper.⁴³

Q.931 Messages: All protocol messages follow the format in Figure 3.8. Each of these messages is comprised of at least three information elements (IE):

- a. The protocol discriminator is used to identify the protocol in the message (e.g. X.25). The Q.931 value is "00001000."
- b. The call reference value identifies which particular connection the Q.931 message refers to. The first octet in this IE states the length of the call reference value. The flag denotes which end the message is from (1 for destination and 0 for origination).
- c. The message type tells which kind of protocol message is sent. A list of those concerning call establishment are in table 3.2.

Q.931 Protocol Message

Protocol discriminator	
0 0 0 0	Length of call value
0	Message type
Other information elements	

Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.143.

Figure 3.8 Q.931 Message

⁴³ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.360.

Table 3.2 Call Establishment Messages

Message Type	Function
Alerting	Indicates that user SAPIs has begun
Call Proceeding	Indicates that call establishment has been initiated
Connect	Indicates call acceptance by called TE
Connect Acknowledge	Indicates that user has been awarded the call
Progress	Reports progress of call
Setup	Initiates call establishment
Setup Acknowledgement	Indicates that call establishment has been initiated but requests more information

Source: William Stallings, ISDN and Broadband ISDN, (Macmillan Publishing Company, 1992), p.408.

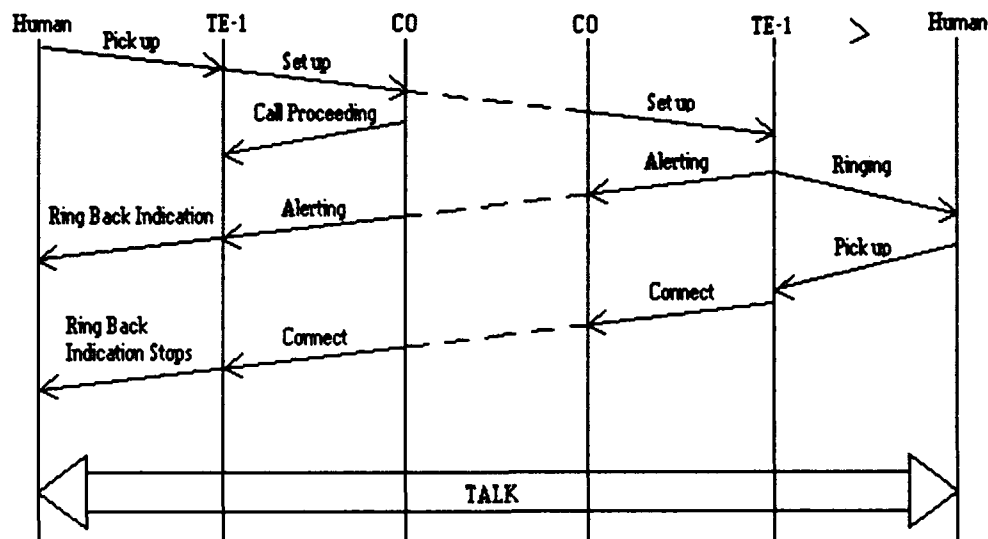
d. Depending on the message type, other IEs may be required (e.g. bearer capability, called party number, calling party number, etc). An example IE is illustrated in Figure 3.9.

0	Calling Party Number Information element identifier		
Length of calling party number contents			
0/1 ext	Type of number	Numbering plan identification	
1 ext	Presentation indicator	0 0 0 Spare	Screening indicator
0	Number digits (IA5 characters)		

Source: Hermann J. Helgert, Integrated Services Digital Networks, (Addison-Wesley Publishing Company, 1991), p.193.

Figure 3.9 Calling party ID

Sample Q.931 Procedure: Figure 3.10 is an example of ISDN communicating with Q.931 messages. This particular case illustrates how ISDN establishes a B-channel call. The actual Q.931 messages are in Appendix B (they were captured from a protocol analyzer on a Teleos ISDN mini-switch).



Q.931 Call set up procedure

Source: William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.322.

Figure 3.10 Call establishment procedures

Common Channel Signaling

Currently, most users control their calls through in-channel signaling. This means that all signaling is transmitted on the same path as the user information. In-channel signaling has worked well for years; however, it has many limitations that restrict network capabilities. Because of this, the telecommunications networks are switching to common channel signaling. In this method, signaling is sent on a separate network that is disassociated from the user information transfer. This configuration has many advantages:⁴⁴

- a. The IEN and the CCSN can develop separately from one another. This enables more flexibility.
- b. Call set up times are quicker.
- c. User data and signaling connections can occur simultaneously. This allows the user to manipulate the connection without interrupting his data transmission.
- d. The customer can transfer user information over the CCSN as well as signaling.
- e. When establishing a call using in-channel signaling, the signals proceed over the user channel to the destination. If the destination is busy, the originator has tied up a lot of IEN resources just to get a busy signal. With common channel signaling, the call is established over the CCSN before any IEN trunks are tied up. If the destination is busy, the originator receives this information back over the CCSN, and no expensive IEN trunks are used.

⁴⁴ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.308.

While CCSN enjoys many advantages, there are also a few disadvantages⁴⁵:

- a. The CCSN needs to be intelligent to route messages to the right place. This is complex and expensive.
- b. All of the signaling resources are in one basket. If the CCSN goes down, no one can communicate.
- c. With in-channel signaling, the signaling information performs an automatic test of the user information circuit (i.e. if the signaling goes through, then user data can get through). With common channel signaling, this does not happen so a separate end-to-end test must be performed on each circuit before talking occurs.

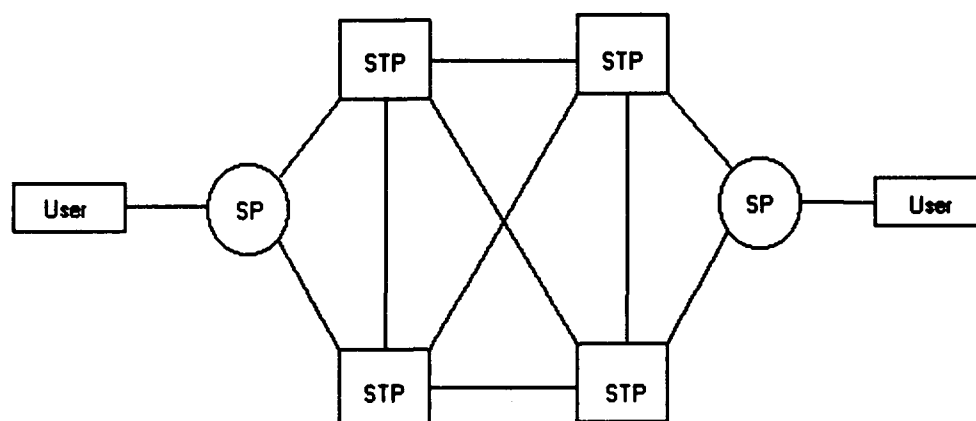
Signaling System Number Seven (SS#7)

The common channel signaling system that ISDN uses is SS#7. This is an internationally standardized system that provides connectionless packet switched information transfer (signaling or user data) using 64 kbps channels.⁴⁶ SS#7 is comprised of three functional entities: Signaling points (SP), Signaling transfer points (STP), and the signaling links connecting the SPs and the STPs (see Figure 3.11). SPs are nodes where messages originate and terminate. This is where the users' Q.931 messages gain entry to the CCSN. STPs are packet switches that act as intermediate nodes to relay

⁴⁵ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.308.

⁴⁶ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.433.

the messages to their destination. STPs are deployed in pairs to provide redundancy.

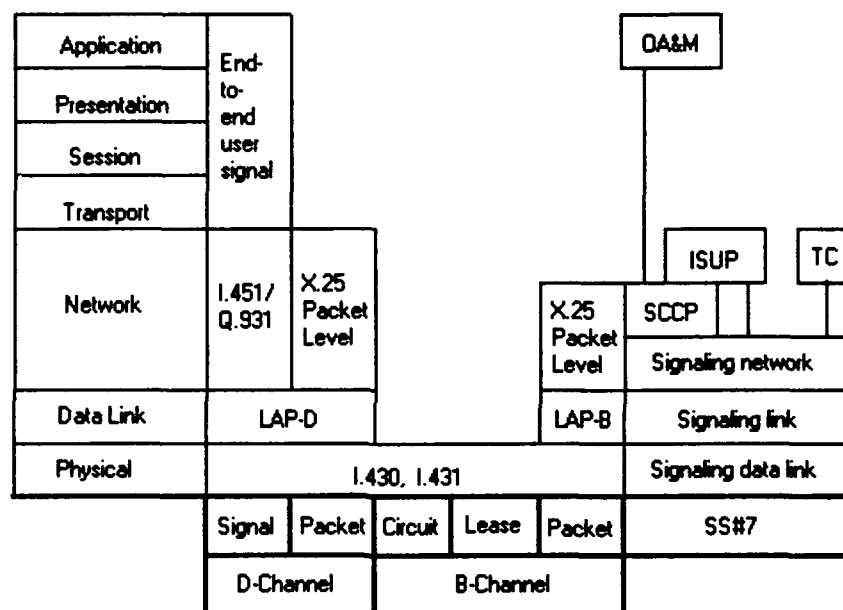


Source: William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p. 435.

Figure 3.11 SS#7 Architecture

SS#7 Protocol Stack: SS#7 was developed separately from ISDN; hence, it has its own unique protocol architecture. All Q.931 messages must be converted to SS#7 messages. Figure 3.12 compares the protocol stacks of ISDN, OSI, and SS#7. The first three layers are called the message transfer part (MTP). The MTP is responsible for reliable connectionless service to route messages through the SS#7 network. The MTP is analogous to layers one, two and three of the OSI model, but they do not perform all of the OSI functions. The Signaling Connection Control Part (SCCP) was developed to support more than signaling. It provides additional layer services (e.g. enhanced addressing) for users that need it. The ISDN User Part (ISUP) provides the basic call control functions (e.g. establish, clear, etc). It is here that Q.931 messages are reformatted to SS#7

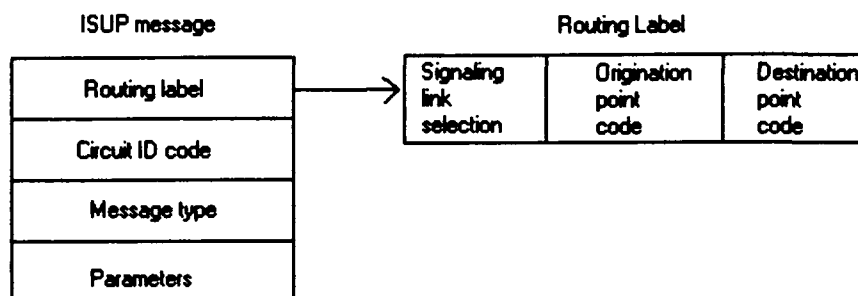
messages (e.g. a Q.931 call set up message is converted to an ISUP initial address message). Figure 3.13 shows the format of an ISUP message. The transaction capabilities (TC) portion provides services to support applications like network data base access. Finally, the operations, administration, and maintenance (OA&M) part is used to manage the entire SS#7 network.⁴⁷



Source: Communications Technology Research, Inc.

Figure 3.12 Protocol Stacks

⁴⁷ Roger L. Freeman, Telecommunications System Engineering. (John Wiley & Sons, Inc), p. 391.



Note: This is very similar to the Q.931 messages. Instead of an address, the ISUP message has a routing label. Instead of a call reference number the ISUP has a circuit ID code. Instead of information elements, the ISUP has parameters.

Source: Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.327.

Figure 3.13 ISUP Message

SS#7 Routing: One of the most interesting capabilities of the SS#7 is that it provides connectionless service with ordered arrival of packets without set up messages. This allows many advantages of both virtual and datagram services. SS#7 accomplishes this feat by having routing tables at every STP, and by using the routing labels on each packet.

When a packet arrives at an STP, it reads the origination and destination codes. The STP then looks the codes up in its routing table and picks one of sixteen possible links on which to forward that message. It then records that all subsequent packets containing that origination/destination pair and that circuit identifier will be routed over the same link. This process is repeated at every STP. Hence, every packet pertaining to a particular transaction will follow the exact route of its predecessor.

This ensures that all packets arrive in order (unless one is lost along the way).⁴⁸

⁴⁸ Hermann J. Helgert, Integrated Services Digital Networks. (Addison-Wesley Publishing Company, 1991), p.328.

Chapter 4

Broadband ISDN

Broadband ISDN (B-ISDN) is defined as any transmission channel greater than PRI (1.544 mbps). It is being developed to meet the ever increasing demand for faster bit rates, especially for video and other imagery applications. The CCITT published some draft recommendation in 1990; some of their comments are as follows:⁴⁹

- a. The term B-ISDN is used for convenience in order to refer to and emphasize the broadband aspects of ISDN. The intent, however, is that there be one comprehensive notion of an ISDN which provides broadband and other ISDN services.
- b. Asynchronous transfer mode (ATM) is the target transfer mode solution for implementing a B-ISDN. It will influence the standardization and digital hierarchies and multiplexing structures, switching and interfaces for broadband signals.
- c. B-ISDN will be based on the concepts developed for ISDN and may evolve by progressively incorporating additional functions and services (e.g. high quality video applications).
- d. The reference configuration defined in I.411 [see Figure 3.1 in chapter 3]. is considered sufficiently general to be applicable not only for a basic access and a primary rate access but also to a broadband access. Both reference points S and T are valid for broadband accesses.

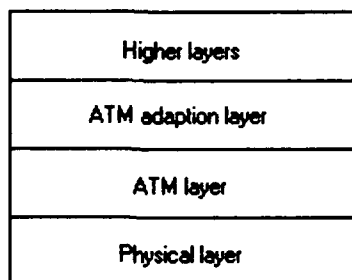
Currently, the CCITT plans for B-ISDN to offer three user interfaces: Full duplex 155.52 mbps, asymmetrical 155.52 mbps (user to network) and 622.08 mbps (network to

⁴⁹ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.497.

user), and 622.08 mbps full duplex.⁵⁰ For switching B-ISDN, the CCITT settled on a fast packet method called Asynchronous Transfer Mode (ATM). They chose ATM over circuit switching because ATM is more flexible and allows the users to easily define a wide range of bit rates for their applications.

Figure 4.1 illustrates the key B-ISDN protocol layers.

B-ISDN Protocol Reference Model



Source: William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.520.

Figure 4.1 B-ISDN Protocol Reference Model

The physical layer is responsible for frame generation and transmission. Coaxial cable can be used for the 155.52 mbps services (100-200 meters), but all others require fiber optic cable. Currently, there are two methods for multiplexing the ATM cells onto the physical media. The first option is to transmit the cells on the line with no frame structure. Synchronization is done on a cell by cell basis using the header error control field as a check. If no errors are detected in the cell, the system assumes the synchronization is good. If there are multiple errors, the system performs a special synchronization recovery procedure.

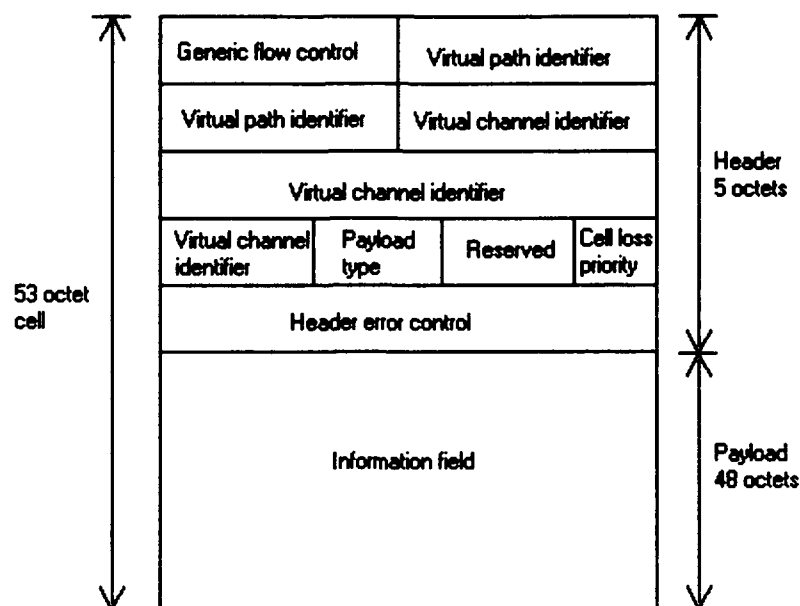
⁵⁰ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.519.

This method of transmitting the cells can only handle the 155.52 mbps interfaces. The second option is Synchronous Optical Networks (SONET) which is based on the Synchronous Digital Hierarchy (SDH) defined in CCITT Recommendation G.709. SONET takes the ATM cells and puts them into frames. This method can provide both the 155.52 and 622.08 mbps interfaces.⁵¹

The ATM layer is where the ATM cells are formed (see Figure 4.2). It is also creates the virtual paths and connections (logical connections of varying bit rates) and provides flow control. The ATM adaption layer segments the user information for insertion into ATM cells. It is this layer that allows non-ATM protocols (e.g. a synchronous BRI or PRI interface) to work over the B-ISDN ATM network.⁵²

⁵¹ William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.524.

⁵² William Stallings, ISDN and Broadband ISDN. (Macmillan Publishing Company, 1992), p.530.



Source: William Stallings, ISDN and Broadband ISDN, (Macmillan Publishing Company, 1992), p.535.

Figure 4.2 ATM cell

Chapter 5

Marketing ISDN

The key elements of marketing are the four Ps: product, price, place (distribution), and promotions.⁵³ These issues are directly responsible for the success or failure of any venture and ISDN is no exception. The telephone companies and CPE vendors will need to provide good ISDN services and equipment at the right price. They then need to get the services and equipment to the customers and convince them that they need ISDN. It sounds simple, but so far, the telecommunications industry has not done very well in marketing ISDN.

Product

The biggest problem with ISDN products thus far is standardization (or lack there of). In spite of the fact that ISDN is supposed to be standardized, it is not (e.g. an AT&T phone will not work on a Northern Telecom Inc switch). The major incompatibility is caused by the Q.931 messages. While the CCITT provides specifications for these protocols, they still leave enough room for vendors to implement their

⁵³ Benson P. Shapiro, Robert J. Dolan, and John A. Quelch, Marketing Management Principles, Analysis, and Applications. (Richard D. Irwin, INC.), p. 7.

own non-interoperable (proprietary) solutions.⁵⁴ Vendors are reluctant to standardize because they fear it will make it easier for customers to jump to a competitor (e.g. Centrex Service or another vendor). However, even with standardization, creative vendors have enough room to add their own value added services (that will only work on their PBXs) and still produce an ISDN terminal that is interoperable.⁵⁵

Had ISDN been implemented before divestiture, all these problems would be moot. Bell Laboratories would have set the standards, and all vendors would have followed them. Since ISDN happened after divestiture, there has been no central control in the U.S. on ISDN standards. Recently, the major vendors and the telephone companies have bonded together to fill the void left by Bell Laboratories. In February, 1991, they agreed upon some standards and called them National ISDN-1 (ISDN-1). ISDN-1 is supposed to solve the interoperability problems. However, since the agreements are voluntary, it remains to be seen if all will adhere to them. Among other things ISDN-1 defined specific implementations for a basic set of features called the foundation services:⁵⁶

⁵⁴ Michael Finneran, "ISDN-Not Dead, Just Sleeping," Business Communications Review, June, 1990: p.106.

⁵⁵ Michael Finneran, "Can the Telcos Develop a Market for ISDN?", Business Communications Review, November, 1991: p.49.

⁵⁶ Michael Finneran, "Has ISDN Turned the Corner?", Business Communications Review, June, 1991: p.43.

- a. Call forwarding.
- b. Automatic callback.
- c. Call hold.
- d. Additional call offering.
- e. Flexible calling.
- f. Calling number identification services.
- g. Message service.
- i. Display service.
- j. Electronic key telephone systems.
- k. Station message detail recording.
- l. Multiline hunt groups.
- m. Basic business group.
- n. Business group dial access features.
- o. B and D-Channel data services.

Even with all of the problems, organizations are finding ISDN valuable and sales are growing. 1990 sales for ISDN products were \$770 million (see Figure 5.1) and are expected to hit \$2.5 billion by 1995.⁵⁷

⁵⁷ "New ISDN Customer Premises Products will Send the Market Soaring," ISDN Newsletter, January, 1992: p. 9.

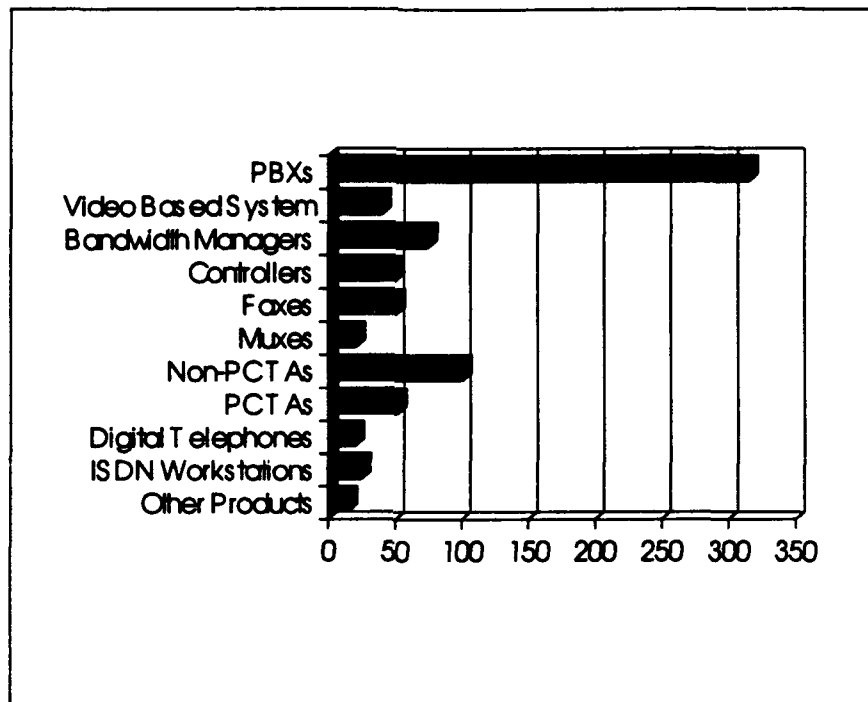


Figure 5.1 ISDN Product Sales (figures in \$millions)

Price

Price has been another stumbling block for ISDN deployment. The equipment is expensive! Until recently, a voice only ISDN phone could cost \$700. Considering the fact that you can buy a brand new PBX with proprietary digital phones for an average cost of about \$600 per telephone (including the switch), it is not surprising that ISDN phones were not selling well. Fortunately, this is changing fairly quickly. ISDN-1 standardization enables chip manufacturers to develop chip sets to generate the D-Channel signaling rather than writing software to do it. Experts expect this development to push the cost of a fully functional data and

voice terminal to between \$100-\$200 (less than the cost of a high speed 19.2 kbps modem).⁵⁸

In contrast to CPE costs, the ISDN tariffs are (for the most part) fair. Typically a BRI runs about 1.2 to 2 times the cost of a POTS subscriber line. Given the additional functionality of ISDN, this is reasonable. New England Telephone (NET) recently filed a tariff in Massachusetts. Table 5.1 shows what they proposed, what was approved and compares the rates to other areas. NET wanted to charge much more than what was approved. Their view was that demand for ISDN was low and inelastic (non-responsive to price changes). Therefore, they needed to charge high rates in order to recoup their investment in a reasonable time frame. Other service providers like Prodigy and Sprint argued against NET's high rates. They asserted that ISDN demand was responsive to price and that by setting a high tariff, NET was creating a self fulfilling prophecy of doom. The public utility commission (PUC) agreed with the other service providers and lowered the tariffs. Hopefully, all PUCs will agree with Massachusetts and keep ISDN tariffs affordable.⁵⁹

⁵⁸ Michael Finneran, "Has ISDN Turned the Corner?", Business Communications Review, June, 1991: p.45.

⁵⁹ Susan M. Baldwin, "ISDN Rate-Setting in Massachusetts," Business Communications Review, June, 1992: p.49.

Table 5.1 ISDN Tariffs

Service	NET Original Proposal	NET Marginal Cost	MASS. PUC Approved	New York (NY Tel)	Maine/ Vermont (NET)
Digital Subscriber Line	\$5.00	\$7.40	\$8.00	\$10.00	\$5.00
Circuit Switched Voice	\$0	\$0	\$0	\$0	\$0
Alternate Data/Voice	\$22.00	\$2.50	\$5.00	\$2.00	\$22.00
Low Speed Packet Data	\$8.00	\$3.30	\$6.60	\$2.00	\$8.00
High Speed Packet Data	\$75.00	\$38.00	\$50.00	\$20.00	\$8.00

Source: Susan M. Baldwin, "ISDN Rate-Setting in Massachusetts," Business Communications Review, June, 1992: p.49.

PRI rates are reasonable as well. The only additional monthly cost of a PRI over a DS-1 is the D-Channel access charge (about \$400 per month). But since up to 20 PRIs can share one D-channel, that is only an additional \$20 per T-1.⁶⁰ This additional cost is more than justified by PRI's call-by-call capability. In a DS-1, a channel is either outgoing or incoming. If all outgoing channels are busy, a user cannot call out, even if an incoming channel is vacant. With PRI's call-by-call capability, a channel can be incoming, outgoing, or both. This service can effectively increase capacity by forty percent or more without purchasing additional T-1s.⁶¹

⁶⁰ Tibor G. Szekeres, "ISDN: Field Experience in the Real World," Business Communications Review, June, 1990: p.59.

⁶¹ Ian Angus, ISDN. A Manager's Guide to Today's Revolution in Business Telecommunications. (Telemanagement Press, 1990), p.265.

Place

Place usually refers to channels of distribution; however, for ISDN it means, "where is it available?" To fully deploy ISDN and make a true national digital network, several things have to happen:⁶²

a. Digital switches, SS#7, and ISDN equipment need to be installed. Table 5.2 lists the current deployment of these systems for several Regional Bell Operating Companies (RBOCs) . It lists the percent of their COs that have the equipment and the percent of their total subscriber lines that have access to this equipment.

Table 5.2 ISDN Deployment Progress

	<u>ISDN</u>		<u>DigitalSwitch</u>		<u>SS#7</u>	
	% COs	% Access lines	% COs	% Access lines	% COs	% Access lines
Ameritech	6.0	0.3	64.5	40.4	24.1	42.6
Bell Atlantic	7.6	0.1	72.9	48.3	54.7	75.5
Bell South	3.3	1.9	78.2	51.1	34.2	57.8
Nynex	2.6	0.2	57.9	56.7	14.1	08.1
PacTel	4.2	0.1	59.4	35.6	32.3	30.7
SW Bell	3.4	0.2	31.9	25.8	01.3	03.8
US West	4.8	0.4	38.4	35.3	01.0	02.1

Source: Michael Finneran, "Has ISDN Turned the Corner?", Business Communications Review, June, 1991: p.44.

b. Operation, administration, and maintenance (OA&M) issues need to be resolved. This is a major problem for telephone companies. ISDN will require expensive retrofits to the existing OA&M infrastructure. They need to upgrade

⁶² Michael Finneran, "Can the Telcos Develop a Market for ISDN?", Business Communications Review, November, 1991: p.46.

all of the support systems that make telephone service reliable, cheap, and easy to provide.

c. Outside plants need to be upgraded. One of ISDN's biggest advantages is its ability to use the existing local loops. However, about 25% of the existing cable plant is not suitable for ISDN because it has loading coils on it. These loading coils have to be found and removed which is both time consuming and expensive.

d. The telecommunications workforce needs retraining. This will require time and commitment. Currently, detailed knowledge on ISDN in the telephone industry is limited to a chosen few. For the most part, it is tough to get answers on even simple technical questions.⁶³

In the U.S. there are now 50,000 BRI lines in service (there are no figures on PRIs). This is about double that of its closest competitor, Japan. However, in Japan, 96% of their cities have access to ISDN as compared to 2% of the U.S. Chances are, with that kind of availability, Japan's ISDN growth will outpace the U.S. very quickly.⁶⁴ But things are looking up in the U.S. Thanks to agreements at ISDN-1 conferences, the RBOCs (e.g. U.S. West) have agreed to step up their ISDN deployment. Table 5.3 lists their ISDN availability projections by 1994.

⁶³ Tibor G. Szekeres, "ISDN: Field Experience in the Real World," Business Communications Review, June, 1990: p.61.

⁶⁴ Michael Finneran, "Why ISDN Sells in Japan," Business Communications Review, March, 1992: p.64.

Table 5.3 ISDN Deployment Projections

	<u>ISDN</u> Switches	<u>Available</u> Access Lines
Ameritech	597	87%
Bell Atlantic	700	90%
Nynex	80	27%
Pac Bell	135-175	40-50%
SW Bell	167	32% (47% Metro)
US West	230	51% (76% Metro)

Source: Michael Finneran, "Has ISDN Turned the Corner?", Business Communications Review, June, 1991: p.45.

Promotion

The best way to describe ISDN promotion thus far is "hype." It is ... "a case study on how not to market a technical product or service."⁶⁵ The salesmen have misled the public to the extent that no one really knows what ISDN means or does. As a result, ISDN has a bad reputation with many customers. The following are some common misconceptions about ISDN that have stemmed from all the hype:

a. ISDN is a universal solution for all data and voice communications. This conception was pushed by the ISDN vendors. It drove customers' expectations to a level that could not be met. Customers are now using those high expectations as a yardstick against which to measure ISDN's capabilities. Its no wonder that ISDN has a bad reputation. "Promise candles and people will be very happy with electric lights. But if you promise to deliver all the illumination

⁶⁵ Michael Finneran, "Has ISDN Turned the Corner?", Business Communications Review, June, 1991: p.45.

of a thousand suns, even the lights of Broadway will be a disappointment."⁶⁶ The bottom line is that no technology is a solution for everything. ISDN has its value and can solve some problems but not all problems.

b. ISDN is too little, too late. This complaint comes from the customers' dashed expectations on ISDN. They compare its 64 kbps channels to fiber optic connectivity (100-600MBPS). To say the least, this is an unfair comparison. Wide spread fiber optic connectivity is still a long way off. ISDN can provide customers with BRI or PRI connectivity today. While this is not at fiber optic speeds, it is still better than what most users are currently getting (usually 2.4-9.6 kbps modems). Even customers that use switched 56kbps data services could benefit from the increased speed and flexibility of ISDN.⁶⁷

c. ISDN has no applications. It is true; ISDN does not currently provide many value added services. Chances are that it never will -- it is not supposed to. ISDN is an enabling technology. It will enable service providers to create value added services for customers and present them to customers over ISDN pipelines. However, like any new enabling technology, it will take a while for applications to

⁶⁶ Ian Angus, ISDN. A Manager's Guide to Today's Revolution in Business Telecommunications. (Telemanagement Press, 1990), p.32.

⁶⁷ Ian Angus, ISDN. A Manager's Guide to Today's Revolution in Business Telecommunications. (Telemanagement Press, 1990), p.39.

develop. The personal computer (PC) was around for several years before it had any real applications (e.g. spreadsheet). ISDN will probably follow a similar path. At first, it will just replace existing capabilities (e.g. modems). Eventually users will become familiar with ISDN and start identifying new applications for it.

d. ISDN will replace LANs. If fifty users share a 10 mbps Ethernet LAN, each would have an average throughput of 200 kbps ($10\text{MBPS}/50=200\text{ kbps}$). ISDN BRI service allows an average throughput of 256 kbps [two B-Channels = 128 kbps * 2 (for full duplex) = 256 kbps]. The casual observer examining this simple calculation might think that ISDN is better (figures do not lie, but liars figure). The truth is that neither is better; it is like comparing apples to oranges. An Ethernet is designed for bursty traffic. This means it assumes that all users do not want access at once. Because of this, a user may see throughputs of 1, 2, or even 10 mbps depending on how many users do want access. ISDN is designed more as a flexible pipe that can be redirected at will (i.e. call another number) and then provide a dedicated line for as long as the user is connected. After which, the connection is torn down to allow others to access the line. The final analysis is that one is not better, they are just different. It is very likely, that a customer will need both.⁶⁸

⁶⁸ Ian Angus, ISDN, A Manager's Guide to Today's Revolution in Business Telecommunications. (Telemanagement Press, 1990), p.35.

e. Why buy narrowband ISDN (N-ISDN) when B-ISDN is just around the corner? When B-ISDN gets here it will be more capable than N-ISDN, but the CCITT has just started to define ISDN standards. It will likely be another ten years before it is deployed. To wait this long for true widespread digital connectivity may be a waste. Today, people think nothing of upgrading their PCs from XTs or ATs to 286s or 486s at a cost of several thousand dollars. It is hard to believe that these same individuals will not spend an additional two to five hundred dollars on ISDN equipment that could double or triple the value of their computer. Besides, N-ISDN is likely a necessary learning step before implementing B-ISDN. You cannot jump from a horse and buggy to the space shuttle without gaining experience on a few modes of transportation in between.

Conclusion

After much controversy, the ISDN market is finally progressing. ISDN-1 has breathed new life into ISDN. Customers are finally becoming more optimistic on ISDN. However, many are still skeptical after having been fed so many empty promises in the past. If ISDN is to become the communications system of the future, it will require a carefully planned and executed marketing effort.

"Ironically, the telcos over-hyped ISDN when they had nothing

to sell; now that ISDN-1 has given them something tangible, their silence is deafening."⁶⁹

⁶⁹ Michael Finneran, "Can the Telcos Develop a Market for ISDN?", Business Communications Review, November, 1991: p.46.

Chapter 6

Research Methodology

This thesis is part of the Emerging Technologies Research Program at the University of Colorado. The objective of this program is to identify the critical success factors that a manager needs to control to successfully implement a particular technology.⁷⁰

The Emerging Technologies (ET) group intends to meet this goal by combining the data of several researchers (students and faculty) over an extended period of time. Each researcher chooses a particular emerging technology and then performs an in-depth case study of an organization that is implementing that technology. Currently, the technologies under consideration are Integrated Services Digital Networks, Computer Aided Systems Engineering, Executive Support Systems, Group Decision Support Systems, Document Imaging systems, and Object Oriented Analysis and Design. Eventually, the ET group will gather enough information to perform a meta-analysis which will yield the "big picture" on the successes and failures of implementing emerging technologies.⁷¹

⁷⁰Dana J. Barnes, Bonnie K. Buckland, and James C. Brancheau, Methodological Issues in Emerging Technologies Research: Experiences and Recommendations, Hawaii International Conference on System Sciences faculty working paper (September 1991), p. 3.

⁷¹Dana J. Barnes, Bonnie K. Buckland, and James C. Brancheau, Methodological Issues in Emerging Technologies Research: Experiences and Recommendations, Hawaii

Selection of Participant

In the past, researchers in the ET group identified about seven to ten organizations to study. Due to time and travel constraints, this large number of participants led to less than optimal results. In many instances, only one individual per company was interviewed. As a result, the studies were cursory and tended to be biased (by the single interviewee).⁷² To correct this, the ET group decided to lower the number of companies researched (per thesis) to one or two. This way the researcher could perform an in-depth case study where several individuals per company are interviewed and where all of the important implementation variables were covered.

I chose to study a military organization which I will refer to as the "Legion." I picked the Legion because I have a lot of experience with this organization as well as many contacts. The Legion allowed me access to all levels within its structure, and they let me sit in on a major planning meeting. I also chose the Legion for my case study because I felt that my knowledge of the organization would add more

International Conference on System Sciences faculty working paper (September 1991), p. 3.

⁷²Dana J. Barnes, Bonnie K. Buckland, and James C. Brancheau, Methodological Issues in Emerging Technologies Research: Experiences and Recommendations, Hawaii International Conference on System Sciences faculty working paper (September 1991), p. 6.

depth and insight to this study (particularly in analyzing the contextual variables).

Research Strategy

As discussed before, the method of collecting data is an in-depth case study. "Case studies examine a single organization, group, or person in detail. Data are usually collected through multiple means, such as interviews, observations, and documentary materials. Case studies do not involve experimental designs or controls. Investigators usually intend to generate hypotheses rather than test them."⁷³

There are two approaches to researching the implementation of emerging technologies: A factors study and a change process study. The factor study tries to determine and measure the effect of implementation variables (e.g. top management support) on the success or failure of deploying a new technology. A change study looks at the implementation as a process of organizational change. It tries to comprehend the behaviors of the different parties involved.⁷⁴

This thesis will concentrate mostly on the factors study approach. It will attempt to identify the critical factors

⁷³Izak Benbasat, An Analysis of Research Methodologies, Management Support Systems, p. 51.

⁷⁴Izak Benbasat, An Analysis of Research Methodologies, Management Support Systems, p. 51.

that affected the Legion's ISDN implementation. However, many aspects of the Legion's organizational behavior and changes have affected ISDN deployment. Hence, some change study elements will also be discussed.

Information Gathering Methods

Information for this case study was gathered from three sources: Interviews, a planning meeting, and company publications (e.g. regulations, pamphlets, manuals, reports, etc.). The company publications provided excellent documentation on how the Legion is structured and how they document and fulfill their telecommunications requirements (including ISDN). The company meeting (that I attended at the headquarters for informations systems) covers where the Legion is in ISDN deployment and how ISDN fits in with future Legion requirements. Finally, the interviews supply details and opinions on the Legion's ISDN implementation.

Interview Specifics

I structured the interviews to cover as many of the implementation variables as possible (see table 6.1). Because of the interviewees' vastly different knowledge levels and job responsibilities, not all areas were covered by every interview.⁷⁵ For example, when I interviewed the

⁷⁵See appendix A for complete list of questions.

end users, I hardly discussed ISDN, I only asked specific questions on the application that ISDN was facilitating. The actual interviews lasted from 30 to 120 minutes, depending on the users depth of knowledge and their availability.

Table 6.1 Typical Implementation Variables in Emerging Technologies Research

1. CONTEXTUAL VARIABLES 1.1 Organization . Industry (information intensity) . Structural form (organic vs mechanistic) . Management support (champions) 1.2 Workgroup . Culture, norms (innovativeness) . User management support (champions) . Informal communication network (gatekeepers, opinion leaders) 1.3 Technology Investment . Existing technical infrastructure (maturity) . Stage of growth for specific technology	3. INDIVIDUAL-LEVEL IMPLEMENTATION VARIABLES 3.1 End-User . Education, experience . Communication behavior . Beliefs, attitudes 3.2 Task . Position level (autonomy) . Task characteristics
2. ORGANIZATIONAL-LEVEL IMPLEMENTATION VARIABLES 2.1 Structural Variables . Implementation project characteristics . Support services and staffing (training etc.) . Policies and control procedures 2.2 Structuring Variables . Structural form (for user support mechanism) . Linking mechanisms (technology assessment groups, etc.) . User involvement . Communication channel	4. TECHNOLOGY VARIABLES 4.1 User-System Interface . Ease of use 4.2 Perceived Attributes . Relative advantage, complexity, etc. 4.3 Interaction Effects . Appropriateness for task and users 5. OUTCOME VARIABLES 5.1 Organization Level . Market share (%) . Profitability (return on investment) . Customer service (satisfaction) 5.2 Workgroup Level . Workgroup productivity 5.3 Individual Level . User productivity . User satisfaction . Quality of work life.

Source: Dana J. Barnes, Bonnie K. Buckland, and James C. Brancheau, Methodological Issues in Emerging Technologies Research: Experiences and Recommendations, Hawaii International Conference on System Sciences faculty working paper (September 1991), p. 8.

Analysis

First I intend to merge all of the collected data, and construct my own answers to some of the variables in table 8.1. Then I will try to fit the Legion into the innovation diffusion model (discussed later). Finally, in the conclusion, I will try to generalize some of the findings in this case study to implementing ISDN in any organization. However, since I only studied one organization, some of these generalizations will likely prove incorrect after more ISDN case studies are performed by the ET group.

Chapter 7

Legion Organization, Procedures, and Planning Documents

This chapter is divided into two sections. The first section details the Legion's structure and procedures. It describes some of the key organizations, their roles, and their interactions with each other. The next section provides details on the two key Legion communications and computer systems planning documents. It explains how these documents affect the implementation of ISDN within the Legion. It is important to note that all information for this chapter came directly from Legion personnel, regulations, pamphlets, manuals, and correspondence. The specific references, however, are omitted in order to maintain some degree of anonymity for the Legion.

Legion Organization and Procedures

The Legion's mission is to defend the United States and her allies against all enemies, foreign and domestic, and to win battles/wars. It is a highly bureaucratic organization with many commands and layers. Figure 7.1 provides a simplified organizational chart of those agencies that affect ISDN deployment. The following sections provide a quick overview on the functions of the different entities and the information/dollar flow between them.

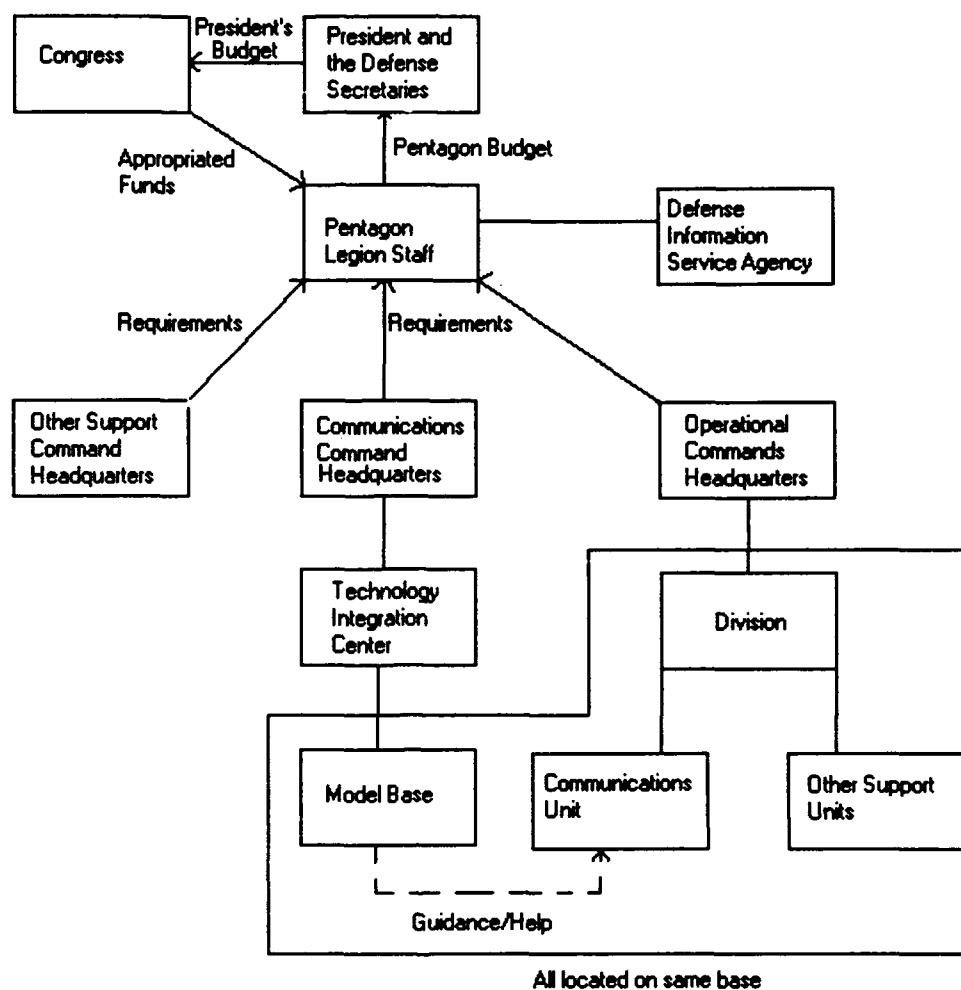


Figure 7.1 Legion Abbreviated Organizational Structure

Pentagon/Legion Staff: The Pentagon is the overall strategic planner and policy maker for the Legion. They act as an information clearing house. The Pentagon gathers data (e.g. current systems problems, requirements, enemy intelligence, etc.) from all of its subordinate commands and analyzes threats. The Pentagon then develops long term plans to meet these threats. The Pentagon is also the banker for the Legion. They draft a budget and then try to convince the President and Congress to support that budget.

Defense Informations Systems Agency (DISA): This is an interservice communications Agency. DISA can be considered the long haul carrier of the Department of Defense (DOD). They provide all of the interbase/long haul connectivity. They do this through a series of leased and owned lines and switching equipment.

Operational Command Headquarters (OCH): These entities are responsible for the overall management of all divisions. They do the tactical planning which includes identifying what support they need from the support commands (like communications command). They also prioritize these requirements so the Pentagon knows what to fund first. OCH creates policies on issues that affect more than one division. Finally, the OCHs pay for everything (with money allocated from the Pentagon). However, once the requirements are funded, the money is handed over to the appropriate command to manage. For example, if new telephone switches are required, the money is given to the communications command to administer.

Communications Command Headquarters (CCH): As stated above, the operational commands are responsible for funding communications and identifying communications and computer systems (CCS) requirements. While they know what they need from the communications units (e.g. I need to talk from here to there), they are not experts on the interworking requirements of a communications unit (e.g. what a communications unit needs in order to talk from here to

there). This expert knowledge is provided by CCH. This entity creates the communications tactical plans which support the operational commands' tactical plans. CCH also provides systems (communications, computers, air traffic control, etc), standards, technical policies, integration/interoperability guidance, and engineering and installation support.

Division: The building block of the Legion is the division. It is at this level that the mission (i.e. fighting) is performed. The division is responsible for performing this mission and creating the operational plans to carry it out. These plans often make demands of the support units (e.g. we need 5000 phones in these locations). It is up to the support units to create their own operational plans to meet the division's requirements.

Technology Integration Center (TIC): The TIC is part of communications command. It is responsible for the following:

- a. Guidance for Legion Systems Engineering, integration, and testing for base-level communications and computer systems (CCS).
- b. CCS architectures, standards, regulations, and publications.
- c. Systems engineering of broad end-to-end technical solutions with an emphasis on integration and interoperability.
- d. Technical assessments of CCS affecting base-level systems.
- e. Evaluation and prototyping new commercial off-the-shelf technology.

Communications Unit: This entity manages, operates, and maintains most CCS for a base. They also create the operational CCS plans to support the division's operational plans and requirements. While they get technical guidance from communications command, they work for and report to the division. The communications unit could be looked at as a combination of a telephone local exchange (e.g. U.S. West) and an information systems service provider.

Support Commands/Units: Like communications organizations, these entities support the divisions and operational commands. They include functions like military police, legal services, base supply, and many others.

Base: A base is like a miniature city that is centered on the division. It has a mayor (base commander), telephone company (communications unit), stores (base supply), food (commissary), transportation (motor pool), etc. Everyone on the base works for the division commander and is there to support the division. A base can cover any where from 10 to 600 square miles and contain several hundred buildings. There are usually 5,000-25,000 people working on a base and all of them require some type of communications.

Model Base (MB): This is where most of the actual ISDN activity is currently happening, and it is where I held most of my interviews. Because of this, I will provide more details on its organization and procedures. MB's mission is to apply emerging technology in CCS to an operating division/base's mission. It focuses on solving the real-

world needs of a combat division. It validates which technologies and concepts are mission and cost effective before fielding them to the rest of the Legion. MB also evaluates the interoperability of commercial hardware and software products that are proposed for Legion implementation. To perform its missions, MB is associated and located with one operational base and its communications unit. It works with the base to help identify where a new technology may fulfill an operational requirement. It then works with the base to test and implement the technology. If the results are positive, MB exports the information to all commands so that they can consider the new system for wider implementation.

MB has a director and two branches: Development and Management (DM) and Technical & Engineering (TE). Besides being the leader and overall manager of MB, the director acts as a high level marketing agent. IF MB finds a solution that works, the director takes this information to the OCHs. He then tries to sell them on the virtues of the solution. If the OCHs are impressed, they will include requirements for this solution in their funding process.

Development and Management (DM) is responsible for the development, management, delivery, and marketing (at a lower level than the director) of all projects. DM is also where the functional area representatives (FAR) are assigned. The FARs are independent agents from operational and support areas (e.g. military police, personnel, supply, etc). They

manage all projects for their respective headquarters. The FARs tend to keep MB and their projects focused on fulfilling the real-world user requirements.

Technical & Engineering (TE) provides the wide range of technical skills (e.g. computer programming and electrical engineering) that are needed to work the projects. They provide a pool of technical manpower and they work for the MB project managers in a matrix management arrangement. They also act as a barometer. The technical manpower mix in TE is similar to that of a division. Chances are that if some solution is too complicated for TE, it will be too complicated for a division.

MB has a specific methodology for managing their projects. The following is a description of how MB manages a project (see Figure 7.2):

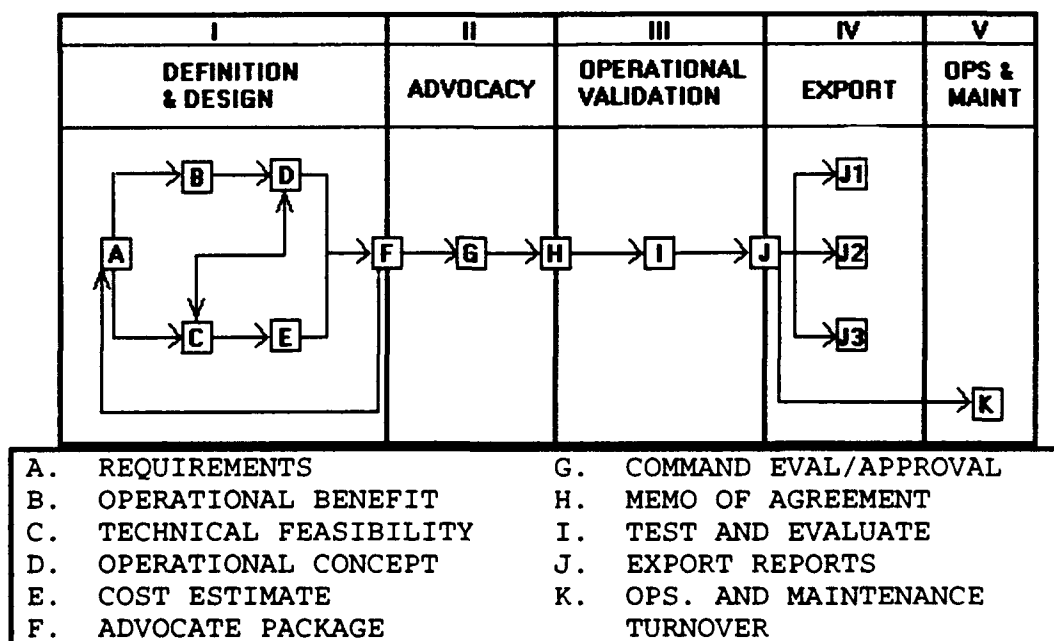


Figure 7.2 MB Project Flow

- a. Requirements documentation: The user states her need. This document is given to DM to manage as a project.
- b. Operational benefit analysis: The user defines what benefits he expects to see if this requirement is fulfilled.
- c. Technical and architectural feasibility: TE determines if the project is feasible and doable.
- d. Operational concept (and prototype if required): The user works with DM and TE to define how the benefits will impact their mission. The results of the technical feasibility may affect this and visa versa. If the concept or technology is new or risky, a small-scale prototype may be required to verify the logic.
- e. Initial cost estimate: With information from the technical feasibility and operational concept, TE will produce a rough cost estimate.
- f. Advocacy package (AP): This is the first major decision point. The package includes data from all of the previously mentioned steps and is intended to define the potential cost versus benefit analysis. At this point, the base and MB decide whether or not to proceed with the package. If the cost benefit analysis proves favorable and achievable, the AP is forwarded to the appropriate command headquarters (i.e. the command that needs the system).
- g. Functional/technical evaluation and support: This is where the affected command decides whether or not the project will proceed (i.e. whether or not they will pay for it). First, the command decides if the benefits are really

worth the costs. Second, the command's resident communications experts decide if the project fits in with the commands overall communication architecture.

h. Memorandum of agreement (MOU): If the command decides to proceed, an MOU is drafted. This document defines objectives for evaluation, defines specific deliverables and schedules, and identifies resource requirements and commitments. The MOU also states the mission importance of the project to the advocate. This is the second major decision point and is outside MB responsibility. At this point, the project is either dropped, supported, or sent back for further work.

i. Operational evaluation and validation: MB works with the users to develop and run an operational test on the proposed system. The test is designed to evaluate if the system meets the expectations. This test is much more in-depth than a prototype and is normally run using real-world conditions rather than simulations.

j. Overall results and recommendations: A report containing results and recommendations is targeted to three separate agencies:

- 1 MB. The document is given to MB for publishing and dissemination.

- 2 Communications Command Headquarters. This agency will use the report to determine how well the tested system fits into the overall Legion CCS architecture (perhaps the system or the architecture needs changing). The

communications command can also recommend to the Pentagon that the tested system be implemented throughout the Legion. The Pentagon may then begin budgeting and programming for the new system (if it gets enough advocacy from the operational and/or support commands).

3 Advocate: The results are also forwarded to the command who sponsored the test. They may then decide whether or not to implement the system at other organizations within their command.

k. Operations and maintenance plan: Assuming the system tested well, it is handed over to the local Division communications unit for operation and maintenance. During the testing period, MB personnel and other temporary specialists are the individuals primarily responsible for operating the system. This transition plan spells out how the responsibility for the new system is transferred to the local communications unit (e.g. training plan, etc.).

Legion Requirements/Acquisition Process

The term requirement is very generic. It means anything that is needed from a telephone to a B-2 bomber, or just a new policy. A requirement can be identified at any level. Generally divisions (or below) identify day to day requirements; command headquarters identify requirements for the next 2-5 years; and the Pentagon works with requirements that are 5 years and beyond. When working these

requirements, the different levels do not work in a vacuum. There is communication up, down, and across the Legion in order to properly define exactly what is needed to fulfill the requirement.

For example, say the Pentagon (through intelligence reports) has identified a threat. They will work with the command headquarters (who in turn work with their subordinate units) to determine exactly what is needed to counter this threat. Let us assume that the Legion has decided they need a new tank. All of the commands provide their inputs as to what is needed to support this tank (e.g. new buildings, new CCS systems, etc.). The Pentagon then consolidates these inputs and puts together a budget proposal. The requirements definition stage can take a year or longer.

Every two years, the Legion staff at the Pentagon prioritizes all Legion requirements and puts together an overall budget request for the next six years. This budget is forwarded to the President who makes his cuts and then passes the budget to Congress for approval. Assuming that the tank requirement made it through this gauntlet, the Legion can now begin contracting for the tank. Usually, this requires a competitive bid, and if everything goes right, the Legion can begin fielding tanks about 1-2 years after they get approval from Congress. If extensive research and development is required, it can take much longer.

This is a long and difficult process. Often, by the time a system is fielded, it is already out of date. Also,

if the Legion does not obligate the money within a certain time period, they lose it and have to go through the whole budget process again to get it back. This sometimes leads to hurried, suboptimal compromises.

Legion Communications Planning Documents

The Legion's two key planning documents are the Communications and Computers Systems (CCS) Architecture and the Standard Base Infrastructure Template (SBIT). The CCS Architecture is the overall Legion strategic plan for CCS. It is supposed to guide the Legion into the next century. The SBIT is a Tactical CCS planning document. It provides guidance on how individual bases should design their internal CCS structures in order to meet the goals in the CCS Architecture. When programming for a new system, CCS planners should consult these two documents to insure compatibility with Legion goals.

Legion CCS Architecture

The Pentagon tasked Communications Command to develop an overall Legion communications and computers (CCS) architecture. This document provides the framework and standards needed to guide planning, development and implementation of CCS systems throughout the Legion. In essence, this document is the overall CCS strategic plan for

the Legion. All requirements for Legion CCS should either stem from this document, or at least be compatible with the architecture (unless there is some pressing, mission critical reason).

The CCS architecture is organized into three main sections. Section one describes the current state of Legion CCS and some of its deficiencies. Section two describes the target architecture. Section three contains a transition strategy on how to reach the target architecture. The following discussion will expand upon these different sections as they pertain to ISDN deployment.

Legion CCS Current State and Deficiencies

Intrabase CCS Current State: The majority of voice communications within the Legion currently is through analog phones. There is a mixture of old analog and new integrated voice/data private branch exchanges (PBX). However, even where there are digital PBXs, most of the phones are analog. Data communications is normally dedicated to an individual or a cluster of functional users and not widely available. Additionally, the majority of data communications systems (e.g. LANs) are not interconnected. There is very little imagery communications (e.g. video teleconferencing). Most large offices share one or two fax machines, but this equipment is not connected to their computers.

Interbase CCS Current State: Interbase communications (for the most part) is provided by DISA. The voice network is primarily analog. They are upgrading to digital, but this is a long process. The interbase data communications is via AUTODIN and the Defense Digital Network (DDN). AUTODIN is mostly used for formal and/or classified documents. There is not direct access to this network from a user's desk top. They must hand carry either a disk copy or a hard copy (to be read by an optical character reader) to the communications center for transmission. DDN is mostly used for informal communications (e.g. action officer to action officer). A user can access this network from his desk top if he is connected to a LAN that is hooked up to DDN. However, this access is not widely available.

Legion CCS deficiencies: Some of the Legion CCS deficiencies are as follows:

a. Existing data networks consist mostly of incompatible proprietary systems that were designed to meet specific needs with various topologies. These networks use proprietary protocols and interfaces that make integration difficult. Most of the networks are star configurations using either direct wiring or dedicated circuits through the PBX to a central data processing system. There are also many LANs installed which are serving various requirements. Often, these LANs were purchased without considering interoperability and integration into a base-wide network.

The Legion owns a large analog communications infrastructure. This results in two separate information transfer infrastructures: analog (voice) and data. In the target architecture, these two structures will be merged.

c. Much of the Legion's equipment is old and has limited capabilities. Most of the data transfers require modems. Most of the phones are analog key telephone systems which use dual-tone multiple frequency or rotary pulse in-channel signaling.

d. The CCS acquisition and implementation process is horrendously slow and unresponsive. Often, by the time a system is fielded, it is already out of date. As a result, the end users have often by-passed the system and purchased equipment on their own. This leads to non-standard, non-interoperable systems.

e. There are insufficient network management capabilities. As the end-to-end transmission capability evolves to a digital, highly interconnected long-haul system, the Legion needs to be able to monitor and control this system (e.g. dynamic bandwidth allocation).

Legion Target CCS Architecture

The overall goal of Legion CCS is to provide a seamless, end-to-end exchange of voice, data, and imagery communications. Figure 7.3 displays the target Legion base architecture.

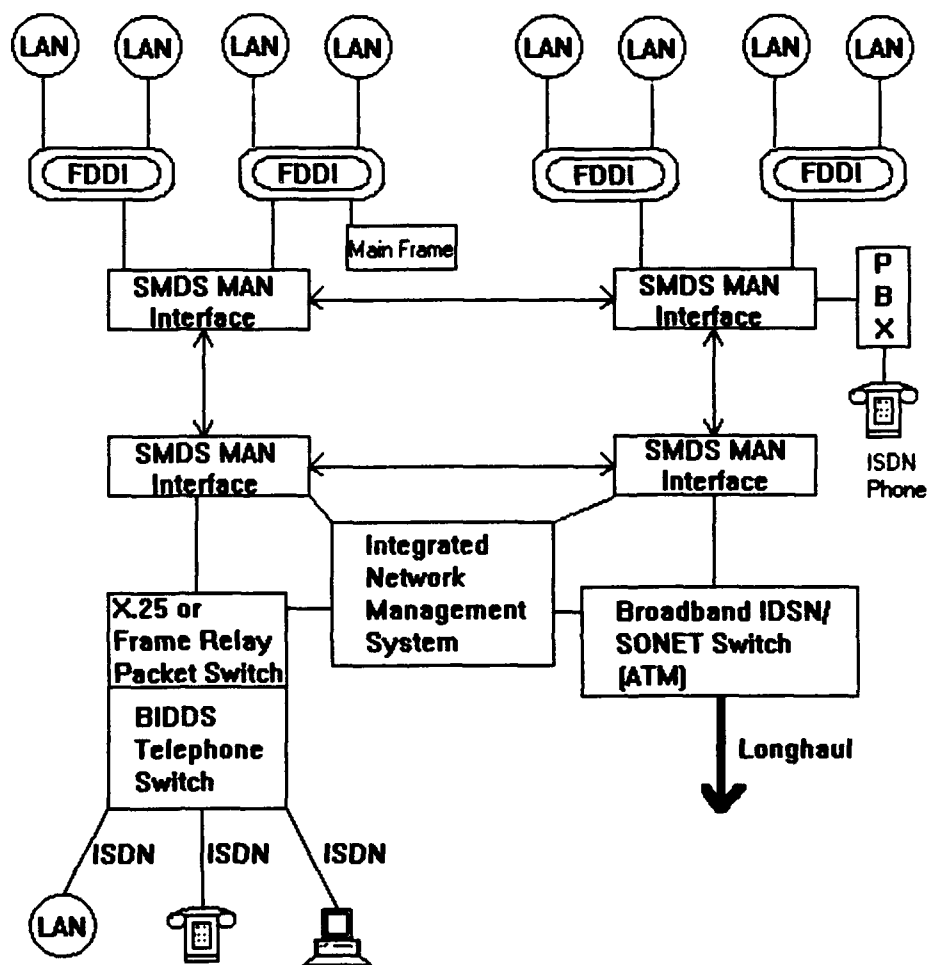


Figure 7.3 Legion Target CCS Architecture

Its primary feature is the distribution of switching, transmission, and connectivity capabilities into a base-wide digital network of multiple information transfer nodes

(ITNs). The ITNs will provide circuit and packet switched connectivity to the users. LANs will support the bulk of intraorganizational data traffic, while the backbone will carry cross-base traffic. Switches will concentrate voice and data traffic and pass it to the long haul system via intelligent gateways. The gateways will efficiently manage access to the long haul network. The gateway will provide automatic rerouting of traffic around disrupted communications links and nodes. When implemented, this architecture will have the following characteristic:

a. End-to-end digital connectivity: The goal is to have a digital system that supports integrated access to voice, data, video, graphics, and other special services. The benefits of this approach include elimination of noise and other interference that can degrade analog connections. Additional benefits include the ability to increase throughput to the user and to incorporate end-to-end features (e.g. calling number identification and authentication). Digitization advances a "system design" rather than a "connection-by-connection" approach to designing the communications systems.

b. Open systems design: The key to interoperability is the standardization of the protocols and functions associated with information transfer systems and networks.

c. Integrated transmission and mixed media: The target will facilitate the integration of voice, data, and video into a common transmission backbone. This will ultimately

provide a highly standardized communications system which offers service to different types of terminal equipment (e.g. phones, facsimile, video stations, etc.).

d. Single Interface. Each user will access and receive service via a single interface. Costs will be lowered through standardization. Performance will increase through elimination of cumbersome and unique access procedures.

e. Centralized Network Management and Systems Control. Centralized management and control will allow a diverse group of systems to be monitored and controlled as one integrated system.

Legion CCS Transition Strategy

Among other things, the Legion wants to posture itself to implement narrowband ISDN (N-ISDN) and broadband ISDN (B-ISDN) services as the technology matures and the requirements dictate. They want to further integrate services to the user by upgrading the switching and distribution systems to provide BRI, PRI, and common channel signaling that will integrate video, data, and voice. However, the Legion will hold off on full scale implementation of ISDN until industry as a whole has adopted these standards.

Standard Base Infrastructure Template

The Standard Base Infrastructure Template (SBIT) is a tactical planning document for building the data CCS infrastructure on a base.⁷⁶ It takes the generic guidance provided in the Legion CCS Architecture document and expands on it. The long term goal of all Legion CCS is to evolve into one huge international and inter-service B-ISDN with SONET network. The SBIT outlines six intermediate, near term solutions that will facilitate the eventual transition to B-ISDN:

- a. LANs with bridges and routers.
- b. X.25 packet switching.
- c. Switched Multimegabit Data Services (SMDS).
- d. Fiber Optic Distributed Data Interface (FDDI).
- e. N-ISDN.
- f. Frame Relay.

Since all of these proposed solutions either complement and or compete with ISDN, I will briefly discuss each one as it pertains to the Legion.

It is expected that the CCS planners at each base will take the SBIT guidance and develop their own tactical plans to meet their base's specific operational requirements. These base CCS planners can use some, all, or intermingle (e.g. N-ISDN with X.25) the proposed solutions.

⁷⁶As technology advances, voice traffic will be included on many of these technologies (e.g. FDDI II).

In addition to describing proposed near term solutions, the SBIT outlines the characteristics of four major Legion programs:

- a. Defense Management Review Decision.
- b. Defense Messaging System.
- c. Personnel Concepts III.
- d. Base Information Digital Distribution System.

These four programs were chosen as a representative sample of base-level communications requirements because they account for about 75% of the base data traffic. The SBIT shows how these programs could be served and/or interoperate with the proposed solutions. Since these programs strongly impact the way the Legion is employing ISDN, I will also briefly discuss these programs and their requirements.

Near Term Solutions

LAN Bridge/Router Solution: This near-term solution uses bridges and routers to consolidate data users by interconnecting their respective LANs. The types of LANs characterized in this solution are based on the Institute of Electrical and Electronics Engineers (IEEE) 802.3 technology employing carrier-sense multiple access with collision detection. Most of the Legion's bases are at least partially implementing this solution. However there are still many isolated LANs, LANs that do not comply with 802.3, and users that are connected by modems (see Figure 7.4).

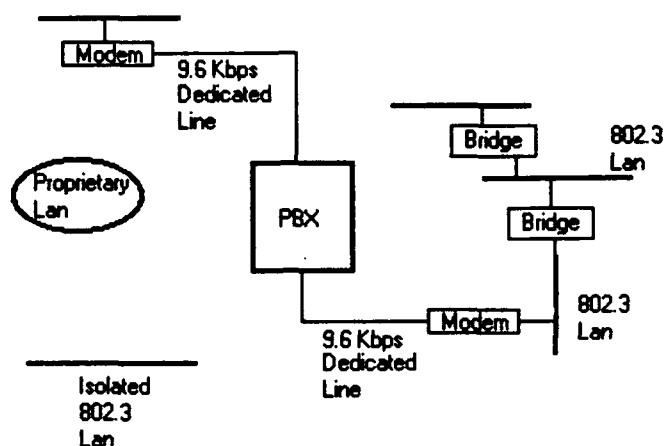


Figure 7.4 Current Legion Base Architecture

FDDI Solution: This solution advocates implementing an FDDI network to provide a high-speed (100MBPS) transport for data users. FDDI was developed and adopted by the American National Standards Institute (ANSI) Accredited Standards Committee (ASC). The general design of a FDDI network is that of a dual counter rotating token ring. It uses the token ring because this is currently the most efficient design for LANs (e.g. do not have to worry about collisions as in an Ethernet). Also, the star or passive bus design would require taps, and these cause attenuation which severely limits the number of possible nodes. FDDI uses the dual ring design to provide redundancy. As a side note, the dual ring also provides the potential to provide 200mbps on FDDI networks. FDDI has a maximum distance between stations of two kilometers and a total maximum distance around the ring of 100 kilometers. The Legion wants to employ FDDI as a backbone for LANs or to enable distributed computing (i.e. dividing the workload on a given job between different processors). They want to provide isolated users

connectivity to the FDDI ring via dial up ISDN lines, or a shared ISDN line with a packet switch (Figure 7.5). Currently, not many Legion bases have deployed FDDI technology.

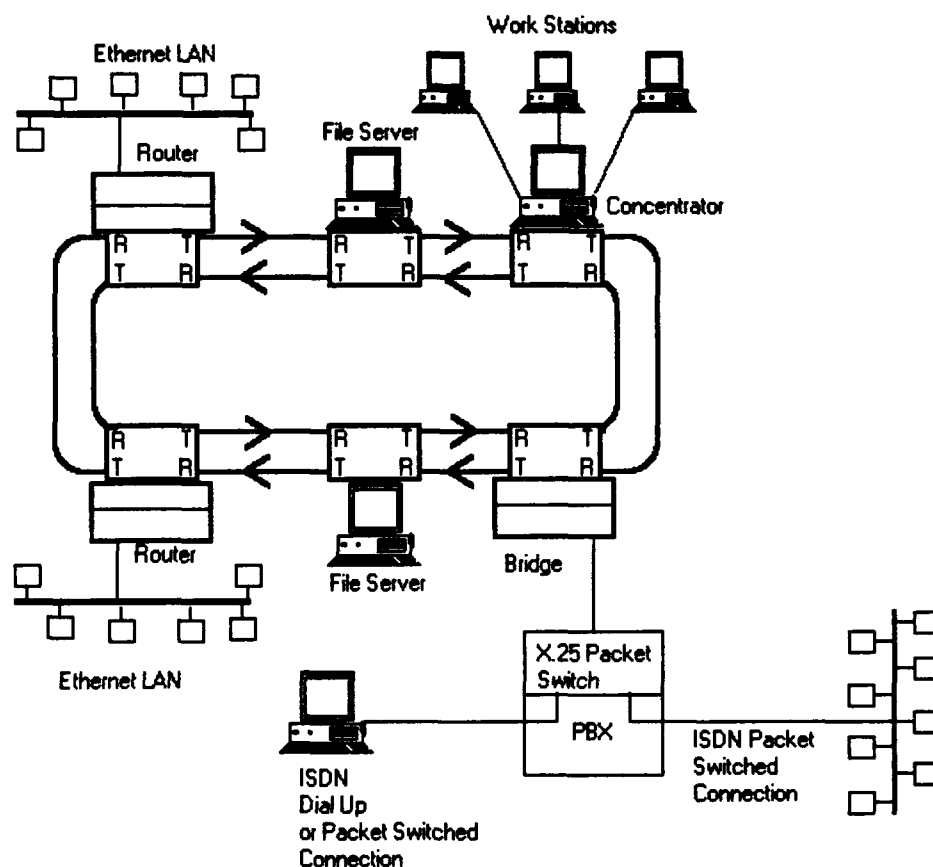


Figure 7.5 FDDI Solution

X.25 Packet Switching Solution: X.25 gateways (or Packet assemblers-disassemblers (PAD)) are interconnected to a single X.25 packet switch that connects them to a long-haul X.25 network, such as the Defense Data Network (DDN). The combination of these PADs and a X.25 packet switch form a Metropolitan Area Network (MAN) to connect various data users on base (e.g. LANs) and form a Wide Area Network (WAN) with

other bases (Figure 7.6). The X.25 packet switch can accommodate user data rates from 2.4 kbps to 1.544 mbps and is very reliable. It ensures that the packets arrive intact and in order. X.25 protocols and packet switches are currently being used for Legion interbase communications on some links of the DDN. However, they are not being used for intrabase communications at this time.

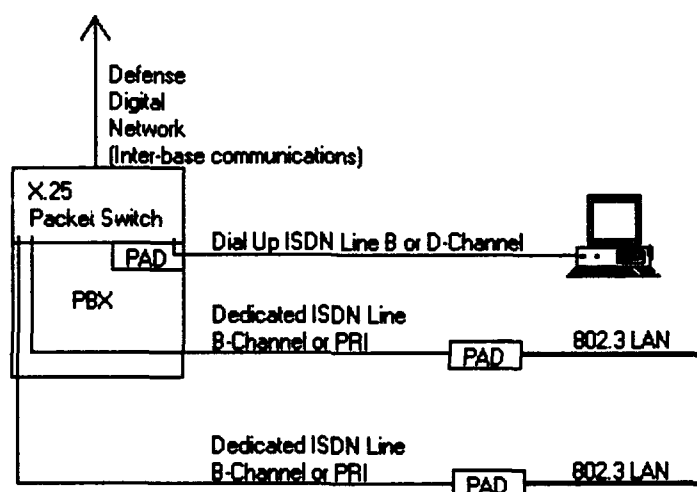


Figure 7.6 X.25 Solution

Frame Relay Solution: Frame relay is a packet switching technology similar to X.25 packet switching; however, since it does not require the extensive error detection and correction of X.25, it can reach much higher speeds (up to 45 mbps). The Legion wants to use frame relay for MAN and WAN connectivity (Figure 7.7). Currently, there is not any frame relay employed in the Legion. Chances are, that even once frame relay is widely deployed, the Legion will still have to maintain an X.25 capability to ensure world-wide interoperability.

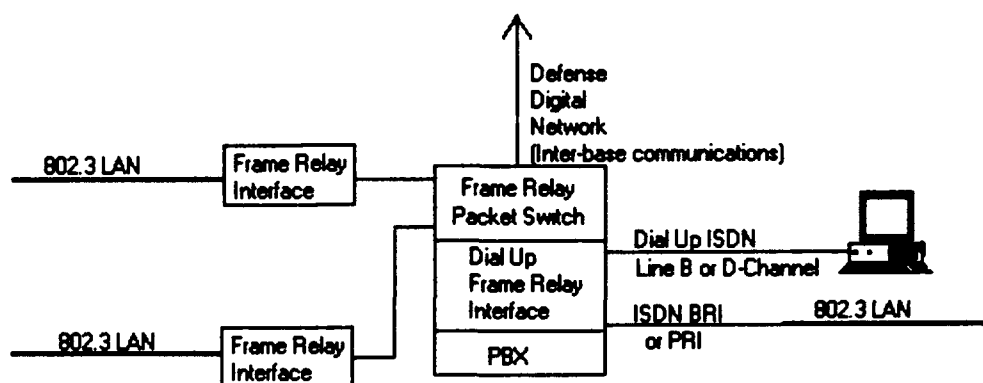


Figure 7.7 Frame Relay Solution

Switched Multi-megabit Data Services (SMDS) Solution:

SMDS is a high speed connectionless public, packet switched data service that extends LAN functionality from the subscriber over WANs. The Legion plans to use SMDS (or IEEE standard 802.6, whichever becomes the industry standard) as a MAN to interconnect LANs, provide distributed computing, data archival and retrieval, centralized imaging, and computer aided design (Figure 7.8). SMDS has a common slot structure (53 octets: 44 data, 7 header, and 2 trailer) with that of B-ISDN. Hence it is the best technical solution (of those presented) for the eventual transition to the long term target.

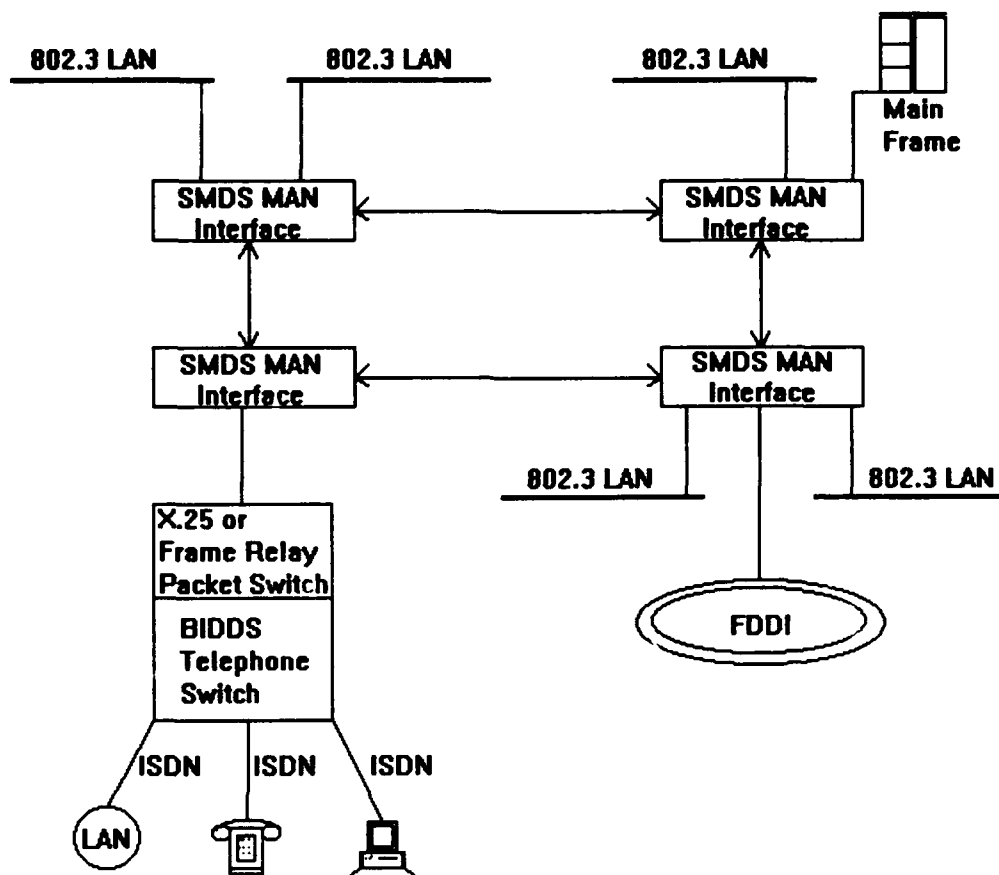


Figure 7.8 SMDS Solution

Narrowband ISDN (N-ISDN): Besides voice communications, the Legion intends to employ N-ISDN as the "utility solution." This means that N-ISDN will fill any gaps that are not covered by the previous solutions or it may even replace one of the previous solutions. For example even if all of the previous solutions are in place at one base, there will still be many users that are not connected to anything but their phone. In this instance, N-ISDN could be used to call the packet switch and access any LAN, MAN, WAN, or server on base. Also, there may be bases where their data requirements do not justify a high speed backbone (e.g.

FDDI). In this case ISDN could be used to interconnect the LANs, or connect all LANs to a packet switch. All of the previous figures illustrate the many uses of ISDN in the Legion's planned architecture. While N-ISDN is available at many bases, it is hardly used at this time.

Overall Solution: The bottom line is that each Legion base can employ one, some or all of these solutions. The combination employed depends on two things:

- a. What their data requirements are.
- b. How much the division commander (and/or the operational command commander) is willing to spend on CCS at the expense of his other requirements (e.g. guns and bullets).

Current Legion CCS Programs

Base Information Digital Distribution System (BIDDS) Program: The BIDDS program was developed to provide the overall base infrastructure. This is the program that includes all Legion ISDN capabilities. The goal of BIDDS is to replace existing telephone switches and upgrade the cable distribution systems with integrated digital telecommunications systems that are capable of efficient, high capacity communications transfer.

Under this program, the Legion is purchasing the Northern Telecom Incorporated (NTI) MSL-100 telephone switch.

The MSL-100 is an electronic stored program control digital switch capable of switching the following:

- a. Voice analog circuits.
- b. Quasi-analog data circuits.
- c. Digital data circuits.
- d. N-ISDN circuits.

It can provide N-ISDN BRI and PRI circuits that are compatible with the Defense Switched Network (DSN) functions such as multiple precedence and preemption. The N-ISDN capabilities are currently limited to islands of users homed off of the same base switch. This is because the DSN interbase switches do not currently support ISDN interfaces.

Currently the MSL-100 is configured to provide switched and non-switched communications based on the single line concept. Dedicated lines are installed between the switching center and each user making user-to-user connections available to and from all locations. On the line side, connectivity is via twisted pairs. On the network side, connectivity is via digital wire or optical fiber trunks. The switching systems may consist of multiple switches, a single switch with remote switching terminal, or a single switch.

All voice and data transmissions are routed through the cable plant to the MAN distribution frame (MDF). From the MDF the call is routed through the MSL-100 for intra and inter base communications. Data users (including N-ISDN

users) are connected through the switch to other data users by accessing the appropriate modem pool or ISDN interface.

Currently, the BIDDS switches are not configured to handle X.25 packet switching, frame relay, or SMDS interfaces. However, the next BIDDS contract (due to be let in March 1993) is projected to have all three. The specific configuration of the actually installed switch will depend on the individual base operational requirements.

Defense Management Review Decision (DMRD): DMRD is attempting to move all base-level data processing (mainframes) to regional processing centers (RPCs). The goal of this program is to save the Legion money by reducing computing manpower requirements and the number of mainframe computers, without affecting the quality of service. Some of the applications that are targeted for RPCs are the dental data system, base accounts receivable, Legion standard civilian automated pay system, standard base supply, and many others.

The current and projected information flows are in Figure 7.9 and 7.10 respectively. Currently, printed products are all produced at the base-level processing center (BLPC) and hand carried to the user. The new configuration requires that more high speed printers (many documents are several thousand pages) be deployed to the users. This added expense, however, is more than compensated for by the reduction in personnel and main frames.

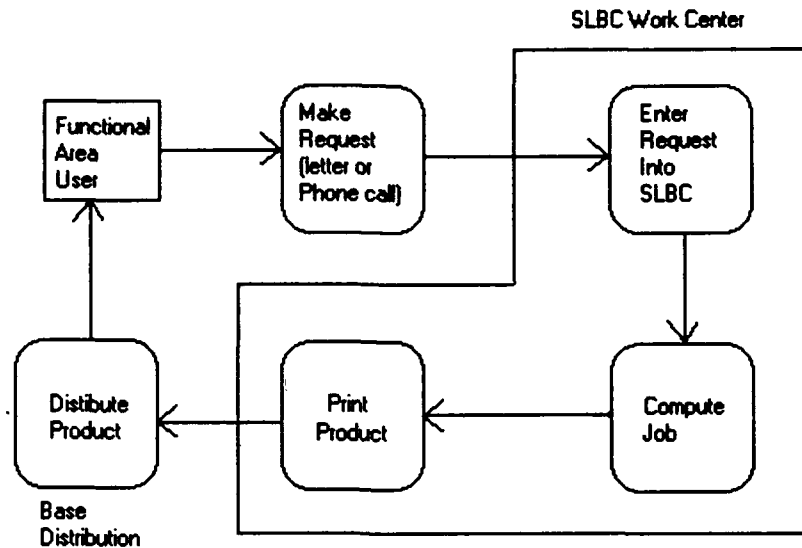


Figure 7.9 Current DMRD Information Flow

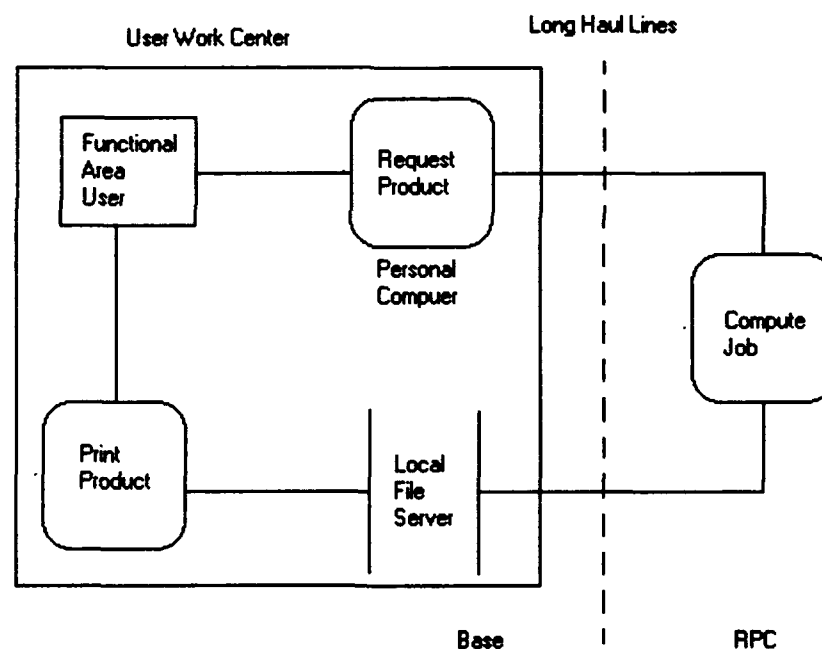


Figure 7.10 Projected DMRD Information Flow

Defense Messaging System (DMS): DMS is the Legion program which implements the jointly developed Department of Defense (DOD) messaging system architecture. It is a program to transition from today's over-the-counter manual services to writer-to-reader message service across the DOD. This

includes electronic delivery of messages between organizations and individuals. The DMS program will provide a single method for sending and receiving messages between users based on CCITT X.400 message handling systems and X.500 directory services. The goal of this program is two-fold. First, it expects to replace an old system that is based on 1960's technology, policies, and procedures. This system is costing a lot in manpower, operating and maintenance costs. Secondly, the DMS program intends to stop the proliferation of different proprietary E-mail systems residing on various hosts.

Currently, the Legion messaging system consists of two separate, disjointed systems: Automatic Digital Network (AUTODIN) for organizational messages, and DDN (E-mail) for individual messages. AUTODIN processes critical command and control information. Since AUTODIN messages can command organizational action, they must go through a formal process (see Figure 7.11 for current AUTODIN information flow). Usually, a paper copy of the message is generated, coordinated, and signed. Then the paper copy, with authenticating signatures, is hand carried to the communications center to transmit. DDN messages are for informal information. An individual can access the base DDN host via a LAN or a modem and then send/receive his E-mail messages (see Figure 7.12 for current DMS information flow). However, many individuals do not have access to a LAN or a modem.

Eventually, the two systems will be merged (see Figure 7.13 for the combined projected information flows). The information flow for individual type messages is relatively unchanged. The information flow for organizational messages will be similar to individual E-mail except there will be procedures and precedence features, and delivery and "read" receipts.

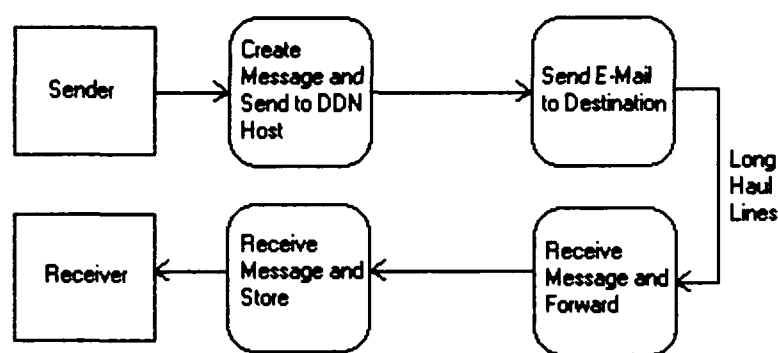


Figure 7.11 Current DMS Information Flow

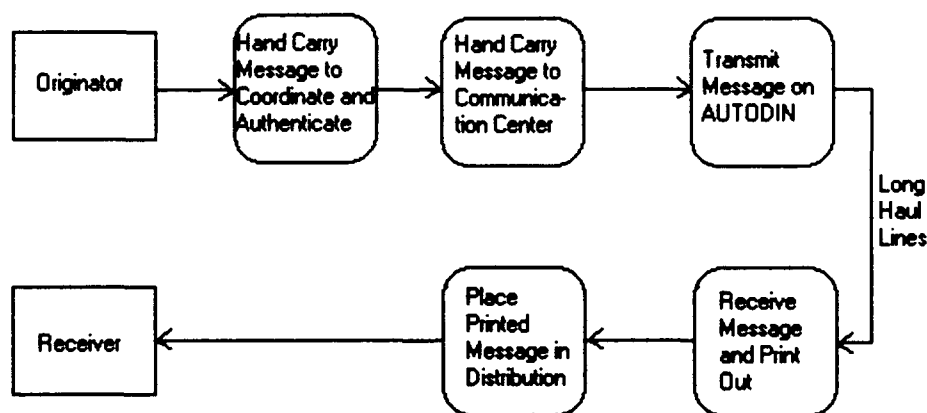
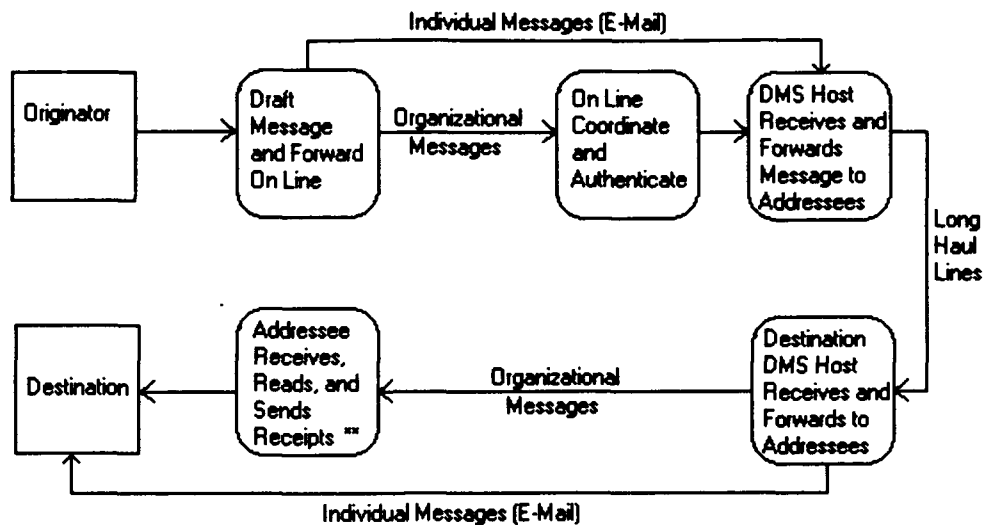


Figure 7.12 Current AUTODIN Information Flow



*** The receipt process isn't shown. Receipts just go back through the DMS Hosts to the originator

Figure 7.13 Future Information Flow Of Messaging Systems

Personnel Concepts III (PC-III): PC-III extends

Automated personnel data support to the following users:

- a. Commanders and staff agencies.
- b. Unit orderly rooms.
- c. Individuals.
- d. Consolidated Base Personnel Offices (CBPO)
- e. Non-personnel agencies (e.g. military police and the finance office).
- f. Major unit work centers.

Some of the applications that PC-III will support are as follows:

- a. Locator (to find the location of an individual).
- b. Performance Reports.
- c. Automated personnel file.
- d. Projected outbound assignments.
- e. Projected inbound assignments.

f. Re-enlistment.

g. Separations and retirements.

The goal of PC-III is to provide enhanced personnel service and provide Legion individuals with the necessary personnel information that they need to manage their jobs.

Currently, all of the Legion's master personnel files are maintained at the Legion Military Personnel Center (LMPC) located at "base x." The local base CBPO is the only organization with access to this information. All reports are generated on a CBPO printer and are sent through base distribution to the requestor. In the future, access to the MPC personnel files will be distributed among the base. However, because this information contains data subject to the Privacy Act, the PC-III system will still be relatively closed. Only certain networks and or terminals will be allowed access. Individuals who want to view this information will have to go to the nearest PC-III access terminal. Figure 7.14 and 7.15 show the current and projected information flow for the PC-III system.

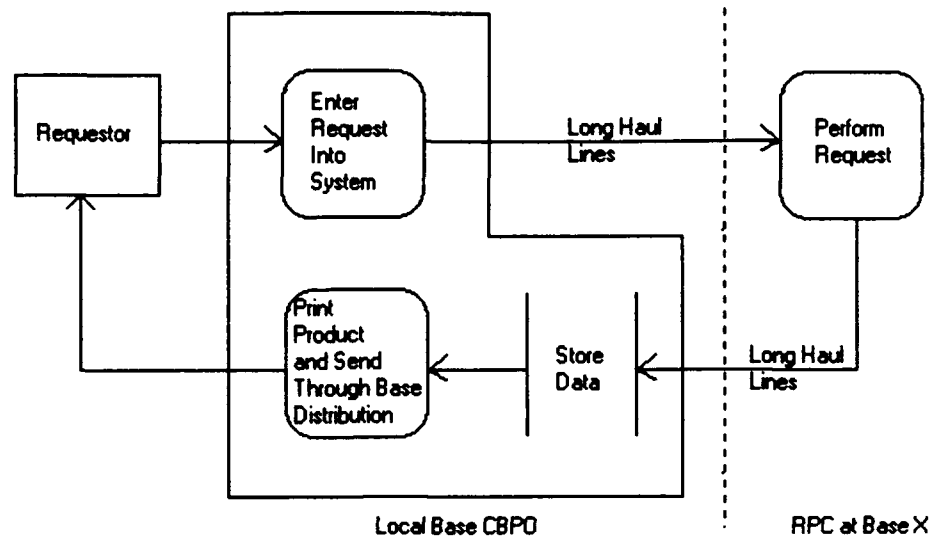


Figure 7.14 Current PC-III Information Flow

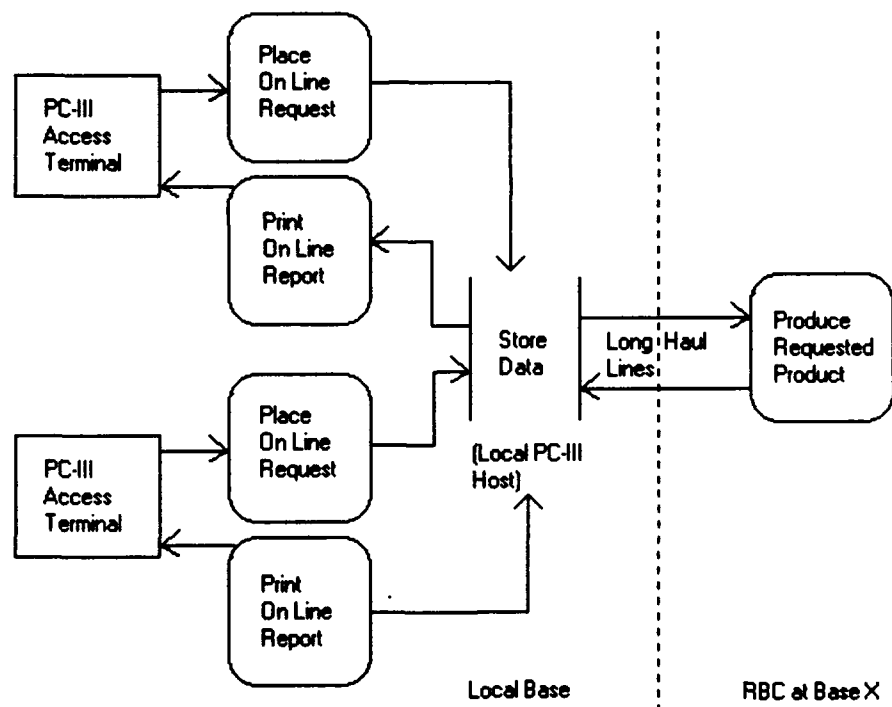


Figure 7.15 Projected PC-III Information Flow

Chapter 8

Legion ISDN History and Implementation

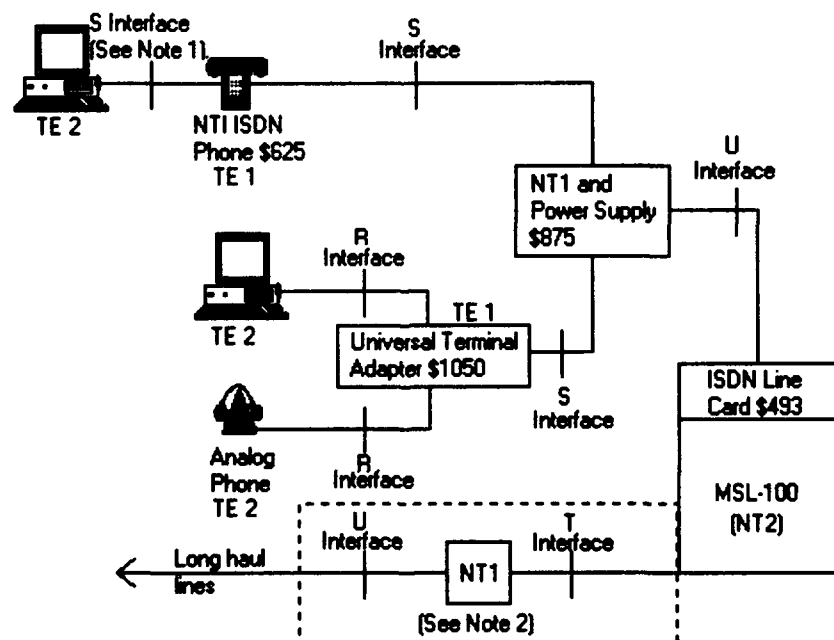
The CCS infrastructure on most bases evolved from plain old telephone service (POTS) requirements. It consisted of a step by step circuit switch located in the base dial central office, an outside plant cable distribution system consisting of twisted pair cables, duct systems and the customers telephones. This system served the Legion well past its life expectancy. Logistics support became costly or impossible. Mission requirements grew more complex, and the demand for improved and expanded services exceeded the performance capability of the POTS infrastructure.

The Legion recognized that the current system was failing and that the requirements were changing. Around 1984-85, the communications command was tasked to develop the future Legion CCS infrastructure and they published this guidance in the Legion CCS Architecture document (discussed previously). About this time, one of the architecture authors had been reading articles about ISDN. After further research and discussions with vendors, the communications command felt ISDN was the wave of the future. They placed ISDN into the Legion CCS architecture documents as part of the target base infrastructure.

By 1986 communications command (with advocacy from the operational commands) convinced the Pentagon that the Legion needed a new base infrastructure to meet the current and

future operational requirements (i.e. that the Legion needed a new phone system more than they need some new gun). As a result, the Base Information Digital Distribution System (BIDDS) was developed. This program allocated about \$880 million dollars to install new digital switches at 134 bases over a six year period starting in 1987.

ISDN Equipage: The Legion awarded the contract for the switches to Northern Telecom Incorporated (NTI). At the time, ISDN was a relatively untried technology. As such, the implementations available were rather awkward and expensive. The Legion configuration for N-ISDN and their costs are in Figure 8.1. Each instrument has an NT1 in order to increase the distance allowed between the user and the MSL-100.



Note 1: A PC attached to an NTI Telephone can only communicate at 19.2 KBPS
A PC attached to an NTI Universal Terminal Adapter can go at 64 KBPS

Note 2: This part of the configuration is for PRI interbase connectivity; however, the Legion currently does not have Interbase ISDN capabilities.

Figure 8.1 Legion ISDN Configuration

Because of the cost, the Legion employed ISDN only in a limited mode. They settled on the arbitrary Figure of about one percent ISDN capability per base (about 50 to 100 instruments). The rest of the voice equipment is either NTI proprietary digital phones or analog key systems. The Legion's rationale for their one percent ISDN deployment was two-fold:

a. ISDN terminal equipment would become more standardized, less costly, and more capable as time goes by. Hence, it would be foolish to purchase lots of it now without specific mission requirements. Most of the current user requirements could be met with the cheaper proprietary digital phones and/or modems.

b. The Legion employed the one percent to allow the bases to experiment with ISDN capabilities and learn about them. They were convinced that ISDN would improve mission readiness and eventually would be the only feasible option (i.e. analog and proprietary digital phones would go the way of the horse and buggy). The Legion expected that as the bases played with ISDN, they would like it and find more uses for it, and therefore, require more ISDN equipment. The bases could then purchase the additional equipment via an open contract with NTI using their own base supply money.

By October 1991, about 500 ISDN phone sets were deployed. The Legion performed a survey to see how the one percent ISDN capability was being used. What they found was disturbing. In most cases, the phone sets were not even

hooked up. The users who did use the phones were only using them as regular phones. They were not using any special functionality like automatic number identification or simultaneous voice and data. The result of this survey was to recommend the Legion stop the arbitrary one percent ISDN deployment and only purchase ISDN equipment when there was a validated user requirement for ISDN.

The key factors causing problems in the Legion's deployment of ISDN were the lack of guidance and the lack of training (the SBIT was not published until February 1992). The ISDN equipment was just dumped on the bases. There was very little training provided on how to use the equipment, and there was no guidance on where to employ the ISDN capabilities (i.e. what missions it could support). This deployment strategy is analogous to someone dumping a computer on a user's desk, showing him how to turn it on, and then expecting him to develop applications for it.

In spite of this survey, the Pentagon decided to proceed with the current one percent ISDN implementation plan for the following reasons:

a. Because of the agreements at the National ISDN-1 conference and assurances from vendors and phone companies (e.g. AT&T and MCI), the Legion is still convinced that ISDN is the wave of the future. They feel they need to proceed with ISDN, or they will be left behind the power curve when it finally arrives.

b. The programming and budgeting process in the Legion is long and complicated. They currently have money allocated for ISDN capabilities. If they cut this money now, they do not know when they will be able to get money in the future (i.e. use the money or lose it).

c. The Pentagon expects that users will experiment with the one percent ISDN capability and find uses for it. Then they will probably demand more ISDN equipment and fund it out of their own operating money. The Pentagon feels if they do not provide the users with the initial one percent ISDN capability to experiment with, they will never try it.

c. Model Base has been testing ISDN on current operational requirements, and the recent data has been positive. The Pentagon feels that this recent information is sufficient to proceed with their ISDN plan.

Model Base (MB) Influence on ISDN

As stated before, MB's mission is to apply emerging technologies to real-world division requirements. This is not a laboratory environment. MB is located at an operational base (geographically separated from the TIC). They work with the base communications unit and the division personnel to apply new technologies to fulfill current requirements. If the new technology proves to be a good solution, MB publishes this information so that other bases can use the new technology. If the new solution has wide

applicability, chances are the command headquarters and the Pentagon will get involved to begin programming and budgeting for the new technology.

MB has had two distinct phases in its existence. Phase I was when MB was initially formed back when the BIDDS program was started (about 1986-87). One of their major charters was to obtain an ISDN capability and experiment with it. They were supposed to find operational uses for the ISDN technology. MB purchased an AT&T 5ESS ISDN equipped switch to perform their mission (this was before the Legion gave the telephone switch contract to NTI).

At first, MB received all the money they needed (this was before the major defense funding cuts). Anything they wanted, they got. Their focus was on testing ISDN capabilities to see what it could do. MB would put together some interesting systems and then try to sell them to the users. There was very little user involvement during the system development. As a result, the users would often agree that the system was interesting, but not something they were willing to spend money on. This went on till about 1990. During this time MB gained a lot of knowledge on ISDN, but they did not produce many useful solutions. Plus, many of the ISDN systems they did test on the AT&T switch were not portable to the NTI switch (because of proprietary incompatibility problems).

Phase II for MB started about 1990 when they were forced to make many changes. First they got a new commander.

Second, the base they were located on was closing so MB had to move. And third, the Legion was going through major budget cutbacks, so MB no longer could get all of the money that they wanted. These three things altered the entire focus of MB and surprisingly helped it.

MB moved to a base that had a new NTI telephone switch, so they no longer had to worry about the proprietary incompatibilities with the AT&T switch. The new commander and the budget cutbacks forced MB to change their methods. Before, MB would use their own money to develop ISDN systems and then try to find users. Now, MB takes existing division operational requirements and examines whether ISDN can fulfill that need. If ISDN is suitable, MB will get money from the user (assuming the user is convinced) to develop and implement the system. This methodology requires a lot more user involvement (see functional area representatives discussed earlier) and leads to better, more useable ISDN solutions.

Since MB moved to their new location, their major thrust has been to establish a base-wide MAN using a combination of existing LANs, N-ISDN, and a Netrix X.25 packet switch attached to the MSL-100. MB determined (by reviewing user requirements documents) that the base needed this kind of system. MB put together their base-wide MAN plan and was able to sell the idea to the division commander and the PC-III, DMRD, and DMS program managers. These last three are critical because their programs are fully funded. If they

like what they see at MB, the program managers can pay for lots of additional ISDN capabilities throughout the Legion.

Until now, every new program arriving on a base (e.g. PC-III, DMRD, and DMS, all described earlier) would provide their own base connectivity. This led to many isolated, proprietary solutions that would not interoperate, would not provide universal access, and required a lot of dedicated circuits (see Figure 8.2). A user would have to walk to a specific PC-III terminal, or DMRD terminal rather than access it from their own PC.

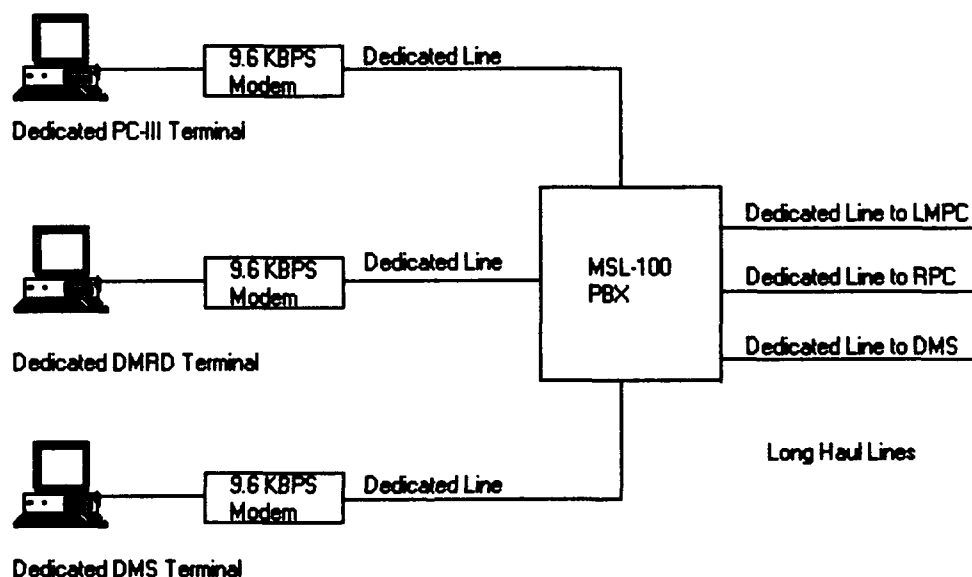


Figure 8.2 Current DMS, DMRD, and PC-III Plan

MB's proposed MAN will change this configuration (see Figure 8.3). The X.25 packet switched and ISDN network provides universal base-wide data connectivity that users can employ in place of or in conjunction with their own systems. For example, the PC-III program manager was going to provide three or four PC-III terminals per base and have dedicated

lines using 9.6 kbps modems going to each. Now the program manager only needs to provide connectivity from the Legion Military Personnel Center (MPC) to the local base X.25 packet switch. The required users can access the MPC information from their own terminals (assuming that they are an authorized access point) using the base-wide MAN. This saves on modems, dedicated circuits, dedicated terminals, and provides a wider access (instead of 3 or 4 PC-III terminals, MPC can designate as many as they want). Security is provided via the X.25 switch which can allow or deny access to specific terminals and/or specific LANs. Another example could be a user that requires an FDDI LAN. While MB's MAN could not replace the requirement for the high speed connectivity provided by FDDI, it could provide connectivity to the FDDI ring for many isolated users or LANs.

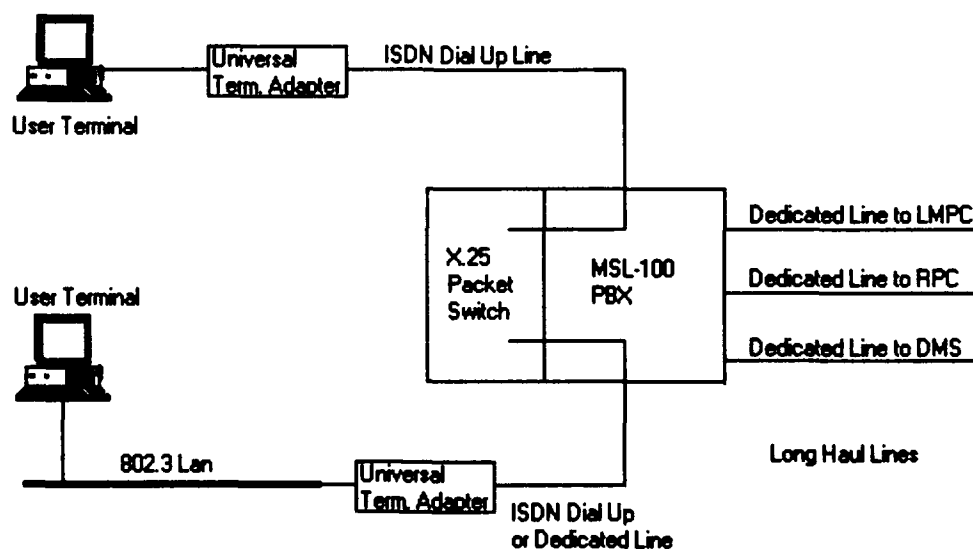


Figure 8.3 MB Proposal on DMS, DMRD, and PC-III Plan

Using the MB's project flow chart to describe their progress, they are just beginning phase III. They have memorandum of agreements signed with all of the major players (division commander, PC-III, DMRD, and DMS), and they have started operational evaluation. The X.25 switch with ISDN interconnectivity is up and running. MB has tested some local division applications (described further in the interview section). One of the key selling points is the fact that the ISDN equipment they need for their systems is already purchased. Therefore, this saves their individual budgets money. Whether it saves the Legion as a whole money remains to be seen. Part of Phase III's test and evaluation includes an extensive cost versus benefit analysis, but the results will not be available until October 1992,

Another initiative MB is working on is interbase ISDN services. At this point, there are no interbase ISDN capabilities. DISA has not upgraded the defense long haul network to handle ISDN. However, DISA has recently agreed to fund some trial ISDN circuits between MB and selected other bases. This enables MB to test capabilities like video conferencing and simultaneous data and voice. This is important because a key factor in selling the Legion on ISDN was reducing travel requirements (via services like video conferencing). So far ISDN has not met these expectations, and as a result, the Legion's leaders are disappointed and critical of ISDN.

Chapter 9

Summary and Analysis of Results

The following discussion synthesizes the data collected from the Legion and their ISDN implementation (see Appendix C for the interview results). The results are divided into the five classes of variables that affect a typical implementation of an emerging technology (see table 6.1 in chapter 6): Contextual variables, organization-level implementation variables, and outcome variables.

Contextual Variables

The Legion is a huge bureaucracy with several hundred thousand civilian and military employees. This is both a blessing and a curse. It is a blessing because the Legion has a lot of money to invest in new technologies. So far, they have spent about \$50 million on ISDN, and this has gone a long ways toward providing the Legion an initial ISDN capability.

It is a curse because it takes forever to purchase and implement new communications and computer systems (CCS). They have to propose a budget for it. The proposal has to get approved by Congress and the President. And, finally (if approved), the Legion has to go through the competitive bid process. Even after the Legion lets the contract to the winning vendor, the losers can contest the bid (claiming

unfairness or something else) and stall the process even more. At best, it usually takes 2 years from the time the CCS requirement is approved at the Pentagon until the Legion begins to implement the system. They were fortunate with ISDN. They were able to start fielding equipment within 2 years after identifying the requirement and have a 10 year plan to equip all bases with digital, ISDN capable switches.

One of the biggest stumbling blocks for ISDN implementation in the Legion has been the lack of authoritative CCS planning guidance from higher headquarters. The SBIT is a good, although late, start (it was not published until February 1992, nearly 6 years after ISDN was introduced into the Legion). However, it only provides standards that bases should follow, but they do not have to comply if they choose not to. Because of this many bases obtain "stove pipe systems"⁷⁷ that do not fit the Legion CCS architecture. If the SBIT was authoritative, this problem would go away. The bases would have to purchase systems that comply with the CCS architecture guidance. This in turn

⁷⁷ The term "stove pipe system" is used regularly by Legion communications personnel. It refers to a system that a user purchases by circumventing the procurement process. While the user can get the required system quicker this way, it has many problems. Often, the user does not consult with anyone and ends up purchasing a system that does not interoperate with anything. Also, the users purchase the system without programming for logistic support or operating and maintenance personnel. Technically, this means that the user is solely responsible for this unique system. However, in practice, the users purchase the system and then "dump" it on the local communications unit. They then expect them to operate and maintain the system without any prior planning, training, or any additional money.

would encourage more ISDN usage because ISDN is part of the overall architecture.

Another problem with higher level headquarters has been their lack of support for ISDN. Other than providing money for equipment, the Pentagon has been completely neutral on ISDN. So far, all ISDN initiatives have been pushed from MB rather than from the Pentagon. The Pentagon says that it is waiting for MB to develop some mission critical applications before it advocates heavy ISDN usage throughout the Legion. MB says that the Pentagon is not providing enough support for ISDN and this is slowing their applications development. It is a "Catch 22."

The Pentagon and MB need to have a meeting to jointly map their plans for ISDN. The Pentagon can provide help for ISDN implementation without advocating full scale implementation. For instance, MB had to negotiate with the program managers of DMRD, DMS, and PC-III just to get them to participate in an ISDN test. This was a very political process and took a lot of time and effort. MB should have been able to go to the Pentagon and have them convince the program managers of those programs to participate in the test. They would have been more easily persuaded to try ISDN on their programs had the request come from the Pentagon, rather than MB. In addition, this high-level support from the Pentagon would help motivate the entire Legion to consider ISDN as a possible solution to some of their CCS requirements.

Organizational Variables

The Legion first studied ISDN around 1985 when they were creating their first CCS architecture. One of the drafters of this document read several documents about ISDN and talked with the vendors. She was convinced that ISDN was the telephone system of the future, so she included it in the architecture. From this guidance, ISDN was incorporated into the Legion program for new digital telephone switches (BIDDS), and by 1988, the Legion had its first ISDN capability.

At first, there was no controversy about investing in ISDN. Most thought it was the solution to all data and voice requirements. The Legion liked the fact that ISDN used the existing cable plant and they felt ISDN was the only way to get data connectivity on every desk top. However, as time went by and ISDN remained unused, the wisdom of investing in ISDN was questioned.

The Pentagon reevaluated their approach to ISDN, and they considered stopping all future ISDN purchases unless there were validated user requirements for ISDN capabilities. The Legion decided however to proceed with ISDN procurements. The Pentagon realized that ISDN was not the panacea they originally envisioned, but they felt it could still an important part of the overall Legion CCS strategy. Their

opinion was that all ISDN needed to get started was some good applications and a better implementation strategy.

Thus far, the Legion's implementation strategy for ISDN has not worked very well. This failure was caused by three factors:

- a. Their ISDN terminal equipment deployment strategy is poor.
- b. They have no interbase ISDN capabilities.
- c. Until recently, their technology assessment group has been ineffective.

The Legion's ISDN terminal equipment deployment strategy was to provide an arbitrary one percent capability with every switch.⁷⁸ They provided no guidance and very little training on what to do with the ISDN equipment. The Pentagon and the communications command expected the end users to experiment and develop uses for ISDN. The one percent was supposed to provide an initial capability that users could "play" with for free. Then, once the users liked ISDN, they could purchase more ISDN terminal equipment to meet their requirements (using their own supply money).

The Legion thought that ISDN usage would be similar to that of the PC: People would play with it, find uses for it, and finally incorporate it into their daily operations. While there are several analogies that can be drawn between

⁷⁸ It was too expensive to provide 100% ISDN capability. The remaining phones are either POTS analog or NTI proprietary digital phones.

PCs and ISDN (e.g. they both require applications to be useful) there is one key difference -- ISDN is a networking technology. A PC, while more useful when part of a network, is valuable in a standalone mode. A user can do word processing, create data bases and spreadsheets, play games, etc. A single ISDN phone, with no other ISDN phones to talk to, is just an expensive phone -- nothing special.

The Legion deployed the one percent ISDN capability without any distribution plan. The phones were divvied out in a random manner. This means that at best, an ISDN user has a one percent chance of talking to another user with an ISDN phone. With this kind of availability, it is hard to convince a user to spend time experimenting with ISDN capabilities (even when the phones are free, let alone when the user has to start buying them).

There are two ways to rectify the Legion's deployment policy: Program for additional money and provide the critical mass of ISDN capability or devise a better plan. Both of these options are discussed more in the next chapter.

The next problem with the Legion's ISDN implementation is their lack of interbase connectivity. ISDN reaches its true value as a WAN, and without interbase ISDN capabilities, the Legion will not receive these benefits. The main stumbling block in obtaining interbase connectivity has been DISA. This agency (not under the Legion's control) is responsible for all DOD long haul connectivity. So far, they have been reluctant to upgrade their networks to handle ISDN.

Fortunately, DISA has recently agreed to install some ISDN capability on a test basis, so this situation will hopefully change in the future.

The last major problem the Legion has had in implementing ISDN is with their technology assessment group. Until recently, MB has been ineffective. They were supposed to test ISDN and find operational uses for it. During Phase I of MB's existence, they tested ISDN for a long time, but they did not develop any useful applications. Their problem was that they were not focused on user needs. They were playing with technology for technology's sake. According to the Pentagon, MB is one of the reasons many in the Legion have lost faith in ISDN. The feeling is that MB has played with ISDN for close to five years without any visible results; so ISDN must not be any good.

Fortunately, in Phase II of MB's existence they changed their approach. They have heavily involved end users in developing useful applications like their ISDN/S.25 packet switched base-wide MAN⁷⁹ (which will likely become a Legion standard). This MAN configuration that MB developed (described earlier) has the potential to vastly increase Legion ISDN use. First of all, it can be implemented using the "free" one percent of ISDN capability (or less) that

⁷⁹ MB is using a Netrix X.25 Packet Switch which they have on a bailment agreement. This means that Netrix rents the switch to them for a year at a cost of \$1 to experiment with. If they like it, MB can purchase the switch at the end of the rental agreement at a much reduced rate. Netrix does this in hopes of selling many switches to the Legion.

currently exists. Second, it will leverage the usefulness of all remaining standalone ISDN terminals. Before, if a user had an ISDN phone, he had at best a one percent chance to use it is capabilities. With MB's MAN, a user with an ISDN phone will immediately have access to all base LANs, DDN, and the Internet (through DDN). This functionality will more than justify the expense of ISDN equipment for many users.

Individual Level Implementation Variables

Currently, the Legion is hardly using ISDN; hence, there is very little data in this area. The few individuals that do employ ISDN tend to be technicians with extensive Legion communications-electronics training, or communications and computer officers with technical degrees.

Technology Variables

The Legion is using the Northern Telecom Incorporated (NTI) MSL-100 PBX with NTI ISDN phones, NTI proprietary digital phones, and POTS analog phones. Unfortunately, the NTI ISDN phones are proprietary and will not work on anyone else's switch. However, at this time, all vendors' ISDN phones are proprietary, so this is not unique to NTI. Hopefully, this will change now that agreements were reached with National ISDN-1.

Thus far, there is not much user experience with ISDN applications. Therefore, there are not many opinions on the user interfaces. Most users look at the ISDN phone as just a phone that is no better or worse than what they are used to.

One of the most frequent questions asked in the Legion about ISDN usage is, "Why use ISDN over some other networking technology like bridged and routers, what technical advantages does it provide?" The primary reason the Legion supports ISDN is that they feel it is the only way to completely achieve the goal of universal data connectivity. If someone has a phone line, they can get BRI digital connectivity immediately. If they move, they can have their digital connectivity again as soon as they plug in their phone (this flexibility is not available on LANs). Even on a base where there is a full complement of high-speed LANs (e.g. 802.3 or FDDI) there are many isolated users that do not have access to a LAN. In these instances, ISDN could be used to fill the gaps and provide digital connectivity between isolated users and high-speed LANs. The bottom line is that ISDN is used more to complement other networking technologies than to replace them.

The variable in this section that has had the largest affect on ISDN implementation is vendor support (or lack thereof). MB personnel have a hard time getting specific technical and costing questions answered about ISDN. The NTI salesmen do a good job selling the products and promising the moon, but when it comes to getting help with ISDN

implementation, NTI comes up short. They promise products and do not deliver. Sometimes they deliver a product that does not work (e.g. the problem with the TA interface software discussed earlier), and cannot offer help on how to correct the difficulties. NTI is helpful in other areas on the MSL-100, but they seem inept when it comes to ISDN issues. Unfortunately, this is not just an NTI problem. As stated in Section I, the entire industry is relatively uneducated on ISDN issues. If ISDN is to succeed, this situation has to be corrected fast.

Outcome Variables

In spite of the fact the Legion has had limited ISDN capability for five years, they have realized practically no benefits. Therefore, due to the expense involved, the financial impact has been negative. However, this is because of their poor implementation strategy. They now seem to be on track and should start seeing some benefits within the next year (at least at some bases).

The Military Police and Administrative Section applications are the only ISDN developments that are realizing any benefits. The Military Police at the MB location are using ISDN phones to provide high speed data access to their security personnel files. They need access to this information to check people's identifications and see if they are or are not allowed access to a facility. Before

the ISDN connectivity, an officer would call and verbally request that someone at the central security office check the identification number and then relay the information back over the phone. The ISDN connectivity frees up the individual at the central office to do other duties, and it allows faster identification checks. Also, the ISDN equipment enables the police officers to use the phone for voice calls while they are running an identification check. If they used modems, they would need two phone lines to provide this functionality.

The administrative personnel are using ISDN to distribute forms and regulations. Customers can call up and electronically request the form or regulation, and it is automatically downloaded to their computer. Eventually, the administrative personnel hope to collect forms through ISDN as well. This, however, will require major upgrades to their computer systems. It is too early in their tests on this application to provide definite data on its benefits, however, their initial feed back leads them to believe they will achieve the following benefits:

- a. We should be able to lower our manpower requirements because we no longer have to pack, unpack, place orders, or manage the forms and regulations for a base.

- b. The customers can fill out the forms on their computer instead of by hand or with a typewriter. This saves time, increases accuracy, and saves on wasted forms.

c. Eventually, when we get to collect the forms electronically (instead of having the user print out a copy and forward it through distribution) it will move the Legion closer to a paperless office.

d. Regulations are updated or corrected rather frequently. Customers currently have to post these changes and make lots of pen and ink corrections. It is very time consuming. Electronically distributing the regulations fixes this problem. The customer can periodically get the newest version of a regulation and it will already include the most current changes.

The Legion's poor implementation strategy has prevented them from realizing any other advantages from ISDN. However based on the results of MB's recent initial tests, the following are some advantages they expect to gain through ISDN:

a. Market share. The communications units expect that ISDN will increase their scope of responsibility to include "officially" managing the users' isolated LANs. Currently, they "unofficially" help users with their stove pipe systems. ISDN connectivity will enable them to better manage these systems and sometimes detect problems before users know anything is wrong. Also, the users will now be more inclined to involve the communications units before they purchase their stove pipe systems, thus assuring more maintainable and interoperable systems.

b. Cost Savings. The Legion expects to save money with ISDN by doing away with many dedicated lines and modems.

c. Quality of work life. Applications like electronically distributing publications and forms will enable users to spend less time on tedious tasks (e.g. making pen and ink updates to regulations) and more time on their real job.

Conclusion

The Legion has made mistakes, but they have also done some things right and have learned from their mistakes. A lot of their problems were caused by the fact that they were a pioneer in this technology. They had no one to look to as a model, and the vendors were not much help. They now seem to be headed in the right direction and will likely realize many benefits from ISDN within the next two years.

Chapter 10

ISDN Diffusion

This chapter analyzes two theories of innovation diffusion and compares the Legion implementation to those theories. The first theory is the innovation diffusion theory. It tries to explain the "spread of new ideas and new technologies among people."⁸⁰ The second theory is the critical mass theory and it attempts to explain the diffusion of an interactive innovation (e.g. telephone, or E-mail) through an organization or society.

Innovation Diffusion Theory

Individuals look to innovations to solve existing problems or provide new opportunities. Because the innovation is usually new to a potential user, there is a large amount of uncertainty (e.g. will it work, is it good enough, etc). To overcome this uncertainty, the potential user often obtains more information on the innovation (usually from their coworkers or friends who have already tried the new idea). From this information, the potential user either adopts or rejects the innovation. This process is repeated again and again, thus diffusing a successful

⁸⁰ James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989: p.23.

innovation throughout an organization. Innovation diffusion theory attempts to examine and explain this process.⁸¹

"Innovation diffusion theory provides a general explanation for the way new ideas and objects spread through a social system over time."⁸² While the theory can be used for many levels of analysis, it is best when examining the adoption of individual users within an organization.

Innovation diffusion theory has four key parts:⁸³

- a. S-Shaped adopter distribution.
- b. Innovativeness and adopter categories.
- c. Individual adoption process.
- d. Diffusion networks and opinion leaders.

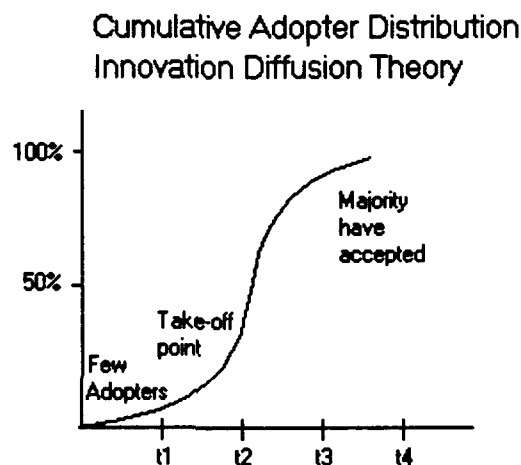
The rate that an innovation diffuses through an organization is the speed at which users adopt the new idea. It is usually measured by the amount of people that adopt an innovation in a given time period. Innovation diffusion theory proposes that the cumulative number of users adopting an innovation in a given time segment will follow an S-shaped curve (see figure 10.1). This curve suggests that the number of adopters raises gradually at first. This is because there

⁸¹ James C. Brancheau and James C. Wetherbe, "The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing," Information Systems Research, June, 1990: p. 116.

⁸² James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989:p. 23.

⁸³ Ibid. p.23.

is a large degree of uncertainty about the innovation. If successful, the good news about the innovation will spread rapidly, and the rate of adoption will increase quickly, causing the sharp increase of slope on the curve (take off point). Eventually, the demand decreases (because most of the potential users that will adopt the innovation have done so, and the curve flattens out.⁸⁴



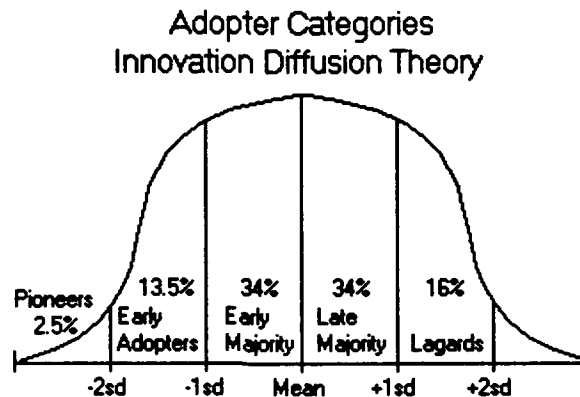
Source: James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," *Chief Information Officer Journal*, Fall, 1989: p.25.

Figure 10.1 S-shaped Curve

Another part of the theory states that different types of individuals adopt new ideas at different times (Figure 10.2). The pioneers and early adopters tend to be innovators -- willing to try new things. They are usually younger, more educated, more widely read, better at communicating, and more likely to be opinion leaders than their peers. By contrast,

⁸⁴ James C. Brancheau and James C. Wetherbe, "The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing," Information Systems Research, June, 1990: p. 118.

the laggards are more conservative and afraid of technology -
 - the nay sayers. They tend to be older, less educated, and
 more internally focused than the pioneers and early
 adopters.⁸⁵



James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," *Chief Information Officer Journal*, Fall, 1989: p.26.

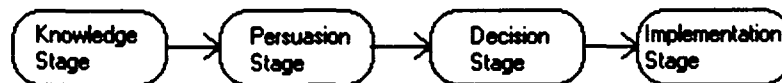
Figure 10.2 Adopter Categories

The next component of the theory states that individuals tend to go through a process before they decide to try a new idea (see Figure 10.3).⁸⁶ First, a person gains knowledge of a new idea (knowledge stage). This can be through mass media, trade journal, friends, coworkers, etc. The most influential source tends to be coworkers. Then from this information she forms a positive or negative opinion of the

⁸⁵ James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989: p.26.

⁸⁶ James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989: p. 24.

idea (persuasion stage). Then she decides to adopt or reject the idea (decision stage), and finally (if the innovation is successful), she actually tries the new idea and becomes an adopter (adoption stage).



Source: James C. Brancheau and James C. Wetherbe, "The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing," Information Systems Research, June, 1990: p. 118.

Figure 10.3 Individual Adoption Process

The final component of the theory involves diffusion networks and opinion leadership and how they affect the adoption process. This part of the theory discusses the way information about an innovation travels through an organization. When going through a decision process, individuals are most influenced by information from their peers who have already adopted (or rejected) an innovation. These informal communications (i.e. word of mouth) are referred to as diffusion networks.⁸⁷

Related to the diffusion networks is opinion leadership. This refers to the influence an individual (opinion leader) can have on others that are considering adoption of an innovation. The opinion leaders can act as a facilitator

⁸⁷ James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989: p.28.

within their department to encourage others to adopt the innovation.⁸⁸

How the Legion Fits Into the Innovation Diffusion Theory

The innovation diffusion model is most useful for describing the spread of new ideas that are valuable in a standalone mode. This means that the innovation should be useful to an adopter by itself, without having to interact with another adopter using the same technology. The theory assumes that there is a sequence of events, that if taken to the beginning, probably leads to a single or very few initial adopters (the first pioneers). From these first pioneers, the idea (if successful) will diffuse throughout the organization. The potential users of an innovation observe earlier adopters and then try to imitate the adopters to replicate their benefits. Obviously, for an innovation to take hold in this manner, it must provide value to the early pioneers, or else they would never have adopted the innovation.⁸⁹

Unfortunately, the Legion did not keep these ideas in mind when they implemented ISDN. As stated before, ISDN is a

⁸⁸ James C. Brancheau and James C. Wetherbe, "Understanding Innovation Diffusion Helps Boost Acceptance Rates of New Technology," Chief Information Officer Journal, Fall, 1989: p.28.

⁸⁹ M. Lynne Markus, "Toward a Critical Mass Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," Communication Research, October, 1987: p. 494.

networking technology and is not very valuable in a standalone mode, yet this is exactly how the Legion deployed it. They expected their implementation to follow the innovation diffusion model, however they did not structure it to follow the model. No matter how innovative a pioneer is, she would have trouble finding a use for a standalone ISDN terminal. Therefore, it is unlikely that the Legion's current implementation will progress along the S-shaped curve if left as it stands.

Although ISDN is a networking technology and better fits the critical mass theory (discussed next), the Legion could have structured their ISDN implementation so that it would fit the innovation diffusion model. To do this, they would have to devise a plan that would provide immediate value to standalone ISDN users, and MB's ISDN/X.25 packet switched MAN will meet this requirement. Through their ISDN phones, individual users will have access to all base LANs, the DMS, and the Internet. Pioneers will now be able to employ ISDN equipment, and from there, (if ISDN proves successful) the Legion's diffusion of ISDN has a better chance to follow the S-shaped curve. It should be noted, however, that this is only for non-interactive ISDN applications (i.e. applications that do not require another user to have ISDN). Although, if enough users purchase ISDN capabilities for non-interactive applications, there will eventually be sufficient quantities for interactive applications to be successful (i.e. critical mass will be achieved).

Even after the Legion corrects their implementation plan, the informal communications network (i.e. mouth to mouth) will cause problems for ISDN deployment. As stated before, the most influential source an individual depends on when deciding to adopt a new idea is her peers. While the Legion has very few pioneers to provide positive information on ISDN, it has no shortage of nay-sayers. As a result, even when ISDN gets deployed in an effective manner, it will have an uphill battle to change the negative opinions that the users have already formed. It is probably in this area that the Legion will have the most trouble.

Critical Mass Theory

Interactive media like ISDN (and telephones, e-mail, etc.) are different than other innovations for the following reasons:⁹⁰

- a. Widespread usage creates universal access, a public good that individuals cannot be prevented from enjoying even if they have not contributed to it.
- b. Use of interactive media entails reciprocal interdependence in which earlier users are influenced by later users as well as visa versa. Consequently, interactive media are extremely vulnerable to start-up problems and discontinuance.

⁹⁰ M. Lynne Markus, "Toward a Critical Mass Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," Communication Research, October, 1987: p. 491.

The critical mass theory tries to explain how universal access comes about and presents some conditions that make it more or less likely to occur.⁹¹

The first proposition of the theory states that it will be difficult to encourage the first users to employ an interactive medium like ISDN. However, once enough users have been coaxed into adopting the innovation (i.e. critical mass is met), the utilization of the new technology will spread throughout an organization until universal access is achieved. On the other hand, if only a few users were coaxed into trying the new interactive media, they will not realize enough benefits and will stop using the innovation; hence, the theory proposes an all or nothing outcome to diffusion.⁹²

The second proposition states that the lower the entry barriers a potential user has to hurdle, the greater chance the interactive technology will have to succeed. In other words, anything that makes it easier for the user (e.g. well designed user interfaces, low start up costs, etc.) will facilitate the growth towards universal access.

The next part of the theory indicates that the more spread out an organization is, the more it requires interactive technologies (e.g. there is not much use setting

⁹¹ M. Lynne Markus, "Toward a Critical Mass Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," Communication Research, October, 1987: p. 499.

⁹² M. Lynne Markus, "Toward a Critical Mass Theory of Interactive Media: Universal Access, Interdependence, and Diffusion," Communication Research, October, 1987: p. 500.

up a video conference with somebody in the next office). Hence, the more dispersed an organization is, the faster it will adopt interactive technologies, and the faster it will reach universal access (within its own company).

The fourth proposition of the critical mass theory suggests that an organization will have a more successful implementation if it has a high-level, well known user as an early adopter. This will encourage many other users to try the innovation and facilitate universal access.

The last part of the theory indicates that management can positively affect the diffusion by forming a proactive intervention strategy. For example, they could offer additional funding to organizations that try the innovation, or they could mandate that the interactive technology be purchased and used.

How the Legion Fits the Critical Mass Theory

The Legion implemented ISDN with the intention that it would follow a path similar to the innovation diffusion model. However, most of the applications the Legion expected to use on ISDN were interactive in nature (e.g. simultaneous voice and data and video teleconferencing) and better fit the critical mass theory. As a result, their implementation has failed.

The legion could, however, restructure their implementation to fit this model. For example, the Legion

could implement ISDN as they did the facsimile (fax) machine, another interactive technology. When fax machines were first deployed, they were only located in the administrative areas of large work centers. There was usually one fax expert who operated the machine, and everyone dropped off their documents to be sent. This expert had a list of fax machine numbers throughout the Legion so he knew who could and could not receive faxes. Eventually, the expert dropped out as users learned how to operate the fax machine. Finally, the users got tired of walking to the administrative section and waiting in line to send their faxes, so they bought one for their own office. They would then distribute their new fax number to all the organizations that they do business with.

This same method could be used for ISDN. ISDN work stations could be located in administrative sections with a local expert. This expert could help users set up and operate ISDN transactions. Eventually, users would learn how to use ISDN applications, and many of them would purchase their own ISDN equipment for their offices.

This kind of ISDN implementation could work in the Legion. Their 1% ISDN capability should be enough to connect all of the major work centers, thus meeting the critical mass requirement. In addition, the users would have a low start-up cost because they would not have to buy the equipment (at first), and they do not need any training because the "expert" would do everything for them until they eventually learned by watching.

An alternate approach to achieve critical mass is to reallocate all of the Legion ISDN equipment to a small number of bases and give those bases 100% ISDN capability. These bases could then set up some interactive applications (e.g. teleconferencing) with each other and serve as a model for the rest of the Legion. Other bases would see how valuable the ISDN capabilities were and they would begin to program for their own ISDN capabilities. For this approach to be successful, the initial bases would have to be carefully chosen. They would need to be bases that have a large requirement to interact with each other (e.g. command headquarters and their subordinate divisions), and have leadership that is open to change and innovation.

Another possible approach to achieve critical mass with the existing Legion ISDN equipment would be to reallocate the ISDN capabilities to groups that work together; hence, giving those work groups 100% ISDN capability. For example, the Legion could provide the supply managers on every base with an ISDN capability. These managers could then use ISDN to share files, submit requisitions, etc. Other work groups would observe the value the supply managers were getting from ISDN and program for their own ISDN equipment. Again, the choice of initial participants in the ISDN trial is critical. They should have a large requirement to interact with members of their group at other bases, and they should be open minded and not afraid of technology.

For any of the above options, there are three major obstacles the Legion would have to overcome to make them work:

a. They would have to work with DISA to provide interbase ISDN connectivity. Unless there is interbase connectivity, this plan is useless. The ISDN workstations could then only be used to talk to other on-base workstations. In most cases, it would be easier to drive across the base and talk face to face than set up an interactive ISDN session.

b. They need to get some high-level advocacy and users. For example, if some Admirals announced that they had ISDN and would like all future phone briefs to include interactive data, this would go a long way towards encouraging universal access for ISDN.

c. The Pentagon or command headquarters would likely need some intervention strategy to promote ISDN usage. For example, they could cut travel budgets and increase supply money for ISDN equipment. They could then mandate that teleconferencing on ISDN would replace X% of travel requirements.

Conclusion

The Potential benefits of a critical mass approach to ISDN implementation are greater than that of the innovation diffusion type of implementation (e.g. MB's ISDN/X.25 MAN).

However, the critical mass implementation is much more difficult to do, and it is a much greater risk. Given the current (shaky) state of ISDN in the Legion, I think MB is wise to proceed with their ISDN/X.25 packet switched MAN. If things go well, MB's base should be at the bottom of the S-shaped curve by January 93. Assuming this MAN provides enough benefits to the individual ISDN users (i.e. non-interactive applications), then their diffusion should progress along the curve. If not, then their application will never reach the take-off point. If MB's application is successful, ISDN will get established and confidence will build. Then MB and the Pentagon can consider a critical mass approach.

It has taken six years and many false starts, but the Legion finally appears on track with ISDN implementation. If MB's testing goes well, their base should be at the bottom of the S-shaped curve by January '93. From there, it is only a matter of time before the rest of the Legion gets on the ISDN diffusion curve as well.

Chapter 11

Conclusion and Limitations

This thesis attempted to identify some of the critical factors that affected the Legion's implementation of ISDN. The following is a summation of the most important elements for implementing ISDN in an organization:

- a. Provide immediate value to the initial ISDN users. ISDN is unique. It differs from technologies like PCs because it is of little value in a standalone mode. It differs from other networking technologies in that it is usually deployed in single user pieces (e.g. ISDN terminal here, ISDN terminal there, etc). Companies either must deploy massive amounts of ISDN equipment at the same time or develop an efficient and effective ISDN diffusion plan. If they choose the latter, they need to create an implementation that provides immediate value to the individual ISDN users (e.g. creating ISDN work stations, or tying the ISDN terminals into a packet network, both discussed earlier).
- b. Manage user expectations. Do not build up the users expectations on ISDN too high. Otherwise, they may never be satisfied, even if they are getting good service from it.
- c. Apply ISDN to existing user requirements. Too often, there is a temptation for technology professionals to play with "gee whiz" applications on new technologies. ISDN will have greater success if it is first applied to existing

(mundane) requirements like modem replacement and LAN interconnection. Then, once the users are acquainted with ISDN operations, they will experiment with the "gee whiz" applications and decide which ones they need.

d. Do not focus too much on using ISDN as simply a replacement of existing capabilities. In some what of a contradiction to the above statement (letter c), users and telecommunications professionals should try to be farsighted and realize what ISDN can do for them tomorrow as well as today.

e. Get user involvement early. Get the users involved in every stage of ISDN deployment. This way, they have a greater stake in its success, and the system will more likely meet their need.

f. Vendor support needs to improve. There appears to be a void of ISDN knowledge at many vendors. If ISDN is to succeed, the vendors need to educate their employees better so that they can help the customers. Otherwise, there will be a lot of unhappy, disillusioned customers that will not incorporate ISDN into their daily operations.

I feel that the telecommunications industry as a whole has been struggling with these same issues, particularly their implementation strategies. They have been straddling the fence between critical mass and innovation diffusion implementation approaches just as the Legion has. On one side, there are elements stating ISDN is an essential service

and that the industry and the government should be striving toward universal access. On the other side, the factions are stating that ISDN should be driven by user demand only. They expect that customers will try ISDN, and if it is successful, the usage will diffuse throughout the U.S. gradually based on increasing demand for ISDN services.

The bottom line is that the industry needs to pick one strategy and move forward. If they choose the critical mass approach, they will likely require government subsidies and government pressure on the public utility commissions to make it work. Otherwise, the public will never pay for it. If the industry chooses the innovation diffusion approach, they need to develop some applications that are useful in a standalone mode (i.e. they do not require another ISDN user to receive benefits). Some possible examples could be on-line white and yellow pages, or a service like Prodigy. Perhaps the telephone companies could even work with banks to allow ISDN users to bank by phone (who knows, it could catch on like Automatic Teller Machines). Whatever applications are chosen, they need to provide immediate value to the individual ISDN users.

Given the current fiscal condition of the federal government, I do not think that the critical mass approach is feasible; therefore, that leaves the innovation diffusion approach. If the telephone companies are to make ISDN a complete success, they need to develop some highly desirable applications now, or ISDN may never reach its full potential.

Limiting Factors

The two main limiting factors in this research are study size and author bias. Since I only studied one organization, it will be difficult to draw accurate conclusions. However, since this thesis is part of a linked study within the ET group, there will eventually be enough data to draw accurate conclusions. The second limitation is in regards to my own biases. First of all, I have strong ties with the Legion, so my observations may be slightly biased in their favor. Secondly, I tend to be pro-ISDN, so again, my observations may be biased in favor of ISDN. To minimize this limitation, I have separated the raw data from my conclusions (the raw data is in Appendix C). This way, readers can examine the information and determine for themselves if they agree with me.

Summary

After many years and lots of controversy, ISDN is finally being deployed. It does not do everything that was promised years ago, but it is still a valuable service and can be used to solve many problems. Regardless of ISDN's benefits, there are still many opponents who feel ISDN will never be worth the cost. To these nay sayers, I offer the following quote:

How do you cost justify a copying machine? Simple, savings on carbon paper. However, they quickly found out that carbon paper was cheap, and so they had to become more creative in their attempts at justifying the new technology's cost. Next they began to look at how many mistakes a typist makes on the average page, total amount of lost productivity time...You get the idea.

Today we look back and wonder how they could have missed the point. The copying machine was not just a replacement for carbon paper; it was a cheap printing press that revolutionized the flow of information in organizations. But the pioneers who were first acquainted with the new technology could see it only in the context of an existing technology: carbon paper. By focusing on the current, they almost missed the arrival of a technical marvel that we take for granted today.

ISDN may be confronting a similar strain of technocratic shortsightedness. By looking at ISDN in the context of hold buttons and modem replacements, we might be completely missing the point -- again.

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Appendix A

ISDN Questionnaire⁹³

I. General Questions.

- * What is your job title?
- * What do you do?

II. Contextural Variables.

- * How do you rate the support from higher headquarters?
- * How do you rate the user support for ISDN?

III. Organization-Level Implementation

- * When did your company first begin to study ISDN?
- * When and why did your company first begin to work with ISDN?
- * Was there any debate or controversy about investing in ISDN (please explain)?
- * What were the overriding factors in proceeding with ISDN?
- * What do you think about the way your company has implemented ISDN?
- * Would you say that your initial expectations for ISDN have changed since you first started to use it?
- * Would you recommend that your company make the same commitment today, knowing what you do now?
- * How was the company's initial ISDN investigation funded and how is it currently funded?
- * Are you getting any financial support from the vendors?
- * Are there any formal support services (e.g. help or training classes) that are in place to help the deployment of ISDN.
- * What has been the user involvement in structuring the employment of ISDN?

⁹³Note: Many of these questions were taken from the following source: Jane Oliverio, Managine Emerging Technology: Case Studies in Integrated Services Digital Networks, Masters Thesis, University of Colorado, Boulder (1989), p. 141.

IV. Technology Variables.

- * What ISDN equipment are you using?
- * Is it proprietary or standardized?
- * What do you think of the ISDN user interfaces (e.g. the phone or computer program)?
- * Does it provide you any technical advantages (e.g. bandwidth management)?
- * How do you rate your vendor support?
- * Why use ISDN instead of a competing technology (e.g. proprietary digital phones and bridges/routers)

V. Outcome Variables.

- * What benefits are you currently getting from ISDN?
- * What benefits do you expect to get in the future?
- * Is ISDN increasing the IS/Telecom personnel's scope of responsibility?

Appendix B

Q.931 Messages

<== Q.931 01:45:33

```

      Cpu= 3 Line= 1 TEI= 64
Phone      Call Reference= 0 7
Off        M 05 Setup PD= 08
Hook       I 04 Bearer Capability          Len= 04
              88 Coding Standard             CCITT
              Transfer Capability            Unrest. Digital
              90 Transfer Mode               Circuit
              Transfer Rate                  64 Kbits/s
              21 Layer Identifier             (01)
              Protocol Identifier            Rate Adaption
              8f Rate                         56 Kbits/s
              I 18 Channel Identification     Len= 01
              83 Interface Id Present        Implicit
              Interface Type                  Basic Rate
              Preferred/Exclusive             Preferred
              D-Channel Indicator             Non D-Ch
              Channel Selection               Any Channel
              I 2c Keypad                     Len= 04
              Digits                          3002
              I 7c Raw IE                     Len= 07
              8890284b723bc0
      Current State= 00 Null
      New State=    01 Call Init

```

==> Q.931 01:45:33

```

Cpu= 3 Line= 1 TEI= 64
Call Reference= D 7
M 02 Call Proceeding PD= 08
I 18 Channel Identification          Len= 01   Switch
      89 Interface Id Present        Implicit got
      Interface Type                  Basic Rate message
      Preferred/Exclusive             Exclusive and call
      D-Channel Indicator             Non D-Ch proceeding
      Channel Selection               B1-Channel
Current State= 01 Call Init
New State=    03 Out Call Proc

```

==> Q.931 01:45:33

```

Cpu= 3 Line= 2 TEI= 127
Call Reference= 0 16
M 05 Setup PD= 08
I 04 Bearer Capability          Len= 04   Setup message
      88 Coding Standard             CCITT   to destination
      Transfer Capability            Unrest. Digital
      90 Transfer Mode               Circuit
      Transfer Rate                  64 Kbits/s
      21 Layer Identifier             (01)
      Protocol Identifier            Rate Adaption
      8f Rate                         56 Kbits/s
      I 18 Channel Identification     Len= 01
      89 Interface Id Present        Implicit
      Interface Type                  Basic Rate
      Preferred/Exclusive             Exclusive
      D-Channel Indicator             Non D-Ch
      Channel Selection               B1-Channel
      I 34 Signal                     Len= 01
      40 Value                         (40)

```

```

I 6c Calling Party Number          Len= 0c
   00 Type of Address              Unknown
      Numbering Plan Id.           Unknown
   80 Presentation Indicator        Allowed
      Screening Indicator           User Provided
      Address Digits                3032343001
I 70 Called Party Number            Len= 05
   80 Type of Address              Unknown
      Numbering Plan Id.           Unknown
      Address Digits                3002
I 7c Raw IE                        Len= 07
      8890284b723bc0
I 00 Codesets 2-6                  Len= 0f
      96
      3c0c110333303332333433303031

```

Current State= 00 Null

New State= 06 Call Present

```

<== Q.931 01:45:33
Destination      Cpu= 3 Line= 2 TEI= 64
got call and     Call Reference= D 16
ringing          M 01 Alerting PD= 08
                  Current State= 06 Call Present
                  New State= 07 Call Received

```

```

==> Q.931 01:45:33
Cpu= 3 Line= 1 TEI= 64
Call Reference= D 7
M 01 Alerting PD= 08
Current State= 03 Out Call Proc
New State= 04 Call Delivered

```

**Ring back indication
to originator**

```

<== Q.931 01:45:46
Cpu= 3 Line= 2 TEI= 64
Call Reference= D 16
M 07 Connect PD= 08
Current State= 07 Call Received
New State= 08 Connect Request

```

Destination picks up

```

==> Q.931 01:45:46
Cpu= 3 Line= 1 TEI= 64
Call Reference= D 7
M 07 Connect PD= 08
Current State= 04 Call Delivered
New State= 10 Active

```

Connection is made

```

<== Q.931 01:46:23
      Cpu= 3 Line= 1 TEI= 64
      Call Reference= 0 8
Originator      M 45 Disconnect PD= 08
hangs up        I 08 Cause
                  80 Location
                  90 Cause Value
                  I 36 Raw IE
                  00
                  Current State= 10 Active
                  New State= 11 Disc Request

```

Len= 02
User
(10)
Len= 01

```

==> Q.931 01:46:23
Cpu= 3 Line= 2 TEI= 64
Call Reference= 0 17
M 45 Disconnect PD= 08
I 08 Cause
    80 Location
    90 Cause Value
Current State= 10 Active
New State=    12 Disc Indication

```

Switch tell destination
other side hung up
Len= 02
User
(10)

```

==> Q.931 01:46:23
Cpu= 3 Line= 1 TEI= 64
Call Reference= D 8
M 4d Release PD= 08
Current State= 11 Disc Request
New State=    19 Release Request

```

Switch tell originator
that the call is disconnected

```

Destination
acknowledges
disconnection

```

```

<== Q.931 01:46:23
Cpu= 3 Line= 2 TEI= 64
Call Reference= D 17
M 4d Release PD= 08
Current State= 12 Disc Indication
New State=    00 Null

```

```

Originator
acknowledges
disconnection

```

```

<== Q.931 01:46:23
Cpu= 3 Line= 1 TEI= 64
Call Reference= 0 8
M 5a Release Complete PD= 08
I 08 Cause
    80 Location
    90 Cause Value
Current State= 19 Release Request
New State=    00 Null

```

Len= 02
User
(10)

Appendix C

Interview Answers

This appendix presents the results of the Legion interviews. All interviews were conducted face to face with the exception of the Pentagon individual. This interview was conducted over the phone. I did not ask everyone all of the questions. For example, the end users knew relatively little about ISDN or how the Legion implemented it. Therefore, I only talked to the users about their specific applications for which they were using ISDN. Also, in order to keep the interviews length to a minimum, I only asked one individual the factual questions (e.g. who is your vendor and what equipment are you purchasing from them).

Person One

1. **What is your job title?** Commander of MB.
2. **What do you do?** Run MB and work with the higher layers of Legion leadership.
3. **How do you rate the support from higher headquarters?** They have been neutral. I would like them to have one pot of money (centrally managed at the Pentagon) which pays for all common user communications. Then, if a new program is established that needs communications, that program should give money to this centrally managed communications fund. The communications fund manager could then decide how to best supply the required communications connectivity. This way, there would be no "stove pipe systems"⁹⁴, and the interoperability would be assured.
4. **How do you rate the user support for ISDN?** Like any new system, the users did not like ISDN when they felt it was being forced on them (e.g. here is the solution, use it).

⁹⁴The term "stove pipe system" is used regularly by Legion communications personnel. It refers to a system that a user purchases by circumventing the procurement process. While the user can get the required system quicker this way, it has many problems. Often, the user does not consult with anyone and ends up purchasing a system that does not interoperate with anything. Also, the users purchase the system without programming for logistic support or operating and maintenance personnel. Technically, this means that the user is solely responsible for this unique system. However, in practice, the users purchase the system and then "dump" it on the local communications unit. They then expect them to operate and maintain the system without any prior planning, training, or any additional money.

However, now that we are involving them in the design and implementation process via the functional area representatives, they have been very accepting of ISDN. They feel they have a stake in it now.

5. When and why did your company first begin to

work with ISDN? Around 1985, the National Academy of Sciences (NAS) did a functional management inspection (FMI) on how the Legion used communications and computer systems (CCS). The NAS felt that there was no overall Legion CCS architecture, and because of that, there were a lot of unique, non-interoperable systems. Because of the FMI results, the Legion created the CCS architecture document. The original drafters of this document felt that ISDN was a good corner stone on which to build the Legion infrastructure, so they included ISDN into the architecture (they got their information from technical journals and from discussions with vendors). From this guidance, ISDN was incorporated into the BIDDS program.

6. Was there any debate or controversy about

investing in ISDN (please explain)? At the time BIDDS was started, no one debated ISDN. We all felt it was the only way to go. However, recently ISDN has gotten a lot of bad press. There are now many discussions on whether to drop N-ISDN and wait for something better. The problem is that if you are always waiting for something better, you never get anything done.

7. What were the overriding factorss in proceeding with ISDN?

a. ISDN was predicated on international CCITT standards. We were convinced that eventually, there would be no other way to communicate. Since we have a mission requirement to communicate with our allies as well as ourselves, we felt ISDN was the best way to go.

b. ISDN provides an all digital network that can provide data connectivity to every desk top. Also, being all digital makes encryption much easier.

c. We wanted to maximize the market value of the existing wire and cable plants. Also, ISDN makes the reconfiguration of networks easier -- we can dynamically identify where the customer is and let him take his phone and phone number with him.

d. Services. We were told by vendors that cheap, wide spread, value added services would be quick in coming.

8. What do you think about the way your company

has implemented ISDN? Overall, I think the Legion has done pretty well considering the slow deployment/development of ISDN in industry. Also, this "try before you buy" is a good concept. We have purchased a limited capability and are testing it. This lets us see how appropriate the technology is before we dive in. I still feel ISDN is the way to go, and our early involvement can only help us climb the learning curve quickly when ISDN finally gets here in full force.

9. **Would you say that your initial expectations for ISDN have changed since you first started to use it?** Yes. At first, we thought ISDN would fulfill all of the Legion's voice and data needs-- a panacea. We now know ISDN can not fill all of the Legion's communications needs, but it can still fulfill many of them.

10. **Would you recommend that your company make the same commitment today, knowing what you do now?** Yes.

I still feel that ISDN is the phone system of the future, and will eventually be the only way to make a phone call. The only difference is we know that there will be other technologies (e.g. FDDI, SMDS, etc) the Legion will use in conjunction with ISDN in order to meet all of our needs.

11. **How was the company's initial ISDN investigation funded and how is it currently funded?**

a. The one percent ISDN capability is centrally funded through the BIDDS program. Users can employ this equipment at no cost to them. If they need more than the one percent, users can buy additional equipment with their own operations and maintenance money using the NTI open contract⁹⁵. If demand for ISDN equipment gets very large, the Pentagon will likely start a new program.

b. Initially, ISDN testing at MB was centrally funded. We got whatever money we wanted to try out its capabilities.

⁹⁵The Legion has an open contract with NTI which states that they can (if they choose) purchase up to a certain amount of additional ISDN equipment at a stated price.

Now, we still get some of our own money, but most of our operating funds have to come from the users. We need to convince them that the ISDN system we are testing could be beneficial to them before they will give us the money.

12. Are you getting any financial support from the

vendors? Not really, but Netrix has given us the X.25 packet switch on a bailment agreement (they rent it to us for a year at a cost of \$1). This gives us time to test out our solutions and see if we want to purchase the switch. If we do, the money for the packet switch will come from the users.

13. Are there any formal support services (e.g.

help or training classes) that are in place to

help the deployment of ISDN? No. The users are given a quick briefing on how to use the phone (e.g. how to dial and what the buttons mean), but they get nothing on how to take advantage of ISDN technology. Hopefully this will change in the future.

14. What has been the user involvement in

structuring the employment of ISDN? We have the functional area representatives (FAR) that are involved in every step of the development. This helps insure that the users have a stake in the solution. It also keeps us focussed on what the users really want.

15. What ISDN equipment are you using? NTI MSL-100 (with all of its internal ISDN equipment like line termination cards, upgraded ISDN software, etc.), NTI Universal Terminal Adapters, NTI NT-1s, and NTI ISDN phones.

16. Is it proprietary or standardized? Unfortunately, all of our ISDN equipment is proprietary and will not work on anyone else's switch (e.g. AT&T). However, at this point, all of the vendors have proprietary ISDN implementations, so this limitation is not unique to NTI.

17. What do you think of the ISDN user interfaces

(e.g. the phone or computer program)? Telephones are telephones. As far as software interfaces on computers, we do not care. We [communicators] only provide the ISDN pipeline. It is up to the software developers to provide a good interface.

18. Does it provide you any technical advantages

(e.g. bandwidth management)? We expect much better bandwidth management capabilities and a lot more configuration flexibility. For example, Say a community of users had a disaster and lost all of their networking capabilities (e.g. a bomb took out their LAN). Chances are, the people in this facility would have to be split up and relocated all over the base. It would be hard to quickly configure a LAN to cover all of their new locations. But, it would be relatively easy to give them all ISDN phones and hook them up to the X.25 packet switch. This means they

could have networking capabilities back before the day was up.

19. How do you rate your vendor support? MB has a "special relationship" with NTI. Whenever I have a problem, I just call, and it is taken care of. Of course, the individual I speak with is only a couple of levels below the CEO of NTI. You may find that others in MB have a different opinion because they talk to different people.

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and bridges/routers)? If two LANs have a requirement to interoperate at greater than a PRI rate, then the bridges/routers are the way to go. However, for the most part, I feel N-ISDN in conjunction with an X.25 packet switch is the way to route among LANs. This way, there is only one hub to maintain instead of a hundred routers, and the relocation is much easier. The initial MB [Phase I] tried to set up a base-wide MAN with routers and bridges. It cost \$6 million plus \$380,000 per year to maintain. On top of that, this MAN did not reach everyone. I know that our configuration can reach everyone on base, and it will be a lot cheaper.

21. What benefits are you currently getting from ISDN? None right now.

22. What benefits do you expect to get in the

future? We expect a lot of benefits but exact costing figures are hard to come by. We are having a professional cost study done and we expect to get the results in October 92.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? Sure, when we tie all of the isolated LANs and other systems into the BIDDS switch, the communications units have more say in the operations of those isolated systems.

Person Two

1. **What is your job title?** Chief of the MB technology and engineering branch and second in command of MB.

2. **What do you do?** Mainly consists of marketing the MB solutions (i.e. getting users to support the solutions with money).

3. **How do you rate the support from higher**

headquarters? I would rate their support as OK. They provide some standards and guidance, but its not authoritative enough. For example, the SBIT provides some standards and interoperability requirements that all program managers (that require communications for their systems) should comply with. However, they do not have to comply if they do not want to. The PC-III, DMRD, and DMS programs were all looking at providing their own unique proprietary solutions that did not comply with the standards. This would have been expensive and difficult to manage. It took MB to go out and sell our overall solution (the X.25 and ISDN network) to those program managers. This "selling" should have taken place at the Pentagon where they have the authority to direct the action rather than just negotiate it.

Another problem with the lack of authoritative guidance is that users go out an purchase "stove pipe systems." Once they get the system, they turn it over to the communications unit and expect them to manage, operate and maintain it.

4. How do you rate the user support for ISDN? The end user is willing to try new technology if it works, is easy, and can benefit them. So far, ISDN has had mixed reviews. Most of the applications we are working on right now are invisible to the users (e.g. LAN interconnectivity). They like the extra connectivity, but other than that, they have no particular opinion. The users (the few that use them) are neutral on the ISDN voice connectivity. To them, it is just a fancy phone. When ISDN is more wide spread and the users can benefit from services like Automatic Number Identification or Automatic Callback, I think their opinions will get more positive.

6. Was there any debate or controversy about

investing in ISDN (please explain)? There is a continuing debate about whether or not ISDN is worth the expense. ISDN currently has a poor reputation. Because of this, it was hard to sell our proposed solution to the program managers (e.g. PC-III). But that is why we are here. We apply new technology to fulfill existing requirements. If it works, the users can employ our solution. If it does not work, they can use that information as well.

7. What are the overriding factors in proceeding with ISDN?

a. ISDN provides the most effective use of the huge amount of installed twisted pair cable on Legion bases.

b. We have a goal of providing world wide data connectivity to every desk top. ISDN is probably the only

way to completely reach this goal. Even on a base with a full compliment of LANs, MANs, and WANs, there will likely be individual LANs and/or users that are isolated. These isolated users would need ISDN to provide effective data connectivity.

8. What do you think about the way your company

has implemented ISDN? Now, MB is on track. Before [Phase I], we were just playing with ISDN with a "hobby shop mentality." MB just tried things to see what ISDN could do. Now, we are focusing on the user requirement, and we are making a lot of progress. ISDN implementation should move a lot faster.

9. Would you say that your initial expectations

for ISDN have changed since you first started to use it? Yes. The Legion initially thought that ISDN would fulfill all data and voice requirements. We now know that ISDN is not a fit for all situations, but it is a good solution for some requirements. It is part of our job to decide which requirements are best fulfilled by ISDN and which are best solved with other technologies.

10. Would you recommend that your company make the

same commitment today, knowing what you do now? Yes. I still think ISDN is the future standard telephone system. In spite of the fact many nay sayers feel we should wait until B-ISDN arrives, I do not think we should wait for this "perfect solution." There are operational requirements that ISDN can fill today, and I think that the strategic value of

ISDN will only get better. By experimenting and using it now, we will better position ourselves to take advantage of ISDN capabilities as they mature. Also, when B-ISDN finally does get here, our experience with N-ISDN will help us make the transition easier.

17. What do you think of the ISDN user interfaces

(e.g. the phone or computer program)? NTI provides a good phone, but it is still just a phone, nothing special until we get more services out there. As far as software interfaces and applications like screen sharing, that is not our concern. We provide the pipe line. It is up to other folks to develop the user friendly interfaces and applications which take advantage of the pipe line.

18. Does it provide you any technical advantages

(e.g. bandwidth management)?

a. Much better bandwidth management. With ISDN and the X.25 packet switch, there are fewer dedicated lines. The lines that are dedicated are shared by many users, so the bandwidth is more efficiently used.

b. ISDN allows an integrated voice and data environment. This enables one communications unit to effectively manage all of the base communications.

19. How do you rate your vendor support? NTI is pretty good. Their products have "proprietary hooks," but then no vendor supplies truly standard ISDN CPE. The biggest problem I have with NTI is that they promise stuff that they do not have or that is on the "drawing board." For example NTI kept

promising an integrated X.25 packet switch that would allow D-Channel packet switching. Eventually, we had to go with Netrix because NTI never produced. The Netrix switch did not have the D-channel switching capability, but it was a good, currently available packet switch.

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and

bridges/routers)? There is no single solution for

communications requirements. "If a user needs 100MBPS FDDI ring, then by all means, he should get one." However, there are user requirements that are best fulfilled with ISDN. The bottom line is that user requirements and/or physical/fiscal constraints dictate the solution, not the other way around.

21. What benefits are you currently getting from

ISDN? None now.

22. What benefits do you expect to get in the

future?

a. User responsive bandwidth: Lan users will have available bandwidth associated with their LAN distribution method. Data rates starting at 64 kbps, increasing to 1.544 mbps will be possible over the intrabase telecommunication backbone. Standalone users will be able to transfer information beginning at 9.6 kbps up to 1.544 mbps depending on their terminal and application.

b. Terminal consolidation: Due to the unrelated program implementation methods used in the past, the user has been forced to operate separate computer systems for each

program. Under a packet switched and ISDN environment, a single terminal can be used for all applications.

c. Decreased cost: Terminal consolidation and access to responsive bandwidth will translate to lower operating costs to the user. Terminal consolidation will reduce hardware requirements. Responsive bandwidth will reduce hardware costs for the link, while conserving man-hours through improved data rates.

d. Migration toward a standard environment: Use of available commercial off the shelf hardware and software for network implementation means lower costs for the user, in systems acquisition, upkeep, as well as training.

e. A step toward a paperless environment: Providing a low cost, virtual network progresses toward the paperless environment. Paper intensive tasks such as forms requisition, mail distribution, and document coordination will all be possible.

f. Base-wide bandwidth management: Efficient use of the available bandwidth associated with the existing base cable plant. Portions of the bandwidth can be set aside for high volume data subscribers. Common users can be allotted the minimum data rates and upgraded when their requirements dictate.

g. Address simplification: Implementation of the recommended packet network will result in a simplified addressing plan. ISDN is based on a world wide telephone dial plan. Users with a direct ISDN tie to the telephone

will simply address their data to the destination terminal telephone number. Network gateways will perform the conversion from an internet protocol address to the dial plan addressing system and visa versa.

h. Consolidated Maintenance Facilities: The digital distribution backbone is based on the existing telecommunications infrastructure. Cable plant, switching, and CPE are presently maintained by the base communications personnel. Incorporating data distribution into the voice network will utilize that existing maintenance structure.

i. Survivability: A digital backbone over which packet oriented data flows is the ideal, survivable network. Adaptive routing algorithms are commonplace today in the telecommunications and computer areas. Link or node failures are bypassed daily without the customer's knowledge. By implementing BIDDS and a zonal architecture on base, survivability will be an inherent benefit.

j. Risk avoidance: by basing the digital backbone on the capabilities provided through BIDDS contract, the risk of technology obsolescence is minimized. Each BIDDS switch is upgradable to "fast" packet, or frame relay as a result of the purchase of commercial off the shelf hardware and software. This trend is consistent with the natural progression of telephony products within the marketplace today.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? Yes, ISDN is hooking up all of the cats and dogs that are out there and tieing them into our virtual network. Basically, this shifts much of the management responsibilities for these isolated systems to the local base communications unit.

Person Three

1. **What is your job title?** Systems Engineer.

2. **What do you do?** Project manager and technical specialist on MB projects.

3. **How do you rate the support from higher**

headquarters? There is a lack of support and guidance from upper management. The SBIT is a good start, but I would like to see even more detailed and authoritative guidance.

4. **How do you rate the user support for ISDN?** The users seem neutral. They have some negative opinions about ISDN because of the bad press, but they are willing to try it if we prove that it is effective.

6. **Was there any debate or controversy about**

investing in ISDN (please explain)? Yes. We question whether ISDN is worth the expense. I think the equipment should be a lot cheaper.

7. **What were the overriding factors in proceeding**

with ISDN? The Legion is convinced that ISDN is where the telecommunications industry is headed and we want to keep up in order to remain interoperable.

8. **What do you think about the way your company**

has implemented ISDN? As far as MB is concerned, I think were doing well now. At the initial location, MB was in a "test bed, toy box mode." They wanted to try out new things just to see if they would work. Now that we are

concentrating on fulfilling "real-world" requirements, we are making lots of progress toward realizing benefits from ISDN.

9. Would you say that your initial expectations for ISDN have changed since you first started to use it? Yes. We thought ISDN was going to "be all to end all -- the universal solution." We now know different.

10. Would you recommend that your company make the same commitment today, knowing what you do now? I still think ISDN will make it. But, I think the Legion should have waited longer to implement ISDN; at least until the CPE standards were completely developed.

17. What do you think of the ISDN user interfaces (e.g. the phone or computer program)? I would like the phones and TAs and NT-1s to be standardized across all vendors. This would allow us to purchase a phone from other vendors besides NTI. This would increase competition and drive prices down.

The software interfaces are not our responsibility. However, they will influence the demand for ISDN, and they also need to be standardized. A user cannot do simultaneous voice and data unless both of them have the same screen sharing application.

18. Does it provide you any technical advantages (e.g. bandwidth management)? ISDN will help us manage and allocate our available bandwidth efficiently.

19. How do you rate your vendor support? Vendor support has been very unresponsive. The marketing guys can sell up a storm, but when you get down to asking technical questions and exact costs, they often do not know and will not call back when they get the answer.

20. Why use ISDN instead of a competing technology (e.g. proprietary digital phones and bridges/routers)? We like the X.25 and ISDN network because addressing is easier and there are no layers upon layers of routers, and this makes maintenance and management much easier.

21. What benefits are you currently getting from ISDN? None.

22. What benefits do you expect to get in the future? I think eventually, features like video conferencing will provide the biggest benefits and the most savings.

23. Is ISDN increasing the IS/Telecom personnel's scope of responsibility? Yes, with our proposed network, we expect to operate and maintain the entire base network, and that includes the isolated LANs.

Person Four

1. **What is your job title?** Telecommunications Systems Engineer.

2. **What do you do?** Project manager and electrical engineering specialist for MB projects.

3. **How do you rate the support from higher headquarters?** "What support?" We do not see any support from higher headquarters at this level. They just dumped the ISDN equipment on the communications units and handed over the manuals. There was very little training and no guidance on how to use ISDN. The training that was provided was not formalized into the units' training plans. So when the one or two technicians that received the training transfer, there is no ISDN experience left.

4. **How do you rate the user support for ISDN?** The users think ISDN is a big expensive telephone.

6. **Was there any debate or controversy about investing in ISDN (please explain)?** Yes. There are people out there (me included) that think ISDN is too expensive for what it provides.

7. **What were the overriding factors in proceeding with ISDN?** It was a "knee jerk reaction to all the hype the vendors were dishing out."

8. **What do you think about the way your company has implemented ISDN?** I think the way MB is currently operating is good. We are trying to apply ISDN to meet

existing requirements. Since the Legion has the ISDN equipment all ready, we may as well use what we have got. The initial MB [Phase I] was not very good. They only played with new products and did not solve any existing problems.

I think deploying one percent ISDN capability across the board was pretty dumb. There were no user requirements to justify the one percent and the Legion did not provide any guidance on how to implement it. As a result, the ISDN equipment ended up being expensive paper weights.

9. Would you say that your initial expectations for ISDN have changed since you first started

to use it? Yes. The vendor promotions lead us to believe ISDN was going to be our "savior." We know differently now.

10. Would you recommend that your company make the

same commitment today, knowing what you do now? I would not. The MSL-100 can be configured with or without ISDN. I would have waited to add ISDN until the standards were more formalized and until the technology was more deployed throughout the telecommunications industry. I think the Legion took a lot of unnecessary risk when they jumped on the ISDN bandwagon early; and so far, it has not paid off.

17. What do you think of the ISDN user interfaces

(e.g. the phone or computer program)? It is a good and expensive telephone, but so far nothing else.

18. Does it provide you any technical advantages

(e.g. bandwidth management)? None. Anything ISDN can do, I can do better and cheaper with something else.

19. How do you rate your vendor support? They are not very supportive on providing good, timely information about ISDN. They promise stuff they cannot deliver. Also, it is hard to get accurate pricing information from them, so it is difficult perform and an accurate cost benefit analysis. For instance, we are getting a supernode upgrade on the MSL-100. This does other things than just increase ISDN capabilities. When we asked how much of the upgrade cost was for ISDN, they could not give us an answer.

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and bridges/routers)? Because we have the capability already, it is probably cheaper than buying new routers and bridges.

21. What benefits are you currently getting from

ISDN? None, ISDN is more expensive than all the other alternatives.

22. What benefits do you expect to get in the

future? Unless ISDN CPE gets a lot cheaper and/or more value added services become available, I do not expect to see any benefits in the future either.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? Yes, the X.25 and ISDN network we are proposing will pull all of isolated networks out there under the communications unit umbrella of responsibility, at least to some extent.

Person Five

1. **What is your job title?** Chief of the applications division.

2. **What do you do?** Work with the customers to help define their requirements.

3. **How do you rate the support from higher headquarters?** It has been absent. We would like to see Legion leadership and guidance on what the plans are for ISDN. For example, I am the Legion representative on the North American ISDN Users' Group. I think this job should be done by someone on the Legion staff at the Pentagon. Some of the other military branches' representative report directly to the secretaries of their respective services.

4. **How do you rate the user support for ISDN?** Right now, ISDN is invisible to them. As long as it helps them and does so at the right price, they will accept it.

6. **Was there any debate or controversy about investing in ISDN (please explain)?** Yes. There is lots of arguing on whether or not ISDN is cost effective. In fact, the Pentagon is now considering stopping all further ISDN purchases until it matures more and gets less expensive.

7. **What were the overriding factors in proceeding with ISDN?** The Legion wanted to put digital connectivity on every desk. They felt the best way would be ISDN because it could use the existing twisted pair cable.

8. What do you think about the way your company

has implemented ISDN? We have been too slow in getting effective ISDN solutions for user requirements to the customers. As a result, they are losing faith in the technology. Another problem we have had is in identifying customer requirements. Often, they do not know what they want. We tend to wait until they request a system before we act. This tends to be too reactive. We have just begun something called "information modeling." We go to the customers and see what they do. Then we work with them to identify the kinds of CCS that will help them meet their missions better than they are doing now. I think this kind of process is more proactive and will help in identifying where ISDN best fits in.

**9. Would you say that your initial expectations
for ISDN have changed since you first started**

to use it? Yes. We thought it would be the answer to all communications connectivity requirements. We were wrong.

**10. Would you recommend that your company make the
same commitment today, knowing what you do now?**

Probably, I still think ISDN is going to be the standard, and we need to gain experience in it now.

17. What do you think of the ISDN user interfaces

(e.g. the phone or computer program)? The phones are good.

18. Does it provide you any technical advantages

(e.g. bandwidth management)? The biggest technical advantage I see is the simplification of addressing. In stead of worrying about an Internet address, we just plug in the phone number. The gateways take care of any necessary conversions.

19. How do you rate your vendor support? I am not pleased with NTI support. NTI is so big, it is hard to find a person who is in charge and willing to give a definitive answer. Also, we usually end up dealing with sales people instead of the technical experts.

In contrast, the Netrix vendors are great. They provide all of the information we need. Also, they are willing to modify the user interface [the packet switch network manager terminal] to suit our needs.

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and bridges/routers)? We could not find any better technology that would take advantage of the existing installed twisted pair cable.

21. What benefits are you currently getting from

ISDN? None now.

22. What benefits do you expect to get in the

future? Right now, there are many isolated LANs and other systems that the users buy and dump on the communications unit to support. ISDN is an effective way to connect all of these isolated systems and centrally manage

them. This will save on manpower. It will also enable us to find and correct some errors on their networks before the users even know there is a problem. This makes them happy and makes us look better.

23. Is ISDN increasing the IS/Telecommunications

personnel's scope of responsibility? No, it will just make their job easier. Even though the communications unit is not supposed to be responsible for those isolated non-common-user systems, they are. By connecting them all with the X.25 and ISDN base-wide network, it will enable the communications unit to effectively manage and maintain the isolated systems.

Person Six

1. **What is your job title?** Project officer for BIDDs at communications command.

2. **What do you do?** Manage the installation of BIDDs switches and ISDN capabilities.

3. **How do you rate the support from higher**

headquarters? We need to provide more support and guidance to the folks in the field. Right now, they are not using ISDN. We expected the users to pick up on ISDN, play with it, and generate more requirements. That did not happen. So we will need to educate them on what they can do with ISDN. One of the problems is that we are waiting on MB to produce some good applications that we can promote to the commands. MB has been slow in providing this information, but I think this is changing. They seem to be making a lot of progress right now.

4. **How do you rate the user support for ISDN?** The customers have never used it, so they cannot have an opinion yet. MB is the only place where anyone is actually trying ISDN. Part of the problem is in educating the CCS planners at the bases. They are uninformed on ISDN so they cannot map validated user requirements to ISDN, even if ISDN might be the best solution for a particular requirement.

6. Was there any debate or controversy about

investing in ISDN (please explain)? There is now. We have been playing with ISDN for over four years and have not shown any real benefits. We are now reconsidering our position on ISDN to determine if the Legion should continue to invest in this technology.

7. What were the overriding factors in proceeding

with ISDN? There were a couple of things. We were sold on the services, particularly video conferencing and simultaneous voice and interactive data. We expected this functionality to decrease our travel budgets and improve our communications. We also liked the fact that ISDN used the existing cable structure. And finally, we expected ISDN to become a national and international industry standard by now. We figured that if you did not have ISDN, than you would not be able to effectively communicate.

8. What do you think about the way your company

has implemented ISDN? I think the one percent across the board ISDN capability is a good idea. It provides an initial (free to the customers) ISDN functionality. This way the users can try out ISDN and see where it can meet their needs. However, the customers and the CCS planners in the division are not educated on ISDN, so they do not even know enough to play around. Hopefully, once MB starts publishing more information on their X.25 and ISDN implementation, we will see more ISDN usage.

9. **Would you say that your initial expectations for ISDN have changed since you first started to use it?** Yes. We expected ISDN to infiltrate the market much faster than it has. The fact is, that until ISDN is deployed in greater numbers, its usefulness is greatly limited.
10. **Would you recommend that your company make the same commitment today, knowing what you do now?** Yes, but we would be more proactive on identifying uses for ISDN. We would not just drop it on the users and expect them to find a place for it in their requirements.
17. **What do you think of the ISDN user interfaces (e.g. the phone or computer program)?** It is a good phone with a lot of functionality.
18. **Does it provide you any technical advantages (e.g. bandwidth management)?** The bandwidth management and the fact that we can use the installed cable are the two biggest technical advantages.
19. **How do you rate your vendor support?** It is hard to get definitive information from them, especially concerning pricing. This is very frustrating.
20. **Why use ISDN instead of a competing technology (e.g. proprietary digital phones and bridges/routers)?** Routers and bridges will not provide universal access. They have their places, and ISDN can be used to compliment them.

21. What benefits are you currently getting from

ISDN? None.

22. What benefits do you expect to get in the

future? As mentioned before, we expect to save money on traveling. Also, ISDN in conjunction with LANs, MANs, and WANs will likely be the only efficient way to get data connectivity on every desk top.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? ISDN has the potential to connect a lot of these user owned and operated "stove pipe systems." Chances are that this will shift some of the responsibilities for managing these systems from the users to the communications people.

Person Seven

1. **What is your job title?** Communications unit technician.
2. **What do you do?** Maintain and operate the MSL-100.
3. **How do you rate the support from higher headquarters?** We are not getting any guidance on how to use ISDN, so to us, it is just another type of phone to manage.
4. **How do you rate the user support for ISDN?** They do not know much about it.
6. **Was there any debate or controversy about investing in ISDN (please explain)?** We wonder why most of the ISDN CPE is just sitting in closets.
7. **What were the overriding factors in proceeding with ISDN?** I do not know.
8. **What do you think about the way your company has implemented ISDN?** I think someone should tell us how to employ it.
9. **Would you say that your initial expectations for ISDN have changed since you first started to use it?** I thought it was supposed to provide a lot of services, but right now, it does not provide anything more than an NTI proprietary digital phone.
10. **Would you recommend that your company make the same commitment today, knowing what you do now?** I would not, I think it is just a waste of money to buy the equipment and just let it lie in closets.

17. What do you think of the ISDN user interfaces

(e.g. the phone or computer program)? To the customers it is just a phone. To us, it is kind of a pain because we have to program each phone and TA with its capabilities and phone number before we deploy it to the customer's location. This in itself is not too bad, but the interface program that NTI gave us to program the TAs does not work. We had to create our own way to program the TAs.

18. Does it provide you any technical advantages

(e.g. bandwidth management)? Not now.

19. How do you rate your vendor support? For the MSL-100 switch concerning non-ISDN aspects, NTI is great, very responsive. On ISDN capabilities and CPE, NTI is not real helpful.

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and bridges/routers)? We have the equipment, why not use it.

21. What benefits are you currently getting from

ISDN? None.

22. What benefits do you expect to get in the

future? Hard to say.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? The X.25 packet switch and ISDN network that MB is creating will connect all of the isolated systems. This will transfer many of the management responsibilities for these systems to the communications unit. But that is ok, because we end up managing them any way. Right now, a customer will go buy a system to meet their needs and not tell us anything. The first we hear about it is when they have problems. They call us to fix it. Often, their new system is something that we have never seen and know nothing about. By connecting the users with ISDN, they will be forced to confer with us on purchases, or they will not be hooked up to the base network. Hopefully, this will make them buy systems that are interoperable and that we can maintain.

Person Eight

1. **What is your job title?** BIDDS Program Manager assigned to the Pentagon.

2. **What do you do?** Responsible for managing the overall BIDDS programming which includes arguing for additional money and defending current appropriations from being cut.

3. **How do you rate the support from higher**

headquarters? I think we have done pretty well in providing funds for ISDN. We are waiting for more information from MB on their latest ISDN implementations before we get more involved.

4. **How do you rate the user support for ISDN?** They are not using it. I think it is because the users are not sophisticated enough to know how it can benefit them. Also, the CCS planners are not educated enough on ISDN to know where to best install ISDN.

6. **Was there any debate or controversy about**

investing in ISDN (please explain)? Yes. I just got done defending ISDN from being cut from the BIDDS program. Since we have been experimenting with ISDN for years without any visible results, many at the Pentagon want to stop future ISDN purchases until there is a clear operational need. There is also many who feel the B-ISDN is just around the corner and that this will bypass the need for N-ISDN. However, we decided to proceed with our original one percent implementation plan.

7. What were the overriding factors in proceeding

with ISDN? Cutting ISDN would save about \$300-500 thousand dollars per base. But we still think N-ISDN is going to be a major player sometime in the near future so we are pressing ahead. If we cut the money now, it will be a long time before we can program for the funds again. Ideally, I would like to set the ISDN money aside and let the Legion experiment with the ISDN equipment that we already have. Then when the operational requirement for ISDN is defined, we could purchase more equipment. As an additional benefit, this waiting period would allow vendors to better standardize their ISDN equipment. Also, chances are that the equipment we would buy after waiting would be cheaper and more capable. Unfortunately, the current budgeting process does not allow us that flexibility. It is either spend it now or lose it.

8. What do you think about the way your company

has implemented ISDN? The decision to penetrate the Legion with a one percent capability was wise. However, the way we deployed that one percent was not smart. We just dropped the ISDN equipment on a base with no concept of operation and expected the customers and the communications units to decide how to employ it.

9. **Would you say that your initial expectations for ISDN have changed since you first started to use it?** Yes. We thought it was going to be the solution to all of our problems, one huge homogeneous voice and data network. Now we know ISDN is only part of the solution.
10. **Would you recommend that your company make the same commitment today, knowing what you do now?** Yes. ISDN is going to be important to the Legion. It might be better to have wait and buy ISDN when it was better established. Unfortunately, we need to buy the new switches now because the old analog switches cannot keep up with Legion demands. If we do not buy ISDN capability with the switches now, chances are we may never get the money to do it for a long time.
17. **What do you think of the ISDN user interfaces (e.g. the phone or computer program)?** I have not had much feedback on that.
18. **Does it provide you any technical advantages (e.g. bandwidth management)?** Not right now.
19. **How do you rate your vendor support?** Top notch. The salesmen are very helpful and provide me with all of the information I need. My only problem with NTI is that they keep offering capabilities that they do not have or that are "just about complete."

20. Why use ISDN instead of a competing technology

(e.g. proprietary digital phones and

bridges/routers)? We still need the other technologies,

but ISDN is the most feasible way of putting multimedia communications on every desk.

21. What benefits are you currently getting from

ISDN? None now.

22. What benefits do you expect to get in the

future? We do expect to save money on travel.

Eventually, we think that some LANs can be deleted. But we think the largest benefits will come from improved communications. With the huge force draw downs and budget cutbacks, everyone is expected to do more with less. Under these circumstances, effective, fast communications are essential. We think ISDN will be crucial to providing the required connectivity.

23. Is ISDN increasing the IS/Telecom personnel's

scope of responsibility? ISDN will make the telephone switch a major hub for data communications. This means that the communications unit will take more of a role than they do now in managing the data connectivity for a base.

Customer One

1. **What is your job title?** Administrative manager.
2. **What do you do?** Manage the administrative duties of an office (e.g. forms, regulations, correspondence, etc).
3. **What are you using ISDN for?** We are using ISDN to distribute forms and regulations and eventually collect the forms. The customer calls up and electronically requests the form or regulation and it is automatically downloaded to their computer.
21. **What benefits are you currently getting from ISDN?** It is too early in the test to provide a definite answer.
22. **What benefits do you expect to get in the future?**
 - a. We should be able to lower our manpower requirements because we no longer have to pack, unpack, place orders, or manage the forms and regulations for a base.
 - b. The customers can fill out the forms on their computer instead of by hand or with a typewriter. This saves time, increases accuracy, and saves on wasted forms.
 - c. Eventually, when we get to collect the forms electronically (instead of having the user print out a copy and forward it through distribution) it will move the Legion closer to a paperless office.

d. Regulations are updated or corrected rather frequently. Customers currently have to post these changes and make lots of pen and ink corrections. It is very time consuming. Electronically distributing the regulations fixes this problem. The customer can periodically get the newest version of a regulation and it will already include the most current changes.

Customer Two

1. **What is your job title?** Military policeman.
2. **What do you do?** Responsible for restricting access to the base.
3. **What are you using ISDN for?** We use the ISDN phone to provide high speed data access to our security personnel files. Sometimes it is necessary to check a person's identification to see if they are or are not allowed access to a facility. Before the ISDN connection, a cop would call and verbally request that someone at the central security office check the identification number and then relay the information back over the phone. Now, we use the ISDN phone to provide remote access to our security data base and check the identification ourselves using a PC.

21. What benefits are you currently getting from

ISDN? It frees up the individual at the central office to do other duties, and it allows us to perform checks faster. Also, the ISDN equipment lets us use the phone for voice calls while we are running identification checks on our PC. If we used a modem, we would need two phone lines to do this.

22. What benefits do you expect to get in the

future? Nothing more than what we are all ready getting.