1 SLAC ISDN Proposal

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This proposal reviews the current status of the Integrated Services Digital Network (ISDN) that is being deployed by the phone companies worldwide. It looks at possible SLAC applications for ISDN and makes some recommendations.

1.1 Introduction

The telecommunications industry has an important lesson to learn from the computer industry. The most valuable contribution of the computer industry in the past generation is not a machine, but an idea - the principle of open architecture. To bring the benefits of the information age to the American public, this country needs to build an open, ubiquitous digital communications platform for information services. The components of such a platform are already available in the public switched telephone network. A long-planned but dramatically under-utilized service called Integrated Services Digital Network (ISDN), can meet many of the near-term information needs of the public if only it were deployed widely and affordably priced by the nation's local and long distance phone companies. In this paper we will explore a couple of uses of relevance to SLAC.

1.2 What is ISDN?

The digital telephone network has evolved since the 1960's to include transmission equipment, long distance switching offices, and local telephone company central offices. ISDN takes the digital network the next step to the end user's desktop.

ISDN is a network that provides end-to-end digital connectivity to support a wide range of voice and non-voice services, to which users have access by a limited set of user interfaces.The limited set of channel types defined include; B, D and H channels. The B (Bearer) channel (64 Kbps) carries user information and can be used for voice, data and image transmission. The D-channel (16 or 64 Kbps for Basic and Primary rate respectively) carries packetized signalling information to control the setup, modification and clearing of calls and services. The H-channels are used for packet mode user data and telemetry. The main H-channels in the U.S. are 384 (H0) and 1536 (H11) Kbps.

Two general ISDN interfaces are described, the 2B+D Basic Rate Interface (BRI) and the 23B+D Primary Rate Interface (PRI). BRI has an information carrying capacity of 144kbps. It is organized as two 64 Kpbs full duplex B channels and a 16Kbps full duplex D channel. PRI gives twenty three 64 Kpbs full duplex B channels that can be grouped together to create larger than 64 Kbps bandwidths, plus a full duplex 64 Kbps D channel. PRIs are also available in H0 and H11 configurations, e.g. 4H0 or 3H0+D or H11.

With ISDN, calls are set up in a fraction of the time compared to analog facilities. For example, national circuit switching speeds are fractions of a second for ISDN, compared to tens of seconds for analog circuits.

ISDN implementation requires the cooperation of many organizations like Telcos, customer premise equipment (CPE) providers, the California Public Utilities Commission (CPUC), Users, and Interexchange carriers (IEC).

1.3 Who is Using ISDN?

The European Community and Japan are the global leaders in ISDN deployment. The applications that they have identified using ISDN for are computer based training, credit card authorization, customer service applications, document image communications, EDI payment services, file transfer, leased circuit back-up, PC desktop conferencing, picture communications, private voice network, teleworking, and video conferencing.

In the U.S. national ISDN standards are being set which work towards the objectives of:

1. Availability of an end-to-end digital network platform with standard access to circuit-switched and packet-switched services.
2. A variety of voice, data, and image service capabilities in a standard format available on a nationwide basis.
3. Availability of innovative and cost-effective applications software and services.
4. A multi-vendor operating environment, supported by industry and offered by multiple providers that promotes cost effective development, provisioning and maintenance of the network platform as well as services on that platform.
5. Standard end-user equipment from many sources that will interwork effectively and efficiently with the evolving network.

Today, the federal telephone system (FTS 2000) is the largest ISDN network in the world.

There is very little that can be done with ISDN that cannot be done some other way. However, ISDN may be the cheapest and or most effective way of accomplishing the application. A later section of this proposal will show cost comparisons between ISDN and these other technologies.

ISDN applications must be the solution to business problems. Such an approach implies an understanding of business needs, which is a very time-consuming process and requires support from upper management.

Many places around the country are using ISDN for various applications. For example:

- LLNL uses it for network and modem replacement and as an Ethernet gateway. In the near future they plan to use ISDN for Group 4 (G4) Fax, work at home using the ISDN network, Ethernet extension over ISDN, NERSC videoconferencing network, PRI connectivity to outside world, and electronic cataloging.
- The Defense Information Systems Agency is using ISDN for desktop conferencing, secure voice, multi-media conferencing and video conferencing.
- The IRS is using ISDN for Group 4 Fax, LAN interconnectivity, file transfer, and desktop conferencing.
- The Jet Propulsion Laboratory is using ISDN for ISDN telephony, host system asynchronous connectivity, remote LAN connection, desktop video conferencing, and extended office configuration.
- NIST is using the technology for desktop video conferencing, Group 4 Fax, LAN interconnectivity, image and data transfer, and medical imaging.
- West Virginia University is using ISDN for a Novell and Appletalk LAN, Appletallk networking, desktop conferencing video conferencing, and remote IPX and TCP access.

ISDN uses existing telephone inside wiring for an on-site applications.

The advent of nationwide ISDN will represent a fundamental change in American telephony. ISDN provides multiple services - voice, data, video, graphics, signaling-on demand, through a single telephone line.

1.4 Availability of ISDN

The nation is moving toward ISDN. In California, Pacific Bell announced that by 1997 their network will be 100% ISDN capable. In the meantime Pacific Bell has deployed ISDN in about 130 central offices out of 600 total, plans to deploy 190 central offices by 1993-end, and 85% of central offices by 1995-end. Now most tariffs are written for business with residential tariffs being considered. Chico and San Luis Obispo already have ISDN and are using it for distance learning programs. The Palo Alto and Menlo Park central offices have ISDN as well as most other Bay Area central offices. The only central office that does not have ISDN in the Bay Area is Danville**.** However, there are still issues around inter central office ISDN communication capability which we will need to understand as part of the trial.

1.5 What are the Costs of ISDN?

The costs for single line ISDN service for a data network user is compared to other relevant services in Table 1.

Table 1: Costs of ISDN Home Service Compared with Other Forms of Service

Item	**ISDN Single Line Service (BRI)**	**Analog Phone Line**	**Dedicated 56 Kbps Service**
Bandwidth Available	128 [a]Kbps	14.4[b] Kbps	56 Kbps
Time to transmit 2 MByte file	2 mins	20 mins	4 mins
Incremental Cost to transmit 2MByte file	$0.02	$0.19	$0.00
One Time Costs	$2890[c]	$645[d]	$4240
Monthly Lease Costs	$54	$17	$500
Monthly Use Costs[e]	$37	$37	$0
6 Month Pilot Cost/User	$3275	$958	$7240
5 Year Life Cycle Costs/User	$6742	$3777	$34240
5 Year Life Cycle Cost/User/Kbps	$52.67	$262.29	$611.43

a. Assumes use of both B channels. In some cases it may be more cost effective to only use one B channel. Given the fast call set up times for ISDN circuits it is practical to dynamically drop and raise the second B channel in mid session based on traffic requirements.
b. Vendors are close to shipping V.32terbo 19.2Kbps modems, and in the next year or so we can expect V.fast 28Kbps modems.
c. Assumes dedicated Half Bridges and Networks Terminal Adapters at Home and at SLAC
d. Assumes a modem at home and a pro-rated share of a modem at SLAC
e. Assumes average of 2 hours use/day

From Table 1 it can be seen that the older dedicated 56 Kbps service is no longer cost competitive. It can also be seen that the one time costs for ISDN are about 5 times that for an analog phone line. This is mainly driven by the cost of the equipment needed (Half Bridges and Network Terminal Adapters compared to Modems) and the fact that today sharing of the central site equipment (a la modem pools) is not practical at the moment for ISDN. As the ISDN market and technology matures costs are expected to drop and sharing of central site ISDN equipment will become practical so this difference is expected to narrow dramatically.

At today's costs ISDN service is about 80% more expensive than analog over a five year life cycle. On the other hand, if one compares the cost per Kbps then ISDN is 5 time cheaper than analog services.

Furthermore due to the short circuit switching times for ISDN it may be practical to automatically drop the circuit when not in use and automatically re-establish it transparently when required. This is not practical with the tens of seconds circuit switching times for analog, so that users tend to keep the circuit up for longer periods even when not busy, since it takes so long to re-establish. This feature could help reduce ISDN usage charges compared to analog, especially for users who need to have "instant" access to some service in order to respond to a trouble call.

1.6 ISDN Applications of Interest to SLAC

1.6.1 Home Use of ISDN to provide Computer Network Access

The maximum line speed of today's standard (v.32bis) dial-up analog voice modems is 14.4kbps. In the next year or so, this is expected to double as new standards are finalized and introduced. Even the new modems will still be much slower than ISDN BRI services. Thus one major application for ISDN BRI services is to replace voice modems for data communications to the home, since the costs of the phone services are similar while the speeds are improved and the circuit setup times are reduced by almost 2 orders of magnitude.

1.6.1.1 Requirements

Today many SLAC applications require Graphics User Interface (GUI) support, and are unavailable on dumb ASCII terminals. Examples of such applications at SLAC include: a Network Management System which requires point & shoot interfaces to navigate the application and graphical maps of the network topology; network diagnostics tools, and, the SLC Control Processor (SCP).

Such applications are becoming increasingly important to critical people on call to resolve network and accelerator problems. Being able to use the application from the home may save valuable time in understanding and addressing the problem and restoring service and reducing the number of call-backs requiring travel back to work.

Unfortunately such applications are often not usable at home with today's "high" speed 14.4kbps voice grade modems, even when using compression. The delays in updating the displays are so great that reasonable interaction is not possible, and not only leads to frustration but can lead to errors in using the application. For better response an order of magnitude higher speed connections to the home are needed.

In addition new applications that are graphics intensive, or heavily networked (such as groupware), or allow the integration of voice, images or even video clips are driving the need to deliver large volumes of information remotely. Even Email will require GUI support as files are appended containing images and graphics etc.

1.6.1.1.1 PPP Solution

To utilize ISDN for data networks, manufacturers are providing ISDN BRI adapters and software for workstations and routers from IBM, Sun, HP, SGI, Cisco etc. The cost for an ISDN BRI adapter is typically a few hundred to a thousand dollars today. Typically these adapters are used with the Point to Point Protocol (PPP) to connect to a similar device at the remote site. PPP and its antecedent the Serial Line Interface Protocol (SLIP) are in fairly common use today by power users, though usually with high speed modems with analog lines.

1.6.1.1.2 Bridge Solution

Other manufacturers are providing devices to bridge Ethernets to ISDN BRI in a protocol transparent fashion. These devices allow any Ethernet equipped device (e.g. a workstation or X terminal) to appear as if it is on the remote site's Ethernet Local Area Network (LAN). They have the advantage, compared to PPP connections, that no extra software needs to be installed and configuration is much simpler.

Several sites are successfully exploring the Ethernet bridging option, including Stanford University, LLNL and FNAL. Typical one-time per user costs, including ISDN installation and the bridge equipment, are around $3000.

Both solutions allow users to use the same network services whether from their offices or from their homes. This is not unique to ISDN, it is also possible to accomplish this over point to point modem links. The advantage ISDN brings is substantially higher speed.

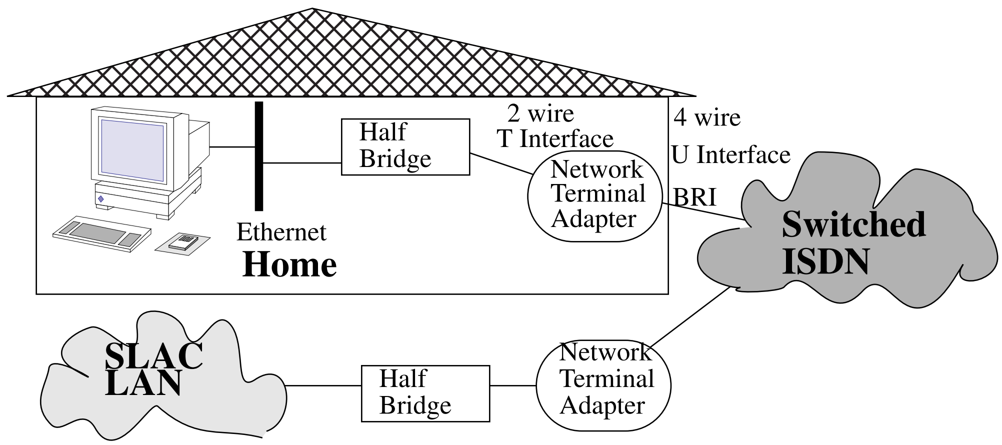

FIGURE 1. Schematic setup to use ISDN BRI to Ethernet half bridges to connect a workstation in the home to the SLAC LAN.

1.6.2 ISDN for Video Conferencing

SLAC is currently using ISDN PRI for video conferencing through FTS 2000. In the near future, we plan to use ISDN PRI FTS 2000 services for switched voice telephone service. Many vendor provided desktop video conferencing systems recommend using ISDN BRI service through the public switched network. SLAC needs to understand how these services compare to the Internet packetized video experiments that are currently in progress.

1.7 Recommendations

SLAC's Telecommunications and Networking groups propose a joint effort to get experience with ISDN at SLAC.

We propose a 6-month pilot study to provide ISDN BRI home services to a few critical on-call people. We will explore both the PPP and Bridged solutions mentioned above. In order to check the configurations we will start with bench top setups at SLAC. The first home installations will be with people with computer and networking expertise. These installations will identify what documentation, procedures etc. are needed, the relative merits of the various services, the security aspects, what are reasonable expectations and customers for the service, and what is the future way to provide access from home to SLAC. The anticipated non-labor cost for the study is about $10,000. Requirements of the study will be to focus on critical areas like technology, security, and applications. During the study period, data will be collected and a summary report developed to recommend SLAC ISDN policy and future direction.

Follow on studies will be based on perceived needs and resources, but could include the evaluation of ISDN BRI services for desktop video conferencing, and evaluating the needs to provision the SLAC phone switch for ISDN.

1.8 Acknowledgments

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