SUPERHIGHWAYS FOR OPEN AND DISTANCE LEARNING

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Abstract

An educational information network, is a multimedia network with a centralized architecture for the provision of educational services. The educational services comprise basic network applications (such as multimedia e-mail, fora for debates on educational subjects, access to already existing information), video distribution of multimedia lessons and a custom developed teletraining tool for the conduction of lessons over a broadband networking infrastructure.

The suitability of the widely available broadband networking technologies (ATM, ISDN), as opposed to the alternative of using already existing networking infrastructure (Internet, CATV), for the implementation of educational networks for the realization of an Open and Distance Learning Environment will be examined. More specifically the types of educational services that can be best hosted by each technology and the costs as opposed to the maturity for the deployment of each networking technology will be cited.

Finally, a proposal for an implementation scheme of an educational information network, concerning the appropriate (and cost effective) networking infrastructure that can best accommodate the aforementioned educational services will be elaborated.

Multimedia Networks

Many multimedia applications, such as on demand multimedia services, video-conferencing, collaborative work systems and multimedia mail require networked multimedia. In these applications, multimedia objects are stores at a server and played back at the clients' sites. Such applications might require broadcasting multimedia data to various remote locations or accessing large depositories of multimedia sources.

Multimedia networks require a very high transfer rate or bandwidth even when the data are compressed. The traffic pattern of multimedia data is stream-oriented and the network load is long and continuous. The multimedia networks carry a heterogeneous mix of traffic, which could range from narrowband to broadband and from continuous to bursty.

Traditional networks are used to provide error-free transmission. However, most multimedia applications can tolerate errors in transmission due to corruption or packet loss without retransmission or correction. In some cases, to meet real-time delivery requirements or to achieve synchronization, some packets are even discarded. As a result, we can apply lightweight transmission protocols to multimedia networks. These protocols cannot accept retransmission, since that might introduce unacceptable delays.

Multimedia networks must provide low latency required for interactive operation. Since multimedia data must be synchronized when it arrives at the destination site, networks should provide synchronized transmission with low jitter.

In multimedia networks, most communications are multipoint, as opposed to traditional point-to-point communications. For example, conferences involving more than two participants need to distribute information in different media to each participant. Conference networks, use multicasting and bridging distribution methods. Multicasting replicates a single input signal and delivers it to multiple

destinations. Bridging combines multiple input signals into one or more output signals, which is then delivered to the participants.

Following is the discussion of suitability of the two prevailing technologies widely available wide area networking technologies (ISDN, ATM) versus already existing network infrastructure, for the implementation of a multimedia network. The multimedia network under consideration, is supposed to be best suited for the provision of educational services to a wide community of learners.

Educational Networks

An educational network is a large distributed multimedia information network, that allows its users to communicate, interact among themselves and receive various services. In such a network, information is located in some central points, which are administered, maintained and updated by authorized entities, thus offering educational and instructional services to a community of learners worldwide. Such a setting, enables Open and Distance Learning (ODL) to be adopted and exploited

Open and Distance Learning can be regarded as learning by means of Telematics (i.e. the combination of means of telecommunications, information technology and multimedia), by which way among other things:

- all interactions between, for instance, learners, teachers and courseware, necessary for the learning process, can be realized,
- all information and knowledge (in different representations), required for the learning process, is accessible and readable, and
- a high degree of flexibility regarding place, time and pace of learning, can be realized.

Services of an Educational Network

The services offered by an educational network fall in the following major categories:

1. Interpersonal communication services. Electronic mail (E-mail) service with the extension of handling multimedia information should be offered to the users of an educational network, as well as “fora” for discussion and debates on various educational subjects via a news service.
2. Creation and maintenance of a Web server, providing information to the users of the educational network. Access to sources of information existing in the Internet, as well as other educational networks, via a Web browser.
3. Video distribution of lessons, that reside in remote servers. These lessons will contain multimedia information and will offer the equivalent of an electronic textbook.
4. Multimedia teletraining tool. This tool will allow the on-line delivery of remote training sessions from the trainer to the trainees.

Wide Area Networking Technologies

ISDN

Integrated Services Digital Network (ISDN) is an access and signaling expansion to the basic technology of the public switched telephone network, with the main purpose to support non-voice communications. The local loop connection between subscriber and switch is made in a digital form, with multiple multiplexed information channels supported per access line.

Present optical network technology can the Broadband Integrated Services Digital Network, (B-ISDN) standard, expected to become the key network for multimedia applications. B-ISDN access can be basic or primary. Basic ISDN access supports 2B+D channels, where the transfer rate of a B channel is 64 Kbps, and that of a D channel is 16Kbps. Primary ISDN access supports 23B+D channels in the US (1.544 Mbps), and 30B+D channels in Europe (2.048 Kbps).

The two B channels of the ISDN basic access provide 2 x 64 Kbps, or 128 Kbps of composite bandwidth. Three types of connections can be set up over a B channel: (a) circuit switched, (b) packet switched and (c) semi-permanent. The semi permanent connection is setup by prior arrangement and is equivalent to a leased line. The D channel is used for common channel signaling.

ISDN can be well suited for the high rate applications, which would include both data applications and videoconferencing. Videoconferencing applications can use part of the ISDN capacity for wideband speech, saving the remainder for purposes such as control, meeting data, and compressed video.

Asynchronous Transfer Mode

Asynchronous Transfer Mode (ATM) is a packet oriented transport mechanism proposed independently by Bellcore and several telecommunications companies in Europe. ATM is the transfer mode recommended by for implementing B-ISDN. ATM is considered the network of the future and is meant to support applications with varying data rates.

The ATM network provides the following benefits for multimedia communications:

- it can carry all kinds of traffic, and
- it can operate at very high speeds.

The ATM network can carry integrated traffic because it uses small fixed size cells, while traditional networks use variable-length packets, which can be several KB of size. The ATM network uses a connection-oriented technology, which means that before data traffic can occur between two points, a connection needs to be established between these end points using a signaling protocol.

Two major types of interfaces in ATM networks are the User-to-Network Interface (UNI) and the Network-to-Network Interface (NNI).

An ATM network comprises a set of terminals and a set of intermediate nodes (switches), all linked by a set of point-to-point ATM links. The ATM standard defines the protocols needed to connect the terminal and the nodes; however it does not specify how the switches are to be implemented.

Internet

Internet is a loose connection of thousands of networks. Internet was developed by researchers and there is no global network administration. The Internet is the largest interconnected computer network in the world that provides information exchange. All the computers connected to the Internet can easily communicate with one another using the TCP/IP protocol suite, which enables connection among computers produced by different vendors. Since 1983, the Internet has shown a remarkable growth rate. In the early 1996, the number of networks connected to the Internet was 60,000 with about 5 million hosts and 40 million user stations connected to them. It is expected that the Internet will connect by year 2000 10 million hosts and 100 million user stations.

The basic limit of the Internet is that it is a low-speed data network. Also in interconnecting various networks, multiple layers of protocols must be processed, resulting in large and highly variable end-to-end delays. These delays represent the potential bottleneck of the Internet in offering real time services. The Internet backbones must be upgraded also, in order to overcome these drawbacks. The IETF is studying various methods to solve these problems. Protocols for real-time communication

(RTP, RSVP), MIME, next generation IP (Ipv6) and Mbone are examples of such kind of approaches to enable Internet hosting of multimedia applications.

Proposal for the implementation of Educational Superhighways

Information superhighways, or the high speed, broadband communication network, that carry out the actual transfer of information are the primary component of the information infrastructure and they are in the lowest layer of the information infrastructure. Only after building the information highways can various information processing and storage functions be installed to provide versatile applied information services to users who are distributed all over the network.

Currently there are three different approaches toward building the information superhighways. The first is to rely on, and to speed up, the existing telephone network, the second is to use the Internet, and the third is to exploit the cable (and perhaps the satellite) network.

ISDN is basically the amalgamation of services on top of the existing telephony network, and B-ISDN is the extension of this idea to broadband services. Therefore, implementing educational information superhighways on the basis of existing telephone networks implies nothing but building the B-ISDN.

This approach, can be regarded as being idealistic. Because all access networks will be based on the basic 155 Mbps high-speed communications network, all types of applied information can be supported. But connecting all access networks with optical fiber is something that will require a huge amount of investment and time, and it may become possible only if the governments lead the investment.

In contrast to the telephone-based approach, the approach based on the Internet is economical and gradual. Because building on Internet does not mean building a new network, but connecting existing networks, it is relatively cheap and has a lot of flexibility. For these reasons, the Internet has been expanding rapidly and is becoming a plausible basis for the infrastructure, without any overall investment plan and based only on the spontaneous participation of its members.

The approach based on cable communications is regarded as the most practical method to provide broadband real-time educational services, because CATV networks are readily deployed in many places. If interactive functions can be added to CATV networks so that it can be used as high-speed access network and if a backbone B-ISDN interconnects the CATV networks, the educational superhighways will be built rapidly.

From the viewpoint of the user access network, the CATV network-based approach appears to be in direct competition with the telephone network-based approach, but the two become complementary in that the B-ISDN can provide a backbone network for the interconnection of CATV networks.

On the other hand, the approach based on CATV and B-ISDN networks appears to be in direct competition with the approach based on the Internet. One side is television-based approach, while the other is a computer-based approach. While the penetration of television is much larger, the growth of home computer is also exponential. From the functional point of view, a television with a set top box pair cannot be compared with the rapidly developing computers of today. But in the area of real-time video service the television still has an advantage over the computer.

We think that the approach with the best combination of investment and initial costs and availability and applicability of available wide area broadband networking technologies, in order to build educational information superhighways, is the combination of B-ISDN as backbone network interconnecting the educational services' providers and the alternatives of CATV networks and Internet for the user access network.

Conclusions

Once the information infrastructure network is complete a revolution is expected in the field of education. Teachers will be able to use multimedia texts to increase the effectiveness of education, connect to digital libraries, and show information or related data on displays during class, use a videophone to connect to distant experts for opinions, or connect to other classrooms for video-conferencing. Students who could not attend lectures will be able to access on-line databases storing lecture material and study at any convenient time.

It will also be possible to offer educational services to people at home or offices through the use of distance learning tools. Distance learning enables the learners to access various developed electronic studying tools and study the material by themselves in an interactive fashion.

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