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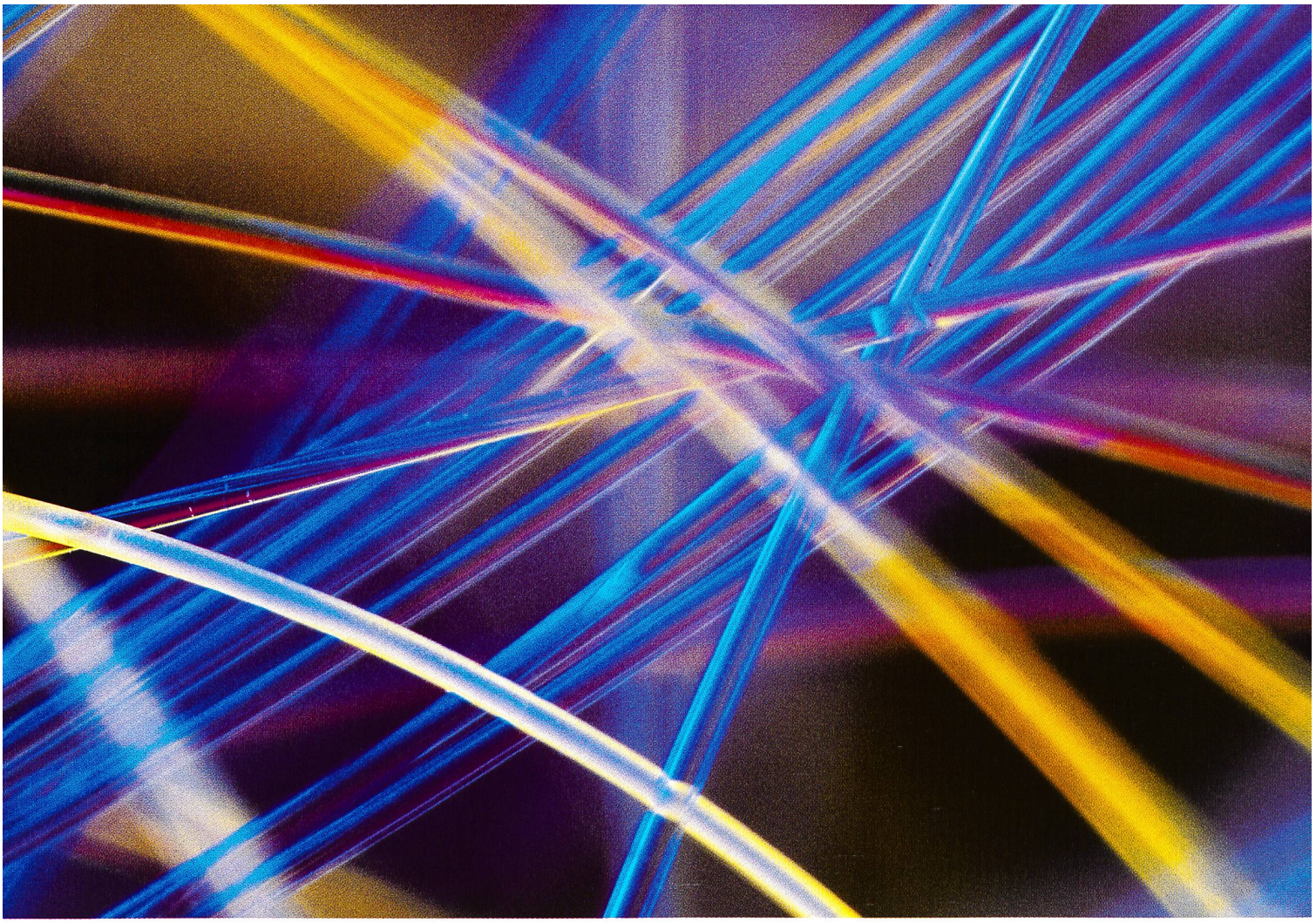


ASYNCHRONOUS TRANSFER MODE (ATM), A CORNERSTONE

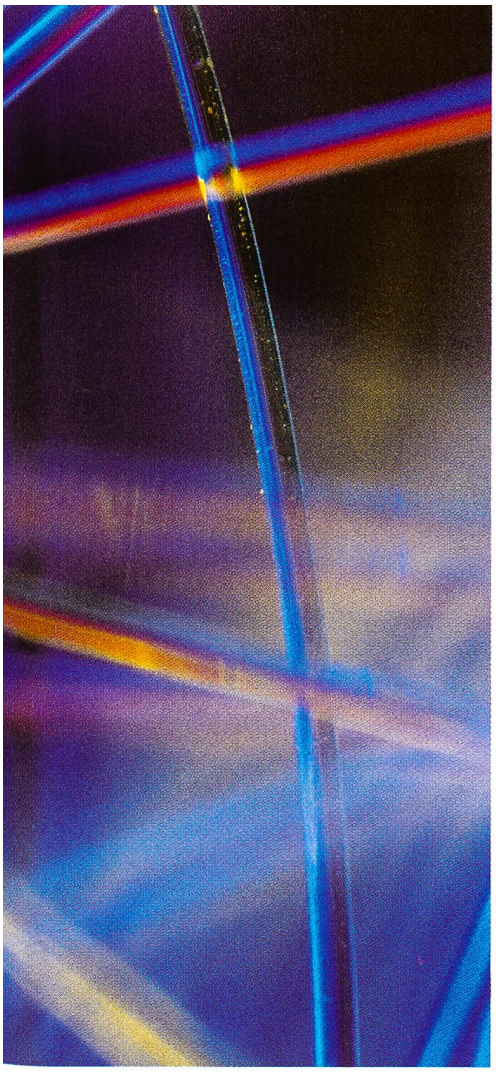
CORNER STONE IN THE IMPLEMENTATION OF INFORMATION HIGHWAYS

PATRICE HALDEMANN
ET HANS-PETER HEIERLI, BERNE

The recent technological breakthroughs in the field of information technology, audiovison and telecommunications allow the conveyance and handling of a considerable information volume. Economical structures, means of organization and production, access to knowledge, free time and working methods will also be likely to undergo profound changes. The resulting economical and social impact will certainly have worldwide repercussions.

Information society

Infrastructure for telecommunications, applications, social aspects, intellectual property rights, media society, security of information are such a challenge that it was understandable to raise them up to the level of a common approach between governments. On this subject, the report of the European Commissioner Bangemann 'Europe and the Universal Information Society' as well as the recent meeting of the G7 in Brussels have demonstrated the political will of the responsible institutions to throw themselves into the conquest of the era of information. The economy sector might be the first one to take advantage, by the acquisition of new markets, the creation of new jobs and the dislocation of working procedures. The creation of this society, in any case, depends on the setting up of information highways. Although their realization seemed rather hypothetical a few years ago, it seems well within reach today, owing to the recent progress in the field of micro-electronics, signal processing, video compression techniques and computers. As a major link within the chain of information, the high-speed data networks become reality following two



H. R. Bramaz

By means of a network infrastructure based on the latest technological development and by the provision of diversified and innovative achievements responding to the expectations of its customers, Telecom PTT intends to promote information highways in Switzerland to provide a telecommunication infrastructure in our country, enabling the enterprise to take on a universal challenge which has no precedence.

fundamental technological breakthroughs: the optical transmission and ATM (Asynchronous Transfer Mode).

ATM in the creation of information highways

After the mid-eighties, the ATM technique was investigated by the normalization bodies and has received its first rewards as a universal technique for the conveyance of broadband services. Actually, ATM was born from the urgent need to obtain a flexible transport technique for conveying information at high bit rates. It is the answer to the needs of future broadband applications. Its characteristics make it suitable for transporting multimedia services composed of various types of information, such as voice, data, video, images and graphics. In addition, the ATM technique allows for dynamically adapting the transfer rate on the network to the actual rate of the information source. This property confers the advantage of making better utilization of the transmission capacities and hence reducing the cost of the information transport. Adopted by the information and telecommunication sectors as an industry standard for public and private networks, the ATM technique will really act as an interface between these two sectors. The resulting economy of scale and integration is unbeaten. By means of ATM, the information can be searched, sorted, split and rapidly transmitted at reasonable cost. New horizons of development are therefore offered for research, health, education, financial and administrative services and the industrial sector. ATM will also have a definite influence on the information and entertainment industry, the world of the movies, music, television and radio. It will ensure the transport of interactive video services in the residential sector and will offer the public general access to information.

The introduction of the ATM technology will occur in successive steps, covering progressively the market requirements as a function of technological innovation and production costs.

The first stage of realization

The necessity of increasing the capacity of Local Area Networks (LAN) as well as the need for interconnecting the latter over long distances constitute the two major forces which actually dominate the development of the first generation of ATM systems. The current LAN technologies, based on shared resource networks, come up against new demands imposed by the growing numbers of users, the renewing of more efficient work stations, the processing of distributed application and the promotion of teamwork. Among the new LAN technologies being realized, the switched networks based on ATM technology have the highest potential for applications in the long run. Even more, the interconnection of LANs is perceived as a major change which will affect the telecommunication needs of commercial clients in the coming years. This results in the delocalization of work processes and globalization of markets. In this area, ATM also proves to be a very appropriate solution for the conveyance of services

FUTURE

Development perspectives

The wide-band applications are expected to undergo considerable development in the following years. This will result in a higher market penetration, an increase in traffic and a demand for more diversified services. In the commercial sector, the increasing use of interactive multimedia applications will necessitate the establishment of connections on a call-by-call basis. The development of a switched network with its associated signalization functions will be the answer to this demand. The future demand for interactive video services in the residential sector could well speed up the introduction of the switched ATM. The transmission and switching function of the network will then be combined on a common platform. In any case, the interoperability with existing services, networks and operational tools will be the biggest challenge before the ATM technology establishes itself as a universal network protocol, thus making a real step in direction of the wide-band ISDN network.

requiring high bit rates. In all, it constitutes a natural approach in view of an ultimate integration of voice, data and images.

In response to the growing market needs for high bit rate services, Telecom PTT has set up a Wide Area Network (WAN) based on ATM technology. This platform, assembled with mixers and multiplexers, is dedicated to the provision of services called SwissWAN. It satisfies the most stringent criteria imposed by commercial applications and in particular by the interconnection of LANs. In order to prepare the commercial introduction, a pilot phase was realized from mid-1994 to end-1995, so that the technical and commercial aspects of the ATM platform and the SwissWAN services could be tested. The main aims of the pilot trial were essentially:

- validating the ATM standards and technology in a realistic operational environment
- verifying the interoperability of the ATM platform with the existing metropolitan MAN networks
- promoting the new SwissWAN services by proving their acceptability by pilot users
- making known the potentials of ATM for introducing new innovative applications

The applications were the object of intensive trials. Pilot users from research, industry and administration have developed and tested numerous applications in various fields, such as remote telecommunication work, medical picture processing, distance learning, concepts assisted by computers and distributed processing. Telecom PTT has also taken a very active role in research and promotion of key applications related to company networks, multimedia services and in the Exploit project of the European RACE research program. A set of very complex tests aimed at verifying the conveyance characteristics of the ATM technique over satellites and between digital telephone exchanges has been established.

By means of an agreement signed with its European partners in 1993, Telecom PTT was associated with the establishment of a European pilot project. Actually, the Swiss pilot network is connected to our neighbouring countries by adapting to the high bit rate connections. The intensive tasks undertaken within the framework of the European pilot network have permitted the validation of the interoperability of national networks, therefore contributing to harmonizing the standardized introduction of a transnational ATM network. Due to the active participation of the pilot users, wide-band applications have been tested across national borders.

The very positive results obtained during the trial phase have encouraged Telecom PTT to progressively commercialize the SwissWAN services from mid-1995 on. The SwissWAN services will satisfy the basic criteria of numerous applications and provide an efficient and economical tool supporting innovative work processes. Moreover, the ATM platform has a number of distinct advantages for company networks, such as the shared use of the network resources, the ability to extend the infrastructure, the scaling of growing investments guaranteeing harmonic integration of WAN and LAN networks. The ATM technology has reached a degree of maturity which allows guaranteeing the provision of SwissWAN services on the basis of quality criteria required for commercial applications. The commercial phase will be characterized by an extension of capacities and the functionality of the network. Advanced network management techniques based on the recent international standards will be progressively introduced in order to enhance continuously the flexibility and the quality of the offered services. This will enable the progressive extension of the set of SwissWAN services in order to respond to the future demands of the customers. Integrated global WAN and LAN solutions are proposed.

Acknowledgement

The current issue of the 'ComTec', established with the collaboration of the main participants introducing the ATM network, provides an overview of details of services, applications, network and operational techniques in the pilot and the commercial phase.

We would like to thank all the authors of this special issue for their fruitful collaboration.

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This COMTEC edition has been realised in cooperation with employees involved in the ATM Network and SwissWAN projects. Their reports provide a comprehensive overview of the services, applications, networks, and technology of the ATM pilot in commercial and administrative areas. To the authors who have contributed to the successful publication of this edition we express our sincere thanks for their enthusiastic co-operation.

What does ATM mean?

ATM (Asynchronous Transfer Mode) is a technology for data transfer. The first laboratory tests go back to 1986. An important date for the development of this new technology was the approval of twelve international standards in 1991, based on those used for the construction of the first ATM components.
More than ever, the international standardization committees are a guarantee for interoperability of networks on a worldwide scale. At the moment the two most powerful organizations in the domain of ATM are:
– ITU-T (International Telecommunications Union – Telecommunications Standard Sector), representing all the operators of public networks
– IATM Forum, open to all organizations, including the users, but dominated by computer and telecommunication equipment manufacturer
The main motivation which has lead to the development of ATM stems from the wish to discover a switching technology capable of treating speech and data equally well. Also the need for inexpensive bandwidth has always been present, but not in a way experienced today. In order to maximize the optical transmission potential, the need for an intelligent switching element which can handle all kinds of traffic (voice, data, video, multimedia) has arisen. Ideally, such an element should allow for tailoring the pass band to the particular applications, making it available on demand. ATM has been chosen by the network operators as a switching technology capable of satisfying these rigorous demands.

The basic characteristics of ATM

– It is a multiplexing and switching technology based on Fast Packet Switching.
– ATM uses small packets of fixed length, called cells, in order to achieve variations at reasonable delay.
– Each cell consists of 53 octets: 48 octets for the information field and 5 octets for the header.
– It is a connection-oriented technology.
– The connections are virtual in that they do not use bandwidth until the service is activated.
– ATM allows for treating different types of traffic across the ATM Adaptation Layer.
– The cells are transmitted at regular intervals; there are no gaps between them, the unused periods are filled with unassigned cells.
– The order of arrival of the cells corresponds to the transmission order. This is called Cell Sequence Integrity.

The trumps of ATM

The ATM technology was designed to:

– convey any type of information (voice, data or video) over a public or private network
– accept simultaneous information fluxes on a user connection
– offer the user a variable rate according to his needs, from the transmission rate for a simple telephony modem to the one required by a supercomputer, and allowing the transmission of variable bit rates
– use existing transmission networks, being independent of the physical transmission: coaxial cable, optical fiber, air (radio transmission or via satellite)

The ATM transmission network

Although the standard specifying the direct transmission of ATM cells on optical fibres was already approved in 1991, the transmission of ATM cells, in the first phase, is being carried out by using the existing Plesiochronous Digital Hierarchy (PDH) and the Synchronous Digital Hierarchy (SDH).
The PDH and SDH systems operate with a specific transmission frame. In order to establish an ATM network using PDH and SDH networks, the network of ATM equipment fills and extracts ATM cells into and from PDH and SDH frames. The PDH/SDH frames are transmitted via optical fibres.

The adaptation services for ATM

An important objective of ATM standards is to ensure the interconnection of existing communication networks to an ATM network. The public and private telephone networks, the public packet switched networks, the leased lines, the Local Area Networks (LANs) and the Metropolitan Networks (MANs) have different interfaces and communication protocols.
The ATM standards for the adaptation of services cover the services with constant or variable bit rates, with or without the constraint for temporary synchronization (the telephone service is an example for a service with constant bit rate with constraint for time synchronization; the interconnection of LANs is a service with variable bit rate without constraint for synchronization). The standards specify the kind of segmentation of the information units of these service classes into cells and the subsequent reassembly.