Zeitschrift: Bulletin des Schweizerischen Elektrotechnischen Vereins, des Verbandes Schweizerischer Elektrizitätsunternehmen = Bulletin de l'Association suisse des électriciens, de l'Association des entreprises électriques suisses

Herausgeber: Schweizerischer Elektrotechnischer Verein ; Verband Schweizerischer Elektrizitätsunternehmen

Band: 77 (1986)

Heft: 17

Artikel: Evolution towards Wideband Communication Networks

Autor: Decina, M.

DOI: https://doi.org/10.5169/seals-904254

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Siehe Rechtliche Hinweise.

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. Voir Informations légales.

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. See Legal notice.

Download PDF: 01.04.2025

ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch

Evolution Towards Wideband Communication Networks

M. Decina

This draft aims at a brief review of the driving forces and key alternatives in the evolution towards wideband communication networks. Optical fiber networks only are included in this overview.

Ziel dieses Beitrags ist, die treibenden Kräfte und wichtigsten Alternativen in der Evolution zu Breitbandkommunikationsnetzen grob zu skizzieren. Es werden dabei nur fiberoptische Netzwerke berücksichtigt.

L'article donne un bref aperçu des motifs et des alternatives les plus importantes dans l'évolution des réseaux de communication à large bande, en ne tenant compte que de ceux à fibres optiques.

Adresse des Autors
Prof. Dr. *M. Decina*, Italtel Sit R&D Labs.-CLRC, 20019 Settimo Milanese, Italy.

1. Introduction

Communication services, modes, and technologies are independent variables that establish system architectures suitable for metropolitan and wide-area network applications. Modes and technologies are selected to satisfy service needs at reasonable costs giving birth to new forms of communication networks. We review here the evolution of both telephone and high speed data networks into the wideband Integrated Services Digital Network (ISDN).

The *telephone industry* is evolving service capabilities through the enhancement of digital central offices to switch narrowband ISDN user applications, via 2 B+D and 30 B+D lines. As integrated opto-electronics for optical fiber and video codecs are perfected, broadband switching matrices with fiber plants will debut at the local exchanges and eventually at the toll offices. Small scale wideband circuit switches in the form of fiber stars have already been developed and implemented. Research being conducted in "Fast Packet Switching" is attempting to utilize simple protocols and fast switching devices to replace the concept of dedicated circuit switching. Wideband Packet Switching and Wideband Circuit Switching are today conceived to operate at speeds of 34 up to 140 Mbit/s.

The *data industry* approaches the ISDN challenge from another perspective: that of distributed data systems using fiber optic rings and buses with TDM/MA (time division multiplexing with multiple access). These MANs (Metropolitan Area Networks) are already under development. The IEEE 802.6 slotted ring project and the FDDI ring of the ANSI committee are examples of systems that use ring technology to distribute between 100 and 500 Mbit/s of bandwidth over a metropolitan area mixing voice, video, and data. These rings utilize hybrid switching technology and protocols to provide both packet and circuit switching services.

Some alternative network approaches are presented side by side with the service demands that are propelling them.

2. Services, Technologies and Communication Modes

This section deals with the key building blocks to develop wideband communications networks for multiservice applications:
- services,
- technologies,
- communication modes.

Table I shows the range of approximate bit rates suitable for transmission

Rough Bit-Rate for Various Services — Table I

Service	Mbit/s	Class
● Telemetry ● Data/Text ● Voice, Data/Image	0,0001 0,01 0,1	Low Speed
● Hi-Fi Sound ● Videophone ● Data/Image	1 1 to 10 1 to 10	Medium Speed
● Conventional TV ● High-Definition TV ● Data/Image	50 to 100 150 to 1000 10 to 1000 ?	High Speed

Progress in Information Technology Table II

Information Technology	Key Parameter	Typical Growth Factor
Lightwave	Bit Rate x Rep. Spacing: $\frac{\text{Mbit x km}}{\text{s}}$	1000 per Decade (2 per year)
Silicon	Memories: Components Density per Chip	100 per Decade (1,6 per year)
GaAs	Memories: Components Density per Chip	1000 per Decade (2 per year)
Processing	MIPS	100 per Decade (1,6 per year)

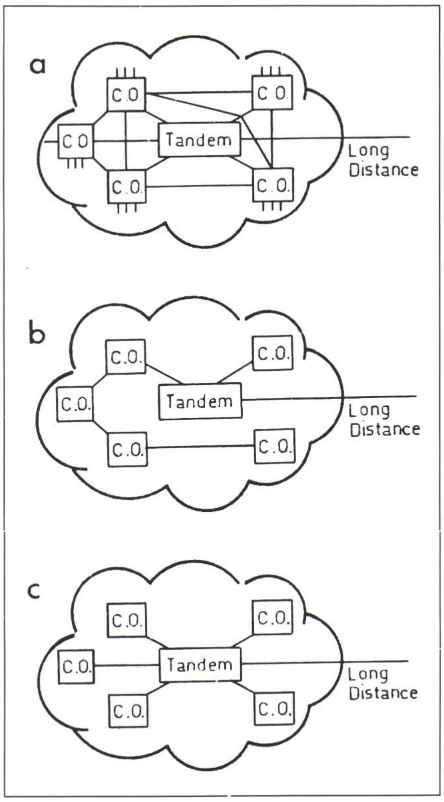


Fig. 2 Metropolitan Area Network Topologies

a Present Telephone Network
b Multi-Access Bus Structures
c Centralized Tandem Hubs
C.O. Central Office

of various communication services. Three classes are roughly identified. The *low speed class* is the target of the narrowband ISDN currently defined by CCITT. The *high speed class* is certainly addressed by the wideband ISDN together with the *medium speed class* services. Image communications for high resolution interactive graphics/data by means of powerful workstations is forecasted to demand speeds on the order of hundreds of Mbit/s.

Table II identifies some "invariants" in the process dynamics of the information technology (computers and communications) evolution. Key technological parameters show typical growth factors in the last decade, and those factors can be used to forecast growths for the next decade. Figure 1 illustrates progress in lightwave technology. A key parameter is the capacity of the fibre transmission systems in terms of information flow and repeaterless span length (Mbit s^{-1}km). The projection shows also that the time delay between commercial deployment and leading edge laboratories' tests is about 6 years. By the end of this decade we will have commercially available: 1 Gbit/s over spans of one hundred kilometers or 10 Gbit/s over 1 km.

The third topic addresses the various modes of communication in terms of network topologies, switching alternatives and network resources control capabilities. Figure 2 shows two possible evolutions of the present telephone network topology: both are stimulated by progress in fiber technology. Alternative switching techniques are listed in Table III. Fast circuit and packet switching are advanced techniques to allow the development of high throughput—low delay switching machines in the packet mode of operation. Hybrid switching recognizes that conventional circuit switching of circuits at hundreds of Mbit/s for high definition moving pictures is superior to fast packet switching (FPS), unless the bit rate of the FPS data link reaches values of at least an order of magnitude greater than the high definition signal peak transfer rate. In other words, FPS of high definition TV channels at 280 Gbit/s requires a data link bit rate of 10 Mbit/s , to take advantage of the statistical properties of several multiplexed TV channels on the data link. Hybrid switching claims indeed use of both techniques: packet and circuit switching. This concept is applied to both narrowband and wideband ISDN approaches. In the wideband network, circuit switching is used for voice, bulk data and motion video, while packet switching applies to voice as well, data and high speed imaging. Both techniques should operate on channels at hundreds of Mbit/s.

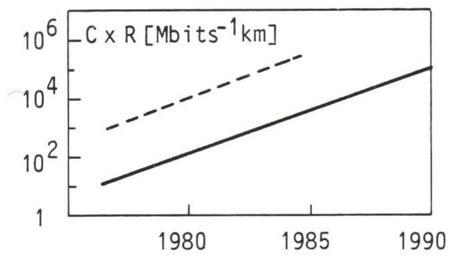


Fig. 1 Lightwave Progress (M.R. Aaron)

C Capacity
R Repeater Spacing
------- Leading edge laboratories' test
——— Commercial Systems

Communications Switching Techniques Table III

●Circuit Switching (CS) -Subrate/Multislot -Fast -Enhanced (DSI & ADM) ●Packet Switching (PS) -Virtual Circuit -Data/Voice Gram -Cut-Through -Fast	●Hybrid Switching (HS) -Basic-CS for Voice Bulk Data & Motion Video -PS for Bursty Data & Imaging -Enhanced (DSI & ADM) -Advanced-CS for Voice,Data & Motion Video -PS for Voice, Data & Imaging

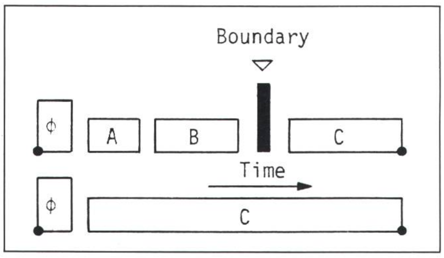


Fig. 3 Bandwidth Allocation Control
Φ Delimitation and housekeeping information
A Signaling and control information
B Circuit-switched information
C Packet-switched information

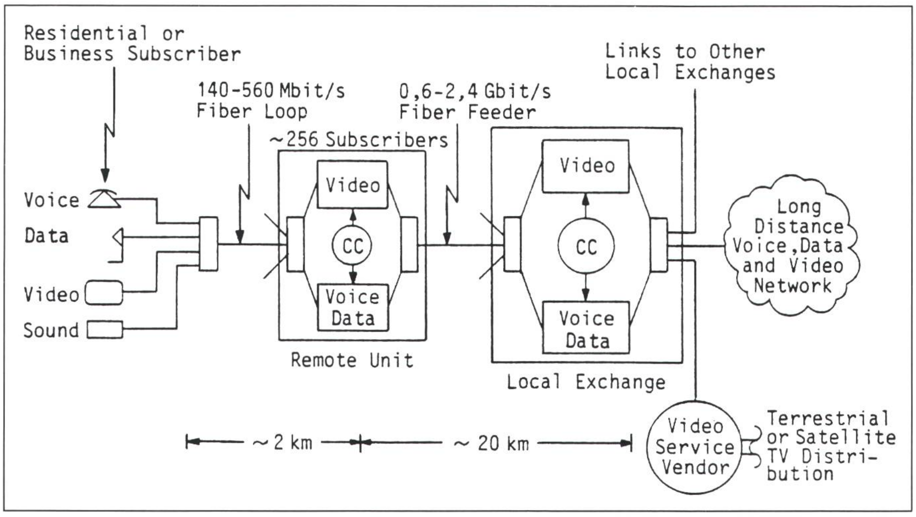


Fig. 4 Wideband Circuit Network — Double Star
CC Common Control

In a hybrid switching environment the degree of control capabilities for flexible bandwidth allocation is of great importance. Figure 3 illustrates the problem with reference to a TDM frame format used on hybrid channels. A field of the time frame (0) is devoted to OSI Layer 1 features. These are the TDM transmission formats to be used on optical facilities to allow proper maintenance and operation features such as: add-drop capabilities, span and network supervisory channels, protection switching and cross-connect switching (see for example the Bellcore's SONET standard proposal). This is required also in cases of fully packetized networks. The other fields include signaling (A), circuit switched TDM channels (B), and packet switched message-interleaved channels (C). Signaling can be used to set up both "physical" and "virtual" circuits in the B and C fields, as well as to move the boundary. In an alternative approach the A field is empty, while the signaling channel is virtual and embedded in the C field. This high speed signaling channel controls both virtual circuits in C and physical circuits in B, as well as boundary movements. Which way to go for such features in the future is not clear to the writer. The problem of flexible bandwidth control is complex and applies both to data link utilization and to switching machine design. Current technical activities are focused on such problems and probably require different solutions in different network scenarios: local (< 5 km), metropolitan (< 50 km) and wide (> 50 km) area networks.

3. Wideband Network Approaches

The *telephone* and the *data industries* are approaching the development of wideband multiservice networks from slightly different perspectives, as shown by the technical literature and the standards activities in CCITT, IEEE and ANSI. Both approaches seek for high speed circuit and packet channels (up to hundreds of Mbit/s) with hybrid switching capabilities. On the other hand, the telephone industry is focusing on metropolitan and wide area networks for residential and business applications, while the data industry looks primarily for local and metropolitan business applications. We review here some alternative typical approaches to wideband networks; they focus on long-term (5 to 10 years) sample scenarios. One-way broadcast and two-way point-to-point and point-to-multipoint connections are allowed by all four network architectures.

3.1 Wideband circuit network

The double-star topology is used in this scenario where the metropolitan area is partitioned in a two-level hubbing system (fig. 4). Fibers are monomode in the loop and the feeder. High speed (140 Mbit/s) video switching uses dedicated space division matrices under common control with low speed voice and data. Figure 5 shows that the video service vendor delivers a full set of broadcast TV channels up to the remote switching units. Here the TV channels are individually switched on demand towards the requesting subscribers. In this latter figure, the OSI layering is applied at the various system interfaces (Tab. IV). Two-way video applications are also allowed in the depicted scenario.

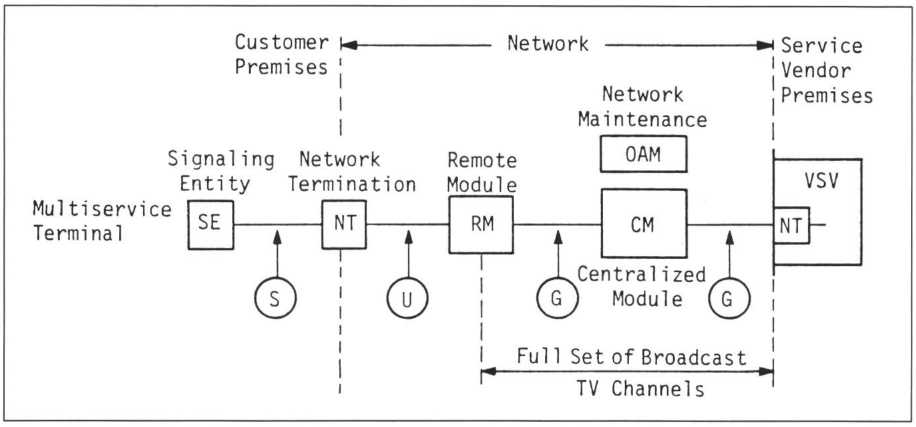


Fig. 5 Wideband Circuit Network — Signalling Scenario for Broadcast and Interactive Video Services
S, U, G Reference Interface Points (see also table IV)

Interfaces Table IV

OSI Layers	1	S_{BB}	U_{BB}	G_{BB}	G_{BB}
	2	LAPD ^{E}	LAPD ^{E}	LAPD ^{E}	LAPD ^{E}
	3	Customer Access Protocol		Remote Module Protocol	Service Access Protocol
	4 to 7	← Customer-Network Application →			← Service-Network Application →
		← Customer-Service Vendor Application →			

Interfaces

BB: Broadband

LAPD: Link Access Protocol D

LAPD^E: Extended LAPD

3.2 Wideband packet network

Packet switching is largely absent in the wideband circuit network approach. The contrary occurs in the opposite wideband packet network approach, as drawn in figure 6. The core of the network is composed of FPS nodes interconnected by high-speed data links (let's say up to 140 Mbit/s). The access is provided through access interface devices that implement gateway conversions of signal and protocol formats. Access is offered to the telephone and narrowband ISDN network, to customer premises equipment and private local networks. Switching equipment is designed to introduce low message delays in order to permit real time man/machine communications (a few milliseconds each switch). High speed data/image communications are allowed together with medium-speed moving video signals, let's say up to 10 Mbit/s. This network architecture is also applied to a double-star topology in the metropolitan areas.

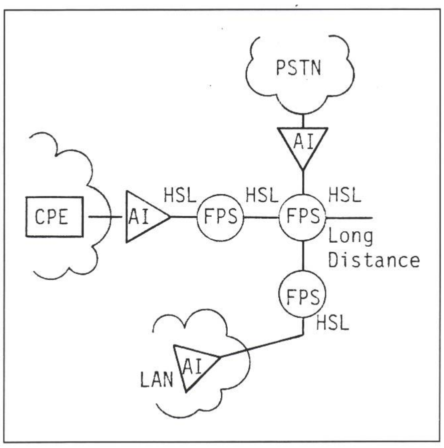


Fig. 6 Wideband Packet Network — Double Star

PSTN Packed Switch Telephone Network
FPS Fast Packet Switch
HSL High-Speed Link
AI Access Interface
CPE Customer Premises Equipment

3.3 Wideband multi-access network

A distributed access approach is followed by the data industry driven network implementations for local and metropolitan areas. A fiber feeder connects several access nodes in a distributed network topology to form rings, buses and trees (fig. 7a). Access nodes use the full feeder capacity to switch physical and virtual circuits throughout the network. Access interface devices perform access gateway conversion functions and channel distribution to user devices or to internetworking connections. In a "slotted ring" approach the feeder bit rate is subdivided in composite building blocks as shown in figure 7b. These blocks may correspond to the hybrid circuit and packet information bit frame discussed in the introduction to figure 3. Movable boundary control in a distributed multi-access network for a metropolitan plant is a complex issue in the design of such networks. IEEE and ANSI standards are going to study incorporation of such a feature in 45, 100 and 500 Mbit/s multiple ring network architectures.

3.4 Wideband hybrid network

Such a network derives from the merging of the best features of the circuit and packet technologies. A double-star topology is assumed for the network layout in the belief that this topology meets easy growth and operational requirements. In this approach, switching nodes can be implemented by switching matrices or by any other switching interconnection mechanism (such as a ring or a bus) realized in a reliable local physical equipment.

Figure 8 shows three TDM frame formats to be used at the access interfaces of the hybrid network. Fixed boundary is used between circuit and packet resources. Two formats apply at 560 Mbit/s with four chunks at 140 Mbit/s each. In the first format no

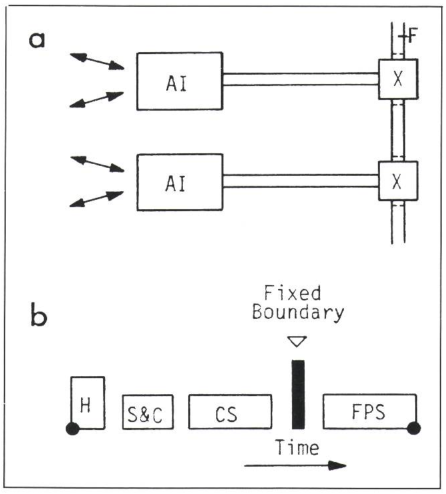


Fig. 7 Wideband Multi-Access Network — Ring, Buses and Trees

a Distributed Topology/Control
b Frame Layout (140 Mbit/s Blocks)
AI Access Interface Channel Distribution
X Access Control/Protection Switching
F Fiber Feeder, n x 1,2 Gbit/s
H Header
S&C Signaling & Control
CS Circuit Switching
FPS Fast Packet Switching

low-speed ISDN channels (B and D) are included. Hence signaling is conveyed in the FPS wideband channel for control of both the 3 wideband circuit switched channels and the virtual FPS circuits. The second alternative in addition incorporates two B-channels and one D-channel at 64 kbit/s each. In this case, the D-channel is used for circuit switching of all circuit switched channels. It remains to be evaluated the D-channel capability to support at such slow speed (64 kbit/s) setting up

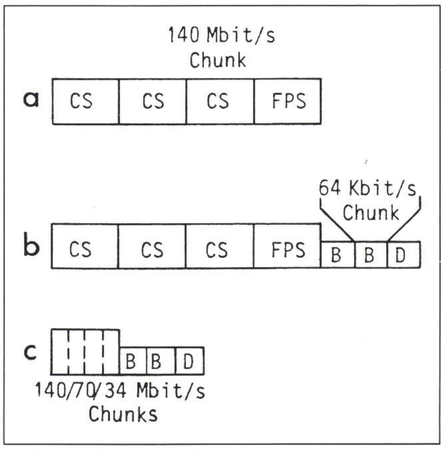


Fig. 8 Widebank Hybrid Network — Double Star, Access TDM Frame Layout

a 560 Mbit/s
b 560 Mbit/s
c 140 Mbit/s

and tear down of virtual circuits in the FPS wideband channel (140 Mbit/s). The last frame format in figure 8 shows similar criteria applied at a 140 Mbit/s interface where the chunks are at 34 Mbit/s each.

4. Summary Remarks on Alternatives

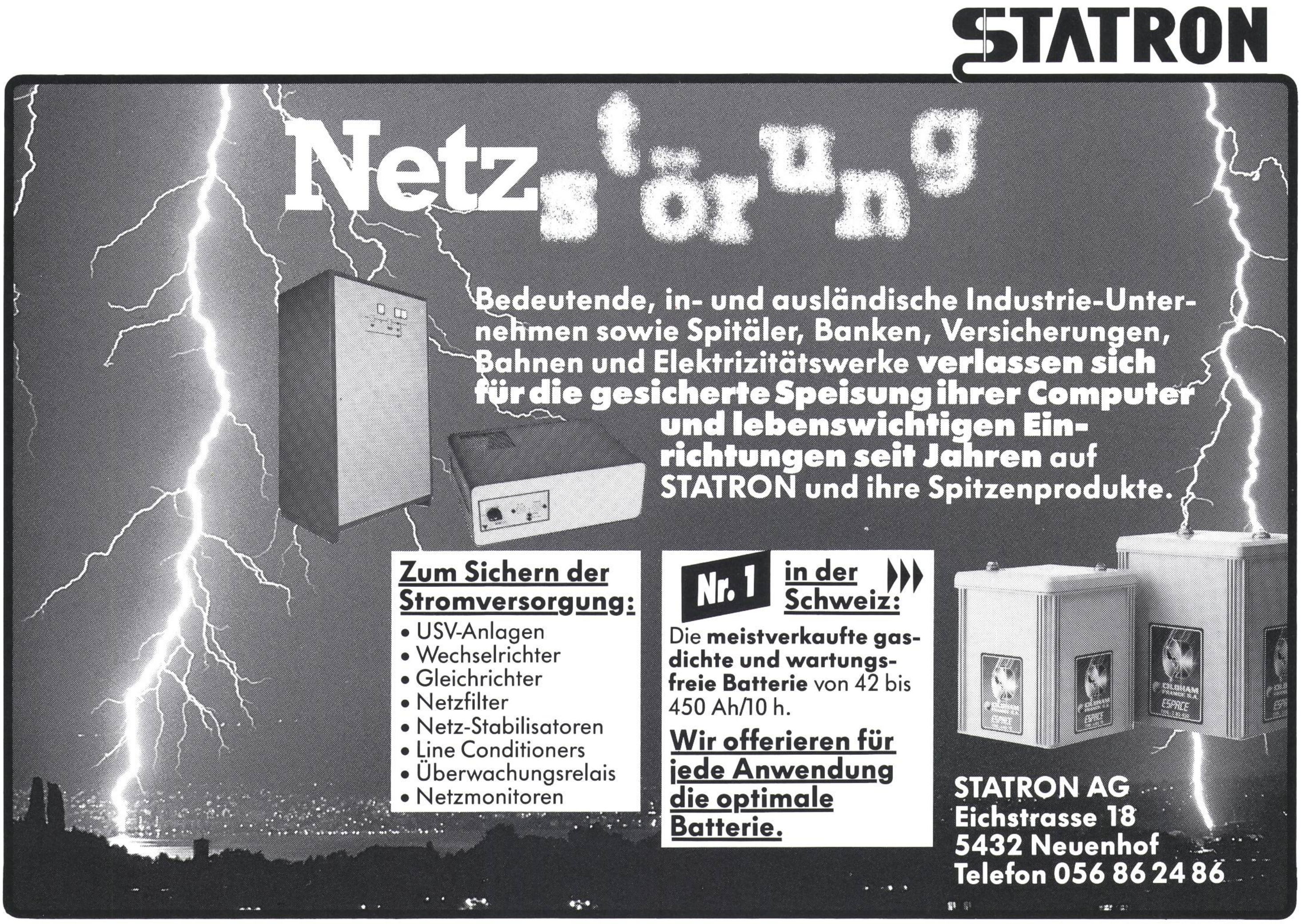
Table V tells us that the driving forces towards development of wideband fiber networks include the following components.

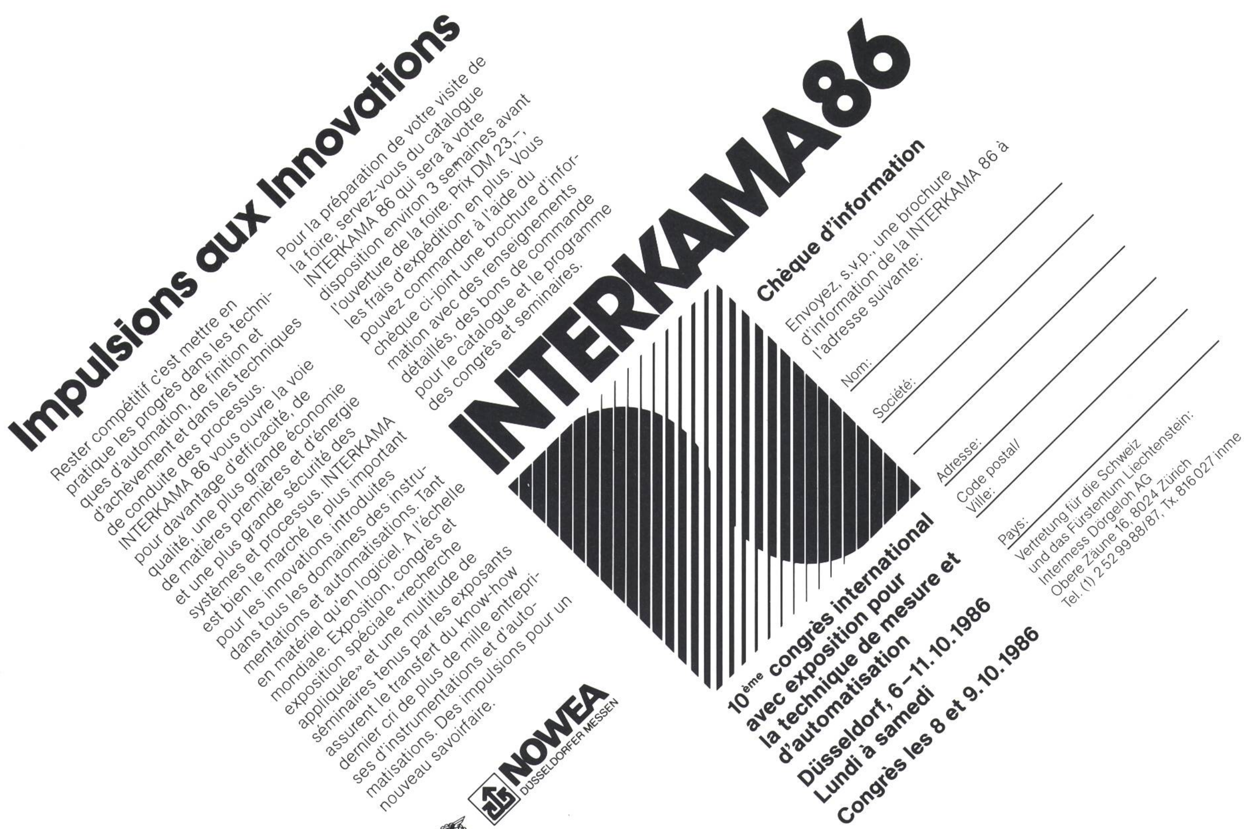
- *Services:* High speed is the emerging requirement for both video and data.
- *Technologies:* Remarkable advances in lightwave technology and high speed integrated circuits are supporting aggressive cost reduction perspectives.
- *Networks:* High speed switching in both circuit and packet modes is the necessary mechanism to satisfy most emerging service requirements; dynamic bandwidth allocation and the network control techniques are the challenges in the design of large wideband networks loaded by unknown service input traffic profiles.
- *Deployment strategies:* That is to say that the best network architecture should meet the market needs; market driven requirements of cost versus performance for various service applications should ultimately dominate the selection of the equipment and the deployment strategy. Business needs and residential needs should be carefully evaluated in particular for the choice of the services that should economically justify the large investments needed for the wideband network deployment.

Summary Remarks Table V

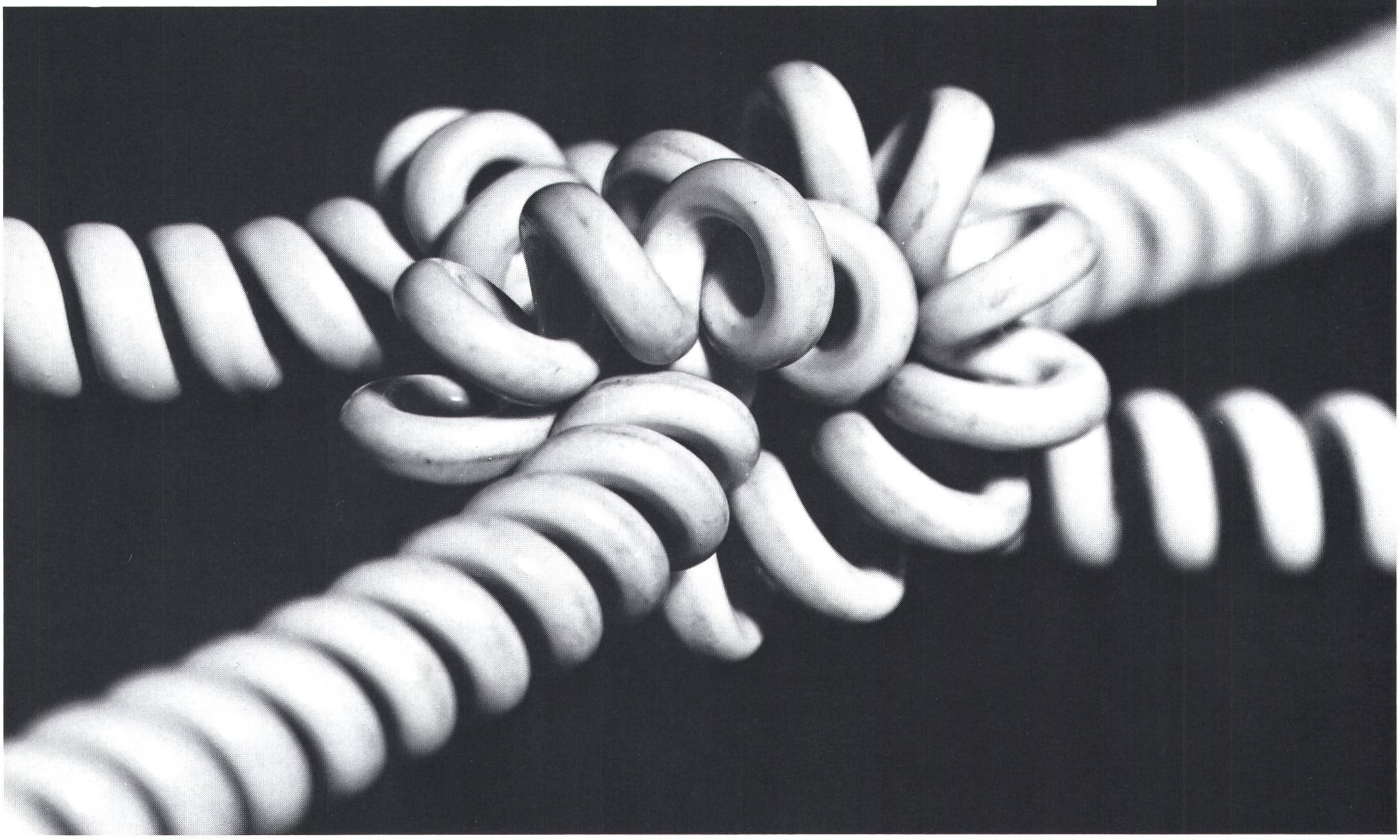
• Services (High Speed) • Image Communications • High Speed Data	• Networks (Flexibility) • Dynamic Bandwidth Allocation • Statistical Switching • Topology/Control
• Technologies (Intergrated Optics) • Fibers • Optoelectronics (E/O) • VHSIC	• Deployment Strategies (Marketplace Demand) • Business • Entertainment

VHSIC:
Very High Speed
Integrated Circuits


STATRON
Netzstörung
Bedeutende, in- und ausländische Industrie-Unternehmen sowie Spitäler, Banken, Versicherungen, Bahnen und Elektrizitätswerke verlassen sich für die gesicherte Speisung ihrer Computer und lebenswichtigen Einrichtungen seit Jahren auf STATRON und ihre Spitzenprodukte.
Zum Sichern der Stromversorgung:
• USV-Anlagen
• Wechselrichter
• Gleichrichter
• Netzfilter
• Netz-Stabilisatoren
• Line Conditioners
• Überwachungsrelais
• Netzmonitoren
Nr. 1 in der Schweiz:
Die meistverkaufte gasdichte und wartungsfreie Batterie von 42 bis 450 Ah/10 h.
Wir offerieren für jede Anwendung die optimale Batterie.
STATRON AG
Eichstrasse 18
5432 Neuenhof
Telefon 056 86 24 86


Impulsions aux Innovations
Rester compétitif c'est mettre en pratique les progrès dans les techniques d'automation, de finition et d'achèvement et dans les techniques de conduite des processus. INTERKAMA 86 vous ouvre la voie pour davantage d'efficacité, de qualité, une plus grande économie de matières premières et d'énergie et une plus grande sécurité des systèmes et processus. INTERKAMA est bien le marché le plus important pour les innovations introduites dans tous les domaines des instrumentations et automatisations. Tant en matériel qu'en logiciel. A l'échelle mondiale. Exposition, congrès et exposition spéciale «recherche appliquée» et une multitude de séminaires tenus par les exposants assurent le transfert du know-how dernier cri de plus de mille entreprises d'instrumentations et d'automatisations. Des impulsions pour un nouveau savoir-faire.
Pour la préparation de votre visite de la foire, servez-vous du catalogue INTERKAMA 86 qui sera à votre disposition environ 3 semaines avant l'ouverture de la foire. Prix DM 23.–, les frais d'expédition en plus. Vous pouvez commander à l'aide du chèque ci-joint une brochure d'information avec des renseignements détaillés, des bons de commande pour le catalogue et le programme des congrès et séminaires.
INTERKAMA 86
Chèque d'information
Envoyez, s.v.p., une brochure d'information de la INTERKAMA 86 à l'adresse suivante:
Nom:
Société:
Adresse:
Code postal/Ville:
Pays:
Vertretung für die Schweiz und das Fürstentum Liechtenstein: Intermess Dörgeloh AG Obere Zäune 16, 8024 Zürich Tel. (1) 252 99 88/87, Tx. 816 027 inme
10ème congrès international avec exposition pour la technique de mesure et d'automatisation
Düsseldorf, 6–11.10.1986
Lundi à samedi
Congrès les 8 et 9.10.1986
NOWEA
DÜSSELDORFER MESSEN

Gegen schlechte Verbindungen.



Zellweger ist führend in der Entwicklung und Herstellung modernster Kommunikations- und Datensysteme, die überall dort gebraucht werden, wo zuverlässige Verbindungen entscheidend sind. Das ist in der Armee der Fall, aber auch bei der PTT und in der Privatwirtschaft. Nebst einigen Typen der neuen TRITEL-Telefonapparate stammen sämtliche Telefonkapseln aus unserem Werk Hombrechtikon. Wenn Computerdaten zu übertragen sind, steht das TELEPAC-System zur Verfügung, das eine paketweise Übertragung in Sekundenbruchteilen ermöglicht. TRITEL und TELEPAC, das sind zwei unserer bedeutenden Beiträge zur Entwicklung der Telekommunikation, die immer wichtiger wird, weil man in der modernen Gesellschaft ohne gute Verbindungen nicht weiterkommt. Zellweger für sichere Kommunikation.

02.2.234 D

Zellweger TeleCommunications

Zellweger Telecommunications AG
CH-8634 Hombrechtikon, Telefon 055/41 61 11