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Telematic access network with universal communications processors

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Summary: The age of the general use of 'electronic' information services has started. The various specialized communications networks have usually grown with the development of a service. A uniformly conceived network between user and service provider can facilitate communication when different systems are used. A general-purpose access network, consisting of programmable communications processors, is an economical alternative to specialized networks both for private organizations and for the PTT.

1 Introduction

In parallel to the development of electronic data processing (EDP), the supply of 'electronic' information services has grown considerably over the last ten years. Public data bases containing information on the fields of science, technology, economics, and finance are used mainly by experts in the specific fields. With the introduction of information services for the general public, small companies and private households are increasingly included in this development.

The PTT administrations make great efforts to offer their customers a suitable platform for the development of their information services. The Swiss PTT offer such services under the names of *Videotex* (information and services) and *arCom 400* (message handling).

Since demand for the services mentioned is steadily increasing, the existing networks have to meet high standards with regard to the access possibilities for terminals. Functions supporting the user and applications will be provided at the network access point. This results in both the improvement of facilities for network users and the possibility of making economical use of the network provided.

The requirements mentioned can be met by means of an intelligent access network, which in most cases forms an access layer around a packet-switched data network (PSDN). In Europe, such access networks are primarily conceived for 'open' videotex systems and offered as a service. On the occasion of the *Telecom '87* exhibition, *Posts and Telecommunications of Finland* (PTH) presented such a system [1]. In Switzerland, too, Videotex plays a major role in the use of new access techniques [2].

Already in 1986, the PTT worked out a concept of how to optimize the access techniques for telematic services on the basis of universal concentrators [3]. The project has been adapted to the latest technical developments and is being implemented.

2 Concept for an access network

The concept for a telematic access network is based on geographically distributed access points forming an access layer around a backbone network. The backbone network is responsible for the data transport to the computer systems (hosts) of the service providers. The user accesses the access point by means of his terminal via the telephone network (PSTN) or via a direct line.

The access point supports the characteristics of the terminal and performs application-oriented functions. Support services for secure access to the network and for the selection of services are also part of the access network. A modular concept of the functional units allows to create an open, uniformly conceived network for different terminals and applications.

21 Network structure

The access network as a part of the infrastructure for telematic services is shown in *figure 1.* The system components of the access network and the networks used for the data transport *(backbone network)* and for subscriber access *(data transmission network)* are subsequently described with regard to the access network.

211 Access network

The basic element of the access network, the *access point,* is located close to the subscriber. The concentration achieved reduces the transmission costs and allows

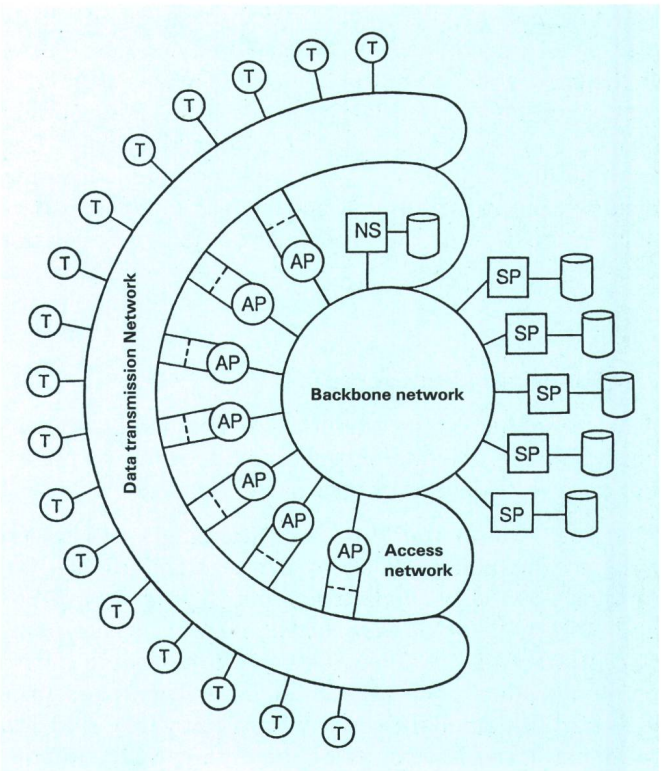

Fig. 1
The access network as a part of the network infrastructure for telematic services
AP Geographically distributed access points
NS Central server for the services of the access network (network server)
SP Provider of information services (service provider)
T Terminal

an even load of the backbone network. The access point locally performs transport- and application-related functions. Executing these functions locally is of importance because the data transfer via the backbone network can be optimized.

Centrally located *network servers* keep data files which must be available within the whole network. The access points are connected with the servers via the backbone network; moreover, the access network contains the elements required for its operation, administration and maintenance.

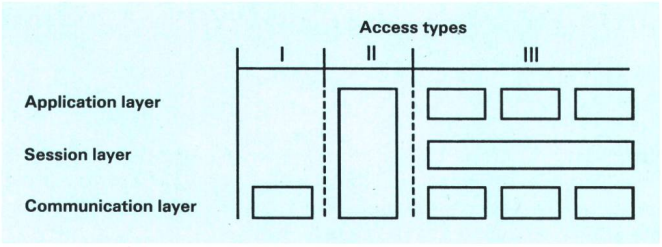

Fig. 2
Functional architecture of the access network

212 Backbone network

The backbone network is responsible for the data transport of the access network. Network-specific tasks up to layer 3 of the OSI reference model (open systems interconnection) are part of the backbone network (in most cases as a packet-switched data network). In case of large traffic volume, mixed operation with a circuit-switched digital network could be provided.

The access point is connected with the backbone network via network-internal connections. The backbone network has to meet high standards with respect to reliability of service. It provides the gateways to other networks at home and abroad.

213 Transmission network

Either direct lines (modem lines) or connections via the switched telephone network are used as transmission network between terminal and access point. It is planned to provide access for local area networks (LAN) to the access point. For that purpose, the access point is moved to the subscriber premises. The transmission costs are an important part of the connection fees. Decentralized installation of the access points reduces the distance between terminal and access point considerably. In most cases, the transmission network does not exceed the boundaries of the local telephone network.

22 Functional architecture

A closer look at present and future terminal types is of importance in that the access point assumes the function of a *terminal server* for certain applications.

'Classical' examples of proprietary terminal types having reached the status of an industrial standard are the terminals *VT100* by *Digital Equipment Corporation* (DEC) and *3270* by *International Business Machines Corporation* (IBM). The VT100 plays a central role in the 'open' communication, because subfunctions have made their way into the standardization committees (e.g. into the American National Standards Institute [ANSI]). In contrast, the 3270 is mainly used in an IBM environment.

For the Videotex service, the characteristics of the terminals are the ones laid down by CEPT (Conférence européenne des administrations des postes et des télécommunications). In Europe, three different profiles are in use.

A *personal computer* (PC) can be used for emulating the terminals mentioned, if the necessary hardware and software is available. Besides, owing to its 'intelligence', the PC is able, if used as an *intelligent workstation,* to serve as a complete interface to the user. This means that communication will take place from 'process to process'.

Special terminals for applications, such as *electronic funds transfer at the point of sale* (EFT/POS), will also determine the picture of terminal equipment with communication facilities.

This diversity of terminals with various fields of application forms the background for the definition of the functional architecture of the access network. By means of the simple model shown in *figure 2* (the figure does not correspond to the OSI reference model), the functional units are described in general. The model is based on three functional layers which represent the basic access types (I-III). A comparison of the characteristics of the various access types is given in *table I.*

221 Communication support

The communication between terminal, access point and host belongs to this functional layer. The data relevant to the application are not interpreted. The access point locally processes the communication protocols used by the various terminal types. The adaptation to the network-internal protocol and addressing scheme is, if required, a further task of the communication support.

In the access network, mainly internationally standardized communication protocols are used, e.g. those laid down by the International Telegraph and Telephone

Table I. Characteristics of the access types

Access type I	Access type II	Access Type III
– Communication-oriented – Application-independent	– Communiaction-oriented – Application-oriented – Fixed relation between terminal and «closed» system application	– Communication-oriented – Application-oriented – Common functions for identification and selection of services – Extended access possibilities to various applications with one terminal type «open» system

Consultative Committee (CCITT) or by the International Organization for Standardization (ISO). Manufacturer-related protocols can in principle be included, but they lose significance, since standardized protocols are also being increasingly used for the lower layers of the OSI reference model.

222 Session support

A major element of the 'intelligent' access network is the network-wide availability of functions, which are made possible by the use of network servers. The subsequent explanations refer to possible session services:

- The selection of services is menu-guided, whereby the access network inserts the network address of the service selected and maintains the directory services needed.
- An identification of the user is possible. On the basis of the identification code, the access network can enable access to services subject to subscription without further identification procedures. A list of the services permitted and further information (e.g. for billing) are contained in the access network such as personal information of the user.
- Identification can be performed either by means of the 'classical' method of the combination 'name/password' or by means of a chip card. If no identification is desired, the chip card – used as a prepaid card – can be directly used for charging the services received [4].

Open communications networks require security measures, allowing access to sensitive data to authorized subscribers (persons or terminals) only. The fact that the number of subscribers of a public network (or service) can be almost unlimited asks for more cryptographic security mechanisms based on public-key methods. Security precautions such as key distribution can be offered as an additional service of the access network, provided by the corresponding servers.

223 Application support

The purpose of the application support is to separate the specific features of a terminal from the application. The user should be able to use as many applications as possible with his terminal; at the same time, the target systems should not grow too complex.

Mainly the character-oriented tasks (echo, forms processing, etc.) related to the application are processed by the access point; thus, the network and the application host are off-loaded considerably. The adaptation of the application-related protocols to the various terminals is another function of this layer.

Current efforts made by the ISO towards the standardization of a protocol for the *virtual terminal service* (VTS) progress only very slowly. The fast development and the very diverse features of the manufacturer-specific terminals hamper the process of standardization. For that reason, only specific applications of general interest can be supported by the access network.

23 Integration into operation

231 Environment

For the operational integration of a subnetwork, its network management system is of major significance. *Figure 3* shows the position of these systems within an operational environment consisting of several independent subnetworks.

The management of the network elements of each subnetwork contains functions for control and administration. A central system enables the operational integration of the subnetworks. The main purpose is to streamline the administration procedures reaching beyond the individual subnetwork. Basically, the information flows vertically in a hierarchical way. The network elements exchange information with the control system, and the administration system communicates with the central system. The aim is to combine the individual systems in an integrated network management with a peer-to-peer data flow. However, this aim can be achieved only on the basis of internationally agreed standards, once they exist.

International committees, manufacturers of communications networks and network operators work hard on the standardization of architecture and protocols for an 'open' network management including both hierarchical and peer-to-peer management [5].

232 Control and management of the access network

The individual network elements of the access network are not physically interconnected. The communication takes place by means of logical connections via the backbone network. For operating the network elements, a logical structure, allowing a hierarchical management of the access network, is superimposed on the physical network topology. The network elements generate alarms for specific events within their environment. These alarms are, according to their significance, transmitted to the control system. Control commands initiating mainly changes of status or test functions are passed on to the network elements via the control system.

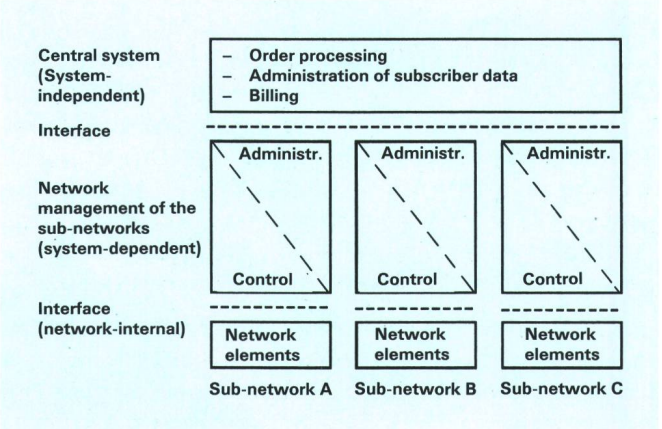

Fig. 3
Operational environment with several subnetworks

During operation, the network elements generate statistics and accounting data. These data are collected by the management system, where they are processed to calculate the charges for the services used.

The creation of new subscribers is performed by the network-internal management system. It prepares the corresponding configuration data and transmits them to the network elements. This system can obtain the input data from the central system.

233 Central system

The central system contains functions such as order processing, acquisition and administration of subscriber data and processing of accounting data for the purpose of individual billing. The exchange of data between the central system and the management systems of the subnetworks takes place via a globally defined interface. This interface links the system-dependent subnetworks and the system-independent central system. The control systems of the subnetworks are normally not influenced by the central system.

This division into the various system areas enables the operational integration of new subnetworks or functions with reasonable personnel and technical costs.

3 Field trial

In a field trial, the PTT are testing the basic elements of an access network. The aim is to gradually prepare an access network, which has been conceived, according to Section 2, for commercial operation. The communications processors by *Telematics* are the core element. *Standard Telephone and Radio* (STR) has been appointed by the PTT as the system supplier. STR is also responsible for the development and adaptation of additional features necessary for the system integration. The subsequent description of the project and the system elements used are based on documents developed in close cooperation with STR.

31 Procedure

The field trial in progress in several parts of Switzerland consists of two phases. The test focuses on the *telematic access processor* (TAP). Parallel to the test, the existing operational organization is gradually adapted to the new tasks.

Basle, Lausanne and Yverdon have been in the first phase of the field trial since 1st February 1988. TAPs of the standard version with the corresponding operational functions are in use. A major aim of the first phase is to reach a stable state of operation of the TAP network as a basic infrastructure. Thereby, the necessary adaptations and additional features still to be developed have to be identified and made available for the second phase.

Presently the second phase is in preparation. It includes an extension of the network in the areas St. Gallen and Zurich by means of system components which meet the requirements of the PTT to a large extent. By introducing additional management functions, the operation of the network will be adapted to the size of the TAP network. For testing these new functions, a test installation will be equipped in Berne.

Phase 2 will be completed when the technical and operational conditions for commercial operation are fulfilled. The following criteria are taken into account:

- The elements of the access network have to meet the system requirements.
- The system documentation and the manuals for installation and operation have to be available.
- The operational organization has to be built up.
- The operating staff has to be trained.
- The functions offered have to be completely reliable.
- The customer documentation has to be available/adapted.
- The commercial aspects have to be settled.

After termination of the field trial, the access network will be extended swiftly, according to an introduction strategy based on the market requirements. New functions will gradually be integrated into the network. Full operational integration will be achieved by means of additional developments in the area of network management.

32 System overview

321 Telematic access processor

The TAP is a programmable communications processor which is structured as a multiprocessor system. The operating system used is event-controlled and communications-oriented and makes possible the implementation of specific applications. Several tasks can be performed simultaneously (multitasking). The system and development environment is open, so that the system can be extended — even by a third party. These features guarantee the product a long lifespan as a universal access processor.

According to the number of communications lines and the resources required for the applications, there are different systems and configurations available. Up to 480 ports, five processors (CPU cards) and memory cards up to a total of 16 Mbyte can be configured. A basic system consists of a programmable communications processor (PCP), the operating system (TRAX), the network software (Net25), and an integrated system for the network management (INF). The applications can be loaded onto the system as required. The systems designated for the access network and the typical configurations are defined according to *table II.*

Table II. Typical system configurations

Type	System	Ports	CPUs	Memory
I	S 200	≤ 34	1	4 Mbyte
IIa	S 1000	≤ 52	2	8 Mbyte
IIb	S 1000	≤104	3	8 Mbyte
III	S 2000	≤204	4	12 Mbyte
P_ NCC	S 2000	—	3	8 Mbyte
S_ NCC	S 2000	—	4	12 Mbyte

P_ NCC Regional NCC
S_ NCC Central NCC

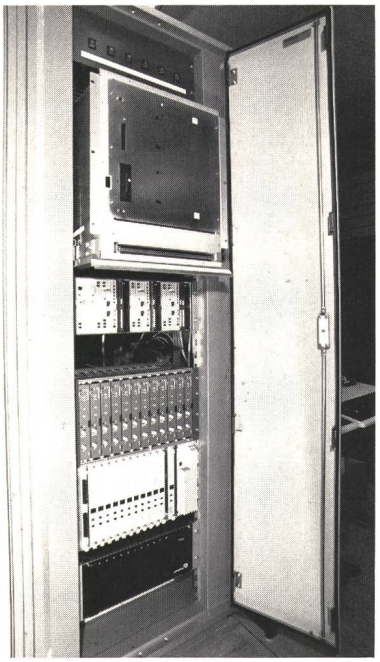

Fig. 4
TAP with doors opened

Types I to III are designated for connecting subscribers. Basically, they are designed for remote operation without operating staff. They will be installed mainly in large local and transit telephone exchanges.

A TAP without user ports configured as a *network control center* (NCC) assures the regional operation of the network. The NCC is installed, where operating staff is available.

A central NCC is used for the operation and the management of the whole access network. In case of a failure of a regional NCC, it assumes the functions of the latter.

The equipment for a TAP is housed in a basic cabinet (types I, IIa and NCC). For larger installations (types IIb and III), extension cabinets for additional communications cards and transmission equipment are necessary. *Figure 4* shows the structure of an installation type IIa. The PCP is installed in the upper part of the cabinet because its heat generation is relatively high. The racks containing the modems are located below the PCP. The necessary infrastructure, such as the distributor for the subscriber lines, the power supply and the alarm unit, is installed in the same cabinet.

The system entirely meets the PTT requirements concerning electromagnetic compatibility (EMC) and acoustic noise level.

322 Access to the backbone network

Each system element of the access network (TAP, NCC) is connected to the packet-switched data network of the Swiss PTT *(Telepac)*. Telepac, based on the SL-10/DPN technique by *Northern Telecom* (NT), assumes the function of the backbone network (see section 212).

The units of the DPN architecture used at present are functionally assigned to the following two layers:

- network layer
- access layer

The function of the *network layer* is to ensure the connections between exchanges and between countries. It assumes the actual switching function and the routing. A failure of a connection or even of a network module within the network layer does not result in an interruption of service, as there is always another path available.

The *access layer* contains the access modules for Telepac. The TAPs, being components of this layer, are integrated into the network. *Figure 5* shows the access configuration of a DPN-50 exchange.

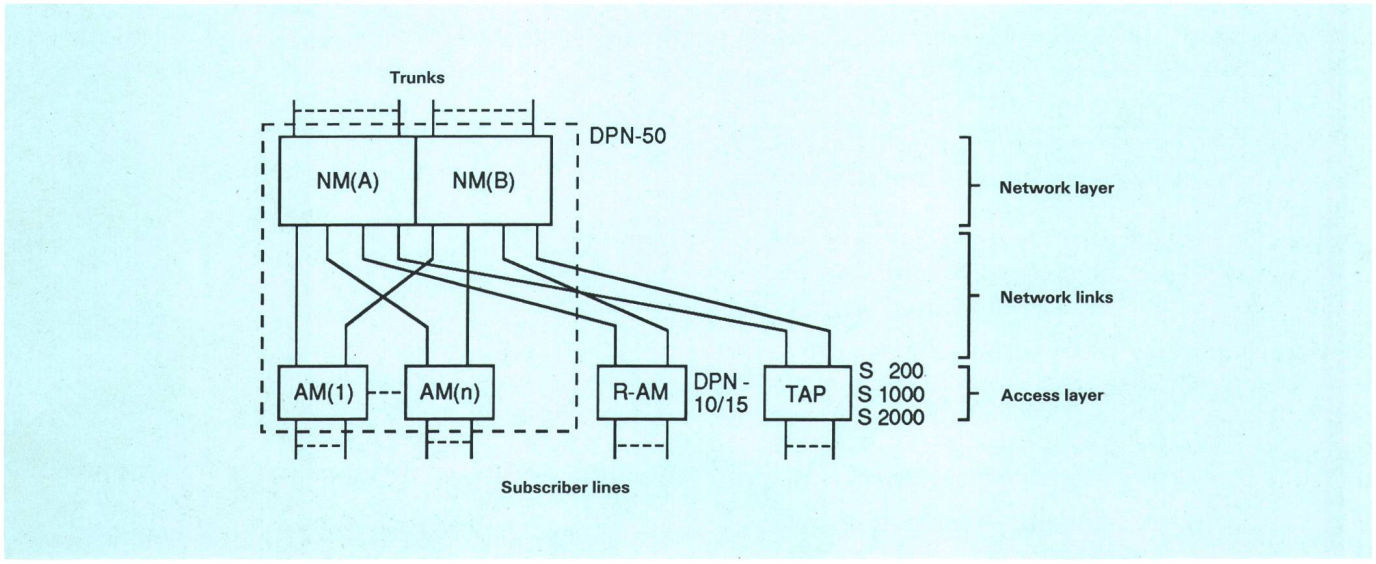

Fig. 5
Access configuration of an exchange of the type DPN-50

NM	Network module
AM	Access module
R-AM	Remote access module
TAP	Telematic access processor
DPN-10/15/50	Product names of Northern Telecom
S200/1000/2000	Product names of Telematics

Table III. Numbering scheme for the access network

	0 228 7 NNNNN TT SSS
0	Prefix
228	Country code for Switzerland
4	Network code for Telepac
NNNNN	Address of a network link to the TAP
TT	Subscriber number
SSS	Subaddress area

The network links between TAP and backbone network, with a transmission speed of up to 64 kbit/s, correspond to the CCITT Recommendation X.25. Extended functions are required to use the TAP as planned. This primarily refers to the bidirectional transparent signalling of call progress signals. The quality of service required is ensured by redundant connections to the backbone network and to a special back-up configuration.

Access network and backbone network share the same range of numbers available. The numbering plan is defined in the CCITT Recommendation X.121. *Table III* shows the numbering scheme used for the access network. The national address, which is important for the backbone network, has been cut to six digits, which allows to allocate two digits to the access network for the subscriber numbering (the present subaddress range of three digits remains).

323 Connection of the subscribers

The terminal is connected with the TAP either directly via a dedicated line or via the telephone network. Both types of connection serve the mere data transmission between terminal and access network (see section 213).

Since the transmission equipment of the digital backbone network of the PTT has proven reliable for direct access, this equipment has been used. A system overview is given in [6].

For the connection of subscribers within short range of the TAP, the local subscriber line is used for transmitting both voice and data simultaneously without interference. The data signal is superimposed to the audio signal by means of the economical modulation method *'data over voice'* (DOV).

The use of the modulation method *'Frequency shift keying'* (FSK) with carrier frequencies of 50 kHz or 60 kHz (A-channel) and 95 kHz or 105 kHz (B-channel) allows a relatively simple and very reliable data transmission system for speeds of up to 19.2 kbit/s.

For the field trial, DOV systems by *Autophon* and *Datentechnik* are used. They are based on the corresponding CEPT Recommendation [7] for the simultaneous transmission of voice and data. The subscriber device is designed to fit in an office environment *(figure 6).*

In case of sufficient data traffic via the telephone network, the data is already sorted out in the local exchange and directed to the TAP. Speeds of up to 2.4 kbit/s are generally used as transmission rates. Besides the nine-digit numbers with 'artificial' area codes (047 and 049) already in use for telematic services, three-digit service numbers are under discussion. Thus the time required for the connection set-up in conventional signalling can be cut considerably.

33 Functions

During the field trial, only data services with access protocols according to the CCITT Recommendations X.25 and X.28 and with extended access possibilities for Videotex are available.

331 Data services

In addition to the data services of the packet-switched data network Telepac, the following services are available:

a) X.25 with predefined profile

The existing access possibilities for terminal equipment working in packet mode allow a flexible design of the access configuration. Today, the scope of terminal equipment ranges from mainframe to *personal computer.* The need to connect low-end terminal equipment to a data network at reasonable cost is of growing importance.

Thus, as a trial, the access network provides preconfigured ports of a given profile. The reduced configuration costs and the optimized access method (concentrator with DOV modem) offer an economical option for a constantly growing market.

b) X.28 with improved features

Terminals working in character mode are commonly used today. On the one hand, there are video terminals, on the other personal computers, most frequently containing a standard communication interface.

This fact is taken into account by standardization committees, such as the CCITT, and by suppliers of communications software in that the features offered are improved. In addition to the standard functions according to the relevant CCITT Recommendations (X.3/X.28/X.29)

Fig. 6
DOV subscriber device including telephone set

of 1984, the access network offers the user the following features as options:

- access speeds of up to 19.2 kbit/s
- additional X.3 parameters and values
- replacement of operator commands by symbols
- menu for the selection of services

332 Access to Videotex

The Swiss Videotex system is explained in [2]. The functional extension, which is described subsequently, refers to the front-end part of the Videotex centers, i.e. the access area. The software used can be considered an integral component of the whole system. Based on the functional architecture of the access network (see section 22), there is a fixed relation between the terminal and the application (figure 2, type II).

For the field trial, the subfunctions are extended in that the Videotex terminal can also be used for applications not directly related to the Videotex service. This means that the access is divided into a 'closed' part for subscribers to the service and an 'open' part not actually belonging to the Videotex service. In that case, the access network is loosely connected with the Videotex system for certain administrational tasks only. The 'open' function for example allows a Videotex terminal to have direct access to the electronic directory of the PTT without subscriber identification.

34 Operation

The operation of the access network is based on the organization of Telepac. The actual operation centers are located in the same place as the Telepac exchanges. Management functions within the network are combined in a central system.

341 Control area

The TAPs of an area and the corresponding NCC are combined to a control area. This area includes functions such as supervision, alarm, data acquisition (billing and statistics), but not the processing of these data.

In case of a local fault, the TAP normally reacts immediately by means of automated command procedures. In certain cases, the operating staff is required to intervene manually. The system operators and the necessary infrastructure (operator positions, measuring devices, documentation, etc.) are located in the same place as the NCC. The regional NCCs are connected with the central NCC, which can assume the function of a regional NCC in case of a failure of the latter.

342 Operating area

The central NCC, including all units of the network, forms the operating area. The central NCC assumes all tasks within the network to be performed centrally. This includes the configuration management of the complete network and the processing of the statistics data.

At a later date, all system units assuming network-wide functions will become part of the operating area.

4 Outlook

The project for the development of a universal telematic access network will serve as a platform for an economical alternative to the specialized public and private networks. Based on the experience gained from the field trial, the necessary steps for the introduction of new services and functions will be taken.

A swift extension of the access network is planned in areas with high subscriber density. The access via the telephone network will be laid out for large traffic capacity. The interworking with the ISDN of the Swiss PTT, *Swissnet,* which will be introduced over the next few years, is also of major importance.

The 'open' access to telematic services of private as well as public providers is being extended. The use of servers paves the way for an 'intelligent' network. The extensions mainly concern the access for Videotex and ASCII terminals. The user benefits from a uniformly conceived access to the different services.

Whether the access network can be used as a transport network for the EFT/POS application is being examined. This project is based on the cost-efficiency and flexibility of the access network.

The installations for the network operation are extended, above all in the area of network management, in such a way that reliable operation of the decentralized network elements is guaranteed and that the customers are offered a high quality of service.

Bibliographie

[1] Description of the Finnish Telematic Access Network. General Directorate of Posts and Telecommunications of Finland (PTH), Helsinki. Specification TMT 876203, October 5, 1987, BID BJ0678.

[2] *Galluser R.* and *Wüthrich U.* Das Schweizer Videotex-System auf dem Weg zum intelligenten Netz. STR Report 2/87, S. 25.

[3] *Blum A.* and *Ruf A.* Einführung von Universalkonzentratoren zur Optimierung der Zugangstechnik für Teleinformatikdienste. Bern, Techn. Mitt. PTT 64 (1986), 12, S. 599.

[4] *Kunz R.* Autelca AG. Die Chip-Karte – Multifunktionskarte der Zukunft. Hasler-Mitteilungen Nr. 4/1986, S. 75.

[5] *Klerer S. M.* The OSI Management Architecture: An Overview. IEEE Network, March 1988, Vol. 2, No. 2, p. 20.

[6] *Hürzeler J.* Die zweite Generation Datenübertragungseinrichtungen im digitalen Basisnetz. Bern, Techn. Mitt. PTT 66 (1988), 3, S. 92.

[7] CEPT-Recommendation. For a voice-plus-data system. September 1985, Rec. T/CD 01-13.