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## STEPS TO A DYNAMIC AND FLEXIBLE MANAGEMENT NETWORK

# THE NETWORK MANAGEMENT CENTER (NMC) IN THE PILOT PHASE

The network management center covers all management functions for the pilot phase (configuration, fault, performance, accounting and security). Based on the experience acquired from the cooperation within the European ATM research project EXPLOIT, the Directorate (TD) Basel of the Swiss Telecom has been chosen as best suitable for this center. The conception of the network management architecture with various operation systems has been carried out according to the usual requirements of a modern network. A future non-proprietary management network must be able to adapt in a dynamic and flexible way to the continuously changing customer needs as well as to the rapidly decreasing lengths of the actual technology cycles.

The Swiss pilot network is in operation since a year and is supervised by an experienced operational team in Basel (Fig. 1).

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## The NMC Basel

The requirements to pilot project teams having network management tasks for a country-wide network in Switzerland can be formulated as follows:

- perceptiveness and flexibility, good manner of expression
- possibly uncomplicated and direct structure of organization as well as a straightforward general work flow (no redundant organizational structures)



Fig. 1. NMC Basel at Wallstrasse 22 (personnel partially represented)

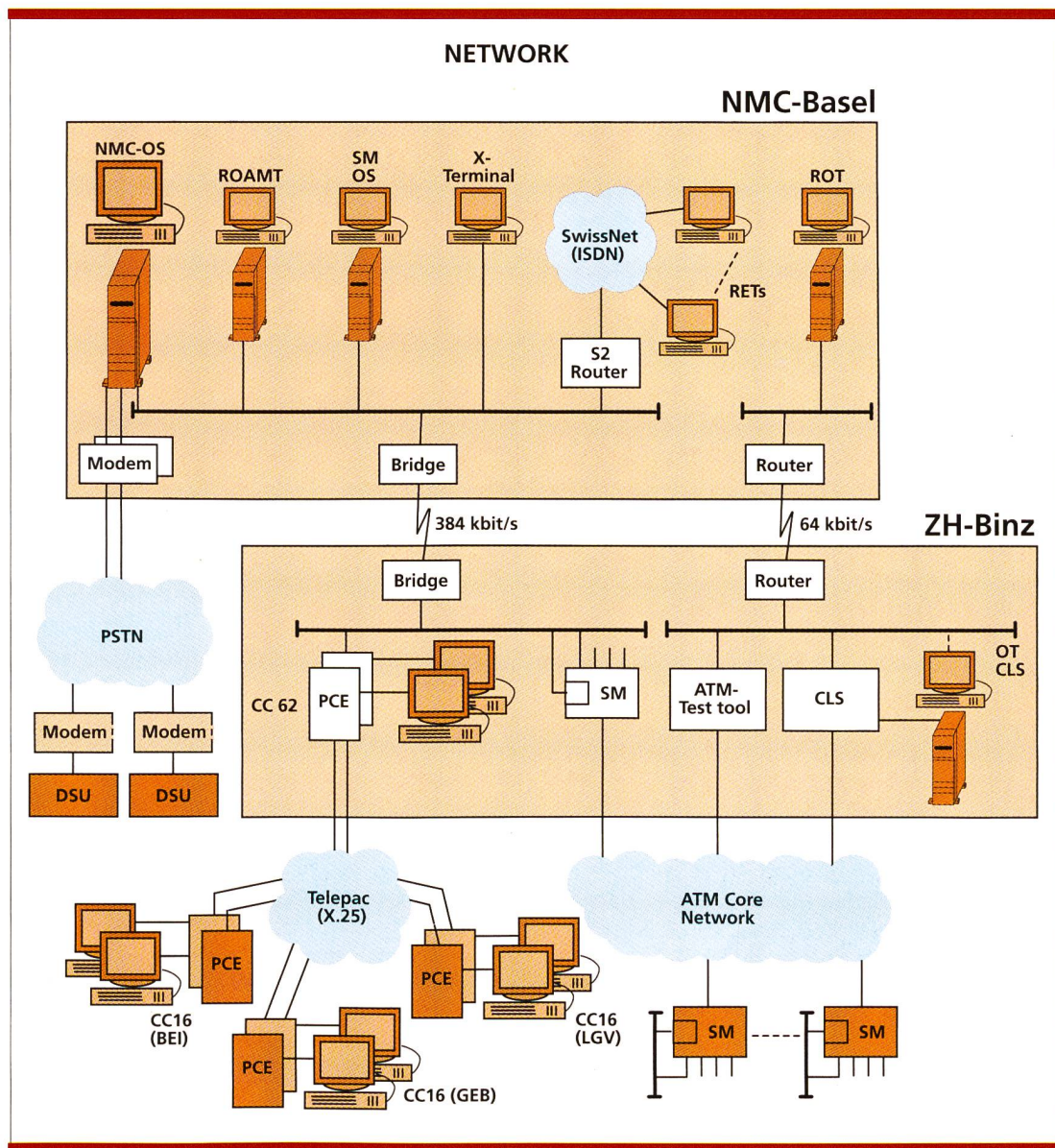


Fig. 2. The complete network at the management plane

- already played-in work procedures must be taken over since no time is available for exercising with new and unproven ones
- the set goal must be reached despite the technical and operational drawbacks (readiness for compromise)
- a basic awareness of responsibility for all occurring problems
- a lot of patience and a sense of sympathetic understanding when helpdesk or support problems are to be dealt with
- readiness for bringing-in operational experience into the work groups that have the task to define the commercial service
- readiness for further continuous personal education since the actual

- schooling and training portions are mostly quite short
- readiness to let the operation of the pilot to be transferred to already foreseen hierarchical organizations
- In a first operational level, the NMC has taken over the responsibility for the management of the service, the network and the network elements within the ATM pilot network. In a second level, the group takes over the responsibility for the local network elements. The necessary competence over the various new tasks has been acquired through the following measures:
- assignment of tasks in respect to a specific network element or a specific function (cross-connect CC,

- service multiplexer SM, accounting, etc.)
- realization of clear directions for the work flow concerning the operational tasks
  - temporary assignment of the general responsibility from the NMC to a specific person, e.g., the person monitors the momentary state of the NMC

### Operation of systems and network elements

In Figure 2, the complete networking on the level of the network management is visible. Within the ATM pilot network, management systems and pertinent network elements of diffe-

rent origin are used. The functional interworking at the network management level is not being applied, except for the cross-connect systems. The equipments or network elements, respectively, do not include yet the Q3-Interface required. Also, there are no special adapters (mediation devices) available enabling the necessary adaptation to a Q3-interface. Only a 'screen level integration' at the operational surface is attained in the NMC-OS. Every network element thus can be controlled by using its own window at the screen. As a software basis for the management applications, the operational system (OS) software is used. The communication with the resident OS is achieved by X.11 protocols, the operational surface for the operator is realized in a uniform way according to OSF-Motif (windows technique).

For managing components and functions, the architecture according to the standards for telecommunications network management (TMN) according to ITU-T, M.3010 is applied as far as possible. The information flow for the management functions thereby occurs over the existing data communications network (DCN) inherent of the TMN. The DCN consists of three different types of partial networks. This solution described was chosen from a technical point of view as well as for considerations of safety.

#### Operation of system for the cross-connectors (CC)

The networking of the CC's for the user network is defined as the core network. Here, the virtual path connections (VPC) are formed and they represent the actual base service. The switching and monitoring activities of VPC's are the main task of the NMC.

The CC's are connected over two links over DCN (X.25) with the CC located in Zurich. The local control in Zurich however keeps a master function towards all other CC's in Bern, Geneva and Lugano. For reasons of redundancy, the control implementations, including the switching matrix, are implemented twofold. One control is active, the other continuously receives the necessary information about the state of the system but remains in the standby mode.

Three basic access methods for the system management are in use:

## REQUIREMENTS

Modern telecommunication networks become increasingly complex and thus are also more and more complex to operate. To be able to operate such networks more efficiently and safely, user-friendly management systems are required. In general, these systems have to satisfy the following requirements:

- ◆ fast realization of customer requirements
- ◆ monitoring and thus maintaining of the functions of the network
- ◆ possibly a reduction of administration and maintenance
- ◆ cost-efficient operation of the overall network

The consequences of these requirements are that the flow of work is to be optimized. All operational and maintenance tasks, except for the exchange of hardware, are to be dealt with in a centralized network management center. It is self-understanding that the functionalities of the center can be reproduced at the locations of all network elements involved. In this manner, it is assured that even in the case of a breakdown of the management center, the operation of the network is maintained. The system architecture of the network management center was chosen in such a way that it can be integrated into the future concept of a telecommunication management network (TMN). All network elements are centrally operated over vendor-specific operation systems (OS).

- Local access, directly to the CC-OS. This is being used especially in the case of an error, if a localization is required at the local level. For this purpose, various graphical realtime tools (GRAP) are available, offering a deep and accurate description about the functions and relationships involved.
- Remote OAM terminal (ROAMT) from the NMC.
- The screen-level integration of the ROAMT from the standpoint of the NMC-OS.
- The server of the NMC-OS also al-

lows an access from an X-terminal at the same LAN in the NMC-OS.

- All NMC functions can as well be offered from the NMC to a remote end terminal (RET) which can be connected over the ISDN network (64 kbit/s). For this function, a special S2-router is available that connects to the NMC-LAN and as well to the ISDN network from which it can be called up (Fig. 2).

#### Operation of system for the service multiplexer (SM)

If a customer desires a specific adaptation service (e.g. CE, LAN, Interconnect) on top of the basic service (ATM bearer service) or if there is a pre-concentration of customer connections desired, there is the possibility to connect an SM at the periphery of the actual core network. The management system SM-OS belonging to the same system family is used for the actual control. For the DCN function, the actual ATM user network is applied where in each case, a VPC at 64 kbit/s is connected from the core network to the ATM user network. At the SM, the VPC is coupled out over an Ethernet adaptation card and connected to the control input of the SM. All these VPC's are eventually collected at the master CC in Zurich and again fed to the local LAN over an Ethernet adaptation card. The extension of the LAN to the NMC in Basel allows a transport of this management traffic into the SM-OS. For the operator, identical possibilities exist as those listed for CC-OS.

#### Operation of the data service units (DSU)

The DSU are presently used as adapters for the SMDS/CBDS service. For the DSU, no true management system is applied. The DSU can be operated basically from every ASCII terminal (e.g. VT100). The DSU's are being called over analog modems for switched networks (9.6 kbit/s over PSTN). For reasons of safety, a callback function is applied. At the NMC end, these modem signals are fed directly into the NMC-OS. Here, an automatic DSU dialing is being initiated from the graphical surface. The VT100 terminal emulation is also integrated fully into the graphical surface. The operation can occur from an X-terminal at the

LAN or remotely over a RET terminal (like for SM and CC).

In contrast to other network elements, the DSU does not represent a virtual connection with the NMC, a status query (polling) is therefore required from time to time. Occurring alarms or statistical informations therefore are not automatically transferred to the NMC, they are accumulated locally.

**Operation of system of the connectionless server (CLS)**

To be able to use the SMDS service at ATM in a reasonable manner, at least one CLS is required in the network. It is connected over two STM-1 links to the CC located in Zurich.

The way of management remains in principle the same as with SM-OS and CC-OS. Locally, at the CLS, there is a workstation serving as main management access to the CLS. By extending the local LAN segment over a fixed link at 64 kbit/s into the NMC, an identical operation surface can be used on a remote workstation. At the actual management level, there is no interworking between the CLS system and the remaining management systems.

**Management functions**

**Configuration**

With the aim of an optimal management of the transmission resources, a technical framework document (TFD) was drafted for the European ATM pilot (EAP) containing a draft description concerning the use of the system from the customer side. This document is presented to some potential network operators for examination and finally, it serves to perform an assignment of network resources in a coarse way. In Switzerland, this TFD is taken into account also in network planning on a national level.

Only now the customer can start an actual command for a link using a special fax form. Purely national links have to be ordered at least four hours in advance. For international links, the European ATM pilot specifies a period of 24 hours. A command of international links initializes a fax procedure standardized within the EAP. For a transmission buildup over two transit nodes in the foreign part of the network, not less than seven fax links are required of which four are to be confirmed, again by fax.

Only now, the actual switching procedure begins within the NMC. *Figure 3* shows the basic principle of a switching procedure. Within the NMC, the procedure is basically divided into two steps.

In a first step, a reservation is done within the off-line data bank 'electronic reservation system' (see contribution 'eReS') with a chance of rejection of the link command in case of lack of capacity, on a link in the network (overbooking). Naturally, link orders may concern not only a full link by itself (occasional, periodic, weekly, daily) but also a modification in respect to capacity.

If the order of the link is accepted by the reservation system, it can be entered into the actual on-line configuration system. For orders involving a bandwidth altering with time, only the compatibility with the momentary state of the network is examined. This is actually one of the main reasons, why 'eReS' is used.

In configuring the link in the core network (CC-OS), it is sufficient to mark the two end points of the network. The intermediate links (feeder lines) are automatically defined and configured by the system.

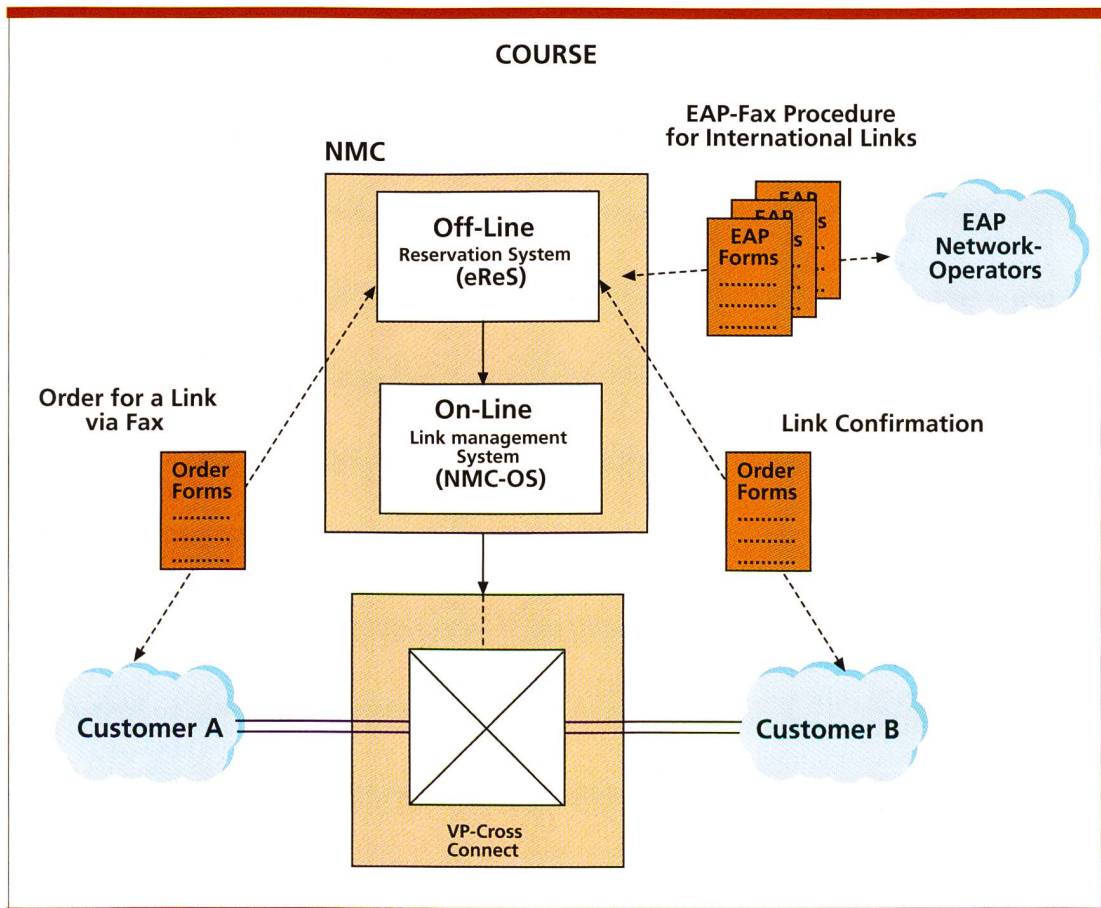


Fig. 3. Flow diagram for the link ordering procedure

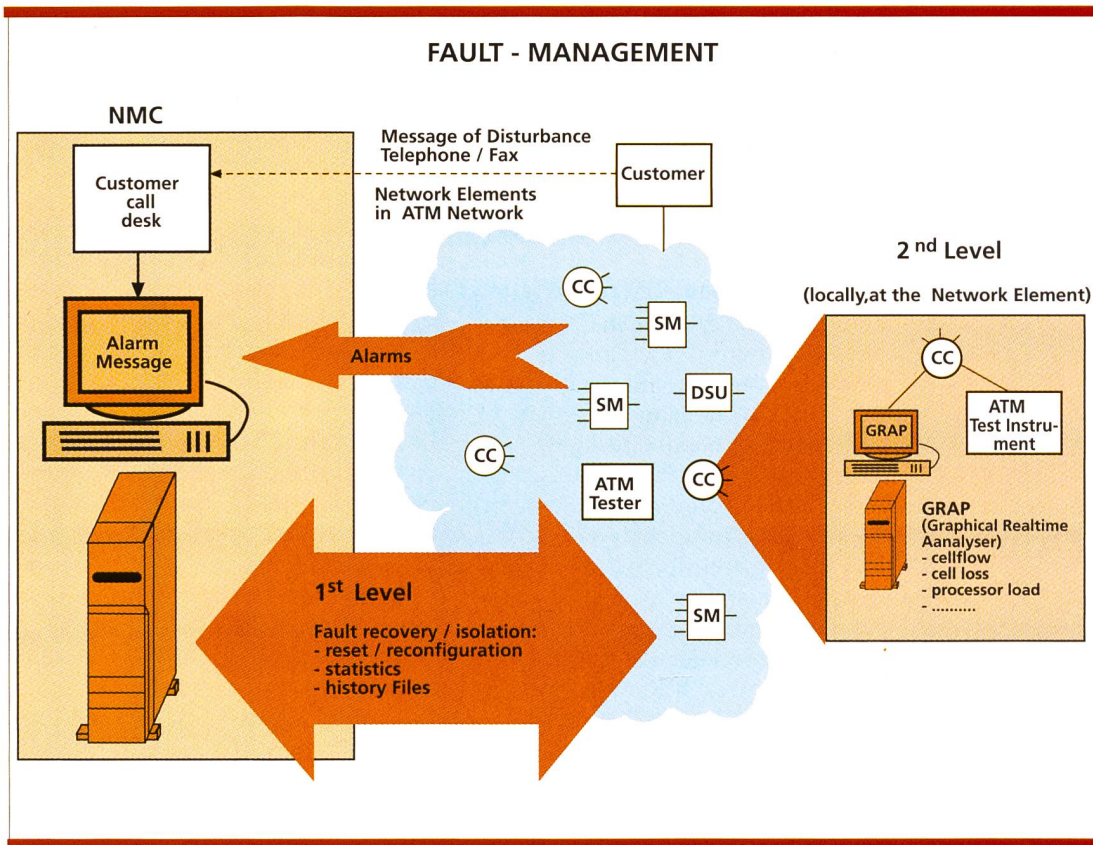


Fig. 4. Flow diagram for the link tax accounting

If the customer operates a special adaptation service (SMDS, Ethernet, E1, etc.) or if a preconcentration of customer connections is performed by an SM, the network elements must be configured separately in addition by using the suitable management system. Every link basically consists of an upstream and a downstream portion. It is not mandatory that both directions of the virtual path (VP) exhibit the same bandwidth. In an extreme case, one of them can be zero and it is thus defined as an unidirectional link. After a link configuration has been performed successfully, the customer obtains a switching confirmation (by fax).

**Fault**

For reasons of economy, the operation of the NMC is offered to the customer only on workdays between 8.00 and 17.00 hours. Outside these time limits, no network configuration activity is to be expected for the Swiss network portion and the same is true for other EAP network operators. The time limits also are valid for any possibly required activity in respect to error search.

Alarms and other informations (Fig. 4) are being transported over the DCN into the NMC and are being monitored in specially designated windows with all details (except DSU). An error indication can be transmitted from the customer to the NMC directly, by

telephone or again, by fax, using a special form. For the localization and remedy of errors, the following possibilities exist (level 1-fault management):

- careful analysis of error message indication

**PERSPECTIVE INTO THE FUTURE**

**Evolution into a telecommunication management network (TMN)**

The management systems used in the ATM pilot are all being operated centrally in the NMC Basel. However, different operating surfaces are being used. Growing numbers of customers and new services, service characteristics and network technologies spur a further growth of the telecommunication networks of public operators. A multi-vendor telecommunication management network (TMN) offers an architecture (Fig. 6) with which the requirements of customers and the rapid technology and product develop-

ment circles can be satisfied in a dynamic and flexible way. It is foreseen that the present as well as the future network elements will communicate with the network control center (OS, operation systems) either over standardized interface Q3 or over an adaptation unit (QA, Q-adaptor) directly or with the aid of a translation unit (MD, mediation device) over a data communications network (e.g. over the Swiss Telecom Telepac network). The operation of the network control center is assured with servers (WS, work station) accessing over the F-interface. Management information between two management networks is being fed over the X-interface, e.g. X<sub>COOP</sub> and between a virtual customer network controlled over a management network over the X<sub>USER</sub> interface.

- analysis of the statistics per port and per path
- evaluation of status of the permanent international test links
- forming of loops per section, within the ports
- connect test links to the centrally located test equipment (HP 7500), configure generator and analyser correspondingly
- initiate various restarts
- initiate reconfigurations

A further localization and neutralization of errors is not possible from the NMC implying that a direct intervention is required at the presumably defect unit (level-2 fault management):

- A CC-OS internal graphical real-time analyzer (GRAP). It allows for an analysis of a detailed cell flow referred to port and path as well as some general statements about the processor load.
- Analysis using locally connected ATM testers.
- Exchange of subunits or equipments.

Errors that cannot be localized by the operational group at the location appear to be of a fundamental character and thus they are to be studied by specialists of the Swiss Telecom and eventually the supplier (level-3 fault management). The information acquired about the state and the investigations as well as possible conclusions are to be transmitted to the customer.

Within the international range (EAP), error procedures have been defined also, but they are not considered as reliable. In an error event, the course of action is decided from case to case, within the frame of procedures defined by the EAP.

**Performance**

All services offered to the customer within the frame of the ATM pilot have been tested in detail by specialists of the department of Research and Development of the Swiss Telecom. Thus, within the operational phase of the NMC, no fundamental investigations are to be expected. Statistics about the traffic load within the network are to be performed by the resource management software

'eReS'. For purposes of double checking, tax data may be used. All network elements at the ATM level are able to deliver very detailed statistics within quarter-hour intervals. This feature is applied first in case of links with performance problems. In the EAP, a possibility was being searched within the performance working group (PWG) to improve the monitoring of performance of international links. Every international node maintains a permanent VPC of 64 kbit/s to the neighbour node which is looped back at the far end. Thus, every network operator has the possibility to monitor his emanating international links by using an ATM analyzer (HP 7500). Such methods are considered as temporary replacement for the future monitoring facilities offered by OAM cells (F4, F5).

**Accounting**

In the ATM pilot, the method that is presently used is the one known under the designation 'subscription method'. It is presently easier to handle the method defined as 'cell counting method' which presumably is to be expected in the future. The second method is based on counting the cells (usage based) but was not available yet for the ATM pilot, both due to technical reasons as well as those of standards.

The cost of a connection is based on the following data:

- The accounting is based on a given reference port per user. Therefore, only one user can be taxed per port of the core network. Hence, a link subdivision per SM is only feasible for the same customer.

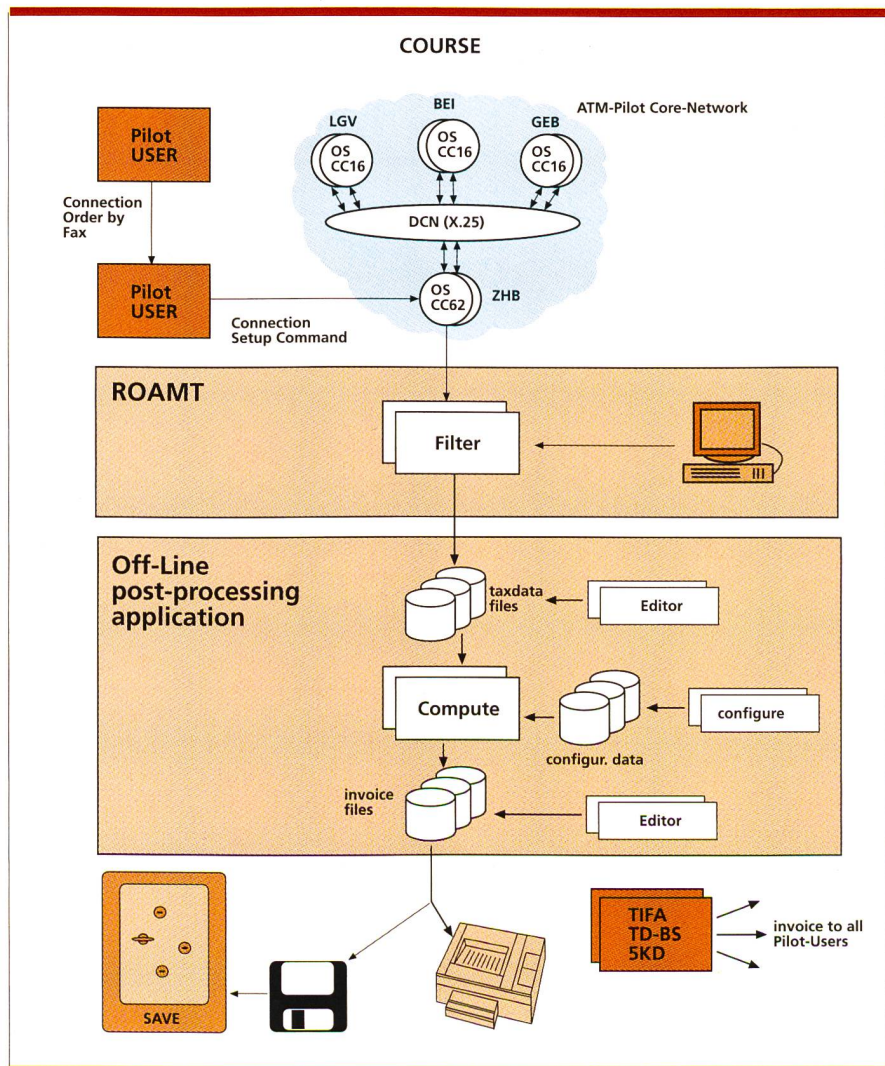


Fig. 5. Fault Management

- The bandwidth, i.e., the peak cell rate PCR ordered by the customer and not the actually used bandwidth.
- The duration of the link established.
- The distance (dependent on zones).
- The time of day (normal and low tariff).

The cost includes also two monthly subscription fares, the fare for accessing the network and those for the adaptations required for the services used by the customer. The behaviour of the tax data is represented in *Figure. 5*. The switching commands for the links are memorized within the data set for the archives within the CC-OS. The data are being transferred into the NMC daily and are applied there to a message filter. Finally, at the input of the off-line postprocessing system (PPS), there are purely tax relevant data available. The actual detailed tax summary, together with the fixed monthly fares, is printed for the customer within the NMC in the form of a bill on paper. Because of the small number of pilot subscribers, the whole account handling is executed directly from Basel over the 'Telefon-informatik-Fakturierungssystem' (TIFA).

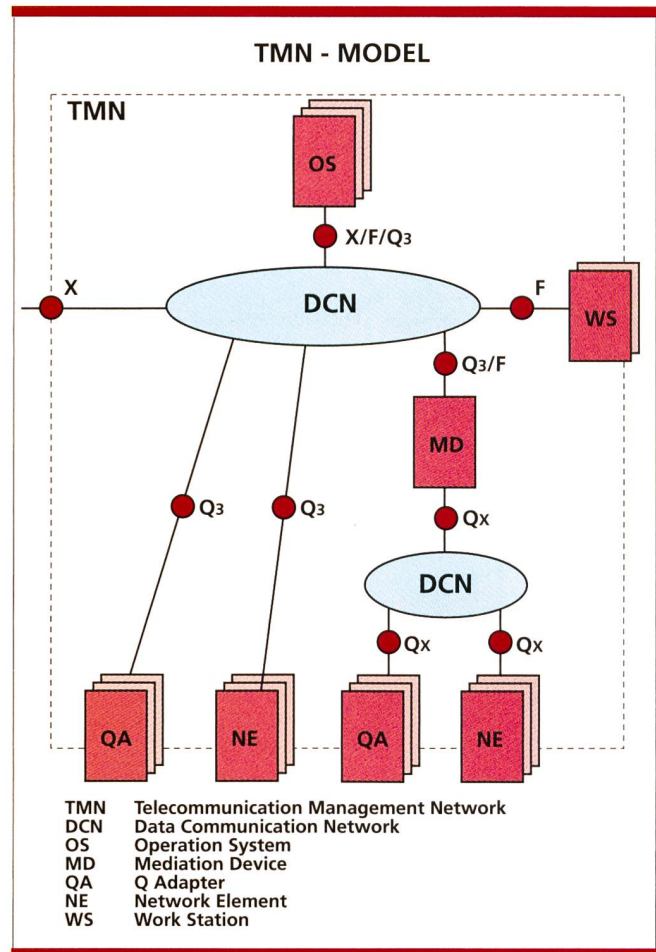


Fig. 6. TMN Model.

**Security**

Every system access requires a previous identification by a password. To every password, a certain depth of access is assigned. The assignment also includes a geographical dimension concerning the location of network elements. There is no integral backup concept in the system yet. At the moment, there are some periodic 'full backups' being performed.



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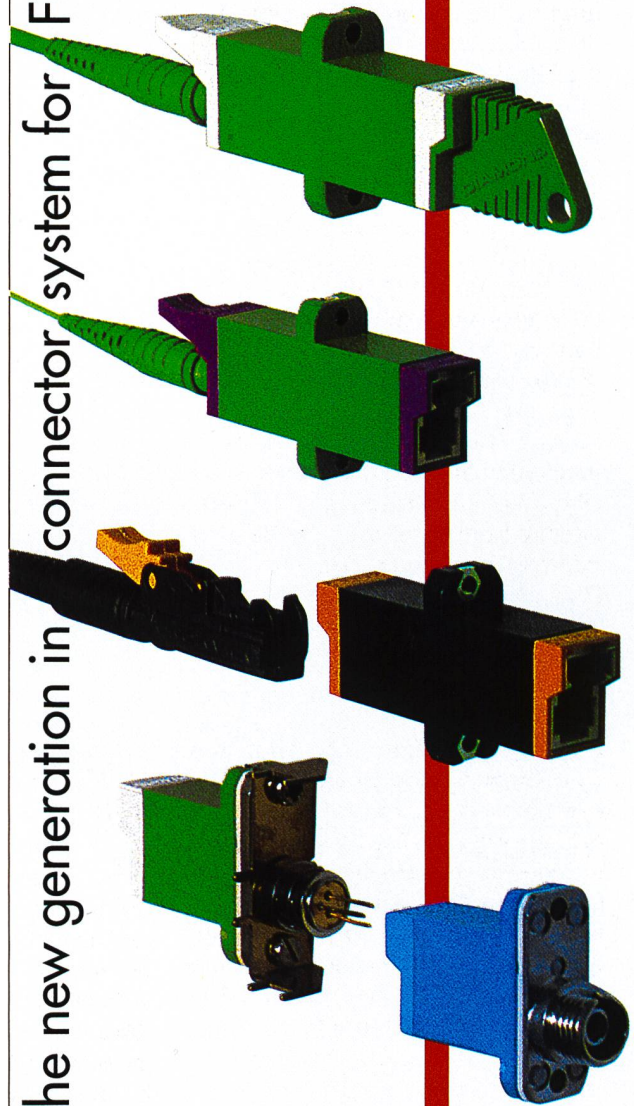
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