

Line monitoring and control of a distribution network

- part of the digitalization of the transmission paths for Telekom Austria AG and the ORF

Facility management programs are used in the industry in various ways. In addition to the management of resources, such software tools can also be employed for the billing of services, the signaling and remedying of errors and other similar tasks. Dimetis has longstanding experience in the programming of software for monitoring, circuiting and controlling line paths. As a part of the digitalization of the distribution network and the line paths of ORF and Telekom Austria AG, a central software program was employed for monitoring, planning, controlling and billing tasks, which will be described in this article together with its functions. Dimetis was commissioned by Telekom Austria for the execution of the entire project. The entire system is currently in the final phase of testing (parallel operation since August 2001) and will completely replace the existing system in April.

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1. Introduction

In cooperation with ORF Vienna, Telekom Austria AG (TA) has set up a new digital broadcasting network (LNet 2000) in Austria, for exclusive use by the ORF for the transmission of television and radio signals. This new digital transmission network has been in the beta test phase since August 2001, running in parallel to the existing analog cable network. Dimetis was commissioned with the execution of the project due to its longstanding experience and cooperation with Telekom Austria.

Program distribution and supply to the broadcast stations is carried out via a DVM and ATM based network. The ATM network consists of two STM1 rings (fiber optics/radio link) and transfers MPEG-2 video, audio (VoIP) and data (LAN, PABX). Video recordings are transferred uncompressed using SDI technology (8x270 Mbit/s rings). This network connects eight regional studios and has complete redundancy. In addition to the construction of a new cable network, the interface peripherals in the studios were also renewed and expanded. SDI multiplexers and change-over switches, ATM nodes and MPEG adapters, MPEG-2 encoders/decoders, MPEG-2 splicers, audio codecs, crossbars and change-over contacts were integrated in the studios and main transmitter locations.

The DIAMANT system (DIAMANT stands for **D**isposition, order processing ("**A**uftragsabwicklung") and **M**ANagement of a broadband ne**T**work) is used for the disposition and the control of the new networks — functions such as e.g. the *management of network capacities*, *execution of feeds* including the *configuration of the involved devices* and the *monitoring of all network components* are, together with the integration of a billing and settlement system based on SAP, among the most important.

The system was commissioned by Telekom Austria and will be made available to the ORF.

2. Networking

Each location in the new digital transmission network is connected to the DIAMANT system via the Dispo LAN. This is a LAN network that is connected to a WAN via the ATM network. As a rule, each location has two LAN switches installed at TA and the ORF. For security reasons, these switches are connected both with each other and with the ATM switch. The connection to the WAN is carried out using routers, which

are components of the ATM switches. Additionally, it is possible to dial-up via ISDN. Depending on local circumstances, the disposition PCs may be connected to the Dispo LAN or to the existing ORF intranet (LAN). In order to protect the ORF's intranet, there is a router/firewall transition between the ORF LAN and the Dispo LAN in Vienna.

3. System Structure

3.1. Central Server

The main component of the DIAMANT system is a central server. It is installed at Telekom Austria in Vienna-Arsenal. A fault-tolerant, self-monitoring *Continuum 419* computer from the company Stratus (HP 8500 CPU, 512 MB RAM, 27 GB hard drives) is employed, in which all components are present in duplicate. HP-Unix 11.0 is installed as the operating system, and Oracle 8i was selected as the central database. Central data management, various application functions and the control of all connected devices is carried out on this server. Various devices are controlled from both the regional studios and the main transmitter locations; these connect the end devices with the central server via the *LocalControllers* and thereby control them.

In addition to the operating PCs, the following interfaces are handled by the central server via LAN/WAN: ATM network management (CiscoWorks 2000) for the handling of network malfunctions, ATM nodes for the execution of feeds, LocalControllers (LC) for controlling all devices in one location, Crossbars for feeding the audio/video signals, SAP for the transmission of billing data and a super terminal for the execution of feeds in the main control room that were not planned for in the long term.

All user workstations (**Fig. 1**) are outfitted with standard PCs (in the regional studios, some with touch screens), which run the DIAMANT application under Win98, NT or 2000.

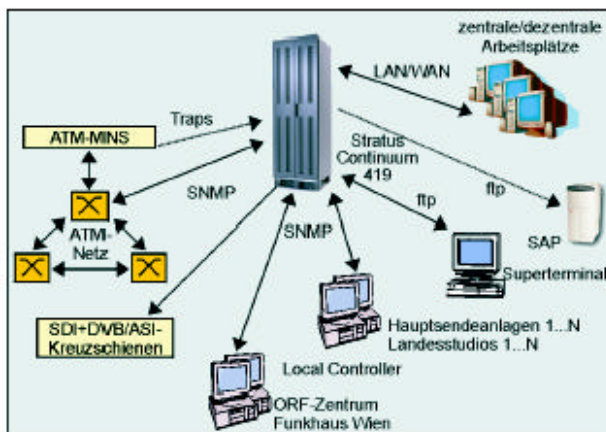


Fig. 1 DIAMANT central server with all interfaces

3.2. LocalControllers

The connection between the central server (Vienna) and the devices to be monitored / controlled at a remote location (e.g. St. Pölten) is established via the *LocalControllers*. With the exception of the ATM nodes and the crossbars, all devices (codecs, ATM adapters, splicers, etc.) are controlled exclusively by the *LocalController* (**Fig. 2**). All devices in one location (including crossbars and ATM nodes) are automatically and regularly checked by the respective LC for malfunctions. Before starting, the *LocalController* receives all parameters for the devices to be controlled. After starting, the LC checks the status and settings of all devices in an infinite loop. Except for one serial interface (SDI change-over switch in the DVM ring), all devices use the SNMP protocol (Ethernet, TCP/IP).

The central server's communication with the LCs is also carried out using SNMP. All information on the LC and the connected devices is available and readable in the MIB. The central server polls the LocalControllers regularly (every 20 s). Both the loss of a LC and the malfunctioning of a connected device are checked, and if necessary, a backup is connected immediately.

One watchdog card each is installed in the LocalControllers, which automatically start the LC if it crashes as a result of a program error.

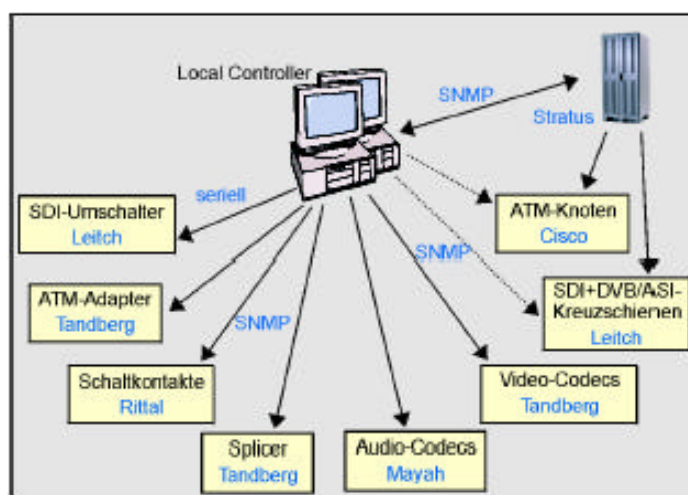


Fig. 2 LocalController with all connected devices

4. DIAMANT

The software program was conceived and programmed such that many functions necessary for the daily operation of a radio station and a service provider are combined in one application.

The individual functions are:

- **Disposition:**

Entering of video, audio, intercom and data feeds for the DVM or ATM network.

Path searching and booking of the network sections under consideration of the network capacities, technical parameters and malfunctions with allocation of VPI and VCI, when necessary with a backup path.

- **Execution:**

Automatic or manual circuiting and disconnecting (setting the switchpoints in the crossbars, setup of PVCs in the ATM nodes, configuration of the ATM adapters, video encoders, audio codecs, closing/opening of contacts, switching the splicers, switching the DVM switches), measurement and ALF (feed into the DVM ring).

- **Monitoring** of devices and circuiting equipment

- **Backup connection** (priority controlled, manual and automatic) in the case of a malfunction by bypassing the problem area.

- Entry of **maintenance times** for a device, activation of this device.

- **Archiving**

- Preparation of **billing data for SAP**

- **Adoption** of line circuits from the super terminal.

4.1. Disposition

In the area of network coordination and ordering, the employees of the line office are responsible for the disposition of feeds. For this, the system offers the possibility to choose between different productions, feed tasks, cyclical feeds and commands. For technical billing reasons, all planned line circuits must be assigned to a production, which may consist of several cost units or centers.

For this, possible productions are defined in a form and the cost centers / production numbers and the distribution are assigned. These entries take place using a GUI, which is programmed according to the requirements of the business (fields, user-friendliness, etc.).

A feed task (**Fig. 3**) always constitutes a framework for multiple feeds that are assigned to a production or an event. This may involve consecutive feeds and/or various line types / paths (audio, video, intercom and data feeds). A task must always be assigned to a production, so that the billing data for SAP can later be determined.

Fig. 3 left Feed task template with entry fields for production data, line paths, times and information relevant to accounting. The transmission of the data to the SAP system is automatically carried out in the background after a feed has been executed

The feed task contains particulars on the production title, the times, the location and the client. Additionally, the individual feeds are defined according to start and end times, feed type (automatic, manual, immediate), disconnection type (automatic, manual, never), quality (bandwidth, encoder profile, network, priority, etc) and source/destination. All feeds are labeled with a unique feed number. Additionally, there is a status display for the current status of the feed, which changes independently during running processing steps.

DIAMANT automatically (in consideration of the availability at the feed time) searches for the “path through the network”, which consists of several path segments (lines), after input of the feed task. In the case of a collision, alternative routes are offered. Likewise, a backup path can be searched for and booked when necessary, to which the feed can be switched to in the case of a malfunction.

If no result is shown for the automated path search, the user will receive an error message and must enter a different quality and/or time or change the conflicting feed. The booked line paths can be seen in a *feed path* form. *Cyclic* feed tasks resemble regular feed tasks, but in these cases a time period for which the tasks are valid is defined, and when they should be executed. DIAMANT monitors these and generates the respective upcoming tasks in advance during the night, and searches for a path.

4.2. Execution

This function is intended mainly for the main control room, the measurement engineers and the regional studios. Execution involves the execution of feeds, connecting and disconnecting, connection of possible backup paths in the case of a malfunction of the lines or the devices, as well as connections for measurement of particular sections (**Fig. 4**). Dialog functions (feed task list, radio feed list, television feed list, ALF, change-over switches, etc.) can be used to monitor the execution.

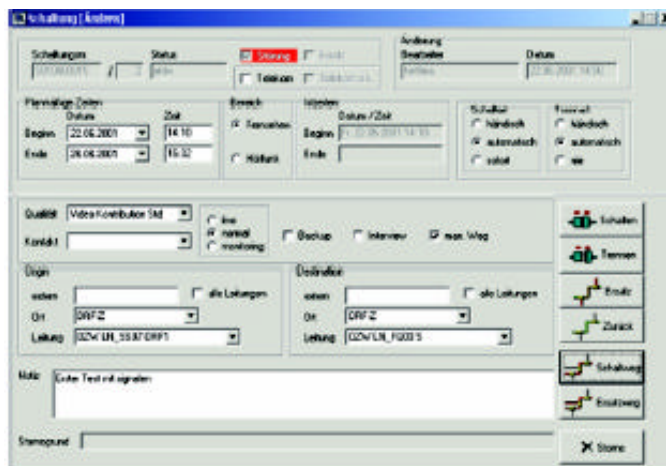


Fig. 4 Feed tasks can be monitored and manually adjusted using a GUI (feed)

The two feed lists for radio and television are preselected for the radio and television business. They contain only the current feeds for their respective area. The lists can be structured differently according to different criteria (times, productions, status, etc.). The entries are displayed in different colors representing different feed statuses.

The user can view the feed path and any existing backup path and can also adjust the line paths taken. One particularity is the *local feed*, as this is used to switch the splicer in a regional studio in order to broadcast a regional program instead of the central program at certain times. Local feeds can only be executed in the particular location of each regional studio.

In a DVM network, *change-over switch* is the term used to describe the *input switch*, which, in one location, feeds a signal into the ring or connects the ring through, and the *output switch*, which automatically selects the better signal (QoS) from the two counter rotating rings. The *Change-over switch* dialog displays the current switch position and the quality of the SDI signals at the input and output switch.

The so-called *ALF-feeds* ("Austausch lokales Fernsehen" – interchange local television) are a particularity among the tasks and feeds. They are processed using one of the DVM rings and contain video circuits that either lead one signal from each studio to the ring or take the signal from the ring to the studio. This allows each regional studio / field studio to react autarkically and to switch its paths off or on.

4.3. Malfunctions

Error messages and malfunctions in the end devices, lines, LocalControllers and the circuiting equipment are received by DIAMANT and entered into the malfunctions list, whereby each malfunction of a device signifies a breakdown of the connected line. This is why a system message for the measurement engineers is provided for each malfunction that occurs. If a malfunction affects a current feed, the main control room is also notified. If an active feed is affected, then a backup path has to be connected manually; for distribution or live feeds, the DIAMANT system takes care of this automatically.

Malfunctions can be caused e.g. by errors in devices (monitored by the LocalController), errors from the ATM network (traps; message via the ATM network management), predefined maintenance times, etc.

The malfunction time and the originator (responsibility) are listed. Additionally, all traps received by the central server are displayed in a separate list.

4.4. System messages

The DIAMANT system generates system messages internally in order to notify particular users of possible error situations (e.g. for the main control room or the measurement engineers). These messages are automatically displayed on the users' displays and have to be acknowledged. The acknowledgement triggers an entry into a log file (sorted in descending order), so that a corresponding log (remedied by whom, who was responsible) can be called up at any time and for any error.

4.5. Archive

All relevant modifications cause a copy of the data set to be created, which is stored with the current time as the modification / archiving time. The user can view this data in the *Archive* dialog, thus allowing him to retrace the entire history of a feed.

The following data is archived automatically: Productions (new entries, deleted entries and significant modifications), feed tasks (new entries, deleted entries and all status changes), modifications to feed-relevant parameters in the feeds and the feed operations, all incoming malfunction reports and all generated system messages.

4.6. Base data

In DIAMANT, the system administrator can freely configure most of the configuration data (operators, locations, access rights, etc.), which provides for high flexibility. In the case of extensions (concerning circuiting equipment, lines and devices), it is not necessary to change the software, the corresponding entries merely have to be extended/modified. This configuration data (called base data) is primarily static data and forms the basis for the entire system.

This ensures that all circuiting equipment (crossbars, SDI ring, splicer, ATM node) is defined in detail (in/outputs, slots, connected to which LocalController, etc.). Also, the system maintains a list of all devices (video encoders and decoders, audio codecs, ATM adapters, contacts, input and output switches) that are connected by the LocalController. The location, the type, the responsibility (ORF or TA), the IP address and further configuration parameters are recorded for each device. Additionally, data on the audio and video encoder profiles is stored together with the parameters that need to be set in an encoder/decoder for feeds of a particular quality.

The line list contains descriptions for all connections between crossbars, ATM nodes, splicers and DVM rings. Each line has a unique name consisting of 24 characters, definitions for the start and end point, line type (uni/bidirectional), information on the permissible signal types and the looped-in devices. The bandwidth of the line – in the case of STM1 lines between ATM nodes – is also important in order to determine the maximum transmission capacity.

4.7. Super terminal

The main control room triggers feeds in the DIAMANT system via the super terminal. For this, the system transmits line data and line qualities, so that this data can be used in the super terminal to define feeds, which must be furnished with start and end times. Feedback on the feeds that are thus defined is provided to the system, where the feeds are then entered into the feed list, executed at the defined time and transmitted back to the super terminal as statuses (feed successful or error occurred).

5. SAP

Each feed that is executed in the DIAMANT system is assigned to a production. The costs produced for one production can be proportionally distributed across several cost centers or production numbers. The system calculates a point value representing the cost of each feed in consideration of the quality, the time period and the peak time. The data is exchanged with the SAP system at regular, customizable intervals (e.g. weekly, monthly). All point values (conversion to Euros takes place in the SAP system) for the last time period are accounted according to cost unit and internal cost type. All feeds of a time period are

accounted for – all feeds that have already been executed (disconnected), as well as the still standing ones (distribution). Feeds with a duration of several months and permanent feeds are accounted for in each period (monthly or similar). Additional expenditures (outdoor broadcasts or leased lines due to capacity bottlenecks) are not accounted for in the DIAMANT system.

6. Final remark

The cooperation between the contractual partners Telekom Austria AG, Dimetis and the ORF formed the basis for the fact that all problems that occurred could be remedied as quickly as possible and that the entire system, after several months of parallel operation, is now ready to be put into operation.

Abbreviations pertaining to DIAMANT:

ALF Interchange Local Television (Austausch lokales Fernsehen)
ATM Asynchronous Transfer Mode
AÜ Outdoor Broadcast (Außenübertragung)
DVM Digital Video Multiplex
FH Broadcasting Center (Funkhaus)
FKE Remote Control Equipment (Fernkontrolleinrichtung)
HKR Main Control Room (Hauptkontrollraum)
HSA Main Transmitter (Hauptsendeanlage)
KS Crossbar (Kreuzschiene)
LC LocalController
LS Regional Studio (Landesstudio)
MIB Management Information Base
MT Measurement Engineering (Messtechnik)
ORF-Z ORF Center
RP Central Control (Regieplatz)
SA Feed task (Schaltauftrag)
SNMP Simple Network Management Protocol
STM Synchronous Transfer Mode
TA Telekom Austria AG
VBI Vertical Blanking Interval
VCI Virtual Channel Identifier
VPI Virtual Path Identifier