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Telekom Austria and ORF introduce new distribution network

In cooperation with the ORF, Telekom Austria AG has digitalized the radio and television distribution network in Austria. Both contractual partners have guaranteed that the interfaces at the respective transfer points (ORF internal to Telekom public) can communicate with one another. Since August 2001, video, audio and data signals may be transferred, both compressed and uncompressed, over the ATM and DVM based network. This article discusses the network structure and the hardware and software components employed. Of particular interest is VoIP and IP-Streaming over ISDN/ATM.

The task consisted of processing all of the ORF's data services, including coding and decoding of radio and TV signals, telephone services, the computer network and all communication, via the new distribution network **(Table I)**. The existing infrastructure was to be replaced digitally and have the guarantee of being upgradeable in the future **(Fig. 1)**.

The infrastructure was specified for services and locations, which had to be reachable / provided with distribution and contribution. These are essentially twenty locations: eight regional studios, ORF central (Vienna), Vienna Broadcasting Centre, Ö3 and nine main transmitters in Kahlenberg, Heuberg, Lichtenberg, Gaisberg, Patscherkofel, Pfänder, Dobratsch, Schökl and Jauerling.

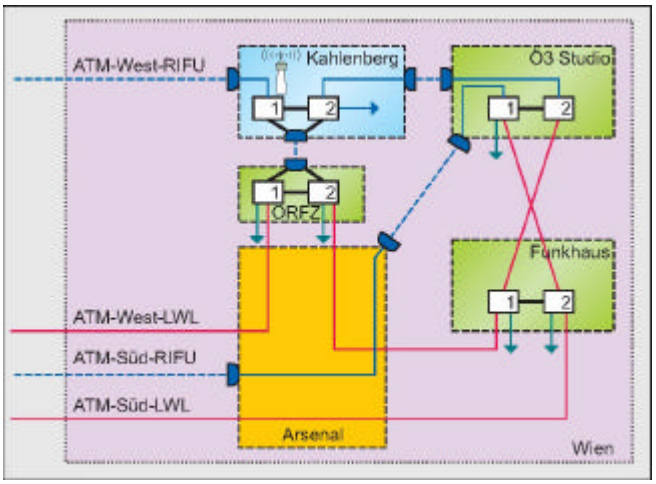

Fig. 1: Overview of the ATM network for Vienna

1. Introduction

About five years ago, Telekom Austria AG first began to consider extending and renewing the existing cable network (RiFu and Cable), as the existing devices could no longer be adapted to the latest technology. At the time, the big

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question – whether to go digital or continue with analogue – was not easy to answer. The devices available on the market were not yet all available in digital technology.

Experience was gathered with the commissioning of the first MPEG satellite transmission networks (Astra, etc.) and the introduction of ATM networks and then, three years ago, intensive planning for the renewal began. Initially, an appropriate provider (the market was currently being deregulated) had to be found, who could offer a suitable infrastructure and thereby also carry out or offer the digitalization of the distribution networks.

Shortly before the contract was awarded, Telekom Austria AG (TA) made the claim of being able to transfer linear video (270 Mbit/s uncompressed) over the digital network. This assertion, to be able to transfer video and audio both compressed in MPEG and uncompressed linear, ultimately led to cooperation and award of contract to TA.

Table I: Project partners and responsibilities

	Telekom Austria	***ORF***	***Dimetis***
digital distribution and administration network	Construction of the entire network including 50 ATM nodes (Cisco)	60 video codecs, splicers (Tandberg)	Delivery and installation of the entire system including the computer hardware
	NMS system (CiscoWorks 2000)	190 audio codecs (Mayah)	Central server (Stratus)
	110 ATM adapters (Tandberg)	25 cross bars (Leitch)	40 local controllers (LC)
	40 SDI nodes (ADC)	10 video decoders	Standard PC's
	240 SDI switches (Leitch)	Overall project management	DIAMANT control system
			Software development (server, client, LC)

2. System components

To determine suitable hardware, a tender was offered for a video and audio codec, which resulted in the choice of NDS (PALplus capable), which was taken over by Tandberg shortly thereafter, for the video codec, and Mayah (with real network capability) for the audio codec. The solution to the problem of potential separation for the different interfaces was what finally tipped the balance. The transfer points were planned such that as few as possible, but in return well-specified transfer points were designed using either fiber optic technology (Ethernet) or SDI-IF (SDI video or DVB-ASI), as this is the only way in which a clean galvanic isolation can be achieved. The components should be able to transfer diverse compression rates up to linear while being simultaneously manageable via SNMP. These requirements were fulfilled by both the video encoders and decoders (Tandberg) as well as by the audio codec (Mayah). For the switching of signals, SNMP manageable cross bars (Leitch) were employed.

The advantage of the SNMP manageability lies in the fact that all system components can be monitored, adjusted, maintained and switched from a central monitoring point over a dedicated network (100BaseT DISPO-LAN).

3. LNet digital

The new digital distribution network is split into two different sections **(Table II)**, which are in turn split into independent fields of service: compressed and uncompressed. The old and new cable and distribution networks from ORF and TA are currently still running in parallel. In June, the bulk of the distribution will be switched over to the new digital network, the remainder will follow July, and soon afterwards, TA and the ORF will reach the "point of no return". Then, Telekom Austria will shut down the analogue radio link network and change transmission direction, as the cable configuration will have changed. The official dismantling deadline is August 2002.

3.1. ATM network

The ATM network comprises about 50 nodes (see Fig. 1), for safety reasons (redundancy) fitted with two ATM nodes per location (regional studios, main transmitters). All ATM nodes at the main transmitter locations are connected via beam radio over an STM1 link with the neighboring locations and the respective regional studios. (*Synchronous transfer mode* (STM) is a transmission technology with which 155.25 Mbit/s data streams can be transferred. However, the bit rate, as opposed to ATM, can only be subdivided into very coarse steps.)

The regional studio nodes and the nodes in Vienna are interconnected both with the associated radio transmitters and via fiber optic cable with the respective neighboring regional studios (one STM1 link between two locations), and both

of a location's ATM nodes are also connected via an STM1 line. The entire network mapping is configurable in the DIAMANT network management system (see article in FKT 6/02, pp. 320-324), and can easily be expanded.

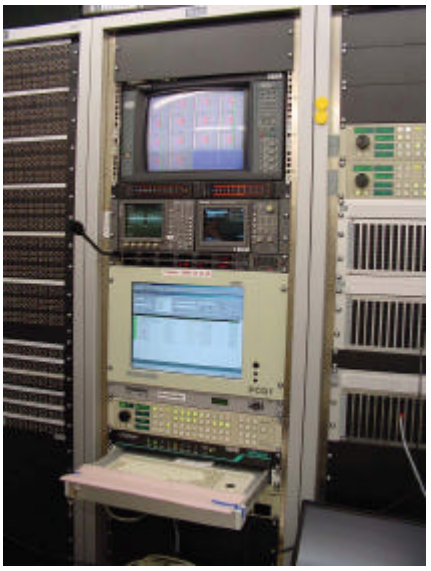

Fig. 2 (top): The end-of-line room, in addition to encoders, coders and interfaces to the ATM network, contains all measurement and test installations for monitoring the distribution network

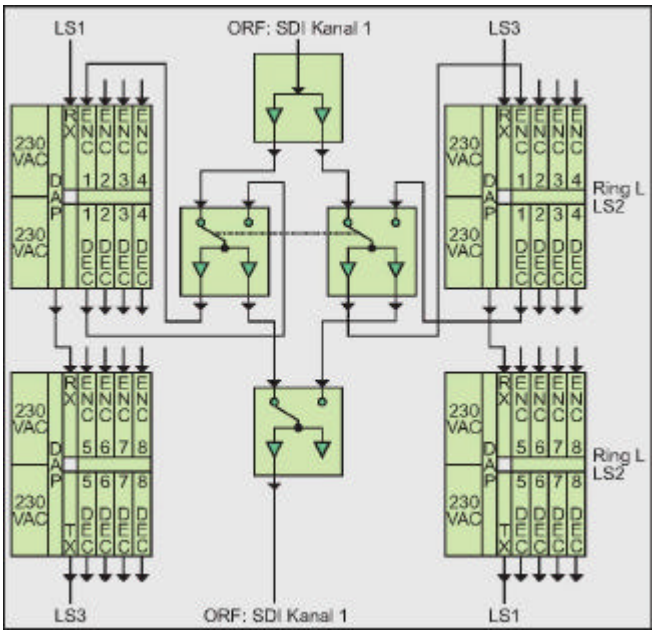

Fig. 3 (right): The DVM network is used for transferring uncompressed video signals (270 Mbit/s). WDM technology (Wave Division Multiplex) is behind DVM at Telekom Austria

3.2. DVM network

Both compressed (MPEG-2@4:2:0 and 4:2:2) and uncompressed, linear transfers **(Fig. 2 and 3)** can run over the *Digital Video Multiplex* (DVM) network. However, the ORF does not employ any DVB/ASI cards. The ORF only uses the DVM network (2×8 DVM channels on two counter rotating rings with multiplexers and demultiplexers) for linear video transfers, and this technology is only available in the regional studios, and not at all locations. DWDM (Dense Wave Division Multiplex) technology is behind the DVM concept at Telekom Austria. An 8×270 Mbit/s ring links the eight ORF regional studios, the Vienna Broadcasting Centre, and the ORF center. For safety reasons, the ring is doubled, whereby the two individual counter rotating rings link all locations with one another. Thus, every location has

eight SDI connections (inputs and outputs) each, in each of the two directions. As an SDI signal is fed into both rings simultaneously, the signal can still be picked up and passed on by the other ring in the case of a malfunction in one of the rings.

Due to the counter rotating ring structure, the ring cannot be used in sections. However, the eight SDI signals can be switched independently, so that eight SDI transfers can occur simultaneously and independently from one another.

Table II: Signal rates and employed protocols via ATM	
Video connections	***Audio connections***
CBR 3…40 Mbit/s	CBR 64…2000 kbit/s
unidirectional	unidirectional
point-to-multipoint	point-to-multipoint
connection: STM1	connection: Ethernet 100 FX
	IP broadcast
Intercom	***Data***
twin unidirectional audio	bidirectional or unidirectional
	CBR / VBR
point-to-point	point-to-point
connection: Ethernet 100 FX	connection: E1, STM1, Ethernet

3.3. Dispo LAN

The Dispo LAN, with around 80 LAN switches (Cisco) is connected to a WAN via the ATM network. A router / firewall junction exists between the ORF LAN and the Dispo LAN (and WAN). This network is employed for SNMP administration of the individual components in the distribution/transmission network as well as for general data communication between the individual nodes. The DIAMANT planning system (responsibility of Dimetis), which is used for link monitoring and control, planning, path-finding algorithm, etc., also has access to this network. The DIAMANT system is based on the ZERMATT (central broadcasting management for audio and TV) system employed by Deutsche Telekom for link monitoring (planning, switching, etc.), with adjustments and extensions to suit the special requirements of the ORF.

3.4. Video / audio components

In addition to the network components, video encoders / decoders, transport stream splicers, ATM adaptors, audio codecs, digital cross bars (SDI, AES/EBU) and analog, SDI switches and contacts (active, passive) are also employed at the respective locations for the transfer of audio and video signals. All components are integrated in such a way that they can be configured, operated and monitored over SNMP.

During the planning phase and the following testing phase, it was established that not all of the components could properly exchange data with one another. One IP stack is not the same as another, and IP specifications must be adhered to! A solution was quickly found by the producers and operators, and these results were incorporated into hardware and software products available on the market today. The use of standard devices was a priority, as it is the only way to guarantee extendibility options in the future.

4. Video

A key component is the SDI node / SDI multiplexer with an encoder / decoder (c-cor.net *DV6000*, formerly manufactured and distributed by ADC), of which 40 units are in operation (2 at each location). The systems concerned are modular, with cards for the transfer of DVB-ASI signals (270 Mbit/s SDI). Up to 16 channels (IF cards for NTSC, PAL, SDI, DVB-ASI, IF, QAM, DS3, E3, T1, BTSC, SDTI, 10BaseT, 100BaseT) can be supported per system, however only SDI cards are employed at ORF.

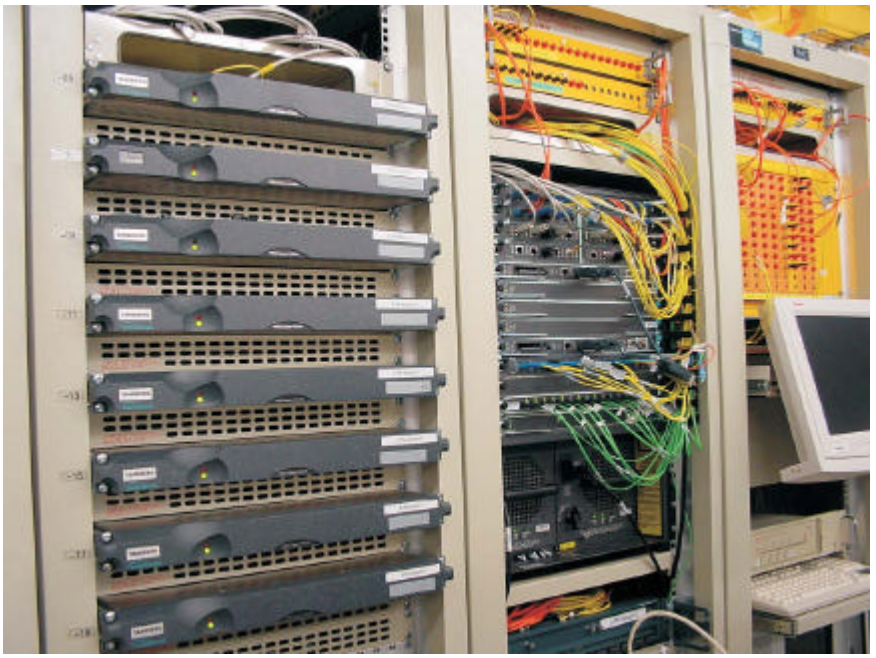

Fig. 4: Network hardware in the ORF end-of-line-room: the left rack contains ATM adaptors (Tandberg evolution 5000) for data preparation, the middle rack an ATM switch (Cisco 8540) and in the right rack there is a patch field for LWL (display, keyboard and PC for a local controller below)

The ORF's entire permanent distribution network runs over the ATM switches (Cisco 8540, provided by Telekom Austria). The Cisco Catalyst 8500 is a Layer-3-*enhanced* ATM switch allowing scalable network load. All ATM switches are integrated into the DIAMANT system via the ORF intranet.

A total of 23 digital AV cross bars and video switches (Leitch *Genesis6000* series 64×64 and 32×32) are integrated into the overall distribution system. The 110 *video decoders* (TT1250), 60 *video encoders* (E5611) and 110 *ATM adapters* (MA5200) are by Tandberg from the *evolution5000* series. The TT1250 can decode MPEG-2-4:2:2P@ML video at up to 50 Mbit/s, so that transfers in the Sony IMX standard are possible. The decoder has an analog video output and two stereo audio outputs (analog and digital.) Dolby Digital and AC-3 audio is implemented. The 240 *SDI switches* (Leitch) are used for switching the video signals in the distribution network. Additionally, 20 *transport stream splicers* are in operation.

TT4030 stream trackers (Tandberg) are used for monitoring the transport streams, they allow for real-time monitoring of the running operation of an MPEG-2 network. The network operator thus has an efficient tool for the assurance of QoS thanks to the error detection and alarm functions in the case of a malfunction.

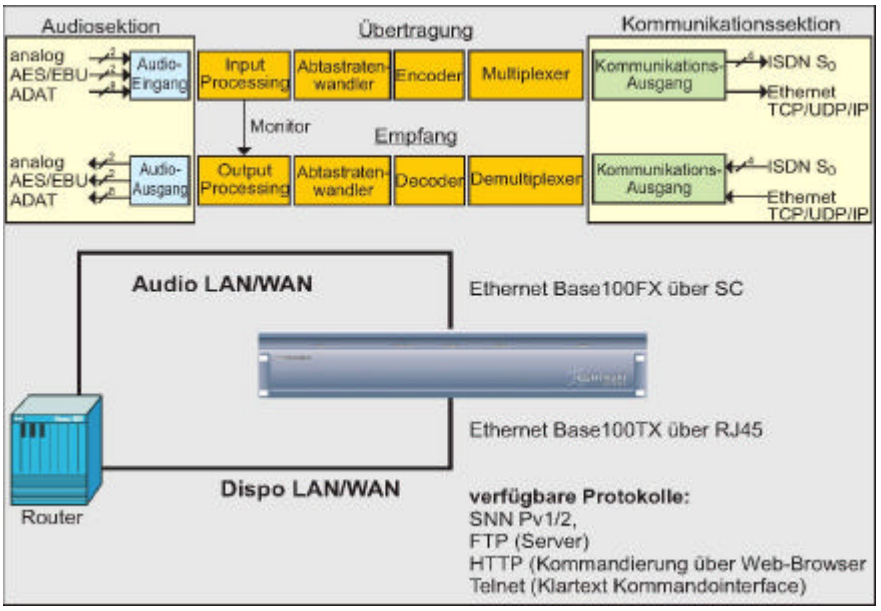

Fig. 5: Block diagram of a Centauri 3000, employed as audio codecs at the ORF

5. Audio

A total of 190 *Centauri 3000* (Mayah audio codec with network capability) are employed at the ORF **(Fig. 4)**. The network protocol used is the Internet Protocol (connection-oriented TCP or connectionless UDP), and all audio codecs are remotely controllable via the network interface. Gateways are connected via a management interface (SNMP v1) in order to achieve their integration into the distribution network structure. Information on the current device status and the condition of the individual interfaces can be requested via SNMP. Additionally, a network notification (trap) can be activated in the case of a predefined event, which is then received and evaluated by the DIAMANT system. A standard IEEE 802.3u (100 Mbit/s Ethernet 100Base-FX) and, via an SC connector, an optical transceiver (Siemens V23809-C8-C10) can be used as a network connection. The optical interface is operable both in *half* and in *full-duplex* mode, but at the ORF it is always used in full mode. The mode can be switched per *user interface*, *remote command* or *SNMP*.

Equipped with 24 bit A/D converters (sigma-delta), sampling rates of 32, 44.1 and 48 kHz can be used. All device parameters conform to the ARD/ZDF system specifications. The following coding algorithms are supported: ISO/MPEG-1, -2, -2.5 Layer III, ISO/MPEG-1, -2 Layer II, CCITT G.722, CCITT G.711 and AAC.

The audio codecs **(Fig. 5)** by Mayah are IP-capable for LAN/WAN, internet and intranet applications and support, in addition to the automatic recognition of the remote station (J.52+ and several proprietary IMUX processes: CCS CDQPrimas, Dialog4 MusicTaxis, AEQ, Prodys, AVT, etc.) linear and coded audio via IP with an extremely short delay time.

J.52 is a digital transfer technology used in sound programs for high quality, which uses one, two or three 64 kbit/s channels for mono and up to six for stereo. Up to eight B channels (ISDN BRI (2B+D)) in the data layers *Layer III* (8…320 kbit/s in 8 kbit/s steps), *Layer II* (8, 16, 24, 32, 40, 48, 56, 64, 80, 96, 112, 128, 144, 160, 192, 224, 256, 320 and 384 kbit/s) and with *G.722* (48, 56 and 64 kbit/s) can be transferred via the ISDN connection. Bit rates of 300, 1200, 2400, 9600 and 38400 bit/s are directly transferable via the additional data channel, or in MUX of 300, 1200, 2400, 9600 and 19200 bit/s (8 data bits, 1 stop bit).

In addition to the standard signals (audio), 4 wire and command signals are also sent via the audio codecs. The use of the devices has proved positive in this area, as the additional payload on the distribution network (ATM, DVM) was possible without a loss of capacity.

6. Final remark

For event connections, Telekom Austria has five OB vans, which, likewise to the stationary locations, are equipped with audio codecs (Mayah), video codecs (Tandberg) and ATM switches (Cisco). The transfer technology for the ATM service is thus not integrated into the ORF's OB vans, but instead is made available in a Telekom Austria event vehicle. All ORF image, audio and data signals are fed into the LNET via the public ATM.

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75 courses were carried out for the training of 400 people (editors, technicians, etc.), so that everyone is able to handle the new system. The digitalization of the broadcasting and distribution network for radio and television in Austria, and the consistent integration of ATM and DVB-ASI technology combined with SNMP capabilities and central control using DIAMANT (the system developed and realized by the company Dimetis), allowed for the realization of a project, which, after a lengthy planning phase and a six month test run, offers more safety than ever before.