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Modat

# An enhanced FM-Transmitter Network

**MODAT is project to enhance the FM network of Swiss Broadcasting Corp. It has three main goals: first and most important, it decreased by 50% the costs for leased lines and maintenance, second, it provides a constant transmission quality over the whole network and finally adds data transmission. This paper presents a combination of innovative solutions that allows to meet the above three challenges.**

In these days of transition towards digital technologies it is sometimes difficult to decide how much money should be invested in existing analog platforms and technologies. In Europe

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money is invested in fast growing new networks, such as DAB or DVB-T. This further complicates the issue of existing network renewal since only little money is left.

In spite of the above statements it is worth investing in an existing network. This paper shows how a completely new concept was implemented on the feeder network for the FM-transmitters of the Swiss Broadcasting Corp. This network feeds about 450 transmitters on 150 different sites. Including the transposers a total of about 1000 FM-channels are maintained.

Although the network operates satisfactorily, costs must be reduced, quality improved and new data transmission features added. All these objectives are covered by the project MODAT where new options on a standard SDH-platform are used and a redundant backbone combining very high reliability with low cost is set up. All the signal are compliant with telecom standard (MPEG coding, G.703 data-stream multiplex). Furthermore, to reduce maintenance costs every single transmitter site can be accessed remotely. Each transmitter can thus be configured from the studio and its programs mapped as well. RDS data is also added to the stream. In this way static and dynamical data, such as TMC, dGPS or any data broadcasting standards can DARC be broadcasted as well.

## Basic Considerations of FM in Switzerland

The whole FM-network in Switzerland was build up to satisfy the various needs of its inhabitants. Indeed, Switzerland has four official languages each located in a fairly defined geographical area. For

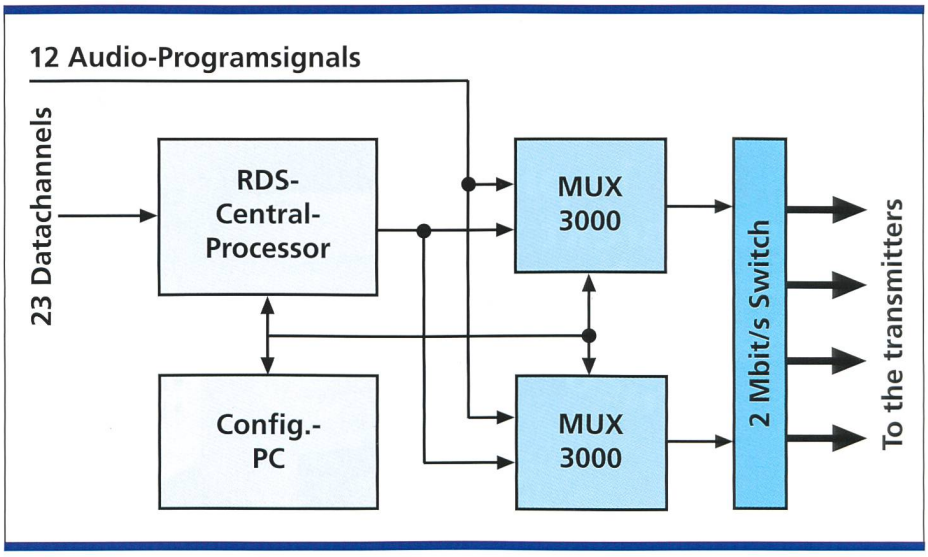


*Fig 1. Old feeding principle.*

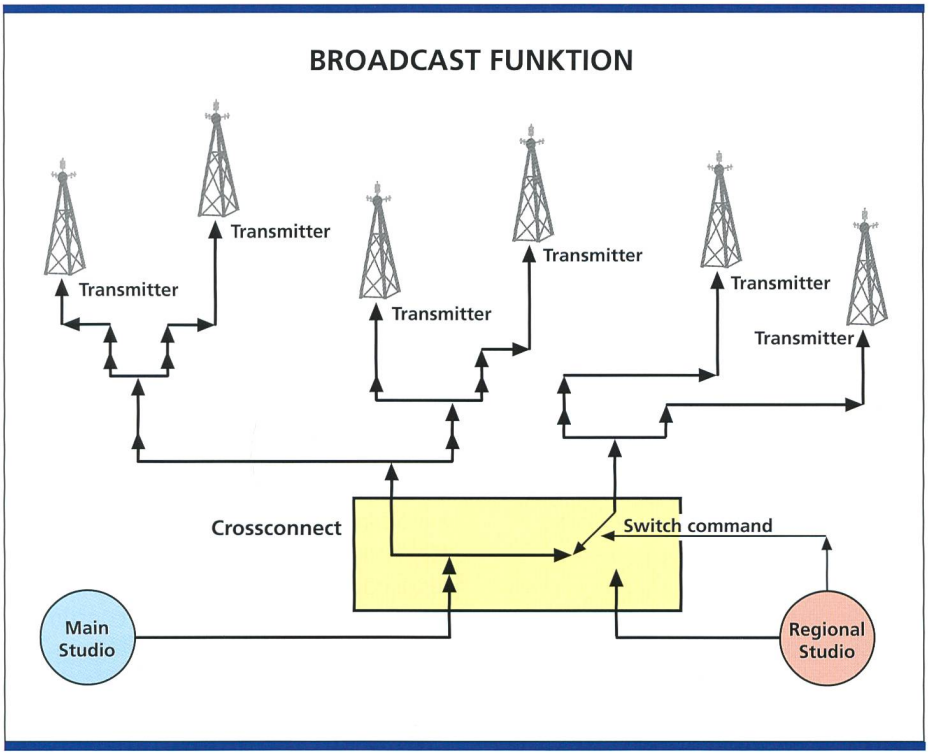


*Fig 2. Broadcast function.*

every language the studios from the national broadcaster SRG produce three different programs. Law requires every language region to broadcast the main program of two other languages as well. Therefore most sites have four or five transmitters.
Furthermore there are also several regional programs. These programs satisfy special needs for defined small geographical regions and are on air only during short dedicated timeslots. These programs are broadcasted on the same frequencies as the main programs. This is achieved by sending a different modulation signal to a subset of the transmitters. In fact, the splitting is done on cross connects in the feeding network (fig. 1). From a technical point of view the system was build according to the philosophy of the early 70s, using the PCM-scheme to transport the audio from the studio to the transmitter sites.

### *Characteristics of the existing System*

The audio input signal is coded according to the J.41 Recommendation [1]. For a monosignal 384 kbit/s is needed, which means that one PCM-channel is able to transport five mono-signals. Since most sites have more than three stereo programs to broadcast, two 2 Mbit/s-lines are necessary to feed the transmitters. Every studio takes its signals to a crossconnect, where a hard-wired programming defines which transmitter sites will be fed. It is possible to switch between the main program and the regional program (fig. 1). The system works with a very high reliability, but the necessary resources are becoming very expensive, since they rely on a special network within Swisscom. Furthermore, customer demands such as dynamical data transport and constant audio quality cannot be matched with the existing net. It has thus been decided to start a project with the goal of building up a new platform to feed the FM-transmitter.

### The new System

The goals of the new system are clear: to cut costs by 50%, to provide constant audio quality over time and weather conditions, and to support dynamical data transfer. MODAT must be fully operative by the end of Q1'00. This also includes the new studio-processors which control what signal is carried out by which transmitter and which data is broadcasted on each sites. The desired return on invest-duration is approximately three years.
To reduce transportation costs our solution aimed standard telecommunication products. Hence, we use 2 Mbit/s datastreams organized according to the G.703 recommendation [3]. Instead of a hierarchical network we defined a backbone ring. The latter is mapped on the SDH network of Swisscom. Every crossconnect is able to support the new broadcast function. That means that on every crossconnect fourteen 2-Mbit/s-datastreams are available and can be brought to the transmitter sites. This function is one of the most important elements in order to reduce the costs. It is however new and it was a demanding challenge to implement it on the different crossconnects (fig. 2). To be able to multiplex all the programmsignals into one G.703 datastream, the signals have to be transported from all studios to a central location of Swiss Broadcasting Corp. This is

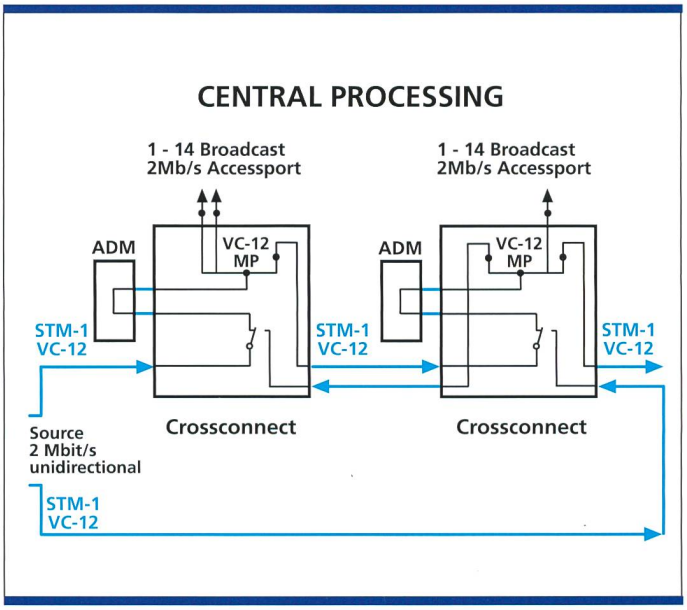


*Fig 3. Central Processing.*

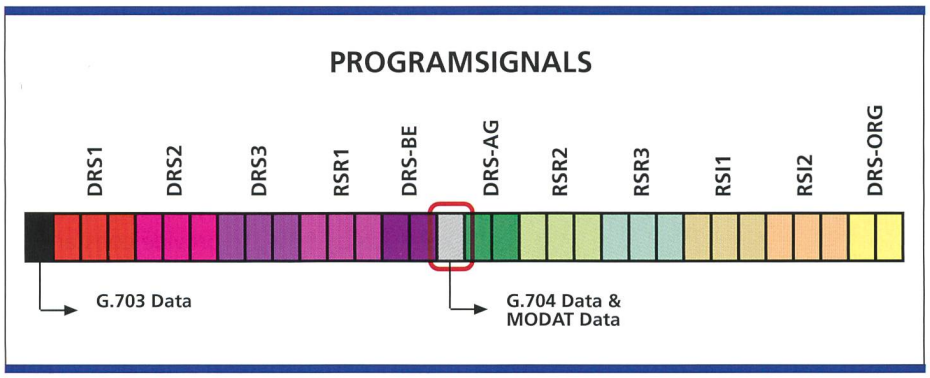


*Fig 4. G.703 MODAT-ensemble; shortcuts for different programsignals.*

realized with a X.21 link. The audio signals are coded using either MPEG1 Layer II or Layer III since the system is able to handle both standards. Data such as RDS-PS or TA (Traffic announcements) is also packed into this datastream.
The central location serves as a center to supervise all the audio and data received from the studios and packed into one datastream to the transmitters.

### *Changes in the Studios*

The new system allows many new features, it is now possible to address every single transmitter and map one of the programsignals to it. Dynamic data such as Radiotext is now also possible. To be able to handle this degree of freedom a studioprocessor is necessary. The processor allows to set up the distribution network required by different demands such as regional news, special events or simply the national main program.
Every studio uses MPEG coder. The main studios use layer II with 192 kbit/s while the regional ones use layer III with 128 kbit/s. The input signal to the coders is defined according to AES/EBU standards.

### *Implementation of central Location*

At the central location here after SBC Dist (Swiss Broadcasting Corp. Distribution Center), all signals are bundled and distributed. The multiplexer processes twelve audioinputs and one datainput from the RDS-central processor. The RDS-processor packs 23 datachannels in a 38 kbit/s datastream, which is multiplexed in timeslot 16 of the G.703 datastream. This datachannel is used to configure the transmittersites. It also provides the possibility to update the Softwareversion of the station equipment. The whole system is redundant to guarantee a very high reliability (fig. 3). To overcome synchronisation troubles every input at the multiplexer is able to handle DCE and DTE modes, furthermore it corrects phase errors of the input signals.
Every programsignal is mapped on two or three timeslots of the 2-Mbit/s-datastream (fig. 4). Timeslot 16 is particular since it is used for CRC and hyperframing according to G.704. Nevertheless some unused capacity remains and can be utilized as a 38,4 kbit/s datachannel.

### *Onsite Equipment*

The 2 Mbit/s-signal is received by a specially developed demultiplexer and decoder, the musidemux 3000. This device is indeed able to decode five MPEG-coded signals and its outputs, the audiosignals are fed to the stereocoders. Furthermore timeslot 16 of the G.703 datastream is demultiplexed and provided over a RS232 interface to the RDS-station controller and the Central processing unit. The former extracts from the datastream all the data necessary to configure the RDS coder and handles all dynamic data. The latter extracts all the data required for the station configuration actions such as switching transmitter input signals or switching to the backup unit if a transmitter fails. This Central processing unit also incorporates a modem, which is used for remote maintenance. This further helps in cost reduction since reaching in accessing the station is often the most time consuming task (fig. 5).

### *Transport*

*From Studios to SBC Dist*

The MPEG coded datastream is delivered transparently over an X.21 interface to the SBC Dist. This transport scheme is implemented on a network that provides automatic rerouting in case of network interruption.As further

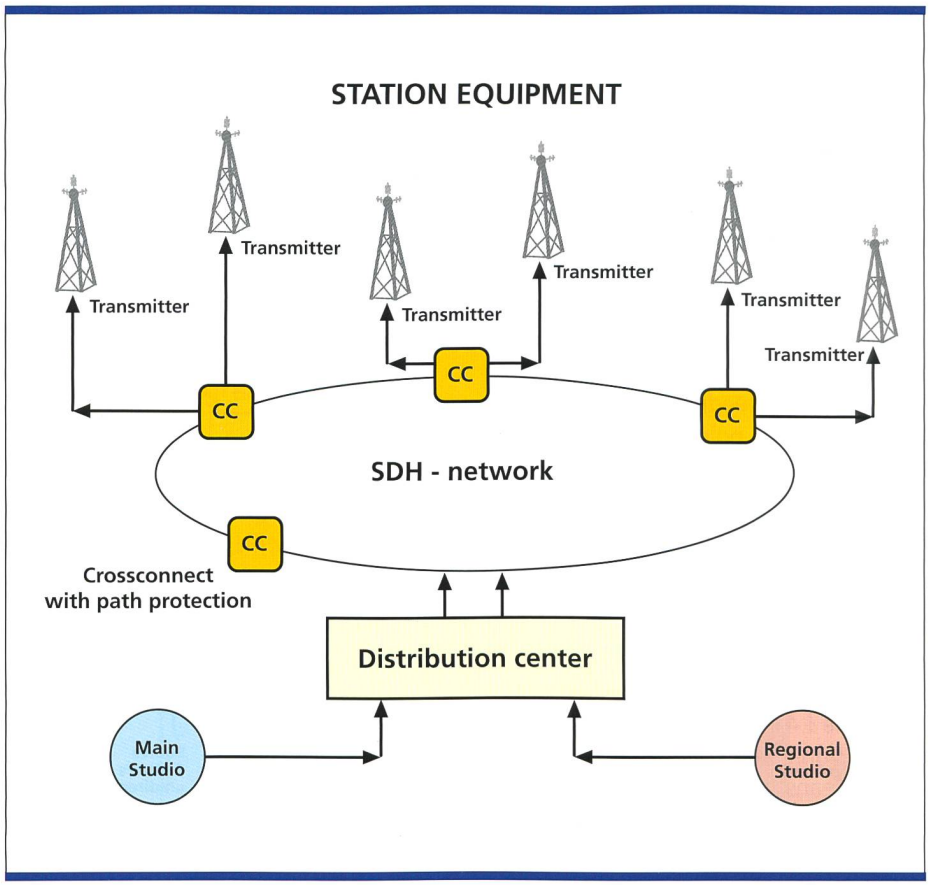


*Fig 5. G.703 MODAT-ensemble; shortcuts for different programsignals.*

protection and back up, an ISDN link is provided for every main program and can be activated from the studio or the SBC Dist. In the SBC Dist the data are extracted from the MPEG-stream and prepared to be multiplexed into timeslot 16 of the G.703 2 Mbit/s datastream.

*Transport from SBC Dist to the Transmitters*

From the SBC Dist there is a redundant 2 Mbit/s distribution network which transports all the data to the transmitter sites. The backbone ring is path protected (fig. 6), this provides a very high reliability. From each crossconnect it is possible to feed fourteen transmittersites with broadcast signals. The connections between crossconnect and sites are not redundant, except for the most important 20%.

**Alternative Sattelite-Feeding**

We also studied a feeding with a satellite network. We intend to use one 2-Mbit/s-link with an availability of 99,9% and a backup link with one of 99%. Also the two uplinks should be located on two different locations. The stations would be equipped with one or two receiving systems depending on the importance of the site. We found that the feeding through the existing infrastructure cause about the same OPEX than the satellite links. Concerning CAPEX the satellite solution demands much more than our solution. Security is also better with our solution. The terrestrial solution is not depending on links, which are out of national control. However Switzerland is a rather small country. It may turn out that for other networks a satellite solution is more efficient than a terrestrial one.

***Net Management***

We use a netelement management system. All messages are sorted in warnings and alarms. An alarm means that at least one programmsignal is not on air and immediate action is required. MODAT allows to login to the FM-site-controller and perform a first level intervention. If it is possible to fix the problem remotely a lot of time and money can be saved. The overall maintenance costs are going down.

***Further Improvements***

The system can be further improved by using more sophisticated coding, like MPEG2AAC (advanced audio coding). We are also studying to migrate the transport onto an ATM-network. Because we are using standard interfaces it should be not a big deal to do it, it is more a question of money, than a technical one. Beside RDS it is also possible to implement DARC dataservices, only small extensions have to be done. Mainly integrate the DARC equipment and allocate one timeslot in the 2 Mbit/s datastream.

With this system it is possible to satisfy demands like distribute background mu-

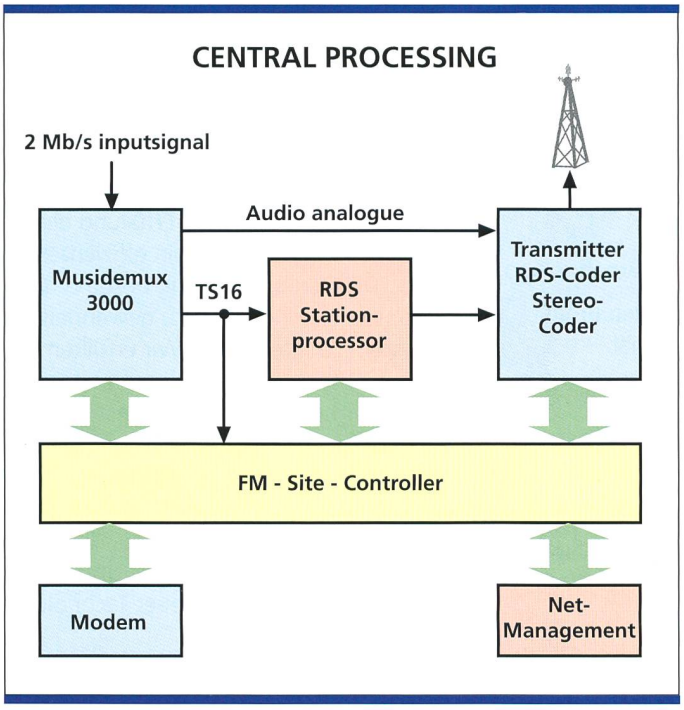


*Fig 6. G.703 MODAT-ensemble; shortcuts for different programsignals.*

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**Glossar**

| | |
|---|---|
| FM | Frequency Modulated |
| SDH | Synchronous Digital Hierarchy |
| MPEG | Moving Picture Expert Group |
| TMC | Traffic Message Channel |
| dGPS | Differential Global Positioning Service |
| DARC | Data Radio Channel |
| RDS | Radio Data System |
| STM-1 | Synchronous Transport Module |
| VC12 | Virtual Container 12 |
| ADM | Add and Drop Multiplexer |
| G.703 | ITU Standard (see also references) |
| DTE | Data Terminal Equipment |
| DCE | Data Communication Equipment |
| DAB or | Digital Audio Broadcasting |
| DVB-T | (or) Digital Video Broadcasting-terrestial |
| PCM | Pulse Coded Modulation |
| Q1'00 | Quarter 1 in 2000 |
| RDS-PS | Radio Data System – Programme Service name |
| AES/EBU | Audio Engineering Society/ European Broadcasting Union |
| CRC | Cyclic Redundancy Check |

sic to shopping malls. Not used capacity is available for other services like a push intranet which provides always actual prices or product information, news for employees and related topics. Advantages like fast consistent information, secure company network and low prices may attract customers despite the availability of internet.

## Conclusion

In this work, we present a solution for an efficient new feeding network for FM-transmitters. The challenge was to cut cost by 50%, to maintain a constant quality of audio and to add dynamic data to the system at the same time. We met it by using a complete new approach on the transport network. The migration from a hierarchical tree topology to a ringstructure and the elimination of former special crossconnects, together with the consequent use of standard technology. This was possible through the availability of the broadcasting function in the crossconnect of the transport network. The switching of the programsignals is moved to the transmittersites controlled by the studios. The new system is much more flexible and meets the requirements of the customer. It is open for new technology and services. 9.4


**Acknowledgement**

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***Markus Grossenbacher*** *was born in 1961 in Solothurn in Switzerland. In 1986 he received his bachelor degree in electrical engineering from the Burgdorf college. He then joined the R&D department of Ascom Radiocom AG and worked in the field of ASIC-Design and DSP-System design. In 1996 he became project manager at the broadcasting services Swisscom AG. His main interests are problems related to the migration from analog to digital broadcasting systems.*



## Zusammenfassung

**MODAT: Ein leistungsfähigeres FM-Übertragungsnetz**

MODAT ist ein Projekt zur Erhöhung der Leistungsfähigkeit des schweizerischen FM-Netzes. Damit wurden drei Ziele verfolgt: erstens - das wichtigste - eine 50%ige Kostensenkung für Mietleitungen und Wartung, zweitens eine konstante Übertragungsqualität über das ganze Netzwerk und drittens die Übertragung von Daten. Im vorliegenden Beitrag wird eine Kombination innovativer Lösungen präsentiert, welche die Erfüllung dieser drei Zielsetzungen ermöglicht. Wir stellen dabei eine Lösung für ein effizientes neues Stromversorgungsnetz für FM-Sender vor. Die Herausforderung bestand darin, die Kosten um 50% zu senken, eine konstante Tonqualität zu gewährleisten und gleichzeitig die Datenübertragung ins System zu integrieren. Wir erfüllten diese Bedingungen, indem wir auf dem Übertragungsnetz ein vollkommen neuartiges Verfahren anwandten. Wir wechselten von der hierarchischen Baumstruktur zu einer Ringstruktur, eliminierten spezielle bestehende Crossconnects und setzten dabei konsequent Standardtechnologien ein. Möglich war dies deshalb, weil die Rundfunkfunktion im Crossconnect des Übertragungsnetzes verfügbar ist. Die Vermittlung der Programmsignale erfolgt neu über die Sendestationen, die von den Studios aus gesteuert werden. Das neue System ist viel flexibler und entspricht den Kundenbedürfnissen. Es ermöglicht den Einsatz neuer Technologien und Dienstleistungen.

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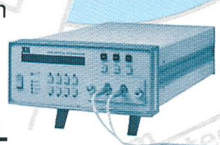

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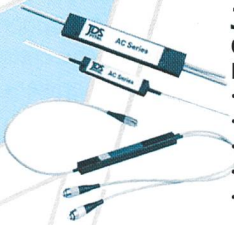

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