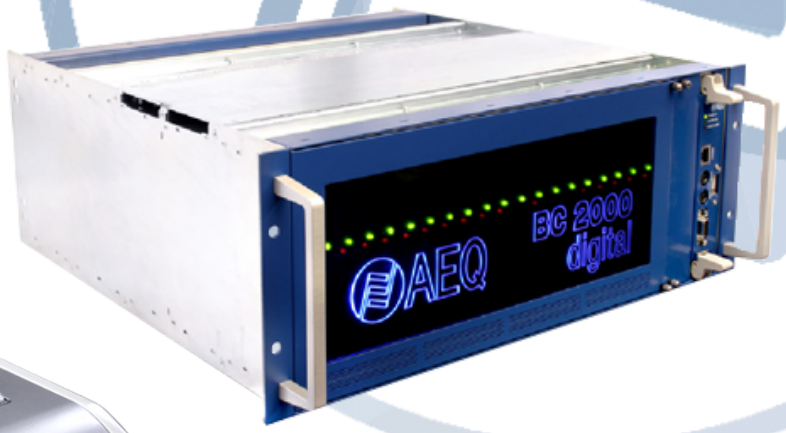
APPLICATION NOTE

Audio distribution systemin large Radio Broadcasting Stations.

Installation of Radio Renasçensa in Lisbon.



AEQ

AEQ AUDIO ROUTING AND DISTRIBUTION SYSTEMS OVER IP NETWORKS APPLICATION NOTE 1

AUDIO DISTRIBUTION SYSTEM IN LARGE RADIO BROADCASTING STATIONS. INSTALLATION OF RADIO RENASCENÇA IN LISBON

1.- SUMMARY. BASIC IDEAS

Since the last years of the XX century, large installations for Radio Broadcasting and Program Production Centers have relied on digital audio matrix architectures based on one or several TDM (Time Division Multiplexing) buses for the distribution of audio signals between the different studios and external contribution and distribution circuits.

These matrices have improved over the years with the incorporation of systems for redundancy, optical fiber multichannel links between the different matrix modules and large studio consoles, greater processing capabilities and hierarchical and distributed control that minimizes operational errors.

On the other hand, the recent and widely adopted Audio over IP (AoIP) distribution systems has brought up a contradiction: they simplify wiring, make their operation more flexible, but at the expense of renouncing some of the advantages of TDM systems.

Because of this, at the time of the design engineering of the new Program Production Center for Radio Renascença, we combined both technologies to obtain a no-compromise solution that takes advantage of the strongest points of each one: 4 AoIP Dante networks have been deployed as a flexible audio transport and distribution infrastructure, and they have been centralized into a TDM-bus based matrix that combines all the circuits from all these AoIP networks with another few hundreds of circuits that come directly to the matrix. This way, the processing and hierarchical control capabilities of the matrix are extended to all the AoIP-distributed circuits.

At this moment, we believe that this is one of the worlds largest installations in a radio program production center taking advantage of Audio over IP distribution. If we add that to the fact that the matrix “core” is based on TDM buses, with signal summing and processing capability, the result is a project with great technical complexity that allows for a great deal of performance and operation flexibility.

At this point, there are many technical details that we would like to share, why we encourage the reader to continue with the reading of this document.

2.- RADIO STATION DESCRIPTION

Radio Renascença is a Portuguese radio company that is managed by the Catholic Church through its Lisbon Parish, offering general programming, focused on information and entertainment. It takes part in R/Com, one of the two main Portuguese private radio groups, also running RFM, Mega, Hits FM and Rádio Sim music stations. In 2016, they undertook the project of moving to a new building in Lisbon surroundings, and took opportunity to enhance their technical installations, that were contracted to AEQ.

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2.1.- TECHNICAL OBJECTIVES AND CONSIDERATIONS

At the time of renewing equipment due to the move, Radio Renascença assessed solutions from a several manufacturers, all of them according to a variety basic ideas following their vision and experience concerning state-of-the-art radio production equipment:

- All studio mixing consoles should be digital.
- Critical equipment deployed in the studios cannot generate heat or noise: in particular, all the engines or cores of the main studios consoles should be concentrated within a technical room located in the control center.
- Main studio mixing console engines should be installed in the Technical Centre technical room. Signals generated or ending in the studios, such as microphones, CD players, headphones or control speakers should be transported between the studios and the technical room over IP networks.
- All studios should be interconnected using a centralized infrastructure allowing the use of any signal from any location with a high level of availability and reliability.
- This infrastructure must offer a high level of reliability and availability.
- Multi-pair and cable bundles should be avoided, making multichannel routing more flexible, abandoning MADI in favor of AoIP technology.
- Technical center will be assisted by technicians. Circuit routing operations won't rely on controllers or talents.

3.- SYSTEM TOPOLOGY AND DIMENSIONING

Radio Renasença produce 4 different programs: Radio Renascença (RR), RFM, SIM and MEGA FM. Each program has its own installations for broadcasting and recording studios.

3.1 BROADCASTING STUDIOS

Broadcast studios in Portugal are typically using two or three audio consoles:

- A main console operated by the controller and another ancillary console used by the talent or journalist from the studio.
- Additionally, frequently there is a third main console inside the main broadcasting studios that is configured for automatic programming for the time slots where the programs are not complex and the presence of an audio technician is not justified.

This way:
Two consoles have been installed for RR1 broadcasting studio: One AEQ Arena for automatic broadcasting and an AEQ Capitol for the journalist. In the Control room, behind the glass, another AEQ Arena console has been installed that is configured for Audio Technician assisted Control-Studio Operation and for the On-Air production of programs of certain complexity.

At the left, Broadcast Studio 1 at Radio Renascença (RR1). Above these lines, its ancillary console.

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(Arena is a high-level broadcast Modular Digital Audio Mixing console. Capitol is a small Digital Audio Mixing console for small broadcasting studios or ancillary use. Both are designed and manufactured by AEQ and feature multichannel MADI and Dante AoIP connectivity)

RR2 broadcasting studio is identical to RR1 with the same equipment and topology and the SIM broadcasting studio is very similar in its layout.

SIM broadcasting studio and its assistance control

Two consoles have been installed for RR1 broadcasting studio: One AEQ Arena for automatic broadcasting and an AEQ Capitol for the journalist. In the Control room, behind the glass, another AEQ Arena console has been installed that is configured for Audio Technician assisted Control-Studio Operation and for the On-Air production of programs of certain complexity.

RFM broadcasting Studio

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On the other hand, RFM broadcasting studio never operates in Control-Studio configuration, so two consoles have been installed (Arena for automatic broadcasting and a Capitol for a journalist).

MEGA FM is a music station with a very straightforward programs production, so a single Arena console for automatic broadcasting has been installed.

MEGA broadcasting studio

3.2 RECORDING AND AUXILIARY STUDIOS

All recording studios in Radio Renascença are automated. Three studios have been equipped with an ARENA console, one with a CAPITOL console and another two studios are using FORUM consoles.

The following recording studios have been prepared:
One for Radio Renascença with CAPITOL console.
One for RFM with ARENA console.
One for SIM, also with ARENA console,
One for Mega, also with ARENA console, plus two with a shared FORUM console.

(Forum is a mid-range, modular, Digital Audio Broadcast Mixing Console. It is designed and manufactured by AEQ and features multichannel MADI and Dante AoIP connectivity)

Further, there are 4 ancillary information cabins using Capitol consoles.

Above these lines: Mega FM recording studio featuring an ARENA console. At the left: auxiliary information booth with CAPITOL console. Below: FORUM console in a shared recording studio.

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RFM recording studio.

3.3 CENTRAL CONTROL ROOM – TECHNICAL CONTROL CENTER

All systems and technical equipment that are usually distributed throughout the different studios and cabins of a large radio station have been centralized and integrated in the Technical Control Center, a controlled and safe place.

This includes, for example, the audio engines for all ARENA audio consoles installed in the different recording and broadcasting studios, audio PC frames, Off-Air receivers for FM, satellite and television, and encoders for the links to different destinations. This centralized installation has reduced the use of radial cabling since all the devices are located together. Also, and as is common practice, all devices for communications, audio processing and management, Transmission, Receiving and monitoring are installed here.

These pieces of equipment have been wired to an audio switching and distribution system based on BC 2000 D digital audio matrix, terminated in AoIP Dante and an ARENA mixing console. Everything can be managed from the Technical Center, the Studios or remotely from any place that has Internet access. Maintenance tasks are simplified, as technicians no longer need to travel to the Program Production Center for every intervention.

A BC 2000D digital audio matrix with AoIP interfaces has been installed in the Technical Center, as well as an ARENA console.

(BC 2000 D is a top-range Modular Digital Audio Matrix. It is based on two TDM buses with a maximum capacity of 5000 x 5000 audio channels. It is designed and manufactured by AEQ and features proprietary multichannel connectivity using 1000-channels optical fiber modules, as well as standard MADI and Dante AoIP technology.)

The main element in the new Technical Center is the AEQ BC-2000 audio switching and distribution matrix, based on a TDM bus but providing BC2224 64-channel AoIP interfaces using DANTE protocol, together with AEQ NETBOX 32 AoIP terminals, using the same protocol. Also, the AEQ ARENA engines, featuring BC2224 interfaces, can be found in the Technical Center.

This equipment is connecting to systems not located in the Technical Control Center such as the Arena Console Control surfaces and the Dante interfaces installed in the AEQ Capitol and AEQ Forum mixing consoles.

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Also located in the Technical Control Center, is the core of the structured network cabling, switches and other devices that are part of the stations connectivity and that are forming part of the different Gbit networks with QoS management.

This architecture has made it possible to limit the need to deploy equipment in the Studios and Control rooms. Only Audio Input and devices for control have been installed on these locations. Further, this architecture is also reducing signal wiring between Studios and Technical Center since the entire installation is accomplished with standard Ethernet cabling. This provides great flexibility in the wiring and circuit assignment, leading to important cost savings for both installation and maintenance.

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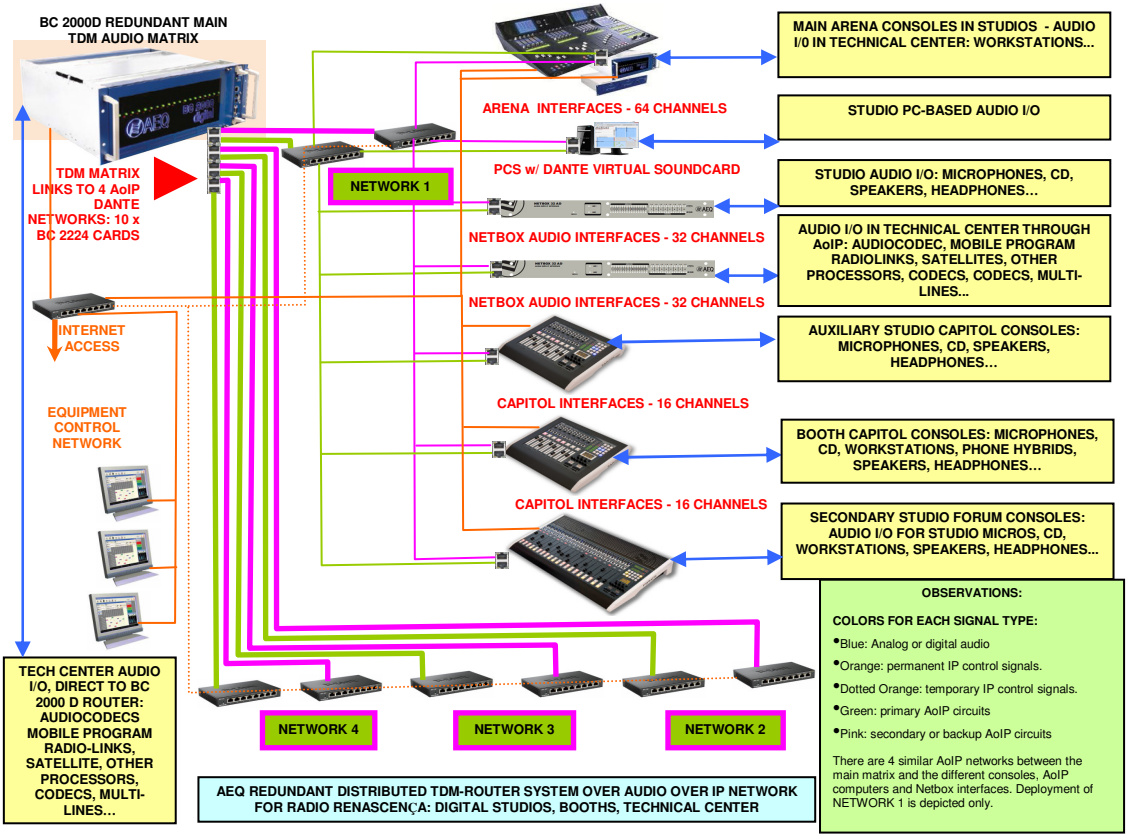
4.- IP NETWORK TOPOLOGY

4 redundant Dante Gigabit Ethernet networks have been deployed between the BC 2000D matrix and the different audio equipment in the station, most of them located in the Technical Control Center. Each network has a maximum capacity of 512 audio channels and is built using a pair of main and backup switches.



The TDM matrix includes 10 BC-2224 Dante AoIP interfaces with 64 I/O each, that are shared by all 4 networks.

Each one of these redundant networks provide connectivity to part of the Studios, so in case that a network failure happens, only part of the connected Studios would be affected and, besides, it would fail over to the Backup network.

3 BC-2224 cards (192 channels in total) are connected to network 1 in order to provide service to some consoles, AEQ Netbox 32 I/O interfaces and the Audio Management system PC with DANTE Virtual sound cards installed.
3 BC-2224 cards (another 192 channels in total) are connected to network 2, while 2 BC-2224 cards (summing 128 channels) are connected to network 3, and another two to network 4. Services provided by networks 2, 3 and 4 are similar to those covered by network 1.

In order to provide more details, hereunder we provide a list of equipment related to Network 1 and connected through DANTE interfaces:
.- BC-2224 1,2 y 3 cards in Technical Center AEQ BC-2000 Matrix.
.- AEQ Netbox 32 I/O interface Nº1 in Technical Center
.- BC-2224 in the AEQ Arena console corresponding to Radio Renascença 1 broadcasting studio.
.- Dante interface in the AEQ Capitol console located in Radio Renascença 1 broadcasting studio.
.- AEQ Netbox 32 I/O interface in Radio Renascença 1 broadcasting studio.
.- BC-2224 card in the AEQ Arena Console installed in Radio Renascença 1 assistance studio.
.- AEQ Netbox 32 I/O interface in Radio Renascença 1 assistance studio.

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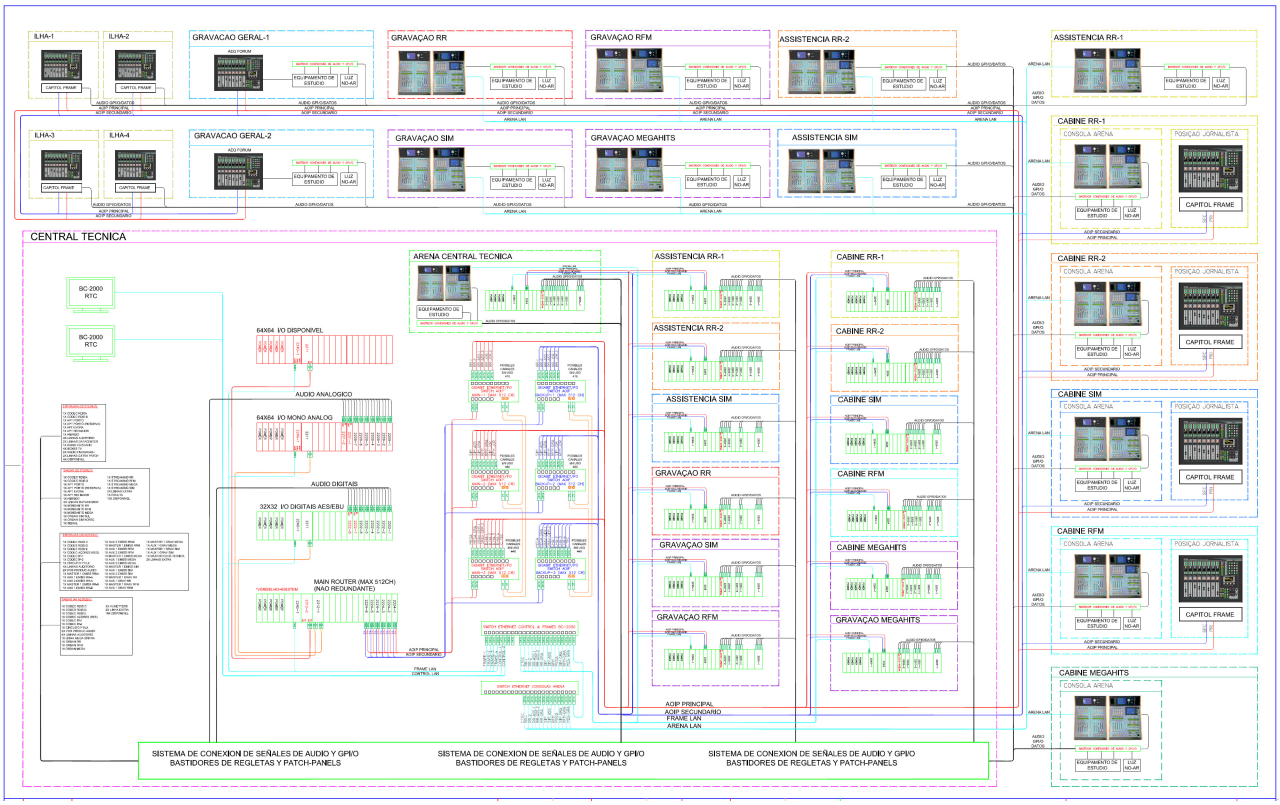
.- BC-2224 card in the AEQ Arena console frame corresponding to Radio MEGA broadcasting studio.
.- AEQ Netbox 32 I/O interface in Radio MEGA broadcasting studio.
.- Dante Virtual Soundcard interface installed in Radio Renascença 1 broadcasting studio general PC.
.- Dante Virtual Soundcard interface installed in Radio MEGA broadcasting studio general PC.

5.- AUDIO DISTRIBUTION TOPOLOGY

The central element in charge of the audio routing, summing and distribution is a AEQ BC-2000 D TDM-bus based matrix with 1024 x 1024 input / output channels. It is built on 4 BC2000D frames that are linked together through high capacity fiber optic link cards.



Part of this matrix was already installed in the old studios, and the modules and chassis that the station already had available got were updated in order to form part of the new configuration.

The main frame manages the 1024 input and output channels.
Frame number 1 holds 8 BC-2224 Dante AoIP cards with 64 (redundant) channels each, for a total capacity of 512 I/O channels.
Frame number 2 includes BC-2209 and BC-2201 analog input and output cards with a total capacity of 64 I/O channels as well as 2 BC-2224 Dante AoIP cards with 64 channels each, thus summing a total of 192 channels.
Frame number 3 includes 8 BC-2202 digital audio cards with capacity for 32 AES/EBU channels.
Also in the Technical Center, and linked to this matrix (although not being part of it) there are 5 I/O AEQ Netbox 32 interfaces connected through 4 AoIP redundant DANTE networks, that enlarge the physical connection capacity with 80 extra analog and 40 digital AES/EBU inputs and outputs.

All the matrix physical analog and digital inputs and outputs are connected to the devices in the Technical Center through 6 Ghielmetti 32 port patch panels allowing the technical staff to

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monitor and redirect the signals from the devices to different destinations or configure backup procedures during system maintenance.

Matrix-connected devices through the patch panel are mainly those destined to the transmission of the 4 program signals to the different distribution media, such as the radio transmitters, satellite uplinks, links using different audiocodecs to other cities, sports fields, etc. Also the main broadcasting Studio audio management workstations and the monitoring and reception systems for different Satellite, FM and TV signals are connected here.

6.- OTHER INSTALLATION'S TECHNICAL DETAILS

Emergency broadcast system

Even when BC 2000D is redundant, an emergency broadcast system has been designed that can operate without the TDM matrix.

In order to achieve that, 2 Ghielmetti 32x2 port patch panels have been installed and connected to the different outputs of the 5 Netbox 32 AoIP I/O interfaces. They allow access to a copy of the analog and digital Program signals from the different broadcast and recording studios, the secondary outputs from the Broadcast Automation Play-out PCs and also to the main outputs of the PCs in recording mode. These outputs are available in the patch panel and will be connected, by means of patch cords, to the required destinations in case of unexpected main matrix failure or during maintenance tasks, as the inputs of all link and transmission equipment are also available in that patch panel (matrix outputs).

Remote maintenance
As already explained in section 3, the installation has been provided with internet connectivity for services of remote maintenance, control and upgrades of the system.
All Arena, Forum and Capitol AEQ consoles, as well as AEQ BC-2000 D frames are connected to an Ethernet switch that allows for individual connection to any of the mentioned devices or to the entire network.

The same way, a link can be established between the 4 AoIP Ethernet networks and the network for control to remotely connect for maintenance and management of the Dante circuits and networks.

This remote management system allows the technical management team at Radio Renascença to supervise all matrix audios from any authorized computer connected to the Internet.

GPIO management.
The particular way that some of the Radio Renascença studios are operating, with up to three audio mixing consoles working almost simultaneously, has obliged to design a complex GPI and GPO system. Monitoring and signaling devices in these studios respond to the monitor mute and ON AIR light commands independently from which console these services are being activated.

This has been programmed by creating virtual audio channels in the ARENA consoles -that are triggered by the GPO signals from the other mixing consoles- and that activates these functions.

WIRING system.
As already commented, all the radial wiring has been implemented using Cat5E FTP cable, as there is not a single analog connection between the studios and the Technical Center. Using this kind of cable has simplified the installation and allowed for considerable cost savings.

Even in that case, given the large size of the installation, comprising almost 20 studios and booths, some of them located at up to 50m from the Technical Center, approximately 15,000m of cable have been required, not taking into account the stations internal IT networks for office equipment.

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All these cables have been properly numbered and classified according to the functions they have. At the Technical center they have been connected to the equipment either directly or using Krone blocks in 19" racks. The centralized cabling has been sorted depending on the transported signals, such as:

.- AEQ consoles Control Ethernet network.
.- Primary (MAIN) DANTE AoIP Ethernet network.
.- Secondary (BACKUP) DANTE AoIP Ethernet network.
.- AES/EBU Audio for AEQ consoles.
.- AEQ consoles GPI/O signaling system
.- Spare cables for miscellaneous use.

Balanced and shielded wire has been used within the studios and Technical Center, depending on the signals to transport (digital, analog or control). This cable, AEQ branded, bundles 2, 4, 8, 16 and up to 24 color-coded pairs (depending on its use), and is also available in single-pair format. AEQ 4-pair shielded cable was used for all microphone signals.

In order to reduce the time for installation, all patch panels and Krone Blocks had been pre-wired at AEQ facilities in Leganés (Madrid).

Together with the installation, a set of AutoCad engineering drawings in both printed and electronic format were provided. The design contains all the connections in the radio station, studio by studio, including all the modifications made on the original drawing during the installation process.

7.- WORK FLOW

The process of installation of Program Production Centers of this type and magnitude can become quite complex, and should always start with a good pre-definition of requisites and the collection of all the information required.

This process took almost 2 months and covered both the actual design engineering and the required logistics. Many meetings were held before it was possible to obtain the general planning that allowed to initiate the works.

A team of installation professionals with more than 25 years of experience in this type of high-level systems were sent from AEQ to Lisbon and stayed there during more than 2 months. They fought against all the challenges generated by the installation of sophisticated cabling and devices that are sensitive to dust and shocks. The more than 2000 m2 building was under construction and the first weeks proved quite complicated since, for example, no electrical mains supply was in place and the team had to work in hard-hats with helmet lamps. Wires were installed in ducts and trays in areas of the building still without roofs or walls.

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The tight schedule to delivery deadline obliged the team to work over a few weekends and even overnight in order to avoid the simultaneous presence of professionals with other responsibilities (painters, construction workers, electricians, air conditioning installers, etc.).

Radio Renascença also provided their best technical staff in order to quickly solve all the issues that commonly appear in this kind of installations, and the construction Company in charge of the building cooperated as much as required.


Once the wiring, equipment and systems installation process was completed, a different engineering team from AEQ traveled to Lisbon in order to properly configure and start up all the devices. Being such a large size installation based on the massive use of the new AoIP DANTE network, the configuration of the system also turned into a training for system operation, maintenance and management.

In the end, all went as planned and the station was “on air” on the date as scheduled.

8.- CONCLUSIONS

Radio Renascença installation introduces several novel aspects concerning the location of the equipment, use flexibility and ease of maintenance.

The massive usage of Ethernet wiring and AoIP are a requisite for a state-of-the-art installation but used without additional considerations, it could have limited the functionality and operation of a center of this size.

Because of this, the most important feature of this installation is the implementation of a mixed topology where several AoIP networks are unified made flexible and their processing capabilities enhanced when routed to a TDM-bus based router.

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