



Digitalization of radio broadcasting – the next step

A network centric approach

eXaudi – IP Audio Streaming, Processing, and Routing System

Current situation

The radio industry has evolved strongly in recent years. The move from the analog to the digital world has not only meant moving from the turntable to the Compact Disc, it has also involved the ‘dematerialization’ of the media. Carts and reels of tape have been replaced by sound files. Scissors and razor blades have been supplanted by editing stations. This evolution has taken place step by step to preserve one of Radio’s fundamentals, its humanity... Thanks to the introduction of Digigram’s PCX sound cards, with specific functions tailored for the radio broadcast industry, manual functions have been replaced on a one-for-one basis by PC software. This has enabled radio automation and transformed the way radio operations are organized, changing the hierarchy of roles within the broadcast chain.

While new technology has brought simplicity and efficiency, the broadcast chain still consists of a chain of specific tasks with little overlap. From the production studio to the On Air studio, to the Master Control Room, to the STL¹ and finally to the transmitter, a chain of highly specific tasks is established with defined interaction but virtually no interoperability. The technician sitting at the On Air console has almost no link to what happens at the transmitter site.

Furthermore, big broadcasters that operate nationwide networks need to manage highly complex interactions to deliver their programs, including: multiple contributions, localized programming, localized advertising, complex audio transport, remote transmitters, etc... Using traditional technology, these tasks often turn into nightmares and each failure rapidly turns into a catastrophe.

¹ STL: Studio Transmitter Link

“Network centric” rather than a “PC centric” audio transport and radio automation convergence

With the advent of digitized audio on the one hand and the ubiquity of ever cheaper, powerful networking technologies on the other, Digigram believes that the use of networking techniques will become more and more important in radio broadcasting. But how can standard networking technologies be used for real-time broadcasting when they have not been designed to cope with the requirements? What is the key for this new step?

More than just a new means of transporting audio signals, networking technologies are now completely synonymous with distributed computing (remember Scott McNealy of Sun Microsystems, “the network is the computer”). Now that individual computers take care of all the tasks related to radio automation, the logical evolution is integration of the job of transporting audio for program contributions and distribution. This leads to a fully integrated “network centric” view rather than a “PC centric” approach.

In recent years, the Internet has shown exponential growth. Underpinning the Internet is the IP protocol, which provides extremely flexible routing as well as reduced communication costs. IP provides an already accepted, manufacturer-independent standard for transporting data over short and long distances and its full separation from the hardware layer makes it entirely suitable for professional applications running on LAN/WAN enterprise networks. Furthermore, with the constant increase of available bandwidth and the huge choice of protocols available, IP offers an ideal pathway for general IT/AV convergence², being able to carry a large variety of signals (audio, control, data, etc.). While most of these protocols were defined for asynchronous data transport, some address real time issues including real time audio streaming over the Internet. Additionally, IP technologies offer multiple stream capabilities to accommodate ancillary information along with the audio information. The advent of IPv6 will bring further maturity to the technical solutions.

Introducing eXaudi

With the introduction of eXaudi, Digigram is addressing the future needs of the radio broadcasting industry by providing reliable and redundant equipment that takes care of both Radio automation tasks in the production studios and at the transmissions sites, as well as program sharing and distribution through IP audio streaming. To handle radio automation tasks, eXaudi accommodates a collection of dedicated processing features such as encoding/decoding, routing, mixing, time stretching, equalization, etc, inheriting some of Digigram’s well-proven developments. For the audio transport tasks, eXaudi includes native support of RTP-RTCP-RTSP streaming protocols and advanced QoS management. Along with these standard protocols, eXaudi provides controlled latency and remote stream synchronization capabilities.

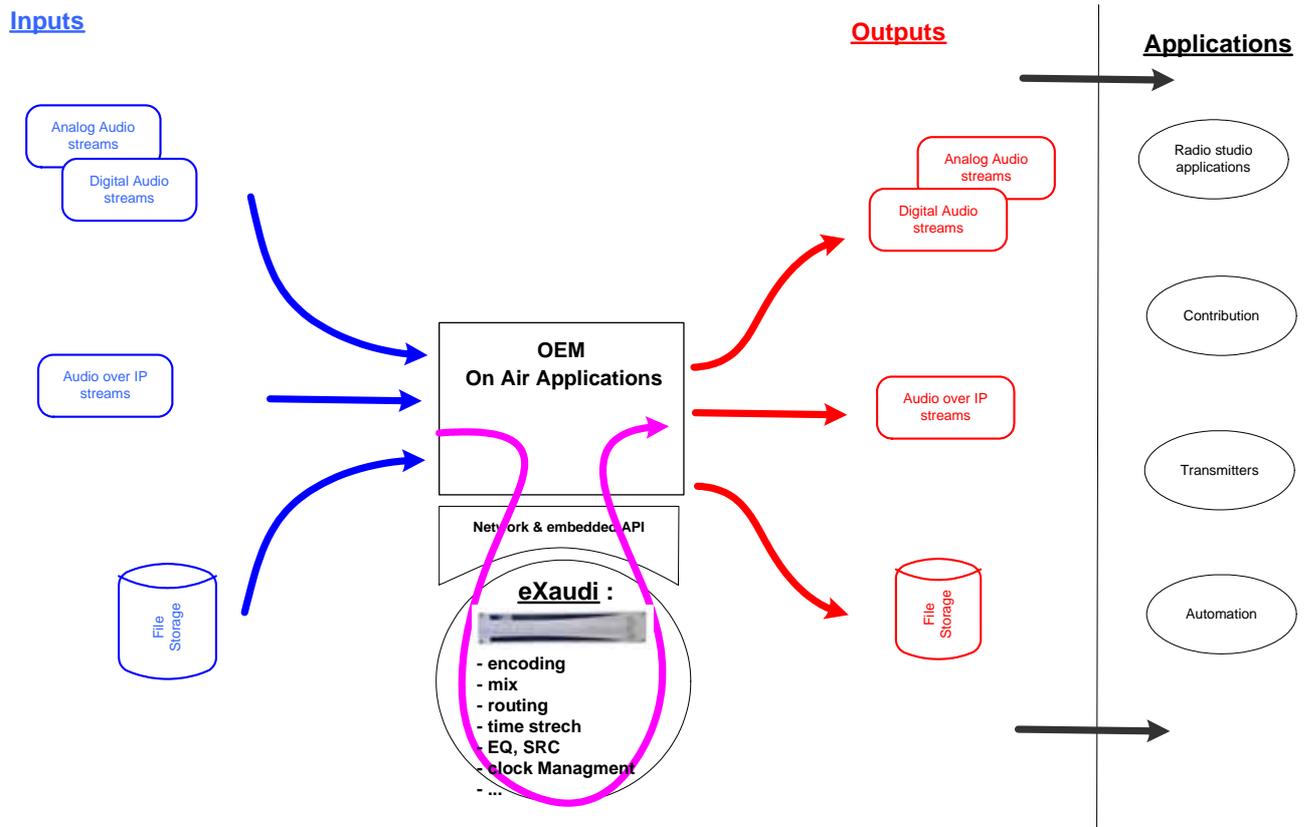
Following the model of Digigram’s PCX cards and their broadcast oriented API³, eXaudi provides strong integration schemes based on a network API for the company’s development partners to provide seamless integration in their own application software solutions.

eXaudi is Linux based for reliability and stability, and the units are ruggedized with full hot-swap redundant power supplies. Software functionality enables the building of a truly remote-monitored, redundant platform.

² IT/AV convergence: Information Technologies and Audio Visual convergence

³ API: Application Programming Interface

eXaudi Functional Design



While the control application takes care of the HUI⁴, eXaudi manages all low level tasks related to audio automation and computer assisted operation, locally and remotely, thus providing a comprehensive integration of the radio On Air transmission steps: streaming, including transport and routing, coding and decoding, and all the signal processing facilities.

eXaudi is a gateway to audio transport integration in radio automation systems for maximum program creativity and flexibility as well as for minimum TCO⁵.

⁴ HUI: Human User Interface

⁵ TCO: Total Cost of Ownership

Audio streaming with eXaudi

Digital audio offers great immunity to transport alteration but traditional formats such as AES/EBU and MADI have not been designed for long distance transport and routing. Telecom infrastructure companies introduced other point-to-point technologies such as leased lines, ISDN and ATM, which were designed with low latency in mind from the outset. But network technologies allow a completely different approach called streaming, which inherently supports routing and multicast distribution.

Use of IP, with full support of IPv6

The use of IP as the transport protocol in eXaudi brings a number of benefits:

- Native support of LAN/WAN technologies,
- Strong cost reduction thanks to IP proliferation (pushed by consumer and telecom markets),
- Full interoperability with most of other equipment,
- Easy mutualisation and multiplexing of various streams, and
- Separation from the underlying physical network layers

thereby providing the broadcaster with an easy way to use any technology suitable for its specific needs, requirements and budget.

Furthermore, providing native support for IPv6, eXaudi will benefit from the improvements of this new standard as the infrastructure becomes available.

Dealing with streaming protocols

Many streaming solutions are based on the IP protocol. Unfortunately, these solutions are focused on consumer applications and have to deal with issues such as lack of guaranteed bandwidth and bandwidth limitations. Accepting that bandwidth is not unlimited, the requirement for professional broadcast can be expressed as high audio quality associated with low and constant latency. So existing solutions do not address the requirements of the professional broadcast industry, or at best address them with a lack of audio management flexibility, and are not therefore fully satisfactory.

eXaudi solves this problem with innovative and sophisticated mechanisms and unlocks the potential of IP networks for fully professional use.

eXaudi benefits from native support of dedicated real-time protocols:

- QoS. Quality of Service ensures that proper priority and bandwidth is allocated to the stream in a shared system. Depending on the importance of the stream, eXaudi provides functions to assign service class information to the RTP streams. Obviously, the whole chain needs to take this information into account.
- UDP. Because of its unpredictable delay and availability, TCP is not suitable for real-time applications. UDP is faster than TCP is because there is no form of flow control or error correction; UDP is only concerned with speed. Furthermore, UDP provides multicast capabilities. Multicast means that only one stream is generated for multiple clients resulting in lower bandwidth usage. Clearly, multicast operation requires a managed network.
- RTP, RTCP, RTSP. Sitting on top of UDP, the real-time transport protocol (RTP) is a thin protocol that provides support for applications with real-time properties, including timing reconstruction, loss detection, security and content identification. With RTP come RTCP and RTSP. RTCP is the control protocol and provides information about the network connection quality such as lost frames, jitter, etc. The application-level Real Time Streaming Protocol, RTSP, aims to provide an extensible framework to enable controlled delivery of real-time data. Optional to RTP, RTSP provides stream remote control capabilities.

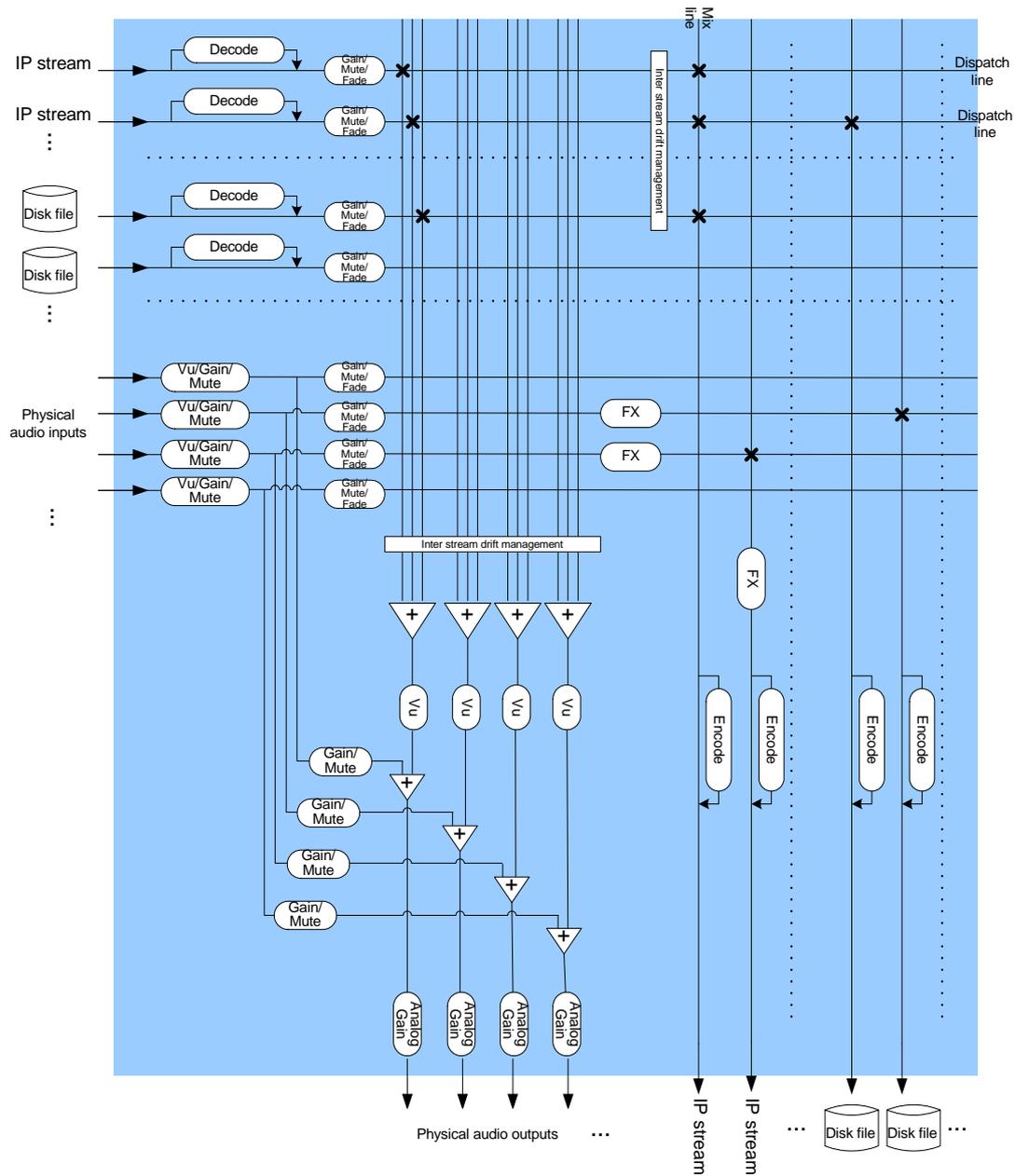
Audio stream synchronization

Streaming audio adds delay and jitter. Delay varies with the path used to reach the destination, while jitter may cause loss of audio if the buffering is too tight. Another key issue in sending audio data to remote transmission sites for broadcast is to ensure that audio data is in sync when it is transmitted. While audio transport can take up to several hundreds of milliseconds, it is vital to make sure that all audio information is broadcast simultaneously and this can only be achieved by buffering to compensate the delay and jitter between the different sites. Being opposite to the goal of minimizing latency, this buffering needs to be reduced to its minimum. eXaudi includes some optimization features:

- Selection of the proper protocols as discussed above.
- Implementation of precise time compensation mechanisms. All audio and ancillary data streams feature a time-stamp so that they share a temporal reference. This provides information on lost or late audio packets, for which compensation is required, and also allows for time alignment of the different streams.
- A proprietary connected system with a distributed NTP based clock synchronization that ensures clock integrity between all devices on the network.

Audio processing with eXaudi

As eXaudi equipment takes care of all audio tasks related to radio automation, some embedded audio processing is obviously needed. This processing addresses three main needs that can be summarized as: mixing, coding, and improving audio quality. So eXaudi equipment features fading/cross fading, stream synchronization, coding/decoding, time stretching, mixing and routing capabilities. eXaudi units take full advantage of the available embedded DSP power.



Coding

Digigram's policy has always been to support and build upon recognized audio standards. When it designed the PCX cards, Digigram strongly supported the MPEG specifications based on its participation in the EBU and IRT standardization committees. eXaudi inherits this tradition by using previously developed and widely accepted audio coding schemes. Various data reduction algorithms can be implemented on the eXaudi platform: MPEG 1 and 2 layer 2, MP3, MPEG4/AAC+, and because eXaudi is an open and flexible platform it will be able to host almost all future audio coding or transcoding developments.

Furthermore, a stream can be encoded into several different streaming formats depending on the target audiences' needs. A high quality stream may be issued for On Air purposes where secondary lower quality streams may be issued for web distribution, monitoring, logging, and other purposes.

As previously mentioned, all these streams can be multicast streams, allowing significant bandwidth optimisation and thus drastically reducing overall costs. Standard streaming players available on desktop computers can also be used for basic remote monitoring purposes.

Routing and mixing

eXaudi provides two levels of audio routing:

- An embedded matrix provides routing capabilities for any input (physical, file, or IP stream) to any output (physical, file, or IP stream). Any input may be mixed with any other before being routed to an output of any kind.
- External routing between eXaudi units is inherent to the IP data network and allows for flexible audio routing from one unit to many others.

Control and management of eXaudi

Control and management is the heart of a distributed eXaudi system.

Managed by a network API, each eXaudi unit is fully remote controlled. Nevertheless, local management needs may require small, dedicated and highly specific applications to be hosted on each unit.

This approach allows a boundary to be set between the audio functions handled by the eXaudi equipments and the management applications that mainly take care of the HUI and other workflow related aspects. This boundary provides better system reliability by removing the risk of human error from the audio equipment.

As a consequence, these applications can be far lighter and can focus on the user interfaces and powerful workflow management functions needed by 21st century broadcasters, such as web oriented applications with thin clients.

Last but not least, SNMP management capabilities can provide network wide monitoring of many types of equipment and warn of system failure. Each eXaudi unit hosts a web server for basic management.

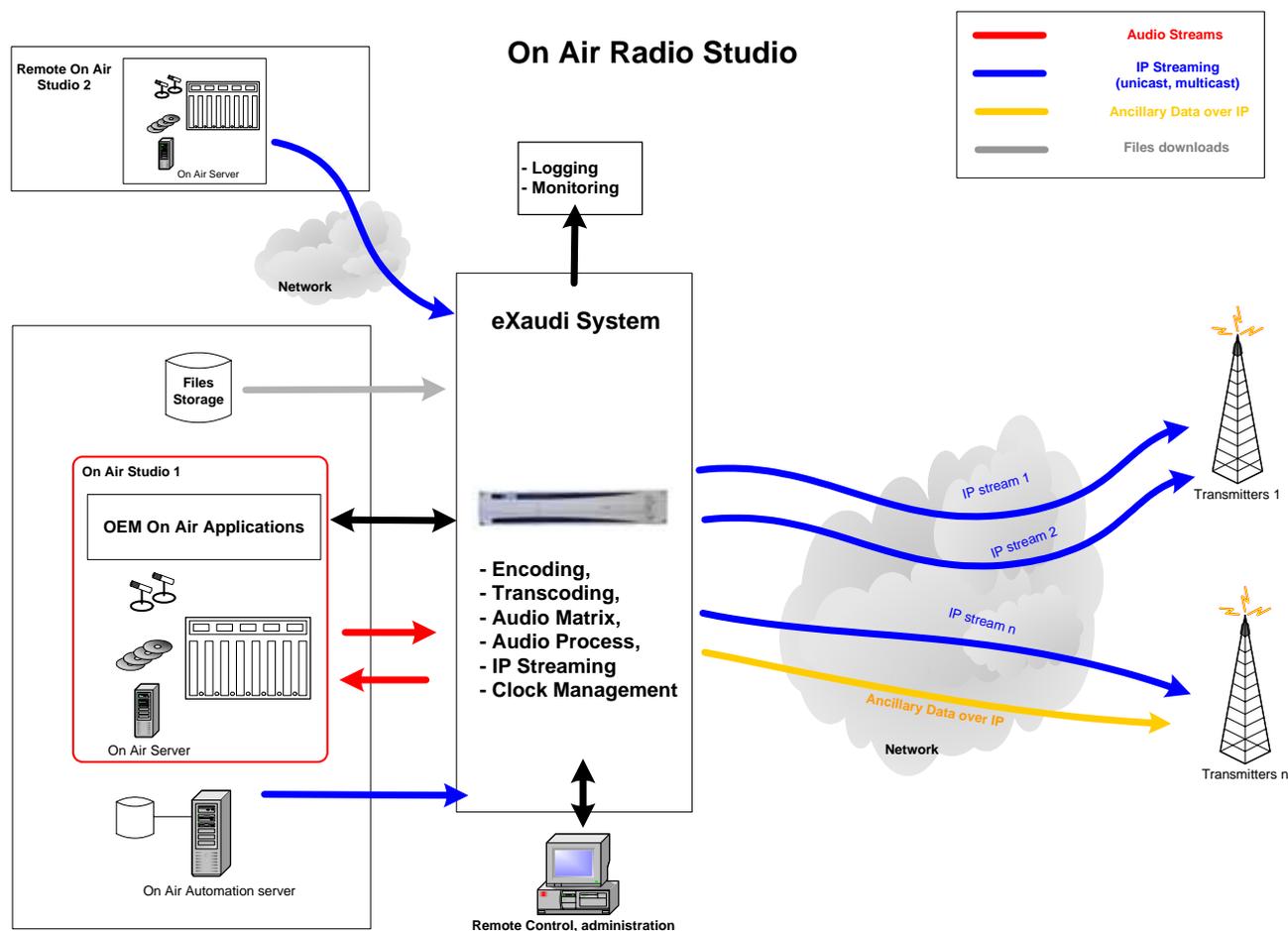
Thanks to this adjustable boundary definition, eXaudi is very flexible and can address many different needs. While the applications are numerous, several typical uses arise from the production studio to the transmitter site.

Typical applications

The production site

The On Air studio

When used in the On Air studio, eXaudi takes care of all the radio automation and audio streaming tasks; it is the heart of the IP oriented broadcasting model. Remote controlled from the radio automation system based on the On Air schedule, eXaudi manages all incoming and outgoing signals.



In addition to the main program stream, there may among the outgoing streams also be a stream feeding the transmitters, and some ancillary streams for purposes such as monitoring, logging and internal distribution. The outgoing stream may also encapsulate service traffic used by the remote devices.

Automated broadcasting of theme programs

Tightly linked with radio automation systems, eXaudi units can take complete care of automatic program generation. When connected to a file server, the units can automatically generate the various theme programs dictated by previously prepared playlists.

Logging and monitoring with eXaudi

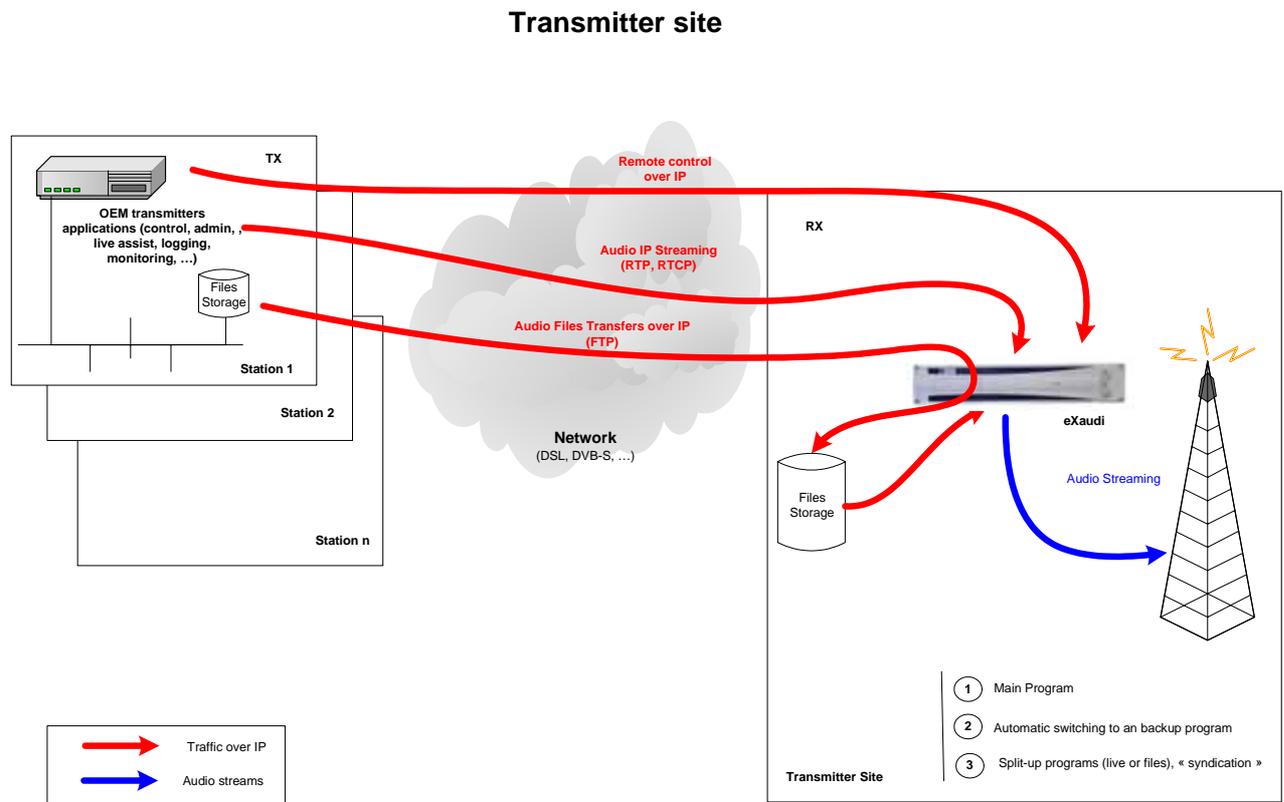
In addition to the classic broadcast applications described above, eXaudi’s capabilities enable it to fill an even wider range of roles. Amongst others, the remote automated recording capability is perfect for logging applications ranging from competitive monitoring to legally required logging. An eXaudi unit can be instructed to record from an audio input or an IP stream and encode in real time for archiving or other purposes. It can also encode streams for low level remote monitoring and audio distribution. Some radio network operators may find invaluable the ability to use a standard desktop multimedia player for remote monitoring of their output.

The transmitter site

Locating an eXaudi unit at the transmitter site can provide an elegant solution for ingesting and adapting the audio stream in ways similar to On Air studio applications. These streams may be:

- one or more main program streams fed by terrestrial or satellite links,
- secondary streams coming from other distant sites, for local programs or advertising,
- live inputs, or
- any other backup stream.

These streams may come from the broadcaster’s different sites, through terrestrial or satellite links, or may be locally generated by eXaudi from audio files previously downloaded.



eXaudi applies all the required processing to these streams – primarily switching from one stream to the other with cross-fades and digital processing – in order to generate the continuous program stream to be broadcast by the transmitter.

The service traffic provides information on when to switch from one program to another or when to insert localization data downloaded off-line and stored locally (hard drive or static memory).

Thus, eXaudi facilitates the installation of a solution directly at the transmitter site that provides the broadcaster with great flexibility. The installation of a control application at its own premises gives the broadcaster, for the first time, a high level of autonomy over his network operator. The broadcaster can now have very precise and direct control over what happens at the transmitter site, allowing him to feed each transmitter with different localized programming. Furthermore, the broadcaster also has fine control of the On Air processing, which can be set to match the precise requirements of his audience.

Last but not least, because of the facilitated transport and self-control functionality, the broadcaster can enjoy significant cost reductions.

Automatic assembly of multiple localized programs

The modularity of eXaudi units, combined with the system wide control capabilities, offers the perfect platform for the automatic broadcast of multiple localized programs.

A system that includes eXaudi units located at the transmitter sites can take care of everything specific to the program. The link to each transmitter site may be terrestrial or satellite. At each transmitter site, eXaudi units can receive programs via unicast or multicast IP streams and handle the local mixing, advertising insertion, program localization, scheduling, etc. Localization jingles and advertising can be downloaded at anytime and stored at the transmission site. A completely automated process ensures both good overall audio and program quality. Furthermore, a backup program can be stored on the remote site in case of a link breakdown.

This architecture also provides the functionality needed to assemble programs for affiliate radio stations running shared programs, while also being capable of switching to a live program interactively or at any predefined time.

A failsafe lower quality backup fallback link for the main link to the transmission site can also be provided.

A main control room provides remote control and monitoring of the units. This includes monitoring of the transmitted audio by listening to low bandwidth monitoring streams.

Conclusion

The network centric approach and dedicated audio design makes eXaudi a very flexible workhorse capable of handling a wide variety of tasks.

Because eXaudi units are stand-alone, ready to use boxes, they are much simpler to integrate than PC sound cards – no need to open a computer or to install drivers. Define their IP addresses and run. Furthermore, they are less sensitive to PC obsolescence so the investment can be amortized over a longer period.

eXaudi sits at the link between the computer and the network but is much more than just another streaming solution, or another codec. eXaudi is a comprehensive system providing tight integration between radio automation and audio transport. And benefiting hugely from Digigram's experience as an OEM manufacturer, eXaudi integrates perfectly into third party software vendors' system.

Whatever the requirements, eXaudi provides the broadcaster with a reliable and flexible solution that will help to simplify workflow and improve efficiency - all at a better cost.

Fifteen years after it introduced the legendary PCX card, Digigram presents eXaudi, the second digital revolution in the world of radio broadcasting.

For more information contact Digigram today.



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