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# AUDIO IN THE COURTROOM

With the correct use of technology, everyone involved will be able to hear and participate.

**BY SCOTT WOOLLEY**

Each year, the Chief Justice of the United States Supreme Court issues a year-end report on the federal court system. The 2004 report addresses the funding crisis currently affecting the federal courts and states that the strategy to reduce costs includes promoting more effective use of technology. This focus on technology extends to the state and local courts as well, and directly relates to the effective use of audio systems in courtrooms.

The audio system is arguably the most fundamental and important technology in a courtroom. If the proceedings cannot be heard clearly by all parties, there is really no benefit to using other technologies such as videoconferencing or video evidence

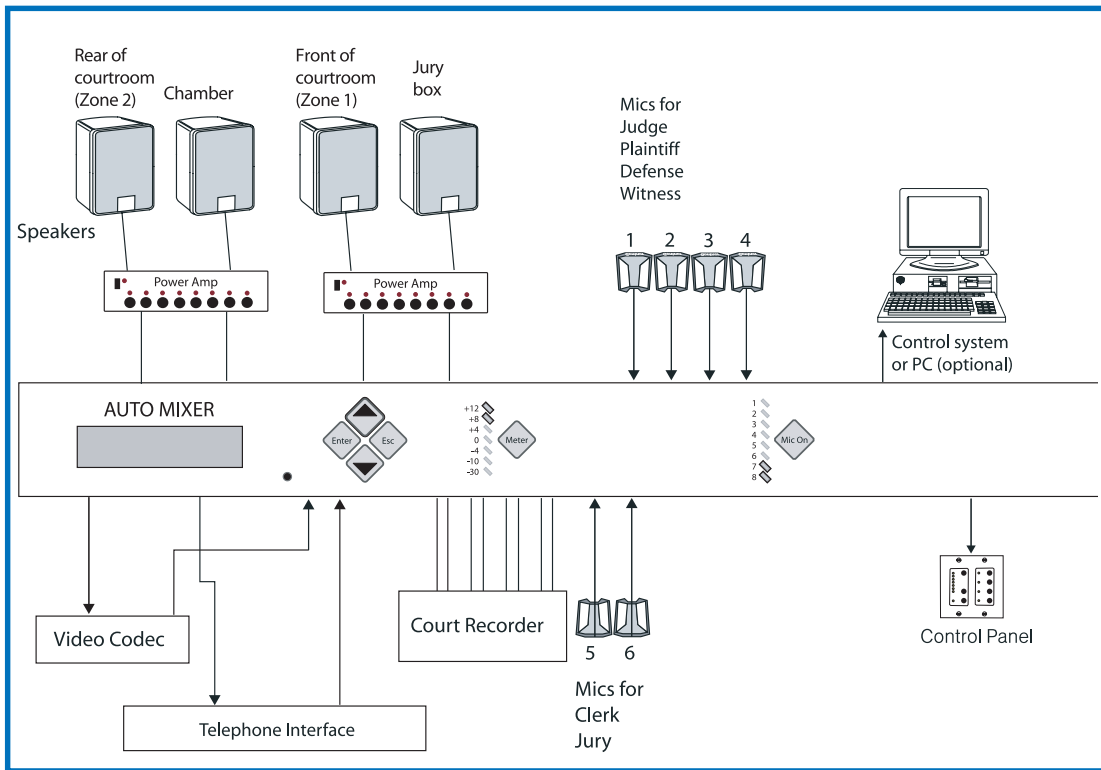
presentation. In addition to meeting the functional requirements, which are discussed here, the audio system must provide cost savings to court operations by incorporating features such as audio conferencing, which can reduce the cost of transporting prisoners between the jail and the courthouse by enabling remote arraignments. It must also have a low cost of installation, operation and maintenance.

## Implementing a System

Implementing such a system can be achieved by using digital audio equipment that features automatic mixing, routing, audio processing and echo cancellation. Using a single product

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**Diagram 1.**  
**Courtroom Audio Installation**  
*Using a single product to perform essential audio functions such as automatic mixing, routing, audio processing and echo cancellation makes it easier to integrate other elements of the audio system, including conferencing, recording and assistive listening.*

that performs all of these key functions simplifies installation and makes it easier to integrate important features, including assistive listening, audio recording, sound reinforcement and conferencing. Because non-technical users, such as judges, clerks and others, are often required to operate the audio system, an intuitive user interface is essential for seamless operation [see Diagram 1].

Close attention should also be given to infrastructure requirements, such as wiring, equipment location, and necessary space for existing and future equipment. Besides the technical issues, the architectural nature of courtrooms raises aesthetic concerns because interior design elements of courtrooms often conflict with the acoustic requirements for providing a high level of intelligibility.

## Audio System Requirements

The functional requirements of a courtroom audio system include providing local sound reinforcement, assistive listening capabilities for the hearing impaired, support for translation services, recording of court proceedings, audio teleconferencing, au-

dio for videoconferencing, playback of evidence, media feeds and remote audio monitoring in chambers, clerk's offices and the offices of those responsible for court security.

For privacy reasons, infrared (IR) assistive listening systems are typically used. Because the IR signal does not penetrate the courtroom walls, it cannot be picked up by a radio receiver outside the courtroom. This same IR system is used often for language translation because the translation system has to be able to support a translator located in the courtroom or a translator who is accessed by a telephone line.

Multi-track audio recorders are used to create a record of proceedings. By routing the audio from each microphone in the courtroom to a different audio track, it is easier to identify who is talking on the recording. Some courts use analog tape recorders to accomplish this, but most are moving to digital recorders. Be sure to determine the input level for the recorder because some require a mic-level signal and others a line-level signal. Consider providing both types to ensure present and future compatibility with the court's audio recording system.

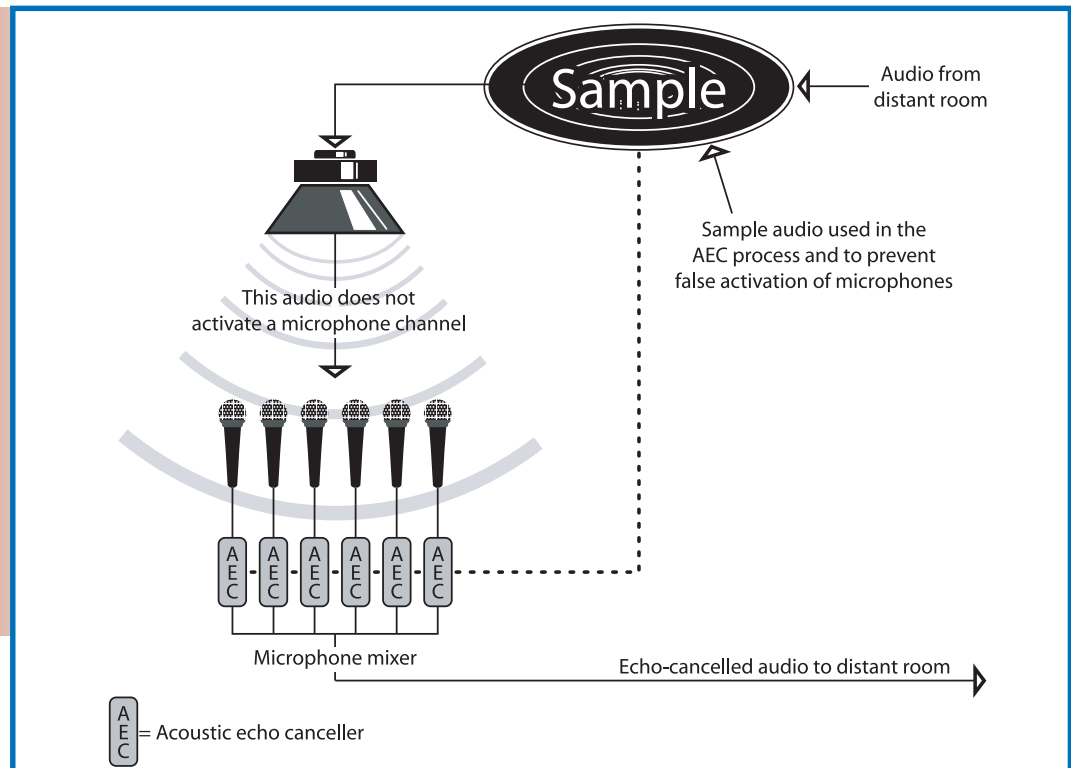
It is important that the court reporter making a transcript of the proceedings be able to easily hear all that is being said. This means that the reporter may need to be able to adjust levels for individual microphones, a loudspeaker or for headphones at his or her location without affecting the primary loudspeakers in the courtroom. This requires that the system allow for different signal mixes for multiple outputs.

Typically, it is best to provide a mix-minus, zoned speaker system. A mix-minus system provides a mix of all microphone signals at a local loudspeaker, minus a signal from the local microphone(s). This keeps microphone signals from being routed to loudspeakers that are close by and decreases the likelihood of feedback.

## Users Have Little Experience

Many of the individuals involved with court proceedings have little or no experience using microphones. Some may speak loudly and others softly. This is especially true of witnesses. Due to the variances in talking levels and the likelihood that witnesses will not always speak directly

**Diagram 2.**  
**False**  
**Microphone**  
**Activation**  
**Audio from a**  
**distant room is**  
**sampled before**  
**exiting the**  
**loudspeaker.**  
**The automatic**  
**mixer identifies**  
**this audio**  
**sample as that**  
**coming from**  
**the loudspeaker**  
**and not a talker**  
**in the local**  
**room to**  
**eliminate false**  
**activation of**  
**microphones.**



into the microphone, it is beneficial to use automatic gain control (AGC) on the witness microphone. AGC is used to ensure consistent voice levels by automatically increasing gain when the level is too low and decreasing gain when it is too high.

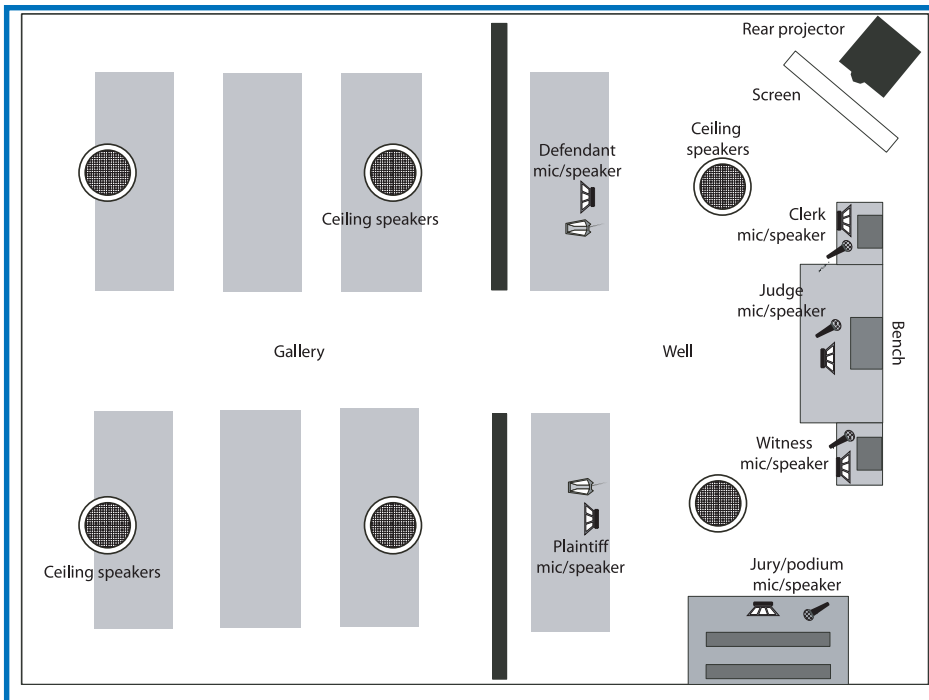
It is also beneficial to use AGC on other microphones, such as the counsel table microphones and the lectern microphone. In addition, AGC can be used on line inputs that experience fluctuations in audio level. These audio level fluctuations are common on videotapes, surveillance audio recordings and wire tap recordings, for example.

Audio conferencing is something courts are depending on more and more to help lower costs. It is used when participants do not have to be present in the courtroom, such as preliminary hearings, judge conferences and remote witnesses. The audio conferencing system is an integral part of the total audio system. It uses the microphones in the courtroom to pick up the audio and send it to the remote location, and it uses the courtroom's loudspeakers to produce the audio signal from the remote location.

A key to achieving high-quality audio conferencing is a close marriage

of the sound system's automatic mixer and the audio conferencing system's acoustic echo cancellers (AEC), which prevent echo during an audio conference. Performing the functions of the AEC and automatic mixer in the same digital signal processor reduces the pickup of reverberation and noise from the microphones, which increases audio intelligibility.

By implementing mixing functions completely in the digital domain in conjunction with the AEC, precision in making auto mixing decisions greatly increases. For example, when audio from another source, such as conference audio from another room, is



**Diagram 3. AV Equipment Placement**  
*Placement of AV equipment, concentrating here on microphone and speaker requirements, in a typical courtroom.*

amplified through the speakers in the room, an automatic mixer typically would activate at least one microphone, as if that audio were coming from a voice in the room. This false activation can be prevented by using an automatic mixer that takes the same audio sample from the AEC process to determine that this audio is coming from the loudspeaker and not a talker in the local room (see Diagram 2).

## Microphone Selection

In a courtroom, microphones are placed in front of judges, clerks, witnesses and attorneys. Each location has its own unique requirements that must be considered when selecting microphones.

The manner in which the attorneys may speak varies depending on the preference of the court. Sometimes attorneys address the judge or others in the courtroom while seated and other times they are required to stand. This

*Audio equipment placed under the clerk's desk results in a cramped and uncomfortable space.*



makes selection of the proper microphone at the counsel table important. Typically, a gooseneck microphone with a directional pick-up pattern is best. The neck of the microphone has to be long to allow for the base to be positioned at the back of the table to provide plenty of room for papers and other materials. A long gooseneck also allows the microphone to be adjusted easily to be closer to the mouth of the speaker, regardless of whether that individual is sitting or standing.

During jury trials, there are times when the judge has to speak privately with the attorneys in the courtroom. To increase the privacy of the conversation, masking noise is activated via the loudspeaker system in the area of the jury. This noise keeps the jury from understanding the discussion between the judge and the attorneys. The judge's microphone also has to be muted to keep the conversation from being overheard.

However, this conversation still has to be recorded as part of the official transcript of the trial, so a special "bench conference" microphone should be used at the judge's bench to pick up the audio from these conversations. The signal from this microphone is routed to the recording system and also to the location where the court reporter sits. The court reporter can listen to the conversation with a set of headphones and document the conversation.

## **Infrastructure Requirements**

System electronics should be located in a convenient space outside the courtroom, with adequate ventilation and plenty of room to access and service the equipment. Placing equipment inside the courtroom often limits future growth. In many poorly designed courtrooms, the equipment is

placed under the clerk's desk or the judge's bench, which results in cramped and uncomfortable spaces for these individuals. It also makes it impossible to maintain or adjust the system without disruption of court proceedings.

A network connection should be provided to the equipment room to allow for remote setup, monitoring and configuration of the system. An analog phone line for audio conferencing is also required. Although it's true that many phone systems are moving to VoIP, it's still wise to plan for the use of a plain old analog phone line.

The most flexible means of handling wiring is to use a raised floor system, which provides maximum flexibility for future growth and allows for reconfiguration of the courtroom's well area to best serve the needs of the court. A raised floor system typically has a higher upfront cost than when using standard conduit, but it can provide cost savings over the life of the courtroom. This savings comes when changes to the courtroom require installation of additional conduit and floor boxes. These types of modifications and the time that the courtroom is unusable during construction can become a substantial cost to the court.

If an existing courtroom is being upgraded and the nature of the existing construction does not allow for implementation of a raised floor system, then the size of conduits should be calculated carefully to ensure plenty of spare capacity, and floor



**High, ornate ceilings or ceilings without wire access require creative speaker placement, such as at the front of the courtroom or in the floor of the jury box.**

*The microphones at the counsel table should be long enough to allow for the base to be positioned at the back of the table to provide plenty of room for papers and other materials, and to be easily positioned close to the mouth of the attorney when sitting or standing.*



boxes should be oversized to provide for future growth. If a video evidence system is not being installed with the audio system, the conduit/raceway system should be sized to allow the installation of these systems at a future date. Wire raceways have to allow for installation of the system cabling in a home-run fashion, not daisy chained from electrical box to electrical box.

## **Aesthetic Concerns**

Many courtrooms are ornate, with high ceilings and substantial mill-and stonework. Often, in older, historic courtrooms, architectural features cannot be modified. As a result, items such as visible wires are not acceptable. This requires creativity in integrating the sound system. For example, distributed ceiling-mounted speakers typically are used in courtrooms, but if a courtroom has an ornate ceiling or a ceiling that is not accessible for wiring, beam-steering loudspeakers with a tight vertical pattern can be mounted at the front of the courtroom. It is important to perform the calculations required to determine if the proposed speaker system will provide a high level of intelligibility.

The hard surfaces and the high ceilings in courtrooms often cause significant reverberation. Without taking actions to reduce the reverberation, it can be difficult to design a speaker system that will provide intelligible sound and acceptable audio quality. Reverberation can be controlled or

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minimized through acoustic room treatments such as installing acoustic panels, hanging curtains on the windows and adding carpet.

Wire raceways are required in counsel tables to conceal microphone and other system cables. When wire ways at the judge's bench, clerk's desk and witness stand are installed, they should be concealed completely. Before ordering, colors for all visible equipment such as connection panels must be approved by the court's representative.

The audio system should be self-operating, with little intervention required by court personnel. Because it usually is controlled remotely by the judge from the bench or the clerk from his or her desk, the control interface must be simple to use, with a limited,

straightforward set of functions. Controls may include power on/off, bench conference, mute/unmute and dialing functions for audio teleconferencing. Level control typically is not needed, except for auxiliary inputs. Due to the limited functions of the user controls, it is often possible to have a button panel control system that connects directly to the audio system's digital mixer.

By careful needs assessment, planning of infrastructure requirements and the use of modern digital audio equipment, audio quality in courtrooms can be improved and the cost of integration can be reduced. By including functions such as audio conferencing within the audio system, courtroom operating cost can be reduced as well. ■