

# Resolving Distance Learning System Audio Problems

White Paper



**ClearOne**



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## Resolving Distance Learning System Audio Problems **White Paper**

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Mr. Woolley has been involved with education in the industry for many years. He has presented at InfoComm and AES and has been published in several industry magazines and professional journals. He earned a bachelor's degree from Utah State University and is a Registered Communications Distribution Designer and CTS.

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## INTRODUCTION

Knowing of my involvement in the conferencing industry, a friend approached me regarding a distance learning system audio problem. He was attending a class at a satellite campus of a major university. He told me he found the class of little value due to poor audio quality between the main campus classroom and the remote classroom where he attended class. He had brought this to the attention of the university as had many other students. The problem went unresolved and he suggested I contact the university to assist in improving the situation.

This problem is not uncommon. This paper addresses the audio issues that cause these types of problems and the issues that need to be considered in order for students in remote classrooms to hear and interact as if they were in the same classroom as the instructor.

## CAUSES OF POOR AUDIO

Allowing remote students to interact with the instructor and other remote classrooms as if the students and instructor are in the same room is needed if students are to receive a learning experience equal to students located in the primary classroom. Inadequate audio quality can prevent natural interaction on student to student and student to instructor levels. The most common audio problems include:

- Echo
- Lack of full duplex
- Low intelligibility due to ambient noise
- Low intelligibility due to poor room acoustics or improper microphone placement

### Echo

When echo happens the annoyance it causes prevents natural conversation between sites. A common cause of echo is due to the audio from the remote location coming out of the local loudspeakers and being picked up by the local microphone(s) and retransmitted back to the remote call participants. The “echo” is caused by the remote participants hearing themselves in their own loudspeakers as the delayed signal travels to the local site and back.

### Lack of Full Duplex

Some distance learning audio systems prevent echo by muting the microphones while audio is coming from the distant site. If the local microphones are muted, the far site audio cannot be picked up and retransmitted back to the distant location. This is a half-duplex system. An example of this is a “walkie-talkie” type system. The down side is that audio conversations do not flow naturally. In order for instruction to take place as if participants are in the same room full duplex audio is required.

### Ambient Noise

The greater the noise level relative to the speech, the harder it is to understand what is being said. Noise comes from HVAC systems, lighting, projectors, laptops and people. Steps to increase the level of the speech compared to the noise are required. The speech signal transmitted from one site to another must be 20-25dB greater than the transmitted noise level in order to prevent listener fatigue and for speech to be

easily understood.

### **Low Intelligibility Due to Poor Room Acoustics**

In rooms with primarily hard surfaces, sound will bounce around the room creating a hollow or boomy sound. This typically is not a big problem for the individuals in the room but when we try and pick-up audio with a microphone in one of these reverberant rooms, the audio the far site hears is fatiguing at best and often not comprehensible. This is because microphones do not have the human ability to discriminate between the noise and the speech. Placing microphones close to the talkers increases the talker's level compared to the sound reflections, improving the audio quality. This requires more microphones. The more active microphones, the more the sound reflections will be picked up. A proper distance learning audio system needs to have microphones located close to participants but also requires keeping microphones that are not being used for speech inactive or "turned down".

## **CLEARONE SOLUTION TO AUDIO PROBLEMS**

### **Acoustical Echo Cancellation**

The key signal-processing technique required to prevent echo is acoustical echo cancellation (AEC). This prevents the incoming audio being picked by the microphones from being retransmitted to the remote participants.

This provides echo-free conversation, eliminates the need for participants to repeat themselves and improves the overall user experience. ClearOne's fourth-generation AEC algorithm is optimized for group conferencing environments like distance learning and automatically adapts to changing acoustical conditions. Improvements in audio quality and echo reduction can be achieved by placing an echo canceller on every microphone signal in an audio conferencing system. This is known as Distributed Echo Cancellation (DEC).

In a typical non-distributed echo cancellation system, all microphones in a room are combined in a microphone mixer to a single output. That output is then sent to an echo canceller. The echo canceller must adapt to the mix of echoes from each microphone. When an echo canceller is placed on each microphone signal, the echo cancellers have a far easier time individually canceling the echo. There are other advantages of Distributed Echo Cancellation. For example, additional audio processing can be done after the echo cancellers, so activation of the microphones and other changes introduced by the audio processing have no negative effect on the echo cancellers.

### **Noise Cancellation**

Noise cancellation eliminates broadband noise sources picked up by the microphones including noise from HVAC systems, laptops, video projectors, and fluorescent lights.

ClearOne's noise-cancellation technology eliminates unwanted audio signals generated from environmental factors. The noise cancellation algorithm attenuates these noise sources while allowing the voice signal to pass to the far-end with pristine quality.

### **Advanced Automatic Microphone Mixer**

As part of the audio conferencing experience, it is important not to activate microphones when they are not in use. And if someone does talk, you want the system to activate one microphone and not multiple microphones in the room because doing so would affect the clarity of the signal going to the far site. As an example, if there is a room with eight microphones and all of them are turned up at the same time, your

signal-to-noise ratio would be 9 dB worse than if you had a single microphone active. (Figure 1) This pick up of additional noise negatively effects intelligibility.

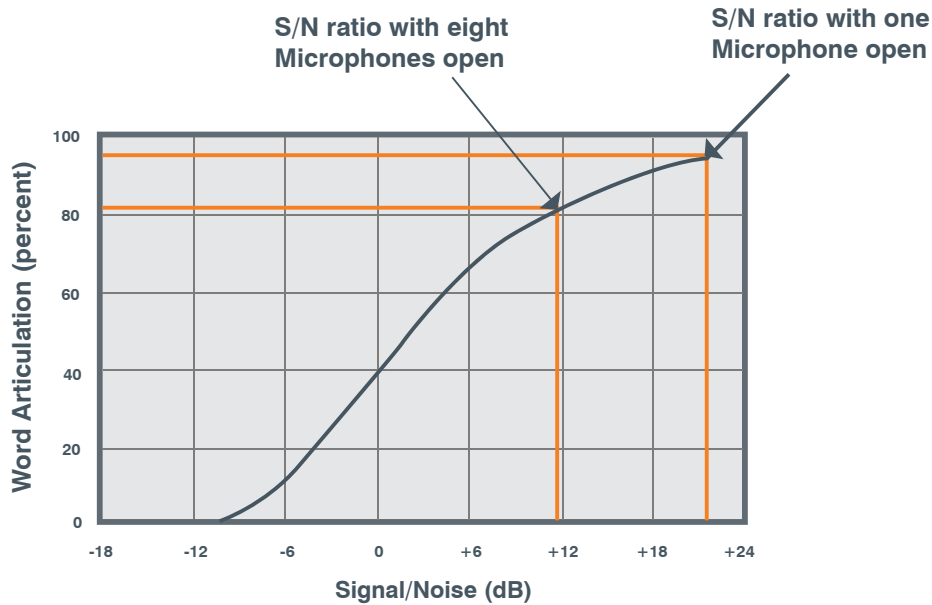


Figure 1

Typically in an audio conferencing application, when the far site speaks the voice signal coming out of the local loudspeaker is at a level that is close to the level of someone speaking in the local room. This voice signal from the far site has the potential to activate local microphones that are not needed, leading to lower intelligibility.

### PA Adaptive

The PA Adaptive function monitors the signal level of the far site and raises or lowers the activation threshold of the microphone accordingly. This prevents the far site audio from falsely activating microphones. By minimizing the number of active microphones, the audio quality is improved.

This function can also be used during playback of local program audio. If there is audio playback as part of a presentation, this program audio would typically activate microphones. Using the PA Adaptive function, you can include the local program audio in the PA Adaptive reference which will prevent the program audio from activating microphones.

### First Mic Priority

In most distance learning situations, participants tend to sit relatively close to one another and may be close enough to multiple microphones to activate more than one microphone when they speak. When audio is picked up across multiple microphones, the first mic priority feature evaluates each channel and activates only the microphone with the loudest pickup. This translates to a cleaner pick-up of the talker with less “phasing” of the audio and also eliminates the far away, hollow quality of someone speaking through a far microphone. This feature is invaluable in more reflective rooms.

## Adaptive Ambience

The purpose of Adaptive Ambience is to prevent the ambient noise in a room from activating microphones. By capturing an ambient noise profile, the system can analyze the noise level and determine when to activate the microphones. The ambient level within a classroom dynamically changes as the number of participants increases, air handlers activate, and similar acoustical events occur. The adaptive ambient algorithm monitors these changes using the microphone element as the pick-up source. The algorithm automatically changes gate thresholds to compensate for the increased noise floor. This ensures that microphones are not falsely activated by ambient noise level changes.

## SUMMARY

The union of Distributed Echo Cancellation (DEC) with advanced automatic mixer features prevent false activation of microphones. By minimizing the number of microphones that are open, noise, reflection pick-up and echo are reduced. This provides greater clarity and intelligibility. ClearOne products include these features along with other sophisticated audio signal processing in easy to implement audio communications systems.

## COMPANY BACKGROUND

ClearOne is a leading global provider of premium audio conferencing systems and other related products for audio, video and web conferencing applications. The reliability, flexibility and performance of our comprehensive solutions save organizations time and money by creating natural environments for effective and efficient group communication.

We have been developing audio products since July 8, 1983 and introduced our first professional audio conferencing systems to the market in 1990. Since that time, we have expanded and diversified our product line to meet all types of audio conferencing needs, from the office desktop to large group conferencing venues such as boardrooms, training centers, courtrooms and auditoriums. In addition to audio conferencing products, we offer microphones and conferencing furniture.

Our products are used by organizations of all types and sizes, from educational institutions, government organizations and small businesses to the world's largest and most prestigious companies and institutions, including Microsoft, Daimler Chrysler, Boeing, Merrill Lynch, NASA, Cisco Systems, Best Buy and the Mayo Clinic.

