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AV TECHNOLOGY

GUIDE TO AV SYSTEMS

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In this converged world of audio-visual, communications, networking, and information technologies, the scope and breadth of product applications – and the benefits they can deliver – have exponentially increased.

I. Introduction

Interactivity is the new black. But the new black comes in a lot of different shades. When you think about it, your interaction with technology is growing all around you. More and more parts of your everyday surroundings are being put into your control. The most recent being audio. The convenience of technology like personal music players is driving the trend – and there is no end in sight.

But how does that affect the worlds of AV and IT? The more comfortable customers become with these environmental technologies, the more they are going to want them at work in their world. Control systems are perfectly aligned to deliver just that, total environment solutions that deliver not only AV control, but the complete automation of the entire room.

The first **AMX AV/IT Guide to System Integration Practices – Part 1** demystified the technology behind AV, took a look at AV best practices, and offered insight into how users communicate with professional AV systems suppliers.

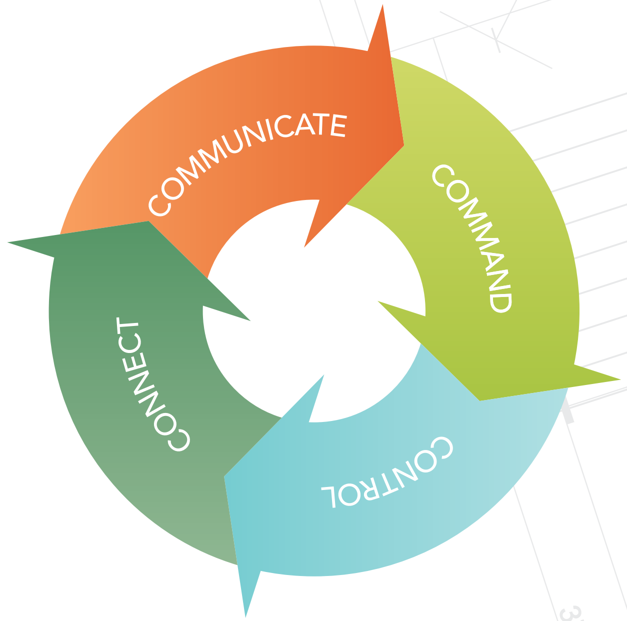
The second **AMX AV/IT Guide to AV Applications – Part 2** took a look at the different ways vertical markets use technology.

The third and final **AMX AV/IT Guide to AV Systems – Part 3** explores the different types of AV systems and details the most important information necessary to design an AV system with control. Part 3 includes:

Designing Systems with Audio
Designing Systems with Video
Designing Systems with Signal Distribution
Designing Systems with Control
Systems in the Real World
AV Industry Training

Levels of system control can vary immensely depending on the user's needs and application but generally fall into three escalating system types:

- Level 1: AV Device Control – Illustrates a simple way of controlling the AV components that generally drive a single-room application such as a conference room or a home theater. Components typically include a Projector or Video Display, DVD Player, Laptop port and Speakers.
- Level 2: Total Environment Control – A Total Environment Solution would cover a room, a home or an entire facility and offers the user control over AV devices but adds
- control of the rest of the environmental systems such as: lighting, window shades, climate, security, sprinklers and other systems that support the installation.
- Level 3: Facility and Building Management – In addition to controlling room devices and the total environment, AMX control systems are available to manage all of the infrastructure systems in an entire facility or building. This includes power, communications, security and surveillance, PA systems, emergency lighting and audio systems and more.



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AMX GUIDE TO AV SYSTEMS PART 3

Here is a closer look at the escalation of levels from simple to complex control systems. First, we follow the linear progression and components used in a Level 1 system to control AV devices. Next is an example of total environmental control of a conference room. Level 3 illustrates all of the infrastructure systems within a building that can be managed with an AMX Facility and Building Management solution.

Depending on the size and scope, AV projects have systems in one or more of these technology areas:

1. Source
For an audio system, sources could be microphones, musical instruments, CD/DVD players, tape machines, etc. For video systems, sources include cameras, VCR/DVD players, computers, etc.

2. Signal Processing
Signal processing includes all electronics that in some way alter the source signal to optimize it for its ultimate destination, whether it's for presentation, recording, or both.

3. Signal distribution
Signal distribution includes the methods used to transmit or move the signal through the chain. These technologies include cabling, wireless systems, switchers, routers, etc.

4. Presentation
Presentation systems are the actual playback devices from which people consume the audio and/or visual content. For audio systems, this includes audio amplifiers and loudspeakers. For visual systems, this includes video monitors and displays, projectors, screens, etc.

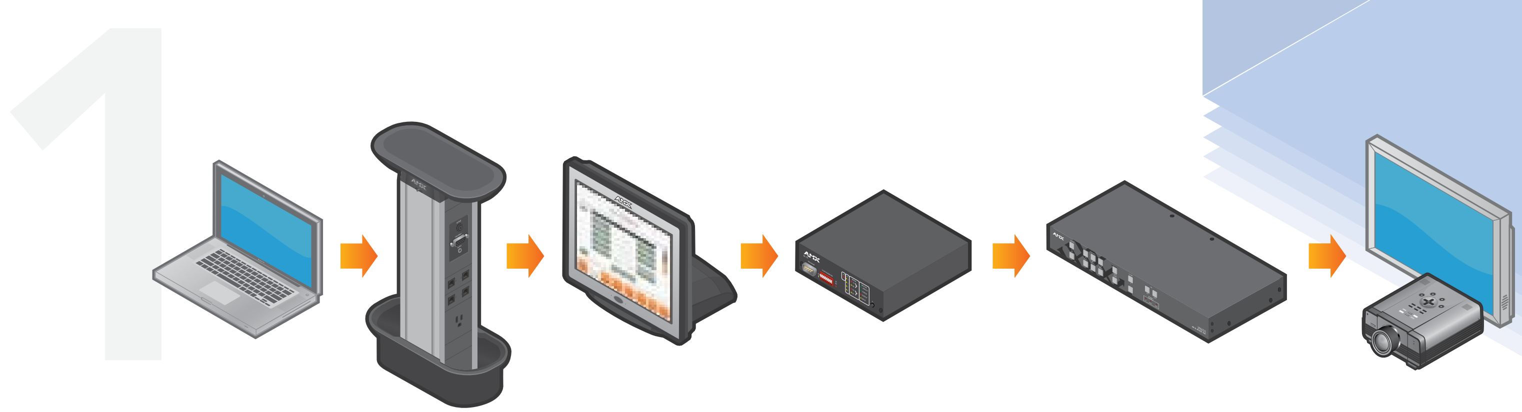
5. Recording and Storage
With digital media, capturing and archiving nearly any type of AV event is simple.

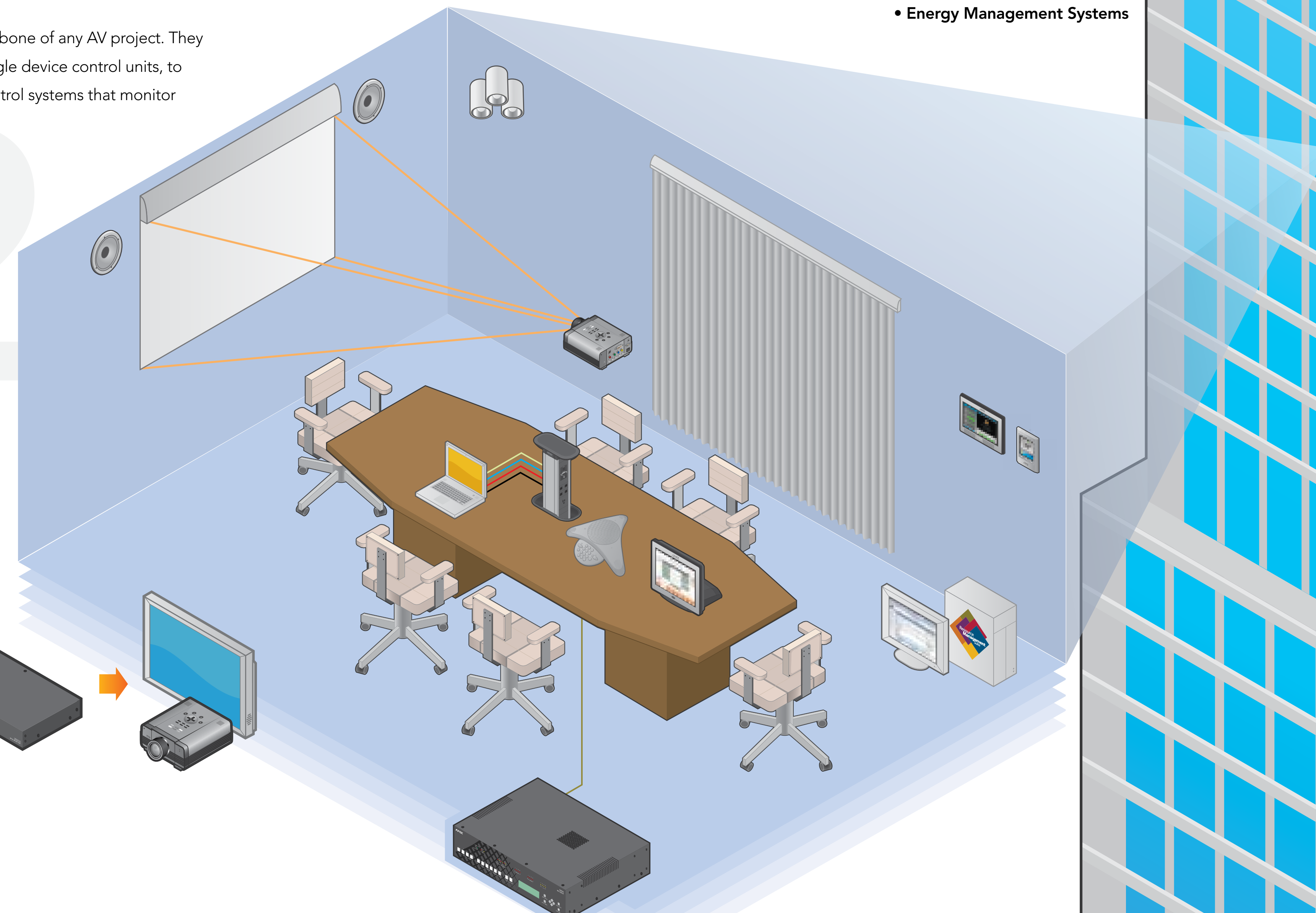
6. Control
Control systems are the backbone of any AV project. They range in complexity from single device control units, to building or campus-wide control systems that monitor and control multiple subsystems. Increasingly, AV control systems interface with other systems such as lighting, HVAC, and security as part of an overall building technology management strategy.

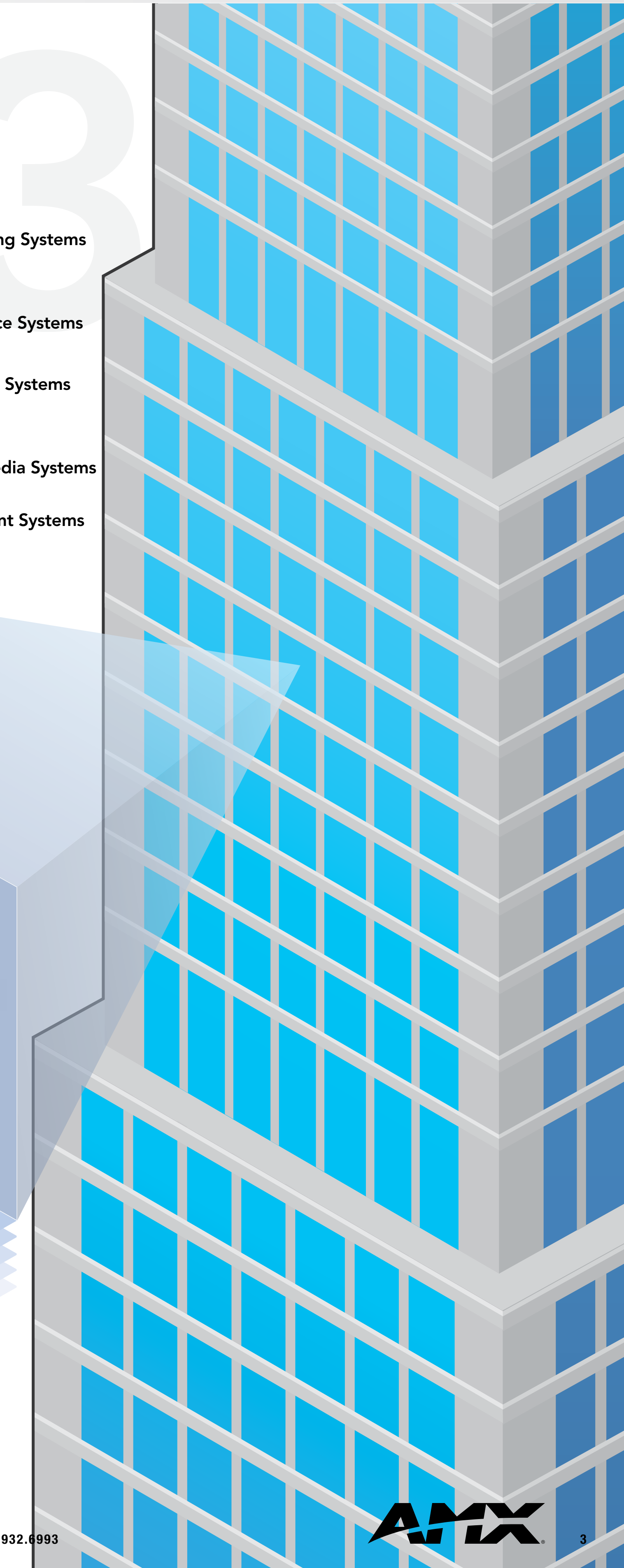
In general, AV systems are comprised of Audio and Video technologies and the means by which AV signals are distributed and controlled.

BUILDING SYSTEMS

- **Power Systems**
- **Air Handling/Cooling Systems (HVAC)**
- **Fire Systems**
- **Security/Surveillance Systems**
- **Lighting/Shades**
- **Entry Management Systems**
- **Audio Systems (PA/Environmental)**
- **Digital Signage/Media Systems (PA/Entertainment)**
- **Energy Management Systems**







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AMX GUIDE TO AV SYSTEMS PART 3

II. Designing Systems with Audio

A. AUDIO SYSTEM TYPES

Audio systems can be classified into two basic types:

- Program systems
- Sound Reinforcement systems

Program systems contain no microphones and are used strictly for the reproduction of recorded or transmitted audio. Program audio can be purely an audio event or audio associated with some sort of presentation (video or live).

Sound reinforcement systems typically amplify an audio event within the same space. These can be music reinforcement systems (e.g. live concert) or speech reinforcement systems, and sometimes both.

For the purpose of this resource, sound reinforcement design considerations will focus on speech reinforcement, though the same principles apply also to music. Music reinforcement typically involves many more open microphones, a wider sound stage, and, more importantly, an extended system frequency response.

In the real world, a single audio system may be required to perform both tasks of program and reinforcement. Additionally, many types of loudspeakers and methods of placing them in a venue are available.

The type of audio content determines the bandwidth requirements of the system and the type of loudspeakers. The three main categories of audio material are:

- Vocal range – which use limited bandwidth loudspeakers primarily for speech – 90 Hz to 16 kHz.
- Full range – requires loudspeakers that cover most of the frequency range of both music and speech – 70 Hz to 16 kHz.
- Extended range – use full range as well as separate bass loudspeakers (or subwoofers) for an extended bandwidth – 40 Hz (and below) to 16 kHz.

HELPFUL HINT

The AMX Professional Services Group Is Always Available To Support Your Projects With:

- System and User Interface Design
- Custom Programming
- Project Management

To overcome the ever-evolving challenges of today's sophisticated control system and network based integration, you need the right team in place. Call on the AMX Professional Services Group (PSG) to expand the capacity of your business. Our specialized skill sets – system and user interface design, programming, documentation, on-site services and technical support - will assist you in completing more projects, faster than before, and with the same high level of quality your customers demand.

Core Competencies

- Control system design services
- Project Management
- User Interface Development
- Custom Programming
- On premise control system Installation and testing

Services Bandwidth

- Six full time designers
- Twelve full time project services resources
- Established PSG trusted partner's for resource augmentation
- Valued Independent Programmer Program on call

For more information and to learn about the wide range of support that AMX Pro Services can offer, contact them by visiting: **www.amx.com/techcenter/requestInfo.asp** to answer a few questions about the scope of your project. You can also request an online quote for your next project directly by visiting: **www.amx.com/techcenter/requestInfo.asp**.

B. PROGRAM AUDIO DESIGN CONSIDERATIONS

The main requirements for a program audio system are that it is loud enough for the particular application, and that it is intelligible. Intelligibility is generally considered a relevant parameter for speech or spoken word, but for music-only program material, a similar requirement for "clarity" is important. It's important that musical instruments are accurately reproduced.

A CLOSER LOOK

Sound Pressure Level (SPL) is a logarithmic measure of the rms sound pressure of a sound relative to a reference value. It is measured in decibels (dB) above a standard reference level.

Contributing factors to whether the system is loud enough are:

- Achieving the target sound pressure level (SPL) with the desired coverage uniformity (typically ±3 dB) throughout the listening area
- Meeting the required frequency response
- Adequate electrical signal-to-noise ratio (SNR); usually greater than 60 dB

To assess whether a given loudspeaker system is capable of delivering adequate SPL, audio system designers and consultants rely heavily on published loudspeaker specifications like power handling and sensitivity.

Factors that contribute to intelligibility are:

A CLOSER LOOK

Signal-to-Noise Ratio (SNR) compares the level of a desired signal (such as music) to the level of background noise. The higher the ratio, the less obtrusive the background noise is.

- Achieving at least 25 dB signal-to-noise ratio (room noise)
- Meeting the required frequency response
- No perceived distortion (less than 1% total harmonic distortion)
- Appropriate direct-to-reverberant sound ratios for the program material

Good speech intelligibility is the result of correct component selection, system design, and room acoustics.

1. Loudspeaker Sensitivity

Loudspeakers are rated by the manufacturer to provide the designer with a performance criterion known as sensitivity. It is expressed as SPL measured directly on axis at a specified distance from the loudspeaker and with a given power input of pink noise band-limited for the system under test. If the loudspeaker is a subwoofer, it is tested only on the very low frequencies. However, if the loudspeaker is a full-range system, it is tested over a much wider frequency range. The standard distance usually is 1 m (3.3 ft) and the power input usually is 2.83 volts, or 1 watt (W) for an 8 ohm loudspeaker.

With the manufacturer's sensitivity rating for a given loudspeaker measured at 1 m (3.3 ft) with a 2.83 volts input, the SPL at a given distance can be calculated using the inverse square law (assuming outdoors, no reverberation):

$$L_{p1} = L_p - 20\log(D_1/D)$$

Where:

- L_{p1} is the SPL at the distant listening position
- L_p is the sensitivity rating (at one meter)
- D is some reference distance where SPL is known (eg., one meter)
- D_1 is the distant listening position where you want to know the level (in meters)

2. Critical Distance

In indoor applications, the critical distance (DC) is defined as a distance from the sound source at which the direct and reverberant fields have the same SPL.

The room space between the source and the critical distance is known as the free (or "direct") field and that which lies beyond is called the reverberant field. There is not a sharp line of demarcation between the two fields, and there is an area of transition lying between them.

Speech intelligibility begins to suffer beyond critical distance, since speech sounds are increasingly obscured by reverberation as you move farther from the source. Critical distance is affected by a loudspeaker characteristic known as "directivity" (or "Q"), and the acoustical nature of the room in

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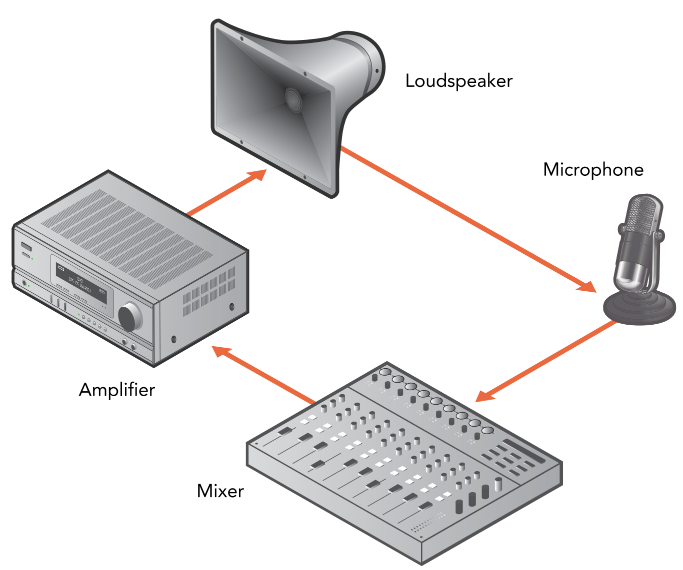
which it is used. A directivity specification is usually provided by the loudspeaker manufacturer. Critical distance can be calculated by the following formula:

$$D_C = 0.14\sqrt{QS\alpha}$$

Where Q is the directivity factor of the loudspeaker
S is the surface area in the room α is the average absorption coefficient of materials in the room

C. SPEECH REINFORCEMENT DESIGN CONSIDERATIONS

The main requirements for a speech reinforcement system are very similar to those for program audio, but in addition to being loud enough and intelligible, it must also be stable; not prone to feedback. Feedback occurs whenever the sound entering a microphone is reproduced by a loudspeaker, picked up by the microphone, and re-amplified again and again. The familiar howl of feedback is an oscillation that is triggered by sound entering the microphone.



A well-designed speech reinforcement system should provide audience members in the least favored listening positions (i.e., the farthest from the talker) with the same listening experience as the audience members closer to the talker.

D. LOUDSPEAKER SYSTEM DESIGN OPTIONS

The two main options for loudspeaker system design are:

- Point source (or central cluster)
- Distributed systems

The point source is a single loudspeaker component (or group of components) gathered together in one location and aimed at the audience. This can be one or more prepackaged cabinets or it can be several discrete components selected for their frequency response and coverage patterns.

The distributed system uses the opposite approach. Instead of having all energy emanating from a signal location, the loudspeaker components are brought closer to the listeners. The effect is to have the loudspeakers distributed throughout the listening area (usually ceiling-mounted for speech systems) each with a much lower SPL output than a point source system would require to cover the same area.

1. Point Source Loudspeaker Placement

A point source is often the preferred method of covering a large area because it can more accurately locate the loudspeaker with the source of the sound (talker, musician, etc.). However, adequate ceiling height is necessary to use this method. The cluster is generally placed above the front of a stage or performing area. Elevating the loudspeaker group reduces the difference in distances from the loudspeaker to the listeners for the nearest and farthest listeners. Since our ears are less sensitive to vertical elevation of sound sources, the sound will appear to be coming from the source on the stage even though the cluster may be elevated significantly higher than the actual source – as long as the loudspeaker is roughly in the same vertical plane.

Loudspeaker elements are carefully selected during the design process for their coverage pattern and frequency response. They are then carefully aimed during installation to ensure proper coverage.

Some consideration should be given for how high the cluster can be mounted without adversely affecting those seated close to the original source. Generally, if the loudspeakers are higher than 45 feet above the source, the listeners who can hear direct sound (from the stage or talker) as well as the loudspeakers may hear an echo.

When considering a central cluster system for an environment, a general rule is that the distance from the loudspeaker to the farthest listener should not exceed four times the distance from loudspeaker to the microphone.

2. Distributed System Layouts

A distributed loudspeaker system uses multiple loudspeakers separated by some distance from each other. Flush-mounted ceiling mounted loudspeakers in a conference room are a common example of a distributed system layout.

A layout begins with determining how much area each of the selected loudspeakers will need to cover. The loudspeaker polar pattern directivity information provided by the manufacturer is used to create an elevation section view of a loudspeaker and the pattern. This allows the creation of the circular area that each unit will cover.

Two measurements must be quickly determined:
• Loudspeaker coverage angle
• Listener ear level

By referencing the polar pattern information, the designer can find the angle at which the target highest frequency is 6 dB below the on-axis level. As an example, this might be at 40 degrees off axis, which would provide 80 degrees of coverage at that frequency.

Next, the listening ear height must be determined, particularly the highest level. If the design is a multipurpose room where the audience may be standing for some presentations and seated for others, the design should be made for the standing audience. The size of the coverage circle with the same loudspeaker can be dramatically different with a low ceiling and a standing audience as compared to a higher ceiling and a seated one.

Speech Reinforcement Distributed Loudspeakers

With a public address (PA) or paging system, the listeners do not necessarily see the talker; many times they are just listening to announcements. In speech reinforcement situations, the listeners see the talker and are able to hear the talker's remarks with natural sound, regardless of their listening distance. To achieve uniform sound coverage, "hot spots" (where sound is overly concentrated) must be avoided. This requires that an appropriate number of loudspeakers located overhead be used so that circular patterns of sound overlap at the hearing level.

For optimal distribution of the full range of important frequencies, overlap of as much as 50% in adjacent loudspeaker distribution patterns is recommended. The lower the ceiling, the more loudspeakers are required; higher ceilings may require fewer.

Another consideration with distributed loudspeakers in speech reinforcement is the use of "mix/minus", which depends on dividing the room into "zones". The zones are made up of both microphone and loudspeaker groups. A microphone group is a mix of the outputs from the individual microphones within a zone. Each loudspeaker group has it own amplifier to allow selective audio sources to be played within a zone. Grouping microphones within a zone allows a microphone group to be played at selected loudspeaker groups. Zoning allows microphones within a zone to be played on loudspeakers of other zones while disabling them from being played within their own zone. By keeping open microphones out of the signal feeding a loudspeaker in the vicinity of these microphones, PAG can be increased. This mix/minus method is often used in conferencing systems.

Localization

An important consideration with both program and speech systems is localization. Localization is important as the listener's attention is drawn in the direction of the first audio heard. In the case of a presenter, it is important for the audio to appear to the listener as though it were coming from the stage as opposed to coming from some loudspeakers above the listener's head. Similarly, a video presentation should have the accompanying audio appear to come from the display area.

A well-designed speech reinforcement system should provide audience members in the least favored listening positions (i.e., the farthest from the talker) with the same listening experience as the audience members closer to the talker.

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Audioconferencing systems are a special case of sound reinforcement where two physically separated groups of people (local and remote talkers) are able to communicate with fast interaction, allowing both parties to speak and be heard at the same time, as if physically in the same room.

The Haas (or "precedence") effect is a psychoacoustic phenomenon that describes the effect of time arrival on our perception of sound location. When the same sound emanates from two different sources (for example, loudspeakers), one farther away than the other from the listener, the sound will actually be perceived as coming from the source that arrives first at the listener's ear - normally the nearer source. Electronically delaying the arrival of sound from the nearer source can make the apparent location shift toward the farther source. This only works up to about 25 milliseconds of delay; a longer delay will cause the listener to hear two separate sources with a slight "echo".

The Haas effect is used to the advantage of the audio system designer by delaying the signal to the loudspeakers closer to the listener. With ceiling delay loudspeakers and the main cluster in an auditorium, the delay can be very slight (approximately 20 milliseconds), allowing the secondary signal to be increased up to 10 dB while still retaining correct localization.

Overhead Paging Systems

Overhead paging systems allow users to broadcast voice messages or audio programming across a network of loudspeakers. In many systems, loudspeakers and horns may be accessed individually, in logical groups (i.e., zones), or all at once (i.e., all call). This type of system may have the capability to provide background music, time tones, night ringing, alerting tones, one way and/or talkback paging, to any or all zones in the system. A PA system can be accessed through a telephone system or may have a dedicated microphone or console.

3. Loudspeaker Types and Selection

Ceiling versus wall mounted loudspeakers

For most workplace or classroom environments, flush mounting loudspeakers into the ceiling is the preferred installation method. Ceiling mounting is less visually intrusive and less prone to theft. Using plenum-rated cabling, ceiling loudspeakers can be mounted in ceiling tiles in the plenum space above a drop-tile ceiling.

In areas with less than 70 dB ambient noise level, the distance between ceiling loudspeakers in a row should be approximately twice the ceiling height. In areas with an ambient noise level greater than 70 dB, the distance between loudspeakers should be decreased.

In some installations, ceiling mounted loudspeakers are impractical due to premises structures that prevent the loudspeakers from being properly mounted. In these installations, using wall mounted loudspeakers may be necessary.

For appropriate sound coverage, wall mounted loudspeakers should be mounted 2.4 m (8 ft) to 3.7 m (12 ft) above the floor. Wall mounted loudspeakers should not be directed toward each other.

Horn Loudspeakers

Horn-type loudspeakers have a very directional coverage pattern and are appropriate for use in environments with more than 70 dB of noise. The loudspeakers may be installed indoors or outdoors, or where larger areas must be covered by each loudspeaker. Horns commonly have a higher power output rating than ceiling-mounted loudspeakers.

Feedback

As discussed earlier, feedback is an unwanted oscillation or tone that quickly grows in loudness. To protect against feedback in paging systems, do not locate ceiling loudspeakers directly above telephone sets or external microphones, or point horns toward telephone handsets used for paging. In applications that require paging from a telephone near a loudspeaker or horn, a digital store and forward message unit that records the page then broadcasts it after the user disconnects from the system, is usually required to completely eliminate feedback. This is a system accessory that is installed with the headend equipment.

Constant Voltage System Design

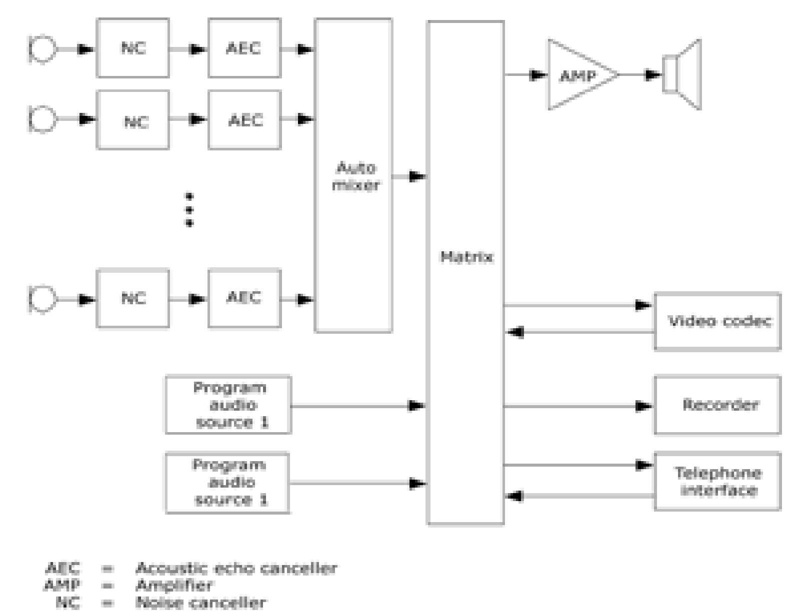
A constant voltage system uses loudspeakers with transformers where all transformers on the line have the same voltage applied to them. Individual taps selected on the transformers can then supply differing amounts of power to the individual loudspeakers, thus raising or lowering the volume on each loudspeaker.

The most common constant voltage system is a 70 V system where the maximum voltage out of the amplifier at full power is 70 volts. There are also 25 V systems; some countries use 100 V and 140 V systems. In a 70 V distributed system, a 5 Watt signal can be transmitted over 5,000 feet on 20 gauge cable with a power loss of only 10%.

E. AUDIOCONFERENCING SYSTEMS

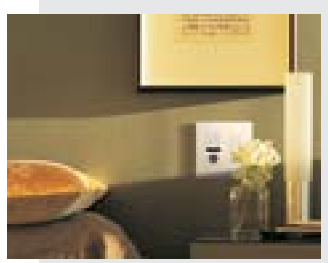
Audioconferencing systems are a special case of sound reinforcement where two physically separated groups of people (local and remote talkers) are able to communicate with fast interaction, allowing both parties to speak and be heard at the same time, as if physically in the same room.

This diagram shows a typical solution for audioconferencing (or audio for videoconferencing) that consists of:



- Local microphones and loudspeakers
- An acoustic echo canceller (AEC) and noise canceller
- Automatic microphone mixers
- Matrix mixers
- Telephony interfaces
- Video codecs (optional)
- Program audio (e.g., compact discs, DVDs, or videotapes)

AMX Distributed Audio Speakers



The Best-Looking Sound on the Market

Listening to music and audio through AMX speakers is like stepping into the perfect acoustical dream. Music surrounds you with clarity and brilliance from every direction. Whether your application requires wall-mounted or ceiling-mounted speakers, you can be sure that every musical note will sound just the way the artist originally intended it.

SPK-W SPK-C SPK-C-DT SPK-EL

AMX Speakers are available in four configurations to support a wide range of applications including: SPK-W wall-mounted speakers, SPK-C ceiling-mounted speakers, SPK-C-DT ceiling-mounted speakers with dual tweeters to offer stereo reproduction via a single speaker, which is ideal for bathrooms and other small rooms. SPK-EL is our flagship speaker line and is available in 6.5" and 8" diameters. All AMX speakers feature a unique pivoting tweeter assembly that creates directionality for the user and a more lifelike soundstage.

Learn more about AMX Distributed Audio Speakers by visiting the Distributed Audio section of AMX.com at: www.amx.com/products/categoryDistributedAudio.asp

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This type of configuration would be installed in each of the rooms conferenced together. One of the audioconferencing challenges is that the loudspeaker audio is not only heard by the local participants, but also by the local microphones. An acoustic echo canceller (AEC) is required to minimize this problem. Without an AEC, the loudspeaker audio is sent back to the remote participants, who as a result hear a delayed echo of their voice.

Other challenges in audioconferencing arise from microphone selection and placement, loudspeaker placement, and balance between the architectural and aesthetic design of the room on the one hand and the audio quality requirements on the other. Compromising audio quality in favor of aesthetics can result in reducing the quality and intelligibility of meetings.

Large Room Environments

The typical room environment introduces ambient noise from heating, ventilation, and air conditioning (HVAC) systems , outside noise, projectors, and computers), in-room reflections of the audio (i.e., multipath audio), and constraints on microphone and loudspeaker positioning.

Conference rooms should be designed to a noise criteria (NC) 30 standard. An NC 30 rating corresponds to approximately 40 decibels A-weighted (dBA) SPL of background noise, leaving about 30 dB of SNR for normal talkers (70 to 77 dB SPL at 1 m [3.3 ft]). A lower NC rating further improves the quality of the audioconferencing system by increasing intelligibility and reducing listener fatigue; however, it also increases the overall cost of the room build-out. For an audio system to have good intelligibility, the signals heard by the local talker should be at least 25 dB above the background noise level.

The surfaces in the room including walls, ceiling, and furniture, affect the quality of the conferencing system. Hard surfaces increase the amount of reflections in the room, causing multiple versions of a local talker's audio signal to be heard by the microphones and for multiple versions of the remote talker's signal to be heard in the local room.

Often, the conference room location is selected due to the view or convenient location. However, the location of a potential conference room should be evaluated to ensure it is not directly underneath a building's HVAC units or near other environmental noise sources such as shipping rooms, loading docks, copy rooms, network operations centers, and other such rooms, to ensure that the outside noise sources are minimized.

Microphones in conferencing applications

The types and location of microphones have a large impact on audioconferencing quality. Microphones translate the acoustic signals from the local talkers into electrical signals that can be processed and sent to remote participants.

Microphones may be omnidirectional or directional (unidirectional) in their pickup pattern depending on how the microphone element is physically mounted within the microphone enclosure.

Omnidirectional microphones pick up sounds from all directions around a microphone (i.e., a 360-degree pick up pattern), while directional microphones are designed to pick up signals in the pickup zone of the microphone and to reject signals outside the pick up zone.

Directional microphones are most often used in conferencing systems due to the:

- Rejection of the background noise.
- Reduction of reverberation/multipath.
- Rejection of the audio from the loudspeakers.

Directional microphones also increase the gain-before-feedback in sound reinforcement applications due to the increased rejection of the loudspeaker signal when it is directed toward the rear of the directional microphone.

Boundary microphones use the surface on which the microphone is installed and the proximity of the microphone element to the boundary surface to minimize the amount of phase cancellation that occurs when audio strikes the boundary. The resulting microphone configuration has a higher sensitivity. The pickup pattern of the microphone becomes halfspherical as the sounds below the boundary are not picked up. For example, if an omnidirectional microphone is placed on a boundary, the pattern becomes hemispherical.

In many boardrooms, gooseneck microphones are used and distributed around the table with one microphone per participant. Each of these microphones has a neck that takes the microphone off the table and brings it closer to the talker's mouth. In addition, these microphones usually have a directional pattern to further improve the rejection of the ambient noise.

In-Room Reinforcement

Sound reinforcement may be desirable if the listeners cannot easily hear the other talkers in the room. The objective of this type of sound reinforcement is to augment the local speaker's voice so that local listeners still have the perception the audio is originating from the local talker. Voice reinforcement or enhancement in a conferencing application is supposed to be just that – reinforcing the level of the talker to improve intelligibility. In a properly configured and calibrated mix-minus system, the best way to find out if the system is functioning properly is to disable it and see if the local participants notice the resulting loss of intelligibility. If they do, then the system is set correctly.

F. SOUND MASKING SYSTEMS

Sound masking systems are designed to provide a masking noise in spaces where conversation may be distracting or where confidentiality of conversations is important. Many factors can affect the recommendation for the use of a sound masking system or the successful implementation of a sound masking system.

Companies have utilized the open office plan for years. Open offices offer a lower cost alternative to the traditional closed offices. The drawback of open offices can be the lack of speech privacy. Sound masking can help alleviate some speech privacy problems with an understanding of its capabilities and potential drawbacks. In cases where an extremely high degree of privacy is required or a challenging architectural construction is encountered, the services of an acoustical consultant should be considered.

Factors Affecting Sound Masking Systems

The major factors that affect a sound masking system include the office furniture orientation and absorption, rating, and noise reduction coefficient (NRC) of the ceiling materials. The ceiling is typically the largest contributor to the reduction of noise levels in the open office. An office with a drywall ceiling would not be a good candidate for a sound masking system since its absorption rating is very low.

The best sound masking systems are designed to provide a steady even masking level throughout the space. Therefore, unducted return air grates pose a problem because they can allow high levels of masking noise into the space. These need to be treated as part of the design process.

Another factor that affects the acoustics of the space and hence the effectiveness of the system are the wall finishes. Direct reflections into the workspace from hard wall surfaces like drywall or large windows should be avoided. If the furniture layout cannot be changed, the hard surface should to be treated.

Before any masking noise is added the space, it's best to begin with as quiet a space as possible. The measure of this noise level is noise criteria (NC), which is a single number index derived from a family of curves that defines maximum allowable noise in a given space. To have a masking system acceptable to those working in the space the NC should not be higher than 35. For new spaces, the NC can be predicted but should be field verified by an acoustics professional.

Sound Masking System Components

The basic electronics in a sound masking system are always the same but may have different configurations. The components include:

- Masking noise generator
- Equalizer
- Amplifier
- Loudspeaker

Systems vary in size from self-contained masking units with all of the components to large systems with racks of amplifiers and associated equipment. Complex systems can incorporate paging and background music.

Sound masking systems are designed to provide a masking noise in spaces where conversation may be distracting or where confidentiality of conversations is important. Many factors can affect the recommendation for the use of a sound masking system or the successful implementation of a sound masking system.

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III. Designing Systems with Video

The single most important trend in the AV world today is undoubtedly video. Between the popularity of video sharing Web sites, the explosion of Digital Video Recorders (DVR) in the home and the industry-wide transition to digital video in camcorders, the use of video in our everyday lives has become a priority. But, like most emerging technologies, video can be a huge addition to any AV/IT solution. Understanding this media and the fundamentals can help keep your workload from exploding as well.

For professional and commercial applications (as opposed to home/residential uses), a key factor in choosing display technologies is character legibility, or the ease with which text can be read. Other technical factors that need to be considered with display selection include:

- Contrast ratio
- Display resolution

Contrast Ratio is a measurement of the difference in brightness between the whitest white and the darkest black within an image. It's affected by the ambient light conditions at the image location. Display resolution of the display device, measured as horizontal and vertical pixel counts, determines the pixel density of the display. The resolution of the display device is very significant since the device should be able to match or at least approach the resolution of the source image. For example, an incorrect match of a lower resolution display as compared to the source signal can result in unacceptable image where significant image pixels cannot be generated by the display.

A. TYPES OF VISUAL DISPLAY SYSTEMS

1. Direct-View Displays

Direct-view displays include:

- Cathode ray tube (CRT) monitors and televisions
- Liquid crystal displays (LCD) and gas plasma flat panels
- Light-emitting diode (LED) and organic light emitting displays (OLED)

HELPFUL HINT

The AMX Professional Services Group Is Always Available To Support Your Projects With:

- System and User Interface Design
- Custom Programming
- Project Management

To overcome the ever-evolving challenges of today's sophisticated control system and network based integration, you need the right team in place. Call on the AMX Professional Services Group (PSG) to expand the capacity of your business. Our specialized skill sets – system and user interface design, programming, documentation, on-site services and technical support - will assist you in completing more projects, faster than before, and with the same high level of quality your customers demand.

Core Competencies

- Control system design services
- Project Management
- User Interface Development
- Custom Programming
- On premise control system Installation and testing

Services Bandwidth

- Six full time designers
- Twelve full time project services resources
- Established PSG trusted partner's for resource augmentation
- Valued Independent Programmer Program on call

For more information and to learn about the wide range of support that AMX Pro Services can offer, contact them by visiting: www.amx.com/techcenter/requestInfo.asp to answer a few questions about the scope of your project. You can also request an online quote for your next project directly by visiting: www.amx.com/techcenter/requestInfo.asp.

Direct-view displays are integrated devices with the image formation technology and the viewing surface combined in the same unit. With the exception of LED and OLED devices, potential image sizes are relatively smaller than projected images and typically intended for small group or individual viewing.

Cathode Ray Tube (CRT) Displays

CRT displays have been the mainstay display technology and the basis for video signal format since their introduction in the 1940s. CRT displays ranging in sizes from 19 inches 40 inches diagonal and larger, have been ubiquitous in homes and desktops. While many consider the direct-view CRT displays to be on their way out of residential and corporate meeting facility uses, the CRT display remains the quality check display standard for broadcast applications.

Flat Panel Displays

The most common flat panel displays are LCD and plasma display panels (PDP). Flat panel displays offer great improvement in light output and contrast ratio, and consume far less power than CRT displays.

Liquid Crystal Displays (LCD)

LCD devices are generally considered more robust in terms of long-term performance and, in particular, resistance to image retention ("burn-in"). Another advantage is the ability to re-lamp the LCD display for greater product longevity. The most common disadvantages have been the lack of a true black level which can affect the color rendition, and limited off-axis viewing angles.

LCD displays are available in a very wide range of sizes from 1.5 inches to 82 inches diagonal, and are used for:

- Touch screen control panels
- Video camera monitors
- Program and preview monitors
- Digital signage and wayfinding
- Conference room displays
- Video displays in nonstop applications
- Small-format confidence monitors
- Computer displays

Plasma Displays

Plasma displays are capable of creating a more correct black level and the color rendition is considered superior compared to those of LCD displays. However, PDPs tend to suffer from image retention if a static image is left on the screen for an extended period of time. Also, PDPs are not recommended for most nonstop operations.

PDPs are available only in larger formats and, therefore, applications are more limited.

PDP devices are most commonly used in:

- Conference and meeting rooms
- Videoconference systems
- Digital signage and wayfinding
- Applications not requiring nonstop operation

Light-Emitting Diode (LED) Displays

LED displays may be the fastest developing technology in the display industry. LEDs are very bright discrete light sources available in monochrome through four-color displays.

The extreme brightness of LEDs support outdoor applications even under daylight conditions. They are commonly used for vote tally boards or information displays in transportation systems. LEDs are less suitable for short viewing distance applications, especially for computer graphic or imagery applications.

LED displays are built in small modules, ranging from 4x4 inches to 10x10 inches, and combine in various configurations to create exceptionally large images, even curvilinear displays. With the wide range of applications and increased resolution, the applications for LED displays are expected to increase.

Organic Light-Emitting Diode (OLED) Displays

OLED is a light-emitting diode (LED) whose emissive electroluminescent layer is composed of a film of organic compounds. The layer usually contains a polymer substance that allows suitable organic compounds to be deposited. They are deposited in rows and columns onto a flat carrier by a simple "printing" process. The resulting matrix of pixels can emit light of different colors.

A significant advantage of OLED displays over traditional liquid crystal displays (LCDs) is that OLEDs do not require a backlight to function. Thus, they can display deep black levels, draw far less power, and can be much thinner and lighter than an LCD panel. OLED displays also naturally achieve much higher contrast ratio than LCD monitors.

2. Projection Displays

Projection displays have a discrete projection device and a discrete image surface (screen). Projection display solutions fall into two general categories:

- Front projection
- Rear projection

Video displays are a significant element of any AV system. The display function of AV systems ranges from simple single image systems to complex multi-image systems.

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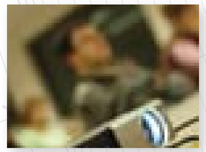

Front Projection

Front projection systems are the most common design solution found today. They combine an efficient use of space and a relatively unobtrusive presence as a table-top or ceiling-mounted device.

Front projection solutions are common for medium- to large-size conference rooms, classrooms, and meetings spaces, typically housing 20 to 30 persons (or more) and having standard office environment ceiling heights of 2.4 meters (8 feet) to 2.74 meters (9 feet). Designs in such spaces vary only by screen location.

In larger spaces, the following factors are considered in front projection design:

- Projector location – In larger venues, larger screen sizes are required due to viewing distances. Larger screen areas require brighter video projectors and the location of the projector can be of concern. If the vertical angle of projection to the screen is less than 30 degrees, the projector's bright light source will impact the talker's ability to see their audience.
- Presenter's location – The presenter's or the lectern's location should not block any portion of the optical path to the screen.
- Screen height – In very large venues, maintaining a minimum image bottom at 1.83 m (6 feet) allows the presenter a path in front of the screen that does not block the projected image.
- Aesthetics – Concern for aesthetics enters into the coordination of architecture and equipment placement. Motorized lifts are typically used to conceal projectors above the finished ceiling when not is use; however, if the operating position for this project is within a bulkhead and has a clear optical path to the screen, a lift mechanism allows for projector service access.
- Acoustics – Larger projectors generate greater operation noise and placement concerns must address the projector's acoustic isolation from the audience. In larger venues, this usually involves a projection booth design, a projector concealed in a bulkhead or, in some examples, a complete projector acoustic enclosure.
- Lenses – For most projectors designed for larger venues, a selection of different lenses for different throw distance applications is available.

Of important concern for front projection screens are the screen materials. With the advent of solid-state projectors and limited ability to generate correct black levels, a variety of neutral gray or black-stripped front projection surfaces have been developed. While such screens improve contrast and black level quality with projected video images, the white background of data images may appear grayed or muted.

Pro Services Brochure
The Professional Services Group is our in-house, full-service specialized support group that can assist with a variety of installation needs such as system and user interface design, programming, documentation, on-site services and technical support.

Screen flatness is of great importance, particularly for maintaining image flatness from edge to edge. To this end, fixed tensioned screens serve very well but are not always practical. Tab tensioned screens are common, but newly emerging screen fabrics include internal tension elements.

Rear Projection

Rear projection and front projection systems differ in several elements aside from screen type and projector location.

Rear projection solutions offer a different character to the space and afford greater latitude in architectural features. For all spaces, with the exception of very large stadium or auditorium venues, rear projection is always an option that should deserve some consideration. Some considerations for selecting rear versus front projection are shown in the following table:

	REAR PROJECTION	FRONT PROJECTION
PROS	Projector is located out of the audience space-acoustic isolation	Front projection efficiently uses the room space
PROS	Projector is located out of the audience space-minimizes aesthetic impact	Front projection screens can be made to nearly any size (with scams)
PROS	Talker standing in front of the image does not cast a shadow on the image	Fully functional with laser pointers and interactive software/writing board solutions
PROS	Allows for a higher ambient light level in the audience space as the rear screen does not reflect ambient light	
CONS	Occupies valuable floor space in the building	Projector is located in the audience space and can be a negative architectural element
CONS	Image size is limited by available rear projection screen material sizes	Projector is located in the audience space and can be a negative architectural element
CONS	Limited application for laser pointers or interactive screen elements	Talker standing in front of the displayed casts a shadow
CONS		Screen reflects ambient light equally with direct light and image appears washed out in higher ambient light conditions

Video displays are a significant element of any AV system. The display function of AV systems ranges from simple single image systems to complex multi-image systems.

Projector Selection

Projector and screen material selection must be made in tandem. Other than diffusion surfaces and matte projection screen surfaces, any screen that reflects or redirects light is affected by how the light is projected onto the screen. For example, a number of the LCD projectors use polarized light as the means to achieve brightness whereas a lenticular-screen surface attempts to redirect polarized light in orthogonal direction with poor image result.

Similar mismatches in the dot pitch of the screen and the pixel resolution of the projector can result in imprecise alignment of projected pixel and the screen surface black backing or stripping, with some light lost to the black and undesirable coloration occurring on the display image.

Rear Projection Mirror Assemblies

Rear projection mirror assemblies are very common in rear projection installations. The primary benefit is reduced floor space requirements, since the image takes a vertical path before exiting the screen on the audience side. When using large-size rear projection, mirror quality is extremely important because any striations on the mirror surface are reflected onto the projected image.

B. VIDEOCONFERENCING SYSTEMS

Videoconferencing systems are becoming more common in especially in corporate environments, educational facilities, and government offices. There is no question that the investment in a high quality videoconference system can provide ROI benefits as long as they are simple to operate and provide a high quality experience for participants.

Videoconference systems also present some unique technical challenges, including:

- The need for controlled lighting, different from standard office light
- Integration of audio conferencing requirements into a video room
- Cameras and displays' point of view

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Many videoconference system manufacturers include one of many PTZ camera types. The differences between the cameras are usually not obvious. PTZ cameras vary in the speed and smoothness of the pan and tilt. Mechanical noise, physical size, electrical connections, and mounting locations are other factors to consider.

Room Setup

A videoconference room should be larger than a similarly populated basic meeting room. The near-end attendees have to be spaced apart so the far-end viewers can more easily see them.

The physical location of this type of conference room should be driven by the needs of the organization and some of the unique videoconferencing criteria. The videoconference room must be located and furnished in a way that allows uninterruptible presentations and conversations. The room should be located away from windows and exterior walls. Controlling the light entering the space is critical to the video quality rendered from the space. Exterior walls allow sirens, truck noises, and other distracting sounds into the space, so you should consider an interior room with ready access to the public spaces in the building. In a videoconference space, the heat load can exceed the capabilities of typical HVAC systems, so it's important to plan for the excess heat load, especially if the conference equipment is planned to remain constantly powered. An auxiliary local cooling circuit should be made available for night and weekend temperature control.

Building and Infrastructure

Local building codes dictate the rules for wall construction. The room should be built with low noise criteria (NC) as a goal. NC 30 guidelines are recommended for videoconference room needs. Wall construction techniques may include a double layer of gypsum board as the interior wall, with offset stud internals and deck-to-deck coverage.

As with any other infrastructure project, attention should be given to access points (APs), cable pulls, and conduit runs. A videoconference room has much more cabling and signal routing than a standard environment, so preplanning is critical. Often, cables are premanufactured with over-molded ends attached. Some of these cables are not conducive to field termination, so oversized conduit runs may be required.

Furniture Layout

One of the objectives of videoconference room design is to make the space amenable to an interactive event and encourage a rapport with the remote connection while maintaining the sense of connection between the people in the local videoconference room. Often, the primary consideration is given to the remote connection, ignoring the local interactions. This may lead to extremely specific, immersive rooms where a video display might be located at the edge of a conference table and special mirrors are used to enable eye contact. These system designs work well for their intended purpose, a face-to-face electronic meeting, but not with larger numbers of participants. Another downside is if the remote site does not use the same technology or video equipment orientation, the perspectives are distorted and the experience may be degraded.

Unless immersive design is specifically required, a trapezoidal table with the wide-end closest to the video display nearly always provides the most satisfactory solution. Variations include the horseshoe (or U), the oval-egg, and V designs. In general, it's important to avoid the traditional long, narrow, boardroom table in any video-enabled space. From the view at the far-end, the scene will always appear to be a difficult picture to watch, especially with the unavoidable obstruction of participants' faces. Camera operation also is compromised by this layout.

Display Placement

Video displays require space. Cameras may be co-located with the far-end image displays. Lighting for video is somewhat directional. Using the standard rules from the presentation field invariably leads to mounting the displays too high for videoconferencing interactions. Since the display location often determines camera location, the errors can multiply. Cameras must be collocated with the far-end display to provide a sense of eye contact.

Aesthetic considerations (e.g., visual symmetry) need to be put aside for these systems to generate a real sense of connection. The AV designer should try to keep the lower visible edge of the far-end display visible to the farthest seated participant. This enhances the sense of remote connection, and eye contact becomes more natural.

Camera Technology

Cameras used for videoconferencing are derivatives of consumer video camcorder cameras. The reasons for this were the reduced costs of manufacturing and the highly competitive variety of camera technologies. Today, most of the available cameras have similar features with the major differences being mounting type, controls, and overall style.

SEE IT IN ACTION

You can see the PTE-300 at work in the real world as featured in the Rehearsals.com customer profile and customer profile video. Just visit: **www.amx.com/markets/customerProfiles/Rehearsals-com/**

Pan-Tilt-Zoom (PTZ) Assemblies

A typical fixed camera position may be substituted in some cases by a pan-tilt-zoom (PTZ) assembly. Many videoconference system manufacturers include one of many PTZ camera types. The differences between the cameras are usually not obvious. PTZ cameras vary in the speed and smoothness of the pan and tilt. Mechanical noise, physical size, electrical connections, and mounting locations are other factors to consider.

Auto-Pointing Technology

A special type of PTZ assembly includes auto-pointing or follower capability. The follower systems have relied upon IR technology to allow a sensor array in the PTZ to find and follow an IR beacon worn by a person; however, such a system is really limited to one user at a time and then the beacon is transferred to the next person.

An advanced design of the follower system auto points and zooms based on the sound location. This type of design cannot follow a voice but points the camera to the current talker. As such, this type of auto-pointing camera can relieve the system operator of the burden of re-aiming the camera whenever a new talker is engaged.

Lighting

To work within the limitations of current camera technology, it's important to understand that light levels translate into depth-of-field, or the distance range, of the scene that appears simultaneously in focus. More light equals greater depth of field. Greater depth-of-field equals sharply defined objects or persons within that view, which gives an impression of a higher video quality.

POSI-tively Superior Camera Control:

The PosiTrack Ethernet Pan/Tilt Head PTE-300

The PTE-300 is a fully integrated camera positioning controller with the ability to command pan and tilt functionality, lens zoom, focus and iris features. By using gears and pulleys to pan and tilt the camera, the PTE-300 ensures broadcast precision every time. It also features an Ethernet control interface that offers more installation flexibility, increased distances to the master controller and no proprietary cable runs. The PTE-300 can be used in VisualArchitect (version 1.2 or higher).

The PTE-300 is ideal for support and control of a wide variety of cameras for use in rehearsal studios, sporting events, concerts and other venues requiring standalone camera operation.

FEATURES

- Supports camera loads up to 30 pounds
- Cradle adjustments allow camera load to be balanced in horizontal and vertical axes
- Stores up to 100 5-axis synchronized presets in on board, non-volatile memory
- Manual local control of pan, tilt, zoom, and focus via four function 3-axis joyswitch
- Installs on a tripod (TM-CAM), podium (PM-CAM), or wall (WM-CAM) by using optional mounting adapters
- Controls servo motor lenses in both positional and speed mode

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SIMPLY THE BEST

Meet the 17" Modero Touch Panel

The executive boardroom is where crucial decisions affect the success, direction and life blood of any company. Chief executives have enough on their plates without having to worry about managing technologically. The flagship of the AMX Touch Panel family boasts an incredible 17 inches of on-screen real estate to display just about any combination of multimedia windows and device controls. During the monthly videoconference, your company's CEO can interface with four vice-presidents at once and still have plenty of room to utilize AMX TakeNote and Computer Control applications to illustrate his talking points onscreen by annotating over a PowerPoint slide being pulled from his PC. The 17" Modero Widescreen – would you trust your company's livelihood to be supported by anything but the best?

A camera's view is two-dimensional. Therefore, the designer must specify a type of lighting that would create a sense of separation between the background (e.g., walls) and the foreground (e.g., people). A level of wash on the viewed wall can enhance the scene rendered to the far-end.

Codecs

A codec is a small but critical piece in any videoconferencing system. Its function is to:

- Take the analog audio and video signals and converts them into digits
- Process the digital signal to reduce the amount of data
- Allow the transmission of the data to a different location over a network
- Decompress the data
- Assign the data to the audio or video decoder, which turns it back into analog signals for listening and viewing

Integration with Room Audio Systems

Videoconference system manufacturers provide microphones that are often adequate and should be used as long as the room does not require additional sound reinforcement. Quality will be adequate under appropriate environmental circumstances, but as the demand for quality increases or the room characteristics become more challenging, videoconferencing integration with an installed audio system is considered.

Network Implications of Videoconference Systems

Until recently, the primary means of network access for videoconferencing has been integrated services digital network (ISDN). Two basic ISDN variations for videoconferencing are:

- Basic rate interface (BRI).
- Primary rate interface (PRI).

BRI consists of two user channels of 64 Kb each delivered over a single copper pair similar to a regular telephone line and was originally intended to supplant plain old telephone service (POTS).

PRI contains either 24 or 32 channels of 64 Kb service and is delivered over two pairs of copper wire. The interfaces are different, often optional, and incompatible. Connections require the correct interface or they will not work.

Multiple channels of BRI are often collected together and operate as a single higher speed connection in a process called inverse multiplexing. Typically, up to four BRI circuits are linked together to provide 512 Kb/s connectivity.

The current trend is to migrate toward IP communications. Almost every videoconferencing system today comes from the factory with an IP interface built in as a basic configuration.

Control Systems

In environments where the videoconference system is a pre-packaged device or where a minimum of peripheral tools is required, the manufacturer's remote controllers may be useful. Manufacturers hire teams of human factor specialists to ensure that their remote control devices are intuitive and simple to use.

If, however, a variety of devices require remote controllers, managing more than two remotes may not be practical. With more complex conference rooms, a control system that integrates functions and simplifies users' efforts is recommended. Control page designs should focus on casual, non-technical users because they will benefit most from the simplicity.

Bandwidth

In considering the bandwidth required for videoconferencing, it's important estimate the total network loads. For circuit-switched systems, the required data rate is divided by 64 Kb/s to obtain the required number of B channels. North American PRI uses 23 B channels, while other countries' PRIs have 30.

Telecommunications companies always plan for oversubscription of their provided networks. The typical rule of thumb is to allow access to 20 percent of the subscribers at the same time.

Unless the PRI is specified as 100 percent utilization, the telecommunications company may provision the CO to only allow 5 channels of access in the United States or up to 6 channels of access in Europe without considering the PRI's intended usage. The designer should specify the need for all channels to be available for 100 percent utilization.

For IP systems, the required data rate is the required call rate plus approximately 20 percent overhead for H.323 (and then doubling if the system is on a simplex network). Hence, a 384 Kb/s call would be 461 Kb/s (i.e., 384 + 77) on a full duplex network. If the network is an older style simplex type, where only one side can transmit at a given time (e.g., WiFi), the rate is doubled to 922 Kb/s for the preceding example.

Network Loading Rules

In calculating the network loading allowed in an IP environment, the designer normally uses the 70 percent rule. The realistic network capacity is only about 70 percent of the advertised capacity. This allows statistical errors to occur and accounts for data collisions, data loss, and retransmitted data packets.

In environments where the videoconference system is a pre-packaged device or where a minimum of peripheral tools is required, the manufacturer's remote controllers may be useful. Manufacturers hire teams of human factor specialists to ensure that their remote control devices are intuitive and simple to use.

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Customer Profiles
We invite you to visit www.amx.com/markets/customerProfiles/ to view our Customer Profile Media Center. There you can choose from over 110 profiles available in .PDF format and segmented by vertical market. These profiles are interesting stories about AMX products at work in businesses and residences around the world.

Videoconferencing is, in some ways, similar to streaming technology. To prevent the degradation of other users' experience on the network, a 30 percent loading should not be exceeded. On a 100 Mb/s network, for example, the conferencing traffic should not exceed 21 Mb/s (30 percent of 70 Mb/s). If the company is running a voice over Internet protocol (VoIP) application, which also is considered a type of streaming traffic, it must be included in the calculations.

Internet Connectivity
Many companies opt for a T-1/E-1 access to the Internet through an Internet service provider (ISP). This option constitutes a shared resource of a maximum capacity of 1.544 Mb/s in the United States through which Web browsing, e-mail, online auctions, and videoconferencing traffic must flow. Since the upper limit for network loading is 30 percent for video, the best practices capacity of T-1 would be 463 Kb/s or one video call.

If Web browsers and e-mail traffic are not considered important, the T-1 network can be used for videoconferencing with a 3-call limit at a call-rate of 384 Kb/s plus overhead, which would leave no headroom for any other service type.

Protocols
All IP networks that use communications have a host protocol. Some protocol versions are optimized specifically for a telecommunications application and include:

- Session initiation protocol (SIP) and live communications server (LCS).
- Simple customer control protocol (SCCP) and call manager.
- H.323 and a software-based PBX and communications control server.

SIP is a new and open protocol that places the requirement for intelligence into the endpoints. The network's task is to recognize the protocol and allow it to pass cleanly. SIP was designed by the Internet Engineering Task Force (IETF) for universal connectivity with expansion and enhancements in mind. All connections are initiated in a way that makes them firewall friendly and opens up near limitless possibilities for call controls. SIP also enables vendor-free telecommunications networks' gaining user freedom of choice.

SCCP is a Cisco proprietary communications protocol but also one of the most widespread throughout the world. SCCP requires strict networking device compatibility. All of the endpoints and edge devices must intercommunicate with the core processing elements, which then allocate bandwidth and determine call routing paths.

Operating a universal device on an SCCP network may be challenging due to the complexity of the SCCP interactions. Typically the network would need to be segmented running a universal, H.323 or similar, subnet and an SCCP-enabled primary net. Deploying specific technologies in such an environment may be difficult but is feasible with the proprietary technical support. H.323 networks do exist and are

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relatively universal but mostly cannot offer useful features like call waiting and call forwarding. The network load imposed by the H.323 applications is significant.

Network Components
Beside the typical network devices (hubs, routers, bridges, gateways, and servers), some of the other devices and applications relevant to videoconferencing are firewalls, border controllers, gateways, and gatekeepers.

Firewall
Firewall is a relatively simple application that prevents certain types of communications from slipping through the company connection into the public Internet or other IP networks. Firewalls also may limit the use of videoconferencing technology by blocking the incoming communications.

Firewall normally has a single open AP, often designated port 80, available to HTTP or Web browser traffic. Other ports may be opened from the inside to allow transfer of information as replies come back through the same port that initiated the request. The ports are closed as soon as the request terminates, preventing unwanted data traffic. H.323 mandates ports for specific aspects of conferencing (e.g., 1720 is for call setup). However, not all firewalls recognize H.323, so the request will not be honored.

Border Controller
A border controller can reduce the interruption factors of firewall application by allowing an easy traversal of the designated communication traffic through the firewall blockade. Typically, these devices operate by working in cooperation with the existing, and creating their own additional, firewall, while allowing the opening and closing of access ports based on the need of the terminal devices. ITU recommendations that govern these operations are H.460 and H.461. IETF recommendations for firewall compatibility also should be consulted.

Gateway
A gateway for videoconferencing has a significantly different purpose than one intended for IP networks, although the function is similar. Gateways typically link one network topology to a different topology.

In an SCCP network, a network gateway would be required to interconnect an H.323 segment with the rest of the SCCP network. In videoconferencing terms, a gateway is a network transition device that allows:

- Outside access to an IP conference system from an ISDN network.
- ISDN dialing access from the IP conference system.
- Crossing the firewall as a firewall gateway.

Built-in gateway devices in certain types of videoconference systems allow call-by-call IP or ISDN choices or both on the same call. Different levels of standalone gateways can manage from 3 BRI to dozens of PRI connections.

Gatekeeper
To make the dialing easy for the users, a gatekeeper is required. This application may be incorporated into a soft PBX package, or it may be a part of a network management system. It could also be a server-based program.

A gatekeeper acts as a traffic director on the IP network. It can manage bandwidth allocations, limit overall conference traffic on the network, and provide alias dialing (i.e., access to an endpoint through an e-mail address or some other substitute for the actual IP address).

Gatekeepers are the best value method of IP-based video communications network management, because with the correct settings they ensure a high-quality experience for all network users. A gatekeeper should be included in the deployment of videoconferencing over an IP network, especially if there is a gateway involved.

Firewall is a relatively simple application that prevents certain types of communications from slipping through the company connection into the public Internet or other IP networks. Firewalls also may limit the use of videoconferencing technology by blocking the incoming communications.

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Different signal types are generally treated differently. For example, viewing several RGBHV computer signals simultaneously is usually difficult or not necessary and, therefore, the signal just has to be switched to the required location.

IV. Designing Systems with Signal Distribution

The infrastructure of an AV system is the signal distribution and routing system. The signal distribution system consists of:

- All inputs, connections, and source devices.
- Switching, processing and distribution electronic devices.
- Connection to all output or end- point destinations.

A very wide range of solutions for the system or the interconnection of devices is available, with great changes occurring with the increased use of digital signal formats.

A. SIGNAL TYPE IDENTIFICATION

Before sources and destinations can be connected you need to determine if they can communicate with each other. As the market grows and changes more and more signal types are emerging. To make the job easier first determine the video and audio signal style of all your source equipment such as computers, DVD players, satellite receivers, cameras etc. And, determine what signals your destination equipment can receive.

Popular video signal styles include:

- Analog: RGBHV (often called VGA), RGB, Y/Pb/Pr and even S-Video and composite are still used in many facilities
- Digital: DVI, HDMI, SD-SDI, HD-SDI

Popular audio signal styles include:

- Analog: Stereo, mono, multi channel
- Digital: S/PDIF, TosLink, Dolby AC-3, DTS, PCM, AES/EBU
- Signals That Can Contain Embedded Audio: DVI, HDMI, SD-SDI and HD-SDI

B. SIGNAL TYPE SEPARATION

When sorting through the various cable types, it helps to start by separating each signal type and grouping common ones together, along with the supporting electronics for the required signal type and quantity.

The first step is to determine the number of inputs for each signal type for the system, including any future or anticipated connections, or growth factor. An AV system typically consists of 1) audio with video, 2) audio with red, green, and blue horizontal sync vertical sync (RGBHV), and 3) audio-only signals. Having a greater number of audio sources than video signal types is not uncommon.

Once signals are separated into signal types, consider how these may connect to the system. Different signal types are generally treated differently. For example, viewing several RGBHV computer signals simultaneously is usually difficult or not necessary and, therefore, the signal just has to be switched to the required location. This is similar for playback video sources or audio sources. However, multiple microphones are often used simultaneously and expected to be heard operating simultaneously; therefore, a multiple microphone mixer is required.

Many manufacturers have combined the signal types into a common product to provide a single set of electronics to handle all of the signal types. Audio can "follow" video when a video signal is selected in switching. Most video and RGBHV switchers have a version with "audio follow" capability. Sometimes, for very small systems, the switching equipment is incorporated into the display device for a complete one-box solution.

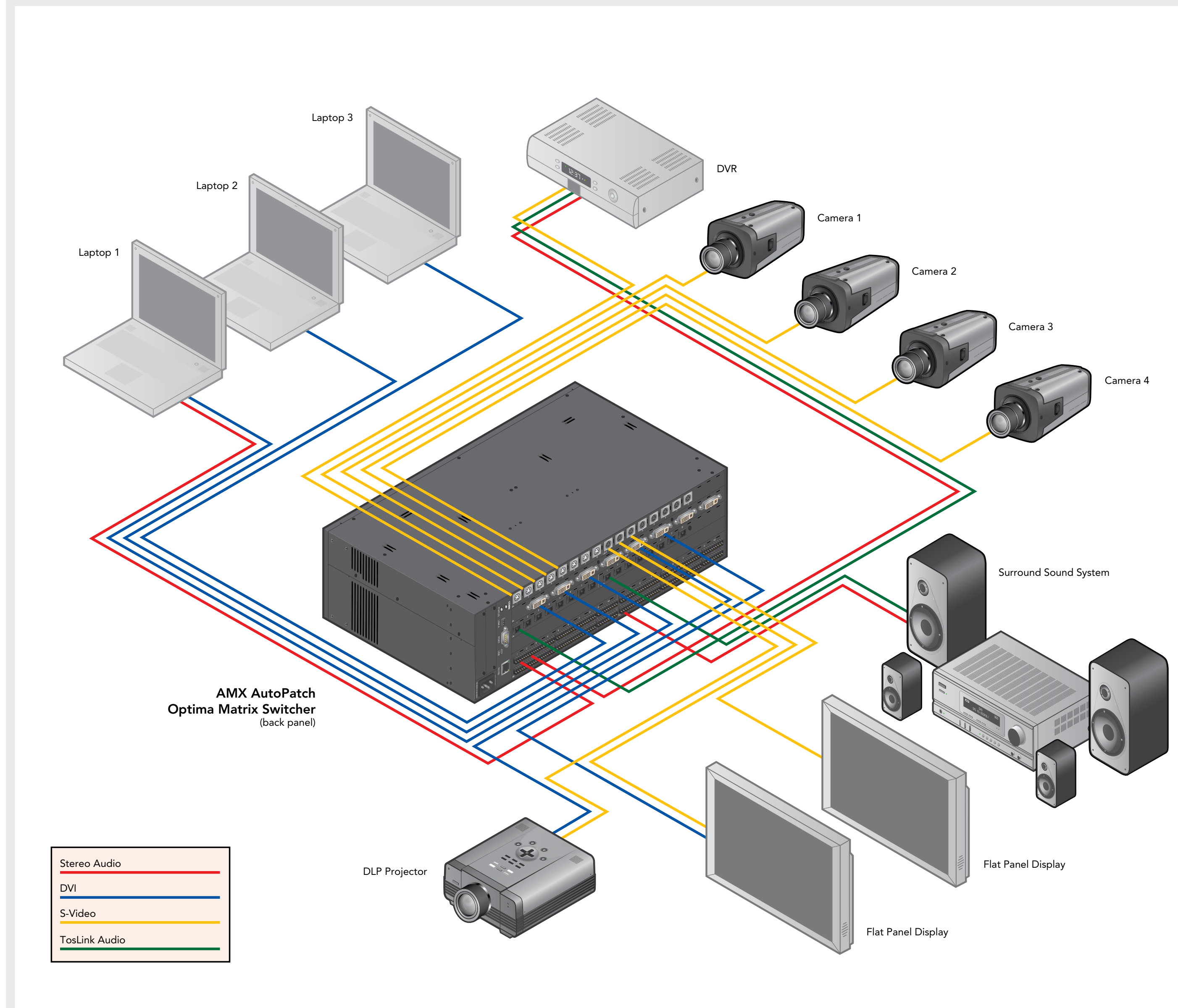
C. COMPONENTS OF A SIGNAL DISTRIBUTION SYSTEM

Timely, accurate signal distribution is critical to any audiovisual installation. All signals must move from source to destination – on demand – in the purest possible form.

Systems are comprised of sources (inputs), distribution devices and destinations (outputs):

- Sources (Inputs) are made up of connections, and source devices – anything that feeds communication into the system such as computers, satellite receivers, cameras, DVD's etc.
- Distribution Devices include switchers, matrix switchers, scalers or other signal processing equipment and distribution devices; essentially anything that touches the signal between source device and destination even the cable
- Destinations (Outputs) are anything that delivers the output of the video and audio for human consumption such as LCDs, speakers, projectors, touch panel video preview etc.

TYPICAL SIGNAL DISTRIBUTION SYSTEM DESIGN



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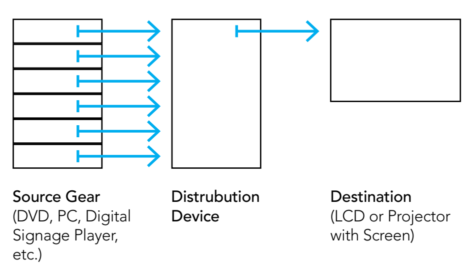
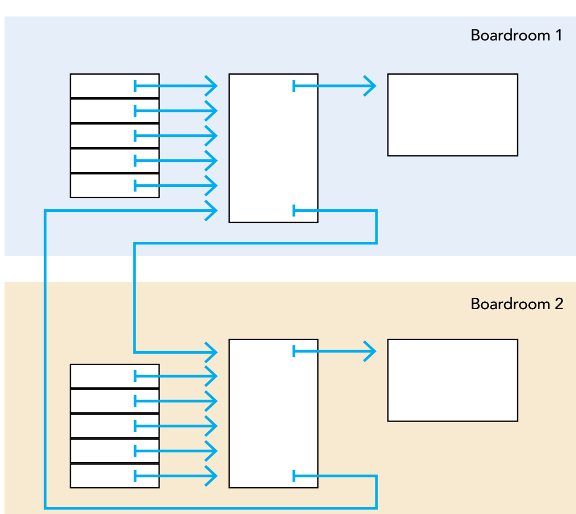
D. SIGNAL DISTANCES

The correct cable type and connectors are essential to the success of the system. Each signal type has a limit to the overall cable length that can be used. To extend that limit, a number of different strategies are available to the designer.

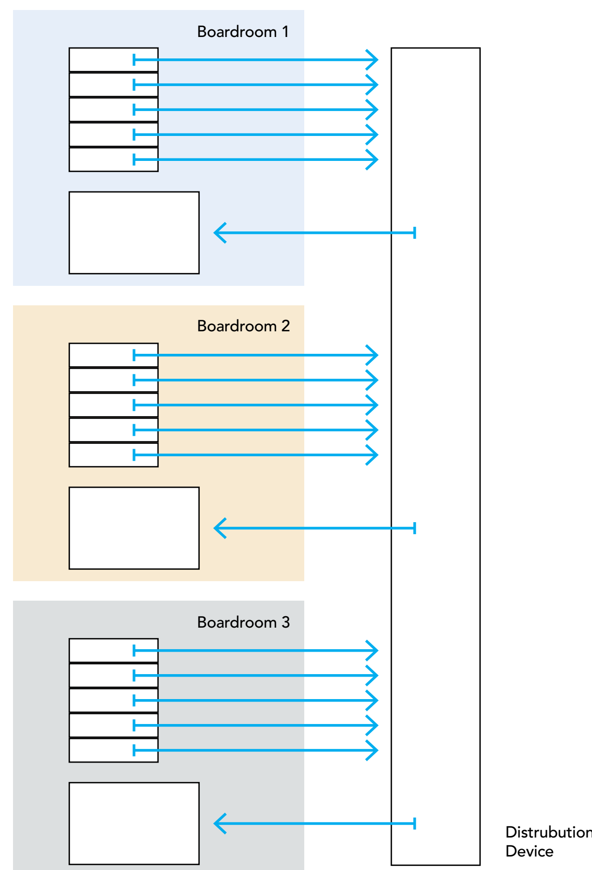
Identifying Rooms / Zones

Most facilities are comprised of multiple rooms each containing audio and video equipment. In many installations each room is self contained and either does not require audio and video signals be sent from room to room, or only requires a single connection from each room's distribution device. In systems such as these each room can be designed independently.





In more sophisticated systems such as command and control centers it is critical for all the sources in every room to be accessible throughout the facility without constraint. It is very common for these facilities to have a central HUB with connections to all the source and destination devices. This HUB is often an entirely separate, secure room and usually has a dedicated staff.



Outlining these basic signal distribution requirements or "paths" will help determine the amount of "ins and outs" you have and the distance that the signals will travel from source to destination. Future growth should also be considered.

Amplification

Signal amplification is the primary means of addressing signal degradation due to the limited cable length. The amplifier is placed at the location of the signal source and drives the signal to the destination. Some amplifiers include signal equalization capability to optimize signal performance.

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Signal Conversion

Now it's time to group your source and destination equipment according to the installations needs. This is where signal conversion comes into play; the industry provides a wide variety of solutions so you can incorporate any mixture of signal types. Step back and document where each source device is expected to be seen / heard and the equipment it will have to go through in order to accomplish that goal. When deciding the appropriate signal conversion gear, we should consider the following:

Signal Format

As outlined earlier in this document, each video signal has its own format. So, for example, in order for an RGBHV signal to be received by a DVI destination signal conversion must take place. In the audio realm, an audio device can convert a microphone level signal to a line level signal that can operate over a greater cable distance with less susceptibility to interference. Audio systems also can convert a signal from a line level signal to an amplified signal for the purposes of driving a loudspeaker.

Video Resolution

In addition to the format of the video your system may be comprised of various video resolution capabilities. A single RGBHV source, although its format does not change, can be viewed in various resolutions. For example, if the presentation device such as a computer is sending a resolution that is incompatible with the end point LCD the video will not be seen even though all of the equipment between the two devices is RGBHV compatible.

Video Quality

Simply converting from one signal format or resolution to another does not guarantee optimal video quality. Industry standards and measurements have been created to help ensure you are getting the best picture possible.

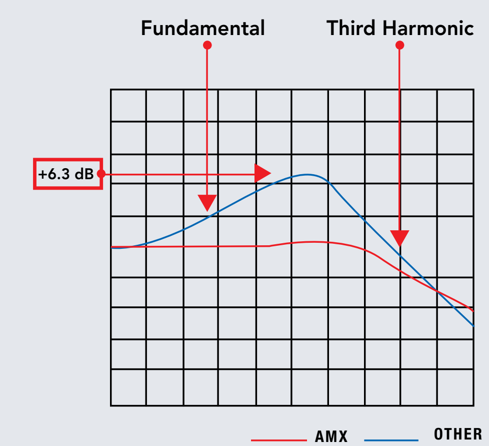
-Bandwidth is a very important specification when distributing analog video.

A CLOSER LOOK

Knowing the bandwidth is not enough

Any expert rock skipper will tell you that it not only matters how far you throw the rock – it also matters how flat your toss is. After all, if you launch the rock into space it will hit the water at the wrong angle to skip.

When passing analog video it also matters how far the goes (bandwidth) and how "flat" (dB measurement) the signal remains. Thus, simply purchasing signal distribution gear that claims a high bandwidth number will not guarantee a quality image. For optimal performance it is important that the signal remains within +/- 3dB. At AMX we are so committed to the quality of our signal management gear that our "Ultra-Flat Response" ensures all our equipment passes signals within this spec.



Defining Transport Methods

The correct cable type and connectors are essential to the success of the system. Each signal type has a limit to the overall cable length that can be used. To extend that limit, a number of different strategies are available to the designer, including.

Amplification

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