AV Like Paint by Numbers

1 = Blue    2 = Red
3 = Green   4 = Orange

Presented By: Eric J. Marshall
When I started in the industry, my boss drew me a picture of what WE DID.
I Upgraded the Drawing
1. Address Cable
2. Address Pathway
3. Address the Stations
4. Address the Head End
What Do We Do TODAY?

Central Processors 4

Cabling Pathway

2

1

Devices 3

Central Processors 4

Cabling Pathway

2

1

Devices 3
Audio Video

Control

1. Input Sources
2. Share It
3. Distribute
4. Process

流程图展示了音频视频的控制过程，包括输入源、处理和共享步骤。
Who are you?
A. Engineer/Designer
B. Sales Agent
C. Installer
D. Project Manager
E. Commission Agent / Inspector
F. Programmer
G. ALL THE ABOVE!
Can we do AV?
I was hired to start doing AV at a structured cabling company.

Do you know how to install cable?

Do you know how to mount things on walls and ceilings?
Let me pull your cable! We are both going to the same place!

TDMM:
Save 30-40%

Sold 2.4 million In 2 months!
4 Steps of AV

Input Sources → Process → Distribute → Share It

- SEE IT
- HEAR IT
- RECORD IT
- STREAM IT
5th Step of AV

Control

Input Sources

Process

Distribute

Share It

SEE IT

HEAR IT

RECORD IT

STREAM IT
Which are the 5 Steps of AV?

A. Select Sources – Share It – Cable It – Process – Control

B. Input Sources – Share It – Distribute – Process – Control

C. Pick Sources – Pick Outputs – Cable It – Share It – Control It
4 Steps of AV

Input Sources → Process → Distribute

- Share It
  - SEE IT
- HEAR IT
- RECORD IT
- STREAM IT
5th Step of AV

Control

Input Sources

Process

Distribute

Share It

SEE IT

HEAR IT

RECORD IT

STREAM IT

BICSI FALL Conference & Exhibition
E.R.I.C. Low Voltage Services
Step 1 – Input Sources
What are input sources?

Anything that generates Audio or Video
Audio Source Examples

- CD Player / Recorder
- DJ Mixer / Karaoke
- MP3 Player or iPod
- Streaming – Spotify, Pandora...
- Audio Server
- AM/FM Tuner
- Satellite Radio

- Cassette Tape Player / Recorder
- Phonograph / Record Player / Turntable
- Microphone
- Instrument
- Public address / Noise Masking
- Bluetooth from Phone
Video Source Examples

- BluRay Player / Recorder
- TV Box or TV antenna
- Digital Signage
- VCR
- DVR / Video Server
- I-Pod Video / Phone
- Camera
- Computer
- Video CDs
- Document Camera
- Game Console
- Web Conference
- Streaming Service
- BYOD Wireless Collab Device
- Microscope / Telescope
You don’t have to worry about all the sources
Devices have connectors

CONNECTORS
CONNECT

HDMI
DVI
VGA

BUT

THE REAL CONNECTION IS THE SIGNAL
Devices have connectors

CONNECTORS
CONNECT

HDMI
DVI
VGA

BUT

THE REAL CONNECTION IS THE SIGNAL
Devices have connectors

CONNECTORS
CONNECT

THE REAL CONNECTION IS THE SIGNAL

CONNECT
CONNECT

BUT

HDMI
DVI
VGA
High Resolution
- RGBHV = 5 Wire
- RGBS = 4 Wire
- RGsB/RsGsBs = 3 Wire

Can be either
- Component = 3 Wire

Low Resolution
- S-video (Y/C) = 2 Wire
- Composite = 1 Wire
- Radio Frequency (RF)
BNC Connector

- Used with coaxial cable.
- It is a round metal connector that is pressed and twisted to lock into place.
- BNC stands for “Bayonet Neill Concelman” (the names of the two developers – Paul Neill and Carl Concelman).
- Used for professional AV applications.
DB / HD Connectors

- Common connector for computers.
- If it has 2 rows of pins it is called a “D-sub” or “DB” connector.
- If it has 3 rows of pins it is called an “HD” connector.
- The connector type is usually followed by a number telling the number of pins it can hold.
  - (ex. DB9, DB25)
  - HD15 is what is used by most computers!
Audio plug

- Plugs are used for many audio applications
- Typical sizes are 3.5mm, 2.5mm, ¼”, and 3/16”
- 3.5mm is what is used on most computers and portable audio devices!
Audio Connectors

Female XLR Connector

Male XLR Connector

RCA Plug

1/4" Plug TRS (Tip Ring Sleeve)

1/8" 3.5mm mini-plug TRS

Speakon for Speakers

Euroblock, Captive Screw or Phoenix Connector

Toslink

Banana Plugs

Spade Lugs

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Digital Connectors

- HDMI
- SDI
- DVI
- Display Port
- FireWire
- Thunderbolt
- USB
What Does Digital Add to Signal?

AUDIO
What Does Digital Add to Signal?

**EDID**
(Extended Display Identification Data)
- Hot Sync
- AV properties
- HDCP
What Does Digital Add to Signal?

HDCP™
HIGH-BANDWIDTH DIGITAL CONTENT PROTECTION

Prevent Non-licensed devices from receiving content
Block eavesdropping – “Man in the Middle” attacks
What Does Digital Add to Signal?

CEC Enabled System

1) Press Play on DVD
2) Turns on A/V Receiver
3) Turns on TV
4) Switches to correct input (from DVD player)
5) And then Plays DVD

4) Switches to correct input (from A/V Receiver)
What Does Digital Add to Signal?

[Diagram showing the difference between a system without ARC and with ARC, highlighting the simplification of cabling with ARC.]
Different HDMI Examples
Different Display Port Examples

Display Port

Display Port Mini
Display Port / HDMI Comparison

<table>
<thead>
<tr>
<th>DVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display Port vs. HDMI</td>
</tr>
</tbody>
</table>

Display Port  
HDMI
DVI Connector

- LFH (low force helix) connector
- DVI-D = 24 pins and a single larger, offset ground bar; carry a digital signal ONLY.
- DVI-I = have 4 extra pins that surround the offset ground bar; carry both digital and analog signals.

- Used for Digital and High Definition Video
## Different USB Examples

<table>
<thead>
<tr>
<th>Connector Type</th>
<th>USB 2.0 Image</th>
<th>USB 3.0 Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td><img src="image1" alt="USB A Image" /></td>
<td><img src="image2" alt="USB A Image" /></td>
</tr>
<tr>
<td>B</td>
<td><img src="image3" alt="USB B Image" /></td>
<td><img src="image4" alt="USB B Image" /></td>
</tr>
<tr>
<td>Micro-B</td>
<td><img src="image5" alt="Micro-B Image" /></td>
<td><img src="image6" alt="Micro-B Image" /></td>
</tr>
<tr>
<td>Mini-B 5 Pin</td>
<td><img src="image7" alt="Mini-B 5 Pin Image" /></td>
<td>-</td>
</tr>
<tr>
<td>Mini-B 4 Pin</td>
<td><img src="image8" alt="Mini-B 4 Pin Image" /></td>
<td>-</td>
</tr>
<tr>
<td>C</td>
<td><img src="image9" alt="USB C Image" /></td>
<td></td>
</tr>
</tbody>
</table>
Don’t get confused by the connectors!
<table>
<thead>
<tr>
<th>COMPUTERS</th>
<th>VIDEO</th>
<th>AUDIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>• D-sub (DB)</td>
<td>• F-type</td>
<td>• RCA</td>
</tr>
<tr>
<td>• HD</td>
<td>• HD</td>
<td>• Plugs</td>
</tr>
<tr>
<td>• DIN</td>
<td>• RCA</td>
<td>• DIN</td>
</tr>
<tr>
<td>• BNC</td>
<td>• BNC</td>
<td>• Captive Screw</td>
</tr>
<tr>
<td>• DVI</td>
<td>• DIN</td>
<td>• Binding Post</td>
</tr>
<tr>
<td>• HDMI</td>
<td>• DVI</td>
<td>• XLR</td>
</tr>
<tr>
<td>• HDMI</td>
<td>• HDMI</td>
<td>• Toslink</td>
</tr>
</tbody>
</table>

CONNECTORS
CONNECT
BUT
THE REAL CONNECTION IS THE SIGNAL
The Physical Connection

• Consists of two major components:
  • Conductors= pieces of wire that carry signals between devices. $$$$$$
  • Connectors= mechanical junctions between the conductors and pieces of equipment.

• To properly understand how to connect devices to the AV system you need to understand CONNECTORS and SIGNALS.
What’s the difference on the connector?

• The Pin Out – the way the conductors are placed in the connectors on each end. The pin out is the “Road Map” for the signal!

• DB9 used for RS232
  – Pin 2 & Pin 3 = TX and RX
  – (go two more) Pin 5 = Ground
What’s the difference on the connector?
What are the Pin-outs?

- Computer = HD 15
- S-video = 4 pin din
- Consumer Audio plug = 3.5mm
- Instrument/Professional Audio plug = ¼”
- RCA Color codes
  - Yellow, Green & Blue & Red = video
  - White, Red, Black, Orange= audio
- What version digital cable?
CONNECTORS
CONNECT
BUT
THE REAL CONNECTION IS THE SIGNAL
Male vs Female Connectors

Male connectors typically send and female receive.
What else makes the difference?

- Cables are a channel for the signal – WHAT GOES IN COMES OUT!!!!!

- Cables/Adapters can not change the signal – electronics or special circuitry within a cable can.

- Examples:
  - DVI signal from a computer is different from DVI signal from a TV.
  - VGA (computer) and component video are different signals.
Gender Changers & Adapters

Make sure signal is same!
Make sure pin out is same!

Change pathway at other end?
Useful for coupling
AES/EBU vs. S/PDIF

The real connection is the signal.
Which is Correct?

A. Connectors connect, but the real connection is the signal

B. You can only connect devices with the same connectors

C. You can use an adapter anytime to connect devices

D. You can use any type of HDMI cable
What is in the signal?

VIDEO

• Resolution
• Signal Type – RGB, Component…
• Digital Add Ons
What is Resolution?

- Resolution = a measure of a video device’s capability to make small dots and lines on a screen.
- **Horizontal resolution** = number of dots that can fill one line
- **Vertical resolution** = Number of lines.
- NTSC standard = 480 lines
- HDTV = 720 and 1080 lines
- UHD = 2K, 4K, 8K

Example Resolutions
- 640 x 480 VGA
- 800 x 600 SVGA
- 1024 x 768 XGA
- 1600 x 1200 UXGA
- 1920x1080 Full HD
What is High Definition?
What is High Definition?

- High Definition is wider and fills more of the eyes viewing area.
- High Definition has more pixels.
- High Definition can be both digital and analog.
What is Resolution?
What is Resolution?
What is Resolution?

This video was captured in 8K
What is with the “i” and “p”? 

1/60th of a second field + 1/60th of a second field = 1/30th of a second frame
What is with the "i" and "p"?

1080i 720p

Progressive Scan  Interlaced Video
30Hz vs 60Hz
What is Signal Type?

### Output Configuration

<table>
<thead>
<tr>
<th>Output</th>
<th>Format</th>
<th>Color Bit Depth</th>
<th>HDCP Mode</th>
<th>HDCP Compliance</th>
<th>Video Mute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Auto</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>2</td>
<td>EVI RGB 444</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>3</td>
<td>HDMI RGB 444 Full</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>4</td>
<td>HDMI YUV 444 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>5A</td>
<td>HDMI YUV 444 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>5B</td>
<td>HDMI YUV 422 Full</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>6A</td>
<td>HDMI YUV 422 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>6B</td>
<td>HDMI YUV 422 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>7</td>
<td>HDMI YUV 422 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
<tr>
<td>8</td>
<td>HDMI YUV 422 Limited</td>
<td>Auto</td>
<td>Auto</td>
<td>No Display</td>
<td>Mute</td>
</tr>
</tbody>
</table>
### Input Configuration

<table>
<thead>
<tr>
<th>Input</th>
<th>Signal Presence</th>
<th>Signal Type</th>
<th>HDCP Authorized</th>
<th>HDCP Encryption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
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<td>7</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
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<tr>
<td>8</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>No signal detected</td>
<td>✔️</td>
<td>No Signal</td>
</tr>
</tbody>
</table>
Which is NOT a component of a Video Signal?

A. HDCP encryption

B. Audio and control

C. Resolution, frames/refresh rate, and color

D. The cable connector
What About Audio?

Pro Audio cables and connectors - an overview: https://youtu.be/AnU27N3Clsw
Measuring 100V line audio systems: https://youtu.be/2RG2i4FtA2M
How to Choose the Best Speaker Cables: Gauge, Resistance and More: https://youtu.be/r7DdcZCbABo
How To Wire Subwoofers - Parallel vs Series - Single Voice Coil and Dual Voice Coil: https://youtu.be/jryFmlCR4qA
How To Test Your Speaker System: https://youtu.be/TCdUL5ZvMHc
Audio Impedance Meter- Testing 70/ 100 volt Speakers: https://youtu.be/NKCN_aK9wgQ
Amplifier to Speaker Matching Tutorial | UniqueSquared.com: https://youtu.be/pUou_noD1Gc
Understanding Sound Reinforcement - Power Amplifiers (Part 1): https://youtu.be/xFRH_1WQw4Y
Understanding Sound Reinforcement - Power Amplifiers (Part 2): https://youtu.be/QS2JXG6QWmQ
Troubleshoot and Eliminate AC Hum on Sound System: https://youtu.be/l4famaQmWnA
Biamp Audio 101 - Wiring & Interconnects: Balanced vs. Unbalanced: https://youtu.be/2uHaQ5OY9ew
Biamp Audio 101 - Gain Structure: Steps for Proper Gain Structure: https://youtu.be/rNbbz9swKto
Biamp Audio 101 - Measurements & the dB: Audio Meters: https://youtu.be/S6cUqud7JiY
SynAudCon: Gain Structure: https://youtu.be/lel8FZ4wLf8
What does bridge on an amplifier mean: https://youtu.be/cwXGd4bl-f0
Wiring Speakers and determine ohms: https://www.kicker.com/app/misc/support/tech/tech_papers/docs/SeriesAndParallelSpeakerWiring.pdf
What About Audio?

Pre-Process
– Mic = -60 dBV (0.001 volt) to -40 dBV (0.010 volt)
– Instrument = -20 dBu
– Pro Line = +4 dBu (1.25V)
– Consumer Line “Aux” = -10 dBV (0.300 volt)

After Process
– Speaker = 25v or 70v or 4/8ohm
## Electrical dB reference chart:

<table>
<thead>
<tr>
<th>Reference Symbol</th>
<th>Reference type</th>
<th>Reference level</th>
<th>Comments:</th>
</tr>
</thead>
<tbody>
<tr>
<td>dBm</td>
<td>power</td>
<td>0 dBm = 1.0 mW</td>
<td>Original electrical dB reference</td>
</tr>
<tr>
<td>dBV</td>
<td>pressure</td>
<td>0 dBV = 1.0 V RMS = +2.2 dBu</td>
<td>Rarely used in pro audio</td>
</tr>
<tr>
<td>dBv</td>
<td>pressure</td>
<td>0 dBv = 0.7746 V RMS</td>
<td>Older version of dBu, rarely used</td>
</tr>
<tr>
<td>dBu</td>
<td>pressure</td>
<td>0 dBu = 0.775 V RMS</td>
<td>Frequently used in pro audio</td>
</tr>
<tr>
<td>dB VU</td>
<td>pressure</td>
<td>0 dB VU ~ +4 dBu</td>
<td>Pseudo-reference for VU meters &amp; LED bar graphs</td>
</tr>
</tbody>
</table>
# Meters

## Scales compared

<table>
<thead>
<tr>
<th>Volts</th>
<th>dBu</th>
<th>VU</th>
<th>dBfs (SMPTE RP155)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.283V</td>
<td>24 dBu</td>
<td>0 dBfs</td>
<td></td>
</tr>
<tr>
<td>9.757 V</td>
<td>22 dBu</td>
<td>-2 dBfs</td>
<td></td>
</tr>
<tr>
<td>7.750 V</td>
<td>20 dBu</td>
<td>-4 dBfs</td>
<td></td>
</tr>
<tr>
<td>6.156 V</td>
<td>18 dBu</td>
<td>-6 dBfs</td>
<td></td>
</tr>
<tr>
<td>4.890 V</td>
<td>16 dBu</td>
<td>-8 dBfs</td>
<td></td>
</tr>
<tr>
<td>3.884 V</td>
<td>14 dBu</td>
<td>-10 dBfs</td>
<td></td>
</tr>
<tr>
<td>3.085 V</td>
<td>12 dBu</td>
<td>-12 dBfs</td>
<td></td>
</tr>
<tr>
<td>2.451 V</td>
<td>10 dBu</td>
<td>-14 dBfs</td>
<td></td>
</tr>
<tr>
<td>1.947 V</td>
<td>8 dBu</td>
<td>-16 dBfs</td>
<td></td>
</tr>
<tr>
<td>1.546 V</td>
<td>6 dBu</td>
<td>-18 dBfs</td>
<td></td>
</tr>
<tr>
<td>1.228 V</td>
<td>4 dBu</td>
<td>-20 dBfs</td>
<td></td>
</tr>
<tr>
<td>1.576 V</td>
<td>0 dBu</td>
<td>-22 dBfs</td>
<td></td>
</tr>
<tr>
<td>0.775 V</td>
<td>-2 dBu</td>
<td>-24 dBfs</td>
<td></td>
</tr>
<tr>
<td>0.616 V</td>
<td>-4 dBu</td>
<td>-26 dBfs</td>
<td></td>
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<tr>
<td>0.489 V</td>
<td>-6 dBu</td>
<td>-28 dBfs</td>
<td></td>
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<tr>
<td>0.388 V</td>
<td>-8 dBu</td>
<td>-30 dBfs</td>
<td></td>
</tr>
<tr>
<td>0.309 V</td>
<td>-10 dBu</td>
<td>-32 dBfs</td>
<td></td>
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<tr>
<td>0.245 V</td>
<td>-12 dBu</td>
<td>-34 dBfs</td>
<td></td>
</tr>
<tr>
<td>0.195 V</td>
<td>-14 dBu</td>
<td>-36 dBfs</td>
<td></td>
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<tr>
<td>0.155 V</td>
<td>-16 dBu</td>
<td>-38 dBfs</td>
<td></td>
</tr>
<tr>
<td>0.123 V</td>
<td>-18 dBu</td>
<td>-40 dBfs</td>
<td></td>
</tr>
<tr>
<td>97.6 mV</td>
<td>-20 dBu</td>
<td>-42 dBfs</td>
<td></td>
</tr>
<tr>
<td>7.75 mV</td>
<td>-22 dBu</td>
<td>-44 dBfs</td>
<td></td>
</tr>
<tr>
<td>61.6 mV</td>
<td>-24 dBu</td>
<td>-46 dBfs</td>
<td></td>
</tr>
</tbody>
</table>

"Unity Gain"
What About Audio?
Balanced vs Unbalanced

Unbalanced wiring
What About Audio?

Balanced vs Unbalanced

Unbalanced wiring
What About Audio?

Balanced vs Unbalanced

Balanced wiring

Audio signal travels in opposing phases

Differential amplifier

Output signal with twice the amplitude

Ground connection isolated from signal
What About Audio?

Balanced vs Unbalanced

Balanced wiring

EMI at the same level and phase in both conductors

EMI disappears when one signal is inverted and summed to the other
What About Audio?

Balanced vs Unbalanced

Balanced wiring

RFI is diverted to ground
What About Audio?

Mono vs Stereo

- Mono - One single channel of audio
- Stereo - Two channels of audio (Left and Right)

Mono Audio → Mono Audio → Mono Audio

Channel A (L) → Channel B (R)
What About Audio?

Mono vs Stereo

When mixing stereo to mono, attenuate both channels by -6dB to the output bus and the sum will be at the same 0 dB as both input channels.
What About Audio?
Frequency, Loudness, and Timing

1-35 ms

amplitude
wavelength

Sound pressure level (dB re 2 × 10⁻⁵ N/m²)

Threshold of audibility

Lowpass
Highpass
Bandpass
Bandeject

Cutoff frequency
Cutoff frequency
Center frequency
Center frequency

Frequency
Frequency
Frequency
Frequency

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Low Voltage Services
Which is NOT a component of an Audio Signal?

A. Voltage / Level

B. Balanced vs Unbalanced

C. The cable connector

D. Frequency and timing
Microphones for Applications

- Handheld
- Shotgun - Theatre
- Parabolic – Sporting events
- Lavalier – Attach to clothing
- Contact pickup – Musical instruments
- Pressure response – Lay on flat surface
- Boundary – Set on Table for meeting
- Ceiling – Theater or Conference Room
• Two common types of microphones are...
  – Dynamic Microphones

  – Condenser Microphones

(Requires phantom power)
## Microphone Pick Up Patterns

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Omni-directional</th>
<th>Cardioid</th>
<th>Supercardioid</th>
<th>Hypercardioid</th>
<th>Bi-directional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polar response pattern</td>
<td><img src="image1" alt="Pattern" /></td>
<td><img src="image2" alt="Pattern" /></td>
<td><img src="image3" alt="Pattern" /></td>
<td><img src="image4" alt="Pattern" /></td>
<td><img src="image5" alt="Pattern" /></td>
</tr>
<tr>
<td>Coverage angle</td>
<td>360°</td>
<td>131°</td>
<td>115°</td>
<td>105°</td>
<td>90°</td>
</tr>
<tr>
<td>Angle of maximum rejection (null angle)</td>
<td>-</td>
<td>180°</td>
<td>126°</td>
<td>110°</td>
<td>90°</td>
</tr>
</tbody>
</table>
Microphone Pick Up Patterns

- Cardioid
- Hyper-Cardioid
- Omni-Directional

Shure.co.uk

MICROPHONE

SOUND SOURCE

BICSİ FALL
Conference & Exhibition
E.R.I.C.
Low Voltage Services
Bicsi
Antenna Distribution

How many channels?
Depends on Frequency!
More money is typically better (features)

- VHF
- UHF
- UWB
- Ultra Wide Band
- Ethernet

Note: Pay attention to “Frequency” with THE MIC also!
Which is NOT a concern with microphones?

A. The cable connector
B. Pick Pattern
C. Application and power requirements
D. Frequency, channels, and antennas
Give the User an Input
• Traditional
  • Skill Required
• Plug and Play
  • Not Hard Lid
  • Limited Futureability
• Twisted Pair
  • Solid conductor plugs
  • 2 cables? = 1 UTP/1 STP
  • Pay attention to A vs. B
  • Cat5E better for analog (Skew Free/Low Skew)
  • IF sending video – USE SHIELDED Cat6 or better
  • IP video follows same rules as our data cabling
Step 2 – Share
4 Steps of AV

Input Sources

Share It

SEE IT

HEAR IT

RECORD IT

STREAM IT
4 Steps of AV

Input Sources

Share It

SEE IT
Projector Types

✓ Pico
✓ Portable
✓ Multi-purpose
✓ Professional \ Large Venue
✓ Interactive

Projectors are the lowest cost method to show video content to a large group.
Projection Types

✓ Standard Throw
✓ Short Throw
✓ Ultra Short Throw
✓ Ultra WIDE Throw
Laser vs Bulb

Bulb Projector
- optical d'Fuse
- microdisplay LCOS, DMD, or LCD
- projector lens
- light bulb
- screen

RGB Laser Projector
- optical d'Fuse
- microdisplay LCOS, DMD, or LCD
- projector lens
- 2D array of red, green and blue lasers
- screen

LAMP vs LASER
- LAMP: 1,000 hours
- LASER: 1,000 hours (no replacement needed)

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Projector Specs

• **Lumens**
  – Minimum 3000
  – Double is noticeable
    • fade over time
  – Keystone can half
  – Color Brightness

• **Contrast Ratio**
  – Light cancels

CAUTION: Use specs MOSTLY to compare models by same manufacturer
Projector Specs

- Throw Ratio
  - Multiply by width
- Native Resolution
  - Rescales to within
- Warranty
- Inputs
Distance from bottom of screen to floor should be 3-4 feet.

Typical Screens are Matt White.
• PC-free presentations
• Wireless
• AUTO keystone
• Wireless mouse control
• Lense Shift
• Corner Adjustments
• Network Capable
  • Control and Monitor
  • Content
• Use furthest distance to determine HEIGHT
• IF showing...
  – Video ÷ 8
  – Data ÷ 6
  – Graphics ÷ 4
• WIDTH is determined by ratio...
  • 4:3 = 1.33
  • 16:9 = 1.78
  • 16:10 (8:5) = 1.6
<table>
<thead>
<tr>
<th>Aspect Ratio</th>
<th>Formula for Width (W)</th>
<th>Formula for Height (H)</th>
<th>Formula for Depth (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4:3 NTSC Video</strong></td>
<td>W = D x 0.8</td>
<td>H = D x 0.6</td>
<td>D = H x 1.667</td>
</tr>
<tr>
<td><strong>16:9 HDTV</strong></td>
<td>W = D x 0.87146</td>
<td>H = D x 0.49</td>
<td>D = H x 1.1475</td>
</tr>
<tr>
<td><strong>16:10</strong></td>
<td>W = D x 0.848</td>
<td>H = D x 0.5299</td>
<td>D = H x 1.1793</td>
</tr>
<tr>
<td><strong>5:4 Data Graphics</strong></td>
<td>W = D x 0.781</td>
<td>H = D x 0.625</td>
<td>D = H x 1.281</td>
</tr>
<tr>
<td><strong>1.85:1 WideScreen (Letterbox)</strong></td>
<td>W = D x 0.881</td>
<td>H = D x 0.4762</td>
<td>D = H x 2.1</td>
</tr>
<tr>
<td><strong>2.35:1 CinemaScope</strong></td>
<td>W = D x 0.92</td>
<td>H = D x 0.3915</td>
<td>D = H x 2.554</td>
</tr>
<tr>
<td><strong>15:9</strong></td>
<td>W = D x 0.8576</td>
<td>H = D x 0.5146</td>
<td>D = H x 1.9433</td>
</tr>
<tr>
<td></td>
<td>D = W x 1.135</td>
<td>D = W x 1.0868</td>
<td>D = W x 1.166</td>
</tr>
</tbody>
</table>
QLED TV

Pros:
- Brilliant whites
- Ultra-bright (1,500 nits)
- Variety of screen sizes between 49-88 Inch

Cons:
- Not as slim (25.4 mm)
- Overly bright
- Less convincing blacks
- Slower refresh rate

OLED TV

Pros:
- Lighter and thinner (2.57 mm)
- Self-lighting pixels
- More convincing blacks
- Faster refresh rate (0.001 ms)
- Judder and blur-free

Cons:
- Only found in three screen sizes: 55, 65, & 77-Inch
- Muted brightness (1,000 nits)
- Expensive

LED TV

Pros:
- Good
- Perfect
- Good

Motion Blur
- Great
- Perfect
- Good

Viewing Angle
- Poor
- Great
- Poor

Color Volume
- Great
- Good
- Good

Gray Uniformity
- Average
- Good
- Average

Luminosity
- Good
- Good
- Great

Image Retention
- Great
- Poor
- Great

Price and Availability
- Poor
- Average
- Great

https://www.rtings.com/tv/reviews/by-type/qled-vs-oled-vs-led
Projector Mounting Examples

Measure twice…
Pay attention to alignment and height
Beware of building vibration
Monitor Display Mounting Examples
Pitch, Roll, & Yaw

- **PAN (HORIZONTAL ANGLE)**
- **TILT (VERTICAL ANGLE)**
- **THIRD AXIS**

- **ROLL**
- **PITCH**
- **YAW**

**HORIZONTAL**

**VERTICAL**
A Word About Digital Signage

- Commercial TVs – made to run brighter longer (16/7 & 24/7)
  - Built in Software or External Box
A Word About Video Walls

- Thin bezel vs video wall
- Built in video wall capability drawbacks
- Can mount vertically or horizontally or architecturally (Remember aspects!)
Which is NOT a concern with projectors or displays?

A. Light source and native resolution
B. Size for height and distance and type of mount
C. Warranty and connections/features
D. Different manufacturer specs to compare brightness
4 Steps of AV

Input Sources

Share It
SEE IT
HEAR IT
Architectural Options for Aesthetics
Constant Voltage vs 4/8 ohm direct

CV can go longer and do more speakers. Direct can go louder and can sound better. CV speaker is actually an 4/8ohm speaker!
1 active and 3 passive Dante network enabled speaker set

Channels (zones): 4

Dante Speakers

Powered Speakers
• Speakers frequency ranges…
  – **Tweeters**-High freq.  
    (2,000-20,000 Hz)
  – **Horns**-Mid.-High freq.  
    (300-8,000 Hz)
  – **Midrange cones**-Mid. freq.  
    (200-8,000 Hz)
  – **Woofers**-Low freq.  
    (40-600 Hz)
  – **Subwoofers**-Lower freq.  
    (20-200 Hz)

If crossover is not built in will have more than one termination block and need processing to filter frequencies.
Speaker dispersion

Work with architect to determine ceiling height for speakers and adequate screen height!
Speaker dispersion

Distributed Speakers

Program Speakers
Speaker Placement

- **Turning volume up does not increase coverage area only loudness**
- Ceiling Speakers
  - Determine # of speakers using ceiling height X2 rule
- Wall Baffles
  - Determine # based on height from floor to speaker
    - 8’ high = space 20’ apart
    - 16’ high = space 30’ apart
    - Stagger on opposing walls
Know the requirements for ADA and your region

California:

11B-219.2 Required systems = An assistive listening system shall be provided in assembly areas, including conference and meeting rooms.

The minimum number of receivers to be provided shall be equal to 4 percent of the total number of seats, but in no case less than two...25% hearing aid compatible...building seats determine actual #...
Which is NOT a concern with audio outputs in our system?

A. Architectural Aesthetics and Application
B. Speaker dispersion patterns and placement
C. People with hearing loss and frequencies
D. What the audio source is
4 Steps of AV

Input Sources

Share It
SEE IT
HEAR IT
RECORD IT
STREAM IT
Recording
Step 3 – Distribute
4 Steps of AV

Input Sources

Share It

SEE IT

HEAR IT

RECORD IT

STREAM IT

Distribute
Audio & Control

- High Res Coax
- Shielded & Control
- Twisted Pair
- Fiber
- Plug & Play
Skew Free / Low Skew UTP

- Not to be used for Digital
- Mark with colored tag for easier identification
- Terminate with different colored jack than data
Audio over Ethernet

REPLACE THIS  WITH THIS
AND ROUTE IT ANYWHERE.

Dante
CobraNet
IEEE 802.1 AVB
Audio over Twisted Pair
Video over Ethernet

VIDEO OVER IP

Networked and SDI video connectivity
Over Ethernet – Switch Recommendations

**Dante Recommended Network Switch Features**
- No EEE or Green Ethernet features enabled
- Gigabit switches
- Unmanaged Switches
  - Single network switch applications
  - Dedicated Dante traffic
- Managed Switches
  - Multiple network switch applications
  - Mixed traffic
Over Ethernet – Switch Recommendations
Over Ethernet – Switch Recommendations

A: Unicast
L2/L3 network
Destination MAC and IP Address
MAC – 00:50:56:01:02:03
IP – 10.20.10.10

B: Broadcast
L2/L3 network
Destination MAC and IP Address
IP – 10.20.10.255

C: Multicast
L2/L3 network
Destination MAC and IP Address
MAC – 01:00:5E:01:02:03
IP – 239.1.1.100

You want a managed switch!
Figure 7-3
Minimum Recommended AV Infrastructure
Make sure to have data connections:

– At input locations
– At displays
– At processing and control equipment
Which is NOT a concern when it comes to distribution in our system?

A. Type of cable

B. What is the latest technology craze

C. Where inputs & outputs are located & data and power near

D. Size of conduits and outlet boxes and paths between
Step 4 – Process
4 Steps of AV

- Input Sources
- Process
- Distribute
  - Share It
    - SEE IT
  - HEAR IT
  - RECORD IT
  - STREAM IT
STEP 4 - Process

• Can be separate pieces of equipment or built into equipment used in step 2
  - Best to use separate
• Can be separate pieces of equipment for each option or one box can do several processing options
  - Save money and space with a box that does many features
Split

Distribution Amplifier
Supe Up (Strengthen)

Line Driver / Amplifier
Switcher for Audio
Matrix Switcher

[Diagram of a matrix switcher with DA and SW symbols]
Superimpose

Title Generator / Graphic Processor

Mixer for Audio
Side by Side

PIP Processor
PIP = Picture in Picture

Window Wall Processor
Swap

Scan Converter
Which is a correct statement?

A. You do not need to spend money on processing
   You can split signals using cables and adapters

B. Displays and sources will perfectly auto adjust their images
   to match after getting EDID settings

C. External processors are better than ones in displays

D. You will need a separate box for each processing option
Audio Processing

A Simple, Ideal Case

Program Source  Mixer  Signal Processor  Amplifier  Loudspeaker
Audio Processing

A Real-World System

"Line Level"

Program Source  Mixer  Signal Processor  Amplifier  Ldspk
**Audio Processing**

### Line Input Building Blocks – Gain Levels
- Individual gain is added based on operating level of the source (gain compensation)
- Target level -17dBFS (allow enough headroom)

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Operating Level</th>
<th>Gain Compensation</th>
<th>Target Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codec Rx</td>
<td>+4 dBu</td>
<td>0 dB</td>
<td>-17dBFS (+4dBu)</td>
</tr>
<tr>
<td>Program Audio</td>
<td>+4 dBu</td>
<td>0 dB</td>
<td>-17dBFS (+4dBu)</td>
</tr>
<tr>
<td>Computer Sound Card (analog)</td>
<td>0 dB</td>
<td>+3.6 dB</td>
<td>-17dBFS (+3.6dBu)</td>
</tr>
<tr>
<td>DVD Player</td>
<td>-10 dBv</td>
<td>+11.8 dB</td>
<td>-17dBFS (+11.8dBu)</td>
</tr>
<tr>
<td>Blu-ray Player</td>
<td>-10 dBv</td>
<td>+11.8 dB</td>
<td>-17dBFS (+11.8dBu)</td>
</tr>
<tr>
<td>iPod (analog)</td>
<td>0 dB</td>
<td>+1.8 dB</td>
<td>-17dBFS (+1.8dBu)</td>
</tr>
<tr>
<td>VCR/DVD Combo</td>
<td>-10 dBv</td>
<td>+11.8 dB</td>
<td>-17dBFS (+11.8dBu)</td>
</tr>
<tr>
<td>Pro Level CD/DVD Player (balanced)</td>
<td>+4 dBu</td>
<td>0 dB</td>
<td>-17dBFS (+4dBu)</td>
</tr>
</tbody>
</table>

### Wireless Microphone Building Blocks

<table>
<thead>
<tr>
<th>Microphone Type, Gain Level</th>
<th>Operating Level</th>
<th>Gain Compensation</th>
<th>Target Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless Mics (+4 dBu)</td>
<td>+4 dBu</td>
<td>0 dB</td>
<td>-17 dBFS (+4dBu)</td>
</tr>
<tr>
<td>Wireless Mics (-10 dBv)</td>
<td>-10 dBv</td>
<td>+11.8 dB</td>
<td>-17 dBFS (+11.8dBu)</td>
</tr>
<tr>
<td>Wireless Mics (-30 dBu)</td>
<td>-30 dBu</td>
<td>+34 dB</td>
<td>-17 dBFS (+34dBu)</td>
</tr>
</tbody>
</table>

EDSP – Building Blocks
Audio Processing
Audio Processing
Audio Processing - INPUT
Audio Processing

A Real-World System

Program Source  Mixer  Signal Processor  Amplifier  Ldspk
Audio Processing

Gain Structure – Not Optimized

Figure 1
Audio Processing

Gain Structure - Optimized
Audio Processing

The Signal Chain

Program Source  Mixer  Signal Processor  Amplifier  Ldspk

1mV  1V  10V  1V  100V  10V
Audio Processing

The Signal Chain

Program Source  Mixer  Signal Processor  Amplifier  LDspk

1mV  10V  10V  100V

"Sensitivity"

VU
Audio Processing
Audio Processing - OUTPUT
Audio Processing

The Signal Chain

Program Source → Mixer → Signal Processor → Amplifier → Ldspk

1mV → 10V → 10V → 100V → ?

VU meter
Audio Processing

Gain structure

Goal
- Maximize signal to noise ratio
- Maintain sufficient headroom for signal peaks

General procedure
- Use proper signal for calibration
- Follow the signal path—i.e., don’t start at the amplifier
  - Get the signal to operating level as soon as possible
  - Maintain unity gain
  - Adjust amplifiers last
- Use meters
Audio Processing

Summarizing

Audio signals can be measured in RMS, Peak or Full Scale values

- RMS gives a better idea on how loud a signal is
- Peak indicates where the signal is in relation to the limits of a sound system
- Full Scale indicates when digital saturation will occur

There’s no rule as to which meter to use where in the signal chain…but
### Meters

#### Scales compared

<table>
<thead>
<tr>
<th>Volts</th>
<th>dBu</th>
<th>VU</th>
<th>dBfs (SMPTE RP155)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.283V</td>
<td>24</td>
<td>+2</td>
<td>0 dBfs</td>
</tr>
<tr>
<td>9.757V</td>
<td>22</td>
<td>+2</td>
<td>-2 dBfs</td>
</tr>
<tr>
<td>7.750V</td>
<td>20</td>
<td>+2</td>
<td>-4 dBfs</td>
</tr>
<tr>
<td>6.156V</td>
<td>18</td>
<td>+2</td>
<td>-6 dBfs</td>
</tr>
<tr>
<td>4.890V</td>
<td>16</td>
<td>+2</td>
<td>-8 dBfs</td>
</tr>
<tr>
<td>3.884V</td>
<td>14</td>
<td>+2</td>
<td>-10 dBfs</td>
</tr>
<tr>
<td>3.085V</td>
<td>12</td>
<td>+2</td>
<td>-12 dBfs</td>
</tr>
<tr>
<td>2.451V</td>
<td>10</td>
<td>+2</td>
<td>-14 dBfs</td>
</tr>
<tr>
<td>1.947V</td>
<td>8</td>
<td>+2</td>
<td>-16 dBfs</td>
</tr>
<tr>
<td>1.546V</td>
<td>6</td>
<td>+2</td>
<td>-18 dBfs</td>
</tr>
<tr>
<td>1.228V</td>
<td>4</td>
<td>+2</td>
<td>-20 dBfs</td>
</tr>
<tr>
<td>0.976V</td>
<td>2</td>
<td>+2</td>
<td>-22 dBfs</td>
</tr>
<tr>
<td>0.775V</td>
<td>0</td>
<td>+2</td>
<td>-24 dBfs</td>
</tr>
<tr>
<td>0.616V</td>
<td>-2</td>
<td>+2</td>
<td>-26 dBfs</td>
</tr>
<tr>
<td>0.489V</td>
<td>-4</td>
<td>+2</td>
<td>-28 dBfs</td>
</tr>
<tr>
<td>0.388V</td>
<td>-6</td>
<td>+2</td>
<td>-30 dBfs</td>
</tr>
<tr>
<td>0.309V</td>
<td>-8</td>
<td>+2</td>
<td>-32 dBfs</td>
</tr>
<tr>
<td>0.245V</td>
<td>-10</td>
<td>+2</td>
<td>-34 dBfs</td>
</tr>
<tr>
<td>0.195V</td>
<td>-12</td>
<td>+2</td>
<td>-36 dBfs</td>
</tr>
<tr>
<td>0.155V</td>
<td>-14</td>
<td>+2</td>
<td>-38 dBfs</td>
</tr>
<tr>
<td>0.123V</td>
<td>-16</td>
<td>+2</td>
<td>-40 dBfs</td>
</tr>
<tr>
<td>97.6mV</td>
<td>-18</td>
<td>+2</td>
<td>-42 dBfs</td>
</tr>
<tr>
<td>77.5mV</td>
<td>-20</td>
<td>+2</td>
<td>-44 dBfs</td>
</tr>
<tr>
<td>61.6mV</td>
<td>-22</td>
<td>+2</td>
<td>-46 dBfs</td>
</tr>
<tr>
<td>48.9mV</td>
<td>-24</td>
<td>+2</td>
<td>-48 dBfs</td>
</tr>
</tbody>
</table>

**“Unity Gain”**
Audio Processing

Gain structure

Adjust input gain for proper operating level
- Use peak meters
- Adjust gain until the peak indicator starts to flash
  - Usually 3~6dB before actual clipping
- Then reduce gain 6~12dB to provide additional headroom

Maintain unity gain throughout the signal chain
- Maintain faders and level controls at 0dB
- Compensate level where needed
Audio Processing

- Mixer = Combines sound levels
- Equalizer = adjust frequencies (filter or enhance)
- Reverb and Delay = adjust for reflections
- Compressors & Limiters = adjust frequency range
- Gates and Expanders = eliminate low noise
Audio Processing

– Mixer = Combine sound levels
Automatic mixer suggested settings:

- Threshold: -40 dB
- Attenuation: -40 dB
- Attack: 1.0 ms
- Release: 50 ms
- NOM Gain: On
- Hold: 1.0 seconds
- Last Mic: Last
- NOM Limit: 4
Audio Processing

- EQ

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– EQ – Starting Points

**Vocals**
- < 200 Hz: Cut for clarity
- 150 Hz – 600 Hz: Warmth
- 500 Hz – 2 kHz: Nasal (Cut to eliminate) Around 350
- 3 kHz – 5 kHz: Sibilance (Cut to eliminate) Around 2750
- 1.5 kHz – 8 kHz: Clarity and Presence 2-4K sweet spot
- 10 kHz+: Airy (Breathy)
– EQ

First, understand that prerecorded program sources like Blu Rays, DVDs, and music CDs have been optimized as audio sources when produced.

Therefore, other than gain, these sources do not need any other input processing.

If these don’t sound good through the system loudspeakers, look to improper equalization on the output processing strip feeding the loudspeakers.
EQ

Input source parametric equalization is only for:
- Microphone
- Telephone
- CODEC optimization

Fixing its response if:
- It is too thin or tinny
- Has too much bass

To notch out feedback ringing in the case of local mics
Audio Processing

– Filters

- Low Pass Filter
- Low Shelf Filter
- All Pass Filter - 3 Band
- Uber Filter - 7 Filter

4 Way Crossover

BICSI FALL Conference & Exhibition
E.R.I.C. Low Voltage Services
Bicsi
Audio Processing

– Filters

<table>
<thead>
<tr>
<th>Filters</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Use High Pass Filters on speech microphones to reduce rumble</td>
</tr>
<tr>
<td>• Use Low Pass Filters on conferencing microphones to reduce noise and reflections in problematic rooms</td>
</tr>
<tr>
<td>• Boost to 2KHz range for enhanced speech intelligibility</td>
</tr>
<tr>
<td>• User higher “Q” filters to remove unwanted resonances</td>
</tr>
</tbody>
</table>
Audio Processing

– Dynamics
Input CoMPression (CMP):

A compressor is used to reduce the level of overly loud signal sources.

Since recorded and broadcast sources are already level-limited, only microphone, telephone and CODEC conference sources can benefit from compression.

A good rule of thumb for setting parameters of an Avia input compressor is:

- Threshold: -12 dB, Ratio: 3:1
- Attack: 5.0 ms, Release: 50 ms
- Soft knee: On, Makeup gain: Off

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Input Automatic Gain Control (AGC):

Automatic Gain Control (AGC) is generally used in broadcasting to limit the dynamic range of a signal source whose nominal level varies too much.

It is tempting to employ AGC for that soft talker who is afraid to speak loudly into their mic, and isn’t loud enough in the local loudspeakers.

But often feedback will occur before they are loud enough.

AGC should only be used if absolutely necessary, and only on remote outputs like far-end teleconferencing telephones & CODECs or recording feeds.
Output LIMiter (LIM):

To prevent excessive output levels:
- Threshold: -3 dB
- Ratio: 20:1
- Attack: 0.1 ms
- Release: 50 ms
- Soft knee: ON
- Makeup Gain: 0 dB

For a 14-dB crest factor (headroom):
- Threshold: -10 dB
- Ratio: 10:1
- Attack: 0.1 ms
- Release: 50 ms
- Soft knee: ON
- Makeup gain: +6 dB
# Audio Processing

## Dynamics

- Use limiters on outputs to amplifiers and recording devices to prevent overdriving
- Use compression on microphones:
  - 2:1 to 4:1 on conversational speech
  - 4:1 to 6:1 on lecture/presentation
  - 4:1 or greater on dynamic instruments
- Use gates on conferencing microphones when automixing is not used
- Use AGC on telephone and recording device feeds
### Audio Processing

<table>
<thead>
<tr>
<th>Automixing</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Use gated automixing for conferencing</td>
</tr>
<tr>
<td>- Use gain sharing automixing for panel discussions and recording applications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Equalize using a “subtractive” process (use cut rather than boost)</td>
</tr>
<tr>
<td>- Understand the bandwidth of any content</td>
</tr>
<tr>
<td>- Know loudspeaker frequency response and power handling capabilities</td>
</tr>
<tr>
<td>- Perform delay alignments before performing equalization</td>
</tr>
<tr>
<td>- Understand the target levels for your application</td>
</tr>
<tr>
<td>- Understand how to accurately use your test equipment</td>
</tr>
<tr>
<td>- Practice</td>
</tr>
</tbody>
</table>
Audio Processing

Room Acoustics

- Reflection
- Absorption
- Diffusion
Which is a correct statement?

A. Start with the amplifier and work back to set levels

B. Amplifiers can handle any level sent to them and you just attenuate the signal if it is too loud

C. Processing can fix any audio issue and especially if you use a lot of processing options

D. Get input to Unity Gain asap and then maintain throughout
Audio Amplifiers

Constant Voltage Easy:
Calculate 80% of Power
(example: 100w = 80%)
Tap speakers so that total amount of taps is within that range
Audio Amplifiers

Rules of Thumb

1. Get an amp 50% more powerful than your speakers.

At minimum – 20%
Audio Amplifiers
Audio Amplifiers

CEA Compliant

Certifies that your amplifier’s output power ratings are real power numbers, not inflated marketing ratings.
Audio Amplifiers

Rules of Thumb

1. Get an amp 50% more powerful than your speakers.

- 2000 watts
- 2000 watts

<table>
<thead>
<tr>
<th>Continuous Power Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS</td>
</tr>
<tr>
<td>Program</td>
</tr>
</tbody>
</table>
Audio Amplifiers

Rules of Thumb

1. Get an amp 50% more powerful than your speakers.

\[ \text{amp} \rightarrow 500 \text{ watts} \]

\[ \text{cloud} \rightarrow 500 \text{ watts} \]
Under-Powered Amp Nearing MAX Output

Distortion

Damaged Voice Coil
Audio Amplifiers

Rules of Thumb

1. Get an amp 50% more powerful than your speakers.

\[ \frac{500 + 250}{750 \text{ watts}} \]

Math

\[ 50\% \times 500 \text{ watts} = 250 \text{ watts} \]
Audio Amplifiers

Rules of Thumb

2. Match your speakers' ohms to the ohms your amp can handle.

- 44, 8, 16 ohms

Diagram:

- 750 watts in 4 ohm load
- 500 watts in 8 ohm load
- Channel 1 and Channel 2
- Amp 1 and Amp 2
Audio Amplifiers

Rules of Thumb

1. Choose your amplifier
   • 4, 8, 16 ohms

2. Match your speakers' ohms to the ohms your amp can handle.
   - Math: 4÷2 = 2 ohms
   - Example: 4 ohms 2 speakers

Channel 1 Amp 2
Audio Amplifiers

Rules of Thumb

2. Match your speakers' ohms to the ohms your amp can handle.
Single Voice Coil
One length of wire wrapped around former

Dual Voice Coil
Two lengths of wire wrapped around former
Audio Amplifiers

When you wire voice coils in series, you will simply add the resistance of all the voice coils to know what the impedance will be at the amplifier.

The coils do not need to be the same impedance but it will affect how much power each speaker receives from the amplifier.

It is never recommended to mix impedances of speakers connected to the same terminals.

If all of the coils are the same impedance, it is very easy to calculate final impedance. You will take the impedance of the voice coils and divide by the number of voice coils. This formula only works if all the voice coils are the same impedance.

You have two 4 Ω speakers and an 8 Ω speaker:

\[
\frac{1}{4 \, \Omega} + \frac{1}{4 \, \Omega} + \frac{1}{8 \, \Omega} = \frac{1}{R_{\text{total}}}
\]

\[
.25 + .25 + .125 = \frac{1}{R_{\text{total}}}
\]

\[
.625 = \frac{1}{R_{\text{total}}}
\]

\[
R_{\text{total}} = 1.6 \, \Omega
\]

***not all the speakers will get the same power
Daisy chain the + on speakers to the + on the amp
Daisy chain the – on the speakers to the – on the amp
Home run a + then send the – of that speaker to the + of the next
Continue to last speaker and then home run -
Need 4 Single Coil speakers.
Should have even number of voice coils
If all four speakers have the same impedance, with series-parallel wiring, the final impedance will be the same as the impedance of a single speaker.

4 Single Coil 4 \( \Omega \) speaker OR 2 Dual Coil 4 \( \Omega \) speakers

\[
4 \, \Omega + 4 \, \Omega \parallel 4 \, \Omega + 4 \, \Omega = 4 \, \Omega \\
8 \, \Omega \parallel 8 \, \Omega = 4 \, \Omega
\]
Over-Powered Amplifier

COOLER

Amplifier Power Output

2 Ohms
700W RMS
runs WARM

4 Ohms
350W RMS
runs COOL
250W RMS 4 ohm

1,000W RMS 1 ohm

Four 4 ohm subs wired in parallel equals a 1 ohm load!
Standard meter (DC)  Impedance meter (AC)
OUTPUT LOADING
Loading 8Ω Minimum for
1 x 8Ω Speaker, or 2 x 16Ω Speakers
100V (100 Volt Line)
30 Watts Maximum or 333Ω.
MID POWER AMPLIFIER

HIGH POWER AMPLIFIER

REMEMBER

THE POWER AMPLIFIER IS DEPENDENT ON THE AC POWER SOURCE TO PRODUCE THE POWER IT WAS DESIGNED TO DELIVER
Amplifier sizing:

Class D amplification is fairly efficient, so given 80% efficiency:

A single 15-amp circuit at 120 VAC delivers 1800 watts (15 X 120) of long-term power, so no matter what an amplifier’s power rating is, the AC circuit is the limiting factor.
IF THE AC SOURCE IS NOT CLEAN,

HUM

OR IF PROPER GROUNDING IS NOT IMPLEMENTED,
There is a voltage difference between the ground points on each outlet.

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Visit www.alectrosystems.com to learn more about Professional Audio and Video
PROPER SETTINGS
Bridged Mono

Push - CH. 1

Pull - CH. 2
Which is NOT a correct statement?

A. Use an amp 20-50% more than your speakers

B. Speaker wiring and total does not change resistance

C. A standard meter can be used to check a lot in audio but to measure resistance you should use an impedance meter

D. You have to pay attention to settings and power for amplifiers to ensure best audio
Sound Pressure Level –SPL:

Loudspeaker Sensitivity: dB
SPL 1 watt @ 1 meter
Power: +3dB for every 2x watts
Distance: -6dB for every 2x distance
• 0dB faintest audible sound
• 50-60dB normal conversation
• 120dB painful

96 dB SPL @ loudspeaker 1W/1M
+ 24 dB (250 W) [8 x 3dB] Amplifier Gain
-30 dB (32 M) [5 x -6dB] Distance Loss

-------------------
90 dB SPL at the listener

Doubling
1
2
4
8
16
32
64
128
256
To make the system appreciably louder, the amplifier should be replaced with an amplifier 4 to 10 times more powerful

- 4X the power = 6 dB louder, which is perceptively louder in volume
- 10X the power = 10 dB louder, which is perceptively twice as loud
- Be sure that the existing loudspeakers can handle the additional power
Crestron – “If you are without a 70-volt amplifier, but need to drive a 70-volt loudspeaker line, a low-impedance amplifier channel rated for 600 watts @ 8 ohms supplies a 69-volt line, for a 100-volt line, 1250 watts @ 8 ohms”
PAG/NAG (Potential Acoustic Gain/Needed Acoustic Gain):

Definitions:
- **D0** Talker-to-farthest-listener distance
- **D1** Mic-to-closest-loudspeaker distance
- **D2** Listener-to-closest-loudspeaker distance
- **DS** Talker-to-mic distance
- **EAD** Equivalent Acoustic Distance, the desired virtual distance between the talker and furthest listener
- **NOM** Number of Open Microphones, always set to 1 when using automatic mixer function
- **FSM** Feedback Stability Margin
Potential Acoustical Gain:

P.A.G. = Potential Acoustic Gain

\[
P.A.G. = 20 \log_{10} \left( \frac{D_1}{D_3} \times \frac{D_0}{D_2} \right) \text{ in decibels}
\]
PAG/NAG (Potential Acoustic Gain/Needed Acoustic Gain):

NAG formula:
• $\text{NAG} = 20\log(\frac{D_0}{EAD})$

For example (imperial):
• $\text{NAG} = 20\log(50 \text{ ft./} 8 \text{ ft.})$
• $\text{NAG} = 20\log(6.25)$
• $\text{NAG} = 15.9 \text{ dB}$
PAG/NAG (Potential Acoustic Gain/Needed Acoustic Gain):

PAG = 22.5 dB [22.4 dB]
NAG = 15.9 dB [15.6 dB]

PAG > NAG

The system parameters will provide enough gain-before-feedback to acoustically locate all listeners within 8 ft. [2.5 m] of the talker.
AEC
Which is NOT a correct statement?

A. You will have to do a lot of math to get best audio

B. If a person on the far end is hearing themselves in a conference call it is a problem on your side with AEC

C. Feedback issues are due to frequency and distances

D. The most secured and easiest method of video conferencing is still with a codec and not soft conferencing
Step 5 – Control
• Control processor with touch panel/software app
• Button panel
• Browser control
• Control anything with
  - Serial
  - IR
  - Ethernet
  - Relay /Contact Closure
Infrared Emitter

Screen Interface

RS232 Cable

Cresnet Wiring

Projector Lift

Gnd—Pin 4 Blk
Z—Pin 3 Wht
Y—Pin 2 Grn
24V—Pin 1 Red
Programmable Systems
Configurable Systems
Conprogable Systems
Which is NOT a correct statement?

A. You have to have years of training to be a good programmer

B. As long as a device has Ethernet, Serial, IR, Contact, or Relay control capabilities we can control it with AV system

C. The type of user interface for controls depends on inputs and outputs and user perception to simplicity
Let’s Put into Practice
Let’s Put into Practice
What you do, ask, and look for in a job walk/review?

- Determine sources & outputs – “Uses of system”
  - Determine locations, distances, pathways
  - What’s existing – likes and dislikes
  - Customer Expectations
- Determine existing network and required additions
  - Who are the contacts and roles
  - Expected timelines
Let’s Put into Practice
What tools do you need on a job walk?
  - Camera
  - Digital Notepad
  - Distance Meter
  - Stud finder
  - Ladder & Tools for access
  - Keys
Let’s Put into Practice

Scenario 1
Customer wants a VHS with composite output, Blu Ray with HDMI output, Rack PC with Display Port Output, and Laptop Show on a TV in a room that seats about 6 people
Does not want multiple remote controls
Scenario 1

Inputs = Customer wants a VHS
Scenario 1

Inputs = Customer wants a Blu Ray

VHS → Composite → Scan Converter → HDMI → Blu Ray

HDMI → Bluetooth

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2020 E.R.I.C. Low Voltage Services
Scenario 1
Inputs = Customer wants a Rack PC

- VHS
  - Composite
  - Scan Converter
  - HDMI

- Blu Ray
  - HDMI

- Rack PC
  - Display Port
Scenario 1

Inputs = Customer wants a Rack PC
Scenario 1

Inputs = Customer wants a Laptop
Scenario 1
Outputs = Customer wants a TV

- VHS
  - Composite
  - Scan Converter
    - HDMI

- Blu Ray
  - HDMI

- Rack PC
  - Display Port
  - Adapter
    - HDMI

- Laptop
  - VGA (with audio)
  - Wall Plate
    - CAT 6 Shielded

TV
  - HDMI
Scenario 1
Process The Signal

VHS
- Composite
- Scan Converter
- HDMI

Blu Ray
- HDMI

Rack PC
- Display Port
- Adapter
- HDMI

Laptop
- VGA (with audio)
- Wall Plate
- CAT 6 Shielded
- HDMI

Switcher
- Scaler

TV
- HDMI
Scenario 1

Control = Customer wants one remote

1. VHS
   - Composite
2. Blu Ray
   - HDMI
3. Rack PC
   - Display Port
4. Laptop
   - VGA (with audio)

Switcher
Scaler
On
Off
VHS
Blu Ray
Rack PC
Laptop
Vol+
Vol-
8 Button Controller
With Transport Companion Buttons

IR
1 2
Let’s Put into Practice

Scenario 2

2 - Divisible Room with TV tuners, Floor Box Input, BYOD

Automatic Switch of controls based on wall status

Projector in each room and monitor at lectern

Want Lesson capture/Streaming
Scenario 2

Inputs = Customer wants TV Tuners

- Tuner 1
- Tuner 2

HDMI

HDMI
Scenario 2

Inputs = Customer wants Floor Box Inputs

- Tuner 1
  - HDMI
- Tuner 2
  - HDMI
- FB 1
  - CAT 6 Shielded
- FB 2
  - CAT 6 Shielded
Scenario 2
Inputs = Customer wants B.Y.O.D.

- Tuner 1
  - HDMI

- Tuner 2
  - HDMI

- FB 1
  - CAT 6 Shielded

- FB 2
  - CAT 6 Shielded

- Wireless Collab
  - HDMI

- Wireless Collab 2
  - HDMI
Scenario 2

Outputs = Customer wants Projectors and Monitors

- Tuner 1
  - HDMI
- Tuner 2
  - HDMI
- FB 1
  - CAT 6 Shielded
- FB 2
  - CAT 6 Shielded
- Wireless Collab
  - HDMI
- Wireless Collab 2
  - HDMI

- CAT 6 STP
- Scaling Receiver
- HDMI
- Projector 1
- CAT 6 STP
- Scaling Receiver
- HDMI
- Projector 2
- CAT 6 STP
- Scaling Receiver
- HDMI
- Monitor 1
- CAT 6 STP
- Scaling Receiver
- HDMI
- Monitor 2
Scenario 2

Outputs = Customer wants Lesson Capture and Streaming
Scenario 2

Connect our Video Pieces

Tuner 1
HDMI

Tuner 2
HDMI

FB 1
CAT 6 Shielded

FB 2
CAT 6 Shielded

Wireless Collab
HDMI

Wireless Collab 2
HDMI

Matrix Switch

CAT 6 STP
Scaling Receiver
HDMI
Projector 1

CAT 6 STP
Scaling Receiver
HDMI
Projector 2

CAT 6 STP
Scaling Receiver
HDMI
Monitor 1

CAT 6 STP
Scaling Receiver
HDMI
Monitor 2

HDMI
L.C.

HDMI
Streaming Box

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E.R.I.C. Low Voltage Services
Scenario 2
Don’t Forget the Audio! = Inputs

Mic Receiver 1       STP 22
Mic Receiver 2       STP 22
Scenario 2
Don’t Forget the Audio! = Outputs
Scenario 2
Don’t Forget the Audio! = Process
Scenario 2
Don’t Forget the Audio!

Matrix Switch

Mic Receiver 1

Mic Receiver 2

DSP

AMP

L.C

Stream

Room 1 Speaker

Room 2 Speaker

STP 22

STP 22

STP 22

STP 22

STP 22

STP 22

SPK

SPK
Scenario 2
Don’t Forget Control!

Controller
Scenario 2
Don’t Forget Control!

Tuner 1
IR Emitter

Tuner 2
IR Emitter

Controller
Scenario 2
Don’t Forget Control!

Tuner 1
IR Emitter

Tuner 2
IR Emitter

Controller

FB?

FB?
Scenario 2
Don’t Forget Control!

Tuner 1
IR Emitter

Tuner 2
IR Emitter

DSP
Com 1

Controller

FB?
FB?
Scenario 2
Don’t Forget Control!

- Tuner 1
- Tuner 2
- IR Emitter
- Controller
- Projector 1
- Projector 2
- Monitor 1
- Monitor 2
- DSP
- Com 1
- Com 2
- Com 3
- IR Emitter
Scenario 2
Don’t Forget Control!

Controller

IR Emitter

Tuner 1
IR Emitter
Tuner 2

DSP

Com 1
CAT 6
LAN

Projector 1
Com 2
IR Emitter

Projector 2

Com 3
IR Emitter

Monitor 1
IR Emitter

Monitor 2
Scenario 2
Don’t Forget Control!

- Tuner 1
- Tuner 2
- IR Emitter
- IR Emitter
- FB?
- FB?
- Projector 1
- Projector 2
- Monitor 1
- Monitor 2
- Controller
- Com 1
- Com 2
- Com 3
- CAT 6
- STP 22
- Divisible Room Sensor
- LAN
- Stream
- Touch Panel 1
- Touch Panel 2
- DSP
- CAT 6
- CAT 6
- CAT 6
- CAT 6
- CAT 6
- CAT 6
- CAT 6
- CAT 6
Let’s Put into Practice

Scenario 3

Board Room with – Rack Pc, 1 Table inputs, BluRay, TV Tuner, 1 Guest Input, Document Camera, Two Room Cameras

2 Side TVs for Audience

10 preview monitors for Board Table

Recording Streaming

Video Conference

Soft Codec conferencing
Scenario 3

Inputs = Customer wants Rack PC
Scenario 3

Inputs = Customer wants Table Input

Rack
PC

HDMI

VGA w/audio

Table
Switcher

HDMI

D.P

CAT 6 STP
Scenario 3

Inputs = Customer wants Blu Ray

- Rack
- PC
- VGA w/audio
- Table Switcher
- Blu Ray
- HDMI
- CAT 6 STP
Scenario 3

Inputs = Customer wants TV Tuner
Scenario 3
Inputs = Customer wants Guest Input

- Rack PC
  - HDMI
- VGA w/audio
- Blu Ray
  - HDMI
- Tuner
  - HDMI
  - VGA w/audio
- Table Switcher
  - HDMI
  - CAT 6 STP
- Guest Input
  - HDMI
  - CAT 6 STP
Scenario 3
Customer wants a Document Camera

- Rack
- PC
- VGA w/audio
- HDMI
- D.P
- HDMI
- Table Switcher
- CAT 6 STP
- Blu Ray
- HDMI
- Tuner
- VGA w/audio
- HDMI
- Guest Input
- CAT 6 STP
- Doc CAM
- HDMI
- Tx
- CAT 6 STP
Scenario 3
Customer wants 2 Room Cameras

- Rack PC
- VGA w/audio
- HDMI
- Table Switcher
- Blu Ray
- Tuner
- VGA w/audio
- HDMI
- Guest Input
- HDMI
- Doc CAM
- HDMI
- Cam 1
- HDMI
- Cam 2
- HDMI
- Doc CAM
- HDMI
- Cam 1
- HDMI
- Cam 2
- HDMI
Scenario 3

Process = Connect to Matrix
Scenario 3

Don’t Forget Outputs

Matrix Switcher

HDMI
Tx
CAT 6 STP
Rx
HDMI
TV 1

HDMI
Tx
CAT 6 STP
Rx
HDMI
TV 2
Scenario 3

Don’t Forget Outputs

Matrix Switcher

HDMI

Tx

CAT 6 STP

Rx

HDMI

TV 1

HDMI

CAT 6 STP

HDMI

TV 2

HDMI

Distribution Amplifier

CAT 6 STP

(8x)

Rx

Monitor

(8x)

Distribution Amplifier

CAT 6 STP

(2x)

Rx

Monitor

(2x)
Scenario 3

Don’t Forget Outputs

Matrix Switcher

- Tx HDMI
- Rx CAT 6 STP
- TV 1 HDMI
- TV 2 HDMI

- Distribution Amplifier
  - Tx HDMI
  - Rx CAT 6 STP (8x)
- Monitor (8x)

- Distribution Amplifier
  - Rx CAT 6 STP (2x)
- Monitor (2x)

- R.S.
  - CAT 6 STP
- Video Conference HDMI

- AV Bridge
  - USB

- 1 HDMI
Scenario 3

Don’t Forget Outputs

Matrix Switcher

HDMI

Tx  CAT 6 STP  Rx  HDMI

Tx  CAT 6 STP  Rx  HDMI

Distribution Amplifier  CAT 6 STP (8x)  Rx  Monitor (8x)

Distribution Amplifier  CAT 6 STP (2x)  Rx  Monitor (2x)

R.S.  CAT 6 STP  AV Bridge

Video Conference

HDMI

USB

1

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Bicsi
Scenario 3
USB Connection
Scenario 3

We need Audio De embedders
Scenario 3

We need Audio De-embedders
Scenario 3
Don’t Forget Audio

A.D. Source
STP 22
STP 22 (10x)

A.D. Source BluRay/CD
STP 22
Scenario 3
Don’t Forget Audio
### Scenario 3

Don’t Forget Audio

<table>
<thead>
<tr>
<th>A.D. Source</th>
<th>STP 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Mics (10x)</td>
<td>STP 22 (10x)</td>
</tr>
<tr>
<td>Lectern Mic</td>
<td>STP 22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A.D. Source</th>
<th>STP 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>BluRay/CD</td>
<td></td>
</tr>
</tbody>
</table>
Scenario 3

Don’t Forget Audio
Scenario 3
Don’t Forget Audio

A.D. Source
Table Mics (10x)
Lectern Mic
Wireless Rx
Wireless Rx 2
VTC

A.D. Source
BluRay/CD
Scenario 3
Don’t Forget Audio

- A.D. Source: STP 22
- Table Mics (10x): STP 22
- Lectern Mic: STP 22
- Wireless Rx: STP 22
- Wireless Rx 2: STP 22
- VTC: STP 22
- S.C. AV Bridge: STP 22 Remote, STP 22 Reference
- A.D. Source BluRay/CD: STP 22
Scenario 3
Don’t Forget Audio
Scenario 3
Don’t Forget Audio
Scenario 3
Don’t Forget Audio
Scenario 3
Don’t Forget Audio
Scenario 3

Don’t Forget Audio
Scenario 3
Push to Talk Buttons
| Table Switcher | RS 232 |

Scenario 3
Don’t forget Control!
Scenario 3
Don’t forget Control!

Table Switcher
RS 232

Guest Input?
Scenario 3
Don’t forget Control!

Table Switcher
Guest Input?
Doc Cam

RS 232
Scenario 3
Don’t forget Control!

Table Switcher
RS 232

Guest Input?
RS 232

Doc Cam
RS 232

Cam 1
RS 232

Cam 2
RS 232
Scenario 3
Don’t forget Control!

Table Switcher | RS 232
Guest Input? | RS 232
Doc Cam | RS 232
Cam 1 | RS 232
Cam 2 | RS 232
Tuner | IR Emitter
Scenario 3
Don’t forget Control!

- Table Switcher: RS 232
- Guest Input?: RS 232
- Doc Cam: RS 232
- Cam 1: RS 232
- Cam 2: RS 232
- Tuner: IR Emitter
- B.R.: IR Emitter
Scenario 3
Don’t forget Control!
Scenario 3
Don’t forget Control!
Scenario 3
Don’t forget Control!

Table Switcher
Guest Input?
Doc Cam
Cam 1
Cam 2
Tuner
B.R.

AV Controller
RS 232
RS 232
RS 232
IR Emitter
IR Emitter

LAN

For Monitors at table
Power Supply with Ethernet Control
Scenario 3
Don’t forget Control!

Table Switcher
Guest Input?
Doc Cam
Cam 1
Cam 2
Tuner
B.R.

RS 232
RS 232
RS 232
IR Emitter
IR Emitter

AV Controller

Power Supply with Ethernet Control

TV 1
TV 2

LAN
Ethernet Connection
Scenario 3
Don’t forget Control!

AV Controller

- Table Switcher
- Guest Input?
- Doc Cam
- Cam 1
- Cam 2
- Tuner
- B.R.

- RS 232
- RS 232
- RS 232
- IR Emitter
- IR Emitter

- Power Supply with Ethernet Control
- AV Bridge

- TV 1
- TV 2

Ethernet Connection

LAN
Scenario 3
Don’t forget Control!

- Table Switcher
- Guest Input?
- Doc Cam
- Cam 1
- Cam 2
- Tuner
- B.R.
- AV Controller
- Power Supply with Ethernet Control
- TV 1
- TV 2
- AV Bridge
- VTC
- LAN
- Ethereum Connection
4 Steps of AV

Input Sources -> Process

Distribute

Share It
- SEE IT
- HEAR IT
- RECORD IT
- STREAM IT
5th Step of AV

Control

Input Sources

Process

Share It
SEE IT
HEAR IT
RECORD IT
STREAM IT
Feel free to contact me:

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Teamviewer Quick Support Module = https://get.teamviewer.com/9ry6cvs