Simplifying Your K-12 and Conference Room AV Applications and Installations

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Today's Presenters

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Introduction

Simplicity, Usability, and Cost

Simplicity

- **Definition:**

  sim·ple

  1. Easily understood or done; presenting no difficulty
  2. Straightforward, easy, uncomplicated, effortless, **painless**

Simplicity

AV system design

"In ^ ~~machinery~~ as in life, simplicity is the ultimate sophistication."

Simplicity in AV Systems

- **At least 3 ways to think about this:**
  - Simple in that the AV solution consists of few components that are easily installed and maintained
  - Simple in that anyone can intuitively walk up and use the AV system
  - Simple in that everything is automated so the user should only have a single button to push
- **Different meaning for different stakeholders**
  - The installer wants simple to place, connect and make work without callbacks
  - The customer wants simple for the least cost to install and maintain and the fastest installation
  - The end user wants simple to use so the experience is efficient and pleasant without frustration
- **But for each, the goal is the same: to create a system that is as painless as possible**

Usability in AV Systems

- **The end user is the ultimate judge of a an AV system – will they use it or not?**
- **In classrooms and conference rooms we see a wide variety of users who infrequently utilize the system**
- **Every user is looking for:**
  - Intuitive control for ON/OFF
  - Instant ON and feedback that the system is working
  - Easy and fast connection of a variety of devices; free from configuration and setting changes
  - Dependability that does not require time-wasting system resets or panic calls to the IT/AV support person
- **Again, the goal is a system that is painless to use**

Cost in AV Systems

- The AV system is usually the very last system to be installed and is often the last system to be adequately budgeted for
- In schools we find conflict between the budget and the number of classrooms that can be outfitted with a chosen technology
- Sometimes in commercial spaces there is no budget at all and an AV system upgrade is driven by a component failure such as a display or projector
- Often, the total lifecycle cost that includes maintenance and upgrades over the lifetime of the system is overlooked

Cost in AV Systems

- **Components of AV system lifecycle cost**
  - Display or projector – usually 60-80% of the room budget
  - Control – can dominate the budget
  - Signal scaling and switching – usually a necessity
  - Connectivity from source(s) to display(s) – usually a few % of the room budget
  - Maintenance
    - Projector lamps
    - Device failure
    - Control software updates
    - Connectivity updates to accommodate newer technology (e.g. VGA to 1080p to 4K)
    - Service calls

Cost in AV Systems

- **Reducing complexity**
  - **Reduces initial system cost and lifecycle cost**
  - **Frees up budget for larger displays or better projectors**
  - **Enables deployment in additional rooms**
  - **Makes the budget process as painless as possible**

Simplicity, Usability, and Cost

- **What is the first thing to happen when a teacher or executive begins a class session or a meeting?**
  - Frustration and wasted time (and money) in using the audio video technology
    - Where is the ON switch?
    - Where is the remote?
    - What screen do I need on this touchpanel?
    - How do I adjust the audio volume?
    - Why hasn't the projector come on?
    - Where is the IT support phone number?
    - Who gave us all of this costly complexity that doesn't work?
    - Get them in here to fix it!

Simplicity, Usability, and Cost – Our Goal for Today

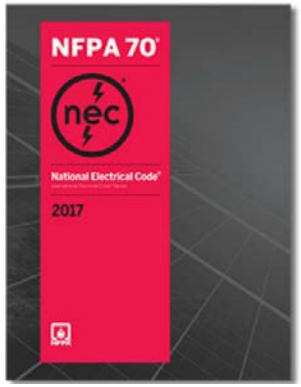
- **Provide practical techniques and tools for evaluating and simplifying classroom and conference room AV requirements**
  - Balancing the diverse functions desired by the end user against the complexity and cost of the system
- **Help with potential end-user experience enhancements**
  - Creating a solution that is intuitive to use for a wide range of non-technical users
- **Provide guidelines for cost effective design of dependable systems**
  - Providing a durable infrastructure platform with upgrade capability
- **Provide you with some tools to help you make money and grow your business**

Rules of the Road

Ground Rules in the Discussion

Electrical Codes and Standards

Electrical Codes

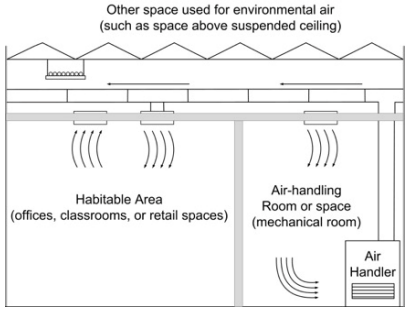


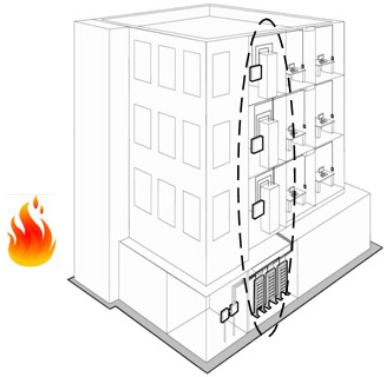
- **National Electrical Code**
- **The NEC or NFPA 70 is enforced in the United States**
- **Published by the National Fire Protection Association (NFPA)**
- **Revised on a three year schedule**
- **The current edition is the 2017 NEC**
- **Covers the installation of:**
  - Communications and optical fiber cabling
  - Equipment and raceways
  - Public and private premise
- **Sections of the NEC relative to audiovisual and telecommunications include:**

Article	Description
100	Definitions
250	Grounding and Bonding
250.126	Equipment Grounding
300	Wiring Methods
640	Audio Signal Procession, Amplification
770	Optical Fiber Cables and Raceways
800	Communications Circuits & Equipment

Electrical Codes

- **Cable Markings**
  - National electrical codes require that cables are marked with their fire resistance and smoke ratings that are listed for use in the specific type of building or building space where they are to be installed.
- **Plenum Spaces**
  - Any compartment or chamber within a building that is connected to one or more air ducts and is part of the air distribution system
  - Plenum rated materials shall be listed to have adequate fire resistance and low smoke producing characteristics
  - Plenum rated cables, innerduct and other materials are required for use in ducts, plenums and other building spaces used for handling environmental air
  - This requirement applies to the space above a suspended ceiling if it is used for environmental air handling purposes. If non-plenum cables are used in these areas, they must be placed in metal conduit
- **Riser Spaces**
  - Non-plenum vertical runs in a shaft or space, typically from floor to floor
  - Riser rated cables, innerduct, and materials shall be listed to have fire resistant characteristics capable of preventing a fire from spreading from floor to floor





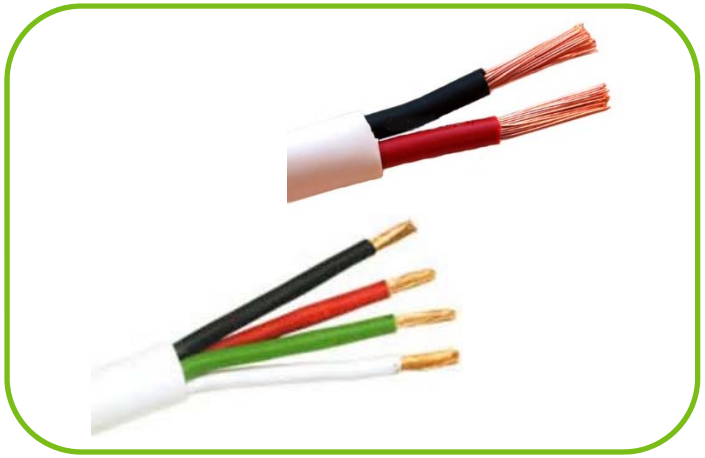
Electrical Codes

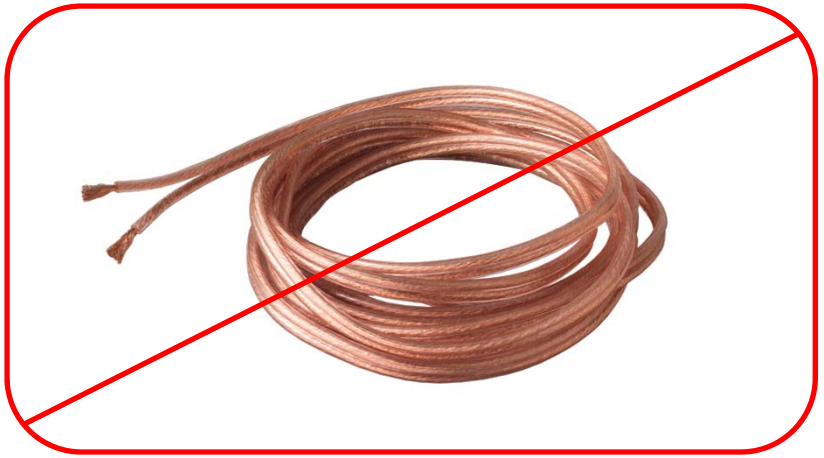
- **General AV Cable Markings**
- **In-wall Speaker, Video and Audio Cable Markings**

NEC 725.154(G)	Application	Permitted Substitutions
CMP	Plenum spaces	none
CL3P	Class 3 Plenum (UL listed to 300v)	CMP
CL2P	Class 2 Plenum (UL listed to 150v)	CMP, CL3P
CMR	Riser cable	CMP
CL3R	Class 3 Riser (UL listed to 300v)	CMP,CL3P, CMR
CL2R	Class 2 Riser (UL listed to 150v)	CMP,CL3P, CMR, CL3R
CL3	Class 3 (UL listed to 300v)	CMR, CMP
CL2	Class 2 (UL listed to 150v)	CMR, CMP

Electrical Codes

- **Use Appropriate Cable!**





Industry Standards

- **Standards organizations include:**
- **ANSI – Oversees standards creation and accredits standards organization in the US**
- **BICSI – Global best practices for information transport systems (ITS)**
- **HDBaseT – An IEEE industry connectivity standard. Utilizing a single category cable for AV distribution**
- **IEEE – Develops technology and standards for computer networking**
- **InfoComm – Develops professional Audio Visual standards**
- **ISO – Largest developer and publisher of International Standards**
- **SMPTE – Society of Motion Picture and Television Engineers**
- **TIA – Telecommunications sector of ANSI. Develops US telecommunications Standards**
  - Certain standards produced by the Telecommunications Industry Association, International Organization for Standardization and Institute of Electrical and Electronics Engineers significantly affect the design, installation and performance of structured cabling systems, and frequently inter-relate with each other.

AV Technology and Terminology

AV Technology – Video Basics

- **Video is made of rows of dots**
- **Dots = pixels**
- **Resolution = rows of pixels x pixels per row**
  - More pixels = better resolution
  - Common resolutions: 480p, 720p, 1080p, 4k (# of rows)
- **SD = Standard definition or standard resolution. 480p**
- **HD = High definition. Generally, any resolution above 480p to 1080p**
- **UHD = Ultra high definition. Resolutions above 1080p. 4k and 8k. The horizontal number is now used. 8K = 7680 x 4320 resolution**

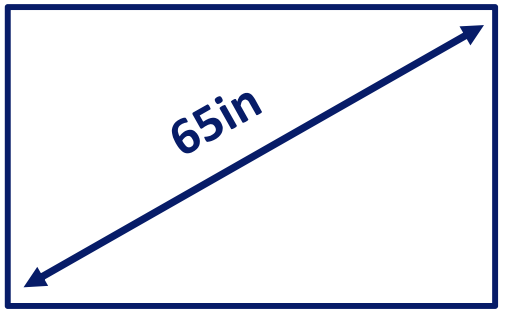
1080x1920 = 2,073,600 pixels

HD Resolution
1080p

SD Resolution
480p

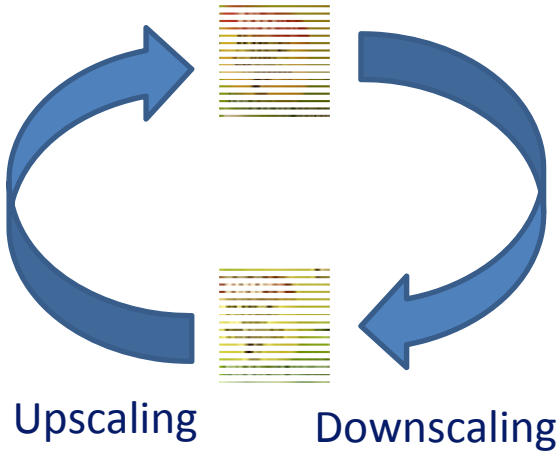
AV Technology – Video Basics

- **Aspect Ratio. Ratio or relationship between picture's width and its height**
- **Aspect ratio written W:H or W/H**
  - 16:9 (1.78:1) – most common. HD format.
  - 16:10 (1.6:1) – presentation format
  - 4:3 (1.33:1) – original standard definition. Letterbox format.
  - 1.85:1 – Widescreen format
  - 2.35:1 or 2.39:1– current cinema format
- **Screen Size is measured diagonally in inches**



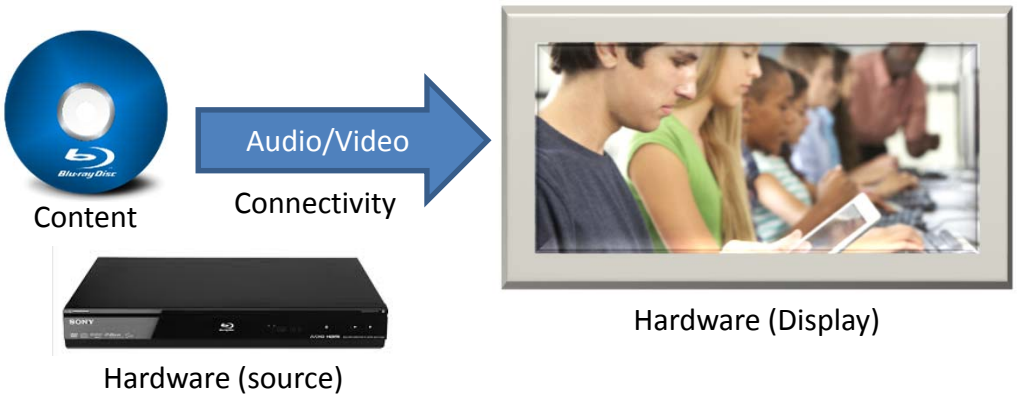
AV Technology – A/V Basics

- **Scaling: a system which converts one signal resolution to another resolution.**
- **Upscaling (or up-conversion): the process of converting a low resolution signal to a higher resolution signal.**
- **Downscaling (or down-conversion): the process of converting a high resolution to a low resolution signal.**
- **ADC: Analog to digital converter**
- **DAC: digital to analog converter**



AV Technology

- **There are 4 fundamental elements of AV:**
  - Hardware or electronics (Display, projector, amplifier Blu-ray player etc…)
  - Connectivity (cabling and connections that enables signal transfer)
  - Environment or the space where equipment is installed
  - Content (video, audio to be played)

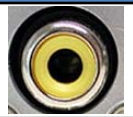


Connectivity - Audio

- **RCA Stereo Audio – Basic analog audio**
- **Mini-Jack (3.5mm) – Analog headphone port**
- **Digital Coaxial – Digital audio**
- **Digital Toslink– Digital optical fiber audio**
- **Speaker cable – Analog audio to speakers**
  - 8ohm system typically uses 16 – 12 gauge
  - 70v system typically uses 24 – 18 gauge
  - 2 or 4 conductors. 16-2 cable = 16AWG 2 conductor
  - 2 conductors are required to drive (power) a speaker (+/-)
- **XLR – Balanced audio cable. Commonly used for microphone**

Connectivity – Analog Video

- Analog Sunset – An industry movement to stop HD over analog and migrate away from analog connections to improve content security

Analog Video	Year	Resolutions	Description		
Composite	1956	480i	1 yellow coax		
S-Video (Separate Video)	1979	480i	4 pin round Separating each color in a pin		
VGA (Video Graphics Array)	1987	Up to 1536i	15 pin PC		
Component	1990s	1080i	3 coax HD RGB Red, Green, Blue		

Connectivity – Digital Video

Digital Video	Year	Resolution	Description		
DVI (Digital Visual Interface)	1999	1600p	DVI-A Analog HD DVI-D Digital HD DVI-I Integrated -both		
HDMI (High Definition Multi-Media Interface)	2003	1080p, 2k, 4k+	HD video and audio, Arc, IP. 30/60hz		
Display port	2006	1080p, 2k, 4k+	HD video and audio Faster refresh (120hz)		
HDBaseT	2010	1080p, 2k, 4k+	HD Video and audio over CAT cable		
MHL (Mobile HD Link)	2010	1080p, 2k	Mobile HD AV. Adapter from Micro USB to HDMI. Phones and tablets		

Connectivity – Control

- **Relay/Contact Closure – Simple 1 or 2-way**
  - Open/close relay actions can trigger events (projection screen, irrigation sprinklers)
  - Contact closure can receive a change of state and react (doorbell)
  - A logic port will provide a binary signal in DC voltage (5 or 12VDC common) – On or Off
  - Simple. Extremely limited control (open or closed)
- **IR – Infrared 1-way communication**
  - Pulses infrared light that represent binary codes to control equipment
  - Simple and easy to use but not reliable
  - Must have line of sight. Noisy light can interfere (sunlight or fluorescent)
- **Serial – 2-way communications. RS232 and RS485 are common protocols**
  - Send commands and receive response to confirm that it was received

Connectivity – Control

- **HDMI – Uses a single HDMI conductor for serial bus communication – Not Universal**
  - Consumer Electronics Control (CEC) enables hardware to talk to each other over HDMI
  - Example: Turn on Blu-ray. Serial signal turns on TV and changes to correct input
  - Benefit: Communicates over existing HDMI cable. But cannot customize or edit
- **IP control – 2 way communication over standard Ethernet. Provides Ethernet and internet connectivity as well as control. (requires some configuration)**
- **USB – Universal Serial Bus 2-way Input device. Keyboard, mouse, smart board, web cam, etc.**
  - Certain audio hardware can accept USB devices as content

Summary:

- For simple residential/ light commercial control IR and HDMI are the easiest and most common
- For more control, customization, and best flexibility, Serial and IP control are best
- Each of these can be done over category cable with the correct equipment

Connectivity – HDBaseT™

5Play™

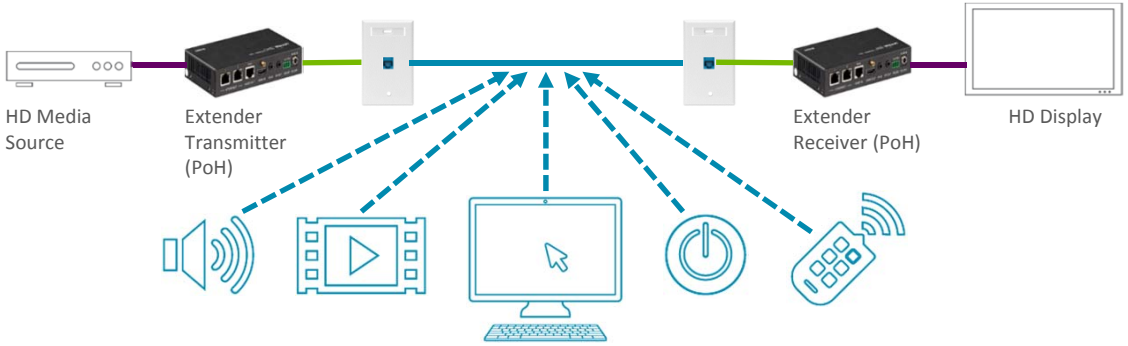
HDBT™

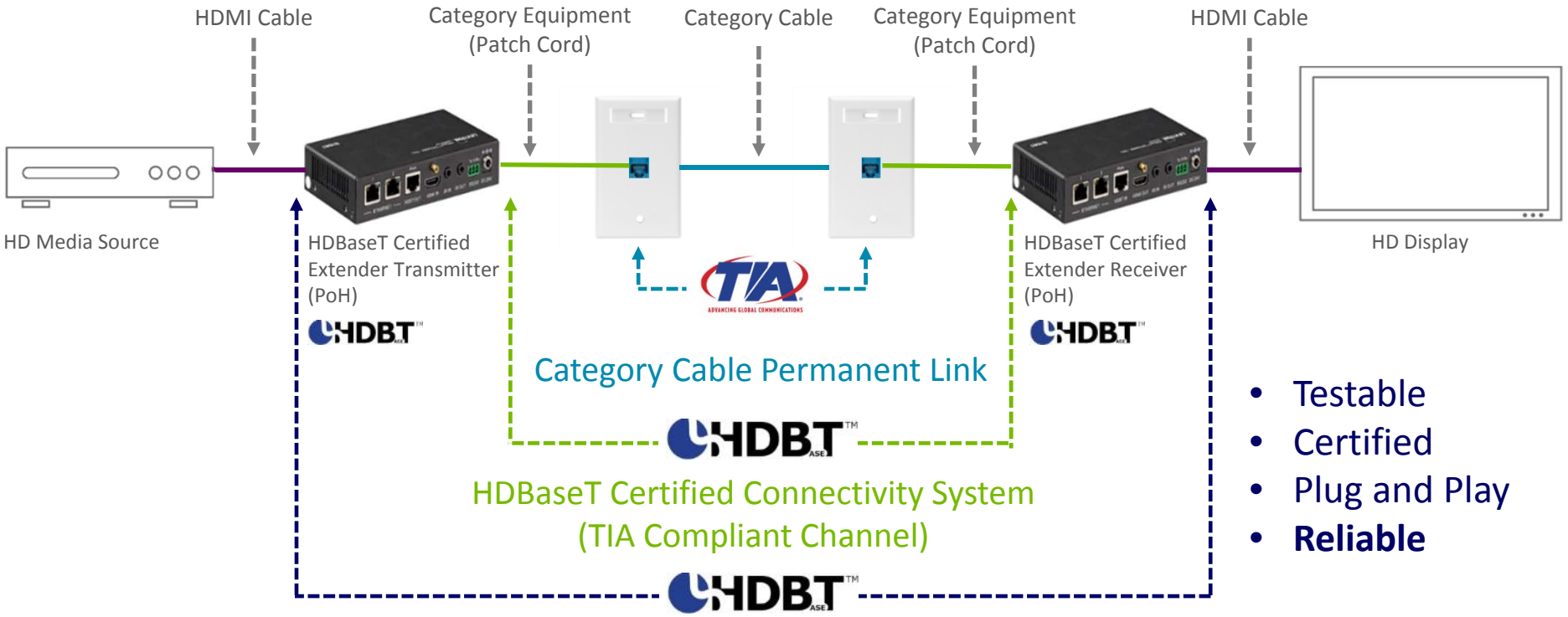
1. Full digital audio
2. HDMI uncompressed video
3. 100Mb Ethernet channel
4. Power (PoH up to 100w)
5. Control via RS-232 and IR

Simultaneous transmission of

All 5

on a **single** category cable





- Testable
- Certified
- Plug and Play
- **Reliable**

Connectivity – HDBaseT™

- **HDBaseT Alliance 1.0 specification lists Cat 5e cabling and above as supported media types**
- **TIA Specifications for standards compliant UTP cable**
  - Cat 5e Frequency Range = 100 MHz
  - Cat 6 Frequency Range = 250 MHz
  - Cat 6A Frequency Range = 500 MHz
- **HDBaseT 1.0 signals have a PAM16 300 MHz clock**
  - Similar to 10GBASE-T signal
  - Generates significant Alien Crosstalk
- **HDBaseT 2.0 devices require 500 MHz cable**

Connectivity – HDBaseT™

- Cat 5e UTP can only carry HDBaseT 1.0 signals isolated point-to-point
- Cat 6 UTP are limited in carrying HDBaseT 1.0 signals
- Cat 6A UTP shows data errors, but no obvious video drop-out
- Cat 6A UTP with AXT prevention and Cat 6A FTP exhibited 0 errors
- Cat 6A STP exhibited 0 errors

Cable Type	Number of Disturbers						
	0	1	2	3	4	5	6
Cat 5e UTP							
Cat 6 UTP							
Premium Cat 6 UTP							
Cat 6A UTP							
Cat 6A with AXT (Mylar Wrap)							
Cat 6A Shielded							

PASS
steady video signal

MARGINAL
random, infrequent dropouts

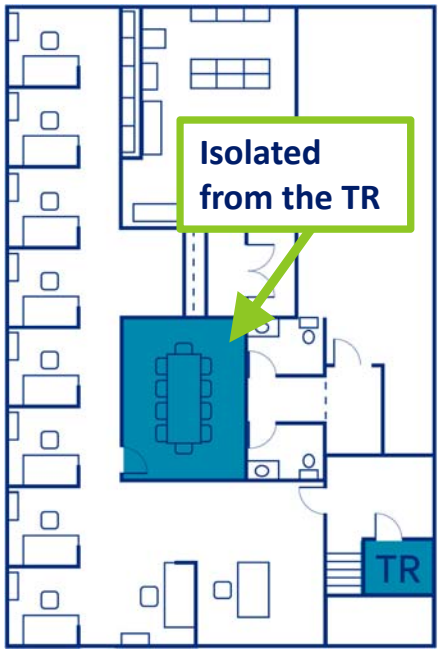
FAIL
frequent or total link loss

- Above results are not totally unexpected for 300MHz signals

Note: Errors as measured with Quantum Data 780B HDMI Tester

Connectivity – HDBaseT™

- **In point-to-point applications it is impractical to use shielded cable**
  - Bonding and grounding is often not possible
  - More expensive cable and connectivity
  - More labor intensive than UTP cable
- **Alternative to shielded cable**
  - XTP or intermittent shielded cable with alien crosstalk prevention technology



Connectivity – HDBaseT™

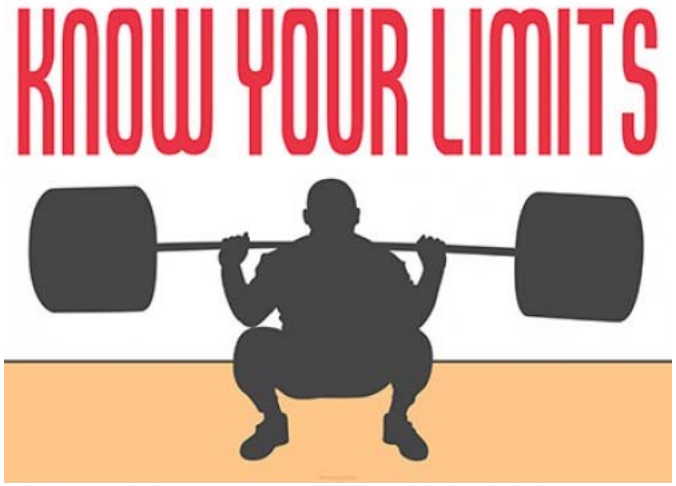
- **Other non-standard solutions**
  - Balun
    - Typically runs over standard category cable or coax
    - Transmitter and receiver box. Requires power on both sides
    - Balun just balances the signal over the selected cable
      - No signal conversion (into packets)
      - No correction
      - More susceptible to noise and attenuation
  - Amplified HDMI cable
    - Older technology to exceed 30’ or 50’ (up to 100’)
    - Usually directional
    - Difficult to pull, easy to damage
    - Not field serviceable or able to re-terminate
  - Wireless HDMI
    - Various products that say they do this
    - No reliable way to accomplish this
  - HDMI over IP
    - Use network switch and infrastructure
  - HDMI over Fiber

The AV Project

Clarify, Spec/Design, Price, and Bid

The AV Project

- **Assess your experience in AV design and *support* before you bid**
- **Start with basic systems**
- **Most customers will be fine with splitting the more complex systems from the basic conference or classrooms, if it saves them money**

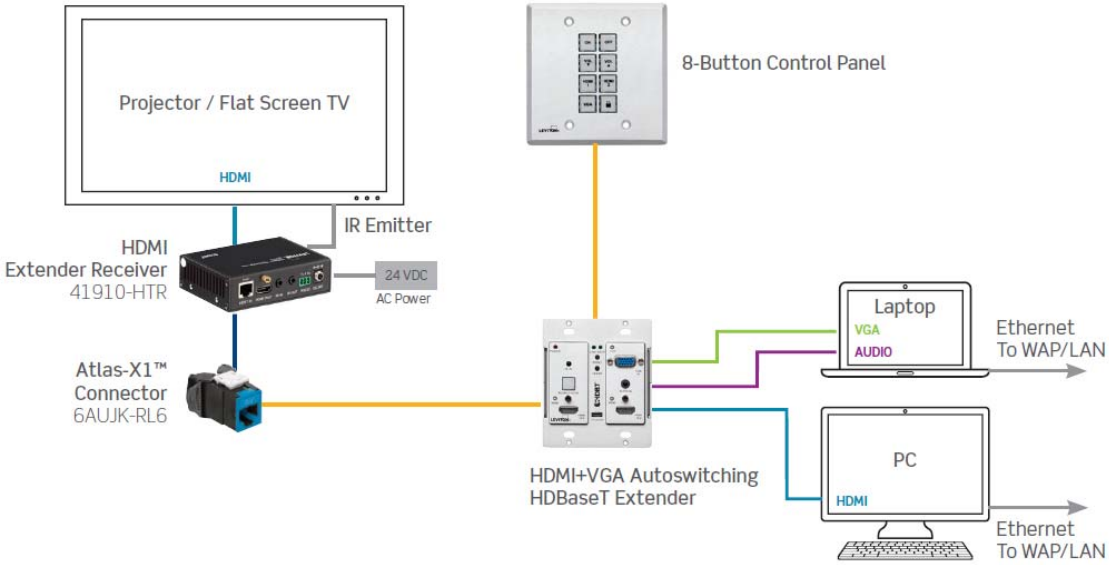


The AV Project

- **An AV project goes through various phases to be able to complete the project in an efficient and predictable way**
- **There are many phases within a project**
- **Infocomm AVDRM manual lists 7 phases: Program, design, documents, bidding , construction, commission, warranty**
- **For simplicity, we'll divide into 3 phases**
  - Pre-installation (program, design, documents, bid)
  - Installation
    - Prewire
    - Rack build
    - Mounting equipment
  - End of project (commission, warranty)
    - Testing
    - Troubleshooting

App Drawing

- **Example rooms with a basic Conference or Classroom application**



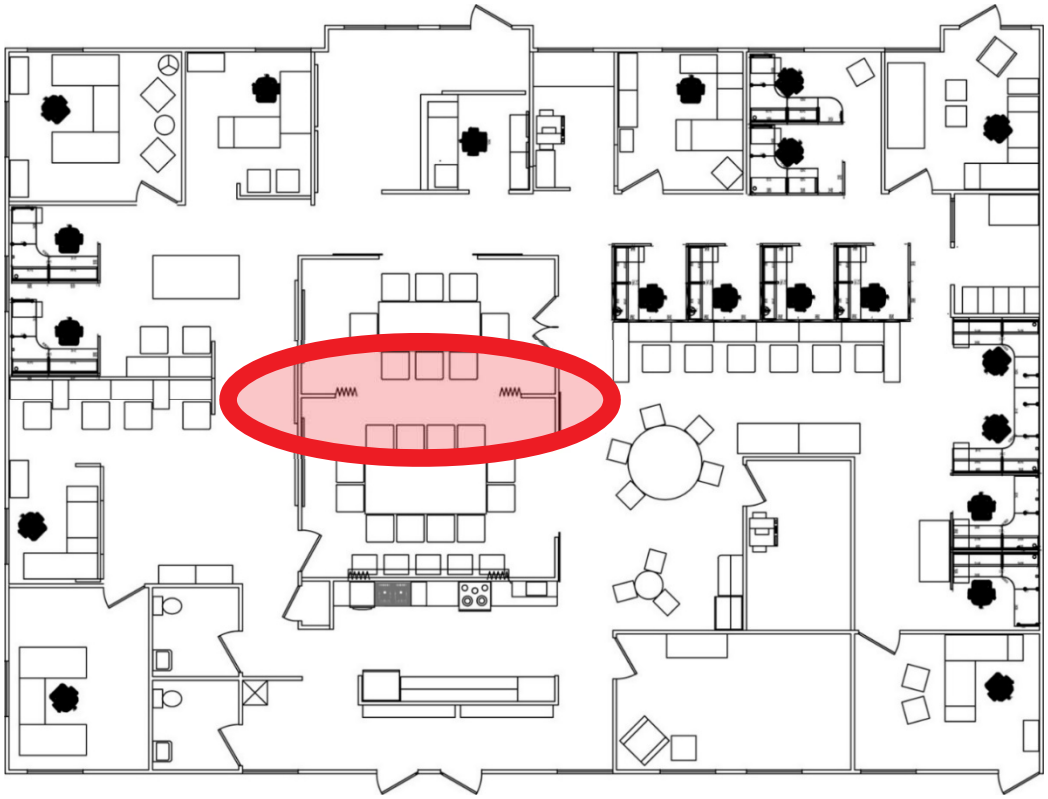
Application – K-12 Classrooms

CR Applications
The Opportunity

- Small Office Floor Plan
- Conference Room in the centers looks like a candidate for IT/AV
- Screens are shown in the drawing

CR Applications
The Opportunity

- This air wall indicates that the rooms can be combined
- This is a multi-input and multi-output system
- This room requires a complex matrix based AV system with programmable control



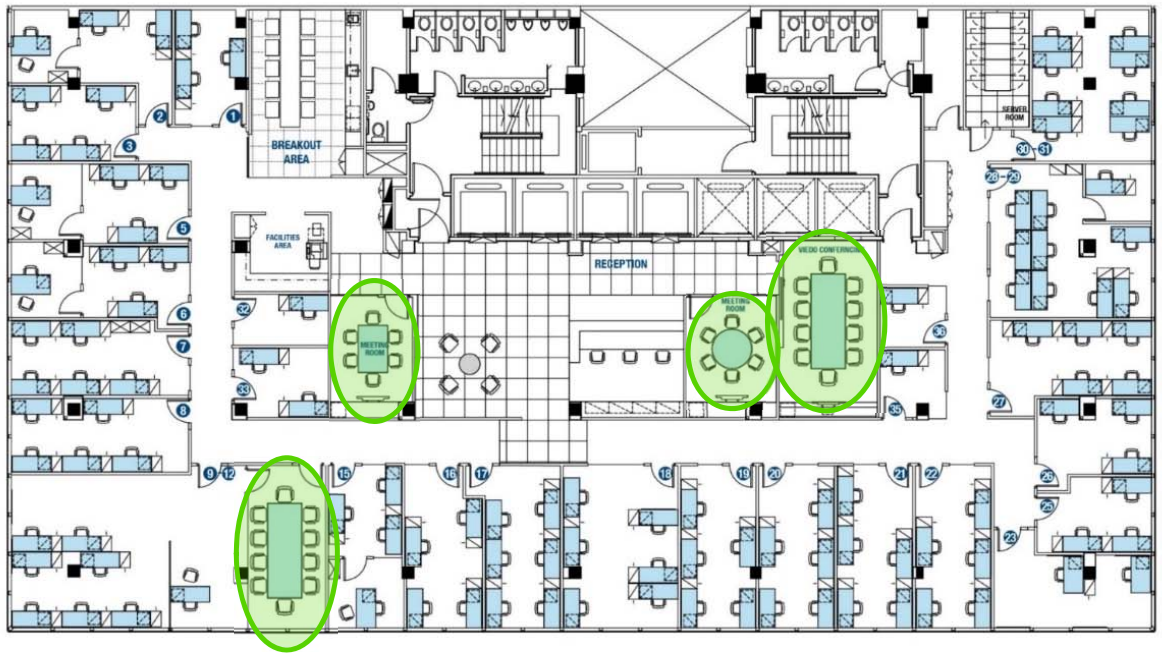
CR Applications
The Opportunity

- 23rd floor of a high rise
- Big AV Training/Conference Center
- Notice air wall
- Notice Multiple Screens
- This room requires a complex matrix based AV system with programmable control

CR Applications
The Opportunity

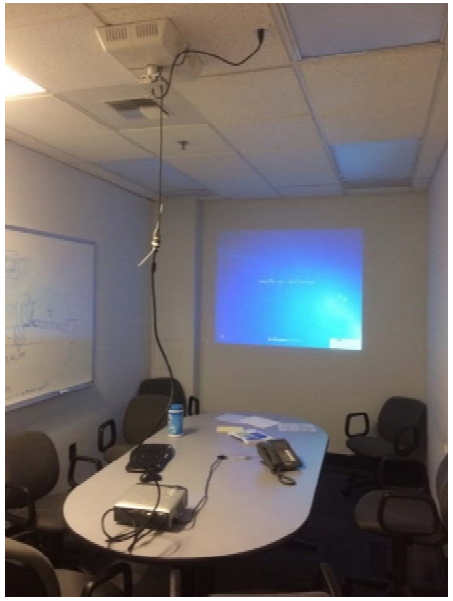
- **Look closer though**
- **There are 9 other spaces in this floor alone opportunities to bring into the IT bid**
- **Each is shown as a small conference room with a single screen**

Other Applications



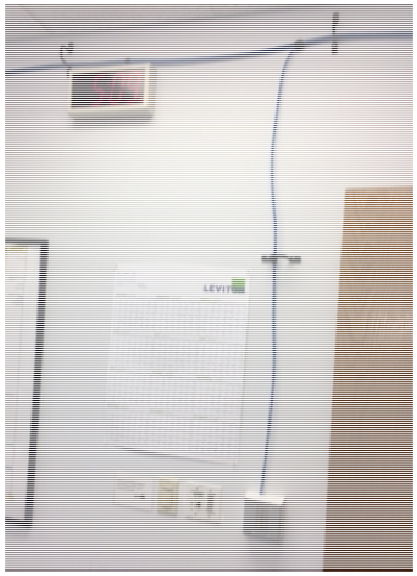
CR Applications - Mauna Kea Cabling Demo

- **Before (Left)**
- **After (Right)**



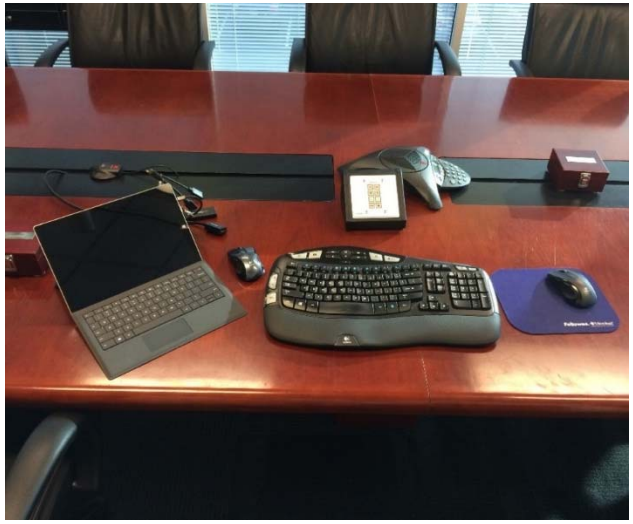
CR Applications - Mauna Kea Cabling Demo

- Cable surface run for clarity of design
- 4K System



CR Applications - Mt Rainier Room

- Exec Conference Room
- 80” 1080 Sharp
- PC inside the table leg



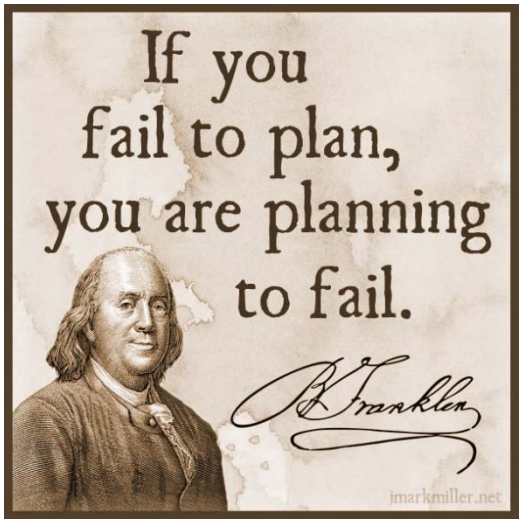
CR Applications - Mt Rainier Room

- Exec Conference Room
- 80” 1080 Sharp
- PC inside the table leg

Scope and Spec

Pre-Bid

- **There are key items that must happen before the project begins**
  - Review the provided scope of project
  - Conduct needs analysis (determine functional/performance goals)
  - Obtain scale drawings
  - Conduct site survey
  - Evaluate site environment
  - Develop a project plan and program report
  - Design the AV system
  - It is critical that we have a clear understanding of the needs and expectations of the customer



The AV or IT Site Walk-Through

- **What is the purpose of the system?**
  - Determine 4/6/8 rule and audience location/arrangement
- **What will the system be used for?**
  - Seated presentations, mobile, Huddle, Conference, Video Conference, Movies…
- **Who will use the system?**
  - From: “Dedicated AV staff setup and operate the room at all times of use”
  - To: “The room is open and can be used by anyone in the company”
- **What are the skill levels and experience of the operators?**
  - Is this a tech company or a tissue factory?
- **What ideas are already in place**
  - Projectors or wall mounted displays – Budget and screen size can make a huge change here
  - Integrating old equipment or all new systems?

Pre-Bid Needs Analysis

- **Conduct needs analysis**
- **Purpose:**
  - Gain a clear understanding of the overall AV goals (including the timeline)
  - Present yourselves as professional and capable of understanding and achieving their goals
- **Meetings with the customer should**
  - Focus on end-user needs
  - Provide education on technologies and trends
  - Review AV tasks and parameters (details)
  - Identify Environment issues (obstacles, interference)
- **More than 80% of communication is non-verbal**
  - Personal appearance (dress code)
  - Body language (smile, standup straight)
  - Actively listen (eye contact)
  - Take notes
  - When appropriate, paraphrase main points
    - "So you would like to point the remote at the TV and have it control the DVD player in the other room?"
  - Never interrupt
  - Ask clarification questions - listen
  - Utilize pictures, drawings and even animate

Pre-Bid Scale Drawings

- **Architectural drawing package**
  - Includes mechanical drawings for HVAC and plumbing, electrical drawings, and structural drawings
- **Audiovisual drawing package**
  - Specific AV drawings. Block diagrams, functional diagrams, connection details, patch panel details, outlet detail, equipment diagrams, rack elevation, etc. . .

Pre-Bid Project Plan

- **After gathering this information, you should be able to develop a project plan and program report**
  - A project plan will guide your project management and will contain:
  - Scope of work. Have clear objectives and goals
  - Time: Contain dates and timelines
  - Cost: Budget information
  - Quality: Performance and functionality to meet expectations
  - Risk: Threats, concerns, opportunities

- **The program report is a preliminary report used to communicate to the customer your understanding of the scope of work details about the solutions you will provide.**
  It should include:
  - Executive summary
  - Space planning
  - Systems description
  - Infrastructure considerations
  - AV budget
  - Operational staff expertise level required
  - Maintenance budget requirements and life-cycle expectations

Pre-Installation

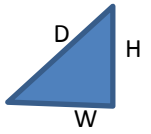
Design

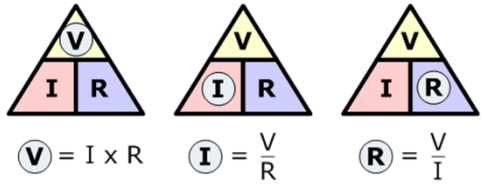
Design

- **A project plan will outline the project and clearly state the objectives of the AV systems**
- **With an approved scope of work, we can design the system to meet or exceed the customers performance objectives**
- **To build a successful design requires knowledge and skills to:**
  - Read and interpret architectural drawings
  - Understand the system requirements and technology
  - Determine the required equipment to meet expectations
  - Determine the proper cabling and its pathways
  - Understand how devices integrate or work together
  - Perform complex mathematical calculations
  - Assess issues that may affect the AV system
  - Technically articulate system specifications and illustrate with drawings (technical writing)
- **The design will include:**
  - Hardware or electronics (Display, projector, amplifier, Blu-ray player, computers. . .)
  - Environment or the User space (Classroom, conference room, lobby, . . .)
  - Telecommunication and AV spaces
  - Connectivity (cabling and connections that enables signal transfer)
  - Pathways

Design – Common AV Math

- **Math reference. Here are some of the formulas needed during the design**
- **Decibels – A doubling or halving of the power results in an increase of decrease of 3dB. Doubling or halving of the voltage results in an increase or decrease of 6dB**
- **Inverse square law**

Aspect Ratio (AR)	Throw Distance (TD)	Screen Height (SH)
AR = Width (W) / Height (H) W=AR*H H=W/AR	TD = Screen Width * Throw ratio	SH= D / F D = dist to farthest viewer. F = Image factor = 4 (best), 6 or 8 (general)
Heat Load	**Power Amplifier Heat Load**	**Screen diagonal (Pythagorean)**
BTU = Wtot * 3.4 (Wtot = total watts)	Total BTU=W*3.4*(1-E) W=Watts or amp E=efficiency	$H^2+W^2=D^2$ 



Ohm's Law (current formula)

V = voltage I = current R = resistance

Design – Common AV Math

- Projector Lumens Output
- Brightness = ((L*C*A)/Sg)/Dr
- L=ambient light at screen
  A= Area of screen
- Sg=Gain of screen
  Dr=projector derating value (usually .75)
- C=desired contrast ratio
  - 7:1 Passive viewing
  - 15:1 Basic presentations
  - 50:1 Analytical presentations
  - 80:1 Full motion video

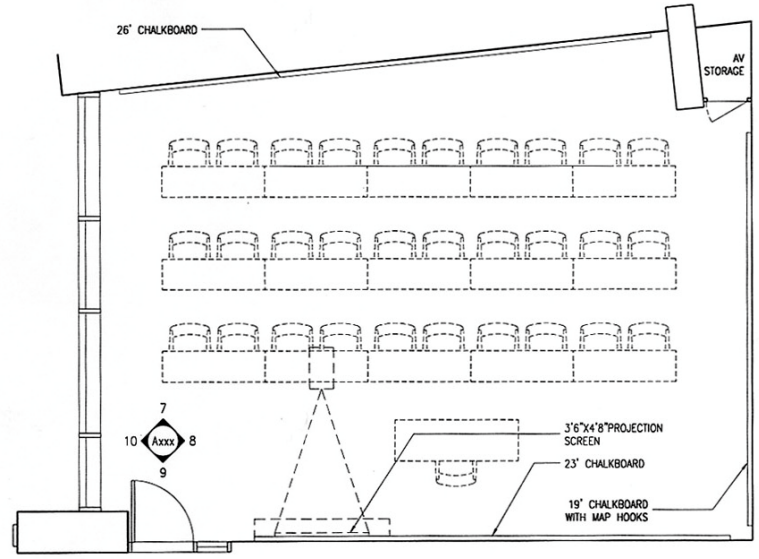
Loudspeaker impedance (Ti) **Series** Ti= S1+S2+S3…Sn **Parallel** Ti=impedance/# of speakers S=speaker	Loudspeaker coverage pattern D=2*(H-Lh)*tan (Angle/2) D=Diameter coverage at listener H=ceiling height (48in) Angle=off-axis coverage angle	Power amp wattage (constant voltage) Wt=W*N*1.5 Wt=required wattage W=watt tap at single speaker 1.5=50% amp headroom
Needed Acoustic Gain (NAG) NAG=20log(D1/EAD) D1=distance from source to listener EAD=Equivalent acoustic distance	Potential Acoustic Gain PAG=20log((D1*D2)/(D3*Ds) D1=distance from source to listener D2=Dist from speaker to mic D3=Dist from speaker to listener Ds=Dist from source to mic	Loudspeaker spacing (ceiling mount) D=2*r (edge to edge) D=r*√2. (min overlap) D=r (center-to-center)

Pre-Installation

Hardware

Design – Hardware

- **In planning the system, usually best to start with the end goal**
  - Review the project plan scope of work (room size, #of people, performance and functional goals)
  - Determine the video requirements (quantity, types and size of displays and **video sources**)
  - Determine the audio requirements (speakers amplification, **audio sources**)
  - Calculate number and types of cables needed
  - AV system control
  - Always allow for room to grow (sources, cables, etc.…)



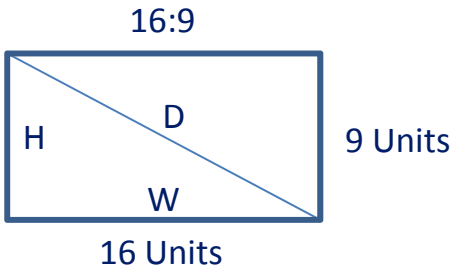
30 SEAT CLASSROOM AT PHYSICS AND FUTURE COMPUTER CLASSROOM

09.25.00

Design – Video Hardware

Selecting the right display

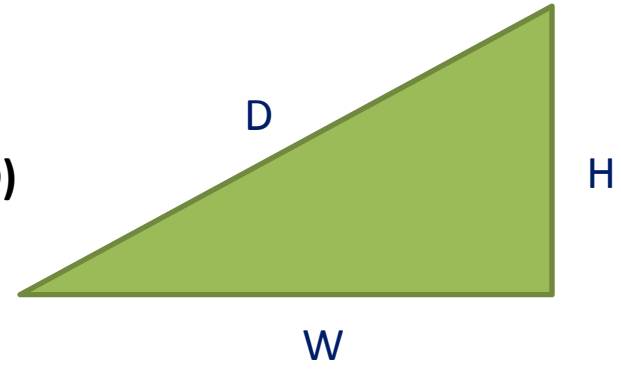
- **We need to know:**
  - Distance to the farthest viewer
  - Purpose of the video to determine the image detail factor
    - Image detail factor (4/6/8 rule):
      4 = finer detail (best), 6=Reading (Better), 8=General Videos(Good)
  - Confirm the aspect ratio (16:9, 4:3, etc…)
  - Good to know dimensions of the room and a scale drawing



Design – Video Hardware

Formulas to use:

- **Minimum image height formula**
  - H = D / F
  - (D= Max viewer distance. F = Image detail factor 4/6/8)
- **Aspect ratio formula (calculate width from the height)**
  - AR = W/H
  - W = H*AR
- **Pythagorean Theorem to solve for the diagonal size (D)**
  - $D^2 = H^2 + W^2$
  - $\mathrm{D} = \sqrt{(H^2 + W^2)}$



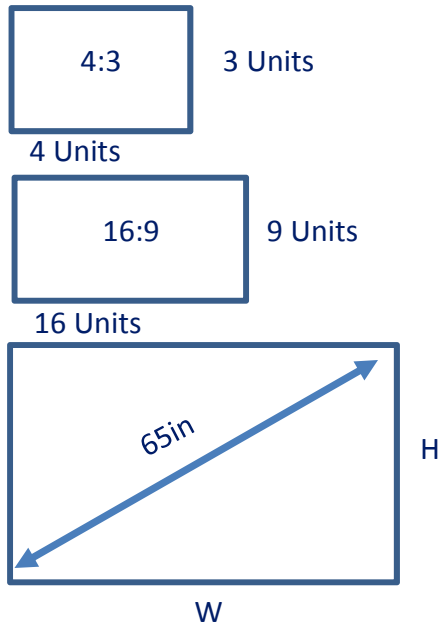
Design – Screen Dimensions and Ratios

$\frac{W}{H}$ = Ratio $\frac{4}{3}$ = 1.33

W=H*AR W = 15in * 1.33

If height = 15in what is the width?

W = 19.95in



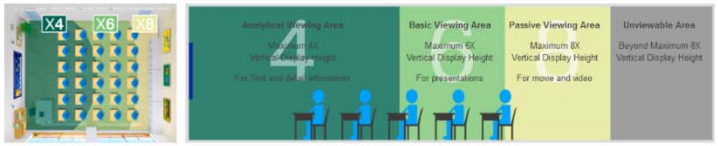
- **What is the aspect ratio for a 1024 X 768 picture?**
- **1024 / 768 = 1.33 Letterbox 4:3 format**
- **Common Aspect Ratios**
  - 16:9 (1.78:1) –. HD format.
  - 16:10 (1.6:1) – presentation format
  - 4:3 (1.33:1) – original standard definition. Letterbox format.
  - 1.85:1 – Widescreen format
  - 2.35:1 or 2.39:1– current cinema format

Screen Size – Conference Room

- **The furthest seat from the display is 24 feet away from the screen. They will be looking at PowerPoint presentations on an HDTV format screen**

4/6/8 Rule Simulator

Check the optimal viewing distance for a classroom display



Display Size

inch: 120

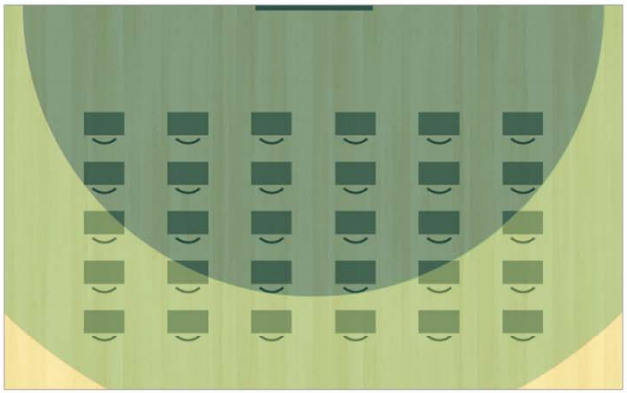
Classroom Size

horizontal: 45.0 vertical: 28.0

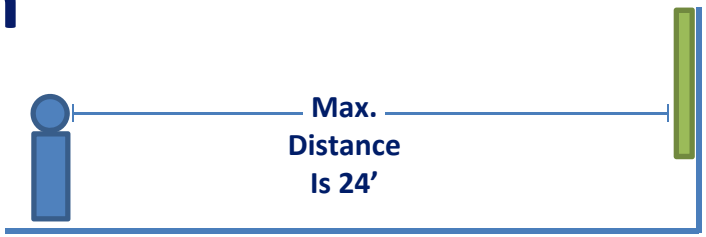
m feet

Seat Layout

horizontal: 6 vertical: 5

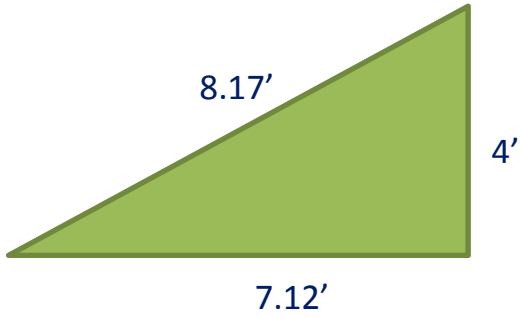


Screen Size – Conference Room



Formulas to use:

- Minimum image height formula
  - H = D / F (D= Max viewer distance. F = Image detail factor 4/6/8)
- Aspect ratio formula (calculate width from the height)
  - AR = W/H W = H*AR
- Pythagorean Theorem to solve for the diagonal size (D)
  - $D^2 = H^2 + W^2$
  - $\mathrm{D} = \sqrt{(H^2 + W^2)}$
- Furthest seats are 24 feet away from the screen. They will be looking at PowerPoint presentations, and the client plans on an HDTV format screen.
- Use 6 x rule of thumb (Reading) to get recommended screen height
  - 24’ = 6 * H H = 24’/6 H = 4 ft
- Find the Width
  - W = H * AR AR for HDTV is 16:9 (1.78)
  - W = 4 * 1.78 W = 7.12 ft
- Find the Diagonal using Pythagorean’s theorem
  - $\mathrm{D} = \sqrt{(H^2 + W^2)} = \sqrt{(4^2 + 7.12^2)} = \sqrt{(16 + 50.7)} = \sqrt{(66.7)}$ = 8.17
  - Convert feet to inches by multiplying by 12
  - D = 8.17 * 12 D = 98 inches



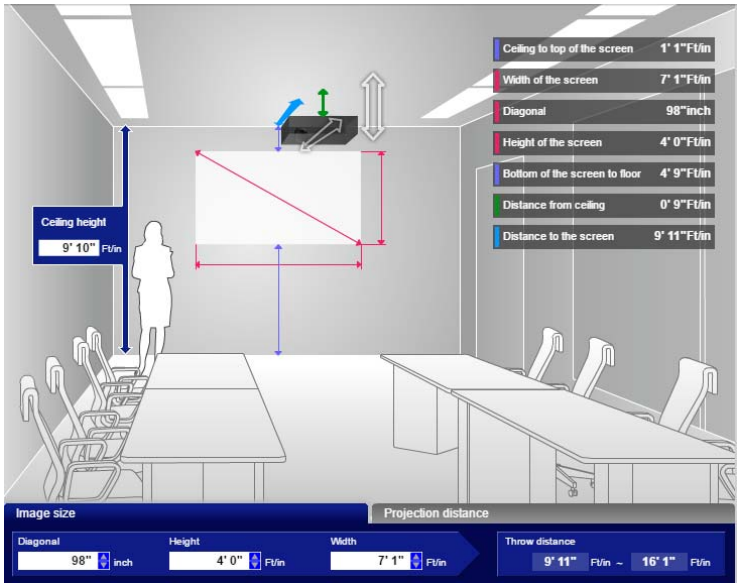
Design – Selecting the Right Display

- **Television**
  - Brighter
  - Not affected by ambient light
  - Audio included
  - One piece to roll in or setup
  - Plug and play. No calibrating for good picture
  - Disadvantages
    - Higher cost / viewable inch
    - Smaller screen options

- **Projection**
  - Larger display size
  - Better for larger audience
  - Portable
  - Disadvantages
    - Adversely affected by ambient light
    - Video only
    - Multiple parts: projector, screen and audio
    - Requires calibrating, aligning and focusing
    - Calculate throw and brightness
    - Bulb life 2,000 – 6,000 hours generally

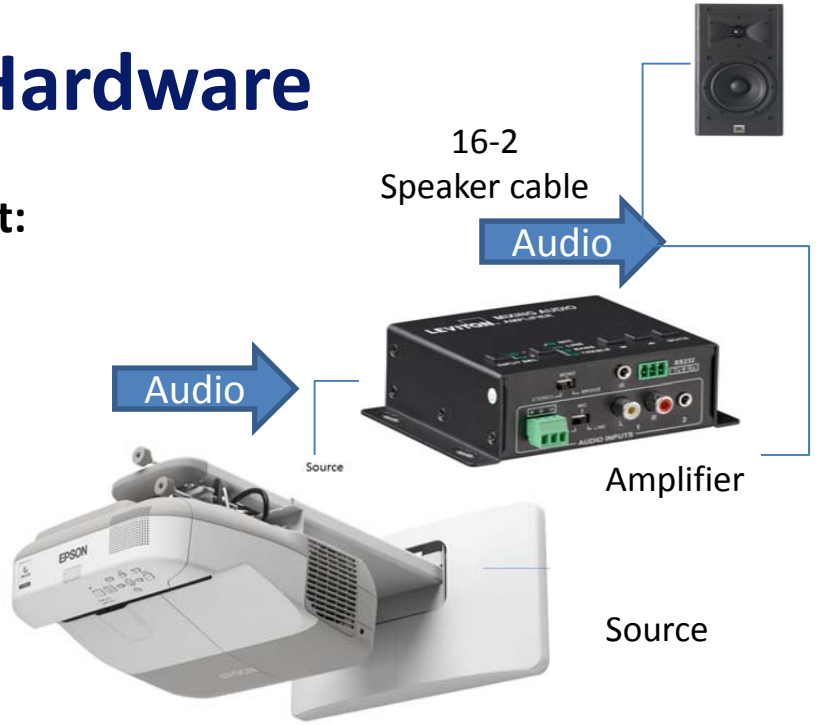
Design – Video Hardware

- **Projector Consideration: Mounting a projector**
- **Determine the exact location to install the projector**
  - Throw distance formula or manufacture website (short throw , standard or long throw projectors)
  - Compatible projector installations (height, upside down)
  - If outside of throw range, picture will not fit screen or will not focus in



Design – Audio Hardware

- **In order to select the audio hardware we must:**
  - Determine number of speakers
  - Estimate the distance from amplifier to the speakers
  - Identify the system purpose (background music instruction, videos, stereo or surround sound)
  - Identify audio sources
  - Identify number of independent audio zones



Design – Audio Hardware

- **Ceiling speaker formula**
- **Place the speakers evenly in the space**
- **Minimum distance from walls = 2’**
- **More speakers = smoother coverage**
  = Less needed room volume
  - Room example: 1100 Sq/ft / 190 sq ft = 5.8 speakers (round to even typically for aesthetics)

To determine the number of ceiling speakers your installation requires, simply divide the area’s total square footage by the speaker coverage as indicated in this chart.

Ceiling Height (ft.)	Coverage (sq. ft.)
8	250
10	400
12	580
14	780

Total Area (Sq. ft.) ÷ Speaker Coverage = # of Speakers

Design – Audio Systems

Loudspeaker Audio (8ohm or 4ohm)

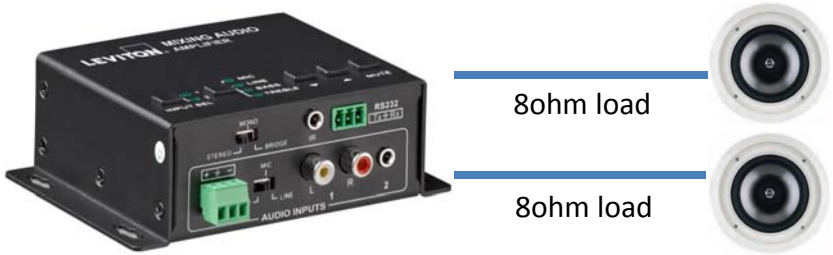
- Stereo full range audio
- Drives 1, 2 or 4 speakers
- Short distance

Commercial 70v Audio

- Mono audio for education or industrial applications
- Drives more than four speakers (example 24 speakers)
- Longer Distance - over 1000 ft

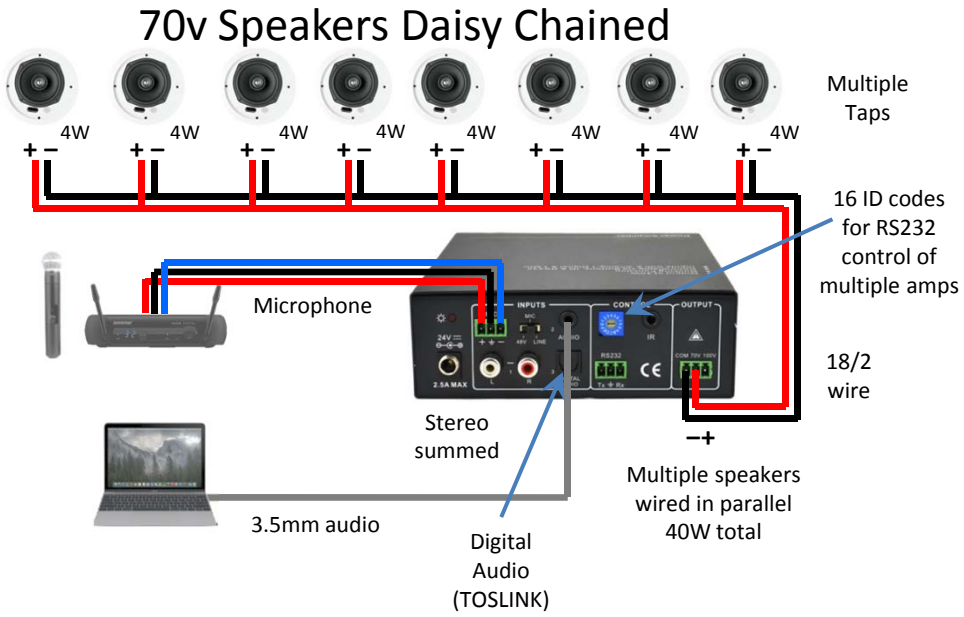
Design – Audio Hardware

- **Which to choose (8Ohm or 70v)?**
  - **<u>Audio purpose</u>**
    - Stereo for local only (Kiosk for instance)
    - Mono 70V for all other commercial applications



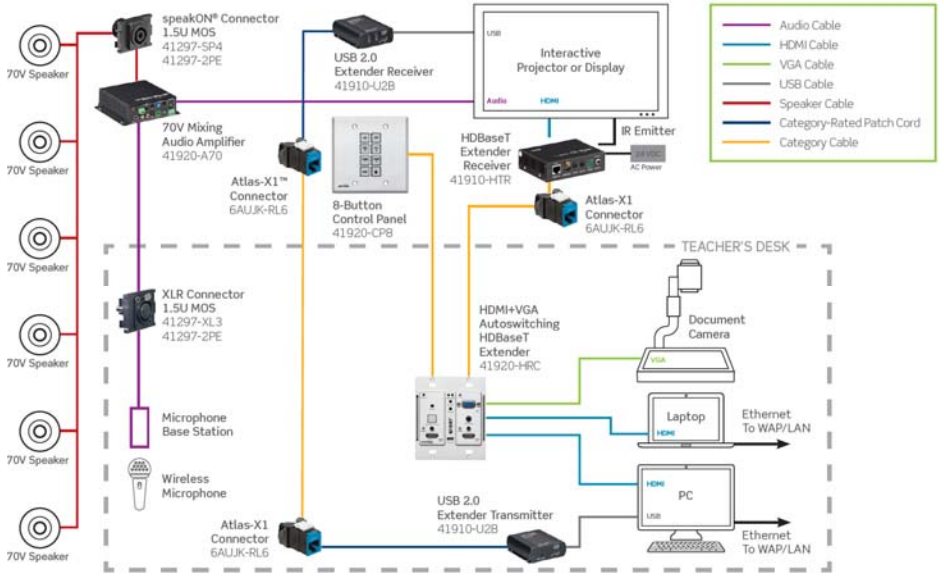
Design – Audio Hardware

- **70 Volt features and benefits**
- **Don't over load the amplifier!**
  - Sum the total number of watts and make sure it is less than the amp rating
  - Rule for design is to plan to load up to 80% of amp. If 100w amp, load up to 80w minimum.
  - 4+4+4+4+4+4+4+4 = 32w



Test the Design

- **Typical Classroom or Meeting room**
  - Always **bench test** your designs!
  - Never try out something new on the jobsite



Pre-Installation

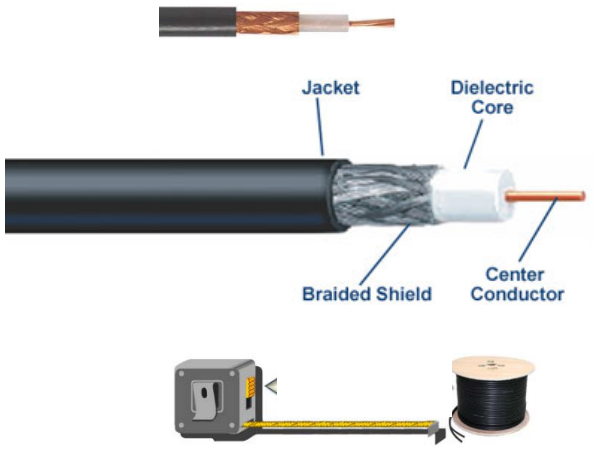
Connectivity

Cabling

- **Category-Rated Cable Selection**
- **Cross Talk Prevention (XTP) Twisted-Pair Cable**
  - Innovative noise-cancelling XTP technology delivers superior alien crosstalk (AXT) suppression
  - Manages the convergence of voice, video, and data at 10 gigabit Ethernet speeds, simplifying networks
  - Verified performance beyond ANSI/TIA-568-C.2 Category 6A by third-party labs (Intertek ETL)
  - Easier installation and cable management with reduced outer diameter of 0.275" (6.9mm), CMP
  - Offers superior electrical performance, as well as AXT and EMI resistance without requiring grounding or bonding
  - Supports both short and long channels
  - Better density and cooling
  - Proudly manufactured in the U.S.

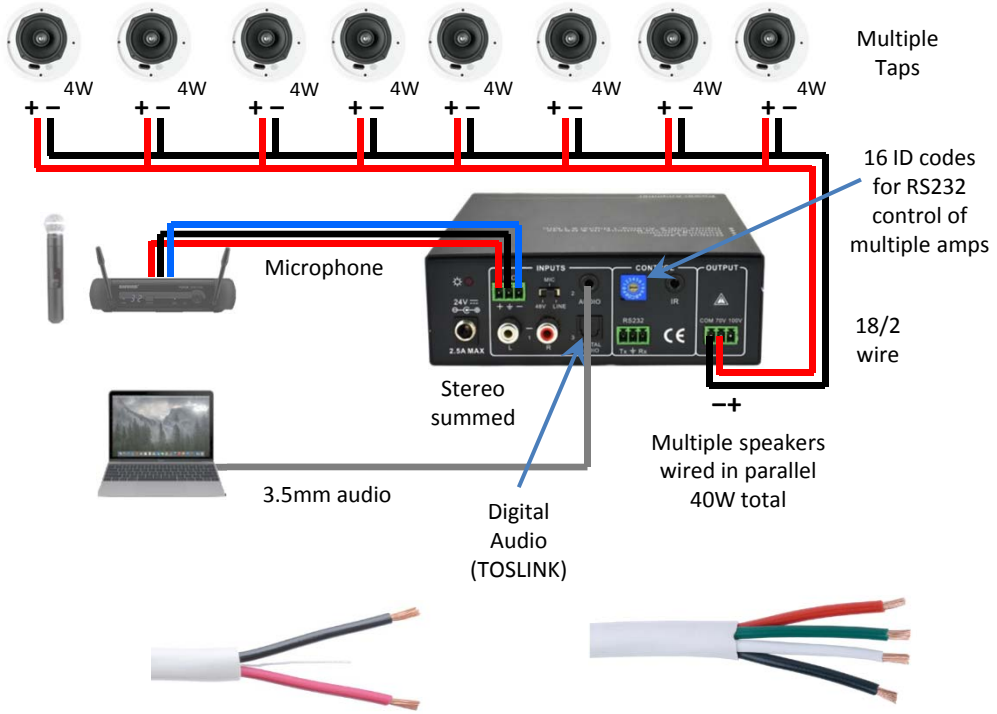
Cabling

- **Coax cable**
  - Types of coax: RG58, RG59, RG6
  - Raw broadcast signals (RG6)
  - RCA (RG59)
  - Component (RG6)
  - Digital Coax (RG6)
  - Subwoofer (RG58)
  - Camera (RG59)
- **RG-59 coax cable max distance: 700-800 feet**
- **RG-59 coax cable with CCTV video amplifier: 3000 feet**
- **RG-6 coax cable max distance: 1000 feet**
- **RG-6 HD video max distance: 460feet**
- **270 Mbps with 540 Mbps possible over a coaxial cable**



Cabling

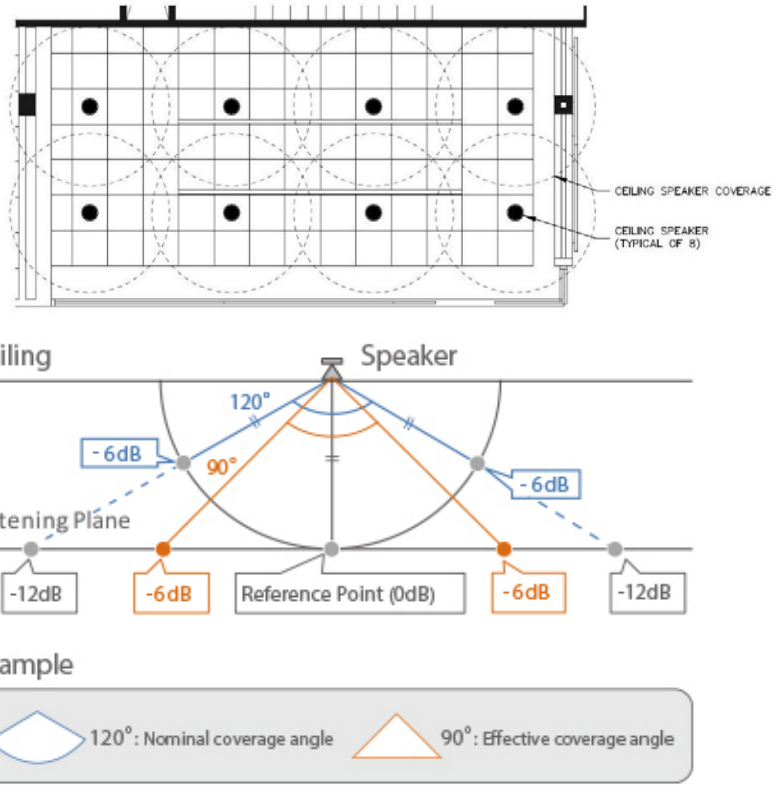
- **Speaker Cable**
- **Loudspeaker**
  - Gauge 18 – 12 typical
  - 2 conductors per speaker
  - Red is positive/black is negative
  - White is positive/green is negative
- **70V**
  - Gauge from 24 – 14
  - 2 conductors per speaker



* Loud speaker cable not recommended under 16 AWG. 12 – 16 AWG is common.

Cabling

- **Calculate speaker coverage**
  - Assume – 4’ from finished floor equals seated height
  - Measure height from seated height to speaker grill
  - Double this distance as the diameter of the circle to draw on the floorplan representing speaker coverage. Allow for 50% overlap



Centralized AV System – No local inputs

Decentralized AV System – Only local inputs

Classroom 1
All Equipment

Classroom 3
All Equipment

Classroom 2
All Equipment

Classroom 4
All Equipment

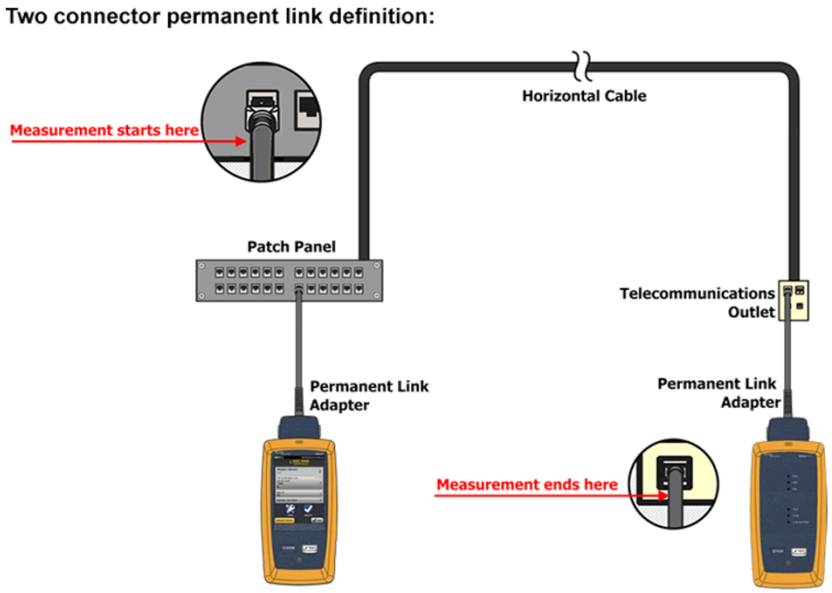
Installation

Field Testing & Certification

- Essential to verify that the installation meets the necessary electrical and optical requirements to perform as intended
- Standards Organizations such as ANSI/TIA and ISO are responsible for creating and updating network cabling certification standards. In North and South America, ANSI/TIA certification parameters are predominantly used
- Unit of Measure – the Decibel:
- Field Test Equipment measures a cabling systems electrical characteristic and provides the measured results by their relative signal strength. The Unit of measure is the “Decibel” abbreviated “dB”
- Decibel (dB) – The function of a ratio of two power levels, typically used to express the relation of the output power to the input power such as the gain in an amplifier or the loss in a transmission line

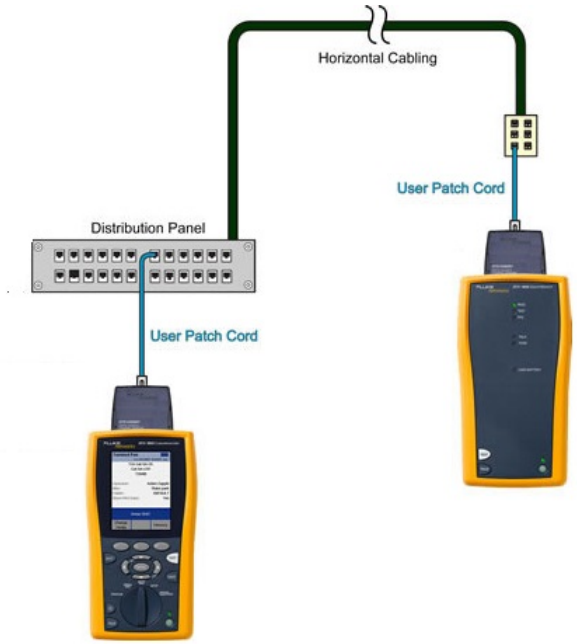
Field Testing & Certification

- Testing the Permanent Link
- Proper testing involves field certification testing of the installed Permanent Link
- Permanent Link is defined as the fixed portion of the cabling from the Telecommunications Outlet to the Horizontal Cross Connect (Patch Panel)



Field Testing & Certification

- **Testing the Channel**
  - Full Channel Testing includes both the Permanent Link, and the installed work area and equipment cords (patch cords)



AV Installation

- Extender Products
- HDBaseT HDMI
- HDBaseT Autoswitching Wallplate
- VGA
- USB

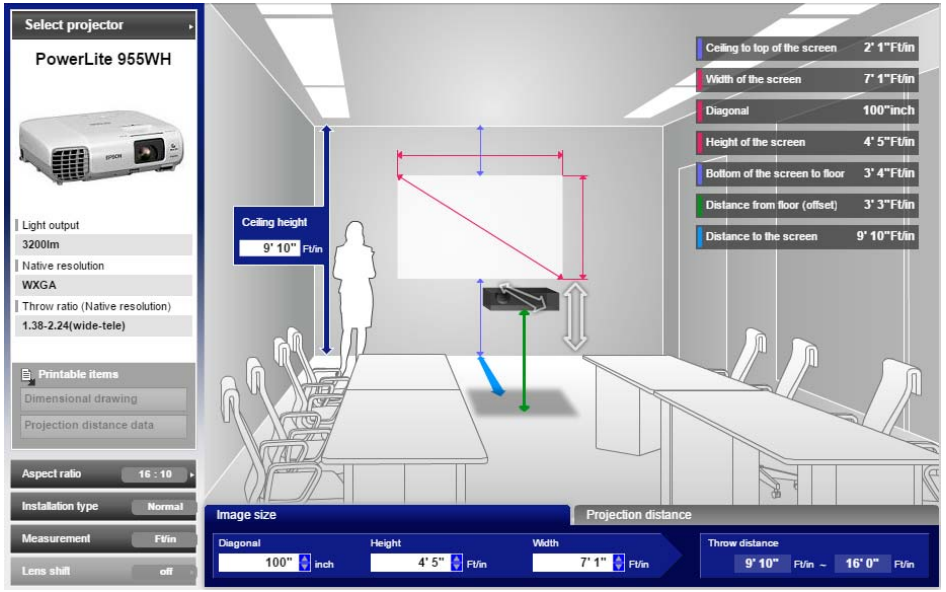
- Basic Installation Steps
- Route the category cables
- Terminate the jacks on each end to create a standard permanent link
- Test and verify the permanent link
- Connect compatible Ethernet cords and AV cables
- Turn equipment on to verify functionality

AV Installation

- Mounting Hardware
- Mounting a projector
- Mounting a display
- Installing/Mounting speakers

AV Installation

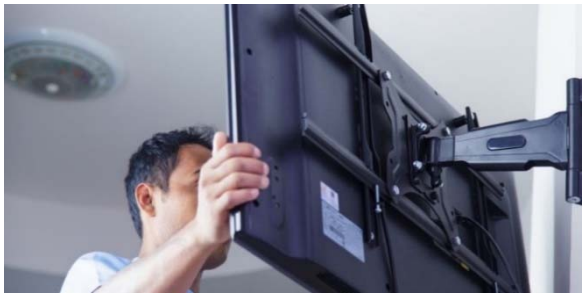
- **Mounting a projector**
- **Determine the exact location to install the projector**
  - Throw distance formula or manufacture website
  - Tip: grab an extension cord and power up the projector at the location



AV Installation

- **Mounting a projector**
- **Determine the exact location to install the projector**
- **Review the mount and compatibility with the projector**
- **Verify the proposed location**
  - Remove tiles
  - Verify space
  - Use the 5:1 rule to verify integrity of installation
    - 5:1 rule means that the structure and material that the mount is attached to must be rated to support 5 times the weight of the equipment + mount.
  - Verify power and signal cables are installed and where they should be
- **Prepare work area. Gather tools, drop cloth, protect or remove furniture, etc.**
- **Install mount and secure. Attach bracket to the projector**
- **Typically with a second person lift and mount the projector to the mount. Lock the projector into place.**
- **Connect power, signal cables.**
- **Turn on projector and project a test pattern. Adjust projector zoom, focus, lens shift and keystone until the picture fills the screen and is square.**

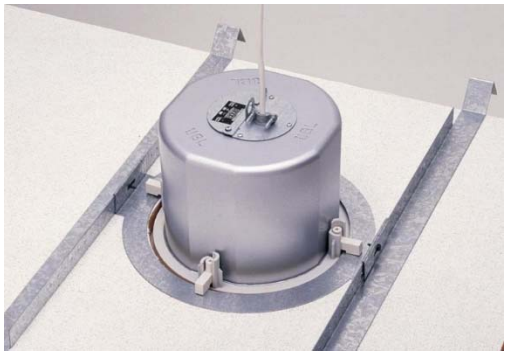
AV Installation



Mounting a flat panel display

1. **Determine the exact location to install the flat panel**
2. **Review the mount and compatibility with the flat panel**
3. **Verify the proposed location**
   - Verify space
   - Use the 5:1 rule to verify integrity of installation
     - 5:1 rule means that the mount and material that the mount is attached to must be rated to support 5 times the weight of the equipment + mount
   - Verify power and signal cables are installed and where they should be
4. **Prepare work area. Gather tools, drop cloth, protect or remove furniture, etc..**
5. **Install mount, level and secure. Attach bracket to the flat panel**
6. **Typically with a second person lift and mount the display to the mount. Lock or secure into place.**
7. **Connect power, signal cables.**
8. **Turn on flat panel to verify functionality**

AV Installation

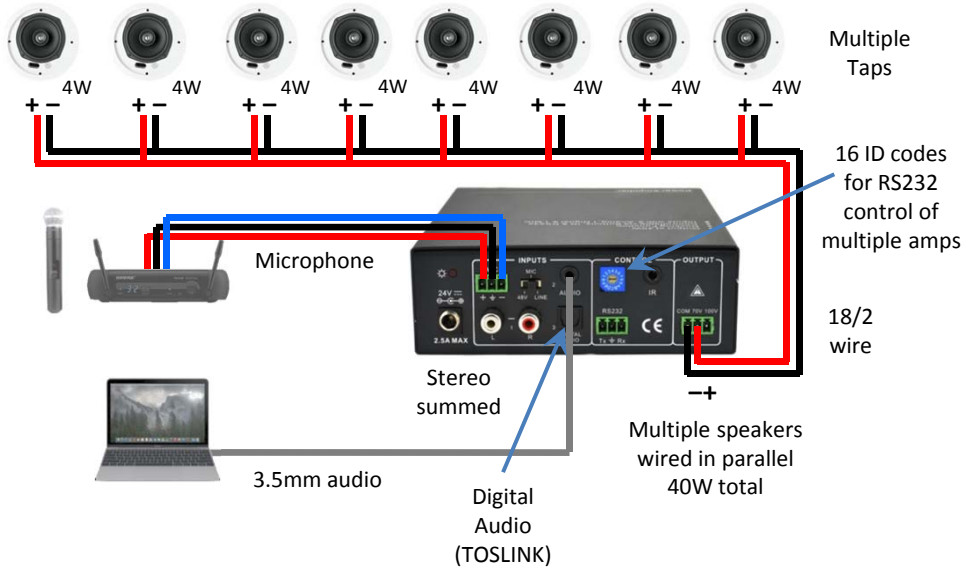


Mounting ceiling speakers

1. **Unplug amplifier**
2. **Determine the exact location of the speakers**
   - Design phase calculates how many and pattern
3. **Review the speaker and mounting hardware**
4. **Verify the proposed location**
   - Remove tiles
   - Verify space
   - Use the 5:1 rule to verify integrity of installation
     - 5:1 rule means that the mount and material that the mount is attached to must be rated to support 5 times the weight of the equipment + mount
   - Verify speaker cables are installed and where they should be
5. **Prepare work area. Gather tools, drop cloth, protect or remove furniture, etc..**
6. **Using speaker template, cut the hole for the speaker. If tile, remove tile to cut. Then replace tile.**
7. **Pull speaker cable through hole , prep cable and connect properly to speaker**
8. **Mount speaker into the space, with low torque, tighten installation screws**
9. **Once all speakers are completely installed and connected, plug in the amp and test.**

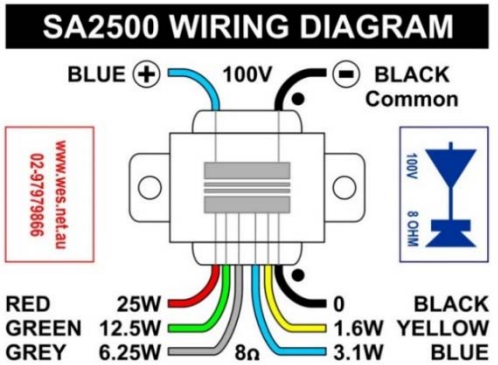
Installation: Cables

- **All cables, structured cable and AV, are to be installed in physical <u>star topology</u>**
- **<u>Except</u> 70v speaker cable**
- **70v speakers**
- **Daisy chained**



Installation: Speaker Connections

- **Connect speakers first:**
  - Amp off or amp disconnected
  - Strip 2in off speaker cable.
  - Strip ¼ ” off red speaker wire
  - Connect red (+) to positive terminal
  - Strip ¼” off black speaker wire
  - Connect black (-) to negative terminal



Field Testing & Certification

- **Speaker cable testing**
  - Impedance test
  - Toner
  - SPL (sound pressure Level)
- **Speaker Line Load calculations:**
  - Z = E2/P
    - Z = Measured Impedance
    - E = Voltage constant, 70V typical
    - P = Power required to drive the circuit

- **Calculation examples:**
  - Measured 350 ohms, How much power at 70V?
    - Z = E2/P
    - 350 = 702/P
    - 350 = 4900/P
    - 350P = 4900
    - P = 4900/350
    - P = 14W
  - 70V amplifier max = 40W,
    What is the minimum impedance?
    - Z = E2/P
    - Z = 702/40
    - Z = 4900/40
    - Z = 122.5Ohms

Field Testing & Certification

- **HDMI Tester**
  - Test Resolutions
  - Test Colors
  - Test refresh rate
  - Full test report

Figure 11: 780A Format Analyzer Test Screen

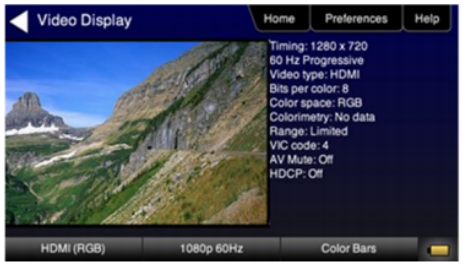


Figure 12: 780A Video Display Test Screen

AV Troubleshooting

AV Troubleshooting

What to do when AV doesn't work:

- Review product limitations & best practices
- Always make the problem smaller. Process of elimination
- Think about the most likely problem (no lights=no power)
- Check simple items. Power, loose connections, etc.
- Verify the equipment
- Bypass components to get to a working state
  (plug DVD directly to Display)
- Test permanent link (for extender products)

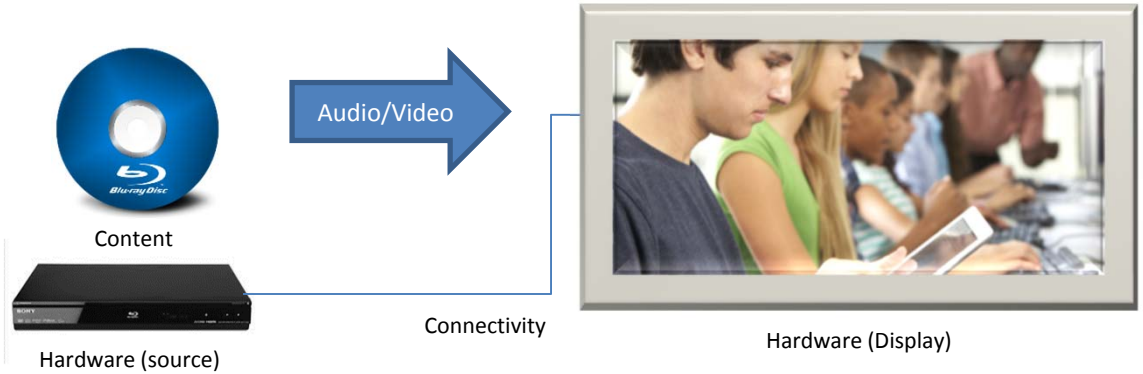
AV Troubleshooting – Video Extenders

No Video:

- Check power and connections (start simple)
- Connect source directly to the display (short circuit test)
- Test both HDMI cables with short circuit test
- Use small CAT6A patch cord and short circuit with extenders
- Test permanent link
- Test or swap cables as needed

List of items to test:

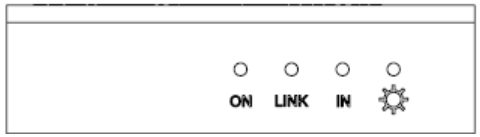
- **Power cables**
- **Loose connections**
- **Test display**
- **Correct input/configuration**
- **Test source**
- **Test HDMI 1, 2, etc..**
- **Test CAT patch cable 1,2, etc…**
- **Test Permanent link**

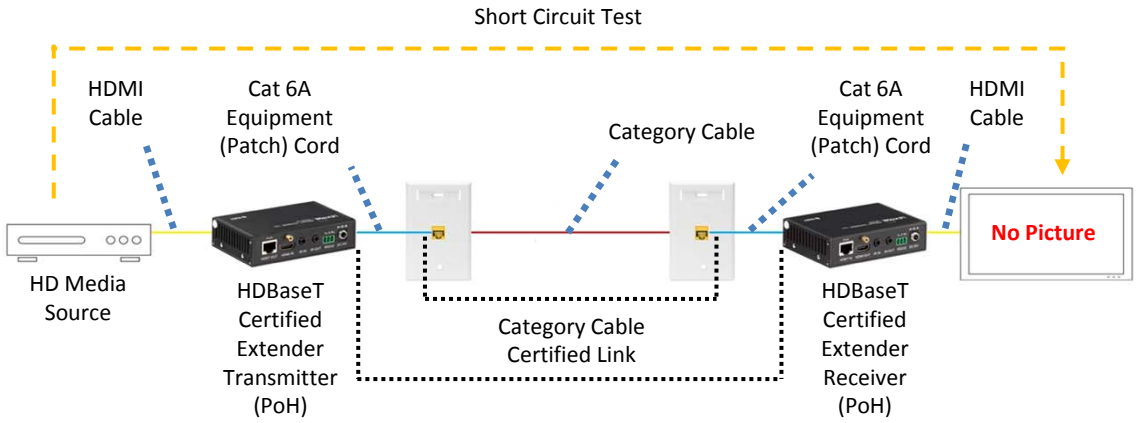


AV Troubleshooting – Video Extenders

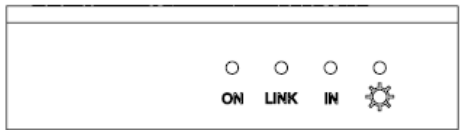
No Video Signal:

- Check power and connections (start simple)
- Connect source directly to the display (short circuit test)
- Test both HDMI cables with short circuit test
- Use small CAT6A patch cord and short circuit with extenders
- Test permanent link
- Test or swap cables as needed



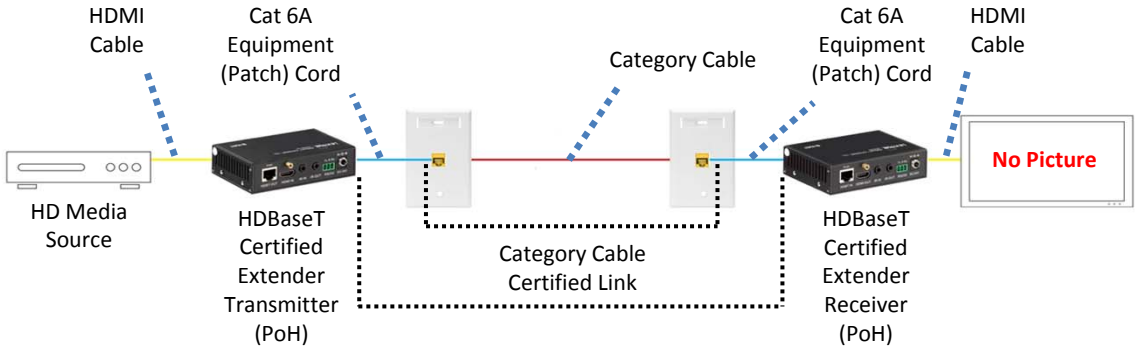


	LED STATUS					
ON	OFF	OFF	ON	OFF	ON	ON
LINK	OFF	OFF	OFF	ON	ON	ON
IN/OUT	OFF	OFF	OFF	OFF	OFF	ON
POWER	OFF	ON	ON	ON	ON	ON
NOTES	CHECK POWER	CHECK TWISTED PAIR WIRING	CHECK TWISTED PAIR WIRING	CHECK INPUT STATUS	HDCP PROBLEM	UNIT WORKING PROPERLY



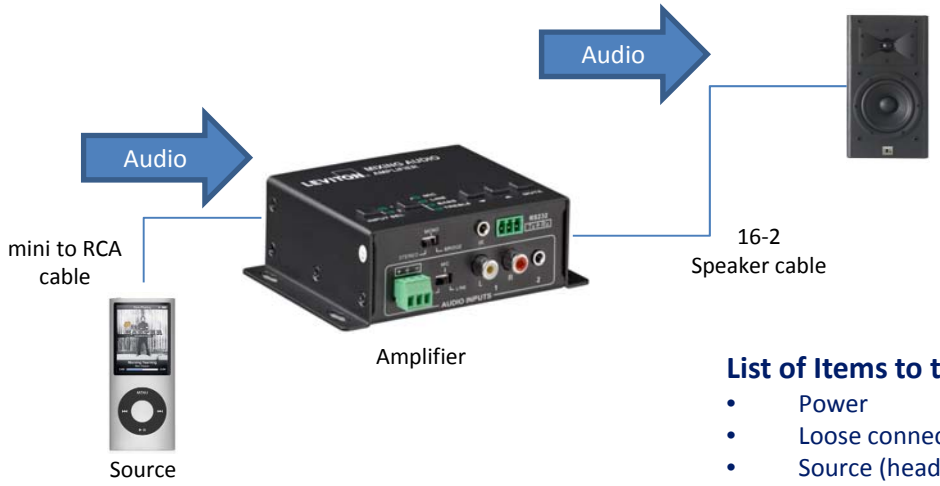
Indicator lights

- On – Green blinking.
  Normal operation
- Link – Green Solid.
  Communicating with other side
- In – Green Solid when HDCP encryption passed
  Green blinking – no HDCP
  Devices don't support
- Power – Red solid. Power is on



AV Troubleshooting – Audio

- **Verify source (test other source)**
- **Verify connections**
- **Verify speakers (test speakers with other amp)**
- **Bypass each component or cable to identify the issue**



List of Items to test:

- Power
- Loose connections
- Source (headphones)
- Amplifier (settings)
- Speakers
- Cable

End of Project

End of Project

- **Now that the system has been installed and equipment connected**
  - Test all permanent links
  - Verify connections
    - Visual verify
    - Test
  - Power on equipment
  - Test functionality

End of Project

- **Train your customer!**
- **Demonstrate all functions in each room to verify function meets need**
- **Have customer operate the system and answer their questions**
- **Be Patient! – This part of the job will drive future opportunities – Take your time**
  - You did account for this time in your proposal, right?

Thank You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