The Modern Workspace

Wired and Wireless AV Collaboration

-Karl Rosenberg-
“Build me a Unified Collaborations Space”
Huddle Room
Huddle Room with Soft VTC
Classrooms and Boardrooms are changing
Classrooms are Changing
Classrooms are Changing
Classrooms and Boardrooms are changing
AV Technology Deployment

4 types
Hard Wired AV Infrastructure using CATx

- Wired AV connections offer benefits related to reliability
- To INCLUDE a CATx for USB
Wireless AV

- Wireless AV offers flexibility, mobility, and benefits for installations that have architectural challenges.
- Network reliability, access, coverage, and congestion can affect performance.
AV Streaming

Lectern
- Camera
- Confidence Monitor
- HDMI
- Power
- Audio
- USB
- Wireless Microphone

Live Stream
- Ethernet
- Content Delivery Networks
- Internet

Facility LAN
- Firewall

Overflow Room
- Display
- HDMI
- Ethernet

Remote Viewer
- Watch on any device
- Laptop
- Tablet
- Phone
AV over IP

- Control?
- Audio distribution?
- Bandwidth/Data rate?
- Compression...yes
- Client Network?
- Your Network?
- 1G
- 10G
AV over IP Considerations
AV over IP – AES 67 Audio Distribution

- AES 67 Standard allows audio transportation over IP based systems
- Interoperability between network audio over IP protocols
- Adds audio networking technology into a variety of applications
- Supports both multicasting and unicasting
AV over IP – Compression

○ Compression – Three factors
  • Bit Rate
  • Image Quality
  • Latency

<table>
<thead>
<tr>
<th>Video Rate</th>
<th>Uncompressed Bit Rate @ 24 bpp</th>
<th>1G Compression @ 880 Mbps</th>
<th>10G Compression @ 4 Gbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>480p60 (SD)</td>
<td>422</td>
<td>1:1</td>
<td>1:1</td>
</tr>
<tr>
<td>720p60 (HD)</td>
<td>1,330</td>
<td>2:1</td>
<td>1:1</td>
</tr>
<tr>
<td>1080p60 (HD)</td>
<td>2,990</td>
<td>3:1</td>
<td>1:1</td>
</tr>
<tr>
<td>2160p60 (UHD)</td>
<td>11,940</td>
<td>14:1</td>
<td>3:1</td>
</tr>
<tr>
<td>4096x2160 @ 30 (4K/30)</td>
<td>6,370</td>
<td>7:1</td>
<td>2:1</td>
</tr>
<tr>
<td>4096x2160 @ 60 (4K/60)</td>
<td>12,740</td>
<td>14:1</td>
<td>3:1</td>
</tr>
</tbody>
</table>
AV over IP – Compression Ratios

- **Lossless**
  - Mathematically Lossless <3:1
  - Visually Lossless <10:1

- **Lossy**
  - Visually Lossy 100:1+
  - HEVC
  - VP9
  - H.264

- DSC <3:1
  - 4:1-10:1
  - 10:1-20:1

- Compression Ratio
AV over IP – Network

- Layer 3 Protocols
  - Multicasting
  - IGMP Snooping
- Client Network?
- Private Network?
Collaboration Space Considerations
Your Goals for the Room?

- How will the space be used?
- What is the budget for this space?
- Who will be using the space?
- VTC?
- How will the space be managed?
- Usability of the space?
- How will the space be operated?
- Cable management within the space?
Making Collaboration Spaces Work

- Signal Integrity
  - Using Shielded CATx cable
  - HDMI and USB
- Table Power
- Conferencing Interface
  - ZOOM Skype
- Wireless Video
- Audio
  - Usually using Speakers on Display
- Control
  - “people forget this all the time”
- Room Scheduling
- Annotation
Keys to success in this Collaboration arena (three C’s)

- **Connectivity**
  - CATx and Wireless and USB

- **Conferencing Interface**
  - Zoom, Skype, your laptops or phones
  - Phone interface
  - VOIP

- **Control**
  - Simple
  - Push button
  - Motion sensor
  - Touchpanel with Interface
Connectivity

Video Signals
Digital Signals – HDMI

- HDMI is an uncompressed digital video signal
  - Designed for the consumer market
Digital Video Characteristics – Loss

- Digital video signals consist of high speed transitions
- Very susceptible to degradation from:
  - Cable attenuation
    - Cable capacitance
    - Cable resistance
    - Impedance mismatch
  - Noise coupling
  - Crosstalk
  - Jitter
- All factors that Affect the receiver’s ability to distinguish high and low transitions
Digital Video Characteristics – Loss

- Difficult to anticipate
  - Image quality does not degrade like analog

- Cliff effect
  - Occurs when the receiver can no longer distinguish high and low values
    - Too many bit errors have occurred
Digital Video Characteristics – Variables

○ Cables can vary widely in performance
  • Adapters are useful but may affect signal quality

Damage caused by faulty HDMI connector
Resolutions

- Old Resolutions
- New standard 1080p
- Headed to 4K/UHD and 8K

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>720x480</td>
</tr>
<tr>
<td>HD</td>
<td>1280x720</td>
</tr>
<tr>
<td>Full HD</td>
<td>1920x1080</td>
</tr>
<tr>
<td>2K</td>
<td>2048x1080</td>
</tr>
<tr>
<td>UHD</td>
<td>3840x2160</td>
</tr>
<tr>
<td>4K</td>
<td>4096x2160</td>
</tr>
</tbody>
</table>
4K Signal Parameters

- **4K DCI is 4096x2160**
  - Four times the resolution of 2K DCI
  - Targeted towards digital cinema

- **4K refresh rates**
  - Varies – 24 Hz up to 60 Hz

- **Color bit depth**
  - 8-Bit, 10-bit, and 12-bit

- **Aspect Ratio**
  - 17:9 – same as 2K
Ultra HD Video Signal Parameters

- Ultra HD is 3840x2160
  - Four times the resolution of 1080p
  - Targeted towards consumer and broadcast markets

- Ultra HD refresh rates
  - Varies – 24 Hz up to 60 Hz

- Color bit depth
  - 8-Bit, 10-bit, and 12-bit

- Aspect Ratio
  - 16:9 – same as 1080p
HDMI 2.0 and HDMI 2.1

- New functionality includes
  - Enables transmission of HDR – High Dynamic Range video
  - Signaling speed to 18 Gbps
  - 4K@50Hz/60Hz, (2160p)
    - 4 times the clarity of 1080p/60 video resolution
  - Up to 32 audio channels with up to 1536 kHz audio sample frequency
    - 32 channels @ 48kHz each
  - Dual video streams on same screen, 4 audio streams
  - Support widescreen 21:9 format
  - Dynamic sync of audio/video
  - CEC extensions with expanded control via single point

- Backwards compatible
USB

Universal Serial Bus
HDMI and USB

CONNECT TO THE HDMI AND THE USB
Digital Signals – USB

- A standard for communication protocols that includes cables and connectors
- Historically used for attaching peripheral devices to computers
- Maximum length of USB 2.0 cable: The 2.0 specification limits the length of a cable between USB 2.0 devices (Full Speed or Hi-Speed) to 5 meters (or about 16 feet and 5 inches).
Digital Signals – USB

○ Over the years speeds have increased and USB supports video and audio transfer
  • USB 2.0 - 480 Mbps
  • USB 3.0 - 5 Gbps

○ Providing additional options for transporting video and audio
USB over distance?
USB Type-C

- Send Data, Video, Audio, and Power
- Latest, high speed, reversible USB
- 10Gbps data rate (V3.1), V3.0 = 5Gbps
- Deliver up to 100 watts! Devices negotiate...
- Supports “alternate modes”... like DisplayPort
- “...beyond 20 Gbps in the future.”
  — Pres. USB-IF
USB Hubs

- Connects upstream port and multiple downstream ports
- Port sharing bandwidth among all connected devices
- Provides status and control information
USB Topology

- Broken down into Tiers
- USB cable length is limited by the speed of electrical signals
- Tiered star topology has a max of seven tiers of communication
- Compound vs composite devices
Cascading Hub Limits
Source to Display

EDID and HDCP
EDID – Extended Display Identification Data

- EDID contains the following information:
  - Sink identity – device type, model number, etc.
  - Sink capability – video/audio
    - Video timing parameters, color space, audio formats, etc.
EDID – Sequence

1. Power on PC or activate external graphics card
2. Computer requests EDID data from display
3. Display sends EDID data to computer
4. Computer attempts to match display parameters
AV System Disparities

- BYOD equipment
  - How do they respond to EDID?

Portable devices:
- iPad may only output 1080p if audio is requested in EDID
- Other devices may not offer/support requested resolution

EDID set to:
- 1280x720@60
- RGB
- 2-ch audio
AV System Disparities

- Display’s native resolution versus other equipment
  - How to choose?

- Media Player
- 4K Blu-ray
- PC
- 4K Laptop

- System EDID?

- AV System
  - Max 720p
  - Native 1920x1200
  - Native 4096x2160
  - Native 1080p

- Codec
- Video projector
- 4K Video projector
- Confidence Monitor
- Codec
- Video projector
- 4K Video projector
- Confidence Monitor
HDCP – High-bandwidth Digital Content Protection

- HDCP protocol is a 3-phase process
  - Authentication
  - Content encryption
  - Renewability

- This can take a few moments depending on the number of downstream devices
HDCP

- Most collaboration spaces don’t have Blu-Rays or Cable Tuners
- You will have to worry about Apple, Recording and VTC products
HDCP Handshakes

- I/O authentication

![Diagram showing HDCP handshakes with inputs and outputs connected through a matrix switcher. The diagram includes labels for PC with DVI output, 4K Blu-ray with HDMI, 4K Display HDCP compliant, and 4K Blu-ray with HDMI. The connections are marked as authenticated.]
HCDP Handshakes With Products That Are Not HDCP Compliant

- Visual confirmation
Uncompressed Video Over Twisted Pair
HDBaseT

- HDBaseT Alliance, is a consumer electronic (CE) and commercial connectivity standard for transmission of uncompressed high-definition video (HD), audio, power, home networking.
Twisted Pair Transmission

- Distance
  - 328 feet (100 meters) between endpoints

Twisted Pair Transmitter for HDMI

Twisted Pair Receiver for HDMI

328 feet/100 meters
Why Use Twisted Pair?

- One twisted pair cable can carry multiple signals
  - Video
  - Audio
  - Bidirectional RS-232 control and IR
  - Ethernet
  - Remote Power
Twisted Pair Transmission

- **Cable**
  - Supports CATx cable
  - Solid conductor, shielded twisted pair cable with shielded connectors should always be used
  - Skew-free cable *should not* be used with XTP Systems
Twisted Pair Signal Transmission

- Shielded cable protects against outside interference from:
  - Air conditioning units
  - Power from adjacent cabling
  - Crosstalk from other cables or within the same cable
  - Radio interference from walkie-talkies

- Symptoms of noisy environments
  - Image drop-out or flashing
  - No image at all
Twisted Pair Shielding

- Different types of twisted pair shielding

<table>
<thead>
<tr>
<th>Cable Name</th>
<th>Outer Shielding</th>
<th>Individual Pair Shielding</th>
</tr>
</thead>
<tbody>
<tr>
<td>U/UTP</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>F/UTP</td>
<td>Foil</td>
<td>None</td>
</tr>
<tr>
<td>U/FTP</td>
<td>None</td>
<td>Foil</td>
</tr>
<tr>
<td>S/FTP</td>
<td>Braided</td>
<td>Foil</td>
</tr>
<tr>
<td>SF/UTP</td>
<td>Braided &amp; Foil</td>
<td>None</td>
</tr>
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</table>
Twisted Pair Signal Transmission

- Types of Category cable

<table>
<thead>
<tr>
<th>Cable</th>
<th>Gauge</th>
<th>Conductor</th>
<th>Outer Shield</th>
<th>Pair Shielding</th>
<th>Required Bandwidth</th>
<th>Crosstalk Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAT 5e (U/UTP)</td>
<td>24</td>
<td>Solid</td>
<td>None</td>
<td>None</td>
<td>100 MHz</td>
<td>~27dB</td>
</tr>
<tr>
<td>CAT 5e (F/UTP)</td>
<td>24</td>
<td>Solid</td>
<td>Foil</td>
<td>None</td>
<td>100 MHz</td>
<td>~27dB</td>
</tr>
<tr>
<td>CAT 6 (U/UTP)</td>
<td>24-23</td>
<td>Solid</td>
<td>None</td>
<td>None</td>
<td>250 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 6 (STP)</td>
<td>24-23</td>
<td>Solid</td>
<td>Foil</td>
<td>None</td>
<td>250 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 6a (U/UTP)</td>
<td>24-23</td>
<td>Solid</td>
<td>None</td>
<td>None</td>
<td>500 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 6a (F/UTP)</td>
<td>24-23</td>
<td>Solid</td>
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<td>None</td>
<td>500 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 6a (U/FTP)</td>
<td>24-23</td>
<td>Solid</td>
<td>None</td>
<td>Foil</td>
<td>500 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 6a (SF/UTP)</td>
<td>24</td>
<td>Solid</td>
<td>Braid and Foil</td>
<td>None</td>
<td>500 MHz</td>
<td>~37dB</td>
</tr>
<tr>
<td>CAT 7 (S/FTP)</td>
<td>24</td>
<td>Solid</td>
<td>Braid and Foil</td>
<td>Foil</td>
<td>600 MHz</td>
<td>~60dB</td>
</tr>
<tr>
<td>CAT 7a (S/FTP)</td>
<td>24</td>
<td>Solid</td>
<td>Braid and Foil</td>
<td>Foil</td>
<td>1 GHz</td>
<td>~60dB</td>
</tr>
</tbody>
</table>
Twisted Pair Installation

- Cable infrastructure and patch points
  - Up to 2 patch points recommended

Typical scenario for AV connectivity
Wireless Technologies

Compressed and Uncompressed
Wireless Video Applications

○ Point-to-point applications where source video signal is converted to a modulated RF signal for wireless transmission to a receiver connected to a display

○ BYOD applications where computing device encodes and transmits video content over a Wi-Fi network to a receiver connected to a display
Collaboration with their WAP

Rx with HDMI

TCP/IP Network
Radio Frequency Spectrum

- 500MHz to 5GHz balances capacity and range
- Transmits through common obstacles, such as walls, with low to moderate loss
Radio Frequency Spectrum

- 60 GHz used for higher data carrying capacity
  - Cannot penetrate solid objects
  - Short range
## Proprietary Wireless Protocols

<table>
<thead>
<tr>
<th>Wireless Interface</th>
<th>Frequency Band</th>
<th>Computing Hardware Required</th>
<th>Uncompressed Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>AirPlay</td>
<td>Wi-Fi</td>
<td>Apple Products</td>
<td>No</td>
</tr>
<tr>
<td>Chromecast</td>
<td>Wi-Fi</td>
<td>PC, tablet, smartphone</td>
<td>No</td>
</tr>
<tr>
<td>Miracast</td>
<td>Wi-Fi</td>
<td>PC, tablet, smartphone</td>
<td>No</td>
</tr>
<tr>
<td>WiDi</td>
<td>Wi-Fi</td>
<td>Intel Products</td>
<td>Yes</td>
</tr>
<tr>
<td>WiGig</td>
<td>Wi-Fi, 60 GHz</td>
<td>PC, tablet, smartphone</td>
<td>Yes</td>
</tr>
<tr>
<td>UWB</td>
<td>3.1 – 10.6 GHz</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>WHDI</td>
<td>5 GHz</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>WirelessHD</td>
<td>60 GHz</td>
<td>None</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Using Your Own WAP
Using Their WAP
Key Features to have in a Wireless Video Platform

- **Easy Wireless and Wired Collaboration**
  - Wireless connections via OS mirroring or app
  - Wired connections via HDMI Input
  - Contact/Tally I/O ports
    - Add Motion Sensor
    - Add Button control

- **Multi-Platform Support**
  - Mac / Windows runtime or installed app
  - Android / iOS app
  - Apple & Android mirroring
Conference Interface
Multiple Types of Devices

- Networks need to be capable of handling multiple types of devices and environments where BYOD is common.
Table connectivity including Power and USB charging
Seamless Conferencing Experience
Control
Motion Sensor or Timed System
Meeting Space Collaboration System
Simple Motion Sensor

- Motion Sensor wiring

- Control system module for Motion Sensor configuration
How a timer works
TeamWork System with Show Me Cables

1. Enters the meeting room
2. Connects laptop
3. Presses Connect Button
4. Content is displayed
5. Enters the meeting room
6. Connects laptop
7. Presses Connect Button
8. Press Connect Button
9. Input switches
10. After a configured period of inactivity the system automatically shuts down

CATx Cable up to 230’ (70m)
Upgrade Options – Wireless Connectivity

- HDMI/CEC
- Occupancy Sensor
- CATx Cable up to 230' (70m)
- Wireless Devices
- HDMI

CATx Cable up to 230' (70m)
Upgrade Options – Touchpanel Control

- HDMI/CEC
- Occupancy Sensor
- CATx Cable up to 230’ (70m)
- HDMI
- Touchpanel
- Ethernet
- LAN
Push Button Controllers
These do NOT count!
Single Display Application

PC

- Ethernet
- HDMI with embedded audio

TCP/IP Network

- Ethernet
- HDMI with embedded audio

Blu-ray Player

- IR to Blu-ray

Projector with internal speakers

- Ethernet/PoE

Screen Control

- Ethernet

Relay to Screen Control

Ethernet/PoE
Features of PUSH –Button controllers

- Manage, monitor, and control AV devices using a standard Ethernet network
- Fully configurable ...NO Programming
- Two bidirectional RS-232 ports
- Two relays for controlling room functions
- One IR port for connecting up to two emitters
- Remote volume control port for external third-party AMPS
Room Scheduling
Scheduling – How it used to be
Room Scheduling Panels
Room Scheduling
Designs
Equipment

- Wireless only
- No power at Table
Equipment

- Cable Table system
- Controller
- Occupancy Sensor
- Shielded CAT 6a
Equipment
Equipment

- Shielded CAT x cables
- HDMI switcher
- Four Input HDMI Switcher
- HDMI and Audio to USB Scaling
- Wireless Collaboration Gateway
- Tabletop Touch Panel
- Control Processor
- Stereo Amplifier - 100 Watts/Channel
- Speakers
The Modern Workspace

-Thank You-
Karl Rosenberg