Interconnections:
Connectivity, protocols & terminology

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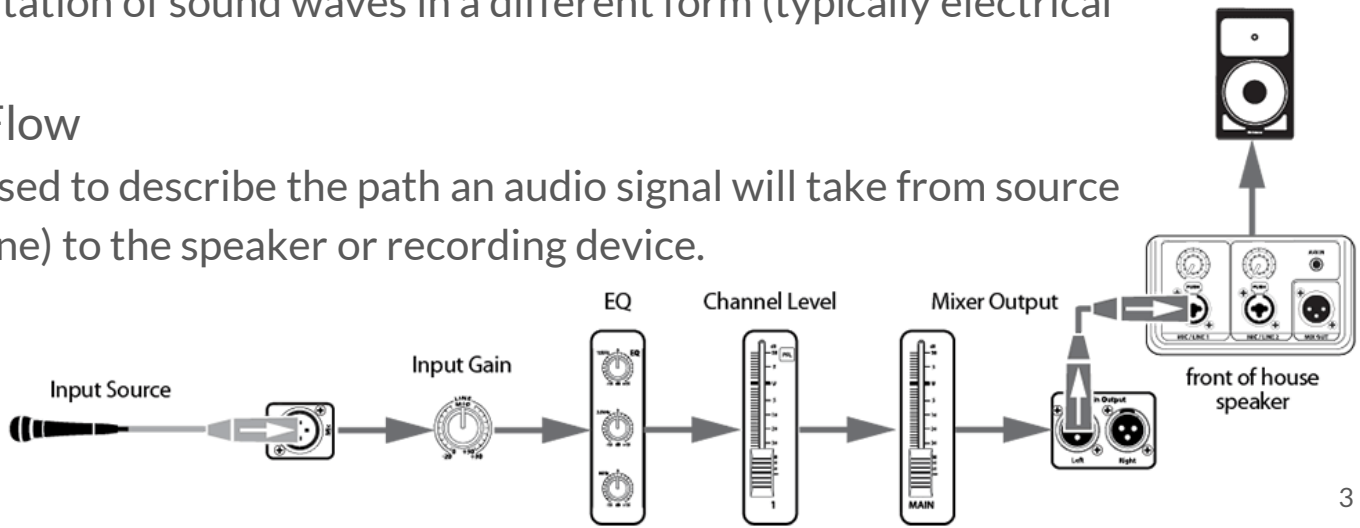
Partially based on:

- Christopher Ariza. 21M.380 Music and Technology: Recording Techniques and Audio Production. Spring 2012. Massachusetts Institute of Technology: MIT OpenCourseWare, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.

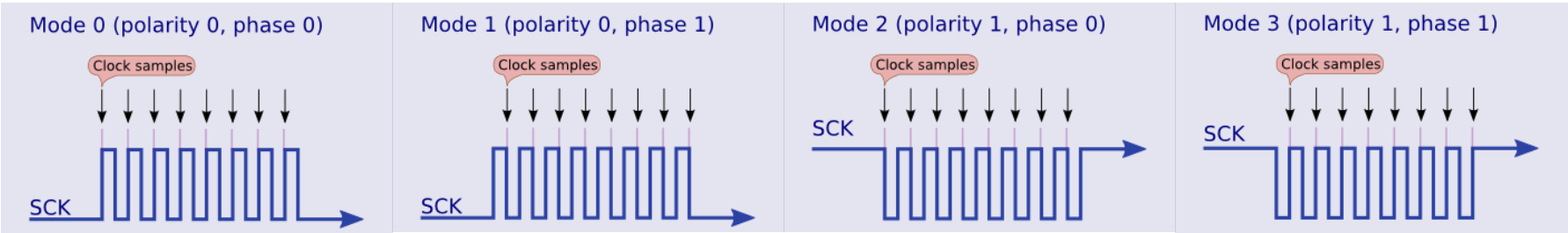
What is Audio Signal Flow?

- Audio
  - of or relating to sound or sound reproduction
- Audio Signal
  - a representation of sound waves in a different form (typically electrical voltage)
- Audio Signal Flow
  - the term used to describe the path an audio signal will take from source (microphone) to the speaker or recording device.



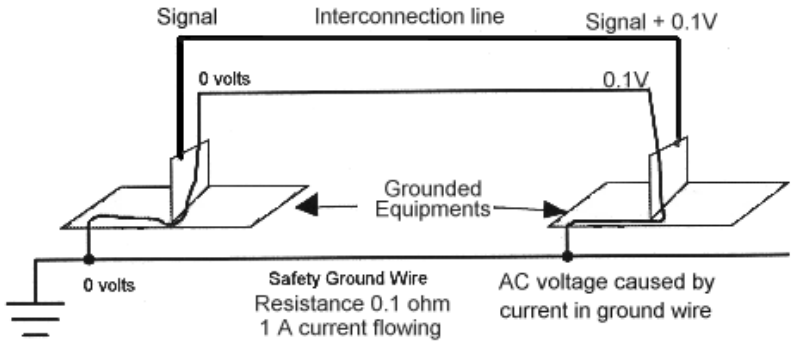
Polarity and Phase

- Sound waves alternate between high pressure and low pressure
- Electrical audio signals alternate between positive (+) and negative (-)
- Polarity indicates a positive or negative value
- Musical Sounds have a repetitive wave pattern - a cycle that repeats
- Phase tells us where we are in a cycle
- Phase is measured in degrees or radians
- One complete cycle = 360 degree of phase



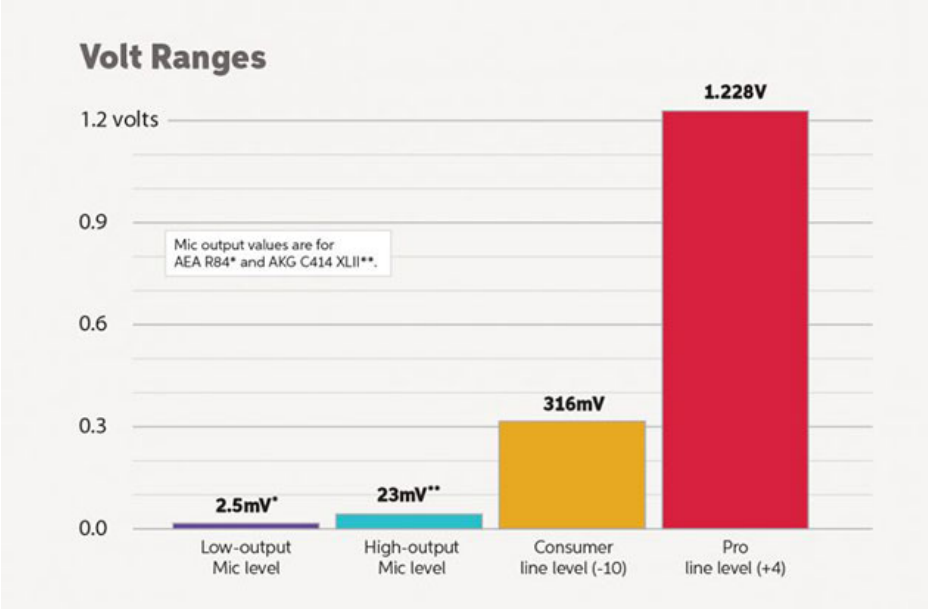
Signals, Voltages, and Grounds

- Analog sound can be represented as a changing voltage
- Grounds are a point of zero voltage
  - For safety: a path for faulty currents
- Ground loops:
  - grounds with differing electrical potentials on the same connection (not exactly a ground), may result in a 60 Hz hum



Audio Signal Levels

- Mic level - smallest (-60 dB)
  - XLR connector
- Consumer level (-10 dB)
  - Home stereo equipment
  - Uses RCA connectors
- Line Level - highest (+4 dB)
  - Professional equipment
  - 1/4-inch or XLR connector

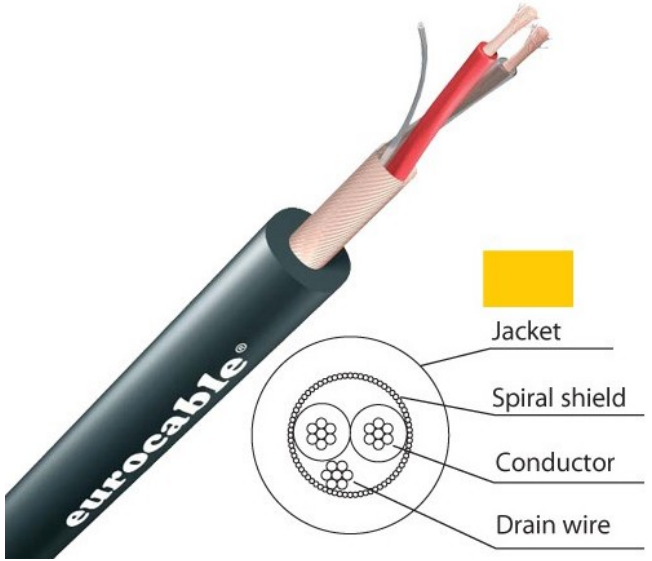


Audio Signal Levels

- A variety of levels are used in passing signals between audio gear.
- Every input expects one type of level.
- Mismatching can result either in distortion or no usable signal.
- Type of connector (XLR, 1/4″, 1/8″, RCA) does NOT indicate the signal level.
- Don’t assume that the levels match just because one connector fits.
- Inputs are generally very clearly marked.

Common Audio Connections

- Cables
- Wires (conductors):
  - carry voltages or grounds
- Shielding:
  - protection from electrostatic fields
- Insulation:
  - outer level of protection
- Connectors and Jacks:
  - provide easy interface

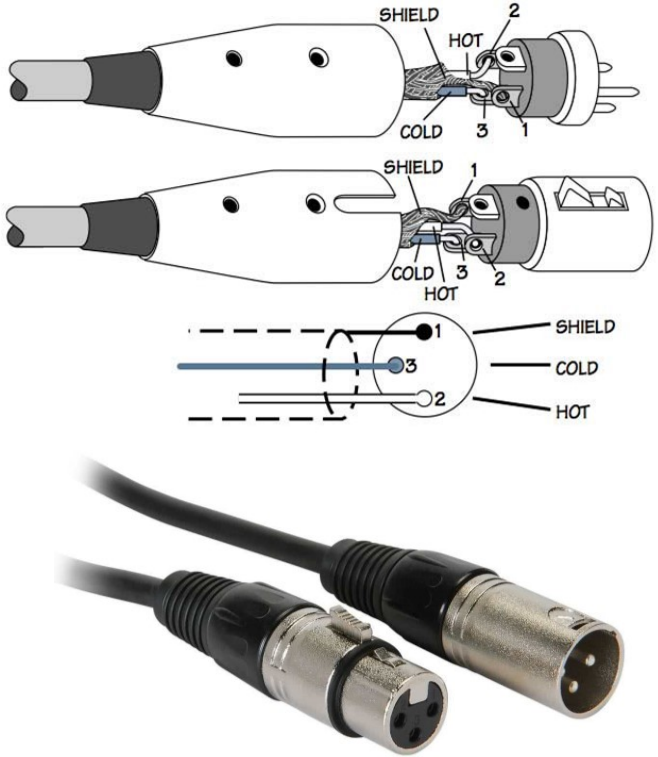


Common Analog Cables: Connectors

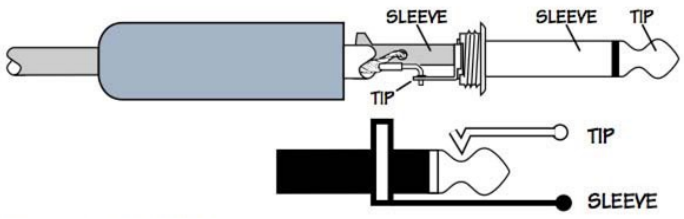
- TS
- TRS
- RCA (Phono)
- XLR

Common Analog Cables: Connectors

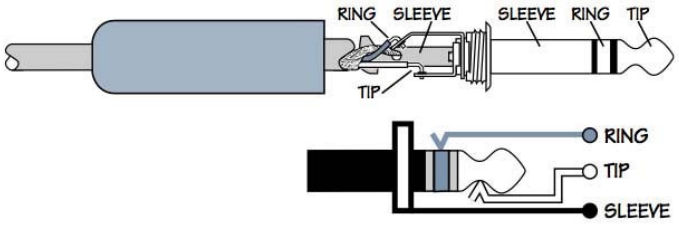
- *Male vs. Female*
  - *use your imagination*
  - An XLR cable generally has two genders
  - With XLR, male tends to be an output and female tends to be an input
  - 1/4-inch and RCA cables are generally male at both ends



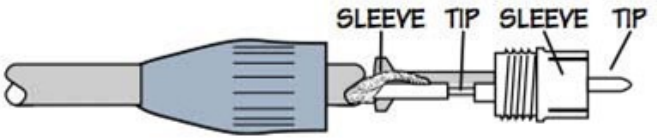
Common Analog Cables: Connectors



TS Plug



TRS Plug

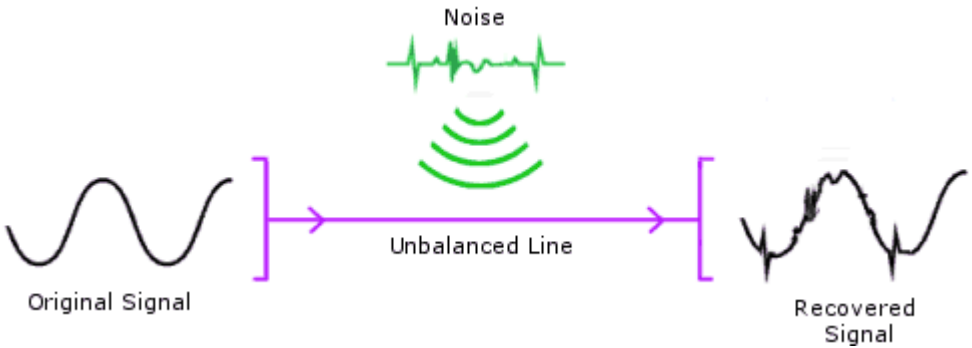


RCA Plug

Balanced vs. Unbalanced

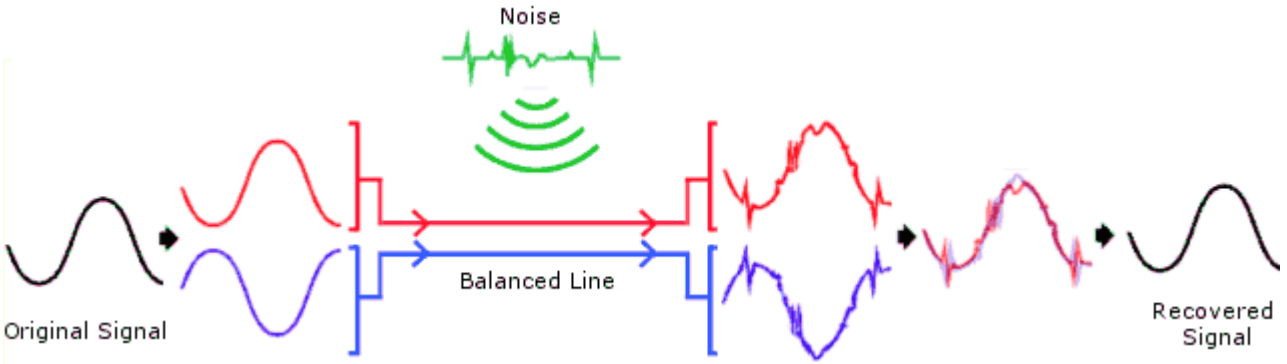
- An audio cable is an antenna
- It picks up noise along its length
- Signal cannot be separated from the noise on an unbalanced signal

- Unbalanced cables require two conductors
- Unbalanced (consumer equipment)
  - 1/4-inch TS, RCA



Balanced vs. Unbalanced

- A balanced signal can eliminate this noise through “destructive interference”
- Balanced cables require three conductors
- Balanced (professional equipment)
  - XLR, 1/4-inch TRS



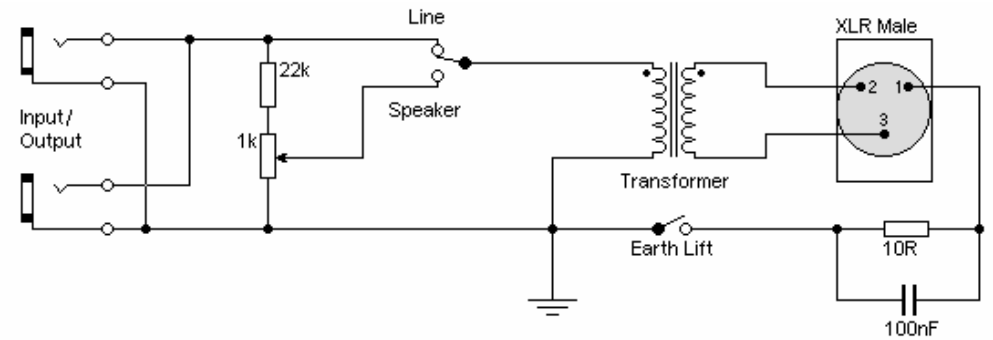
Common Analog Cables: Types

- Unbalanced
  - Two conductors: one signal, one ground
  - SOL: -10 dBV
  - High impedance
  - Length Limit: 25 feet

- Balanced
  - Three conductors: two signals, one ground
  - SOL: +4 dBu
  - Low impedance
  - Length Limit: 1000 feet
  - Active and transformer balanced

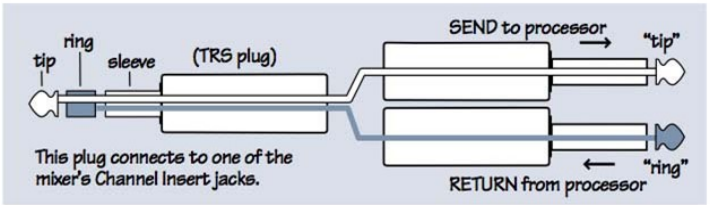
Converting from Unbalanced to Balanced

- Never use an adapter or a cable
- Direct Injection (DI) Box: convert -10 dBu to +4 dBu and balance signal
- Transformer isolation removes ground-hum noise
- Used to connect guitars, basses, keyboards, guitar/bass amp direct outs, turntables, drum machines, synths, et cetera into pro-audio inputs



More Analog Cables

- Mini Stereo:
  - 3 conductors used for 2 unbalanced channels
- Banana:
  - Designed for amplified signals, speaker wire
- Speakon:
  - Designed for high-wattage, amplified signals
- Y or insert cable:
  - 3 conductors used for 2 unbalanced signals

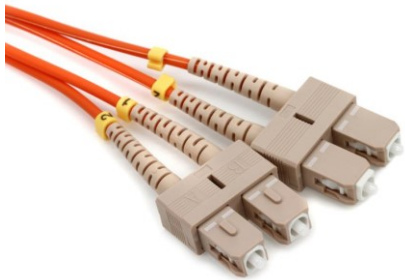


Digital Cables

- Types:
  - Always handle two or more channels per cable
  - Unbalanced
  - Balanced
  - Fiber Optic
- Examples:
  - SPDIF (Coaxial): looks like RCA
  - AES/EBU: looks like XLR
  - Toslink (2 channel optical)
  - ADAT/Lightpipe (8 channel optical)
  - MADI (optical or coaxial up to 64 ch)







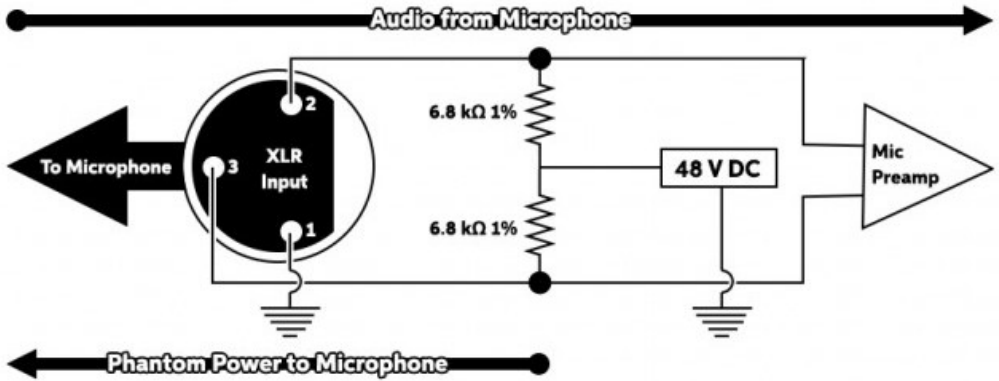
Snakes & Patch Bays

- Bundle cables in a single insulation

- Expose all inputs and outputs in one place

Power: AC and DC, Phantom Power

- Alternating current (AC):
  - 240 volts RMS in a 50 Hz sine wave
- Transformers:
  - rectifies and smoothes AC into DC
- Direct current (DC):
  - not a sine wave
- Phantom power:
  - +48 Volt DC transmitted on +/- signal lines of a balanced cable



Audio over Ethernet

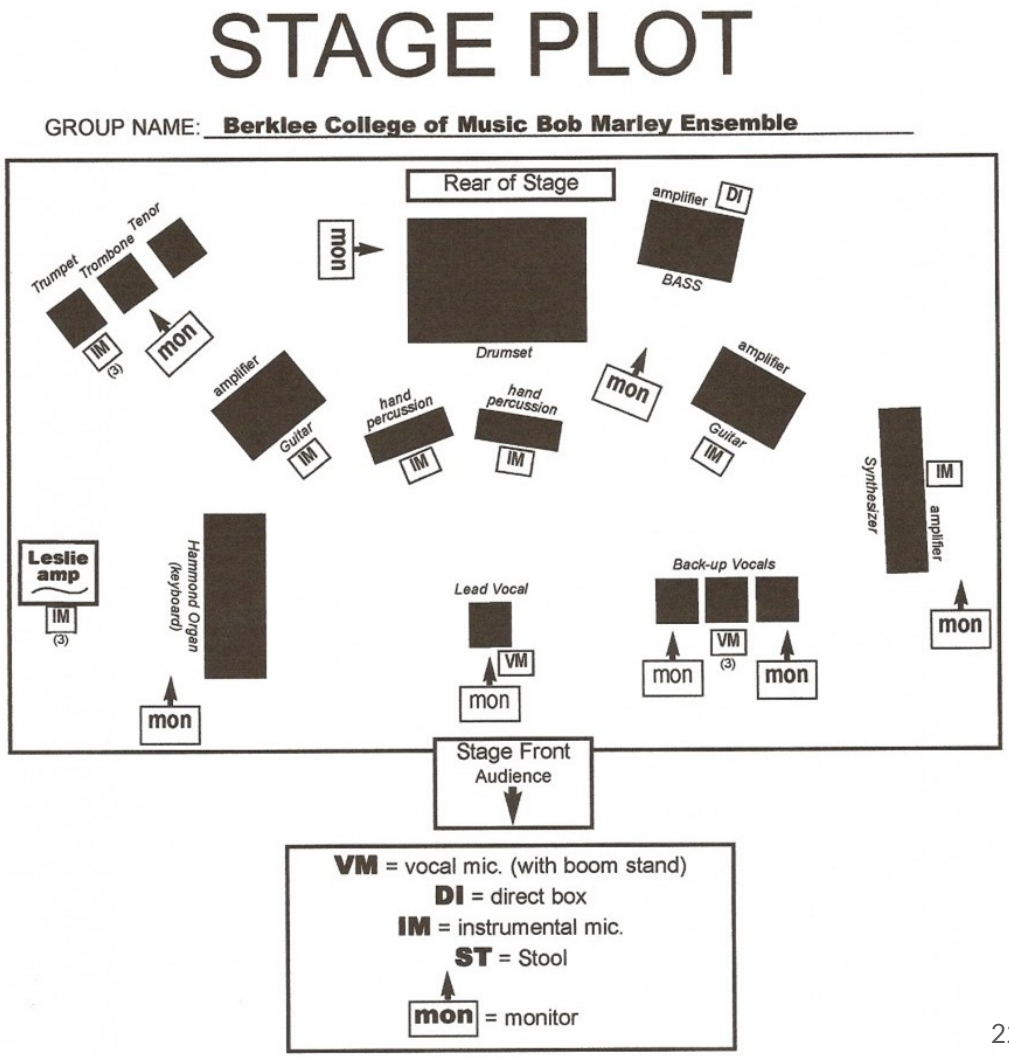
- Real-time digital audio distribution over Ethernet
- Replace bulky snake cables with standard network cabling
- Provide high-fidelity, low-latency professional audio
- Generally do not utilise any audio data compression
- Used for live sound, studio applications, etc.
- Various protocols based on OSI model layers:
  - Layer-1 protocols:
    - AES50, SuperMAC, HyperMAC, ULTRANET
  - Layer-2 protocols:
    - AES51, AVB, CobraNet, EtherSound
  - Layer-3 protocols:
    - AES67, NetJack, Livewire, Dante

Thinking Practical

Class Activity

Research and discuss to formulate suitable connections needed for the setup shown in this stage plot.

Make any assumptions as necessary to complete this task.



Let’s do this...