

# Best practices

Creating effective video-enabled workspaces

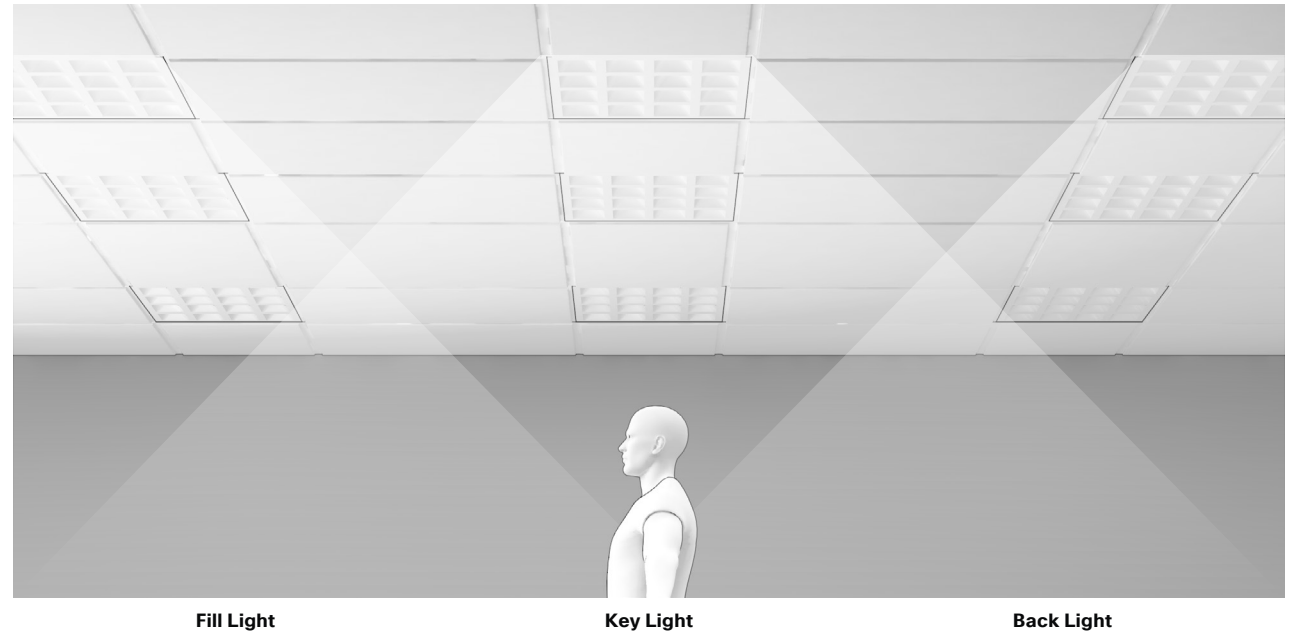
This document discusses the best practices for creating effective video-enabled workspaces.

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## Light essentials

Lighting is essential when building great meeting rooms, supporting both local and remote telepresence meetings. Following are some general recommendations for how to create the best light conditions.

To make meeting participants have the best appearance, they should be lit with key light, fill light and backlight. The key light is the main light source illuminating the subject. Fill light is added to avoid dark shadows over participants eyes, and a lack of it may cause the whites of the eyes to be lost along with any possibility of eye contact. The backlight makes the subjects stand out from the background.



## Recommendations for luminaries selection

- We recommend glare-free luminaries with a beam angle of 90° or wider as it serves as both key and fill light.
- Avoid mixing different lighting technologies such as fluorescent lights and LED as their color profiles might differ. This might reduce the cameras ability to represent colors correctly.
- To maintain the highest quality camera capture we recommend utilizing a lighting system with minimal flicker.
- Generally, a good light color temperature is 4000K but consider increasing this number if you depend mostly on daylight as your light source.
- For flexibility you can also choose luminaries providing tuneable white. This solution is ideal, as it allows for both matching preferences, as well as continuously adjusting the color temperature during the day to match the color of daylight.
- In order to render skin tones and room interior with correct colors, it is important to have a color rendering index (CRI) of 85 or better

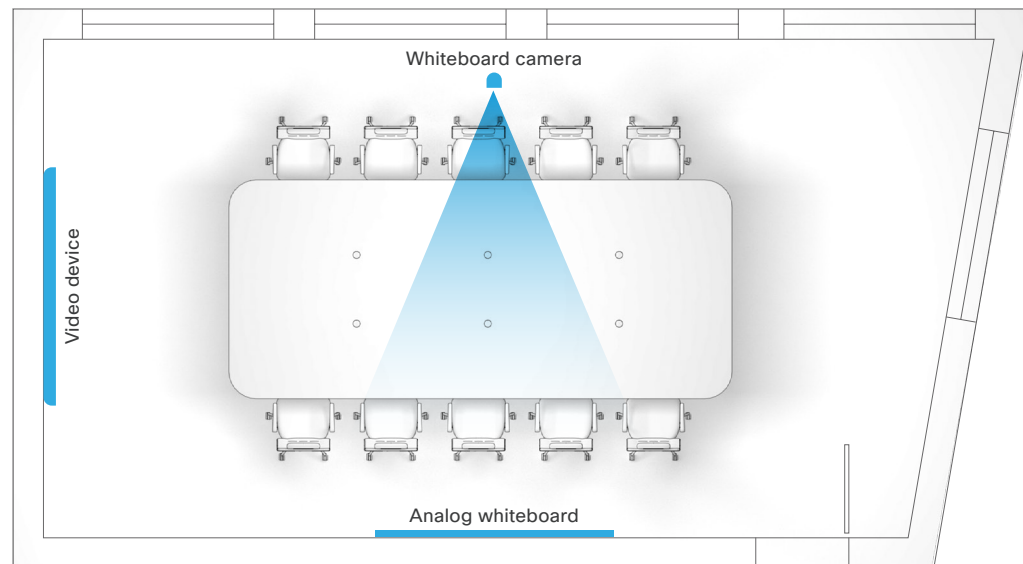
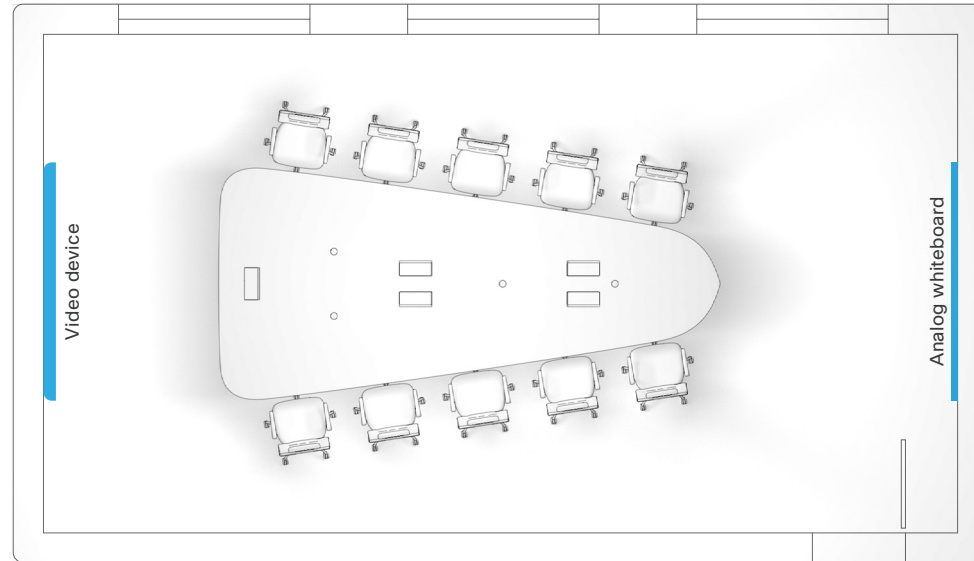


- 1 The recommended light intensity for faces is 400-500lux, measured vertically, and 700-900lux on horizontal work surfaces.
- 2 We recommend a uniformity number ( $E_{min}/E_{avg}$ ) higher than 0.8 on work surfaces to maintain little variance between light and dark areas.
- 3 Make sure you can reduce sunlight to a comfortable level and reduce excessive backlight.
- 4 Avoid placing luminaries too close to the screens or the cameras as it may cause reflections (glare).
- 5 To create a backlight effect we recommend placing light sources close to surrounding, bright colored walls, as light will reflect back into the room.
- 6 To provide additional separation of the subject from background, the background itself should be lit with less intensity than the subjects in the foreground.

## Whiteboard essentials

It is best to have an analog whiteboard visible in the camera overview. An additional camera allows for greater flexibility, such as focusing on the whiteboard.

- If the room allows for it, place the whiteboard on the wall opposite the video device.
- If the whiteboard is on a side wall, place it so that it is visible in the overview and use an additional camera to focus on the whiteboard.
- Point the additional camera directly at and focused on the center of the whiteboard.
- Place the additional camera at least 1.5 m (5 ft) above the floor.



## Acoustic room guidelines

The acoustic conditions of your room play an important role for both video calls and local meetings.

The three primary acoustic factors for the meeting experience are:

- Reverberation in the room ( $RT_{60}$ )
- Noise levels (background noise)
- Sound insulation between the room and the surrounding environment

In a video conferencing room, the acoustic experience depends on the combined effect of the above-mentioned factors of your room and the other meeting participants' room. Consequently, acoustic requirements for video conferencing are stricter than for other rooms. What makes the acoustic experience more difficult to evaluate during a video call, is that some effects of the acoustic conditions of your room may only be apparent to the far-end meeting participants.

## Reverberation time, $RT_{60}$

Reverberation time is a measure of sound decay in a space. The  $RT_{60}$  value is the time in seconds it takes for an abruptly stopped sound to decay by 60 dB and is expressed for one-octave bands from 125 Hz to 4 kHz.

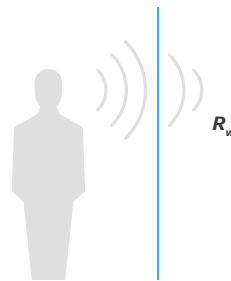
$RT_{60}$  values should be between 0.3 s and 0.4 s for all bands. In rooms fulfilling these requirements, the acoustic experience is pleasant, and you should be able to understand each other clearly.

## Sound insulation

Sound insulation between the room and the surrounding environment provides confidentiality and minimizes disturbance of people inside the room by noise from the outside and vice versa.

Between meeting rooms used for video conferencing and confidential meetings and neighboring spaces, the following minimum permissible levels for the sound reduction index  $R_w$  apply:

- Rooms not connected by a door:  $R_w \geq 52 \text{ dB}$
- Rooms connected by a door:  $R_w \geq 42 \text{ dB}$



## Noise levels

High noise levels negatively impact meeting participants' ability to follow the meeting and may lead to meeting fatigue.

For video conferencing rooms, we recommend a total A-weighted ambient noise level ( $L_{p,A,T}$ ) not exceeding 30 dB SPL.

The limits are maximum permissible levels for the total noise in the room given as A-weighted, time averaged levels ( $L_{p,A,T}$ ). The averaging period corresponds to the time of use and realistic environmental conditions.

These measures reduce noise or disturbance caused by noise:

- Remove noisy equipment from the room, if possible.
- Close windows to reduce traffic noise.
- Do not place microphones close to noise sources such as air-con outlets or your laptop fan.
- Use a carpet. Although this does not reduce reverberation, it dampens the sound of footsteps or moving chairs.

## Sound absorption

The combined sound absorptivity of surfaces in the room and the placement of absorbing materials define the reverberation time. Sound absorptivity, the measure of how much acoustic energy a material absorbs, is given as the noise reduction coefficient **NRC** or sound absorption coefficient  **$\alpha$** . The values range from 0 (a perfectly reflective material) to 1 (a perfectly absorptive material).

Hard, rigid, sealed surfaces, such as painted concrete, marble, or glass reflect most of the incident sound energy, whereas soft, compliant, and porous materials, such as fiberglass, foam, or acoustic panels absorb incident energy.

Although they may sometimes seem at odds with the aesthetics of modern interior design, acoustic considerations are crucial for the suitability of a room as a meeting space and should be part of the design process from the start. Good design balances the aesthetic and acoustic demands to ensure a pleasant experience.

Follow these guidelines for good room acoustics:

- Use a suspended acoustic ceiling consisting of tiles of absorption class A or **NRC**  $\geq$  0.9.
- Place acoustic absorbers on the walls. The combined area of the absorbers should be equivalent to half of the ceiling area.
- Place absorption on at least two walls, preferably adjacent walls. Avoid placing it on opposing walls only. The goal is to cover at least one wall of any pair of parallel walls.
- Ensure the absorption material is distributed evenly on the walls.
- Acoustic wall panels or textile curtains should be mounted at a distance of at least 5 cm (2 in.) from the window/wall.



## Examples of acoustic optimization solutions

Acoustically, the room is designed as a whole. For example, DeAmp panels installed at an angle along the side wall (see illustration) can both absorb acoustic energy directly and redirect reflections toward the acoustic absorbers at the rear of the room. This reduces both flutter echo and reverberation to the far-end meeting participants.

1 Acoustic panels

2 Carpeted floor

3 DeAmp panels ([deamp.com](https://deamp.com))

4 Sound absorbing ceiling tiles

5 Sound insulated walls

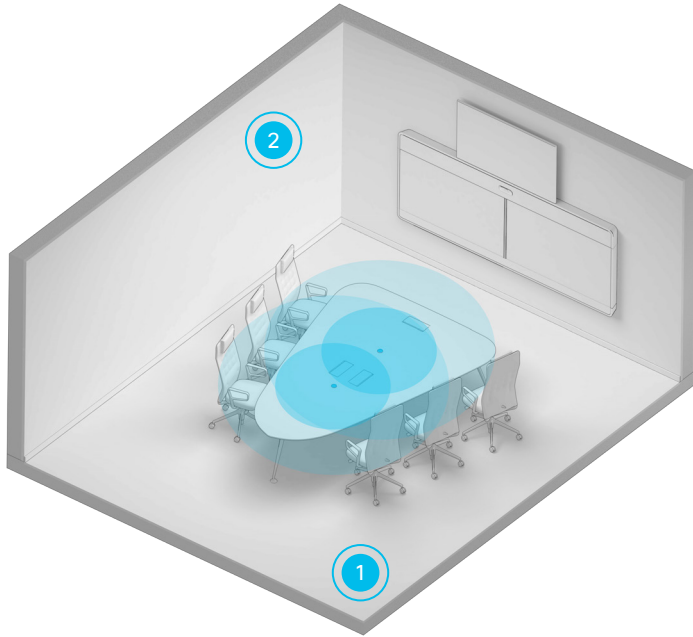
6 Sound insulated door

7 Acoustic panels



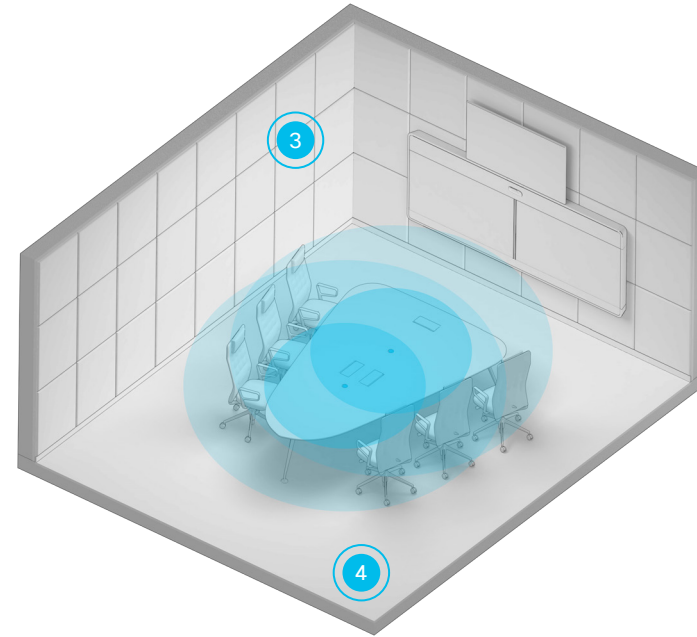
### Room without sound absorption

Smaller microphone range



### Room with sound absorption

Larger microphone range



## Microphone guidelines

When setting up microphones in a meeting room, it is important to consider the following:

- Type of microphone and pickup pattern
- Distance between microphone and meeting participant
- Acoustic conditions of the room (reverberation time, noise level)

These factors affect the sound quality, speech intelligibility and overall audio experience for remote meeting participants and meeting recording.

## Why are distance and acoustic conditions important?

A microphone close to a participant receives more direct sound relative to reverberant sound, which is preferable. A microphone further away receives more reverberant sound relative to the direct sound. This leads to less defined sound, which reduces speech intelligibility and can induce listener fatigue. For a given distance between microphone and participant, the microphone receives more reverberant sound in a room with little absorption than in a room with more absorption (see illustration).

- 1 Reflective/bare floor
- 2 Reflective/bare walls
- 3 Acoustic Panels
- 4 Carpeted floor

## Table microphones

For best voice pickup, we recommend using table microphones. These are closer to the meeting participants, who are usually seated around a table. The microphones can be installed flush in the table or placed on top of it. Table microphones also function as mute buttons within the meeting participant's reach.

A disadvantage of table microphones is that they can emphasize handling noise and other disturbances on the table. Also, if the direct path from participant to microphone is obstructed by an object, for example a laptop, high-frequency content is lost. This is called laptop shadowing and results in muffled sound.

## Ceiling microphones

Ceiling microphones are suitable when the table needs to be clear. They eliminate the risk of laptop shadowing and can cover standing and moving participants for whiteboarding and presentations.

However, because they are usually further away from participants, ceiling microphones capture more of the reverberation in a room relative to direct sound than table microphones. Being close to noise sources like HVAC can also negatively impact their sound quality. Installation of ceiling microphones should follow manufacturer guidelines for spacing and room coverage.

## Other microphones

Cisco video devices are compatible with third-party microphones using standard analogue interfaces. If more microphones are required than there are inputs available, the audio inputs can be expanded with external equipment.

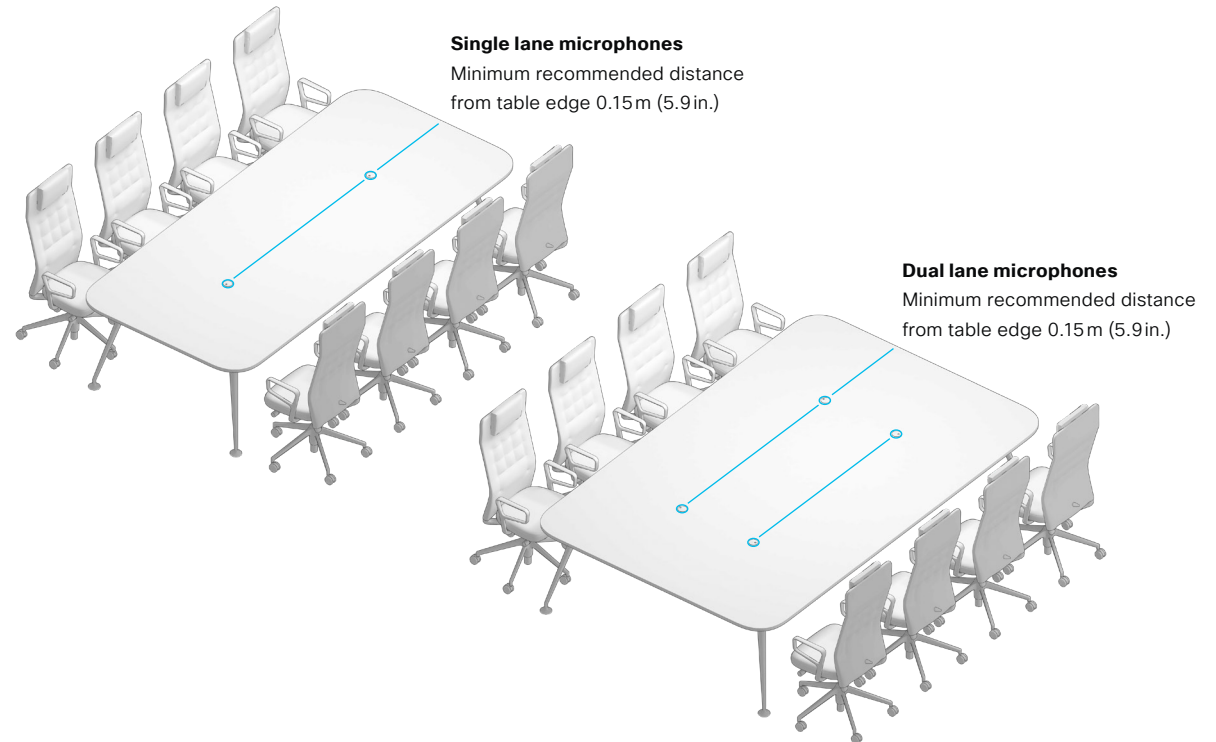
Many modern microphones use a technique called beam forming. Beam forming narrows the microphone's pickup to the direction from which speech arrives, reducing reverberation and noise pickup.

Find more about third-party audio integration vendors and the Cisco collaboration devices certification program: [cs.co/certifiedvendors](https://cs.co/certifiedvendors)

## Cisco table microphones

Cisco table microphones are omni-directional. They capture sound equally from all directions. As boundary microphones, they are designed to be placed on, or flush-mounted in the table.

- Place the omni-directional microphones along the center line of the table.
- A distance of approximately 1 m (39.4 in) to the participant is recommended.
- One microphone generally covers four people.
- Where two people are sitting at the same side of a table, place the microphone between them rather than in front of one of them to avoid laptop shadowing and ensure equal pickup.
- For wide tables, consider using two lanes of microphones.
- Keep the microphones away from the edges of the table. We recommend a minimum distance of 0.15 m (5.9 in.).
- Integrated microphones in video devices cover participants close to the video device. Refer to *Cisco Workspaces* for the video device in question.

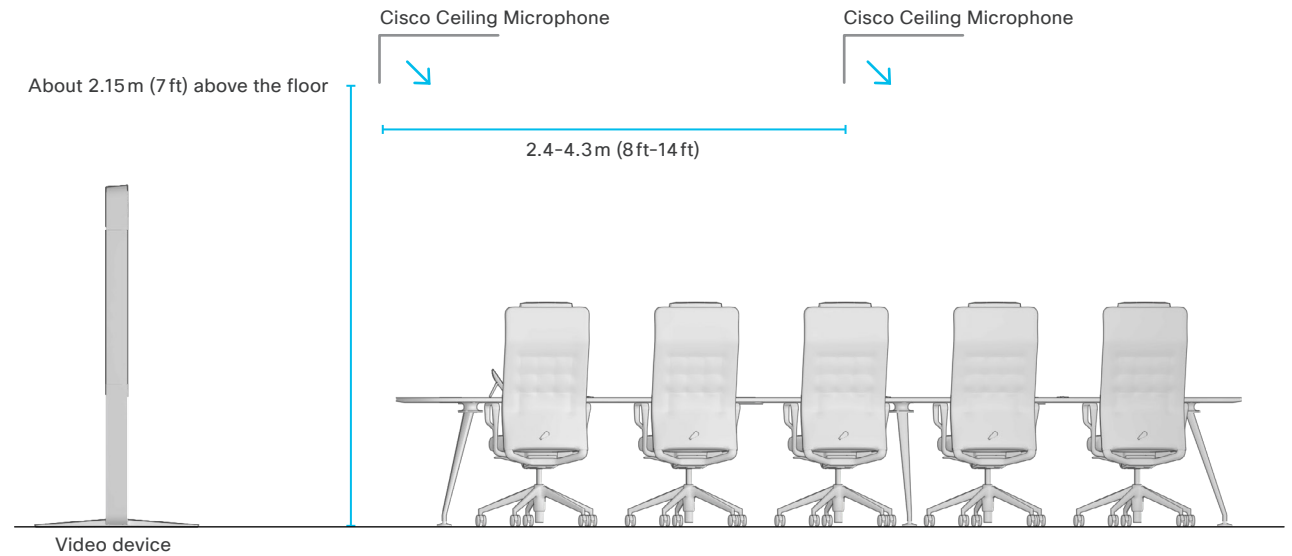


## Cisco ceiling microphones

Cisco boundary ceiling microphones can be used to keep the table free from objects.

Following are some guidelines on positioning the microphone correctly:

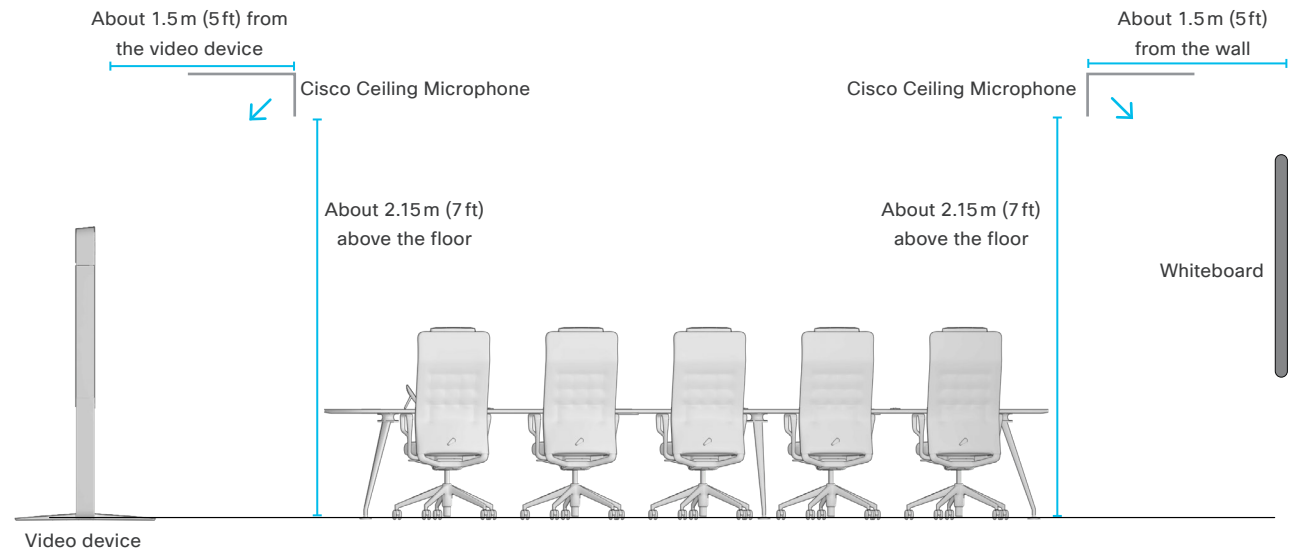
- The microphone can be used with tables seating 8–14 people.
- Align the microphone with the table edge closest to the system. Mount it about 2.15 m (7 ft) above the floor.
- The microphone must face away from the video device to capture the participants around the table.
- For longer tables, mount additional ceiling microphones with a spacing of 2.4–4.3 m (8–14 ft).
- The maximum spacing should only be used in acoustically well-treated rooms. In poorly-treated rooms, the spacing should be decreased to ensure a good direct sound to reverberant sound ratio.



## Ceiling microphones for presenters

In scenarios with a presenter who could be moving around, or working on a whiteboard, an additional ceiling microphone can be used to capture the speaker's voice.

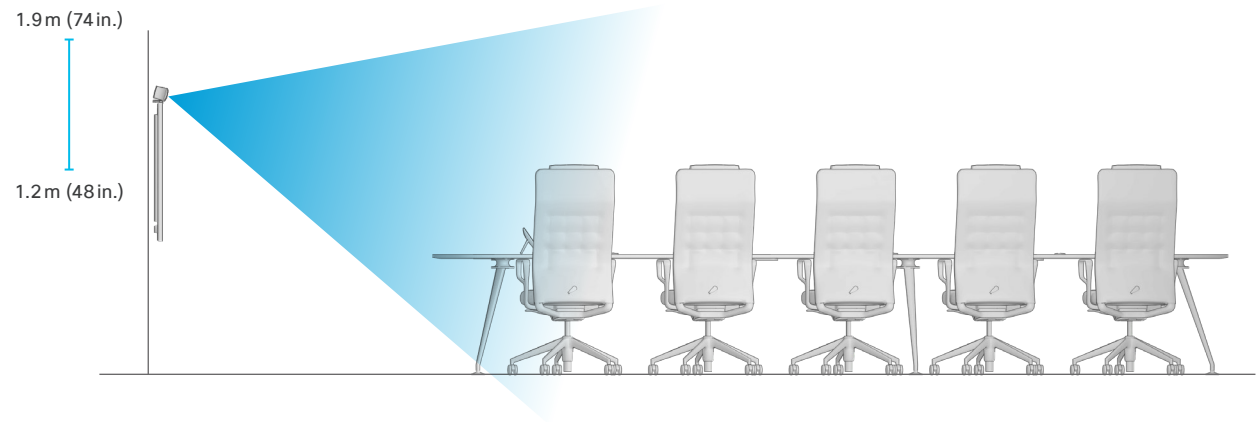
- Use a Cisco ceiling microphone to capture the voice of the presenter
- The microphone must face the presenter, even if that means pointing it in the direction of the video device or whiteboard.
- It should be mounted well above the floor, about 2.15 m (7 ft).
- The distance to the video device or whiteboard should be about 1.5 m (5 ft).



## Camera placement

The camera placement plays a significant role in the overall experience. For most setups, placing the camera above the display is recommended to capture the room and the audience in a good way. However the camera and the display should be considered together during assembly

- In standard meeting rooms, place the camera within the following range above finish floor: 1.2–1.9 m (48–74 in)
- Avoid mounting the camera too high as it will create a bird's view effect.
- If the camera is mounted below the screen(s), its recommended to mount a modesty panel.
- When you adjust the tilt of the camera, use the self-view to ensure the participants are framed in the upper part of the camera's view.
- For a non-standard space, like an auditorium or classroom with raised seating, the camera height rules might not apply. For planning special rooms, use floor plan and elevation drawings with camera's horizontal FOV and vertical FOV to get the best setup.



## Display recommendations

Typically, the optimal viewing distance for video and normal content is one to four times the diagonal of the screen. For example, the optimal viewing distance for a 65-inch screen is between 1.65–6.60m (5ft 5in–21ft 8in).

Additionally, the following can influence the maximum viewing distance:

- To optimally view more detailed content, such as graphics or spreadsheets, reduce the maximum viewing distance.
- If the screen displays only one person, you can increase the maximum viewing distance.

Use displays with lower delay (input latency) to increase the naturalness of communication. Input latency through most displays is often very high (>100ms) and is therefore detrimental to real-time communication quality. Activation of “Game Mode”, deactivation of motion smoothing and/or changing to another HDMI input with different capabilities can reduce the delay. Test a sample before ordering a large number of displays.

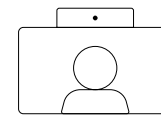
Make sure the display model selected fully supports sRGB color space, as this is used by all Cisco Webex devices.

Cisco has a Webex Certification program for displays, and display models that are Webex Certified deliver the absolute best experience with Cisco devices. The vendors go through an extensive 37 points of testing before the model becomes certified.

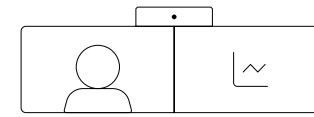
The main benefit of a certified display is the Webex Auto Configuration feature, which makes sure the display is automatically set up with correct parameters and settings for an optimal video conference experience when connected to a Cisco device.

In addition the certification ensures a set of features and parameters integrated in the display specifications. These are features like tested HDMI-CEC compatibility and good optical characteristics with regards to parameters like for example color temperature, luminance and input latency etc.

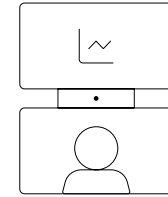
Find more about the Cisco Verified displays and the Cisco collaboration devices certification program: [cs.co/certifiedvendors](https://cs.co/certifiedvendors)



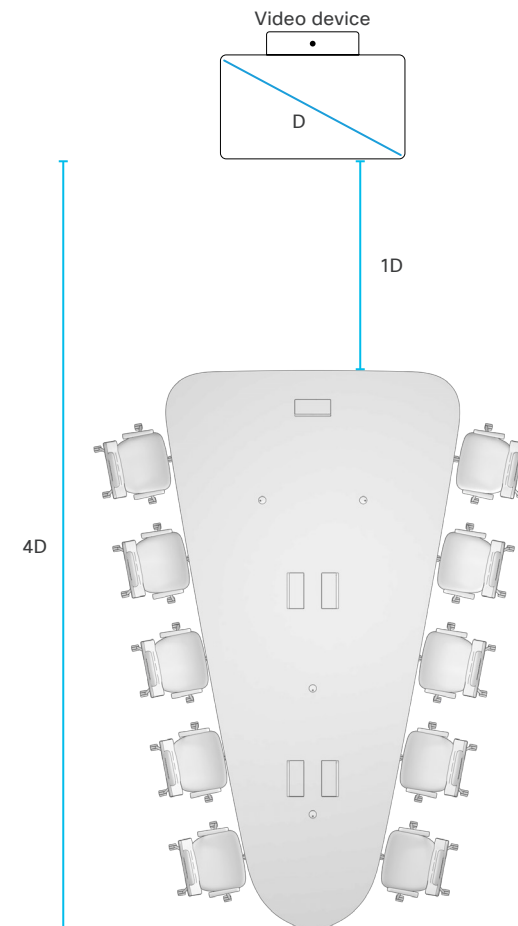
**Single screen**  
Focus on either video or content.



**Dual screens (horizontal)**  
Simultaneous video and content.



**Dual screens (vertical)**  
Video on bottom and content on top for narrow rooms/tables.



## Table recommendations

### Table shape

The table shape plays an important role in the product experience. With a straight table, people in the room naturally fan out to be able to see the screens. A tapered table shape gives all participants free view of the screens as well as free line-of-sight from the camera to each participant.

- We recommend a tapered table shape which is ideal for both video conferencing and local meetings.

### Table color

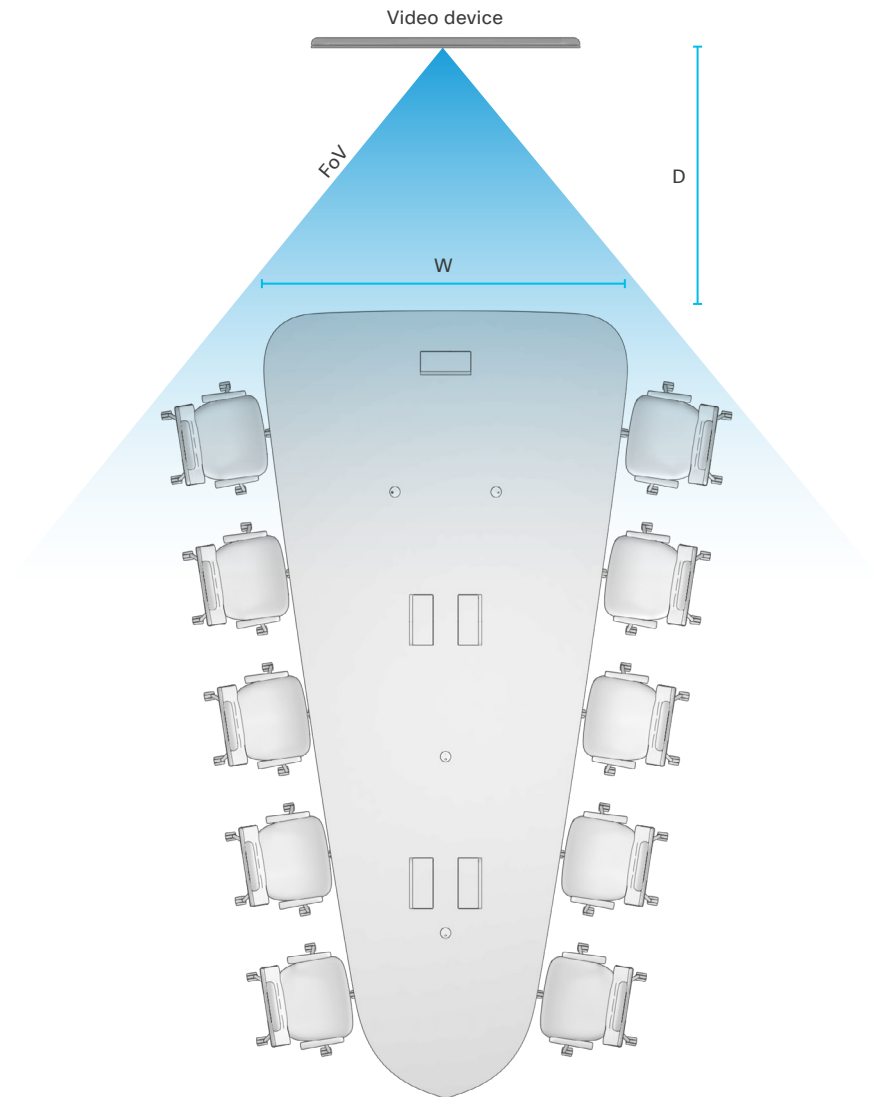
The video system will optimize the exposure of the participants' faces and due to this a white colored table might be over exposed. At the same time the table serves as a reflector from the ceiling lights which has a positive effect on the illumination of faces.

- We recommend light colored tone tables to evenly lit the participants faces.

### Table position relative to the video device

The Field of View (FOV) of the cameras dictates that the distance (D) between the table and the screen. To enable everyone at the table to see the screen, the table width should be slightly wider than the system/screen(s).

- Make sure the entire table is visible in the self-view to capture the entire audience.
- For ultrawide cameras, typically 120 degrees FOV, the distance D should not be less than 0.35 times the width (W) of the table.
- For cameras with around 80 degrees FOV, the distance D should not be less than 0.7 times the width (W) of the table.





## Loudspeakers

The choice of loudspeaker does not only affect the sound quality in the local room, but a poorly performing loudspeaker can cause echo and audio artifacts for remote participants.

### Loudspeaker performance recommendations

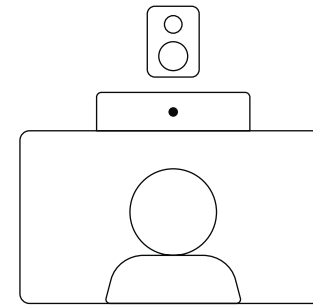
To reproduce voice accurately and avoid echo, follow these guidelines for selecting your loudspeakers:

- Sound pressure level (SPL): Able to produce 80 dB at all listening positions.
- Frequency response: Within  $\pm 3$  dB in the 70 Hz–13 kHz range (see illustration).
- Total harmonic distortion plus noise (THD+N): Lower than 1%.

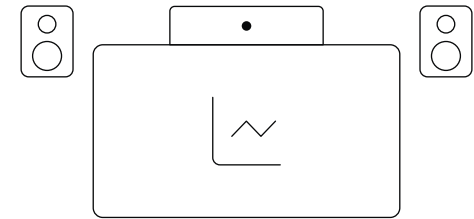
### Loudspeaker placement

- For the most natural voice reproduction, place a mono loudspeaker directly above the screen (see illustration).
- For better content reproduction, place stereo speakers on the sides of the screen (see illustration).

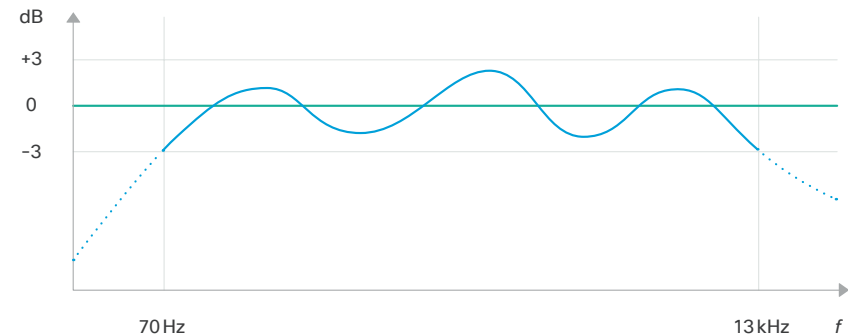
- Loudspeakers must cover all meeting participants adequately. The directionality of loudspeakers in different frequency ranges must be considered. All meeting participants should have line of sight to the high-frequency drivers.
- In larger spaces like auditoriums, extra sets of loudspeakers in the form of distributed systems with delay zones may be necessary to provide adequate coverage.
- If using a speaker tracking system, loudspeakers should be as far away from the tracking module as practically possible.
- An additional subwoofer can be used for improved low-frequency content reproduction.
- Built-in loudspeakers in TVs usually do not fulfil the criteria. Using external loudspeakers is highly recommended. Professional studio monitors are often a good option.

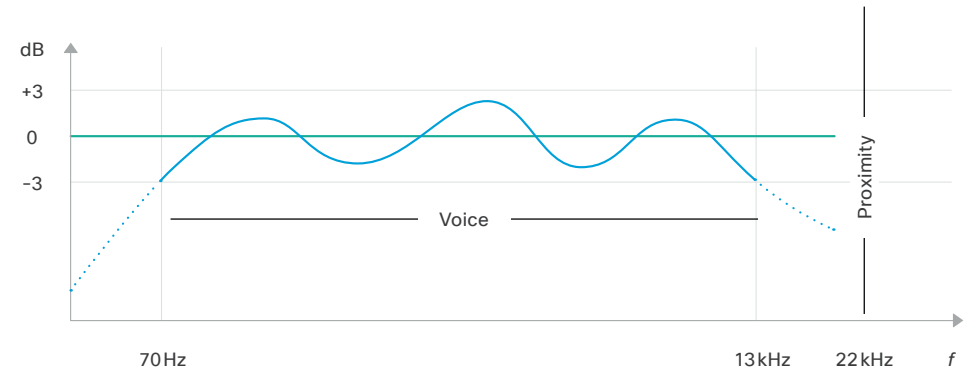
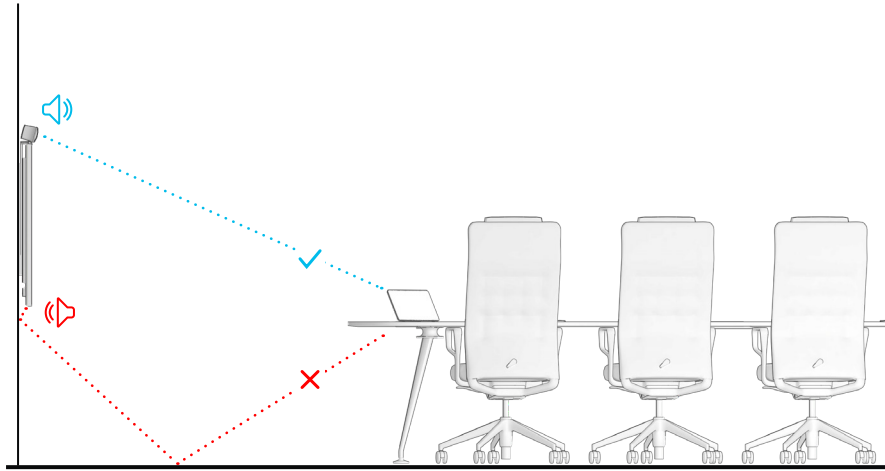


**For natural presence**  
It's recommended to place a mono loudspeaker directly above the screen



**For content reproduction**  
It's recommended to use stereo speakers on the sides of the screen



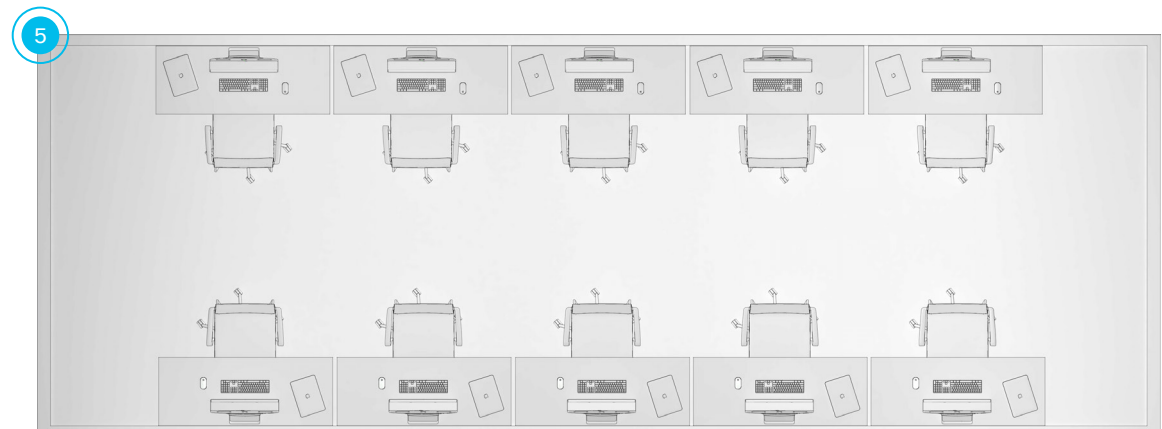
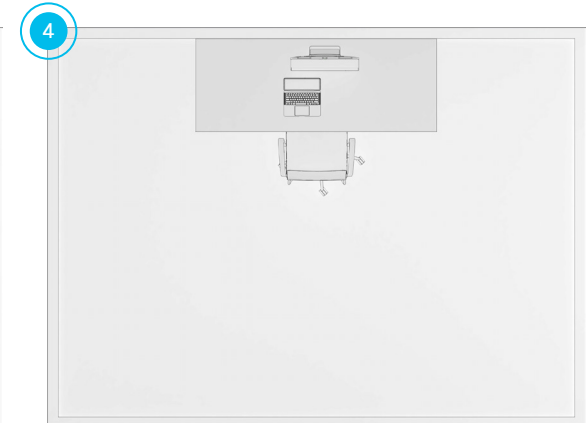
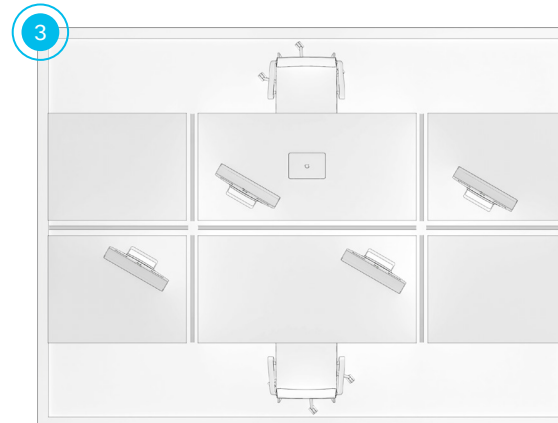
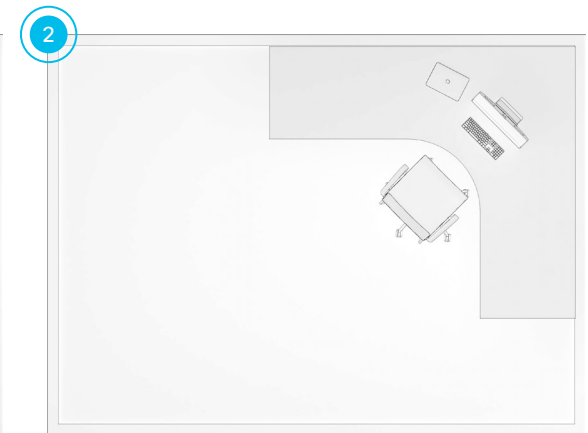
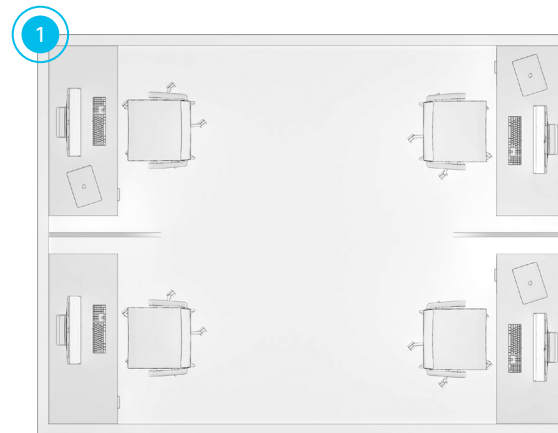


## Device connection using ultrasound

- Cisco video devices use ultrasound for device connection and motion detection, loudspeakers used with this feature should output sound up to 22kHz. Only moderate sound levels are required.
- Most loudspeakers produce sufficient ultrasound levels for pairing purposes, even if this is not specified in their datasheet. The reason they are not specified to this frequency range is that frequencies above 20kHz are typically attenuated more than 10dB and cannot be heard by most people.
- Loudspeakers with dedicated tweeters are more likely to produce sufficient ultrasound levels than full-range speakers, especially those larger than 4 inches.
- Because ultrasound output from loudspeakers is typically highly directional, objects that partly block the speakers may cause pairing issues.
- Displays with integrated speakers radiating backwards or downwards are likely to cause poor pairing performance. Use external speakers to improve this (see illustration).
- If Proximity is used in open and shared spaces, acoustic shielding may be used to prevent unwanted pairing with devices not participating in the meeting. Reduction of ultrasound output level is another option.
- Electronic or digital components in the audio output signal path may filter out the ultrasound needed for pairing. It is recommended that a sample setup be tested before ordering several loudspeakers or displays.

## Desktop recommendations

- 1 Shared office with personal devices
  - Intelligent audio microphone array
  - Internal loudspeakers or headphones
- 2 Home desk with personal device
  - Intelligent audio microphone array
  - Internal loudspeakers or headphones
- 3 Open plan hot-desk device in shared mode
  - Privacy screen
  - Headset
- 4 Quiet room device in shared mode
  - Intelligent audio microphone array
  - Internal loudspeakers
  - Privacy screen if the opposing wall is transparent
- 5 Open plan personal desk with personal device
  - Headset or intelligent audio microphone array together with headphones
  - Privacy screen



## Home offices

In this section we are sharing some best practices for successful video meetings from your home office. Everyone will have a different setup; however we have distilled the essentials for you to consider to enhance your at-home meeting experience.

## Audio

- Verify that the sound quality of your microphone is good, for instance by calling a colleague.
- Avoid placing your microphone next to or directly below air conditioning or fans.
- If you have a desktop device, avoid placing your laptop directly in front of the loudspeaker, as this will negatively impact sound quality.
- Use of a headset with a microphone can be beneficial when calling from a computer.

## Camera and display

- For optimal experience we recommend Cisco Device as it brings together all the necessary features to make video experience seamless and effortless.
- If using a laptop, we recommend using an external display with an additional USB camera on top. This will provide both the best ergonomics as well as meeting experience.

## Lighting

It's recommended to have the light source facing the user.

- Place the work desk by a window or place a light source facing the user.
- Avoid backlight as the user will appear in shadow and wont be clearly visible.
- It's recommended to use the self-view to evaluate the light conditions of the space.
- To address any screen glare we recommend that your device does not have windows or lights directly towards the display.

## Acoustics

Noisy and reverberant working environments are challenging. Controlled acoustics aids concentration, reduce fatigue and create a comfortable working environment. This also benefits other participants in video meetings.

- If possible, use a dedicated space where you are undisturbed.
- Use sound absorbing materials to reduce reverberation. This can be furniture with soft materials, such as couches with thick cushions. Curtains and carpets help too (see illustration).
- Place furniture or absorbers along large walls, especially ones parallel to other walls (see illustration).
- If you are starting out with an empty room, even a little absorption helps a lot.
- Irregular geometries, such as bookshelves help by spreading the sound (see illustration).
- Special purpose acoustic absorbers can be mounted on walls or ceiling. Absorbers suspended from the ceiling can be very effective, are unobtrusive and don't claim working space.



For more information about  
scenarios and setup, please visit:



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