

Hybrid meetings

A surprisingly complex combination of
people and technology

Colin Butcher

Purpose of talk

- Describe the resources and technology needed for hybrid meetings and consider some of the implications
- Establish some guidelines for organisers and speakers
- Assist not-for-profit organisations, smaller businesses and individuals, especially those on a limited budget
- This talk will concentrate on meetings where there is a speaker

Agenda

1. Introduction
2. Why have hybrid meetings ?
3. Roles & responsibilities
4. Technology overview
5. Audio
6. Video & screen sharing
7. Guidelines
8. Summary

Conventional in-venue meeting

- Everything in-venue, no need for on-line meeting software
- Needs good audio (microphones, mixer, amplification, induction loop, etc.)
- Needs a PC with a video connection to the projection equipment
- Needs someone to set up the audio equipment and assist the speaker (if necessary)

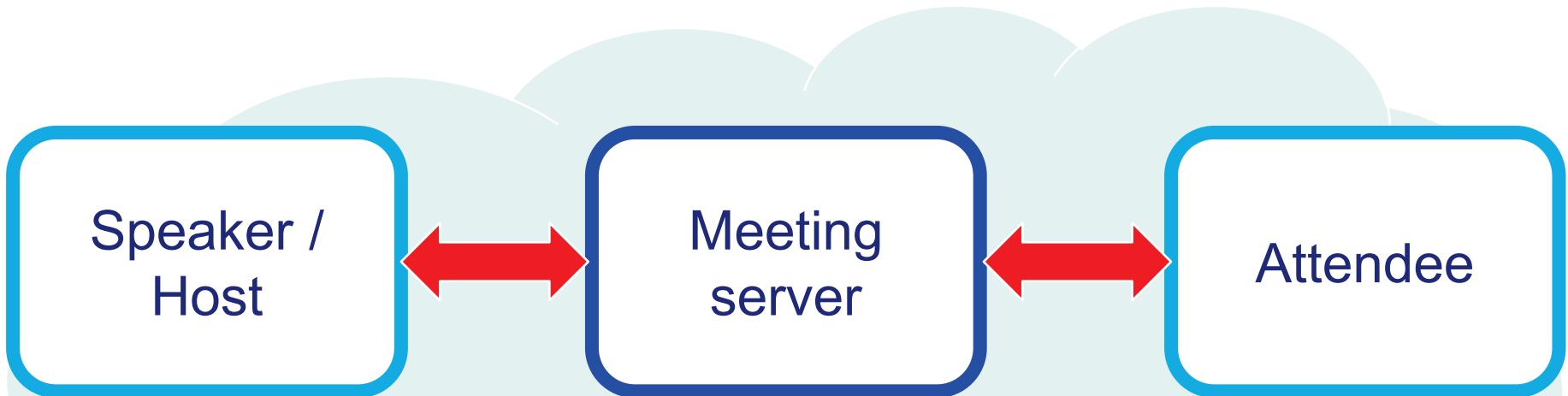
On-line meeting for individuals

- Many people, each on-line at their own personal location with their own PC or smartphone
- No need for sophisticated audio or video equipment
- Generally better to have separate microphone and webcam
- Screen-sharing, audio and video
- Home broadband may not always be good enough

On-line meetings – how they work

- Client PCs connect to a meeting “server”
- Roles: hosts, speakers and attendees
- Audio processing to minimise echo, delay, feedback, etc.
- Multi-platform (Windows, Mac, Android, etc.)
- Recording capability
- Various licence options, free versions generally limited in some way, pay for extra functionality (Zoom, Teams, Google Meet, GotoMeeting, Webex, etc.)

On-line meetings – how they work



- Need good audio and video
- Need good bi-directional network connection
- Joining requires authentication
- Data flows encrypted

Agenda

1. Introduction
2. **Why have hybrid meetings ?**
3. Roles & responsibilities
4. Technology overview
5. Audio
6. Video & screen sharing
7. Guidelines
8. Summary

What is a “hybrid meeting” ?

- Hybrid meetings combine in-venue meetings with on-line participation
- The Speaker, Host, Chair and Attendees can be any combination of in-venue, or on-line
- Speakers and Hosts share audio, video and screen content
- Attendees can participate and ask questions

Why is a “hybrid meeting” desirable ?

- There is a need for greater social interaction than is possible with on-line meetings
- Some people may be unable or unwilling to travel to a venue, for a range of reasons
- The ability to participate on-line can greatly increase the attendance
- The ability to give talks on-line gives greater choice of speakers and topics

Why is a “hybrid meeting” more difficult ?

- A conventional in-venue meeting has little (if any) need for on-line functionality
- Adding on-line functionality to an in-venue meeting requires sufficiently capable equipment in the venue. In-venue PC(s) run the on-line meeting software, use in-venue audio and video equipment and are connected to the Internet. The costs can be significant.
- The primary difference between an on-line meeting for individuals and a hybrid meeting is that of scale within the venue, which increases the complexity

How does a “hybrid meeting” work ?

- Speakers share audio, video and screen content
- In-venue needs screen projection and audio amplification
- On-line needs screen-sharing, audio input to the PC, video camera input to the PC, Internet connectivity, and software
- Attendees need to hear and see the presentation
- Hybrid meetings need to do both in-venue and on-line at the same time.

Agenda

1. Introduction
2. Why have hybrid meetings ?
- 3. Roles & responsibilities**
4. Technology overview
5. Audio
6. Video & screen sharing
7. Guidelines
8. Summary

Roles & responsibilities

- Key roles: Chair, Host, Speaker
 - Chair: Runs the meeting and manages questions
 - Host: Runs the software and equipment
 - Speaker: Gives the talk
- Preparation and briefing for all involved is key
- Equipment setup and testing needs doing every time
- What could go wrong and what could we do about it ?

A well-run hybrid meeting

- Good people in the key roles
- Smooth transitions between Chair, Speaker and Host, especially for questions
- Good preparation
- Good equipment
- Good connectivity (bandwidth & latency)
- Able to cope with unexpected problems (contingency)

Handling questions

- The Chair handles questions
- The Host flags on-line questions to the Chair (chat, raised hands, etc.)
- The Host enables a remote attendee to ask questions by voice (unmute/mute attendee)
- Use a handheld wireless microphone in-venue

Chair (in-venue)

- Responsible for the largely non-technical aspects
- Needs to understand the technology and equipment well enough to set it up and run it if needed
- Handles questions, so needs to be aware of “chat topics” in the on-line meeting

Host (or Technical Director, in-venue)

- Responsible for the largely technical aspects
- Needs to understand the technology and equipment within the venue
- Uses dedicated PC with audio mixer and video inputs
- Starts and hosts the on-line meeting
- Manages the audio and video streams during the meeting (mute all, etc.)
- Questions
- A co-host can be extremely helpful

Speaker (in-venue)

- Responsible for preparing and delivering the talk
- Separate screen sharing PC connected to the in-venue projection system, audio muted
- Hand-held slide controller, ideally with software highlight and pointer capability (eg: Logitech Spotlight)
- Uses wireless lapel microphone
- Can be seen by using a webcam

Speaker (remote, not in-venue)

- Microphone with good audio quality (eg: podcast type)
- Webcam with good video quality, ideally with face tracking and zoom (eg: Jabra Panacast 20), positioned carefully
- Software highlight and pointer capability (eg: Logitech Spotlight)
- In-venue: best to use a separate screen sharing PC connected to the projection system, audio muted

Agenda

1. Introduction
2. Why have hybrid meetings ?
3. Roles & responsibilities

- 4. Technology overview**

5. Audio
6. Video & screen sharing
7. Guidelines
8. Summary

On-line meetings – network concepts

- Bandwidth – maximum achievable data rate (asymmetric)
- Latency – inherent delays in data flows
- Jitter – variation in latency over time
- Contention – what else is happening at the same time ?
- Router – boundary between in-venue network and Internet
- WiFi – shared by all connected devices
- Wired – dedicated port for each connected device

Hybrid meeting (in-venue speaker etc.)

In-venue speaker

In-venue host

Attendees

Video equipment
Audio equipment

Remote attendees

Hybrid meeting (remote speaker etc.)

In-venue host

Attendees

Video equipment
Audio equipment

Remote
speaker

Remote
attendees

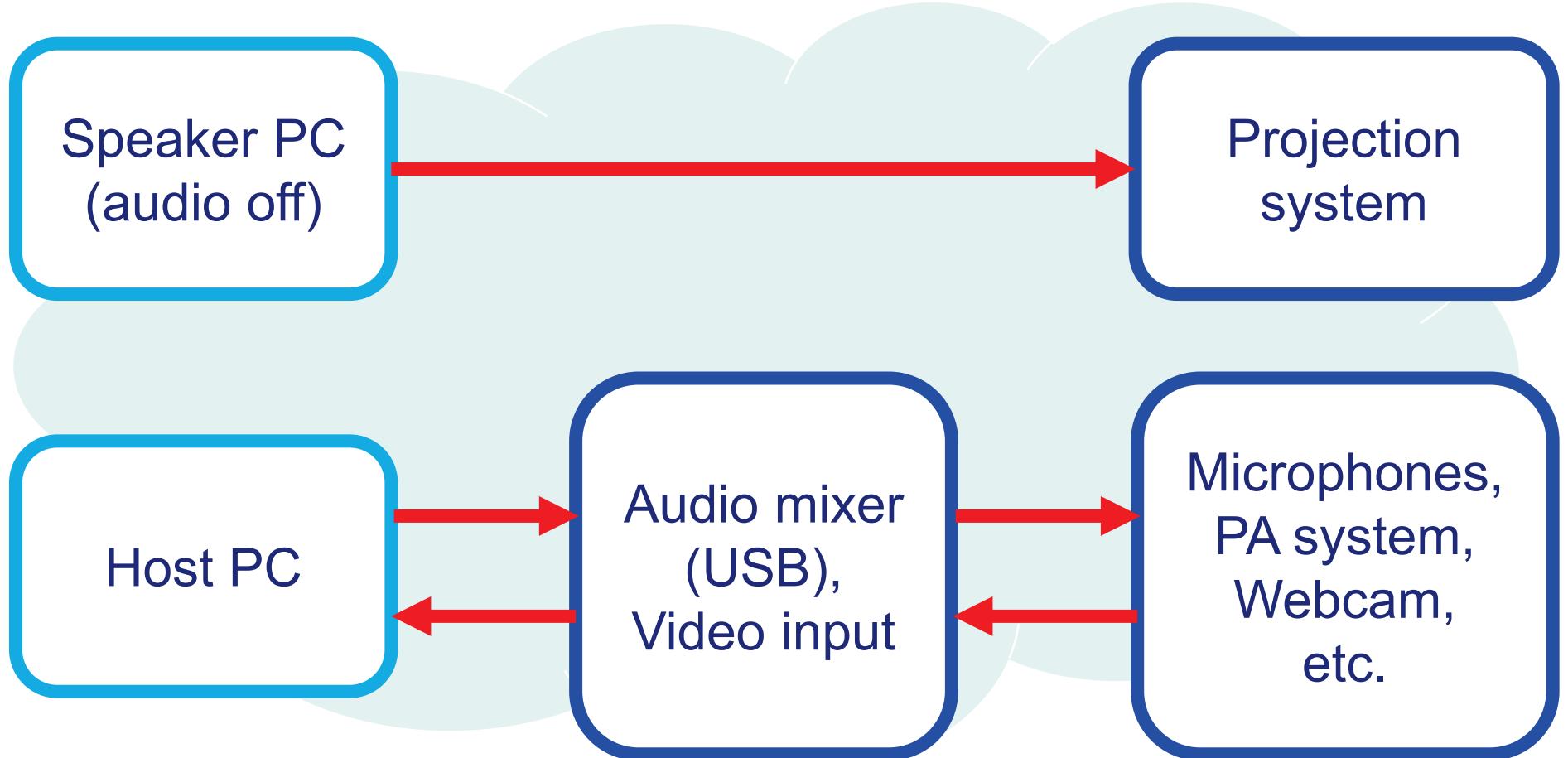
Requirements

- Attendees need to see the shared slides etc. and hear the speaker and might like to watch the speaker during the talk
- Speaker needs to hear and might like to see all the attendees (eg: asking questions)
- Good audio quality (echo cancellation, delay cancellation, avoid feedback loops, minimal contention for bandwidth, best possible latency, etc.)
- Minimise speaker's workload (eg: handling chat sessions)

Hybrid meetings - in-venue facilities

- Projection equipment and/or display screens for in-venue video
- Loudspeakers and amplifier for in-venue audio
- Webcam(s) and video switcher for speaker and attendees
- Microphone(s) for speaker and attendees
- PC for the speaker (screen sharing only, audio muted)
- PC to host the on-line meeting (audio and video)
- Interfaces between the host PC and the audio/video equipment
- Someone to set it all up and keep it working!

In-venue equipment



Agenda

1. Introduction
2. Why have hybrid meetings ?
3. Roles & responsibilities
4. Technology overview

- 5. Audio**

6. Video & screen sharing
7. Guidelines
8. Summary

Audio (1)

- This is the hardest aspect and requires careful design to avoid echo, delay and feedback
- The speaker will generally use a wireless lapel microphone to give their talk
- In-venue attendees will generally use a wireless hand-held microphone to ask questions
- An in-venue chair will generally use the same wireless hand-held microphone as the attendees

Audio (2)

- Audio in the venue needs to be heard locally, typically through a PA (public address) system and a hearing aid induction loop
- Audio in the venue needs to be input to the on-line meeting software
- Audio output from the on-line meeting software needs to be output to the PA system in the venue

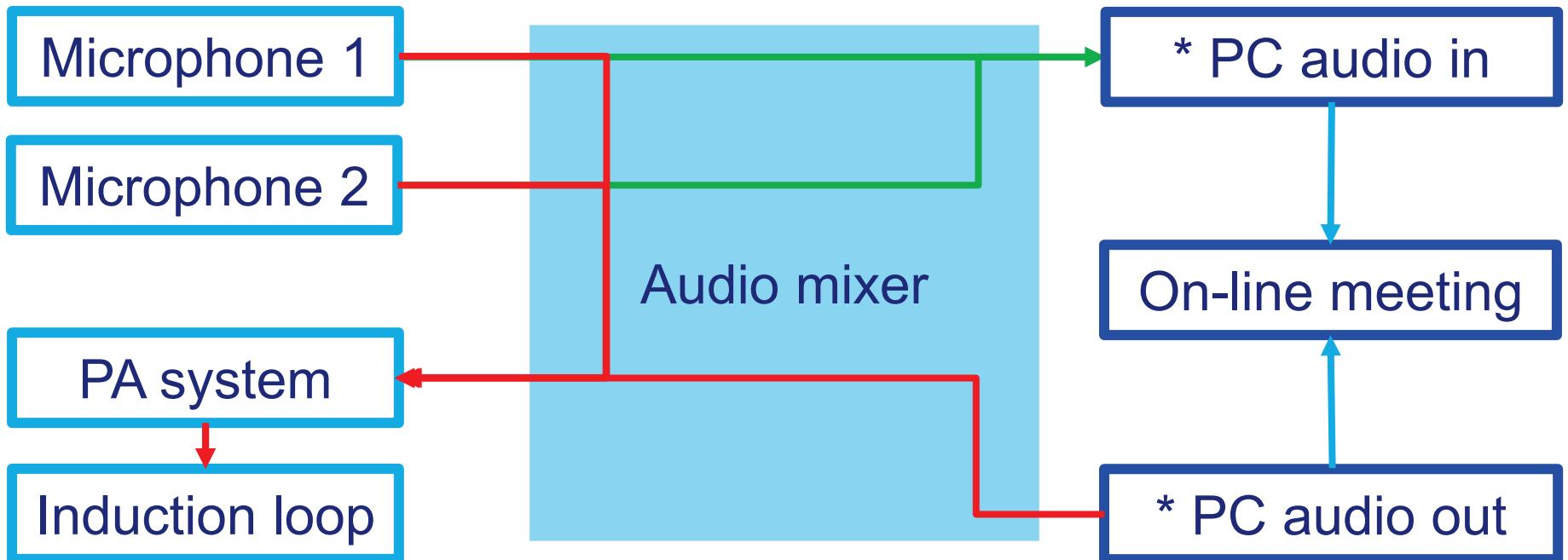
Audio (3)

- Audio signals require protection from interference (noise), especially over longer distances
- Professional audio uses “balanced signals” with shielded cables and 3 pin connectors, generally XLR or $\frac{1}{4}$ ” jack plug
- Microphones must not pick up sounds from PA system loudspeakers, so are generally short range and directional
- Audio signal transmission can be analogue or digital. Too many stages of conversion degrades the quality.

Audio mixer

- The audio input streams from the microphones and other sources can be combined and separated by the mixer
- The combined audio input stream (less the PC audio output) is fed into the on-line meeting software (often known as “mix minus”)
- The combined audio output stream can be fed into a separate PA system
- Low-cost, small mixers with a USB interface are available

Audio streams – signal paths

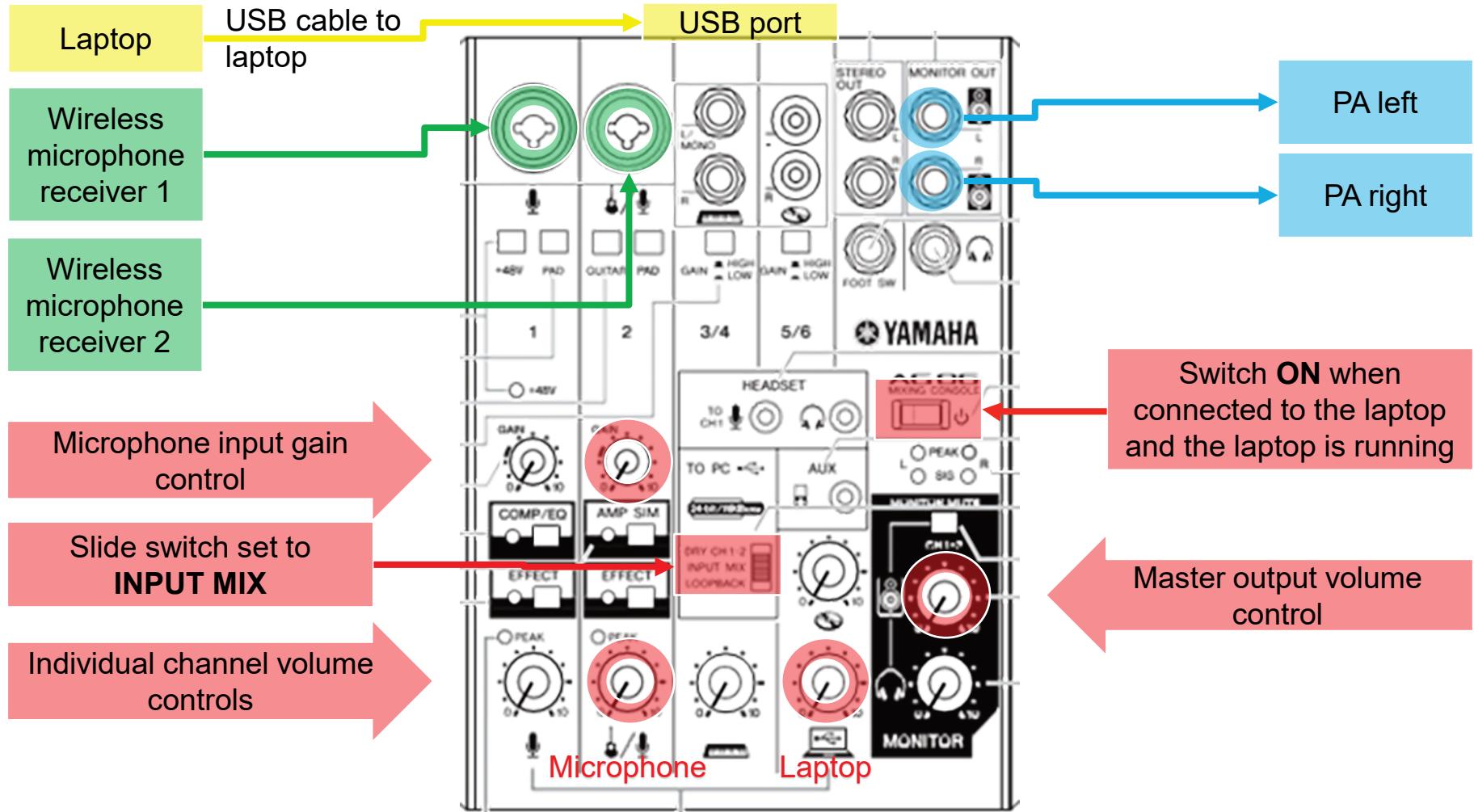


* Digital (USB) audio, not analogue

Audio mixer with USB connectivity

- The mixer presents two digital audio devices over the USB connection: input and output
- The mixer converts the audio signals from analogue to digital (and vice versa)
- The on-line meeting software audio output can be fed into the mixer from the computer as another audio input channel
- The combined audio input stream (microphones etc.) can be fed into the computer from the mixer (all inputs less the computer output, to minimise echo and feedback)

Audio mixer setup – example



Audio mixer – example (1)

- Mixer with USB power, USB audio input and output, two balanced microphone inputs
- PC sees mixer as USB audio input and output devices, which are set as the input and output devices for the on-line meeting software
- PC USB audio input receives combined signal from mixer, typically channels 1 and 2 (microphone inputs)
- PC USB audio output is a source input to the mixer

Audio mixer – example (2)

- Microphones connect to channels 1 and 2, with individual control of gain (amplification)
- Combined microphone inputs sent to PC as the PC USB audio input (see slide switch setting)
- PC audio output is combined with the microphone inputs to generate the mixer output
- Mixer output goes to in-venue PA system inputs. The PA system is connected to an induction loop.

PC audio setup

- Check that the audio output and input devices are the USB mixer sound input and output devices.
- Test the audio from the on-line meeting software audio settings and set the volume levels on the PC and on the mixer as needed. Set the PA system volume level as needed. Check that the induction loop is working.
- Ensure that audio is muted or disabled on all PCs other than the Host PC which has the mixer attached

Agenda

1. Introduction
2. Why have hybrid meetings ?
3. Roles & responsibilities
4. Technology overview
5. Audio

- 6. Video & screen sharing**

7. Guidelines
8. Summary

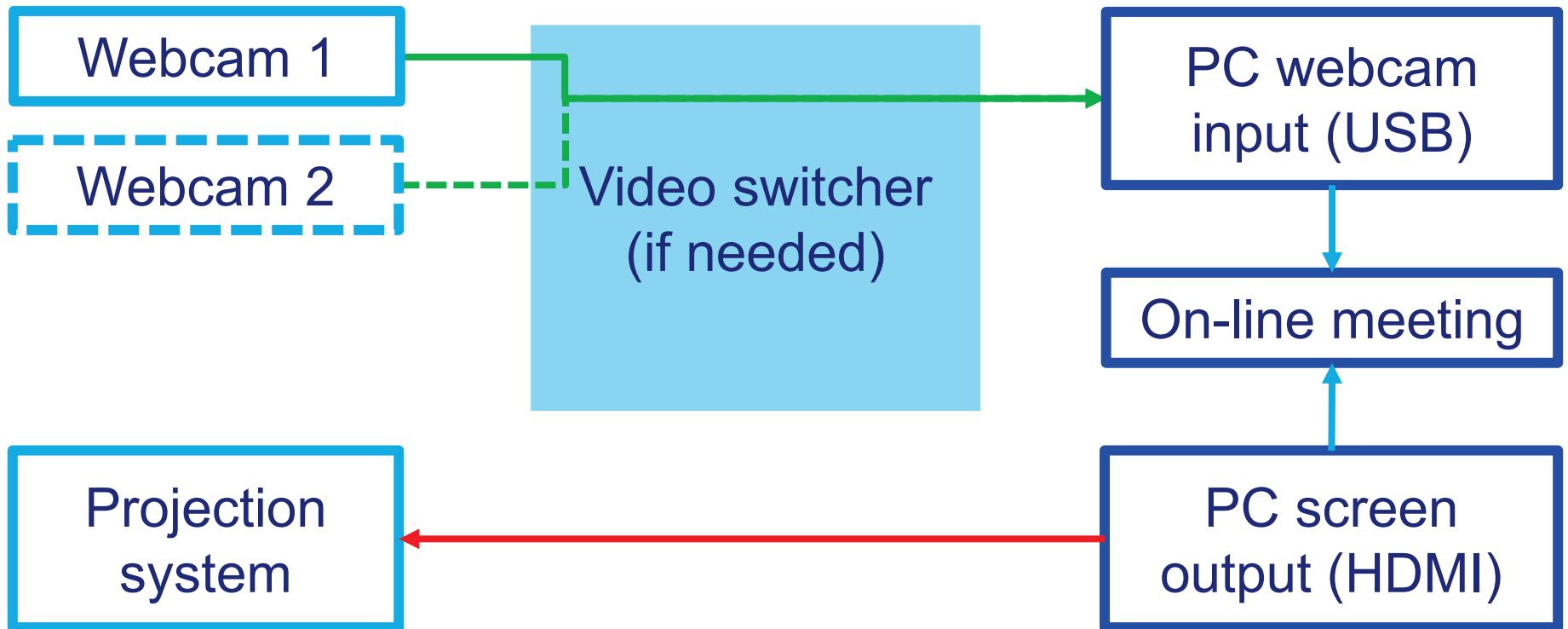
Video within a venue

- A laptop webcam is extremely unlikely to give a good image of the speaker in a venue
- A separate webcam with pan / tilt / zoom capability and good lighting should give a good image. Some digital cameras can be used as a webcam.
- Multiple cameras can be used with a “video switcher”, such as the ATEM Mini (by Black Magic)

Video projection

- The computer will need to be connected to a projection system, generally with HDMI
- If the venue has limited facilities, a portable projector and screen may be needed
- The light output power of a projector and the size of the screen are important, especially in bigger venues

Webcam & Projector – signal paths



Host PC video setup (webcam)

- Set the correct webcam device and test the video from the on-line meeting software video settings
- Built-in webcam best disabled if another webcam is connected
- Open Broadcaster Software and the “virtual camera” can give better control over webcams and provides switching between inputs
- Separate video switchers are available, eg: ATEM Mini

Host PC workload with an on-line meeting

- The PC has a significant set of workloads while running an on-line meeting:
 - On-line meeting software
 - Presentation software
 - Audio processing (echo, delay, etc.)
 - Video processing (background filters, noise reduction, etc.)
 - Data transmission (including encryption)
- Beware automatic updates and other unintended activity

Agenda

1. Introduction
2. Why have hybrid meetings ?
3. Roles & responsibilities
4. Technology overview
5. Audio
6. Video & screen sharing
7. **Guidelines**
8. Summary

What level of quality is acceptable ?

- Affects perception of the organisation
- Webcam video is nice to have, but not essential
- You might be able to manage without screen sharing
- You cannot function without good audio
- Try disabling video to get better voice quality – uses less bandwidth and can give better latency

Beware contention

- Contention for scarce bandwidth is a common problem
- Sharing the WiFi and Internet connection with others will create contention
- Other in-venue devices, video streaming, audio streaming, automatic updates, scheduled backups, etc. will consume bandwidth
- Think of them as background noise, so do what you can to minimise them

Understand the venue facilities

- WiFi or wired network with Internet access – who else might be using it at the same time?
- PA system and connections to it
- Microphones
- Suitable audio levels for mixer channels
- Suitable audio levels for PA system input channels
- Projector connection
- Webcam connection

What might be an ideal setup?

- High bandwidth, low latency Internet connection with minimal contention
- In-venue PA system with hearing aid induction loop
- Wireless lapel microphone for Speaker
- Wireless hand-held microphone(s) for Attendees and Chair
- Audio mixer with sufficient channels and USB connection
- Video switcher with sufficient channels for webcams
- Automatic PTZ (pan-tilt-zoom) webcam with face tracking
- Projector connection
- Hand-held slide controller (“clicker”), eg: Logitech Spotlight

Minimalist setup

For a remote speaker:

- Internet connection
- In-venue PA system (optional hearing aid induction loop)
- Wireless hand-held microphone for in-venue use
- Audio mixer with USB connection
- Projector

For an in-venue speaker:

- Wireless lapel microphone
- Webcam, if needed for speaker
- Hand-held slide controller / pointer

Guidelines – PCs

- Have 3 PCs: host, speaker and “monitor”
- Host PC opens meeting, handles audio and webcam video
- Speaker PC does screen sharing (audio and webcam off)
- Monitor PC shows what is being sent out (use headphones)
- Wireless lapel microphone for speaker
- Handheld controller for slides
- Wireless handheld microphone for host and questions
- Webcam for speaker (ideally auto tracking and zoom)
- Webcam for in-venue attendees

Guidelines – Audio

- Twin channel wireless microphone, without needing an OFCOM licence (frequency band use and allocations)
 - Wireless lapel microphone for speaker
 - Wireless handheld microphone for host and questions
- USB mixer
- Establish audio levels well in advance
- Host controls mixer audio levels during talk

Guidelines – Webcam video

- Webcam for speaker (ideally auto tracking and zoom)
- Webcam for in-venue attendees
- Video switcher (eg: ATEM Mini by Black Magic)
- OBS (Open Broadcaster Software)

Guidelines - speaker

- Wireless lapel microphone
- Handheld controller for slides (ideally with highlight and pointer capability)
- Laptop screen facing speaker
- Wall clock visible to speaker
- Host (or Chair) monitors on-line chat etc. and asks questions by voice

Common problems

- Poor voice quality
- Out-of-sync video
- Other people doing things using the same network connection (contention for bandwidth)
- Auto-updates of software: introducing bugs, using the PC processor and the network connection

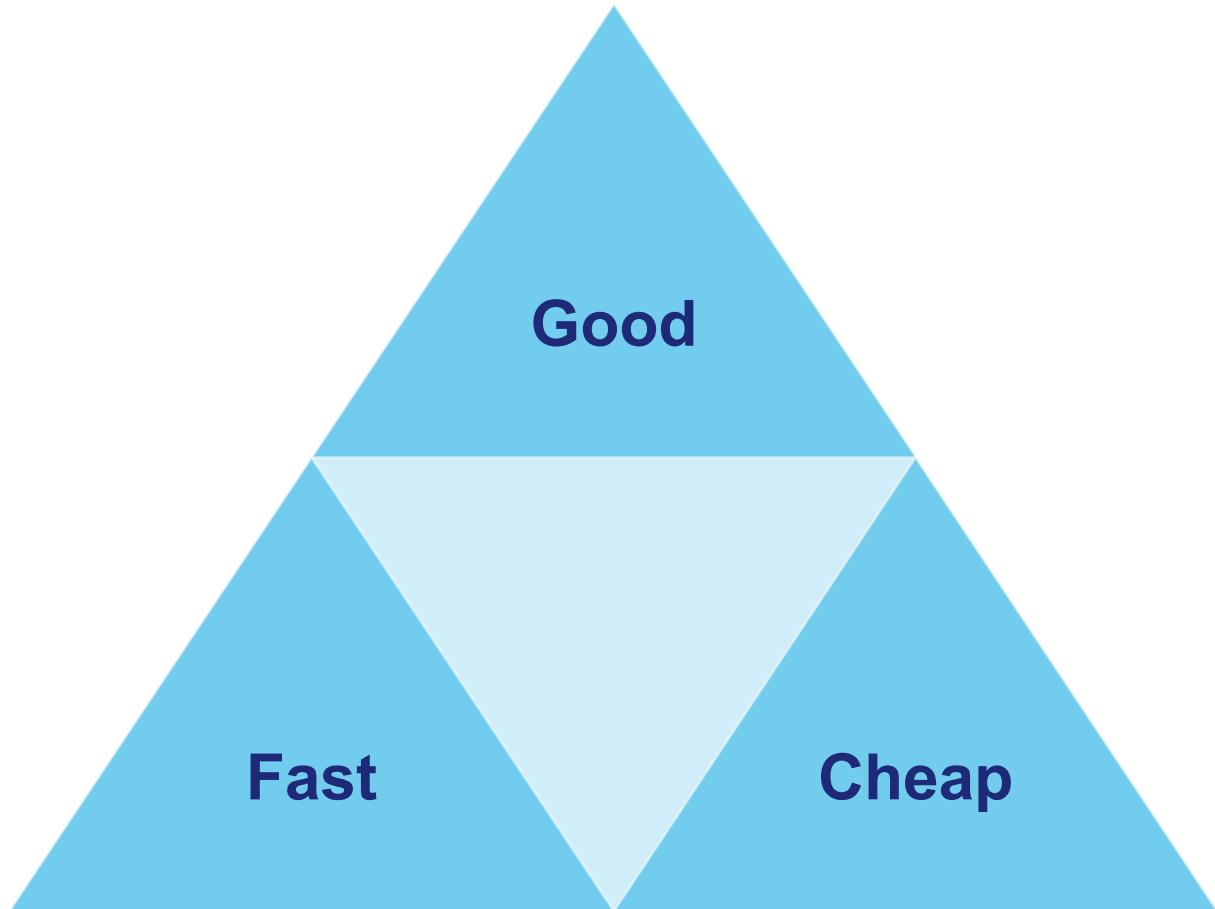
Potential issues

- Do not under-estimate the need for technical knowledge, especially when things don't work as expected
- Beware reliance on too small a number of people
- Beware changes due to software and firmware updates
- Do not under-estimate the amount of time and effort needed to set up and test the equipment ahead of the meeting, especially if the equipment is portable and requires installation and dismantling every time

Agenda

1. Introduction
 2. Why have hybrid meetings ?
 3. Roles & responsibilities
 4. Technology overview
 5. Audio
 6. Video & screen sharing
 7. Guidelines
-
- 8. Summary**

You usually get what you pay for



Key success factors

- Document the setup process, including audio and video settings – have a “crib sheet” and follow it
- Brief the speaker in advance about the facilities you have
- Allow plenty of time before the meeting to set everything up and test it, ideally with another PC to hold a short meeting
- Keep it as simple as you can
- Educate everyone involved as best you can

Hybrid meetings

A surprisingly complex combination of
people and technology

Colin Butcher