October 2023

MEETING-BASED RESOURCE CONSUMPTION INTELLIGENCE

Jieyu Tan

Soya Li

Espen Berger

MEETING-BASED RESOURCE CONSUMPTION INTELLIGENCE

AUTHORS:
Jieyu Tan
Soya Li
Espen Berger

ABSTRACT

In an online meeting involving multiple users, the performance of the devices (e.g., personal computers, laptops, tablets, etc.) utilized by meeting attendees can vary drastically such that, when audio/video material is shared among the attendees, those attendees that are utilizing lower performance devices can experience resource shortages or choppiness in shared material, which can impact the expectations of the meeting attendees. In order to address such issues, meeting-based resource consumption intelligence techniques are described herein in which the resource consumption of devices utilized by participants involved in an online meeting can be monitored and balanced by porting workloads from a media sender's device to any combination of a data center service and/or one or more media receiver's devices.

DETAILED DESCRIPTION

Consider an example online meeting scenario involving three users, User A, User B, and User C in which User A may have lower performance device as compared to higher performance devices of Users B and C. During the online meeting, when User A attempts to send audio/video by initiating a screen share, a choppiness in the audio/video of Users B and C can be caused by resources shortages of User A's hardware, which can impact the meeting expectations of the attendees. Because traditional resource consumption intelligence is often performed on a per-device basis, even with adequate resources available on the devices of Users B and C, such users are caused to suffer poor media quality that results from the low performance device of User A.

In order to address such issues, meeting-based resource consumption intelligence techniques are described herein that may provide for the ability to offload workload(s) from the device on a media sender's side (e.g., User A, in the above example) that may be lacking resources to device(s) having adequate resources on a media receiver's side (e.g., Users B and C, in the above example), thereby facilitating an efficient utilization of meeting participant resources in order to provide an optimal meeting experience for all participants.

During operation of system provided in accordance with techniques of the proposal, the resource consumption states of all meeting attendees can be reported to a meeting server. The meeting server can then evaluate the resource consumption data (e.g., utilizing traditional algorithms, machine learning (ML) models, and/or artificial intelligence (AI) Models, etc.) in order to detect unbalances in the resource consumption for the hardware of each attendee. For example, a resource consumption of 60% Central Processing Unit (CPU) usage on a content sharer's device versus 10% ~ 20% CPU usage on the side of each of the content receivers' devices may indicate that some workloads should be reassigned from the content share's device.

Upon detecting an imbalance in attendee resource consumption, workload(s) can be reassigned from the resource-lacking media sender's side to the resource-adequate media receivers. In one example, an attendee for which one or more workload(s) have been reassigned, can be informed of such workload reassignment via a user interface (UI) display, such as the example UI panel as shown below in Figure 1.

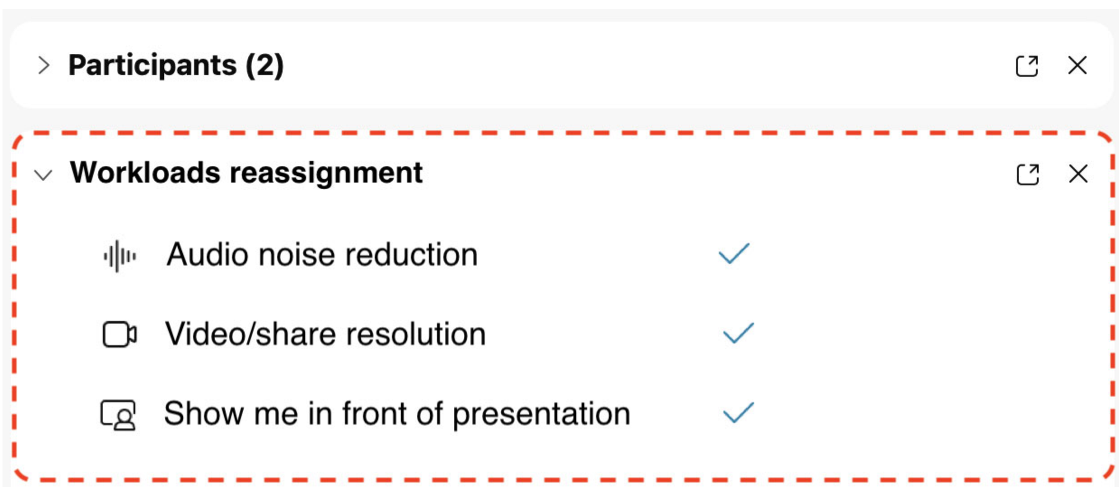

Figure 1: Example Workload Reassignment UI Panel

Consider various example scenarios in which techniques of this proposal may be utilized. For example, audio processing, such as noise reduction, can be offloaded from a sender's side to one or more receivers in some scenarios. In another example, for a sender having lower video processing capabilities, lower video resolution processes can be implemented on the sender's side (e.g., 180p instead of requested 720p) or sharing (e.g., 360p instead of 1080p) can utilized on the sender's side and super-resolution processes (e.g., 180p -> 720p for video or 360p -> 1080p for sharing) can be applied on the receivers' side to meet their own resolution requests.

In still another example, AI-related processes, such as immersive sharing can be implemented on a receiver's side in some scenarios. For instance, some operations, such as applying an AI Model for portrait detection or image blending processes can be offloaded to one or more receivers such that a sender's device can send basic, yet un-choppy media, while more AI-intensive effects (e.g., immersive sharing) can be provided on the receivers' side. Figures 2A and 2B, below, illustrate example details related to transferring workloads from a sender's side to a receiver's side and the resultant view changes that may be presented to each of the sender's view and the receiver's view.

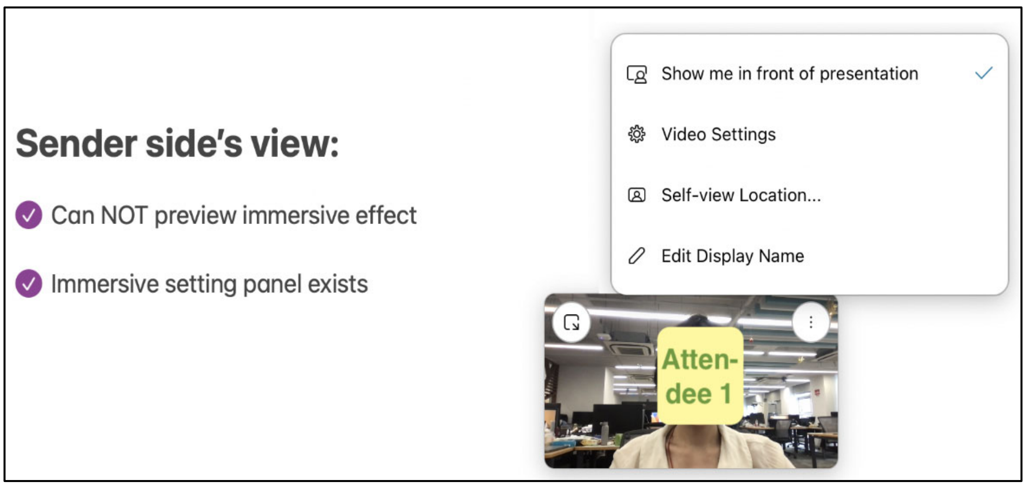

Figure 2A: Sender's Side View for Immersive Sharing Example

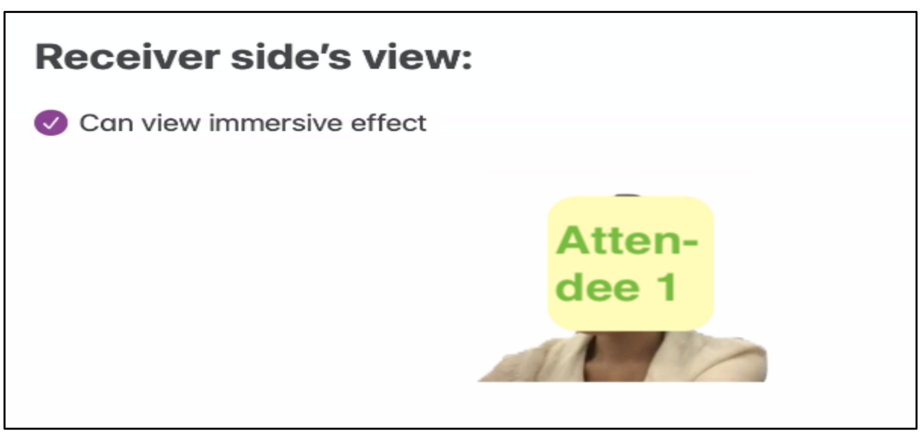

Figure 2B: Receiver's Side View for Immersive Sharing Example

Techniques of this proposal can be extended to evaluate and balance all usable resources for a meeting, including data center resources, sender device resources, and receiver device resources. For example, in some instances, techniques of this proposal can be extended to determine priorities of usable resources at various locations for each of one or more transferrable process or feature. For example, transcoding may be performed on datacenter and sender devices (considered high priority devices for such processes) and not receiver devices (considered low priority for such processes). In contrast, media processing may be performed at any location, but data center and sender devices should be afforded a higher priority because the content processed at these locations is delivered to all the receivers.

Techniques of the proposal may also be extended to facilitate partial offload/reload for different types of processes. For example, to avoid user confusion and reduce the complexity of processing for multiple participant devices, some video features, such as video background (VBG) processing or transcoding, and/or some audio features, such as background noise reduction (BNR) may only be partially offloaded from a sender's device.

For video features, such as transcoding, if a data center lacks resources to transcode between AV1 and H.264 codecs, then the sender's device can be tasked with encoding both AV1 and H.264 streams. Yet, if the sender's device lacks resources, then the device can be tasked to fallback to the more general H.264 codec that can be applied across the meeting.

In another example, if a sender's device lacks resources, a low-cost mode (coarsely provided, but low-cost) video background should be applied on the sender's side (e.g., so that the sender won't feel unsafe), while a refined video background can be provided at the data center or receiver's side(s). Figure 3, below, illustrates example details for implementing partial offload of resource-heavy video features, such as video background (VBG) processing.

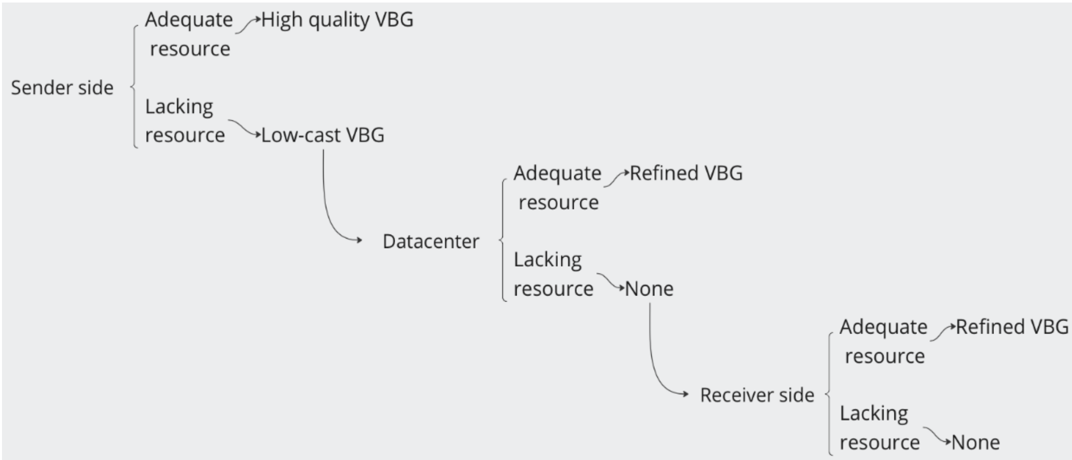

Figure 3: Partial Video Background (VBG) Offload Flow

In some instances, background noise reduction processes can be partially offloaded in a similar manner. For example, if a sender's device lacks resources, a low-cost mode (e.g., coarsely provided, but low cost) background noise reduction process can be provided on the sender's side or the data center side, so that even if some receivers also lack resources, the audio at the receivers' side will not also suffer. Thus, a refined background noise reduction process can be provided on a receiver's side that can be applied as a compliment based on the resource state of the sender. Figure 4, below, illustrates example details for implementing partial offload of resource-heavy audio features, such as background noise reduction (BNR) processing.

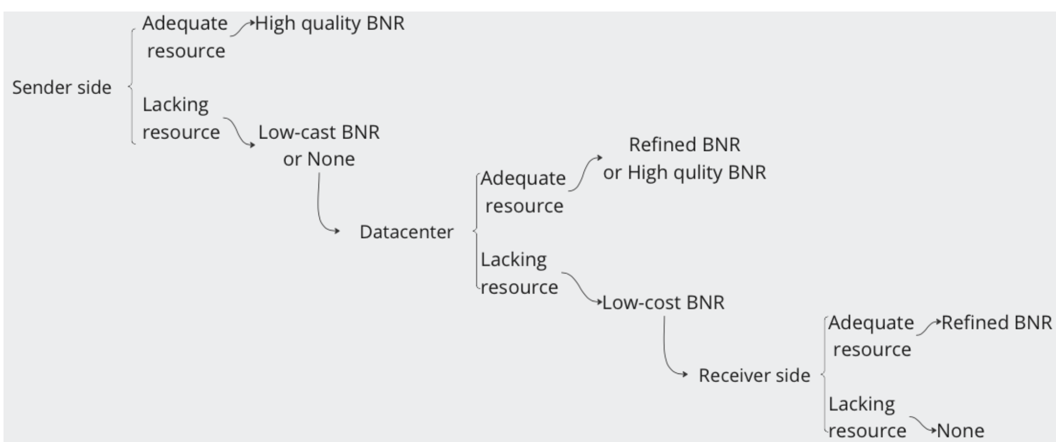

Figure 4: Partial Background Noise Reduction (BNR) Offload Flow

Partial offload of processes may be utilized in other scenarios. For example, in some instances, resource-heavy sharing features, such as optical character recognition

(OCR) processes, which can aid in the accuracy of transcription, can be offloaded/reloaded between data center and device side(s). In some scenarios, device(s) with the most adequate resources can be selected to perform such processing and then pass their results to the data center for continued processing.

In summary, in accordance with techniques of the proposal, resource consumption states of all meeting attendees can be reported to a meeting server. By gathering and analyzing all meeting devices' resource states, the meeting server may be considered a centralized resource intelligence controller that can detect consumption gaps and then reassign workload(s) from busy devices to idle devices, potentially in a prioritized and/or partial offload manner, in order to avoid potential media downgrades that are often caused by devices that lack sufficient resources during a meeting. Thus, techniques of this proposal can be used to ensure that each device resource can be fully utilized such that all attendees for a meeting can enjoy improved media quality.