

Colorfront Remote Streaming

Abstract

Looking at video content remotely at reference quality, from as early as initial camera and make-up tests all the way up to final localized deliverables, has become exceptionally important. Colorfront's streaming solution offers secure, reference-quality and low latency viewing experience that is suitable for critical QC or client approval, and supports a range of display options including: Apple's XDR display, OLED TVs, professional HDR reference monitors or even emissive cinema walls.

Introduction

Now more than ever, productions need to view high-quality media during the production process, from original camera material to editorial, visual effects, color grading and final masters and versions. Remote workflows enable remote work from home on systems in the facility, or from the cloud, and allow creatives to join the process, work in collaboration and review features, TV shows, and commercials as being created.

High-quality masters are expected to be delivered, including Ultra HD, 4K or 8K resolution, HDR and Dolby Vision, mastering at multiple HDR levels and different color spaces. Besides the picture quality, multiple channel surround audio needs to be played in perfect sync to the picture; metadata needs to be sent embedded into the picture; and the output needs to be shown to a variety of high-quality displays. Review and working display include: broadcast reference monitors (such as the Sony BVM HX310), consumer OLED TVs, digital cinema projectors, Macs with XDR screens and iPads.



The common quality of these displays are that they provide some form of HDR and extended gamut. Displays, however, have diverse capabilities, including different maximum brightness levels and contrast ranges, various color gamuts, as well as support for Dolby Vision or HDR10. The expectation is that these displays are handled with a state of the art engine that presents the expected, perceptually correct visual output on all these display devices so that meaningful collaboration and remote work can be achieved.

For mastering and post production facilities, studios, editorial and dailies rooms, VFX reviews and mastering sessions, productions require enterprise-quality solutions for remote video viewing with industry-standard strong security, forensic and visible watermarking, and secure logging of session details and participants. Streaming should work from a variety of systems, including leading dailies, mastering and QC stations, as well as dedicated streaming units that can flexibly connect to any video output for remote streaming.

Licensing of additional clients should be inexpensive and flexible, so that talent can use the streaming as much as needed without hourly costs on devices that can change as production needs dictate, with the highest professional quality. Network performance can range from home

or production suite internet to a dedicated high-quality network. The codec used should scale for the available bandwidth and various network conditions, and provide a robust transport of the media using leading industry standards.

Colorfront's Remote Streaming Solution

Colorfront's high-quality, secure streaming solution for remote screening, color grading and finishing, QC & review and approvals offers the below benefits:

- Exceptional visual quality using 444 10-bit HEVC compression technology
- Lossless audio transmission of 8 audio channels
- Dolby Vision streaming with Dolby Vision HDMI tunneling
- Sub-second latency for interactive sessions while maintaining robustness
- Simultaneous local video output while streaming from on-premise Transcoder or QC Player
- Direct streaming from server to clients or utilizing SRT Gateway for more flexible routing and networking
- Lightweight Windows and Mac client application offering real time playback on cost-effective systems such as the Mac Mini
- Supports a range of displays including the Apple XDR monitor via Thunderbolt, OLED TVs via 12-bit HDMI, as well as professional SDI displays and projectors

Reference quality streaming - Supports 2K, UHD, 4K video formats in 2D and 3D stereo, up to 4:4:4 chroma and 10-bit color depth. Video payload transmission uses HEVC compression with an optimized perceptual encoding color space to maximize compression quality. The color metadata layer in the video stream, such as Rec.709, Dolby Vision HDR, HDR10 or HLG, ensures that the display device connected to the client is triggered into the appropriate mode. Extensive testing revealed that UHD streaming at 30-35 Mbits provides visually lossless quality that can be trusted for critical color-grading, VFX reviews, QC and approvals.

End-to-End Color Pipeline - The combination of the in-house developed, light player application and the GPU-accelerated server side component from Colorfront ensures end-to-end color accuracy and quality. All Colorfront applications running on the Windows platform include the integrated streaming technology that acts like an additional virtual video output. Setup is strikingly easy: no need to worry about mismatching range, matrix or color space issues.

When using the standalone Streaming Server Appliance, the operator can stream from the video output of any third-party editing, grading or finishing system. Color metadata, including Dolby Vision metadata, is automatically extracted from the input signal and channeled to the client application.

Supported Client Displays - The client application can fully utilize the connected XDR monitor when running on the Apple platform, as well as the integrated high-quality displays in 709 or PQ modes. These cost effective solutions offer excellent alternatives to professional HDR reference monitors at comparable quality. The capabilities of consumer TVs connected via HDMI are fully maximized by utilizing the best available operating modes, including 12-bit HDR10 or Dolby Vision. By installing an AJA or Blackmagic Design video output device, you can apply the technology in a stereo 3D cinema environment, using emissive cinema walls or standard broadcast monitors.

Flexible BitRate - The Colorfront streaming solution can easily be adapted to a wide range of bandwidth situations: works well with poor hotel Internet connections when working near set, but can also saturate extremely fast dedicated network links at hundreds of megabits per second. For low bandwidth situations, HD 8 Mbit or UHD 12 Mbit at 10-bit color accuracy can be configured, which provides fairly good quality even when projected to a larger cinema screen. UHD HDR video streams may be configured to use compression levels all the way up to 444 10-bit 250 Mbit.

Low Latency - Sub-second latency providing 'real-time' shared video experience between remote geographic locations. There are no extreme bandwidth requirements to achieve such low

latency. Without having access to dedicated, global network links, third-party services like the Haivision HUB can be utilized to maintain sub-second delay when streaming across continents.

Easy Networking Configuration - Several clients can connect to a single server simultaneously either by using a point-to-multipoint direct connection, or by utilizing the industry standard SRT Gateway. The latter solution has the benefit of simpler networking configuration and more flexible routing setup of video streams.

Studio-Grade Security - 256-bit AES encryption ensures that your valuable content remains safe, even when transmitted over the public internet. NexGuard forensic watermarking and visible burn-ins provide additional security. Streaming from SDI source ensures that there is no need to store critical assets on any device accessible from a public network.

Up to 4 Simultaneous Stream - The Colorfront Streaming Server is capable of simultaneously capturing, encoding and streaming 4 HD or 2 UHD signals. Individual streams may have different frame rates or color spaces, video compression and network parameters can be configured individually. This means the powerful engine of the unit can handle 4 independent sources and the corresponding stream targets.

Streaming Configurations

The server-side application is typically co-located with the original media files: either on premise - in a *facility*, or in the *cloud*.

Streaming From the Cloud

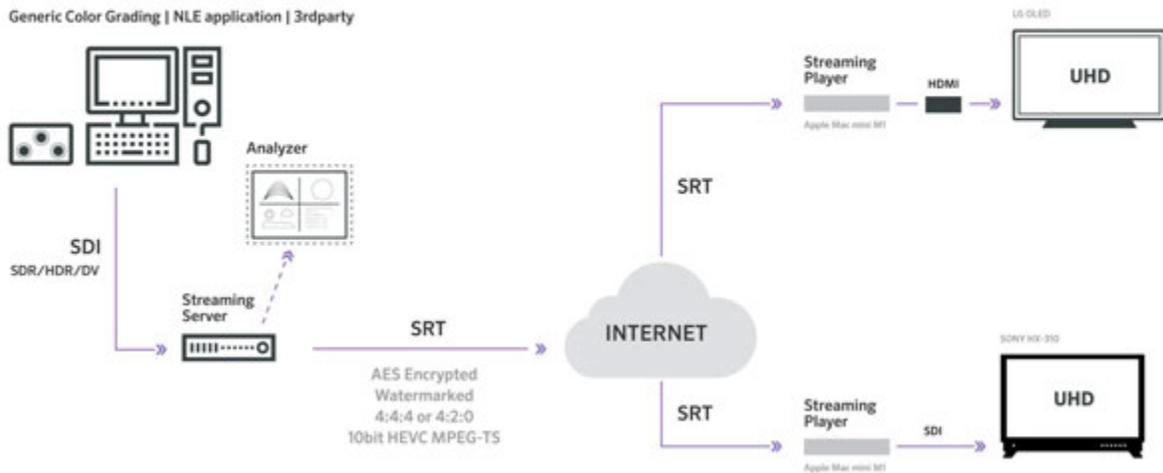
Colorfront has a range of products for dailies and mastering running in the cloud with native S3 object storage support. These versions fully support streaming, so you can play back the heaviest camera original RAW files, mastering and mezzanine formats directly to a local reference monitor. By using a low latency remote desktop solution such as Nice DCV or Teradici in tandem with the Streaming Player client, the operator can work on a virtual computer running in AWS exactly the same as in a local mastering or dailies system.



Streaming From the Facility

When implementing remote workflows from a facility to another location, the embedded *streaming feature of all Colorfront applications* can be used. Furthermore, streaming from a third-party editing, grading or finishing system is also possible via the *standalone Streaming Server* product. This device encodes the incoming SDI video in real time, up to four HD streams simultaneously.

The streaming server functionality has been introduced in the 2020 versions of the Colorfront product line and is available for all users under subscription. The technology utilizes NVidia GPU HEVC compression technology, thus requiring a Pascal, Turing or newer class graphics card.

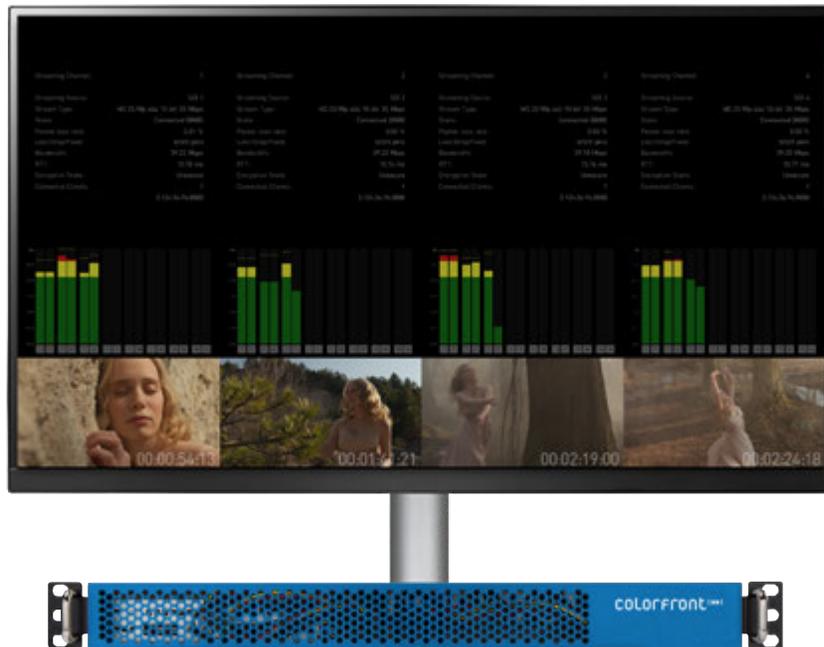


Components

Streaming Server Appliance

Colorfront is announcing a 1RU dedicated Streaming Server Appliance offering multiple channels of live video streaming, via 12G-SDI input in UHD with Dolby Vision over HD-SDI support. Configuration of the system is possible via a web interface from any computer on the same network.

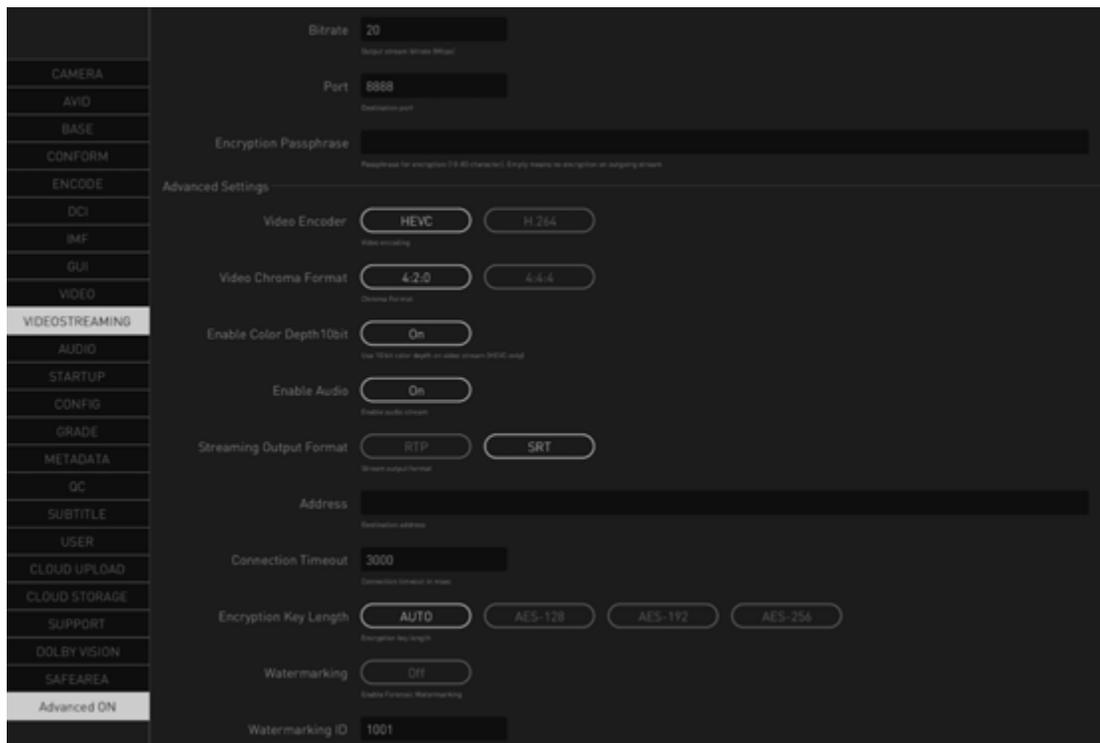
Sub-second latency, reference-quality video streaming from live video ensures the quality of review that would be expected in a grading suite or screening room but remotely. Share color and frame-accurate footage in 4K HDR from third-party applications such as Blackmagic Resolve or Autodesk Flame – all in real-time.



Multiple Hollywood facilities have already started to use the Streaming Server Appliance in production, streaming from their facility to users, who run the same Streaming Player client application. Colorfront has also developed a new web-UI interface to control the server.

Integrated Streaming Server in Colorfront Products

All Colorfront products running on the Windows platform have the streaming component built in. The operator can set up the stream in the VIDEOSTREAMING section of the Settings page, similar to how the local video output is configured. The hardware configuration of the server is required to include Turing class or better NVIDIA GPUs for 444 streaming.



Dailies or mastering operators working remotely typically access these systems using both the Colorfront Streaming Player and some remote desktop solution to manipulate the interface. Nice DCV, HP Remote Graphics Software or Teradici have been extensively used by various users.

For review sessions, where the operator is controlling the server and the client is looking at the live video stream, no remote desktop solution is required. If needed, the client can have playhead controls to drive the session within the player application or using a web interface.

Streaming Player Application

The Windows and the Mac version of the Streaming Player application supports a range of hardware configurations. One of the most cost-effective solutions for the Streaming Player client is the new Apple M1 Mac Mini platform with either an XDR display, an OLED TV or some professional reference monitor (via the Blackmagic Design UltraStudio 4K Mini) connected. This is an inexpensive, quiet, small form-factor setup enabling 4K HDR output via both SDI and HDMI. The optimized Apple Metal acceleration ensures smooth playback with no dropped frames at UHD resolution.

The client software is very easy to install and operate. All settings are either initialized automatically from an invitation email sent from the server, or from the stream metadata itself. If needed, all color space and SDI or HDMI output parameters can be overridden. The client application is successfully used in a variety of configurations, including laptops, Mac Mini setups with an XDR display or OLED TV connected, as well as cinema environments with stereo 3D projection driven by dual SDI feed.



Example Streaming Player platform:

Apple Mac mini M1 with optional Blackmagic Design UltraStudio 4K Mini

Summary

There are many products falling under the banner of streaming technology. There are as many commonalities as there are differences among the features sets of the many offerings. Colorfront's streaming technology has been designed and implemented from the ground up with exceptional image quality in mind, using minimal network and hardware resources on the receiving end. By using the industry standard, robust and secure SRT technology as a foundation, we have built a highly optimized server and a client software capable of transferring UHD HDR video content at uncompromised quality. The technology has been integrated into all Colorfront applications and is also available as a standalone video appliance.

Applications of Colorfront Streaming Technology Include:

- Near-set dailies processing with colorists and QC operators working from their home facility
- Cross-continent review sessions with producers and creative professionals
- Remote grading sessions
- Critical QC of Stereo / Atmos DCPs or Dolby Vision IMF master packages stored in S3 cloud storage

Choosing the Right Streaming Solution

There are a number of remote streaming solutions in the market today. The following questions should be carefully considered when choosing a solution for high-quality remote review:

- Can the technology be adopted to very low and very high bitrates?
- Is the stream robust with no frame drops, or does it fall apart at complex scenes?
- Does it support UHD HDR video? Does it support Dolby Vision HDMI tunneling?
- Is the compression quality suitable for critical viewing? Are there visible compression artifacts?

- Is the stream at least 10-bits per color channel? Are there any banding artifacts when looking at smooth gradients?
- Does the solution offer sub-second latency required for interactive sessions?
- Can the stream travel over the public Internet or does it require a dedicated network?
- Is the video essence properly secured? Does it use some industry standard encryption mechanism?

Concerning the client module particularly:

- Does the client application run on custom hardware?
- Does the viewer have the option to either connect an SDI monitor or use a directly connected HDMI monitor?
- Can the client trigger the HDMI monitor into Dolby Vision mode to utilize the improved image quality for HDR10 review?
- Can the client application adapt to screens with different peak luminance capabilities while preserving the creative intent?
- Is it expensive or complicated to license additional clients?

The Colorfront streaming technology compares favorably to alternative solutions in all of the above aspects.