WHITE PAPER

The Insider's Guide to Live 4K Production Over the Internet

Haivision

VIDEO AT WORK

The Insider's Guide to Live 4K Production Over the Internet

LIVE PRODUCTION OVER IP - 4K READY SET GO!

Whether they've planned for it or not, broadcast engineers, OB van operators, and all types of television producers must now contend with an increasing demand for 4K UHD content. Although the majority of live television broadcasts remain in HD or even SD, 4K UHD screens are beginning to outsell HD displays. The increasing pressure to differentiate and deliver premium service quality for UHD screens is resulting in a growing concern among broadcast professionals that they will fall short once a call comes in to deliver 4K content.

While some broadcast engineers may decide to make a complete switchover to 4K UHD workflows or to add a separate 4K UHD video production unit, the majority will need to continue delivering HD services while also producing more 4K content. As they have already invested a significant sum in their HD broadcast gear, they will therefore also need to consider how to deliver 4K UHD broadcast content through their existing infrastructure including contribution over IP, originally sized for HD content.

MORE PIXELS, MORE BANDWIDTH, MORE CABLES

4K UHD content has a resolution of 3840 x 2160 pixels, which is four times the resolution of HD video. In addition, content for live sports is typically captured at twice the frame-rate of standard HD, that's 60 frames per second in North America and Japan, and 50 frames per second in Europe and most of the rest of the world. By doubling the frame-rate, the size of raw video streams also doubles so that 4K UHD p50 or p60 requires up to eight times the bandwidth as standard HD at 25 or 30 frames per second.

The wide color gamuts (WCG) supported by UHD (SMPTE ST 2036-1) and needed for HDR requires that video is captured in 10-bit pixel depths which can increase content size by about 25% compared to 8-bit video. Add all of these considerations up and it is clear that 4K UHD requires significantly more throughput than HD.

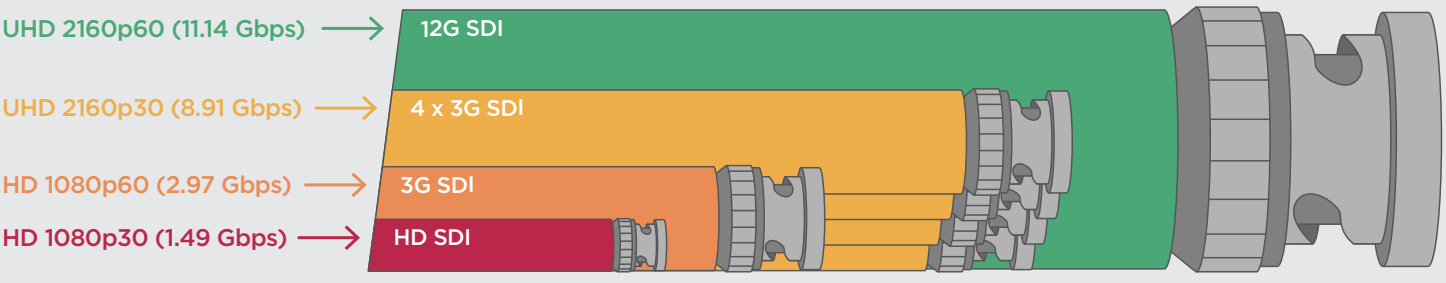

Figure 1: *Diagram comparing 8-BIT HD 30 fps to 4K UHD 10-bit 60 fps (video only).*

For new studio builds or refurbishment projects, 12G SDI cables will be best suited for 4K workflows. Single mode fiber might also be considered for longer distances. Taking a leap of faith to all IP with SMPTE-2110 might also be an option. For everyone else with existing infrastructure designed for HD workflows, options for catering to 4K UHD content without immediately replacing every piece of equipment should be considered.

MORE THAN ONE WAY TO CAPTURE 4K

As every broadcast engineer knows, SDI cables do not come cheap. A 100 foot or 30 meter cable can cost anywhere from between $50 to $300. Multiply this by all the cameras and production equipment needed for a production studio or remote OB kit and the total amount of investment in cable can run to thousands of dollars.

Although newer 4K cameras will feature 6G or 12G SDI outputs, it may make sense to continue using 3G SDI cables, especially in workflows designed to support HD with occasional 4K production. **In this case, a 4K video encoder, such as the Haivision Makito X4, can ingest 4K content over 3G SDI**.

There are two methods for capturing 4K video over 4 3G SDI inputs: **SQD** and **2SI**. **SQD** divides the 4K source image into four separate quadrants which are then stitched together. Each quadrant is essentially a separate encode. **2SI** simultaneously encodes 4 pixels, one from each quadrant, at a time. This approach, although somewhat more complex, is better suited for digital video effects (DVE) as it can handle the entire 4K image at once, versus having 4 separate effect engines per quadrant.

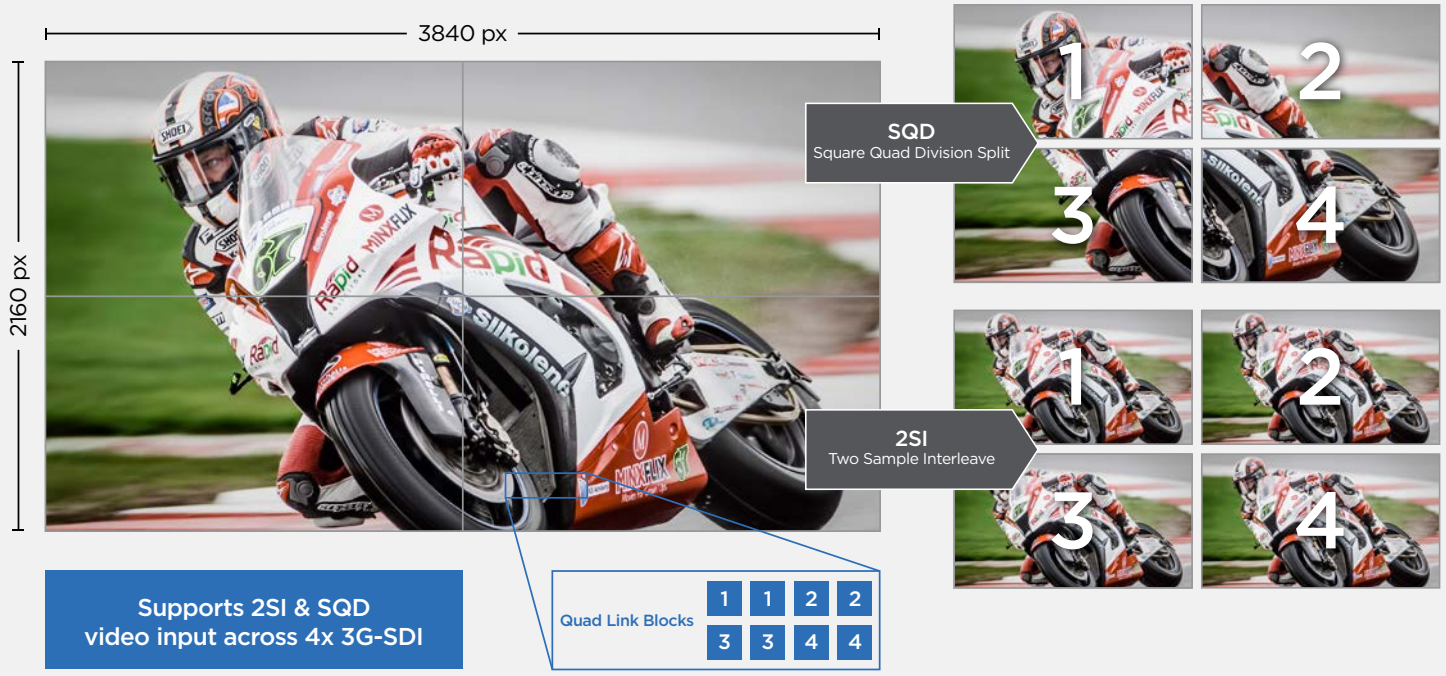

Figure 2: *Diagram comparing SQD to 2SI.*

Live 4K video encoders such as the Makito X4 can ingest unprocessed 4K content over 4 X 12G SDI inputs with 2SI or single 12G SDI input. The Makito X4 has the added bonus of also working as a high-density HD encoder with the ability to ingest 4 HD streams for up to 8 outgoing encoded streams. Working with a versatile encoder that can manage all possible scenarios makes it possible to support both 4K and HD broadcast contribution workflows with the same platform.

4K CONTRIBUTION STREAMING OVER THE INTERNET

Advances in video encoding, especially with the HEVC codec, now make it possible to stream 4K UHD content over a standard internet connection. A 4K UHD video stream can typically be compressed from almost 12 Gigabits per second (Gbps) down to as low as 25 Megabits per second (Mbps), and even lower depending on the type of content, color coding, and frame rate used.

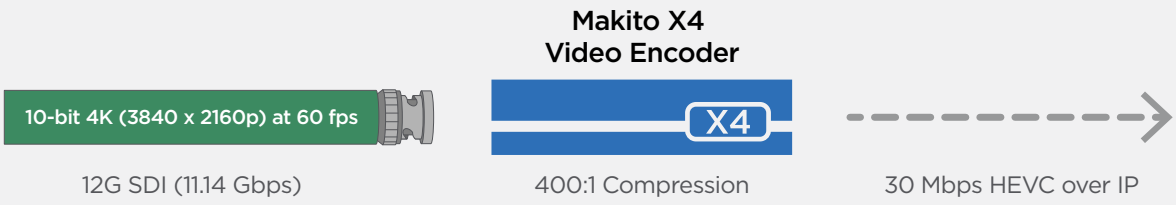

Figure 3: *HEVC video encoding for 4K over IP.*

High bandwidth internet, at over 100 Mbps, is now widely available and therefore 4K UHD content can be streamed at higher bitrates for better quality video. However, worst case scenarios need to be considered in case bandwidth availability suddenly drops.

When using SRT as a streaming protocol, Makito video encoders can analyze end-to-end streaming statistics to determine available bandwidth in real-time. If bandwidth drops suddenly, the encoder can then apply Network Adaptive Encoding (NAE) to increase video compression to lower bitrates until bandwidth increases again. Being able to continuously adapt the compression levels to match available bandwidth, combined with SRT's low latency for packet loss recovery, ensures that live 4K contribution content is continually delivered to central production facilities even in unpredictable network conditions.

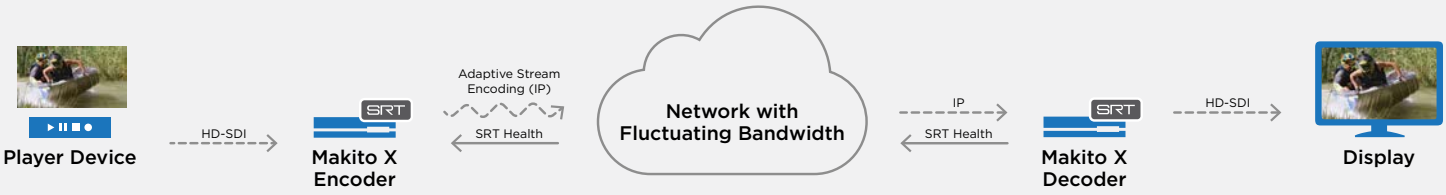

Figure 4: *Haivision's Network Adaptive Encoding feature on the Makito X video encoder series.*

THE CHALLENGES OF 4K FIELD CONTRIBUTION OVER IP

4K UHD becomes particularly challenging when covering events away from the production studio. Although there is a range of professional broadcast 4K UHD cameras now available, most remote broadcast managers do not have the resources to build out a completely new 4K broadcast van or remote production kit, especially when 4K UHD broadcasts remain occasional and not the default HD format. The challenge therefore is how to integrate 4K content within existing HD workflows without ripping apart and redesigning an entire OB van.

The other big challenge for broadcast engineers is how to deliver a 4K contribution stream to central production facilities. Satellite links are a good option, but come at a high cost. Even when a satellite uplink is available, it is usually reserved for primary video contribution, leaving little or no bandwidth for alternative cameras, return feeds, teleprompter feeds, and other streams.

IP, and specifically the internet, provides a cost-effective and ubiquitous alternative to satellite, fiber, and managed MPLS networks. Depending on the type of content and workflow requirements, the internet can be used for all contribution feeds, typically between 25 - 50 Mbps. In other cases where a lightly compressed or uncompressed primary 4K video feed is needed, the internet can serve as an alternative route for secondary contribution and return feeds.

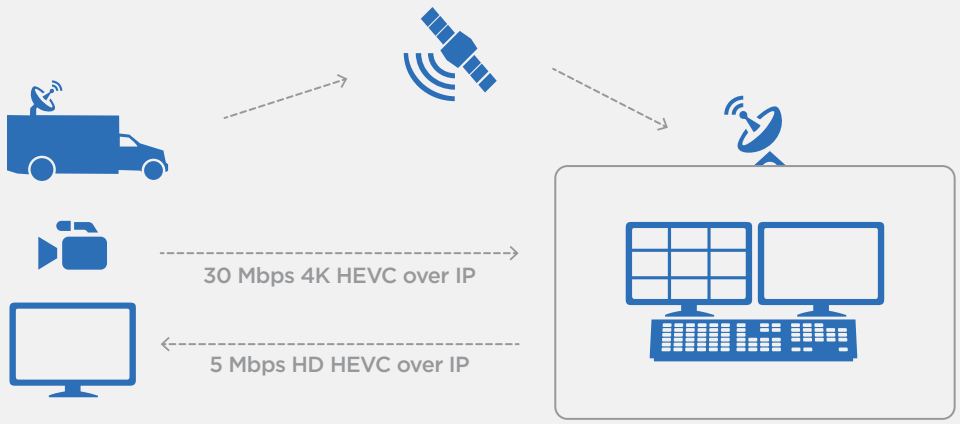

Figure 5: *Satellite links being used for primary contribution and IP for secondary sources and return feeds.*

For interactive video content such as live bi-directional interviews or dialogue between a remote site and central studio, 4K video should to be streamed over the internet at very low latency, ideally under 500ms to prevent any visible delays, with a return feed streamed back over the internet in HD for confidence monitoring, visual interaction with studio, or teleprompting. By relying on the internet, multiple streams over alternative paths can be configured for different types of viewers along the production workflow or as redundant streams for high availability.

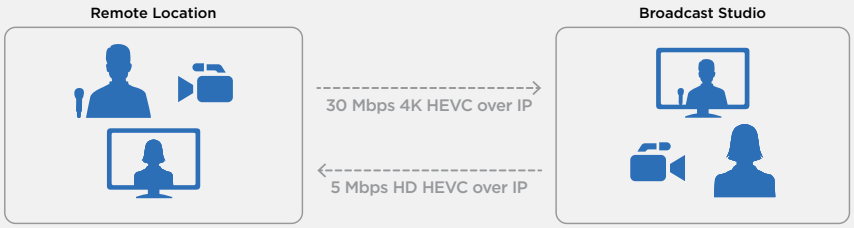

Figure 6: *Bi-directional streaming for a live interview with 4K out and HD return.*

KEEPING VALUABLE 4K CONTENT SECURE

As a newer technology, 4K UHD is often associated with premium content. It is therefore imperative that the content is kept secure from capture all the way to delivery. Using the public internet for live 4K contribution is more cost effective and quicker to set up than a satellite link or dedicated fiber network, however security can be a major concern. Encrypting video in the AES-128 or AES-256 standard, including within the open source SRT streaming protocol, can ensure that 4K streams can only be received and decoded by the intended producer or viewer.

4K ENCODING WITHIN HD WORKFLOWS

The majority of live broadcasters and remote producers do not have the means to maintain separate workflows and contribution systems for HD and 4K. As most live content is still captured in HD, despite the rapid growth in 4K, it simply does not make sense to have dedicated remote production kits and OB vans for 4K, nor does it always make sense to immediately replace all HD production equipment with 4K gear.

3G SDI cables, for example, can be used for 4K workflows. Video encoders such as the Makito X4 can capture 4K video over 4 x 3G SDI cables enabling the ability to easily switch between HD and 4K sources. Alternatively, the Makito X4 can also accept a 12G SDI source for interfacing directly with a 4K camera.

CONCLUSION

Whether it's for an existing production system and workflow or a brand new remote production facility, broadcast engineers, technical directors, and television producers need to have the flexibility of working with both HD and 4K content.

Recent advances in video compression, especially with the ultra efficient live 4K video encoders from Haivision, the Makito X4, designed specifically for IP streaming, combined with the near universal availability of broadband internet, provides a wide range of possibilities for streaming 4K contribution feeds from remote sites to central production facilities.

By including a live video encoder capable of both HD and 4K HEVC encoding and streaming over IP, within a broadcast production workflow, broadcasters can quickly and smoothly transition from HD to 4K.

If you're interested in learning more about Haivision's Emmy® Award winning video streaming solutions, contact us.

info@haivision.com | 1-514-334-5445