XAVC™

XAVC QFHD Long422 200

A new XAVC operating point for advanced media architectures

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1. XAVC QFHD Long 422 200 Development Background

Since introduction, the XAVC codec has been widely adopted for HD and 4K/UHD content creation. Customers around the world are using XAVC to establish high quality ecosystems for image capture, editing, program exchange, delivery and archiving.

XAVC has become the natural choice for high quality 4K/UHD programs and for building end-to-end media production workflows. However, as the number of 4K/UHD titles increased, we started to hear requests for the highest quality performance for which XAVC has become renown, but with the option to operate at lower data rates. Ultra HD broadcasting and OTT delivery has started in several countries and regions, along with migration to cloud-based infrastructures in some areas. A lightweight high quality picture codec is required for such applications.

In order to meet customer requirements, Sony is proud to introduce the latest and most advanced operating point within the XAVC family codec, XAVC-L422 QFHD 200. The data rate of XAVC-L422 QFHD 200 is approximately one-third of that for XAVC-I Class 300 in QFHD at 60p. This lightweight operating point will help reduce costs for storage on removable media, server technology and cloud. It will also enable faster file copying and transfer, maintaining consistent levels of picture quality during production and when creating the highest-quality 4K Ultra HD air masters for delivery to broadcasters for their terrestrial, satellite or OTT services.

2. Sony Codec Evolution

Today's media professionals face an ever-growing choice of codecs and related technologies, standardized by industry bodies such as the ITU-T and ISO/IEC. Each will seek to apply the most appropriate codec to the various parts of the content production and distribution infrastructure within their organization.

In 2013, the ITU-T and ISO/IEC introduced H.265/HEVC, a codec that delivers lower data rates than existing codecs such as H.264/AVC. Against this background, it is logical to ask why Sony has decided to extend the H.264-based XAVC family and introduce XAVC-L422, rather than switch to a newer codec. We need to examine the requirements, constraints and performance expectations throughout the content chain to find the answer.

In distribution applications, a general objective is to maintain good levels of picture quality at ever-lower data rates, with a reduction of 50% of data rate being very much the goal when introducing a new codec. HEVC offers clear benefits here and the media industry has embraced it for applications such as program transmission and web streaming.

In professional production applications, the emphasis is different. Key requirements here are to maintain very high-quality pictures, to keep storage requirements at modest levels and to achieve real-time performance in acquisition, editing and picture manipulation - without the need for excessive computational power. Access to a range of production tools from a selection of technology vendors is also important. It is perfectly acceptable for the data rates of one codec to be higher than those of another if the above production criteria can be met.

It is our belief that Sony's mission is to offer workable, practical and reliable solutions for content creation professionals and not just implement the latest technologies for their own sake. Factors such as the computational power required to process the encoded data stream, the open availability of the codec Intellectual Property for widespread adoption and a data rate chosen to operate efficiently within today's production infrastructures, are critical to the choice of codec.

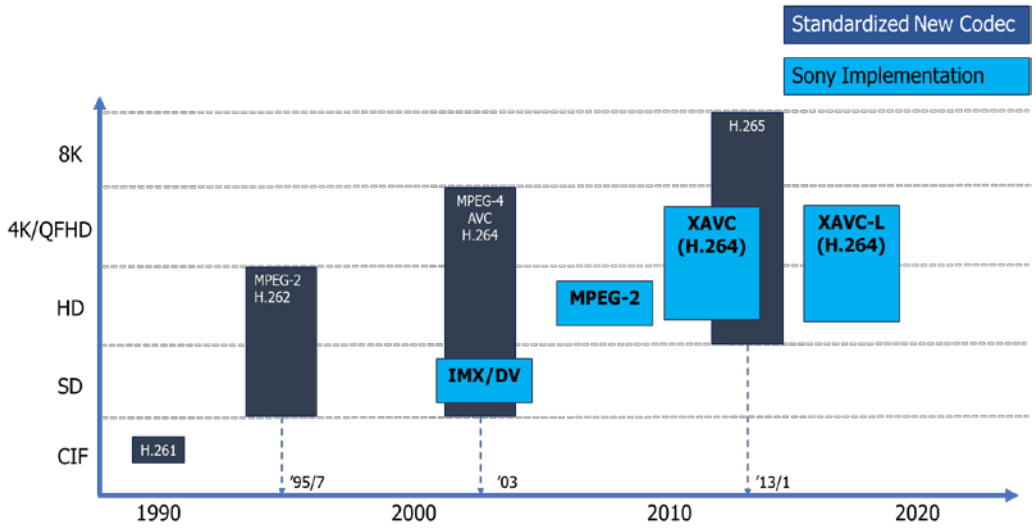

Figure.1 Timeline - Codec Technology and Sony Implementation

While a newer codec, such as H.265/HEVC may be more suitable for UHD, 4K or 8K transmission, it is not automatically the best choice for production environments today. The burden of computation of HEVC makes it almost impossible to handle in "real-time" operations without very powerful processing devices.

In comparison, H.264 is perfectly suited to demanding professional applications at up to 4K and Sony has already achieved a very high level of image quality (over 45dBs of SNR) with XAVC-L422. The rate of XAVC-L422, although around 30% to 50% higher than HEVC, is completely manageable from a computational viewpoint for editing, picture manipulation etc. and for transport around today's broadcast infrastructures.

Technology and solutions vendors can also implement H.264 (XAVC L422) without the expensive and complex-to-arrange patent payments required for various aspects of the use of H.265.

3. Key Features of XAVC QFHD Long 422 200

The Sony XAVC format complies with H.264 at up to High 4:2:2 Profile Level 5.2.

XAVC-L422, a new operating point within the established XAVC family, inherits a number of the proven advantages of intra-frame XAVC-I. These include high picture quality, format robustness and adoption by leading XAVC Alliance Partner organizations within their systems and applications.

The XAVC-L422 QFHD 200 operating point uses Long GOP compression to reduce the data rate compared with XAVC-I QFHD 300, while maintaining the high picture quality of the XAVC codec. Long GOP compression groups multiple frames of sequences (approx. 0.5 sec) as a Group of Pictures (GOP) structure and encodes using the difference in picture information throughout the GOP.

Figure 2 shows the data rates of a variety of QFHD codecs. As can be clearly seen, the use of XAVC-L422 QFHD 200 reduces the data rate substantially.

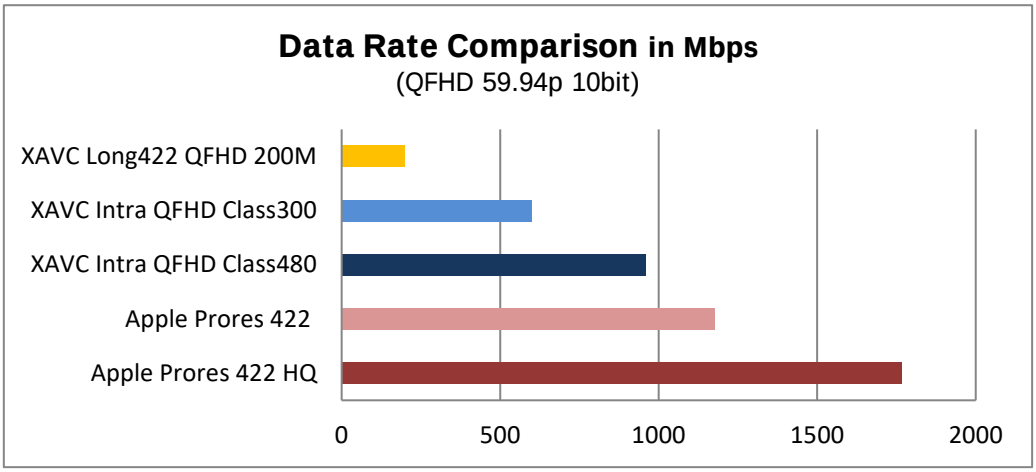

Figure 2 Codec data rate comparison

In the XAVC stream, a PPS (Picture Parameter Set) is allocated to each frame and an SPS (Sequence Parameter Set) is attached to each GOP. This allows the recording device to dynamically optimize the image quality within each picture frame and ensure that the optimized image setting value remains attached to the picture file after editing. It also helps to optimize the image quality during random access playback.

In order to ensure broadcast-standard picture quality, XAVC-L422 QFHD 200 features 10-bit quantization and 4:2:2 color sampling, which is well-suited to the rapidly growing increase in High Dynamic Range (HDR) video production around the world.

4. Products supporting XAVC QFHD Long422 200 (as of April 2019)

- **Hardware Products**

The PZW-4000 is the world's first product that supports XAVC-L422 QFHD 200, along with XAVC-I QFHD 300. The PZW-4000 supports two Professional SxS memory card slots, enabling on-the-fly playout from SxS memory cards without the need to ingest media into the unit's internal SSD storage. The recommended cards are the current SxS PRO+ series and the brand new SxS PRO X series, scheduled for released in the fall of 2019.

Figure 3: PZW-4000, 4K XAVC RECORDER

SxS PRO X

SxS PRO+

It is widely acknowledged that HDR techniques enables the creation of more stunning, vivid pictures with much greater and improved image information throughout the entire luminance range, especially in the highlights. However, how to process the additional highlight information beyond that of the SDR is EXACTLY the key point we should pay attention to.

In order to record a wider dynamic range within the capabilities of a standard recording codec, it is natural to reduce the amplitude of image data in the highlights for processing under a limited number of bits per pixel. This is usually achieved by the use of production log curves such as S-Log3. During the decoding process and subsequent display, the reconstructed data must undergo the inverse process of amplitude expansion, which is especially severe in the highlight region of the image dynamic range. It is in this highlight region where exists a large potential risk for the creation of picture artifacts such as banding, blockiness and exacerbated coding noise. It is also worth mentioning that the coding strategies and bit allocation of most of the traditional image compression schemes have been determined by examining their coding effects on SDR images. When similar compression strategies are then use with imagery with HDR information, it is the concatenation of the squeezing and stretching signal processes in addition to the erroneous distribution of compressed data throughout the dynamic range, that causes, in occasions, severe picture distortions.

In order to prevent these risks of picture coding artifacts, an optimized encoding process for HDR video signals has been developed by Sony, - which was initially introduced for use in the PWS-4500 server in intra-frame form -, and now also implemented in full inter-frame form (i.e., Long GOP) within the PZW-4000.

Please refer to the simulated picture comparison below, especially the blue-sky area on the right.

With Sony's HDR optimized encoding

Normal encoding

Figure 4 Simulated image comparison of with/without optimized HDR recording process

This encoding process is especially suited for HDR recordings, using an optimized bit assignment to suit each OETF characteristic. This unique encoding process ensures the highest picture quality in both SDR and HDR at an easy-to-handle 200Mbps data rate. Also, it should be noted that this coding optimization process is carried out on the encoding stage alone and it does not affect the decoding process, since it generates compliant bitstreams with the standardized decoding syntax and semantics of the H.264 compression system.

- **Software Products**

Speaking of interoperability of compressed streams, XAVC-L422 QFHD 200 has already been supported by a number of major, non-linear editing applications. It is expected that the number of manufacturers and products supporting XAVC-L422 QFHD 200 will increase in the near future. For further details and/or latest status about XAVC interoperability, please refer to the link below

https://www.xavc-info.org/xavc/share/data/XAVC_Encode_Supported_Products.pdf

In initial testing, it has been confirmed that encoding speed could reach almost real-time or faster when sufficient computational power is applied.

Encoding Speed of XAVC-L422 QFHD 200 at 59.94p : 63.177 fps (*)

** Measured by latest MainConcept SDK with E5-2699v4 x2@2.2GHz, 88-thread, 128GB RAM*

5. XAVC Operating Points

Here is the XAVC operating point at a glance.

XAVC Intra		
	Regular Form	Short Form
QFHD (3840×2160)	XAVC QFHD Intra Class480 CBG	XAVC-I QFHD 480
	XAVC QFHD Intra Class480 VBR	
	XAVC QFHD Intra Class300 CBG	XAVC-I QFHD 300
	XAVC QFHD Intra Class300 VBR	

XAVC LongGOP		
	Regular Form	Short Form
QFHD 4:2:2 10bit	XAVC QDHD Long422 200	XAVC-L422 QFHD 200
	XAVC QFHD Long422 140	XAVC-L422 QFHD 140
	XAVC QFHD Long422 100	XAVC-L422 QFHD 100
QFHD 4:2:0 8bit	XAVC QFHD Long150	XAVC-L QFHD 150
	XAVC QFHD Long100	XAVC-L QFHD 100
	XAVC QFHD Long60	XAVC-L QFHD 60

6. Summary

Sony is proud to introduce the latest and most advanced operating point within the XAVC family, XAVC-L422 QFHD 200. This new operating point combines high quality performance, real-time operation and modest storage requirements without the need for extensive computational power or costly and complex patent payments. Sony has introduced XAVC-L422 QFHD 200 for production professionals looking to implement the latest generation of processing architectures for media creation applications and to add even more impact to their 4K Ultra HD content.