

HDR Vivid Standard and Application in China

ABSTRACT: HDR Vivid, a new HDR (High Dynamic Range) standard released in January 2022 in China, is one of the key technologies for ultra-high definition (UHD) video processing. Based on the existing open HDR standard such as HDR10 and HLG, the HDR Vivid standard provides the mechanism to leverage the terminal display capabilities, to ensure the video content being displayed compliantly with the content producers' artist intention. End-to-end systems have been constructed and tested based on this standard to demonstrate their technical advantages and the readiness for large-scale commercial use. More specifications for different application scenarios, test, and certification are under development and making rapid progress.

1. INTRODUCTION

With the rollout of 5G technologies and the improvement of terminal display capabilities, the era of UHD audio and video experience has arrived. HDR, one of the key technologies in the UHD audio and video industry which can provide wider colour volume and higher dynamic range, is gaining more and more attention these years.

In the 2010s, especially in 2019, Ministry of Industry and Information Technology (MIIT), National Radio Television Administration (NRTA) and China Media Group (CMG) jointly issued the "UHD Video Industry Development Action Plan (2019-2022)". With the overall technical route of "4K first, both with 8K". The UHD video industry and its application in related fields has developed rapidly in China. Also, a new HDR solution has been developed, namely HDR Vivid. After strict evaluation, it was officially released as an industrial standard before the 2022 Winter Olympics (GY/T 358-2022). With the cooperation and efforts of a large variety of industrial enterprises, it has been widely adopted by the entire industry chain and now constitutes a complete end-to-end HDR ecosystem.

HDR Vivid provides rich details of bright and dark regions to improve the image quality in terms of contrast and grayscale, making the content more detailed and realistic.

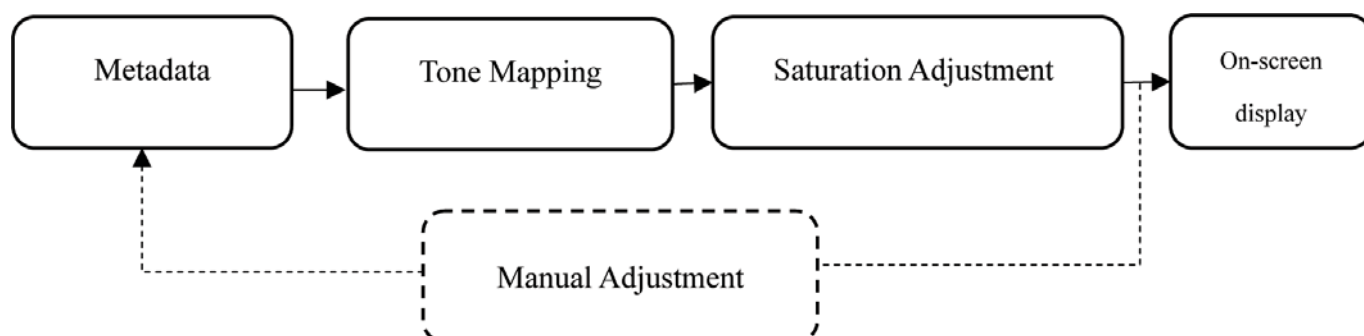
With the joint support of the state and industry, the HDR Vivid technical standard has already been applied to large-scale commercial uses.

2. CHARACTERISTICS OF HDR VIVID

From the perspective of the entire display adaptation pipeline of the terminal, dynamic metadata is generated based on the analysis of source materials first, and then tone mapping and saturation adjustment are performed to match the display capabilities of different screens. Therefore, HDR Vivid has three core technical principles: Dynamic metadata, Tone mapping, and Saturation adjustment.

2.1 DYNAMIC METADATA PROVIDES MORE SPACE FOR COLOURISTS

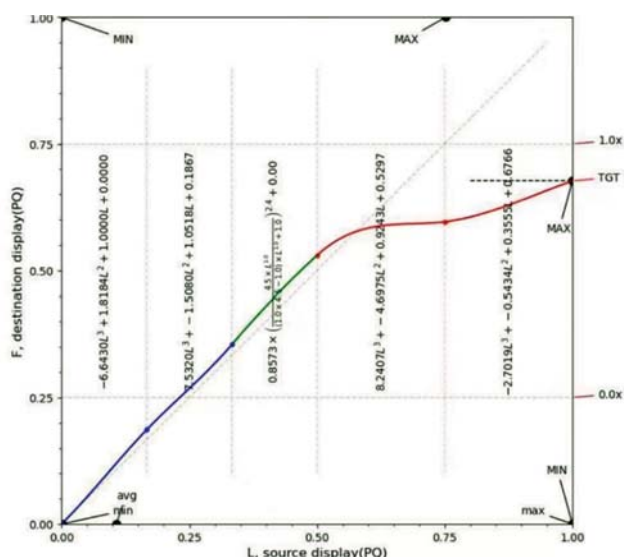
As for static metadata strategy, each piece of content uses only a single item of metadata to control the colour and details of each frame. However, dynamic metadata can record the feature information of each frame or scene, which is more adaptable and effective. In addition, from the perspective of content production, dynamic metadata creates a larger space for colour changers. Colour changers can manually adjust metadata for certain scenarios based on their personal preferences, implementing secondary creation and forming their own unique style.





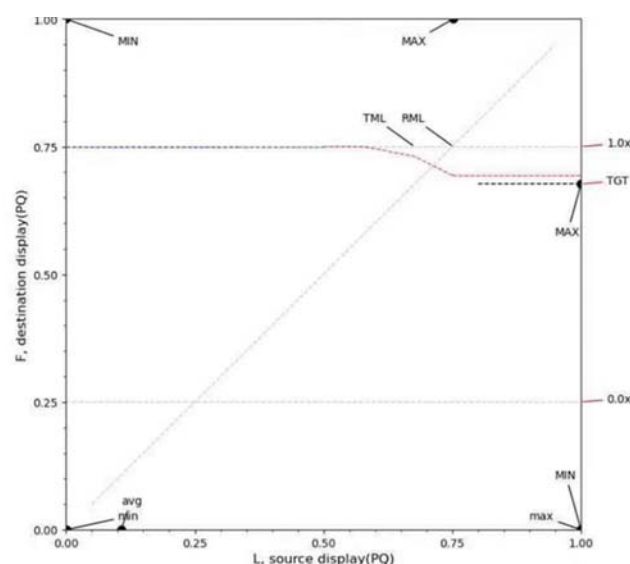
2.2 TONE MAPPING MAXIMISES THE CREATORS' INTENTIONS

Tone mapping is based on metadata, which ensures the consistency of visual experience on different devices and maximises the creators' intentions. Specifically, the tone mapping curve of HDR Vivid can be divided into two forms: basic curve and spline optimization curve. The basic curve takes the shape which is similar to the response of human visual cells, therefore can determine the overall style of tone mapping. Spline-optimised curves can further optimise the effect of tone mapping. For instance, over-darkness can be avoided by applying primary splines and low-bright area cubic splines to protect the dark region, and highlight details could be preserved by using high-bright area cubic splines at the same time.



2.3 SATURATION ADJUSTMENT GUARANTEES THE CONSISTENCY OF COLOUR PERCEPTION

The biggest problem with changing brightness is that it will also cause a change in saturation. Therefore, after tone mapping is performed, HDR Vivid technology also considers colour correction, that is, saturation adjustment, to ensure that the colour perception is consistent within HDR Vivid processing pipeline.



$$Y = Y_{TM}$$

$$U = U_{TM} \times \left(\frac{Y_{TM}}{Y_{org}} \right)^c$$

$$V = V_{TM} \times \left(\frac{Y_{TM}}{Y_{org}} \right)^c$$

3. ADVANTAGES OF HDR VIVID

Compared with other HDR technologies, HDR Vivid has five major advantages.

- 1) **Compatibility.** After receiving HDR Vivid signals, inventory display devices (such as mobile phones, tablets, and TVs) that do not support HDR (HDR Vivid) can directly discard the metadata and display the content in HDR10 format without any abnormal effects.
- 2) **Consistency.** HDR Vivid uses the dynamic metadata solution to generate mapping curves for different target displays based on the capabilities of different terminals. In this way, the display effects of the same content on different terminals are basically the same, which can maximise the creators' intentions.

- 3) **Flexibility.** In addition to supporting automated dynamic metadata extraction solutions, HDR Vivid technology also allows users to manually adjust metadata based on creative intent to create their own style.
- 4) **Adaptability.** HDR Vivid supports various application requirements, such as network audio-visual, TV station production and broadcasting, short videos, games, and industry applications (such as medical care). Both PQ and HLG format are supported as input of HDR Vivid.
- 5) **Openness.** HDR Vivid is a fully open standard. All resources, including code and implementation specifications, are available through designated channels without any charge.

4. ECOSYSTEM OF HDR VIVID

HDR Vivid has been widely applied in content production, colour grading tools, cloud service platforms, coding and transmission system, chips, terminal devices and so on. On 30 January 2022, HDR Vivid standard, "Technical Requirements for Display Adaptation Metadata for High Dynamic Range Television Systems" (GY/T 358-2022) was issued as a radio and television and network audio-visual industry standard.

China Media Group began the construction and piloting of the 8K UHD video production and broadcasting public service platform at the beginning of 2021, and the CCTV-8K channel was officially broadcast on January 24, 2022, according to the goal of "Winter Olympics with 8K". For the first time, CCTV-8K channels were accessible in the home. Along with it, CMG launched a three-year "Bai Cheng Qian Ping" (100 cities, 1,000 screens) UHD video and 3D audio promotion activities, showing the UHD video and 3D audio-visual effects through the outdoor and indoor UHD large screens in public. The outstanding HDR was also demonstrated as a key technology.

Internet video content service companies such as iQIYI, Tencent Video, and Youku have applied the HDR technology in their products. iQIYI has already supported HDR Vivid since September 2021. In August 2022, the "12th Beijing International Film Festival: Film Festival on the Cloud - HDR Vivid Exhibition" was held, and a large amount of high quality content was broadcast based on the HDR Vivid standard.

With the support and collaboration of partners in the entire industry chain, Migu of China Mobile play an important role in demonstrating the application in the European Cup. In early 2022, the Beijing Winter Olympics and Paralympics were live broadcast using HDR Vivid.

Telecom operators have hundreds of millions IPTV users. 4K/8K smart STBs support HDR Vivid, providing users with a more authentic HD video experience. According to telecom carriers' IPTV service planning and centralised procurement requirements, China Telecom and China Mobile both have tens of millions STBs, which will support HDR Vivid totally.

Industry partners are actively applying innovative technologies in short videos, webcasting, VR/AR, games, WeChat videos, and applications in the industry, agriculture, and healthcare industries. HDR Vivid has also been explored and researched in various service scenarios.

In the upstream and downstream of the industry chain, multiple new products of leading enterprises support the HDR Vivid. Mainstream chips such as MediaTek, Jingchen, and Qualcomm have already released related products. Mainstream colour grading tools such as Davinci Resolve and Baselight have also embedded HDR Vivid functions. Huawei, Honor, Sharp, Konka, and Skyworth support this feature in batches. Mainstream carriers such as China Telecom and China Mobile support this feature. In the future, more and more vendors will join the new team that leads the visual and auditory experience and contribute to the new development of the audio and video industry.

5. CONCLUSION

As a new force in the field of dynamic HDR video standards, HDR Vivid is dedicated to optimised content elements such as colour, brightness, and contrast, and provided a better and more comfortable visual experience on various display devices. It will create greater value for the development of UHD video industry and bring infinitely wonderful audio-visual feasts to the industry and consumers.

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In recent years, Ning has carried out productive work in testing, scientific research, standard establishment and technical consultation of the radio and television centre system/equipment. He has participated in a number of scientific research projects of the Natural Science Foundation, the Ministry of Science and Technology, the NRTA, and a number of important national/industry standards. He has been in charge of the testing of numerous TV projects, including major national broadcast events, major industrial projects, 4K/8K systems, etc., and pioneered research on UHD, IP, AI and other related testing methods, serving for high-quality and innovative development of radio & TV and network audio-visual. He has accumulatively compiled more than 40 national and industry standards, participated in the compilation of 2 technical books, applied for 3 technical invention patents in cooperation, and won one special prize and more than ten first prizes of the provincial and ministerial science and technology innovation awards. He has played an important role in the technology system establishment, technology application and technology promotion of the whole industry. ■