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Introduction of HDR Vivid Standard

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Abstract: HDR Vivid, a new HDR (High Dynamic Range) standard released by NRTA this January, 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 standards provide the mechanism to leverage the terminal display capabilities, to ensure the video content being displayed best compliance to the content producers' artistic intent. End-to-end system have been constructed and tested based on these standards 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.

Key Word: Ultra HD video industry, HDR Vivid

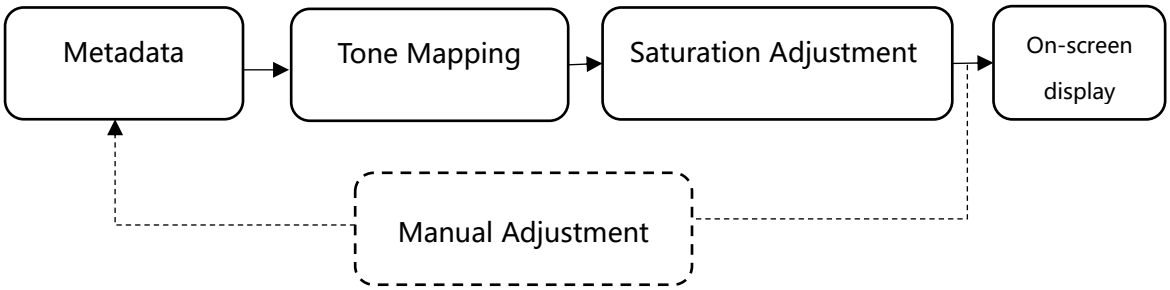
1. Introduction

With the rollout of 5G technologies and the improvement of terminal display capabilities, the era of ultra-high definition (UHD) audio and video experience has arrived. High dynamic range, one of the key technologies in the UHD audio and video industry which can provide wider color volume and higher dynamic range is gaining more and more attention these years.

Since 2010s, with the guidance from the NRTA (National Radio and TV Administration), UWA (UHD World Association) organized several leading enterprises to develop a new HDR solution, namely HDR Vivid. It was originally released as an UWA standard in 2020, and then after the strict evaluation performed by NRTA, it was officially released as an industrial standard before the Winter Olympics 2022. With the cooperation and efforts of a large variety of industrial enterprises, it has been widely adopted by the entire industrial chain and eventually constitute 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 entered the large-scale commercial use phase.



2. Characteristics of HDR Vivid

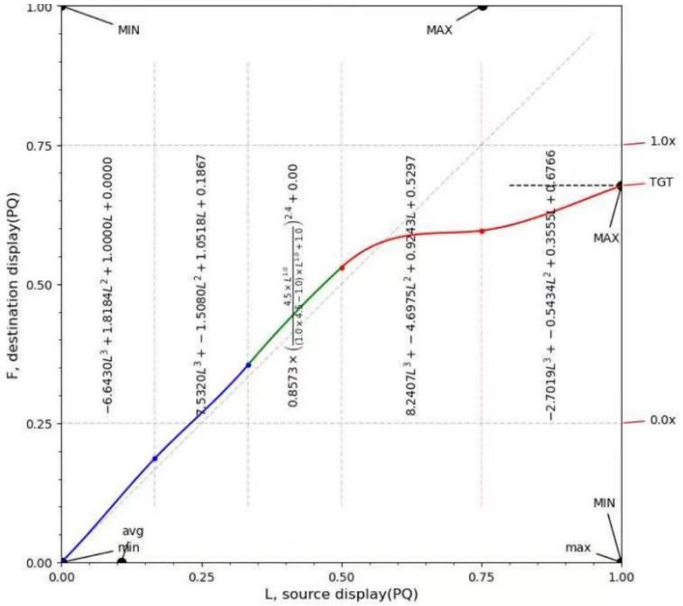
From the perspective of the entire display adaptation pipeline of the terminal, dynamic metadata is generated based on the analysis of source materials first, and then tone mapping and saturation adjustment are performed to match the display capabilities of different screens. Therefore, HDR Vivid has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

2.1 Dynamic metadata provides more space for colorists

As for static metadata strategy, each piece of content only uses a single metadata to control the color 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 color changers. Color changers can manually adjust metadata for certain scenarios based on their personal preferences, implementing secondary creation and forming their own unique style.

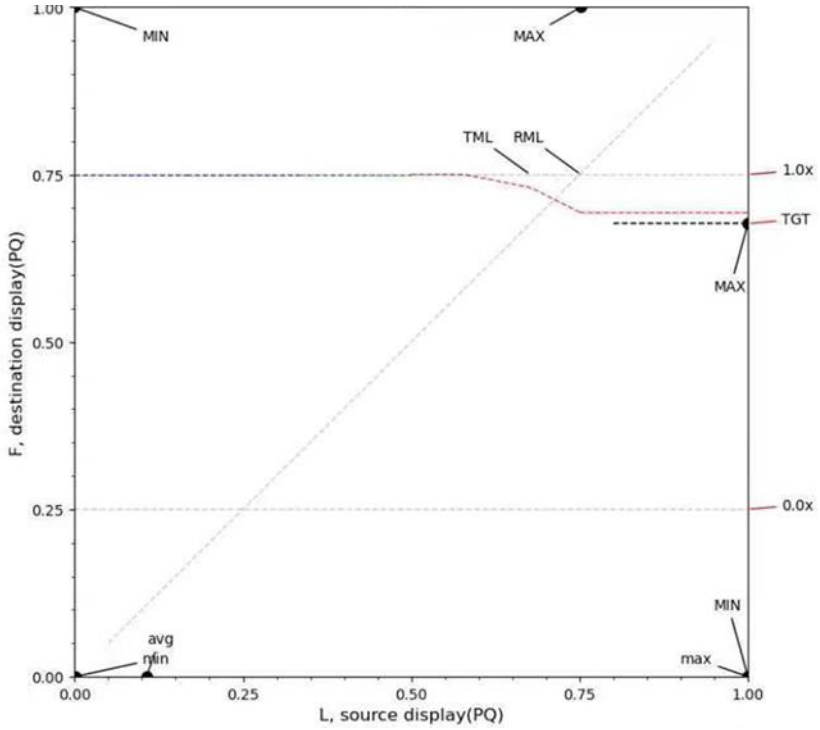
2.2 Tone mapping maximizes the creators' intentions

Tone mapping is based on metadata, which ensures the consistency of visual experience on different devices and maximizes 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-optimized curves can further optimize the effect of tone mapping. For instance, over-darkness could 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 color 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 color correction, that is, saturation adjustment, to ensure that the color 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 maximize 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

Since the release of UWA standard, HDR Vivid has made a series of breakthroughs in content production, color grading tools, cloud service platforms, coding and transmission system, chips, terminal devices and so on. On January 30 2022, HDR Vivid was upgraded to a national standard in the broadcasting and television industry, as "Technical Requirements for Display Adaptation Metadata for High Dynamic Range Television Systems" (GY/T 358-2022) 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 in the world, CCTV-8K channels were accessed to the home and 8K public screens were displayed in 100 cities. 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 "North 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 took the lead in demonstrating the application in the European Cup. In early 2022, the Beijing Winter Olympic Games and Paralympic Winter Games were live broadcast using HDR Vivid.

Telecom operators have more than 330 million 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 centralized procurement requirements, China Telecom has 27 million full 4K smart STBs, China Mobile has 47 million Magic Hundreds, which will support HDR Vivid totally.

Industry partners are actively applying innovative technologies in short videos, webcasting, VR/XR, 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 color grading tools such as Davinci Resolve and Baselight also have 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 intelligently optimizing content elements such as color, brightness, and contrast, and providing a better and more comfortable visual experience on various display devices. The above standards will create greater value for the development of the ultra-high definition (UHD) video industry and bring infinitely wonderful audio-visual feasts to the industry and consumers.