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# Introduction

A set of current and emerging displays were characterized by “families” according to the optical technologies used by each display to create each display’s optimal visual experience [1]. A set of general recommendations was also developed in [1]. This document endeavors to map those recommendations to requirements that could be addressed by MPEG in Phases beyond its Phase 2b timeframe. Note that in order to create a cohesive ecosystem, some of the requirements may need to be addressed by SDO’s other than MPEG, as even in the existing ecosystem for 2D video distribution, not all of the standards used to support that ecosystem were developed by MPEG.

This version of the document (v3) provides additional information about the importance of developing compression technologies for USD [3] as this format is broadly used by the content production ecosystem, and will likely need to be distributed over commercial networks to end-point clients that support input that is sourced from Unity and Unreal engines.

# Mapping of recommendations to MPEG and other SDO requirements

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| **Number** | **Recommendation** | **SDO** | **Requirement** |
| 1.0 | Identify/develop one or more rich media formats that can be used as ingest formats by a service provider that endeavors to support all immersive display families identified in [2]. | Possibly SMPTE, IDEA, ITU-R, or JTC1/SC24 | A single media format that shall support various media types so that a consistent presentation of the media may be rendered by each of the families in [1]. |
| 1.a. | The ingest format must contain sufficient information such that the most demanding display family can create its optimal visual experience (i.e., holographic) based on the intended purpose of the particular ingest format. | Possibly SMPTE, IDEA, ITU-R, or JTC1/SC24 | The ingest format shall support media types that can be used to create photorealistic volumetric results including location-dependent viewing results. |
| 1.b. | The ingest format must be able to be “flattened” to support legacy 2D video displays. | Possibly SMPTE, IDEA, ITU-R, or JTC1/SC24 | The ingest format shall include sufficient information or metadata to direct the transcoding of the ingest format to a legacy 2D video format suitable for the display. |
| 1.b.1 | The ingest format must be able to be “flattened” to support legacy 2D video displays. | MPEG | Network APIs shall support the transcoding of the ingest format to a suitable distribution format according to the capabilities of the target display. |
| 1.b.2 | The ingest format can be transformed into a format suitable for the application and the display. | MPEG | Network APIs shall determine the capabilities of the display and the requirements of the application. |
| 1.b.3 | The ingest format can be transformed into a format suitable to meet the service level agreements for the customer. | MPEG (not sure about this one) | Network APIs shall be able to tune the distribution format into a format that meets or exceeds the customer’s expectations according to SLA. |
| 1.c | Each ingest format must be described sufficiently such that a clear understanding of how to adapt and distribute the media can be determined by the network | Possibly SMPTE, IDEA, ITU-R, or JTC1/SC24 | Each ingest format shall be fully specified for use in a network that adapts the ingested media for use as a distribution format for each client display. |
| 2.0 | Each ingest format will be converted to a distribution format that is suitable for the targeted display, application, network conditions, and SL agreements with the customer. | MPEG | Network APIs shall employ a rendering process to provide an output that can be a suitable distribution format according to the capabilities of the display, requirements of the application, network conditions, and SL agreements (if such information is available). |
| 2.1 | The distribution format can be in a format that allows the display to perform the final rendering. | MPEG | Network APIs shall be flexible to allow various distribution formats to be created by the network rendering process, including allowing the display itself to perform the final rendering. |
| 2.2 | The distribution format must be in a format that can be consumed by the display to permit the display to operate at its most optimal level. *(seems to overlap with requirement 1.a).* | MPEG | Network APIs shall support sufficient attributes and features to allow a display manufacturer to specify the set of features and attributes (i.e. a display “profile”) that shall be used to guide the transformation and rendering processes to convert the ingest format into a format suitable for consumption by the targeted display. |
| 3.0 | The distribution format must be streamable, i.e. can be packetized in a logical structure so that the most relevant information for the scene is streamed prior to less relevant information. | MPEG | The distribution format shall permit rendering of geometric scenes to begin before all levels of detail are available at the display. |
| 3.1 | The distribution format must be streamable, i.e., is “small enough” to be streamed over an access network. | MPEG | Media formats that are typically “dense,” e.g. VDB and Alembic, shall be compressed. |
| 3.2 | The distribution format must be streamable, i.e., is “small enough” to be streamed over an access network. | MPEG | The USD format shall be compressed so that it can be streamed over an access network. |
| 3.3 | The production formats should be compressed in a manner that facilitates the use of the compressed assets to be used as a mezzanine format. | MPEG | The compression technologies generated for production formats, e.g., USD, shall support levels of compression, i.e., qualities, such that the compression technology may be used to create mezzanine formats. |
| 4.0 | The distribution format must be flexible enough so as not to restrict display manufacturers to using only one rendering solution or technology. | MPEG | The distribution format shall support multiple rendering paradigms to enable display manufacturers to implement the desired render technology according to the performance targets of their displays. |
| 5.0 | The conversion of each ingest format to the distribution format can be done in real-time within the network as part of the end-to-end workflow in the distribution pipeline. | MPEG | Network APIs shall guide the service operator to perform the conversion of the ingest format to a distribution format based on real-time, static, or a combination of information obtained in real-time or from static sources. |
| 6.0 | Display manufacturers that require more than 2D video formats as its distribution format will supply specific and sufficient information such that the client-supplied information can be used to create a distribution format suitable for the display | Display manufacturers, MPEG | A list of attributes that are required to create a suitable distribution format shall be identified by MPEG. MPEG shall provide network APIs that display manufacturers shall implement so that attributes that impact the distribution of media are provided by the display to the distribution process. |
| 7.0 | A network-based rendering and/or adaptation process will be designed using well-known and widely-deployed techniques. | MPEG, IDEA | A network-based rendering process shall use techniques and technologies that are widely deployed and used so as to meet the rendering and adaptation requirements of all immersive displays. |

# Conclusions

The contribution endeavors to map recommendations and suggestions of the Ad hoc Group for Future Capabilities for MPEG-I to requirements that can be considered by MPEG or other SDOs. The work toward developing these requirements should be regarded as preliminary, as clearly, an effort to support commercial distribution of immersive media for consumption on a variety of immersive media display types, with widely varying experiences, is a multi-SDO effort, with MPEG potentially developing the majority of new technologies for compression, network processing, and distribution.

# References

1. “Draft report on framework for characterizing emerging immersive displays and media for immersive applications,” ISO/IEC SC29/WG2 Output Document Serial Number M55595, October 2020.
2. “Draft requirements for support of emerging immersive displays and media for immersive applications V2,” ISO/IEC SC29/WG2 Output Document Number N34.
3. An Introduction to Universal Scene Description, https://graphics.pixar.com/usd/docs/index.html