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# Abstract

This document describes preliminary Draft requirements for lightweight Gaussian splat coding. These requirements were agreed as useful information and as a starting point for this activity.

# Introduction

There is high interest of industry in the standardization of Gaussian splats-based representations [1] and coding of immersive environments. The main reasons are the following advantages that this technology offers:

* Being captured with any 2D camera such as smartphone or digital camera(s).
* Training, processing, faster than real-time rendering on mobile devices or consumer grade GPUs. Training as short as minutes on phone.
* High levels of detail and realism in rendered content; ability to render scenes from novel/unobserved viewpoints.
* Ability to edit such obtained scans by adding, deleting, or transforming parts of content.

The following are some of the applications:

* User captured 3D scans of objects/persons and scenes for sharing and interactive/immersive visualization (phone, laptop, television, HMD, etc.).
* Democratized content creation: empowering everyone with smartphone to create digital twin assets, to be used in interactive storytelling applications, like in Augmented Reality or gaming.
* Sport/music event production: users access content to immerse inside the event, from downloading highlights to live streaming.
* Gaussian splats as basis for photorealistic avatars.
* Industrial/government/commercial
  + ADAS: roads and traffic situations (versus simulator)
  + GIS: cities, aerial scans, environmental monitoring (large-scale datasets)
  + Digital twins: factories, stores, warehouses, office buildings, etc.
  + Real estate, construction (interior, exterior)
  + TV/movie/ad production
  + eCommerce
* Medical/educational
  + Realistic training scenarios, etc.
* …

It has been identified that Gaussian splats datasets require 100s of MBs or even GBs of storage per frame in a sequence when stored uncompressed. Therefore, compression technology is a necessity for practical applications.

MPEG’s JEE6.4 activity has been collecting use cases and requirements for Gaussian splats coding (GSC) and is considering two paradigms for potential standardization activities:

* I-3DGS: “INRIA” format coding, which involves trained GS data or “other” point cloud-based representation.
* A-3DGS: Exploration of alternative 3DGS representation that can be trained based on ground-truth images/videos.

It is observed [2] that the research on GSC is evolving fast and it can be argued that standardization is premature, because a potential coding standard can be outperformed by newer technologies before the standard is finalized. However, at this moment, industry already has a need for GSC technology that allows for interchange and storage of datasets. Several proprietary GSC technologies and formats are in use, and many are open source, for example:

* .ply
* .splat
* .ksplat
* .spz (Niantic)
* …

These formats are relatively lightweight (low complexity, fast encoding and decoding), however, they may have certain restrictions and assumptions built-in (quantization, number of parameters, etc.) which limit their applicability, as well as lower achievable compression ratios than the present state-of-the-art.

Given that industry is already using various lightweight GSC technologies, the need for standardization to facilitate interoperability between applications has been identified.

# Draft requirements for static lightweight GSC

This section enumerates agreed draft requirements for single static frame coding with “lightweight” GSC (L-GSC) technology.

The following are representation and coding requirements for lightweight GSC as proposed in document [6]. The list is a subset of the GSC requirements from document [7].

<Representation requirements>

* The representation shall enable 6DoF photorealistic rendering.
* The representation shall be use-case-agnostic (the same representation shall be able to represent, e.g., scenes, actors or objects).
* The representation shall support static scenes.
* The representation shall support non-Lambertian, semi-transparent content properties.
* The I-3DGS frame representation shall support:  
  a) 3D positions: (X, Y, Z) coordinates with a specification of its precision and dynamic range.  
  b) Pre-defined attributes: the attributes associated with each 3D position including colour, rotation, scale, opacity, diffuse (sh0) and specular (sh1, sh2, sh3) spherical harmonics coefficients.  
  c) User-defined attributes per 3D position.
* The I-3DGS frame representation shall offer the option to support compact representations of its attributes and positions.

<Coding requirements>

* The specification shall support lossy compression with variable bit-rate.
* The specification shall support decoding with low complexity, i.e., allow for real-time decoding on low power devices such as mobile devices, glasses and Head Mounted Displays. The example of such device/platform is given in the appendix.
* The specification shall support means of efficient compression to save storage and/or to transmit compressed representation with various (fixed and mobile) networks.
* The specification shall support spatial random access.
* The specification shall provide the option to support for metadata related to camera parameters
* The specification shall provide the option to support lossless compression.
* The specification shall support mechanisms providing error resilience to transmission errors.

The following are low complexity requirements for lightweight GSC based on document [4].

<Complexity requirements>

* The specification shall include a profile that supports encoding and decoding of a static I-3DGS frame with low complexity on low power devices such as mobile devices and Head Mounted Displays. Encoding runtime measurements (excluding training methods) on such a representative or comparable device, which was introduced in the market during 2024 or 2025, shall be an indication of such complexity. In terms of encoding and decoding complexity/quality trade-off the profile shall be competitive with what is available technology in the market that addresses this use case.
  + Note: There shall be systematic runtime and complexity comparisons on such established devices.
* The specification shall include a profile that supports encoding and decoding of a static I-3DGS frame with low system memory usage during runtime that shall not exceed 2GB.
* If the specification supports decoding of a static I-3DGS frame using implementations of video decoders, the specification shall include a profile that supports a maximum of 4 concurrent video decoding sessions while the total pixel rate shall not exceed the video decoder’s profile and level maximum pixel rate. In addition, if the specification supports decoding of a static I-3DGS frame using implementations of video decoders, the specification shall also support a mode where a single video decoder session shall be used.

<Appendix>

In document [3], the implementation requirements are proposed to be refined based on target platform examples:

* Phone SoC: Snapdragon 8 Gen 3 (Samsung S24 series, Xiaomi 14 Series, …), Snapdragon 8 Elite (Samsung S25 series, Xiaomi 15 Series, …)
* HMD SoC: Snapdragon XR(+) Gen2 (Meta Quest 3, …)
* System memory: 8-12GB
* Integrated GPU (Adreno)
* Hardware HEVC encode/decode 8K video (7680x4320, 30/60fps, profile Main10 level 6.1)

# References

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[7] “Draft Gaussian splat coding requirements”, ISO/IEC JTC 1/SC 29/WG 2, Doc. N0473, July 2025.