Study Mission report on Film Grain Synthesis

DVB Document S103

June 2025

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Foreword

DVB is an industry-led consortium of broadcasters, manufacturers, network operators, software developers, regulators and others from around the world committed to designing open, interoperable technical specifications for the global delivery of digital media and broadcast services. DVB specifications cover all aspects of digital television from transmission through interfacing, conditional access and interactivity for digital video, audio and data. DVB dominates the digital broadcasting environment with thousands of broadcast services around the world using DVB specifications. There are hundreds of manufacturers offering DVB-compliant equipment. To date, there are over 1 billion DVB receivers shipped worldwide.

Executive summary

Film grain can be an important aspect of artistic intent in content creation, particularly for movies. However, the process of video compression tends to reduce film grain, often in an uncontrolled manner. Film grain synthesis (FGS) is a technique supported by recent video codecs whereby the film grain in the source video is analysed and parameterised prior to encoding. The FGS parameters are conveyed within the encoded bitstream by metadata and the decoding device can use these parameters to recreate equivalent grain (in terms of level, texture, colour, variation, etc.) in the decoded video. With this in mind, DVB initiated a study mission to investigate whether there was evidence of a complete value chain for the use of Film Grain Synthesis techniques in DVB environments.

The study mission organised an online workshop in March 2024 and sent out a fact-finding survey in August 2024. After analysing the responses to the survey, the study mission did not find evidence that a complete value chain would be in place for the use of Film Grain Synthesis techniques in DVB environments. No further work on FGS is recommended in DVB at this stage, but the ongoing work of other SDOs in this area should be kept under review.

Contents

1. Introduction

DVB specifications for the use of video codecs in DVB applications[1] define many aspects of the encoding and decoding processes, generally in the form of constraints on the encoded bitstream and the minimum level of support required in the decoding device. However, one aspect of recent video coding standards that has yet to be addressed by DVB is Film Grain Synthesis (FGS).

Natural film grain is the random optical texture of processed photographic film and is present in digitized film content. Film grain effects may be added by content creators in modern post-production for aesthetic purposes. Film grain can be part of the artistic intent and an integral aspect of the story telling.

Since film grain is noise-like, the process of video compression can tend to reduce film grain, often in an uncontrolled manner, or even remove it. Accurately conveying the original film grain through a conventional encoding and decoding process would require a much higher bitrate, which may be unacceptable for many applications.

Film grain synthesis (FGS) is a technique where the film grain in the source video is analysed and parameterised, prior to any subsequent grain reduction or removal for encoding. The FGS parameters are conveyed within the encoded bitstream by metadata. The decoding device then uses the FGS parameters within the metadata to recreate equivalent grain to add to the decoded video. The goal is to maintain the original artistic intent at a lower bitrate than would be possible without using FGS techniques.

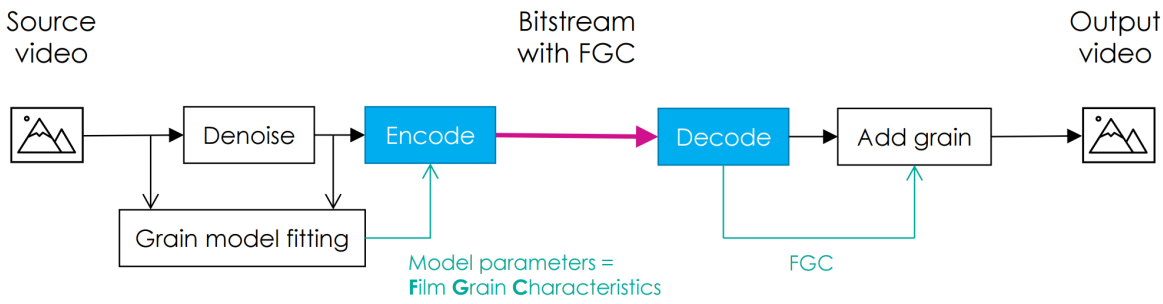

Figure 1: Film Grain Synthesis

The DVB Commercial Module (CM) set up the Film Grain Synthesis Study Mission in order to explore the commercial drivers and obstacles to the potential use of FGS in DVB systems. The Study Mission held an online workshop on 6 March 2024, with the participation of both DVB members and non-members. A fact-finding survey was sent out on 14 August 2024 to all DVB members and also the non-members who had participated in the workshop. The survey included questions covering considerations relating to artistic, commercial and legacy issues.

2. References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, DVB cannot guarantee their long-term validity.

[1]	ETSI TS 101 154	Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcast and Broadband Applications
[2]	JVET-AJ2037	Report on subjective quality testing of the FGC SEI message

3. Definitions and conventions

3.1. Terms

For the purposes of the present document, the following terms apply:

Film grain synthesis	A technique whereby film grain that has been removed or reduced from the source video during encoding is recreated after decoding, based on parameters that describe the characteristics of the original grain

3.2. Abbreviations

For the purposes of the present document, the following abbreviations apply:

CE	Consumer Equipment
DVB CM	DVB Commercial Module
JVET	Joint Video Experts Team of ITU-T SG21 and ISO/IEC JTC 1/SC 29
FGC	Film Grain Characteristics
FGS	Film Grain Synthesis
SEI	Supplemental Enhancement Information

4. Work of other groups and SDOs

4.1. JVET

The Joint Video Experts Team (JVET) of ITU-T SG21 and ISO/IEC JTC 1/SC 29 has performed a technical evaluation activity on film grain synthesis techniques, documented in JVET-AJ2037[2]. The evaluation includes two categories, including a study of the potential bitrate savings using FGS and the potential use of FGS to hide compression artefacts.

The executive summary of [2] states:

> "The film grain characteristics (FGC) SEI message can be embedded in AVC, HEVC, and VVC bitstreams to convey parameters that a decoder can use to synthesize controlled film grain in a post-decoding stage. Such film grain synthesis can be used to recreate a grain that is visually similar to the original, that has been lost due to compression, thus restoring the artistic intent. It can also be used to mask coding defects to some extent.

In this testing effort, the impact of film grain synthesis using parameters provided by the Film Grain Characteristics SEI message for both HEVC and VVC bitstreams has been assessed. In category 1 of the tests, the effect of film grain synthesis on a broad visual quality range has been explored. In category 2, the focus was on the effect of film grain synthesis at high visual quality. The category 1 tests reveal that significant performance improvement can be achieved using FGS technology. For 5 out of 6 test sequences, BD-MOS gains between 1 and 3 on the 11-grade MOS scale have been observed. The tests demonstrate that the overlay of synthetic film grain effectively hides compression artifacts. The results thereby indicate that film grain synthesis seems to generally have a positive effect on the visual quality of the compressed test sequences. The reported tests for category 2 demonstrate that for 5 out of 10 test sequences, the characteristics of the synthesized film grain reach the level of being indistinguishable from the original film grain for the participating viewers at the high rate point of the just noticeable quality difference. For these cases, bitrate savings in the range of 85-96% are reported. Similar gains are reported for both, HEVC and VVC, in both categories. By tendency, gains may be slightly higher for VVC compared to HEVC."

4.2. 3GPP

3GPP TSG SA WG4 carried out a short Feasibility Study to consider potential use cases and scenarios for the use of Film Grain synthesis in 5G video services. This study ended in August 2024.

5. Responses to DVB FGS Survey

5.1. Introduction

29 individuals from 15 organisations had participated in the online FGS workshop on 6 March 2024, including seven organisations that were not DVB members. On 14 August 2024, all workshop participants and all DVB members were sent links to allow them to complete the FGS fact-finding survey.

Eight organisations responded to the FGS survey including one organisation, IMAX, which is not a DVB member.

- 2 broadcasters
- 2 CE manufacturers and streaming providers
- 4 technology providers (including IMAX)

Some organisations skipped some of the questions.

The overall level of response was rather disappointing, since it represented approximately half the number of organisations that had participated in the online workshop. It might be assumed that those organisations that did respond to the survey tended to be those which held the strongest views on the subject, both positively and negatively.

5.2. Artistic Considerations

5.2.1. Potential consumer benefit

The primary goal of film grain synthesis is to maintain the content creator's artistic intent by replicating the level of film grain in the source video at a lower bitrate than would be possible without using FGS techniques. The survey asked for views on how much of a benefit it was expected to be for the consumer to be able to view content with an equivalent level of film grain to that envisaged by the content creator.

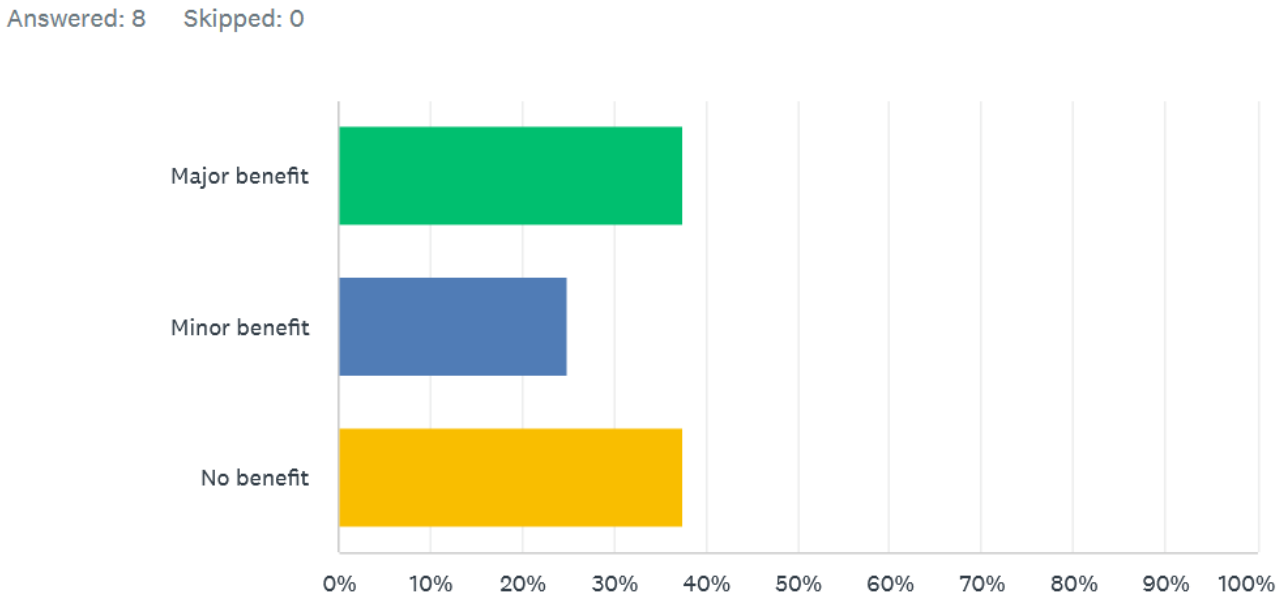

Figure 2: Potential Consumer Benefit

A range of opinions were expressed over the potential consumer benefit of FGS. The responses from the technology providers indicated major or minor benefit, the responses from the broadcasters indicated minor benefit or no benefit and the responses from the CE manufacturers indicated no benefit.

One technology provider commented:
"When grain is part of the narrative: much better fidelity/viewing experience at constrained bitrate, or much lower bitrate for a similar fidelity, which is especially interesting for OTT. Available technology enables replicating not only the level of film grain, but also its aspect and size (with potential variations depending on light intensity, including within a picture)."

One broadcaster commented:
"The consumer must be able to view content that contains the original film grain as envisaged by the content creator to maintain the artistic intent. There is no benefit to the consumer being able to view content with an equivalent level of film grain, over content with the original film grain, and as such we do not support the use of Film Grain Synthesis. If film grain synthesis is to be used then the level, appearance and type of film grain delivered to the end viewer must be consistent with that envisaged by the content creator. Any Film Grain Synthesis technique must accurately replicate the original film grain and maintain the artistic intent throughout the production and distribution chain."

One CE manufacturer commented:
"The vast majority of real world consumers, including many videophiles, will not be able to see any visual benefit or improvement. It is a feature that essentially only has any impact for artistic Golden Eyes which is numerically insignificant and insufficient to warrant the expense of implementation."

5.2.2. Required FGS Reproduction Accuracy

Seven organisations responded to all questions exploring the required film grain accuracy for specific types of content; the eighth organisation responded only for movies and drama. The views expressed on the acceptable differences between the grain seen by consumers and that on the source video are summarised in the table below.

Table 1: Required FGS Reproduction Accuracy

	Visually identical	Visually equivalent to the content creator	Perceptible to content creator, visually equivalent to the consumer	Perceptible to the consumer, but not annoying	Unimportant
Movies	3	3	1		1
Drama	3	1	3		1
Documentaries	2	2	2		1
Music videos			1	1	5
Comedy		1	2	1	3
Sport		1		3	3
News				3	4
General entertainment		1	1	2	3
Gaming	1			2	4

The consensus was that accurate representation of film grain was an important consideration for movies, drama and documentaries. For other types of content, the majority view was that it was unimportant as long as it was not annoying.

5.2.3. Potential consumer control over film grain

In addition to seeking to replicate the level of film grain envisaged by the content creator, it might be possible to allow the consumer to choose to increase or decrease the perceived level of film grain. The survey asked for opinions on how desirable it would be for the consumer to have control over this.

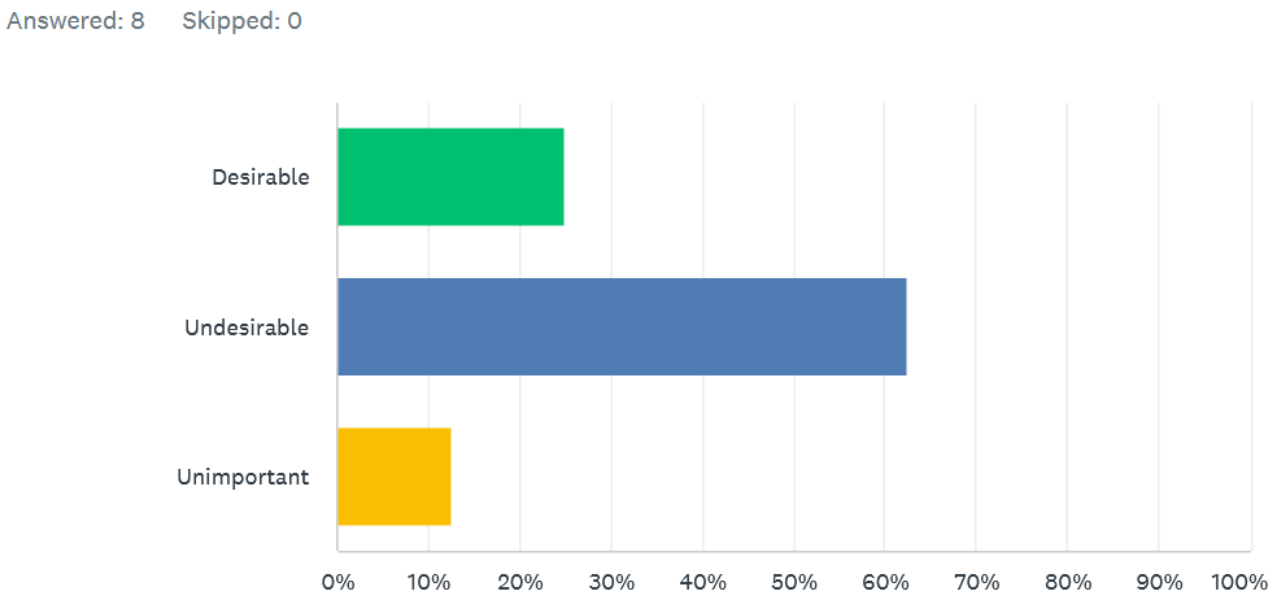

Figure 3: Consumer Control over Film Grain

The majority view was that this would not be desirable, with concerns raised such as the scope for a consumer to accidently implement a bad setting.

5.2.4. Potential texture enhancement

Another potential secondary benefit would be to use film grain synthesis technologies to subjectively enhance other aspects of the video that may be degraded by the video compression process, e.g. to enhance the perception of texture of grass that could have been filtered out. The survey asked for opinions on how desirable this would be.

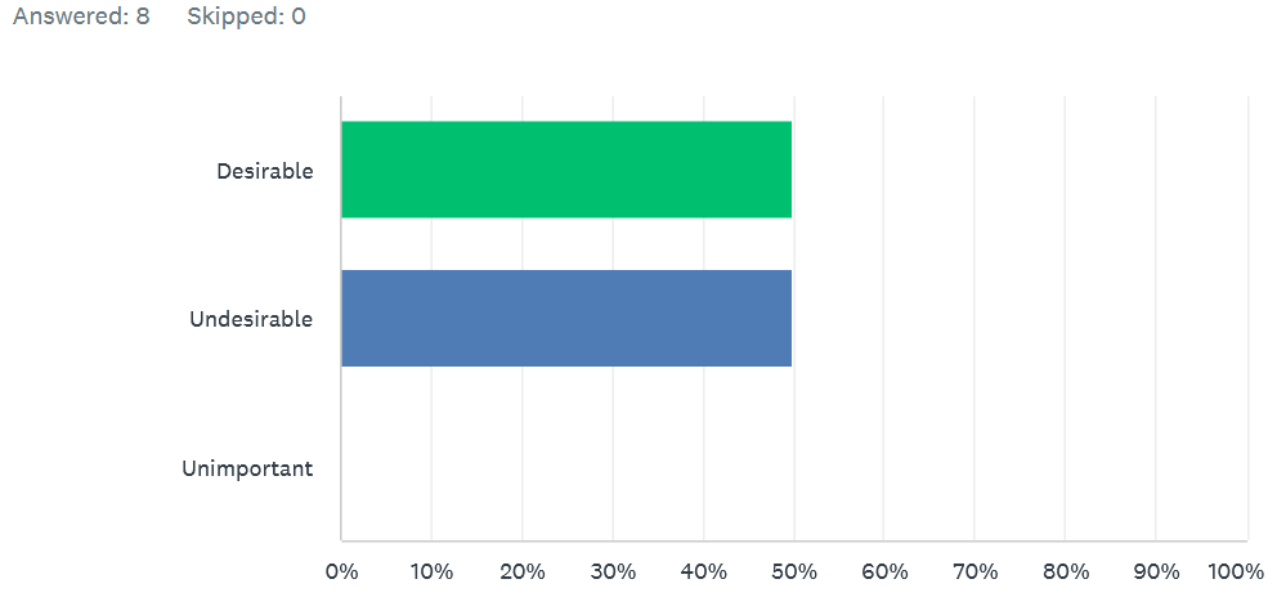

Figure 4: Texture Enhancement

The responses were evenly split between those who thought it would be desirable and those who thought that it would be undesirable.

5.3. Commercial Considerations

5.3.1. Applicability to Coding Standards

The survey asked whether FGS should be considered for mandatory or optional implementation with various generations of video codecs. The results are summarised in the table below.

Table 2: Applicability to Coding Standards

	Consider mandatory implementation in decoder	**Consider optional implementation in decoder**	**Should not be considered by DVB**
DVB codecs that are already widely implemented, e.g. AVC and HEVC		3	5
Recently specified DVB codecs, e.g. VVC and AVS3	1	2	5
Codecs that may be specified by DVB in the future	4	2	2

The majority opinion was that FGS should be considered for codecs that may be specified by DVB in the future, but not for codecs that are already included in DVB standards.

5.3.2. Applicability to delivery methods

The survey asked whether FGS should be considered for various forms of delivery. The results are summarised in the table below.

Table 3: Applicability to Delivery Methods

	Should be considered by DVB	**Should not be considered by DVB**
Services delivered via broadcasting networks, e.g. DVB-C, DVB-S and DVB-T	4	3
Recorded content delivered via IP networks, e.g. VOD movies	4	3
Live content delivered via IP networks, e.g. streaming live sports events	1	5

There was a small majority in favour of considering FGS services delivered by broadcasting networks and for recorded services delivered via IP. There was a clear majority against considering live services via IP, so that does not appear to be a relevant use case.

5.3.3. Potential compression artefact masking

It may be possible to use film grain synthesis technologies to subjectively enhance the decoded video by masking some compression artefacts, e.g. block artefacts, blurring or "mosquito noise". The survey asked for opinions on how desirable this would be.

Answered: 7 Skipped: 1

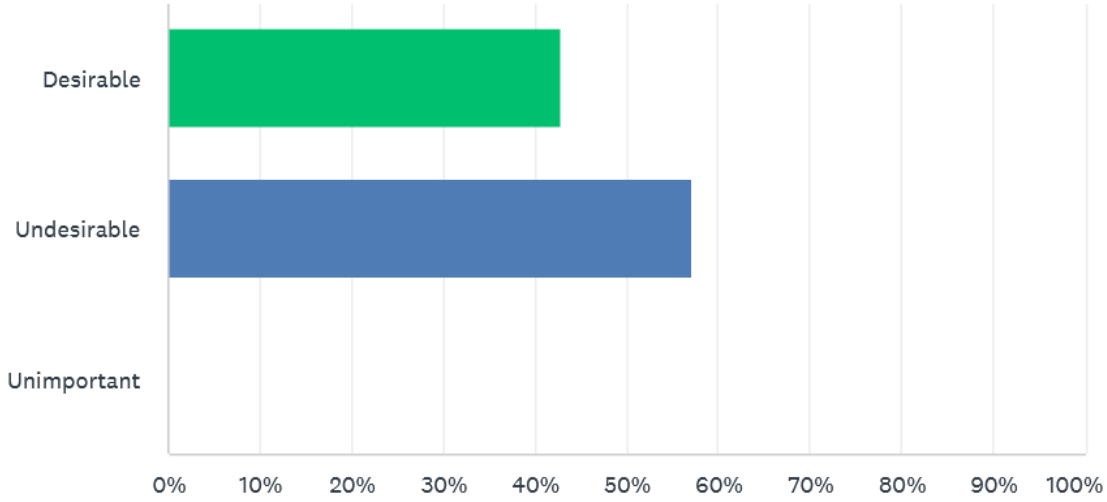

Figure 5: Compression Artefact Masking

There was a small majority that this would be undesirable.

5.3.4. Potential marketing opportunity

The introduction of film grain synthesis technologies may provide some form of marketing opportunity for organisations' products or services. The survey asked for opinions on how much of a marketing opportunity this was seen to be.

Answered: 6 Skipped: 2

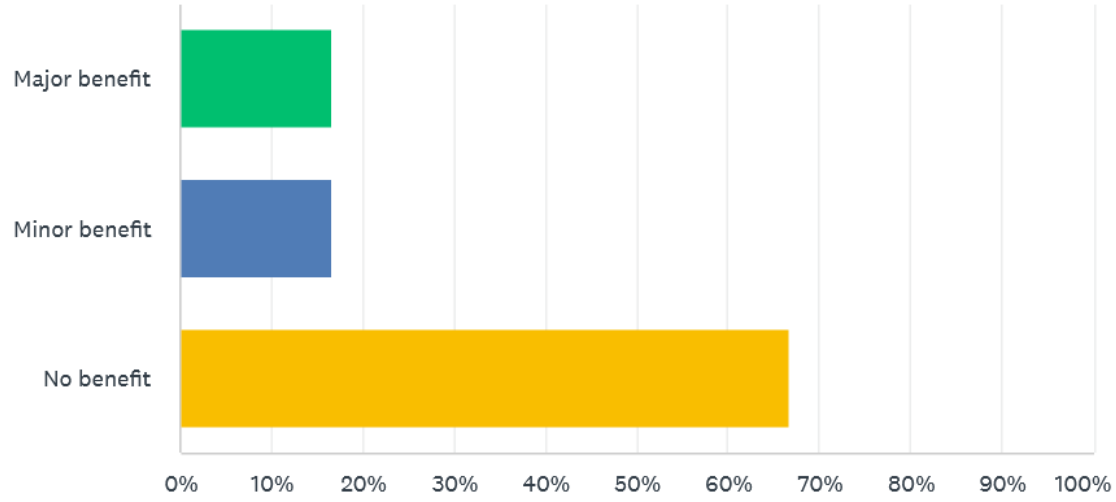

Figure 6: Marketing Benefit

Very few organisations perceived any potential marketing benefit.

5.3.5. Potential consumer confusion

The introduction of film grain synthesis technologies may risk confusing consumers. The survey asked for opinions on how much of a risk of consumer confusion was expected.

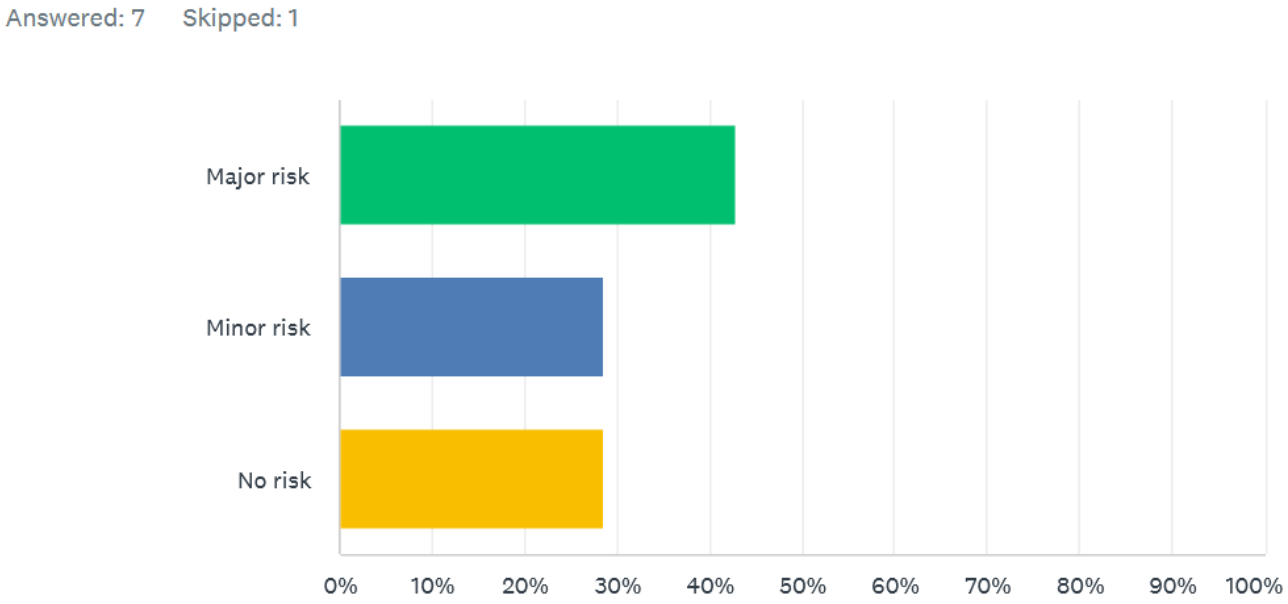

Figure 7: Consumer Confusion

The majority of responses identified some risk of consumer confusion. Some of the comments linked this this to the undesirability of allowing consumer control over film grain: see section 5.2.3.

5.4. Legacy Considerations

5.4.1. Legacy consumer devices

Legacy consumer devices operating in an FGS-enabled ecosystem may potentially deliver a reduced quality of experience due to a reduction in bitrate. The survey asked if this was an issue for concern or not.

Answered: 7 Skipped: 1

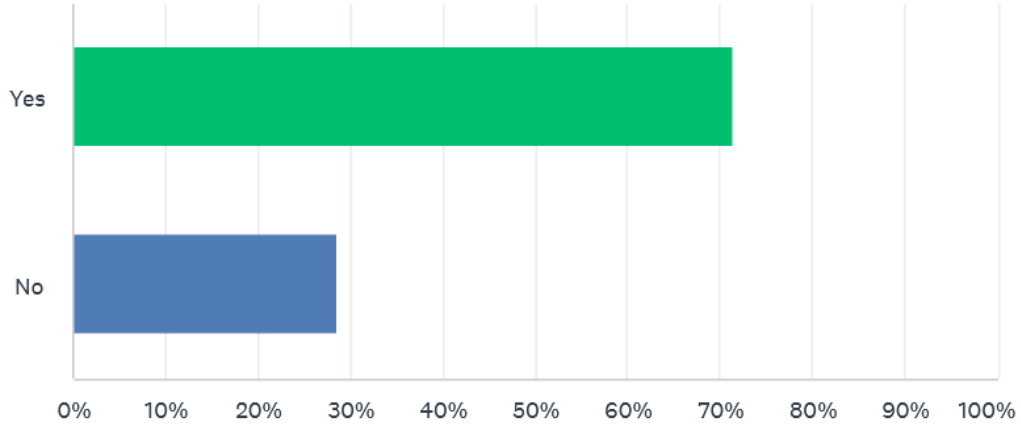

Figure 8: Concern over Legacy Devices

A clear majority viewed this as an area of concern, since a broadcaster or network operator serving a mixed population of receivers would be constrained in their ability to get the full benefits of FGS technology if they still needed to provide a high enough bitrate to give the full quality of experience on the legacy devices.

5.4.2. Existing Delivery Platforms

FGS systems would require in-band FGS metadata to be carried over some existing delivery platforms. The survey asked if any significant delivery chain workflow issues were anticipated in carrying FGS metadata across disparate platforms.

Answered: 6 Skipped: 2

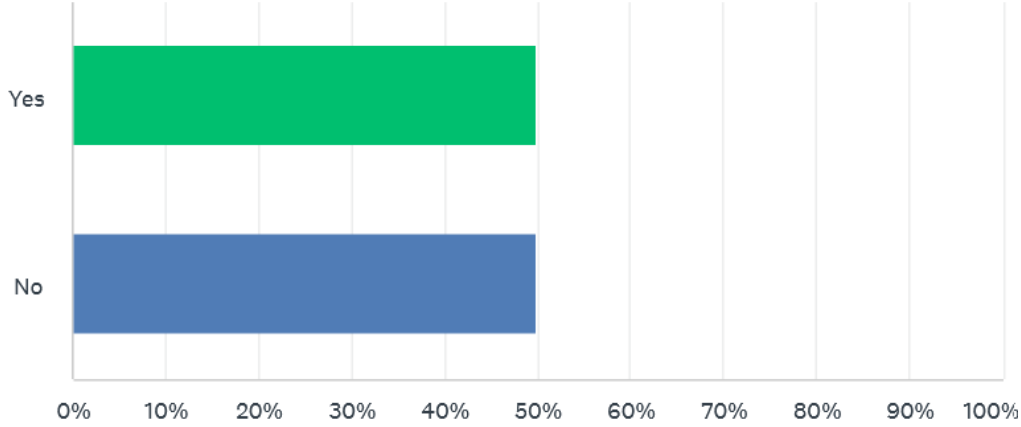

Figure 9: Concern over Existing Delivery Platforms

Opinions were split over whether or not this was likely to be a significant issue.

5.4.3. Security Issues

FGS systems are likely to result in a grain structure in the final video that, although visually equivalent, is not mathematically identical to the source video. The survey asked if any significant risk of interference with security systems, such as watermarking or fingerprinting, was anticipated.

Answered: 6 Skipped: 2

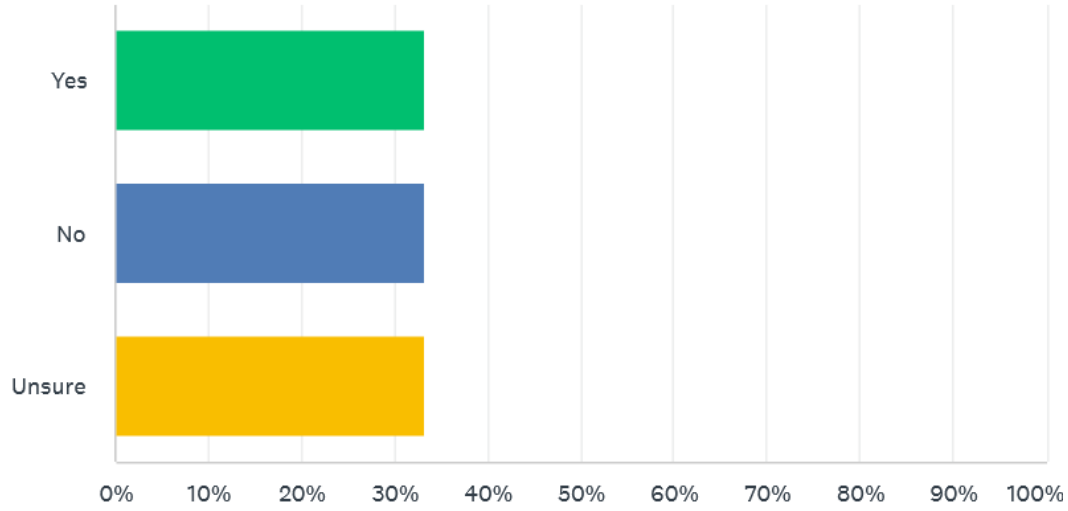

Figure 10: Concern over Security Issues

Opinions on this were split, with two organisations anticipating a risk, two not anticipating a risk, two stating that they were unsure and two skipping the question.

6. Conclusions

Although 15 organisations had participated in the online FGS workshop in March 2024, only 8 organisations responded to the FGS fact-finding survey in August 2024.

After analysing this relatively small set of responses, the Study Mission did not find evidence that a complete value chain would be in place for the use of Film Grain Synthesis techniques in DVB environments.

No further work on FGS is recommended in DVB at this stage, but the ongoing work of other SDOs in this area should be kept under review.

7. History

Version	Date	[Milestone]
S103	June 2025	S103 BlueBook publication (internal document CM2362)