

***CM-AVC Requirements on Scalable Video Coding***

***CM-AVC0137***

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## **1. Introduction**

This document provides a summary of commercial requirements for the usage of the SVC video codec within DVB based applications. Requirements are specified as perceived from the service operators' perspective. A level of realism is applied by input from manufacturers and operators.

## **2. Background**

### **a. General context**

Scalable video coding refers to layered video bit streams:

- a base layer which serves as a root reference
- one or more enhancement layers providing enhanced video in either the spatial, temporal or quality spaces. Each enhancement layer can depend either from the base layer by itself or from other enhancement layers (dependency relationship is a key concept). Additionally, quality enhancements can be implemented across a set of one or more layers.

While Scalable Video Coding was already available with previous video coding standards such as MPEG2 which is currently supported in DVB guidelines, the recent finalization of the scalable extension of H.264/AVC is now offering an efficient scheme for scalable video coding while it was not the case with previous standards such as MPEG-2.

By the meantime, the ecosystem has considerably evolved since the last investigation of scalable video coding by DVB with:

- much more types of services distributing video content: over the air broadcast, IPTV, mobile TV as well as internet TV
- a large variety of different broadcast and access networks: DVB-T and DVB-T2 soon, DVB-S and DVB-S2, ADSL and FTTx, DVB-H\SH, 3G evolutions and the Long Term Evolution (LTE) soon, mobile Wimax, DOCSIS evolutions for cable, etc ...
- a large variety of different personal devices: the TV set which is under migration not only from CRT to flat display technologies but also from standard definition to high definition, the availability of new "TV screens" on the market place with portable media players, mobile phones, etc ...

While this landscape has historically been developed with segmented vertical approaches, there is today a strong trend for more complex and horizontal development approaches resulting in fewer frontiers between these segments resulting in a kind of convergence between services. Actually, an IPTV set top box now often includes a DTT receiver (and some include a DTH receiver) as well as it is able of downloading video-on-content from the internet.

Moreover, this landscape is continuously evolving at a fast-paced rhythm and the needs for scalability are becoming a key requirement for incrementally introducing new capabilities without affecting or compromising the existing deployed base. This is typically the case for the introduction of 1080p HDTV signals at 50 Hz or 60 Hz, which would need consideration of backward-compatibility with the deployed base of 1080i/720p HD capable devices.

Last but not least, there is also a strong trend for providing content portability among personal devices as a key service functionality, typically downloading a movie on a PC and display it later through the set top box or the portable media player (side loading). Another example is at recording a video content on the set top box for differed viewing on a portable media player. The operation for transferring, or streaming, the content between devices may have to be performed over the home network or the content may just need to be made portable by transferring it onto an USB storage key for latter viewing on a device unknown at the time it is stored on the USB key. For the end-consumer, content portability has to be as simple, timeless and costless as possible.

It is worth saying that the current landscape is today fundamentally multi-codec, resulting in jeopardized interoperability and content protection considerations, leading to strong limitations for developing the previously described service targets. But H.264/AVC is approaching its maturity age and its support by end-user devices is close to be considerably generalized on the market place, whatever the video content application is.

All these points are the motivation for considering the introduction of SVC into DVB guidelines.

### ***b. Main use cases***

These use cases have been provided by broadcasters and/or service operators in terms of interest for using the SVC codec. This list is not exhaustive.

- For broadcast and IPTV:
  - o at introducing 1080p50/60 HDTV while guaranteeing the backward compatibility with the 720p50/60 and 1080i25/30 devices already deployed in the homes;
  - o at minimizing the need for additional bandwidth resources for such an 1080p50/60 introduction;
- for IPTV
  - o at delivering at least two HDTV quality levels depending on the access network constraints (reach) and types (xDSL, FTTx) while minimizing the need for additional delivery infrastructure resources (bandwidth, storage, content management systems). These quality levels may imply different bit rates and encoding resolutions. These two quality levels might either be HDTV 720p50/60 and HDTV 1080p50/60 but also two quality levels of interlaced 1080i25/30 for consistency (production and stock of HDTV 1080i25/30 contents);
  - o at allowing the implementation of quality of service and experience mechanisms taking benefit from SVC while limiting the need for extra bandwidth and/or storage resources (e.g fast channel change based on bitstream burst techniques)
- for mobile TV:
  - o at providing graceful degradation means when facing difficult receiving conditions and avoiding service interruption: e.g a base layer associated to a more robust channel protection while the enhancement layer is associated to a less robust one while
  - o at providing different resolutions for addressing different device capabilities (display size, processing) and not "bottom levelling" the offered service

### ***3. Level of commercial interest***

At least 5 DVB member companies from at least the manufacturing and service operators constituencies shall state support for an SVC introduction prior to in depth analysis by the TM-AVC. The purpose of this requirement is to ensure that time is not wasted on good theoretical solutions that are unlikely to achieve market presence.

The list of supporting companies is available and maintained in document CM-AVC0136r3 "Companies supporting SVC in DVB".

### ***4. Requirements***

The SVC compression technology can be seen as "AVC with scalability functionalities". For this reason, introducing the SVC technology in the DVB guidelines is not as *simple* as it would be for

introducing a new codec. Actually, scalability brings other dimensions to be taken into account: number of layers, layer dependencies, implementation complexity issues, etc. These dimensions are obviously highly dependent from the applications. However, as it is briefly described in the introduction section, the content delivery applications today evolve at a fast paced innovation rhythm. Thus, the implementation of SVC in DVB guidelines might not be done in a single step process.

For these reasons, the commercial requirements have been split into three different categories:

- market demand and use case requirements: the needs for SVC
- general technical requirements: the implementation constraints for SVC
- specific TS 102 005 and TS 101 154 requirements

Moreover, each requirement is assigned a priority level for implementation.

### ***a. Priority levels***

In order to provide guidance to the TM-AVC including at considering priorities for the guidelines elaboration, each commercial requirement has been assigned a priority with the following policy:

- High (H): information has been provided for evaluating the market demand and the technical implications and feasibility for implementing this requirement are fully understood. A high priority level requirement is considered as stable. The targeted release of the technical guidelines shall answer the requirement.
- Medium (M): incomplete information has been provided for evaluating the market demand and/or the technical implications and feasibility for implementing this requirement may not be fully understood:
  - o Technical & feasibility implications are understood and the commercial requirement is consensually providing value even if it still lacks commercial demand: the TM-AVC considers the requirement for implementation in the targeted release but after having implemented all high priority requirements
  - o Technical & feasibility implications are not fully understood or the commercial requirement does not reach consensus on providing value. Additional work is required in order to stabilize the market demand or investigate the technical implications. The requirement will be implemented in a future release of the appropriate guidelines.

## ***b. Requirements***

| Req.ID | General requirements for services delivered using DVB guidelines   | Priority |
|--------|--|----------|
|        | <b>Market Demand, Use case requirements</b>  |          |
| 100    | At least 5 DVB member companies from at least the manufacturing and service operators constituencies shall state support for an SVC introduction prior to in depth analysis by the TM-AVC. The purpose of this requirement is to ensure that time is not wasted on good theoretical solutions that are unlikely to achieve market presence   | H        |
| 1000   | The use of SVC shall help with the introduction of new video formats while providing H.264/AVC backward-compatibility with legacy deployed formats.  | H        |
| 1010   | The use of SVC shall facilitate the option to provide efficient bandwidth management over simulcast of TV services. The expectation is to achieve at least 20% savings considering the difference between an SVC bitstream compared to the sum of the equivalent simulcasted H.264/AVC bitstreams for most use cases. However, for consistency reasons in terms of operational deployment, less saving can be considered as acceptable.  | H        |
| 1020   | The use of SVC shall provide tools for improving quality of service (e.g graceful degradation, etc).   | H        |
| 1030   | The use of SVC shall provide tools for proposing an enhanced user experience over an existing service (e.g. transmitting a region of interest focus).  | M        |
| 1040   | The use of SVC shall permit both broadcast TV and video on demand services without discrimination. Broadcast TV refers to real-time streaming. Video on demand refers to both streaming and download.  | H        |
| 1050   | As SVC allows a wide range of scalability combinations and in order to help the implementation of SVC with economical efficiency, the use of SVC shall be profiled on a per application needs basis (e.g services delivered over MPEG-2 TS, services directly delivered over IP, contribution and primary distribution services delivered over MPEG-2 TS). For each set of applications, DVB shall define appropriate SVC IRD capabilities and bitstreams characteristics (SVC profile and level, max number of layers with direct or indirect dependency, scalability combinations, etc). | H        |
| 1060   | The specification shall permit both SVC and H.264/AVC solutions for providing the same capabilities (e.g. HDTV 1080p50/60 delivery).   | H        |
| 1065   | Under some service/applications operating conditions, the specification shall be compatible with mechanisms for enabling/disabling the decoding of an SVC enhancement layer.   | H        |
| 1070   | The use of SVC shall be compatible with DVB content protection solutions (e.g. conditional access).  | H        |
| 1075   | The specification shall be compatible with mechanisms for encryption of layers, where layers can be encrypted or unencrypted, independently from each other. For instance, a base layer can be unencrypted but the enhancement layers can be encrypted, or vice versa  | H        |
| 1080   | The specification shall be compatible with currently available transport and signalling mechanisms.  | H        |
| 1090   | SVC shall be transported in a way that enables synchronization between layers as well as synchronization of other program elements (audio, subtitles, etc ...) in the same service.  | H        |
|        | <b>General technical requirements</b>  |          |
| 1100   | The specification shall provide support for layers with the same colorimetry and source aspect ratio in the same service.  | H        |

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|--|--|---|
| 1110   | Different colorimetry and/or source aspect ratio between layers in the same service imply considerations out of scope of the specification. The specification shall provide strong cautions on these subjects.   | H |
| 1120   | When it is necessary, the PSI/SI should provide information about the resolution of each layer that can be found in an SVC bitstream.  | H |
| 1125   | The specification shall provide support for allowing interlaced to interlaced and progressive to progressive scalability with respect to the currently supported DVB picture formats and accordingly to requirements 1100, 1110 and 1120.  | H |
| 1126   | In the case of interlaced to progressive scalability (e.g. 1080i25 HDTV to 1080p50 HDTV), the horizontal spatial resolution shall remain constant.   | H |
| 1130   | The minimum number of layers a receiver should decode should be defined for the use cases for the following application families: DVB broadcast services delivered over MPEG2-TS, DVB services delivered over IP.  | H |
| 1140   | The specification shall provide support for luminance resolutions of the base layer images currently permitted in DVB specifications.  | H |
| 1150   | The specification shall allow the channel change characteristics to be different between layers.   | H |
| <b>Specific requirements for services directly delivered over IP (TS 102 005 guidelines)</b> |  |   |
|  | <i>Inputs have been provided by some broadcasters/service operators and manufacturers for defining the TS 102 005 SVC commercial requirements. However, further work has still to be carried out for transforming these inputs into requirements. The current text for these requirements is provided in the "future evolution" section of this document.</i>  |   |
| <b>Specific requirements for services delivered over MPEG2-TS (TS 101 154 guidelines)</b>    |  |   |
| 1300   | An SVC IRD shall be able to decode a minimum of 2 layers with the first layer being an H.264/AVC layer and the second layer being a quality/spatial enhancement layer.   | H |
| 1302   | An SVC IRD shall be able to decode a minimum of 2 layers with the first layer being an H.264/AVC layer and the second layer being a quality/ spatial/temporal enhancement layer.   | M |
| 1310   | For higher SVC decoding capabilities and in order to allow further evolutions beyond the basic SVC requirement 1300, TS 101 154 shall implement a mechanism for classifying SVC bitstream and decoding complexity. A recommended mechanism for the decoder is to consider the following classes: <ul style="list-style-type: none"> <li>- A first class with a maximum number of 2 spatial layers for example 1080p over 720p</li> <li>- A second class with a maximum number of 4 quality layer representations</li> <li>- A third class mixing the capabilities of both the first and the second classes with a maximum total number of 4 layer representations including a maximum of 2 dependency representations</li> </ul> | H |
| 1320   | TS 101 154 shall define: <ul style="list-style-type: none"> <li>- accordingly to requirement 1060, an 50/60Hz H.264/AVC IRD capability and bitstream</li> <li>- 50Hz/60Hz SVC HDTV IRD capabilities and bitstreams for allowing SVC for delivery of 1080p 50/60Hz contents. The 50/60Hz SVC HDTV IRD shall provide the decoding functionalities of both a 50/60Hz and 25/30Hz H.264/AVC HDTV IRDs. The 50/60Hz SVC bitstream base layer shall be compliant with 25/30 Hz H.264/AVC HDTV bitstreams.</li> <li>- 25/30Hz SVC HDTV IRD capabilities and bitstreams. The 25/30Hz SVC HDTV IRD shall provide the functionalities of a</li> </ul>  | H |

|      |  |   |
|------|--|---|
|      | 25/30Hz H.264/AVC HDTV IRD. The 25/30Hz SVC bitstream base layer shall be compliant with a 25/30 Hz H.264/AVC HDTV bitstreams.   |   |
| 1340 | In the case of 50/60Hz SVC HDTV bitstreams, the following combinations shall be allowed: <ul style="list-style-type: none"> <li>- base layer with resolutions compatible with the ones supported by an 25/30Hz H.264/AVC HDTV IRD (refer to Table 12, TS 101 154)</li> <li>- enhancement layers compatible with the possible resolutions for an 25/30Hz H.264/AVC HDTV IRD plus the ones possible for an 50/60Hz H.264/AVC HDTV IRD.</li> </ul> <p>In the case of 25/30Hz SVC HDTV bitstreams, both base and enhancement layers resolutions shall be compliant with the ones permitted by an 25/30Hz H.264/AVC HDTV IRD (refer to Tables 9/11 and 12, TS 101 154).</p> | H |
| 1360 | An SVC IRD shall be able to decode an SVC bitstream in which the enhancement layer shows content beyond the borders of the H.264/AVC base layer providing a region of interest compared to the enhancement layer, as per requirement 1030. Support should be provided for allowing a region of interest that may change at the picture level.  | M |

### ***c. Future evolution of these requirements***

The following requirements are not yet completed and are included in this document for information only.

#### ***- TS 102 005: services delivered directly over IP***

The commercial requirements for introducing SVC in the TS 102 005 guidelines still require further analysis and inputs from service operators and manufacturers even if some DVB-H/SH use cases have already been provided. The demand for using SVC in another context than DVB-H/SH applications has not yet been deeply investigated. This work, at least for refining DVB-H/SH related requirements, is expected to be completed by the end of May 2009.

The priorities and text in the following table are indicative and intend to provide information about the current status of the TS 102 005 commercial requirements.

|      | <b>Specific requirements for services directly delivered over IP (TS 102 005 guidelines)</b>  |   |
|------|---|---|
| 1200 | In annex-B relative to TS 102 005 usage in DVB IP datacast applicable to DVB-H/SH applications, SVC shall be profiled for efficiently allowing the distribution of at least 2 quality layers. This may imply hierarchical modulation at the physical transmission level.  | H |
| 1210 | In annex-B relative to TS 102 005 usage in DVB IP datacast applicable to DVB-H/SH applications, SVC shall be profiled for efficiently providing different resolutions of a given set of TV channels (typically VGA on the top of QVGA). This may imply the use of hierarchical modulation at the physical transmission level. | H |
| 1215 | The specification shall provide support for temporal scalability.   | H |
| 1220 | The use of SVC shall be possible over both RTP and MP4 file format delivery.  | H |
| 1230 | The use of SVC is not applicable to the category "A" of IP-IRDs.  | H |
| 1240 | The use of SVC shall be possible for delivering video contents up to 50/60Hz 1080p HDTV.<br>As a new "F" IP-IRD capability is required for this purpose and as per  | M |

|      |   |   |
|------|---|---|
|      | requirement 1060, this capability shall allow the use of H.264/AVC @ level 4.2 and SVC.   |   |
| 1250 | An SVC IP-IRD of category "B" and "C", shall be able to decode a minimum of 2 layers with the first layer being an H.264/AVC layer and the second layer being a quality or a temporal enhancement layer.  | H |
| 1260 | An SVC IP-IRD of category "DB", "D", "E" or "F" shall be able to decode a minimum of 2 layers with the first layer being an H.264/AVC layer and the second layer being one from a quality, spatial or a temporal enhancement layer.   | H |
| 1270 | For higher SVC decoding capabilities of SVC IP-IRDs of categories "E" and "F" and in order to allow further evolutions beyond the basic SVC requirements 1220 and 1225, TS 102 005 shall implement a mechanism for classifying SVC bitstream and decoding complexity.   | M |
| 1280 | In the case of temporal scalability, the frame rate at any layer in an SVC bitstream shall remain compliant with the ones defined in TS 102 005.  | M |
| 1290 | An SVC IRD shall be able to decode an SVC Bitstream in which the H.264/AVC base layer aspect ratio is 4:3 and the SVC enhancement layer aspect ratio is 16:9, as per requirement 1030.  |   |
| 1295 | An SVC IRD shall be able to decode an SVC Bitstream in which the enhancement layer shows content beyond the borders of the H.264/AVC base layer providing a region of interest compared to the enhancement layer, as per requirement 1030. Support should be provided for allowing a region of interest that may change at the picture level. | M |

#### - TS 101 154

One broadcaster raised the need for 8 bits to 10 bits scalability. This feature is not yet permitted by SVC and a future evolution would be required to support this. Moreover, the CM-AVC believes that it is highly related to the introduction of 10 bits for both contribution and distribution applications and thus requires a wider analysis that is not specific to SVC.

There has also been a request for temporal scalability as a suitable feature typically for providing HDTV 1080p50/60 on the top of HDTV 1080p25/30. At the moment, no demand is evident from actual broadcasters/service operators for such scalability.

|      | <b>Specific requirements for services delivered over MPEG2-TS (TS 101 154 guidelines)</b>   |   |
|------|---|---|
| 1305 | In the case of temporal scalability, the frame rate at any layer in an SVC bitstream shall remain compliant with the ones defined in TS 101 154: 50Hz on the top of 25Hz, 60Hz on the of 30Hz, 59.94 Hz on the top of 29.97 Hz. | M |
| 1370 | 8 to 10 bits scalability shall be proposed for distributing 10 bits HDTV contents while remaining compliant with currently 8 bits deployed devices.   | M |

#### - PVR applications

The PVR assistance which has recently been made available within the TS 101 154 guidelines will need to be revisited, not only for taking into account SVC by itself but also for investigating any hypothetical & additional mechanism that would take benefit from SVC.

Nevertheless, as SVC bitstreams include an H.264/AVC compliant bit-stream at the base layer, it is considered that a temporary solution is using the PVR assistance for the base layer.