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TITLE : Compatibility methods for video coding systems

Purpose: Proposal

Abstract

The CCITT SG XV Experts Group for ATM video coding agreed on a guideline that compatibility between the new coding system and existing systems should be highly respected.

In this contribution you will find proposed definitions for upward compatible, downward compatible, forward compatible, backward compatible.

Compatibility methods are discussed and definitions are proposed for simulcasting, embedded bit stream method, syntactic extension, switchable encoder, standard families.

The proposed definitions and methods may be a guideline for discussion on the achievable compatibility between the future and existing standards or between systems for different picture formats.

1. Introduction

In the joint study group 1 of COST 211 ter and VADIS a video coding algorithm for CCIR-601 signals is developed, which will be compatible with the existing ISO-MPEG1 and CCITT H.261 standards. In this group the meanings of forward and backward compatibility were discussed and clarified, and several methods of compatibility were identified.

In study-period 1990-94, the joint CCIR and CCITT task group CMTT/2 studies systems for secondary distribution of digital TV and HDTV signals. In its report 1239, "Standards for digital secondary distribution systems", upward and downward compatibility were defined and mentioned as desirable for TV and HDTV distribution services.

This CCITT SG XV Expert group for ATM video coding contribution reflects the definitions and methods for compatibility as discussed in these groups and are now proposed to be adopted by the members of ETSI NA5 "Video Coding Matters" (VCM). Compatibility may be obtained according several methods and it is useful to discern between these methods.

First, definitions of upward, downward, forward and backward compatibility are given, then several methods of compatibility are presented. Compatibility methods are specified for the encoders, given a set of decoders.

A. Upward and downward compatibility

Compatibility here refers to a transmission system, where **different picture formats** are used for the video encoder and video decoder. Different picture formats do not imply different standards. The system is:

- **upward compatible** if a higher resolution receiver is able to decode pictures from the signal transmitted by a lower resolution encoder.

- **downward compatible** if a lower resolution receiver is able to decode pictures from the signal or part of the signal transmitted by a higher resolution encoder. Two ways of downward compatibility can be discerned:

  - o The decoder reconstructs the entire picture at lower resolution
  - o The decoder reconstructs a window of the input picture

  When no further notice is made, it is assumed the decoder reconstructs the entire picture at lower spatial resolution. The frame rate is not necessarily equal.

B. Forward and backward compatibility

Here, compatibility refers to a transmission system where different standards are used for video encoder and video decoder, i.e. an existing standard and a new standard. The picture formats of these standards can, but need not differ. The system is:

- **forward compatible** if the new standard decoder is able to decode pictures from the signal or part of the signal of an existing standard encoder.

- **backward compatible** if an existing standard decoder is able to decode pictures from the signal or part of the signal of a new standard encoder.

It is assumed the entire input picture is reconstructed by the decoder, possibly at different spatial or temporal resolutions.

2. Compatibility by simulcasting

In this case the encoder system is characterized as follows. Typically, two encoders operate in parallel, one according an existing standard and picture format, the other according a new standard and/or picture format.

a - It transmits N (with N > 1) multiplexed streams of data, which may be separated at the decoder.
b - Data streams 1..K-1 (with K <= N) are decodable by an existing standard decoder after demultiplexing.
c - In a new standard decoder pictures are decoded from a set of one or more data streams K..N without making reference to data streams 1..K-1.

Backward compatibility is achieved by feature b, whereas forward compatibility is not guaranteed. A new standard decoder will discard the existing standard data streams 1..K-1. Decoding of the existing standard may or may not be included as a special option.

Considering upward and downward compatibility, downward compatibility is achieved by feature b, while upward compatibility is not guaranteed, as the information for the two picture formats is transferred and processed independently.

In principle, this compatibility method under certain circumstances could be wasteful of bandwidth as the same picture information is transferred several times in different multiplexed data streams.

3. Compatibility by the embedded bit stream method

In this case the encoder is characterized as follows:

a - It transmits N (with N > 1) multiplexed streams of data, which may be separated at the decoder.
b - Data streams 1..K-1 (with K <= N) are decodable by an existing standard decoder (backward) or a decoder with smaller picture format (downward) after demultiplexing.
c - From data streams 1..K-1 pictures may be decoded without reference to the other data streams, but decoding pictures from a data stream M (with K <= M <= N) is not possible without making reference to one or more of the data streams 1..K-1. Data streams K..N carry information additional to data streams 1..K-1.

Backward or downward compatibility are achieved by feature b. Forward compatibility is achieved as the new standard decoder can decode pictures of existing standard quality from data streams 1..K-1 only.

This also implies that upward compatibility is achieved, as data streams 1..K-1 carry lower resolution pictures, while data streams K..N carry the additional information for full resolution pictures.

In principle there is no waste of bandwidth since the N multiplexed data streams carry complementary information only. In practice however, the constraint of an existing standard or for the data streams 1..K limits the achievable coding efficiency when comparing with an equivalent stand-alone system.

4. Compatibility by a syntactic extension

In this case only one data stream is transmitted.

The data stream produced by the new standard encoder has a syntax which is an extension of the existing standard. This allows for forward compatibility, as the new standard decoder is equipped for the syntax of the existing standard and may decode the existing standard when little adaptations in the decoding process are made.

A similar description is possible for upward compatibility: the data stream for the full resolution pictures is an extension of the data stream for the lower resolution pictures, such that the full resolution decoder can decode the signal of the lower resolution encoder.

Backward or downward compatibility is not achieved by this method, as the signal for the existing standard or lower resolution decoder as such is not embedded or simulcasted in the data stream. A transcoder with more than a demultiplexer and multiplexer would be needed to obtain the existing standard or lower resolution signal.

5. Compatibility by a switchable encoder

This method of compatibility is mainly intended for services where the type of receiver(s) can be identified by the transmitter, e.g. for point to point conversational services.

The encoder is characterized as follows:

a - It transmits one stream of data only.
b - To achieve forward and backward compatibility, the encoder is capable to operate in new standard or existing standard mode. For upward and downward compatibility, the encoder must be capable to produce the signal for full resolution or for lower resolution decoders.
c - Encoder and decoder(s) negotiate to determine which standard and/or picture format will be used for the connection.

6. Standard families

This is not a compatibility method, but allows for joint developments for several standards. A new standard having many commonalities with an existing standard, or a family of standards for several picture formats, may reduce efforts for development and optionally facilitate development of dual-standard equipment. This may be beneficial for introduction of a new service.

Conclusion

In CMTT/2 report 1239 is reported that upward and downward compatibility for TV and HDTV secondary distribution is desirable, as well as forward and backward compatibility if several standards will coexist.

The CCITT SG XV Experts Group for ATM video coding agreed on a guideline that compatibility between the new coding system and existing systems should be highly respected.

The proposed definitions and methods may be a guideline for discussion on the achievable compatibility between the future and existing standards or between systems for different picture formats.

Proposal: Definition of terms.
The following terms are adopted according to the definition given

- upward compatible
- downward compatible
- forward compatible
- backward compatible
- simulcasting
- embedded bit stream method
- syntactic extension
- switchable encoder
- standard families