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SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Transport of Large Screen Digital Imagery

Real-time transmission system for signals of an expanded hierarchy of large screen digital imagery using spatial image segmentation for parallel processing

Recommendation ITU-T J.603

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Summary

Recommendation ITU-T J.603 specifies the function components required to configure a real-time expanded hierarchy of large screen digital imagery (exLSDI) transmission system using spatial image segmentation for parallel processing. The transmission system is designed to maintain conformance with the network service operator's requirements specified in Recommendation ITU-T J.602. The system comprises of multiple video codec function units of any coding standards. The transmission system also enables flexible adaptation to arbitrary image resolution.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T J.603	2011-04-29	9

FOREWORD

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

The general guideline for transmitting large screen digital imagery (LSDI) programmes has been specified in [ITU-T J.601], and the network service operator's requirements for real-time transmission of expanded hierarchy of large screen digital imagery (exLSDI) signals under parallel processing functionality have been specified in [ITU-T J.602].

This Recommendation specifies the function components of a real-time transmission system for exLSDI signals compliant with [ITU-T J.601] and [ITU-T J.602] using spatial image segmentation for parallel processing. This system comprises of multiple video codec function units of any coding standards. The system also enables flexible adaptation to any image resolution available as an expanded hierarchy of LSDI.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T H.222.0] Recommendation ITU-T H.222.0 (2006) | ISO/IEC 13818-1:2007, *Information technology – Generic coding of moving pictures and associated audio information: Systems.*

[ITU-T J.601] Recommendation ITU-T J.601 (2005), *Transport of Large Screen Digital Imagery (LSDI) applications for its expanded hierarchy*.

[ITU-T J.602] Recommendation ITU-T J.602 (2008), *Network service operator's requirements for real-time transmission of exLSDI signals under parallel processing functionality*.

[ITU-R BT.1769] Recommendation ITU-R BT.1769 (2006), *Parameter values for an expanded hierarchy of LSDI image formats for production and international programme exchange.*

3 Definitions

This Recommendation defines no additional terms.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CPU Central Processing Unit

DCT Discrete Cosine Transform

DSP Digital Signal Processor

exLSDI expanded hierarchy of Large Screen Digital Imagery

FPGA Field Programmable Gate Array
LSDI Large Screen Digital Imagery
MC Motion Compensation
ME Motion Estimation
PES Packetized Elementary Stream
VLC Variable Length Coding

5 Conventions

None.

6 Function components of real-time transmission system

6.1 Formulation of function components

The basic function components are summarized in Figure 1. The formulation of every function component included in the figure is described in the following.

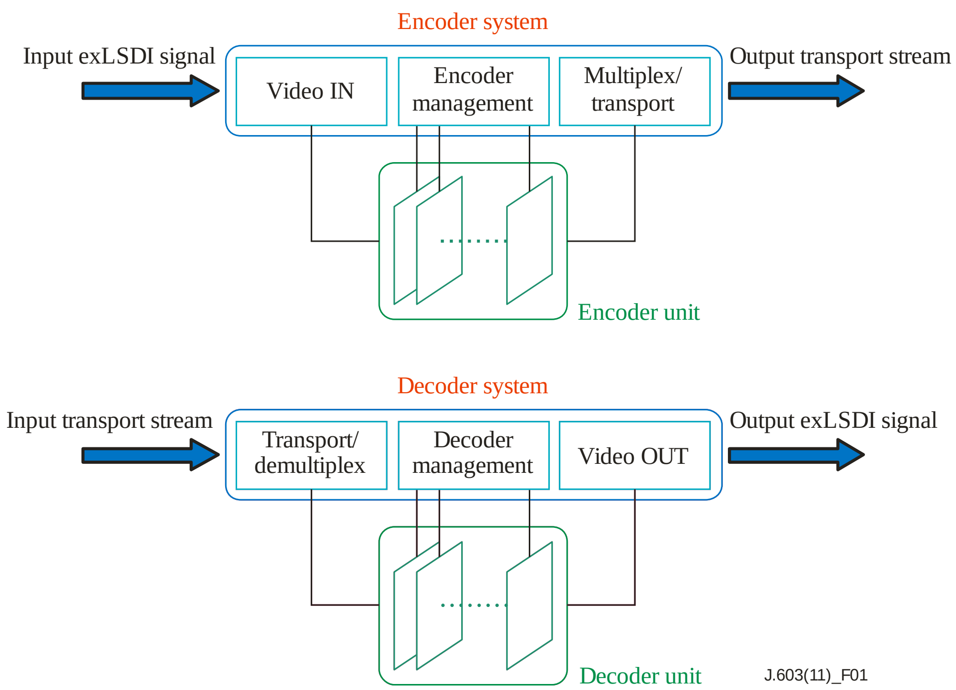

Figure 1 – Function components of exLSDI real-time transmission system

6.1.1 Encoder system

The encoder system manages all encoder units to accomplish real-time encoding at full-resolution level. The encoder unit performs the video encoder process for a partitioned video frame. In the encoder system, the encoder unit is connected to three processing modules: the video input, encoder management, and multiplex and transport. Specific functions required for every module are described below.

6.1.1.1 Video input

The video input module firstly receives a full-resolution video frame from the external device and then divides it into smaller image units, which are simply called partitioned video frames in this Recommendation. Every partitioned video has the same frame rate. In case that an overlapped image area is placed among partitioned video frames constituting an exLSDI full resolution frame, information to identify the overlapped area shall be transmitted. These partitioned video frames are accessible from the corresponding encoder unit. This procedure is conducted frame-by-frame successively.

(Input) Full-resolution video frame.

(Output) Partitioned video frames.

6.1.1.2 Encoder management

This module manages all encoder units. The encoder control functions that should be conducted at a full-resolution level are centralized on this module. For every encoder unit[1], the partitioned video frames are distributed. For this module, actual input and output signals are dependent on an employed encoder unit. As in the example, the input and output are described below:

(Input) Statistical information of the encoding result.

Monitoring information of the processing performance.

(Output) Rate control information.

Prediction control information to enable the motion-compensated prediction across the partition boundary. This information is useful to enable the single video elementary stream at exLSDI resolution.

6.1.1.3 Multiplex and transport

As a result of the encoding process, a partial bitstream can be extracted from every encoder unit. For those extracted bitstreams, the multiplex and transport module generates a full-resolution bitstream after an appropriate multiplexing process.

(Input) Partial bitstream from every encoder unit.

(Output) Single bitstream compliant with ITU-T H.222.0 transport stream which is generated by multiplexing partial bitstreams.

Transport mechanism: For a multiplexed bitstream, a transport mechanism based on [ITU-T J.601] is applied.

Media synchronization: In the case of input material with synchronized audio signals, media synchronization is established by the packetized elementary stream (PES) synchronization mechanism specified in [ITU-T H.222.0].

Spatial dependency identification: For the bitstream corresponding to a specific partitioned video frame, the spatial dependency is identified along the descriptor mechanism specified in [ITU-T H.222.0]. The overall resolution of the exLSDI signal is described by the target_background_grid_descriptor. For every partial bitstream, the spatial dependency within the exLSDI image area is described by the video_window_descriptor.

6.1.2 Decoder system

The decoder system manages all decoder units to accomplish real-time decoding at full-resolution level. The decoder unit performs the video decoder process for a partitioned video frame. In the decoder system, the decoder unit is connected to three processing modules: the video output, decoder management, and transport and demultiplex. The specific functions required for every module are described below.

[1] An implementation example can be found in Appendix II.

6.1.2.1 Video output

The video output module receives partitioned video frames from the corresponding decoder unit, and output a full-resolution video frame via the external interface. This procedure is conducted frame-by-frame successively.

(Input) Partitioned video frames.

(Output) Full-resolution video frame.

6.1.2.2 Decoder management

This module manages all decoder units. The decoder control functions that should be conducted at a full-resolution level are centralized in this module. From every decoder unit, the partitioned video frames are extracted and fed into the video output module. For this module, the actual input and output signals are dependent on an employed decoder unit. As in the example, the input and output are described below:

(Input) Monitoring information of processing performance.

(Output) Prediction control information to enable the motion-compensated prediction across the partition boundary. This information is useful to enable the single video elementary stream at exLSDI resolution.

6.1.2.3 Transport and demultiplex

The transport and demultiplex module receives a single bitstream from the content delivery network. A partial bitstream is extracted from the full resolution bitstream and fed into every decoder unit. For the bitstream corresponding to a specific partitioned video frame, the appropriate decoder unit is identified under the mechanism of spatial dependency identification, as described in clause 6.1.1.3.

(Input) Single bitstream compliant with ITU-T H.222.0 transport stream which is generated by multiplexing partial bitstreams.

(Output) Partial bitstream for every decoder unit.

Transport mechanism: For a multiplexed bitstream, a transport mechanism based on [ITU-T J.601] is applied.

Media synchronization: In the case of input material with synchronized audio signals, media synchronization is established by the PES synchronization mechanism specified in [ITU-T H.222.0].

Appendix I

Conformance to requirements specified in [ITU-T J.602]

(This appendix does not form an integral part of this Recommendation.)

This appendix describes the conformance of the recommended system to [ITU-T J.602].

I.1 Multi-format support

The recommended system can be configured flexibly by selecting the number of the constituting processors to handle various image resolutions, e.g., from HDTV to exLSDI.

I.2 Notification of spatial dependency

In the recommended system, the transmission process is capable of notifying a spatial dependency in a full resolution picture, if parallel processing is adopted for spatially partitioned images.

I.3 Notification of resolution-layer dependency

In the recommended system, the transmission process is capable of notifying a resolution-layer dependency in the overall bitstream by utilizing the standard transport stream descriptor under the resolution scalability coding functionality.

I.4 Single bitstream support

The recommended system comprising multiple codec units generates and accepts the single transport stream.

I.5 Bitstream conformance (multi-codec support)

The recommended system itself does not restrict the coding scheme. Since a codec unit process is implemented on a corresponding programmable module, shifting to another new coding scheme can be realized just by reloading the proper software module.

Appendix II

Example of encoder system under parallel processing functionality

(This appendix does not form an integral part of this Recommendation.)

This appendix describes an example of the encoder system under the parallel processing functionality.

II.1 Parallel processing

Distributed implementation by utilizing several programmable processors such as digital signal processor (DSP), field programmable gate array (FPGA), and central processing unit (CPU) has become more common as a development approach for high-performance hardware systems, because of the successive improvement in processor performance and the availability of high-speed data connection among processors in recent years. Furthermore, distributed implementation with precise timing control is applicable even for real-time applications, as adopted in practical equipment. In general, parallel processing schemes can be categorized into two major types: one is data partitioning, and the other is job partitioning. As for the video encoder process, data partitioning corresponds to dividing input images into smaller image units. Job partitioning assigns a process by the unit of functional blocks such as discrete cosine transform (DCT), motion-compensated prediction, and variable length coding (VLC) coding. In the proposed architecture, data partitioning and job partitioning are jointly used. The total video encoder process is first divided into a front-end part and a coding part, and the coding part is further distributed based on data partitioning.

II.2 Detailed function of encoder unit

The encoder unit encodes a partitioned video frame. As the representative example of an encoder unit, a block diagram of the encoder unit along the MC+DCT coding framework, just as in the case of MPEG coding standards, is shown in Figure II.1. To clarify the relation to other function modules, the figure assumes a single encoder unit, though a parallel distribution of multiple encoder units might be required to accomplish real-time processing at a resolution of exLSDI level.

(Input) Partitioned video frame.

Prediction reference.

Rate control information.

Prediction control information to enable the motion-compensated prediction across the partition boundary.

(Output) Partial bitstream corresponding to the partitioned video frame.

Prediction reference.

Statistical information of the encoding result.

Monitoring information of the processing performance.

Shared memory for prediction reference: This mechanism is required to enable the single video elementary stream at exLSDI resolution. Prediction reference can be referred from the other encoder units that handle the adjacent partitioned video frame in order to maintain high performance in the motion-compensated prediction.

Centralized bit assignment: The encoder management module conducts bit assignment for every partitioned video frame prior to initializing the encoder process for the current video frame in order to suppress the picture quality difference among neighbouring partitioned video frames. Another advantage of applying this mechanism is the expected statistical multiplexing gain.

Adaptive spatial segmentation: The size of partitioned video frames fed into a specific encoder unit should be selected dependent on the processing performance of the single programmable module, so that the total processing time including the video input process, encoding process, and bitstream output process can be stably maintained at less than a video frame interval.

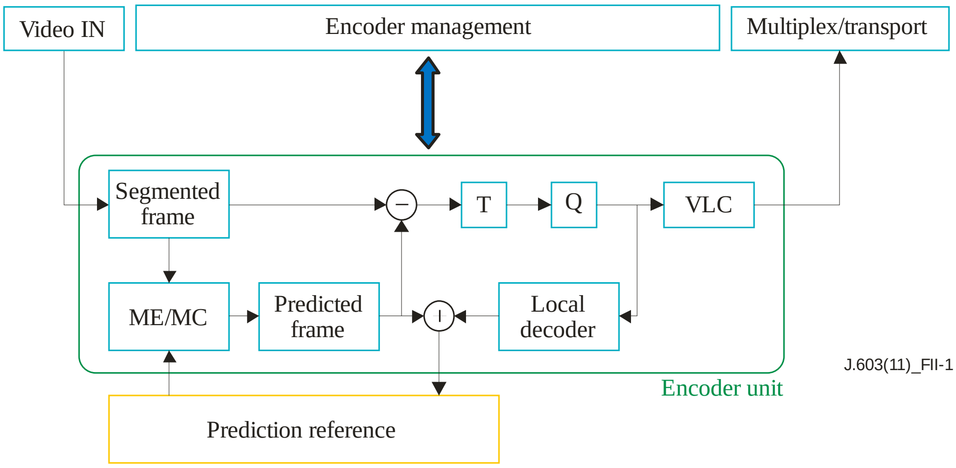

Figure II.1 – Representative block diagram of the encoder unit

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