International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.242
(12/2006)

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

Measurement of the quality of service

A method to reconstruct the received video sequence seen at the receiver using transmission error information to monitor the perceptual video quality at the receiver in digital cable television and video telephony

ITU-T Recommendation J.242

ITU-T

ITU-T Recommendation J.242

A method to reconstruct the received video sequence seen at the receiver using transmission error information to monitor the perceptual video quality at the receiver in digital cable television and video telephony

Summary

ITU-T Recommendation J.242 specifies a method for a transmitting side to reconstruct the received video sequence seen at a receiver using transmission error information. The method can be used with an objective model for video quality measurement to monitor the quality of the received sequence. It is suggested that a standardized method should be used. The method in this Recommendation is applicable in order to:

- monitor the video quality of the received sequence seen at the receiver, with a minimum consumption of additional bandwidth;
- assess the real-time video quality of the received video sequence by the transmitting side.

Source

ITU-T Recommendation J.242 was approved on 14 December 2006 by ITU-T Study Group 9 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had 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/.

© ITU 2007

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

CONTENTS

Introduction

Objective video quality measurement methods may be classified into three categories: full-reference (FR) models, reduced-reference (RR) models, and no-reference (NR) models. Generally, the accuracy of no-reference models is inferior to that of the FR and RR models. However, both FR and RR models require transmission of additional data for video quality assessment. Since bandwidth is a valuable resource in multimedia applications, it is desirable to avoid the transmission of additional data.

In a typical multimedia application, video data is transmitted using packets. During transmission, various errors might occur, which include packet loss and delay. These errors can produce frame freezing, frame skipping, block errors, jittering, delay, etc. In packetized video transmission, all these transmission errors and their effects can be accurately identified. Furthermore, in digital communications, if there are no transmission errors, the video quality of the received sequence will be identical to that of the transmitted sequence.

ITU-T Recommendation J.242

A method to reconstruct the received video sequence seen at the receiver using transmission error information to monitor the perceptual video quality at the receiver in digital cable television and video telephony

1 Scope

This Recommendation specifies a method for a transmitting side to reconstruct the received video sequence in order to monitor video quality at the receiver using transmission error information for packetized video transmission. This Recommendation applies to video services where two-way digital communications are available. The method in this Recommendation requires that each packet can be traced and identified. Some packet transport protocols such as RTP (real-time transport protocol) and ATM (asynchronous transfer mode)/AAL (ATM adaptation layer) have this feature. In order to evaluate video quality at the receiver, the method needs to be used with objective models for video quality measurement such as those contained in [ITU-T J.144]. It is suggested that a standardized method should be used.

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 J.144] ITU-T Recommendation J.144 (2004), *Objective perceptual video quality measurement techniques for digital cable television in the presence of a full reference*.

[ITU-R BT.1683] ITU-R Recommendation BT.1683 (2004), *Objective perceptual video quality measurement techniques for standard definition digital broadcast television in the presence of a full reference*.

3 The Method

Figure 1 illustrates the procedure. The transmitting side includes a transmitter, a received video estimation unit and a video quality estimation unit, and may also include an encoder. According to this method, the quality of the received video sequence seen at the receiver can be evaluated at the transmitting side. Therefore, the source video sequence, or features extracted from the source video sequence, must be available to the transmitting side.

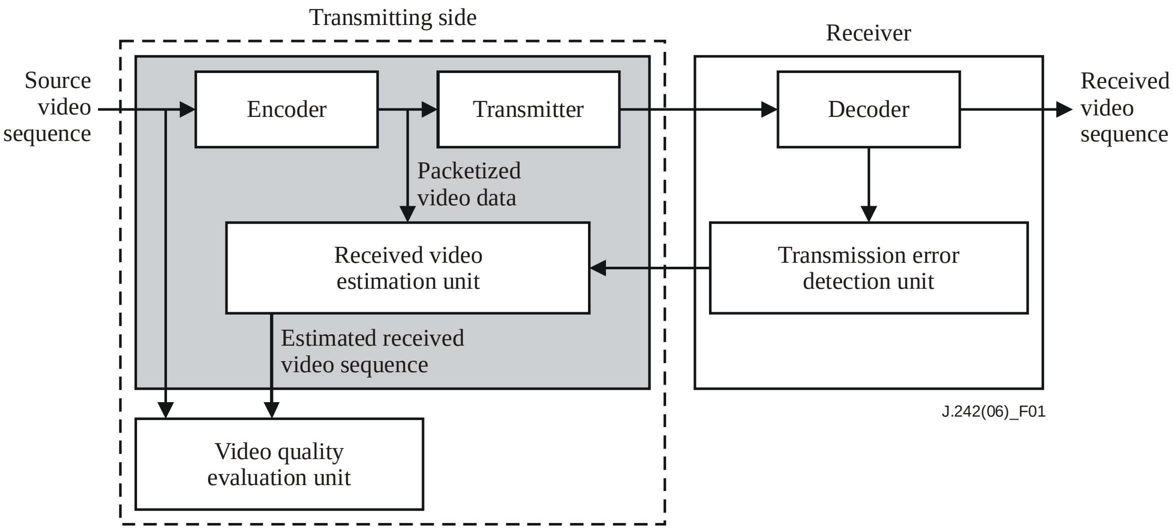

Figure 1 – A method for a transmitting side to monitor video quality at a receiver using transmission error information

The transmitting side transmits packetized video data to the receiver. It is noted that packetization is applied to compressed video data. The receiver has a transmission error detection unit which detects the occurrence of transmission errors. If transmission errors occur, the transmission error detection unit sends the transmission error information, which includes packet loss and delay, along with their effects such as frame freezing, frame skipping, block errors, jitter, etc. to the transmitting side (Table 1 shows typical transmission error information). Then, the received video estimation unit in the transmitting side emulates the receiver and estimates the received video sequence seen at the receiver using the transmission error information and the packetized video data produced by the encoder. Finally, a video quality evaluation unit computes the video quality scores at the receiver using the source video sequence and the estimated received video sequence. Figure 2 shows an example of the method when a FR model is used. The estimated received video sequence in Figure 3 is produced by the received video estimation unit (Figure 2). When the source video sequences are not available at the transmitting side, it is also possible for the transmitting side to use an RR model, provided that feature parameters are available.

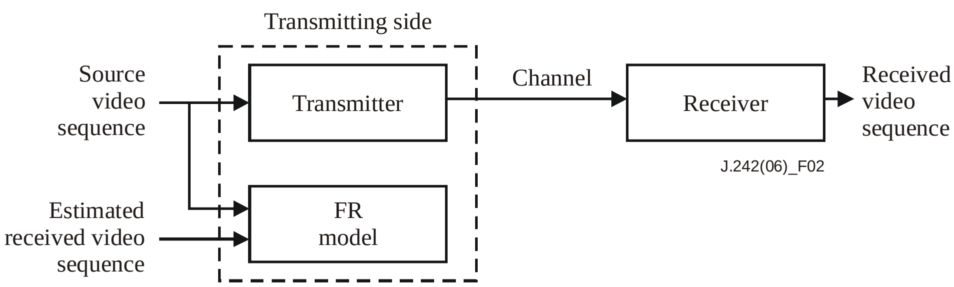

Figure 2 – A block diagram for the transmitting side computing the video quality of the received video sequence using the estimated received video sequence (FR model)

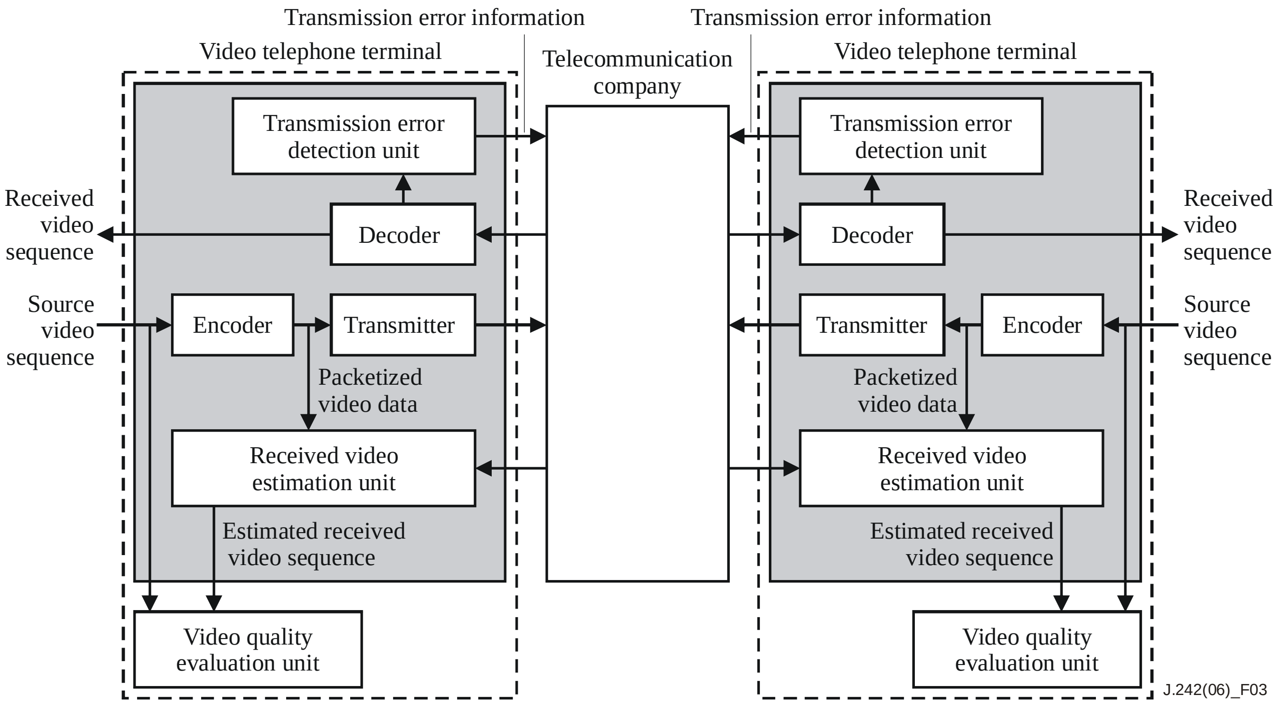

Figure 3 – A method for a transmitting side to monitor video quality at a receiver using transmission error information (video telephony)

A video telephone terminal both transmits and receives video signals. Provided that packetized video transmission or similar transmission methods are used, the method can be used in video telephones. Figure 3 illustrates how the method can be used for video telephony.

In packetized video transmission, the effects of transmission errors can be described as follows:

- Video degradation, such as block errors due to packet loss.
- Skipped (lost) frames due to packet loss, delay, overflow and underflow.
- Delayed frames due to packet delay and underflow.

Therefore, if the receiver sends information on lost or impaired packets, skipped frames and delayed frames to the transmitting side, the transmitting side can reconstruct the received video sequences seen at the receiver.

On the other hand, in video telephony (Figure 3), the telecommunication company may want to monitor video quality at the receiver. In this scenario, the telecommunication company may use an NR objective video quality measurement method which uses bit stream data. In this case, the performance of such an NR method can be improved if the receiver sends additional information on transmission errors, which includes information on BER (bit error rate), delayed packets, etc. Similarly, some service providers (transmitting side) are provided with compressed video data and may not have any information on source video sequences. In this case, an NR method which uses bit stream data may be used and the receiver may send the additional information on transmission errors.

3.1 Applications

The method can be used for packetized video transmission when two-way digital communications are available. The method further requires that each packet can be traced and identified. Some packet transport protocols such as RTP (real-time transport protocol) and ATM (asynchronous transfer mode)/AAL (ATM adaptation layer) have this feature. For example, the method can be used for VoD, IPTV, video telephony and videoconferencing.

4 Messages for sending transmission error information

In this method, the transmitting side and the receiver are cooperative since the receiver provides all the necessary information to the transmitting side. It is also noted that all information on the decoder and post-processing techniques used in the receiver must be provided so that the transmitting side can exactly estimate the video sequence at the receiver.

In order for the transmitting side to estimate the received video sequences, the required transmission error information is summarized in Table 1. For each transmission error, an error-type specific message is transmitted. Such messages consist of two or three fields: type and binary numbers. A number of messages can be combined and then transmitted.

Table 1 – Transmission error information

Type of transmission error	Contents of transmission information
Lost or impaired packets	Corresponding packet indexes
Delayed frames	Length of the delay and delayed frame indexes
Skipped or lost frames	Skipped or lost frame indexes

4.1 Messages for decoder information (receiver model information)

In order to exactly estimate the received video sequence, the transmitting side needs information on the decoder and post-processing techniques used at the receiver. For this purpose, at the beginning of transmission, the receiver needs to transmit a model identification message. It is assumed that the transmitting side has access to a database and can obtain all the necessary information on the decoder and post-processing techniques of the receiver from the model identification message.

4.2 Source identifier

In broadcasting and multicasting environments, when the transmitting side receives transmission error messages, it needs to identify the corresponding source video sequence. For this purpose, the receiver needs to transmit a source identification message. The source information is available in packets.

4.3 Messages for lost packets

For a lost packet, a lost packet index needs to be transmitted.

When burst errors occur, a number of subsequent packets can be lost. In this case, a starting packet index and an ending packet index of the lost packets need to be transmitted.

4.4 Messages for delayed frames

For a delayed frame, a delayed frame index and the length of the delay need to be transmitted.

4.5 Messages for skipped frames

For a skipped (lost) frame, a skipped frame index needs to be transmitted.

When burst errors occur, a number of subsequent frames may be lost. In this case, a starting frame index and an ending frame index of the skipped frames need to be transmitted.

4.6 Hand shaking and error handling

Due to transmission errors, these error messages can also be lost or corrupted. On the other hand, most two-way communication systems employ some error detection and handling mechanisms which can be used to ensure the delivery of the messages. The error messages can be transmitted in real time or may be transmitted in batch-mode.

Table 2 summarizes the error message descriptions. Figure 4 illustrates the received video estimation unit. Examples of error message formats are provided in Appendix I.

Table 2 – Message description

Type of transmission error	Error message description
Receiver	A model identification message
Source identifier	A source identification message
Lost packet	A lost packet index
Lost packets	A starting packet index and an ending packet index of the lost packets
Delayed frame	A delayed frame index and the length of the delay
Skipped frame	A skipped frame index
Skipped frames	A starting frame index and an ending frame index of the skipped frames

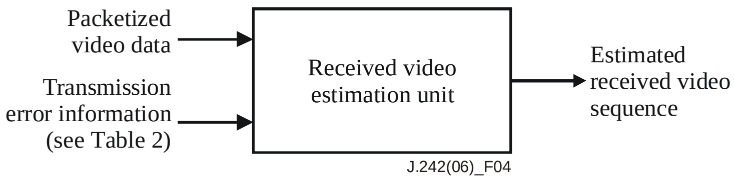

Figure 4 – Inputs and output of the received video estimation unit

4.7 Messages for additional information for transmission errors

When an NR method which uses bit stream data is to be used, the performance of the NR method may be improved if the receiver sends additional information on transmission errors, including information on BER (bit error rate), delayed packets, etc. Thus, when an objective model (e.g., an NR method) requires additional information, the receiver may send additional messages containing the required information (e.g., BER, delayed packets, etc).

Appendix I

Example of error message formats

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

This appendix describes an example of a message format capable of sending transmission error information.

I.1 Messages for decoder information (receiver model information)

A model identification message can be transmitted using a 32-byte message. The first byte is the ASCII code for character 'm' (6D in hexadecimal) representing a model identification. The following 31 bytes are a character string "padded to the right with null characters and" terminated by a null character. For example, if a model number of the terminal is "ABC-1234", the following message is transmitted:

6D 41 42 43 2D 31 32 33 34 ("mABC-1234") followed by 23 null characters.

I.2 Source identifier

A source identification message can be transmitted using five bytes of binary data at the beginning of transmission. The first byte is the ASCII code for character 'i' (69 in hexadecimal) representing a source identifier. The other four bytes are used for source identification:

69 XX XX XX XX (hexadecimal).

I.3 Messages for lost packets

A lost packet index can be transmitted using five bytes of binary data. The first byte is the ASCII code for character 'l' (6C in hexadecimal) representing a lost packet. The other four bytes are a long integer (four bytes) representing the lost packet index. For instance, if the 100th packet is lost, the following message is transmitted:

6C 64 00 00 00 (hexadecimal)

where the first byte is the least significant byte in the four-byte long integer (unsigned).

When burst errors occur, a number of subsequent packets can be lost. In this case, a starting packet index and an ending packet index can be transmitted using nine bytes of binary data. The first byte is the ASCII code for character 'L' (4C in hexadecimal). The next four bytes are a long integer (four bytes) representing the starting index of the lost packets. The last four bytes are a long integer representing the ending index of the lost packets. For instance, if the 60th-90th packets are lost, the following message is transmitted:

4C 3C 00 00 00 5A 00 00 00 (hexadecimal)

where the first byte is the least significant byte in the four-byte long integer (unsigned).

I.4 Messages for delayed frames

A delayed frame index and the length of the delay can be transmitted using seven bytes of binary data. The first byte is the ASCII code for character 'd' (64 in hexadecimal) representing a delayed frame. The next four bytes are a long integer (four bytes) representing the delayed frame index. The last two bytes are a short integer (two bytes) representing the length of the delay in milliseconds. For instance, if the 60th frame is delayed by 300 ms, the following message is transmitted:

64 3C 00 00 00 2C 01 (hexadecimal)

where the first bytes in the unsigned long integer and unsigned short integer represent the least significant bytes.

I.5 Messages for skipped frames

A skipped frame index can be transmitted using five bytes of binary data. The first byte is the ASCII code for character 's' (73 in hexadecimal) representing a skipped frame. The other four bytes are a long integer (four bytes) representing the skipped frame index. For instance, if the 60th frame is lost, the following message is transmitted:

73 3C 00 00 00 (hexadecimal)

where the first byte is the least significant byte in the four-byte long integer (unsigned).

When burst errors occur, a number of subsequent frames may be skipped. In this case, a starting frame index and an ending frame index of the skipped frames can be transmitted using nine bytes of binary data. The first byte is the ASCII code for character 'S' (53 in hexadecimal). The next four bytes are a long integer (four bytes) representing the starting index of the skipped frames. The last four bytes are a long integer representing the ending index of the skipped frames. For instance, if the 60th-90th frames are skipped, the following message is transmitted:

53 3C 00 00 00 5A 00 00 00 (hexadecimal)

where the first bytes in the unsigned long integer and unsigned short integer represent the least significant bytes.

Table I.1 summarizes the error message formats.

Table I.1 – Error message formats

Type of transmission error	Transmission error message in hexadecimal	Description
Receiver (32 bytes)	6D + 31-byte string	'm' + 31-byte string
Source identifier (5 bytes)	69 XX XX XX XX	'i' + 4 bytes (32 bits)
Lost packet (5 bytes)	6C XX XX XX XX	'l' + packet index in long integer
Lost packets (9 bytes)	4C XX XX XX XX XX XX XX XX	'L' + starting packet index in long integer + ending packet index in long integer
Delayed frame (7 bytes)	64 XX XX XX XX XX XX	'd' + frame index in long integer + delay time in short integer
Skipped frame (5 bytes)	73 XX XX XX XX	's' + frame index in long integer
Skipped frames (9 bytes)	53 XX XX XX XX XX XX XX XX	'S' + starting frame index in long integer + ending frame index in long integer

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	**Cable networks and transmission of television, sound programme and other multimedia signals**
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2007