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

User requirements for statistical multiplexing of several programmes on a transmission channel

ITU-T Recommendation J.180

(Formerly CCITT Recommendation)

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ITU-T Recommendation J.180

User requirements for statistical multiplexing of several programmes on a transmission channel

Summary

This Recommendation specifies the user requirements that should be considered for the statistical multiplexing of television and/or sound programmes as well as data programmes in order to improve the efficiency in case of utilizing a constant bit-rate digital transmission channel. It also provides a brief outline of statistical multiplexing techniques.

Source

ITU-T Recommendation J.180 was prepared by ITU-T Study Group 9 (1997-2000) and approved under the WTSC Resolution 1 procedure on 18 May 2000.

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 Conference (WTSC), 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 WTSC 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.

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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, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

Statistical multiplexing is a technique that can be applied to a multiplex of television and/or sound programmes, in order that the maximum benefit may be achieved, in terms of average improvement in subjective picture and sound (and data) quality of the programmes in the multiplex, while at the same time minimizing the risk of an undue reduction of the instantaneous bit rate allocated to each programme. Such a reduction may cause the appearance of annoying instantaneous artifacts in that programme (or even in other programmes carried in the multiplex) if the bit rate required by the programme suddenly peaks as a function of its content. When introducing such techniques in digital transmission, user requirements should be established.

ITU-T Recommendation J.180

User requirements for statistical multiplexing of several programmes on a transmission channel

1 Scope

This Recommendation is focused on the user requirements for new multiplexing techniques that resort to statistical multiplexing in order to improve the efficiency of the utilization of a constant bit-rate digital transmission channel used to carry television and/or sound programme signals. It also provides a brief outline of statistical multiplexing techniques.

These techniques measure the quasi-instantaneous bit rate requirements of each programme component in the multiplex to be transmitted, and they allocate the total bit rate available in the channel to the various components of the multiplex in a dynamic way.

This approach allows to exploit the overall statistical redundancy of the information in the multiplex and its result is a benefit to all channels carried in it, since it amounts to a higher average allocation of bit rate to each multiplex component than would be possible to allocate, if each component were treated separately.

2 Informative References

[1] ITU-T H.222.0 (2000) | ISO/IEC 13818-1:2000, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.

[2] ITU-T H.262 (2000) | ISO/IEC 13818-2:2000, *Information technology – Generic coding of moving pictures and associated audio information: Video*.

[3] ITU-R draft new Recommendation [Doc.11/106], *User requirements for coding for multi-programme transmission*.

3 Terms and definitions

This Recommendation defines the following terms:

3.1 **bouquet**: A collection of services multiplexed in a single data stream.

3.2 **MPEG-2**: Refer to ISO/IEC 13818, where System is defined in [1], Video coding is defined in [2] and Audio coding is defined in 13818-3.

4 Abbreviations

This Recommendation uses the following abbreviation:

MPEG Moving Picture Experts Group

5 User requirements for statistical multiplexing

The following user requirements should govern the specification, design and testing of systems for statistical multiplexing in digital transmission.

5.1 Functional and operational requirements

5.1.1 Number of programmes

The number of programmes to be multiplexed should be more than one. Maximum is not specified.

5.1.2 Range of variable bit rate

Because a range of bit rates which can be varied would affect the size of the buffer, the coding-decoding delay and synchronisation, it should be restricted to an appropriate range to allow decoding by MPEG-2 compliant decoders.

5.1.3 Compatibility

The techniques should allow decoding by an MPEG-2 compliant decoder. The structure of an MPEG data stream has to be taken into account in order to define an appropriate control scheme for multi-programme transmission.

5.1.4 Interoperability

The techniques should be independent of transmission media and should allow a flexible combination of programmes inside a bouquet.

5.1.5 Flexibility

Broadcasters or system operators should be able to reassign dynamically the configuration of services such as: the number of multiplexed programs, the target quality of each program and the picture format, as required to meet their instantaneous needs. The technique used should allow decoders to follow such changes without manual intervention by the user. The ability to provide additional data services should be retained.

5.1.6 Extensibility

Any upgrade to the joint coding technique should be downwards compatible with existing techniques. The use of scalable transmission schemes for graceful degradation and compatible services should not be prevented by introducing the techniques.

5.1.7 Implementation

Consideration should be given to operating a joint coding scheme when the encoders and multiplexers are at separate locations. Consideration should also be given to a re-multiplexing of primary distribution with secondary distribution in a transmission chain.

5.2 Performance requirement

5 .2.1 Picture quality

Overall picture quality obtained by the techniques should be superior to that obtained by conventional constant bit-rate coding. Because the resultant picture quality of a programme is affected by the complexities of other programmes in addition to its own, it is necessary to restrict the influence to an appropriate level.

5.2.2 Recovery time

Introduction of the techniques should not increase the recovery time.

5.2.3 Acquisition time

Introduction of the techniques should not increase the acquisition time.

5.2.4 Relative sound/vision delay

The relative sound-video delay should be kept below the level of perceptibility.

5.2.5 Delay

Coding delay should be close to that of a conventional coder.

5.2.6 Error performance

Introduction of the techniques should not degrade error performance.

APPENDIX I

Statistical multiplexing techniques

I.1 Introduction

In digital broadcasting it is highly desirable to use the available channel capacity in an effective way. In order to achieve this goal several programmes are compressed, multiplexed and transmitted over a single channel. Normally the channel capacity will be divided among these programmes in a pre-determined way, which means that each programme is allocated a fixed bit rate. Due to the fact that the bit rate required to obtain a desired picture quality depends on picture content, a constant bit rate coding leads to large variations of picture quality, and an inefficient use of the channel capacity. This suggests that a variable bit rate compression scheme that allows the channel capacity to be dynamically allocated among programmes would result in improved overall picture quality or bandwidth savings. In order to perform bit allocation across programmes, a control mechanism known as joint coding control has to be introduced. This technique is sometimes referred to as statistical multiplexing, although in conventional statistical multiplexing there is no global control mechanism.

The MPEG-2 encoders available on the market today are designed to support a variable output data rate, e.g. for SDTV material in the range between 2 Mbit/s and 15 Mbit/s. In a multi-programme environment the data rates of several multiplexed programmes can be jointly controlled in such a way that the desired picture quality of each programme is achieved by using a variable bit rate encoding scheme, while maintaining the aggregate bit rate constant at the channel rate.

I.2 Joint coding control scheme

Under the assumption that the programmes to be encoded use an MPEG-2 encoding scheme, the encoders already produce a variable output data rate that is smoothed in the output buffer of the system if a transmission over a fixed rate channel is desired. Instead of controlling the bit rate for each individual programme, a joint coding control scheme provides a variable bit rate for each programme under the assumption that the total bit rate of the system is constant and is in the optimum case the equivalent to the channel capacity. In order to control the total bit rate, the joint coding control mechanism adjusts the appropriate encoding parameters in such a way that the more complex programmes will be allocated more bits than the less complex programmes. This scheme reduces the fluctuations of the picture quality of within programmes and among the programmes transmitted in the same channel. Alternatively, the same picture quality can be achieved at a lower average bit rate per channel.

This coding control scheme needs a bidirectional link between the encoders and the channel multiplexer. An example of such a control scheme is shown in Figure I.1.

Another example could have the coding control in a master encoder controlling other encoders at the same location, thus avoiding a control link from the channel multiplexer to the encoders. However, this necessitates links between encoders.

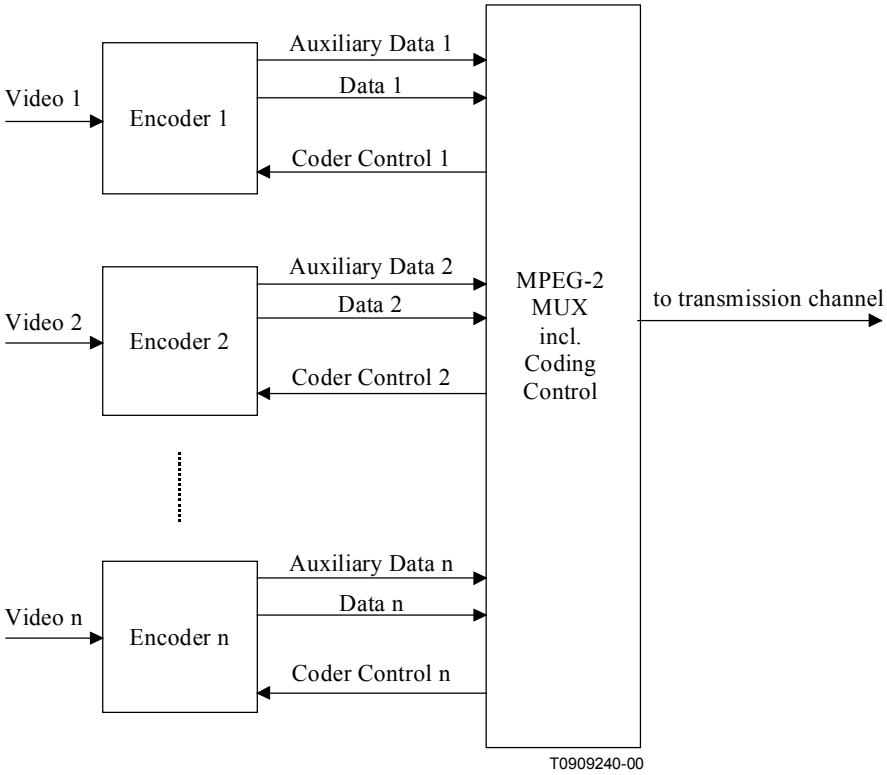

Figure I.1/J.180 – Schematic for a joint coding control system

I.3 Picture quality

According to some published papers, for the same average bit rate, statistical multiplexing provides an equivalent average picture quality to constant bit rate coding. However, statistical multiplexing significantly reduces the probability of lower video quality. Consequently statistical multiplexing allows a lower average bit rate per programmes to be used for the same probability of lower quality.

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