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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Transmission
multiplexing and synchronization

Channel aggregation protocol for multilink operation on circuit-switched networks

ITU-T Recommendation H.226

(Previously CCITT Recommendation)

ITU-T H-SERIES RECOMMENDATIONS
AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Characteristics of transmission channels used for other than telephone purposes	H.10–H.19
Use of telephone-type circuits for voice-frequency telegraphy	H.20–H.29
Telephone circuits or cables used for various types of telegraph transmission or simultaneous transmission	H.30–H.39
Telephone-type circuits used for facsimile telegraphy	H.40–H.49
Characteristics of data signals	H.50–H.99
CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	H.220–H.229
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.399
Supplementary services for multimedia	H.450–H.499

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION H.226**CHANNEL AGGREGATION PROTOCOL FOR MULTILINK OPERATION
ON CIRCUIT-SWITCHED NETWORKS****Summary**

This Recommendation is a channel aggregation protocol for multilink operation on circuit-switched networks. It is intended for use in applications where low latency and high efficiency are important considerations, such as H.324 multimedia telephony. Unlike synchronous time-division-multiplexing channel aggregation protocols such as Recommendation H.221 and ISO/IEC 13871 ("BONDING"), this Recommendation has the ability to operate with a changing number of channels with arbitrary, differing, or continuously varying bit rates (including modems according to Recommendation V.34) as well as fixed-rate channels (such as ISDN B-channels). Unlike packet-oriented channel aggregation protocols such as RFC 1990 ("PPP Multilink Protocol"), this Recommendation finely distributes payload octets across different channels, simultaneously minimizing latency and overhead.

Source

ITU-T Recommendation H.226 was prepared by ITU-T Study Group 16 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 25th of September 1998.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The 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 their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 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, the 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.

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CONTENTS

Page

1	Overview	1
2	References	1
3	Definitions	1
4	Format conventions	2
4.1	Numbering convention	2
4.2	Order of bit transmission	3
4.3	Field-mapping convention.....	3
5	Protocol definition	3
5.1	Protocol overview.....	3
5.2	Header format	4
5.2.1	FLAG	6
5.2.2	CONTROL	6
5.2.3	SEQUENCE NUMBER.....	7
5.2.4	CHANNEL TAG.....	7
5.2.5	CHANNEL PROPORTION.....	7
5.2.6	DATA CRC.....	7
5.2.7	HEADER CRC.....	8
5.3	Procedures	8
5.3.1	Data transmission	8
5.3.2	Data reception	12
	Appendix I – Example of Channel Reference Model operation.....	15

Recommendation H.226**CHANNEL AGGREGATION PROTOCOL FOR MULTILINK OPERATION
ON CIRCUIT-SWITCHED NETWORKS***(Geneva, 1998)***1 Overview**

This Recommendation describes a protocol for aggregation of data over multiple independent channels. The protocol is designed to achieve the following goals:

- low latency transmission even at very low bit rates (including POTS modem rates);
- low overhead even at very low bit rates (including POTS modem rates);
- the ability to accommodate an arbitrary number of channels;
- the ability to accommodate channels of arbitrary bit rate;
- the ability to accommodate channels of differing bit rate;
- the ability to accommodate channels of continuously varying bit rate;
- the ability to accommodate unidirectional or bidirectional channels;
- independence from channel order;
- the ability for channels to drop out or be added arbitrarily;
- low implementation complexity.

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; all 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.

- [1] ISO/IEC 3309:1993, *Information Technology – Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Frame Structure*.

3 Definitions

This Recommendation defines the following terms:

- 3.1 channel:** A single unidirectional data stream over which data is transmitted. Channel aggregation involves transmission of data over more than one channel.
- 3.2 channel reference model:** A model used by the transmitter and receiver to maintain synchronization of the channel aggregation rule.
- 3.3 channel set:** The set of Channels over which a given Data Set is transmitted.

3.4 data set: A portion of the input data stream to be transmitted to which a single channel aggregation rule is applied. Transmission of a Header Set delineates a given Data Set from the previous Data Set and specifies the channel aggregation rule to be used.

3.5 header: A collection of parameters whose beginning is marked by one or more Flags. A Header may either be part of a Header Set, delineating the beginning of a Data Set, or may be used on one or more channels for fill insertion.

3.6 header set: The set of Headers that delineate the beginning of a Data Set. Each Header in a Header Set is transmitted over a different Channel in the Channel Set.

3.7 maximum header interval: The maximum allowed duration of a Data Set. The value of the Maximum Header Interval is not specified in this Recommendation.

3.8 maximum inter-FLAG length: The maximum amount of data that is allowed to be sent between FLAGS on any one Channel. The data counted between FLAGS shall include the portion of the Header following a FLAG and any subsequent Samples prior to the next FLAG. This count shall not include any zeros inserted for transparency control. The Maximum Inter-FLAG Length applies to any FLAGS, including those used to mark the beginning of a Header Set as well as those used for fill insertion. The default value for this Maximum Inter-FLAG Length is 65 534 octets, unless another value is specified by another Recommendation making use of this Recommendation.

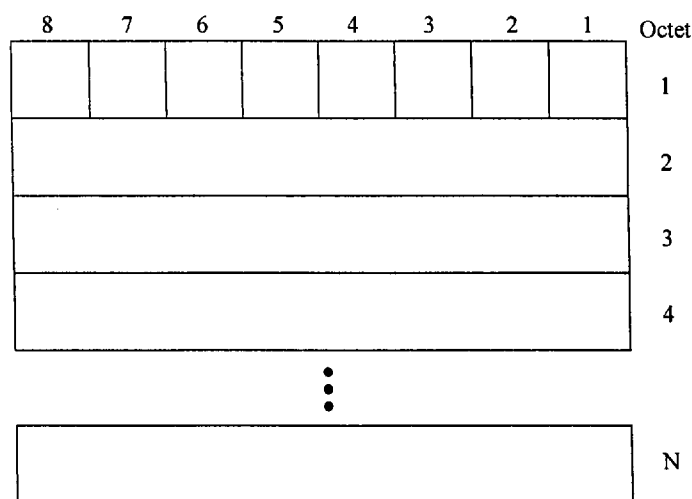
3.9 maximum transmit skew: The largest allowed skew between Channels in a Channel Set at the transmitter. The skew is defined as the difference between the maximum and minimum, across all Channels, of the time duration that a bit of data takes from appearance from the higher layer protocol until it is transmitted over one of the Channels.

3.10 sample: The smallest unit of data which is always kept contiguous when distributing data among multiple channels. The size of the Sample is 8 bits.

4 Format conventions

4.1 Numbering convention

The numbering convention used in this Recommendation is shown in Figure 1. Bits are shown grouped into octets. The bits of a single octet are shown horizontally and numbered from 1 through 8. Multiple octets are shown vertically.



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Figure 1/H.226 – Numbering convention

4.2 Order of bit transmission

The octets are transmitted in ascending numerical order. Within each octet, bit 1 is the first bit to be transmitted.

4.3 Field-mapping convention

When a field is contained within a single octet, the lowest-numbered bit of the field represents the lowest-order value (or the least significant bit).

When a field spans more than one octet, the highest-numbered bit of the first octet represents the highest-order value, and the lowest-numbered bit of the last octet represents the lowest-order value.

An exception to the preceding field-mapping convention are the CRC parameters. In these cases, the lowest-numbered bit of the first octet is the highest-order term of the polynomial representing the CRC, and the highest-numbered bit of the last octet is the lowest-order term of the polynomial representing the CRC.

5 Protocol definition

5.1 Protocol overview

This Recommendation acts as an additional protocol layer inserted below any protocol that would normally transmit data over a single data channel. The interface from the higher layer protocol is a stream of bits, emulating a synchronous serial channel.

The result of the channel aggregation operation is to produce data to be transmitted on a number of separate output Channels. At the receiver, the data from each of these Channels is recombined to reconstruct the original data stream presented to the channel aggregation layer at the transmitter.

The channel aggregation operation divides the input data stream into Samples of 8 bits each. Each Sample is transmitted on one of the available Channels. The channel aggregation operation can proportionally distribute Samples among all available Channels – accounting for their relative data rates – so that as much as possible of the total available bandwidth is used and latency can be kept to a minimum.

In order to reconstruct the original data stream at the receiver, the receiver must be able to determine which Samples were placed on which Channel. This is done by means of a Channel Reference Model that operates in synchrony at both the transmitter and receiver.

For the Channel Reference Model to operate effectively, it must depend on the relative rates of all Channels in use. If the relative rates vary (or if the estimate of the relative rates vary) or if the number of Channels in use changes, the model must be updated with this new information. The Channel Reference Model is updated by transmission of overhead information.

A portion of the input data stream over which the Channel Reference Model operates autonomously without any updates is called a Data Set (see Figure 2). A Data Set may be of arbitrary length – a Data Set continues indefinitely until another Data Set begins in its place.

The beginning of a Data Set is marked by transmission of a Header Set. A Header Set consists of a Header transmitted on each Channel to be used for this Data Set (the set of all Channels to be used by a Data Set is referred to as its Channel Set). The Header Set includes all of the information needed to synchronize the Channel Reference Models at the transmitter and receiver for the duration of the Data Set.