International Telecommunication Union

ITU-T Technical Paper

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(2 December 2011)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS
Infrastructure of audiovisual services – Communication procedures

HSTP-CONF-H701
Conformance testing specification for H.701

Summary

The purpose of conformance testing is to increase the probability that different implementations are able to interconnect. Conformance testing in this document explains test specifications regarding error recovery specified in Rec. ITU-T H.701 "*Content delivery error recovery for IPTV services*". The test involves checking both the capabilities and behaviour of an implementation, and checking what is observed against the conformance requirements in the Recommendation, and against the stated capabilities of the implementation.

Keywords

Change Log

This document contains Version 1 of the ITU-T Technical Paper on "*Conformance testing specification for H.701*" approved at the ITU-T Study Group 16 meeting held in Geneva, 21 November – 2 December 2011.

Editor:	Tsuyoshi YAMASHITA	Tel: +81-6-6466-5632
	Sumitomo Electric Industries	Fax: +81-6-6462-4586
	Japan	Email: yamashita-tsuyoshi@sei.co.jp

Contents

List of Tables

List of Figures

ITU-T Technical Paper HSTP.CONF-H701

Conformance testing specification for H.701

1   Scope

This document specifies a set of attributes and procedures designed to indicate whether IPTV servers and terminal devices meet the requirements in ITU-T Rec. H.701. This set of conformance tests can provide a basic level of interoperability testing.

2   References

[ITU-T H.701]	Recommendation ITU-T H.701 (2009), *Content delivery error recovery for IPTV services*
[ITU-T H.770]	Recommendation ITU-T H.770 (2009), *Mechanisms for service discovery and selection for IPTV services*
[ITU-T X.290]	Recommendation ITU-T X.290 (1995)	ISO/IEC 9646-1 (1994), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications - General concepts*
[ETSI TS 102 034]	ETSI TS 102 034 v1.3.1 (2007), Digital Video Broadcasting (DVB); *Transport of MPEG-2 TS Based DVB Services over IP Based Networks*
[SMPTE 2022-1]	SMPTE specification 2022-1 (2007), *Forward Error Correction for Real-time Video/Audio Transport Over IP Networks*
[IETF RFC 2733]	IETF RFC 2733 (1999), *An RTP Payload Format for Generic Forward Error Correction*
[IETF RFC 3550]	IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications*
[IETF RFC5052]	IETF RFC5052 (2007), *Forward Error Correction (FEC) Building Block*
[IETF RFC5053]	IETF RFC5053 (2007), *Raptor Forward Error Correction Scheme for Object Delivery*

3   Definitions

3.1   Terms defined elsewhere

This document uses the following terms defined elsewhere:

3.1.1   conformance testing [ITU-T X.290]: Testing the extent to which an IUT is a conforming implementation.

3.1.2   dynamic conformance requirement [ITU-T X.290]: One of the requirements which specify what observable behaviour is permitted by the relevant specification(s) in instances of communication.

3.1.3   forward error correction (FEC) [ITU-T H.701]: FEC-based CDER mechanisms generate redundant data to allow the IPTV terminal to correct packet losses. With this redundant information, the receivers can recover from packet losses locally at the IPTV terminal.

3.1.4   FEC base layer [ITU-T H.701]: Most important FEC layer. In the context of this document, this refers to the base layer in the FEC as specified in [ETSI TS 102 034].

3.1.5   FEC enhancement layers [ITU-T H.701]: Subsequent FEC layers. In the context of this document this refers to the enhancement layers in the FEC as specified in [ETSI TS 102 034].

3.1.6   FEC layer [ITU-T H.701]: One FEC stream of multiple ordered FEC streams where support of this layer means that all FEC streams with more important order are also supported.

3.1.7   FEC stream [ITU-T H.701]: IP packet stream associated with a media stream that contains redundant data to allow the IPTV terminal to correct packet losses. With this redundant information, the receivers can recover from packet losses locally at the IPTV terminal.

3.1.8   implementation under test (IUT) [ITU-T X.290]: An implementation of one or more OSI protocols in an adjacent user/provider relationship, being that part of a real open system which is to be studied by testing.

3.1.9   IPTV [ITU-T Y.1901]: Multimedia services such as television, video, audio, text, graphics, data delivered over IP-based networks managed to support the required level of QoS/QoE, security, interactivity and reliability.

3.1.10   IPTV terminal device [ITU-T Y.1901]: A terminal device which has ITF functionality, e.g. a STB.

3.1.11   IPTV terminal function (ITF) [ITU-T Y.1901]: The functionality within the home network that is responsible for terminating the IP signal, and converting the content into a renderable format (i.e. enabling it to be seen and/or heard).

3.1.12   linear TV [ITU-T Y.1901]: A television service in which a continuous stream flows in real time from the service provider to the terminal device and where the user cannot control the temporal order in which contents are viewed.

3.1.13   pass (verdict) [ITU-T X.290]: A test verdict given when the observed test outcome gives evidence of conformance to the conformance requirement(s) on which the test purpose of the test case is focused, and when no invalid test event has been detected.

3.1.14   retransmission [ITU-T H.701]: Retransmission-based CDER mechanisms use feedback messages to recover from packet losses.

3.1.15   source block [IETF RFC5052]: A part of the object formed from a subset of the object's source symbols.

3.1.16   static conformance requirement [ITU-T X.290]: One of the requirements that specify the limitations on the combinations of implemented capabilities permitted in a real open system which is claimed to conform to the relevant specification(s).

3.1.17   verdict [ITU-T X.290]: A statement of "pass", "fail" or "inconclusive", as specified in an abstract test case, concerning conformance of an IUT with respect to that test case when it is executed.

3.1.18   video-on-demand [ITU-T Y.1901]: A service in which the end-user can, on demand, select and view a video content and where the end-user can control the temporal order in which the video content is viewed (e.g., the ability to start the viewing, pause, fast-forward, rewind, etc.).

3.2   Terms defined in this document

This Technical Paper does not define any particular terms.

4   Abbreviations and acronyms

This document uses the following abbreviations and acronyms:

CDER   Content Delivery Error Recovery

CSRC   Contributing source

DVB   Digital Video Broadcasting

FEC   Forward Error Correction

FLUTE	File delivery over unidirectional transport
IP	Internet Protocol
IPTV	IP Television
IUT	Implementation Under Test
MTU	Maximum Transmission Unit
QoE	Quality of Experience
QoS	Quality of Service
RTP	Real-time Transport Protocol
SSRC	Synchronization source
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

5 Introduction

5.1 Scope of testing

A real system is said to exhibit conformance if it complies with the requirements of applicable specifications specified by ITU-T Recommendation in its communication with other real systems. [ITU-T H.701] includes specifications of content delivery error recovery (CDER) mechanisms to be integrated in IPTV-services to maintain a high QoE. CDER function consist of content delivery error recovery functional block and error recovery client functional block as shown in Figure 5-1. [ITU-T H.701] specifies recommendations of coding method, configuration information, and delivery protocols to be supported by these functional blocks in its annexes. Scope of this Technical Paper regarding conformity test of [ITU-T H.701] is the same as [ITU-T H.701]).
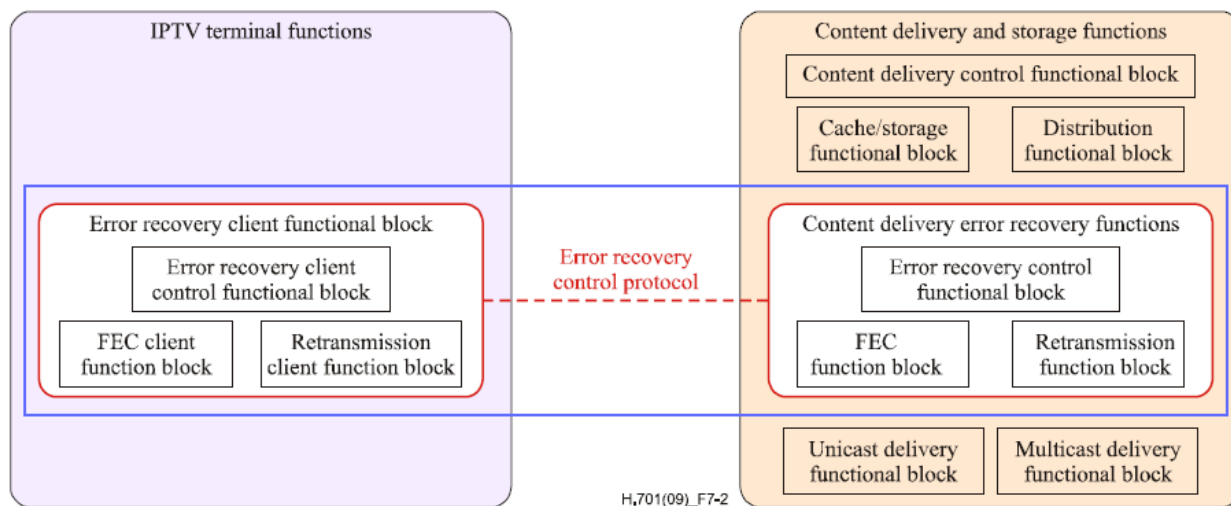

Figure 5-1: CDER functions

5.2 Scope of this version

The scope of [ITU-T H.701] includes both streaming services and content download services. And its CDER mechanisms consist of forward error correction (FEC), retransmission and the combination of FEC and retransmission protocols (Table 5-1). However, the 2009 version of [ITU-

T H.701] only specifies the detail of FEC-based error recovery for streaming distribution. Therefore this document only targets on the conformance testing for streaming procedures with FEC.

Other conformance testing will be specified after additional annexes of [ITU-T H.701] are completed.

Table 5-1: Service type and CDER mechanisms covered by [ITU-T H.701]

CDER / Service type	FEC	Retransmission	FEC & Retransmission
Streaming service	Sending and receiving redundant data flow to correct packet losses (specified in annex A in [ITU-T H.701])	Using feedback messages to recover from packet losses	Hybrid combinations of FEC with retransmissions and feedback
Content download service	Multicast file distribution with FLUTE and FEC	Unicast download with TCP	Retransmission-based file repair procedure

5.3 Conformity requirements

To claim compliance with base specifications, an IPTV system is required to accept and make use of:

– all mandatory elements/attributes specified in base specifications;

– all conditional elements/attributes for which at least one of them is mandatory;

– all the conditional elements/attributes which are mandatory if an optional element/attribute is present;

– all optional elements should be accepted even if not used

Requirements of testing in this document are categorized into followings [ITU-T X.290]:

– Static conformance requirements: specifying the limitation on the combinations of implemented capabilities (e.g., FEC protocols, transport protocols) described in from sub-clause 6.6.1 to 6.6.6 and 6.7.1. These are claimed to be supported by using implementation conformance statement (ICS) which are created before conformity test executions

– Dynamic conformance requirements: specifies what observable behaviour especially described in sub-clause 6.7.2, 6.7.3 and 6.7.4

6 Conformance test for FEC-based error recovery for streaming distribution

6.1 Assumption

[ITU-T H.701] refers to two types of streaming services. They are linear TV and content-on-demand services. There are many differences between them as service architectures but the configuration method is the only difference in FEC-based error mechanisms. The configuration method of FEC is outside the scope of the recommendation as described in sub-clause A.2.2 in [ITU-T H.701]. Therefore streaming and content-on-demand are not distinguished in this document because the same FEC mechanism is applicable except for the configuration.

Then [ITU-T H.701] recommends two types of FEC mechanism referring to Annex E of [ETSI TS 102 034]. One is 1-D interleaved parity FEC (referred to as base layer) and another is Raptor FEC (referred to as enhancement layer). Base layer FEC is mandatory as FEC mechanism but enhancement layer FEC is optional. This version focuses on the conformance of base layer FEC. (The conformance specifications of enhancement layer FEC is for further study.)

6.2   Structure of this clause

FEC-based error recovery mechanism consists of FEC function block in content delivery functions and FEC client function block on IPTV terminal. This clause provides conformance testing specifications of FEC-based error recovery for streaming distribution following to [ITU-T H.701] Annex A for both functions. But they are defined separately for each function basically because servers and client can be implemented by different vendors generally.

6.3   Test system

Figure 6-1 shows a basic test system for the conformity tests. It consists of (1) a content delivery and storage server as one of implementations under test (IUT1), (2) an IPTV terminal device as another implementation under test (IUT2), (3) a port mirroring switch or equivalent and, (4) a packet capturing device and (5) an IP network emulator. IUT1 packetizes source content as media packets, generates FEC packets from media packets by FEC function block, and sends media packets and FEC packets to IUT2 as a unicast or multicast stream. And IUT1 also provides content delivery control function and error recovery control function. IUT2 receives media packets and FEC packets. It may also receive FEC configuration information from IUT1. On IUT2, if a media packet is lost, it is recovered locally from other received media packets and associated FEC packet by FEC client function block. A port mirroring switch and a packet capturing device are used to watch the output packets from IUT1 and the configuration sequence between IUT1 and IUT2. An IP network emulator is used to cause some network impairments like packet losses, out-of-order packets, delay and so on. It is available for the conformity test of FEC client function block.

In addition to the elementary functions described above, the test system in this document is required to be equipped with:

–   Content presentation functionality (on IUT2): To present the received content on a display connected to IUT2. It is useful to check on display of the IPTV terminal device whether error recovery client function works correctly or not in case of error recovering sanity check.

–   Storing packets functionality (on IUT2): This is the function to store the received and recovered packets on IUT2.

     At least either storing packets functionality or content presentation functionality is required for the conformance testing of IUT2.

–   Service discovery functionality: To make IPTV streaming service available for IPTV terminal device as described in [ITU-T H.770].

     Without this functionality, some alternative methods, such as pre-configuration, are required to let the IPTV terminal device know the parameters to communicate with the content delivery server.
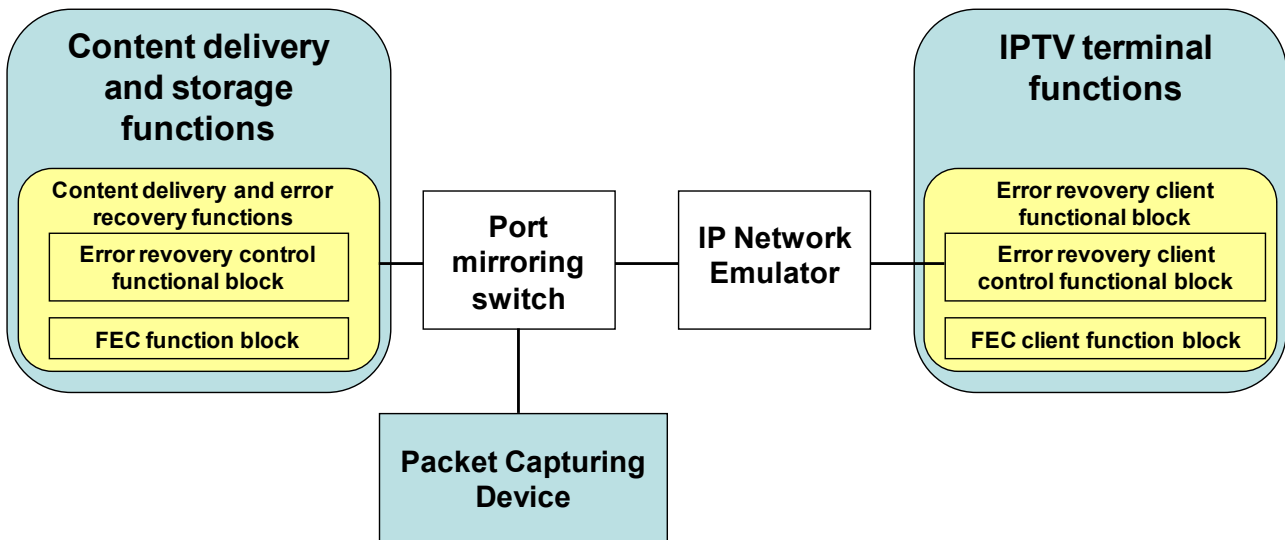
Figure 6-1: Test system

6.4 Configuration of FEC

Several FEC parameters are required to configure the FEC function block and the FEC client function block. In sub-clause A.2.2 of [ITU-T H.701], "Mandatory" and "Optional" setup parameters and additional information for FEC streams are listed on the Table A.1 and Table A.2. It is required that the FEC function block generates the FEC streams conforming to these parameters and the FEC client function block has access to them in some way. Concerning the configuration method, the details and the concrete ways are outside the scope of [ITU-T H.701]. Either pre-configuration or the method of [ITU-T H.770] or both may be available. And other methods are not prohibited either.

6.5 Test parameters for base layer FEC

Figure 6-2 shows base layer FEC encoding scheme defined in [SMPTE 2022-1-2007]. Here, L is the number of columns and D is the number of rows. L and D are fundamental parameters of base layer FEC. A base layer FEC encoder arranges media packets in L*D matrix and generates a FEC packet from D media packets in the same column. Therefore L FEC packets are generated form consecutive L*D media packets. This document does not specify the specific values of L and D for conformance testing. The combination of L and D presented in sub-clause 6.7.2 of this document is available as one of typical values. And other combinations within the restrictions described in [ETSI TS 102 034] are also available.
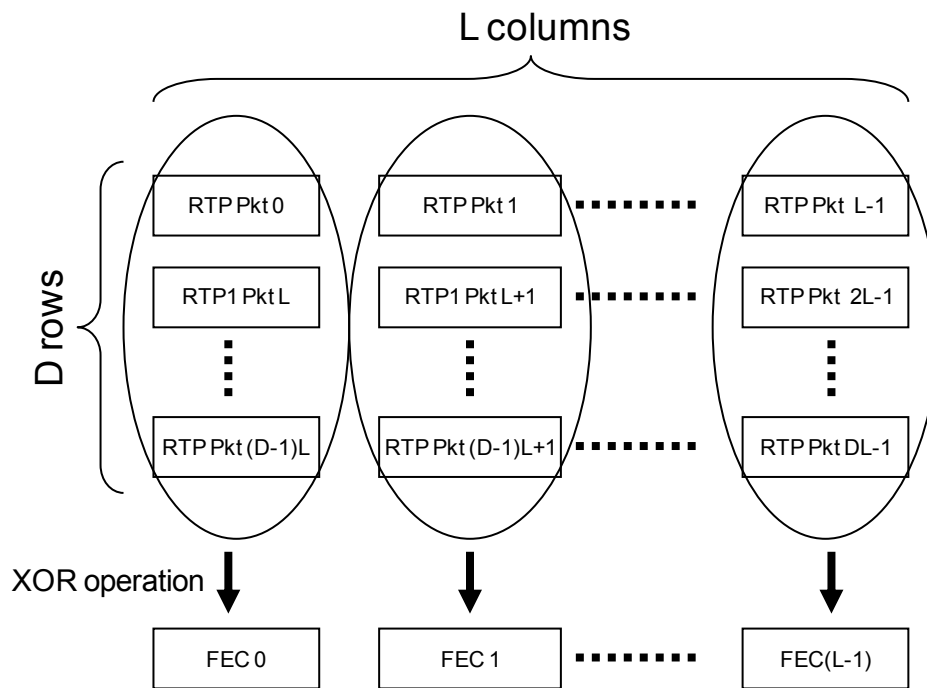
Figure 6-2: Encoding scheme of base layer FEC

6.6 Conformance check of FEC function block for base-layer FEC

In this clause, the conformance specifications to be met by the FEC function block are described. The basic protection operation, which means generating FEC packets from media packets, is defined in [IETF RFC2733]. And some modifications and exceptions are added in [SMPTE 2022-1-2007] and [ETSI TS 102 034] like the format of packets, the range of parameters and so on. Though the procedure of protection operation is described in chapter 7 of [IETF RFC2733], it is the only reference and the implementers can adapt other ways. Therefore the protection procedure is not the scope of this document. The specifications to be validated are the conformity of media/FEC packets generated by the FEC function block, supported features and FEC parameters. The test system is shown in Figure 6-1 and testing procedure is as follows:

1) Configure the media and FEC stream settings.

2) Start FEC protection operation and send media/FEC packets.

3) Capture the output media/FEC packets.

4) Sample one of them, analyze it and check the conformity.

5) If FEC protection operation is enabled, analyze the FEC header of a FEC packet and pick up the associated media packets.

6) Calculate the values of the fields of FEC header from associated media packets and compare them with the values of FEC packets generated by FEC function block.

6.6.1 Basic feature of FEC function block

The FEC function block is required to support the following features and parameter set.

− To be enabled or disabled (described in [SMPTE 2022-1-2007], 8.1 "FEC Packet Arrangement").

− To support values of L and D within the restrictions L*D <= 400 and L <= 40 (described in [ETSI TS 102 034] Annex E.3).

–	The number of generated FEC packets per L*D media packets is L (described in [SMPTE 2022-1-2007], 8.1 "FEC Packet Arrangement").

Here, L is the number of columns and D is the number of rows described in Figure 6-2.

### 6.6.2	Packet format conformance

The media and FEC packets are required to be the format listed in Table 6-1.

Table 6-1: Check item of packet format and references

Check item	Specification	M/O	Reference
Packet format	To be RTP/UDP/IP	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
Packet length	Not to exceed network MTU size	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"

### 6.6.3	Media packet RTP Header conformance

RTP headers of media packets are required to comply with the specifications listed in the following Table 6-2. The format of RTP header and the bit assignment are defined in [IETF RFC1889].

Table 6-2: Check item of media packet RTP header and references

Check item	Specification	M/O/C	Reference
Version (V)	2	M	[ETSI TS 102 034] 7.1.1 "Real-time Transport Protocol (RTP) encapsulation"
Padding bit (P)	To be defined by the associated video/audio transport standards	N/A	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
Extension bit (X)	To be constant for the duration of the session	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
CSRC count (CC)	0	M	[SMPTE 2022-1-2007] 7.1 "RTP/UDP/IP Layer"
Marker bit (M)	To be defined by the associated video/audio transport standards	N/A	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
Payload type (PT)	Not specified	N/A	
Sequence Number	To be one higher than that of the previously transmitted media packet	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
Timestamp	Not specified	N/A	
SSRC	To have the same value in every packet of the stream	M	[ETSI TS 102 034] Annex E.3
CSRC list	Not exist	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"
Extended header	If exist, the length is constant duration of the session	M	[SMPTE 2022-1-2007], 7.1 "RTP/UDP/IP Layer"

### 6.6.4	FEC packet RTP Header conformance

RTP headers of FEC packets are required to comply with the specifications listed in the following Table 6-3. The format of RTP header and the bit assignment are defined in [IETF RFC1889].

Table 6-3: Check item of FEC packet's RTP header and references

Check item	Specification	M/O/C	Reference
Version (V)	2	M	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Padding bit (P)	0 or 1 (Computed from the media packets)	C	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Extension bit (X)	0 or 1 (Computed from the media packets)	C	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
CSRC count (CC)	0 (Computed from the protection operation)	M	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Marker bit (M)	0 or 1 (Computed from the media packets)	C	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Payload type (PT)	96	M	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Sequence Number	To be one higher than that of the previously transmitted FEC packet	M	[IETF RFC2733] 6.1 RTP Header format of FEC Packets
Timestamp	Not specified	N/A	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
SSRC	0	M	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
CSRC list	Not exist independent of the value of CSRC count	M	[SMPTE 2022-1-2007] 8.3 "FEC Packet RTP Header Format"
Extended header	Not exist independent of the value of extension bit	M	[IETF RFC2733] 6.1 RTP Header format of FEC Packets

6.6.5 FEC Header conformance

FEC headers are required to comply with the specifications listed in the following Table 6-4. The format and the bit assignment of FEC header is shown in Figure 6-3. More details of each field in the FEC header are described in [IETF RFC2733] and [SMPTE 2022-1-2007].

Table 6-4: Check item of FEC header and references

Check item	Specification	M/O/C	Reference
SNBase low bits	To be minimum sequence number of the media packets associated to the FEC packet	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
Length Recovery	To be calculated from the length of media packets. The length is the sums of the lengths (in bytes) of media payload, CSRC list, extension and padding of media packets associated with a FEC packet	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format" [IETF RFC2733] 6.3 FEC Header
Header extension bit (E)	1	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
Mask	0	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"

Check item	Specification	M/O/C	Reference
TS recovery	To be used to recover the timestamp of any media packets associated with the FEC packet	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
Reserved bit (N)	0	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
D	0	M	Annex E.3 of [ETSI TS 102 034]
type	0	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
Index	0	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
Offset	The period used to select the media packets associated with the FEC packets. (The number of columns "L" shown in Figure 6-2)	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
NA	The number of media packets associated with this FEC packet. (The number of rows "D" shown in Figure 6-2)	M	[SMPTE 2022-1-2007] 8.4 "FEC Header Format"
SNBase ext bits	0	M	Annex E.3 of [ETSI TS 102 034]

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      SNBase low bits       |         Length recovery          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |E| PT recovery |                    Mask                       |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                          TS recovery                          |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |N|D|type |index|    Offset    |      NA      |SNBase ext bits|
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
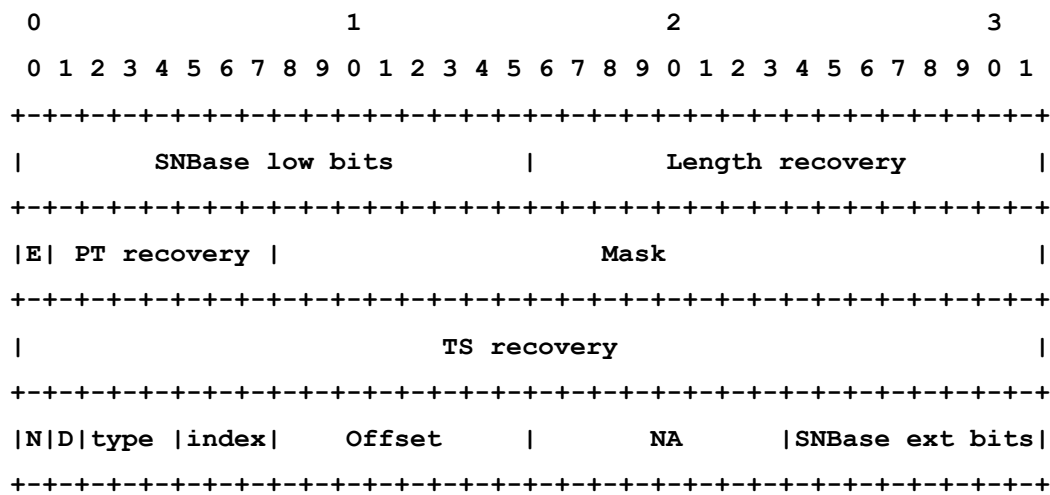
Figure 6-3: Base layer FEC header format

6.6.6 Transport conformance

Media and FEC packets are required to be transmitted following the specifications of transporting in the Table 6-5. Note that these specifications are default settings of [SMPTE 2022-1-2007]. When other values are set by the FEC configuration scheme described in Table 6-5, it is required to follow them.

Table 6-5: Check item of transport protocol layer and references

Check item	Specification	M/O/C	Reference
UDP destination port number of media packets	N (N is an even integer per [IETF RFC 3550])	M	[SMPTE 2022-1-2007], clause 8.1 "FEC Packet Arrangement"
UDP destination port number of FEC packets	N+2 (N is UDP destination port number of media packets)	M	[SMPTE 2022-1-2007], clause 8.1 "FEC Packet Arrangement"
UDP source port number of FEC packets	Same port number as associated media packets	M	[SMPTE 2022-1-2007], clause 9 "System Configuration"

6.7 Conformance check of FEC client function block for base layer FEC

In this clause, the conformance specifications to be met by FEC client function block are described. The packet recovering procedure in the FEC client function block is defined in [IETF RFC 2733] and some additional requirements are defined in [SMPTE 2022-1-2007] or [ETSI TS 102 034]. The conformity of recovery procedure itself is validated by the binary comparison of recovered packets with original packets. More specifically speaking, test pass if the captured media packets by the packet capturing device are the same data as the received and recovered media packets by the FEC client function block on the test system Figure 6-1. If it is not possible to do the binary comparison operation on the IPTV terminal because it is not equipped with packets storing function, to check the displayed video/audio output from IPTV terminal after recovering lost packets is available as an alternative way. If there is no video and audio quality problem, like image impairment or noise, under the environment with some packet losses, delays or other network problems, the conformity of the FEC client function block is confirmed.

6.7.1 Basic function of FEC client function block

FEC client function block is required to support the following features.

–   To be able to process one or zero FEC stream (described in [SMPTE 2022-1-2007], 8.1 "FEC Packet Arrangement").

–   To support values of L and D within the restrictions $L*D <= 400$ and $L <= 40$ (described in [ETSI TS 102 034] Annex E.3).

Here, L is the number of columns and D is the number of rows described in Figure 6-2.

6.7.2 Out-of-order tolerance conformance

The FEC client function block is required to process the packets independently of the arrival order within the range of *max-block-size* source packets as described in Annex E.5.1.1 of [ETSI TS 102 034].

NOTE: The operation of *max-block-size* is optional, then the specification of this sub-clause is applied only in the case *max-block-size* is supported in the system.

Then FEC client function block is required to receive out-of-order media packets and recover lost media packets which need the out-of-order packets. To confirm this, FEC client function block is required to recover lost packets and work correctly in the condition caused by following operation.

1)   Interchange the sending order of a media packet (media packet A) and *max-block-size* packets after media packet of it (media packet B).

2)   Lose one media packet which is protected by the same FEC packets with media packet A.

3)   Lose one media packet which is protected by the same FEC packets with media packet B.

Figure 6-4 is an example in the case L = 10, D = 10 and max-block-size=100. RTP0 is interchanged with RTP100. And RTP10, which is protected by same FEC packet (FEC0) with RTP0, is lost. Then to recover RTP10, the FEC decoder is required to wait for RTP0 until 100 packets after receiving RTP100.
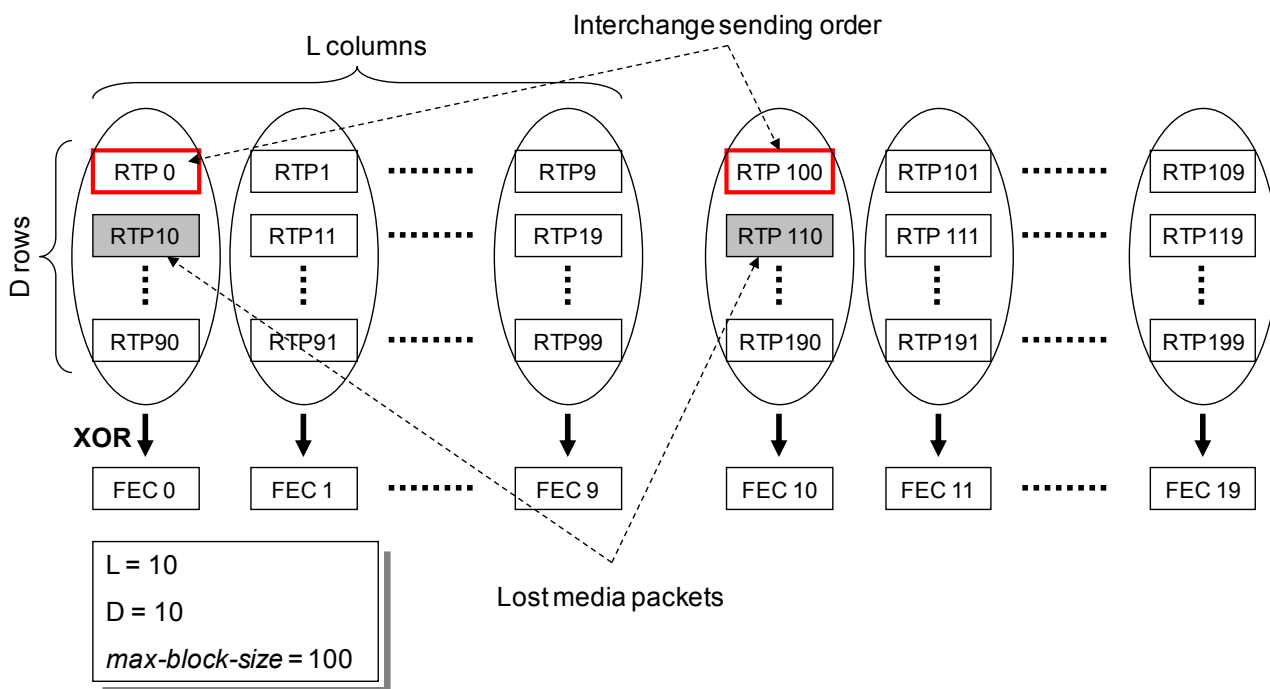

Figure 6-4: Test scheme of out-of-order tolerance

6.7.3 Packet delay tolerance conformance

The FEC client function block is required to process the packets independently of the arrival time within the range of *max-block-size-time* before the current time as described in Annex E.5.1.1 of [ETSI TS 102 034].

NOTE: The operation of *max-block-size-time* is optional, then the specification of this sub-clause is applied only in the case *max-block-size-time* is supported in the system.

Then FEC client function block is required to receive delayed media packets and recover lost media packets which are protected by the same FEC packet with the delayed packets. To confirm this, the FEC client function block is required to recover lost packets and work correctly in the condition caused by following operation.

1) Delay the last one of the media packets protected by a FEC packet to make it arrive at the FEC decoder *max-block-size-time* after the first media packet protected by the same FEC packet is received.

2) Lose one media packet which is protected by same FEC packet with 1).

Figure 6-5 is an example in the case L = 10 and D = 10. Media packets RTP0, RTP10, RTP20, RTP30, RTP40, RTP50, RTP60, RTP70, RTP80 and RTP90 are protected by the same FEC packet FEC0. RTP90, the last packet protected by FEC0, arrives *max-block-size-time* after RTP0 arrives. And RTP10 is lost. Under this condition, FEC decoder is required to wait for RTP90 to recover RTP10.
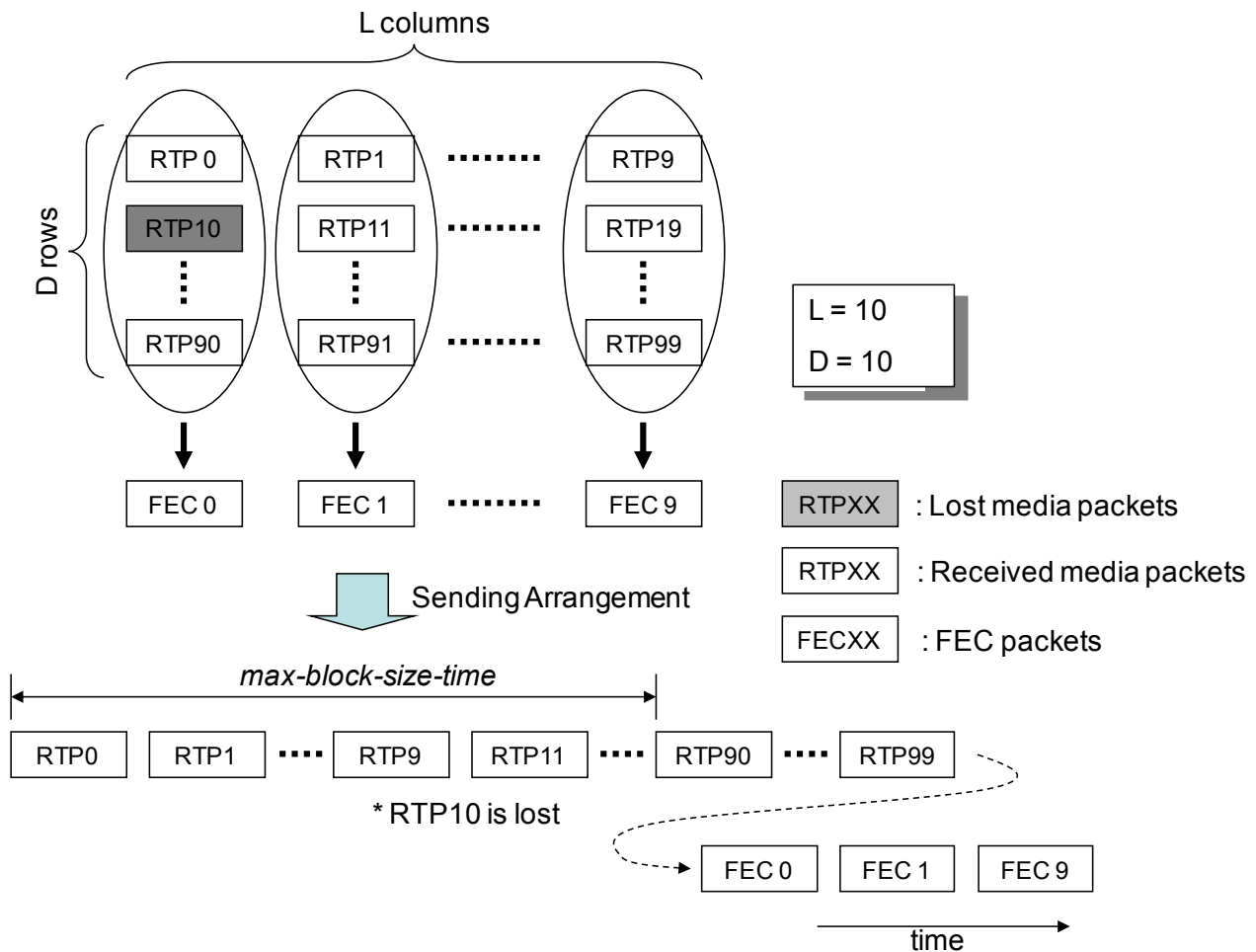
Figure 6-5: Test scheme of packet-delay tolerance

6.7.4 Correctness of the recovering algorithm

Base layer FEC algorithm can recover any L consecutive packet losses as described in clause 8.1 of [SMPTE 2022-1-2007]. Then to confirm the correctness of implementation of the FEC decoding, the FEC client function block is required to recover all lost media packets generated by the following procedure.

1)   Lose the consecutive L packets per (L*D+1) media packets on a network emulator.

2)   Repeat 1) continuously at least L*(D-1) +1 times to test all patterns of L consecutive packet losses.

Here, L is the number of columns and D is the number of rows described in Figure 6-2.

Figure 6-6 is an example of above operation in the case of L = 10 and D = 10. In the first source block (here, the block of L*D media packets protected by L FEC packets), the first 10 media packets, from RTP0 to RTP9, are lost. Then in the next source block, the consecutive 10 packets from the second packet (from RTP101 to RTP110) are lost. Eventually, in the 91st source block, the last ten media packets in the source block are lost. Then all patterns of 10 consecutive packet losses are tested by above procedure.
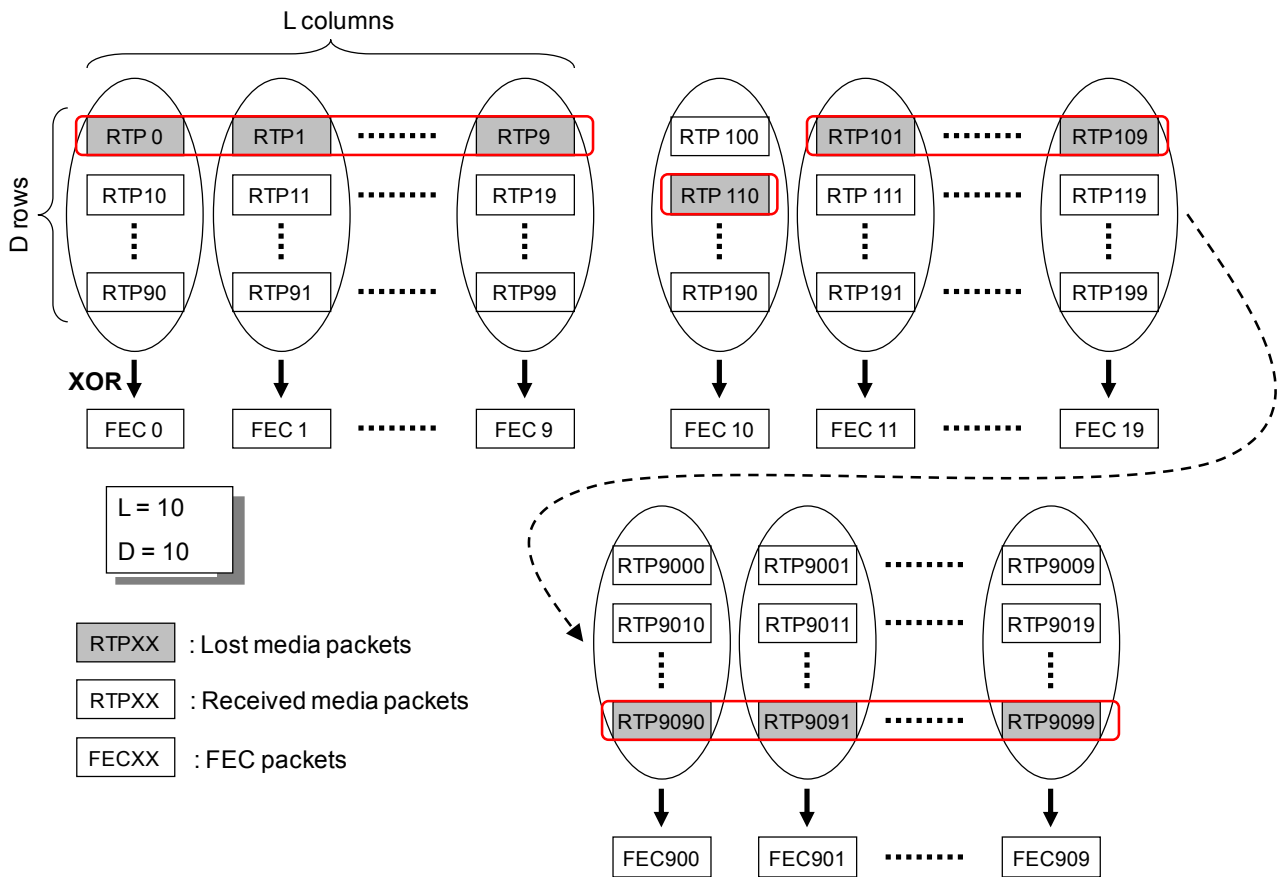
Figure 6-6: Test scheme of correctness of the FEC recovering algorithm

6.8 Conformance check of FEC function block for enhancement layer FEC

Further study

6.9 Conformance check of FEC client function block for enhancement layer FEC

Further study

Appendix I

Checklists for base-layer FEC conformance testing

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

The following is a preliminary checklist for base-layer FEC conformance testing.

A column "M/O/C" in following tables shows requirement levels of check items. Mandatory items are shown "M", optional ones are shown as "O" and conditional requirements are shown as "C".

A column "Result" can be put down the result of each test items and a column "verdict" can be noted the verdict (OK, NG, N/A) by comparing with the specifications of [ITU-T H.701].

A column "Remark" can be put down detailed relevancies to [ITU-T H.701] specifications. If optional elements/attributes are used according to local rules, it should be also described the conditions (ex., only if Linear TV is served, this elements is required) in order to objectively check conformities regarding their semantics.

I.1 Conformance check of FEC function block

Table I.1-1: Basic feature of FEC function block

Check item	M/O/C	Result	verdict	Remark
Enabling FEC	M			
Disabling FEC	M			
L, D (Test parameters)	M	(L, D) =(,) L*D =		
The number of FEC packets per L*D media packets	M			

Table I.1-2: Packet format conformance

Check item	M/O/C	Result	verdict	Remark
Media packet format	M			
FEC packet format	M			
Media packet length	M	MTU= Length =		
FEC packet length	M	MTU= Length =		

Table I.1-3: Media packet RTP Header conformance

Check item	M/O/C	Result	verdict	Remark
Version (V)	M			
Extension bit (X)	M			
CSRC count (CC)	M			
Sequence Number	M			
SSRC	M			
CSRC list	M			
Extended header	M			

Table I.1-4: FEC packet RTP Header conformance

Check item	M/O/C	Result	verdict	Remark
Version (V)	M			
Padding bit (P)	C			
Extension bit (X)	C			
CSRC count (CC)	M			
Marker bit (M)	C			
Payload type (PT)	M			
Sequence Number	M			
SSRC	M			
CSRC list	M			
Extended header	M			

Table I.1-5: FEC Header conformance

Check item	M/O/C	Result	verdict	Remark
SNBase low bits	M			
Length Recovery	M			
Header extension bit (E)	M			
Mask	M			
TS recovery	M			
N	M			
D	M			
type	M			
Index	M			
Offset	M			
NA	M			
SNBase ext bits	M			

Table I.1-6: Transport conformance

Check item	M/O/C	Result	verdict	Remark
UDP destination port of media packets	M			
UDP destination port of FEC packets	M			
UDP source port of FEC packets	M			

I.2   Conformance check of FEC client function block

Table I.2-1: Basic function of FEC client function block

Check item	M/O/C	Result	verdict	Remark
Enabling FEC	M			
Disabling FEC	M			
L, D (Test parameters)	M	(L, D) =(,) L*D =		

Table I.2-2: Tolerance to network disturbance and sanity of recovering algorithm

Check item	M/O/C	Result	verdict	Remark
Out-of-order tolerance	O	max-block-size = Test result :		6.7.2
Packet delay tolerance	O	max-block-size-time = Test result =		6.7.3
Recovering algorithm	M			6.7.4

Bibliography

[b-HTSP.CONF-H770]   Technical Paper ITU-T HTSP.CONF-H770 (2010), *Conformance testing specification for H.770*

[b-HTSP.CONF-H721]   Technical Paper ITU-T HTSP.CONF-H721 (2011), *Conformance testing specification for H.721*

[b-ITU-T X.291]   Recommendation ITU-T X.291 (1995) | ISO/IEC 9646-2:1994, *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications - Abstract test suite specification*

_____