

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.701

(03/2009)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS
IPTV multimedia services and applications for IPTV –
General aspects

Content delivery error recovery for IPTV services

Recommendation ITU-T H.701

ITU-T H-SERIES RECOMMENDATIONS
AUDIOVISUAL AND MULTIMEDIA SYSTEMS

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.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
Mobility interworking procedures	H.550–H.559
Mobile multimedia collaboration inter-working procedures	H.560–H.569
BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619
Advanced multimedia services and applications	H.620–H.629
IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV	
General aspects	H.700–H.719
IPTV terminal devices	H.720–H.729
IPTV middleware	H.730–H.739
IPTV application event handling	H.740–H.749
IPTV metadata	H.750–H.759
IPTV multimedia application frameworks	H.760–H.769
IPTV service discovery up to consumption	H.770–H.779

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

Recommendation ITU-T H.701

Content delivery error recovery for IPTV services

Summary

Recommendation ITU-T H.701 provides content delivery error recovery (CDER) mechanisms for IPTV services. It details the error recovery functions in the IPTV architecture and specifies detailed CDER mechanisms. It also provides guidelines on the applicability of the CDER mechanisms to different IPTV services and network conditions.

Source

Recommendation ITU-T H.701 was approved on 16 March 2009 by ITU-T Study Group 16 (2009-2012) under Recommendation ITU-T A.8 procedures.

Keywords

Content delivery error recovery, forward error correction, retransmission.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). 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 2010

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

CONTENTS

Page

1	Scope	1
2	References.....	1
3	Definitions	1
4	Abbreviations and acronyms	2
5	Conventions	3
6	Introduction	3
7	Content delivery error recovery architecture	5
7.1	Content delivery error recovery in IPTV architecture.....	5
7.2	Content delivery error recovery functions.....	5
7.3	CDER interfaces and protocols	7
7.4	CDER control functional block	7
8	Content delivery error recovery mechanisms for streaming.....	7
8.1	General	7
8.2	Retransmission	8
8.3	Forward error correction.....	8
8.4	Hybrid combinations of FEC with retransmissions and feedback	9
8.5	Usage guidelines for retransmission and FEC.....	10
9	Content delivery error recovery for content download services.....	11
9.1	General	11
9.2	Retransmission-based mechanism: reliable unicast download with TCP	11
9.3	FEC-based mechanism: reliable multicast file distribution with FLUTE and FEC	12
9.4	Retransmission-based file repair procedures.....	12
Annex A	– FEC-based error recovery mechanisms for streaming distribution.....	13
A.1	Assumptions	13
A.2	Forward error correction according to [ETSI TS 102 034]	13
A.3	Recommended FEC for linear TV services.....	15
A.4	Recommended FEC for content-on-demand services	16
Annex B	– Retransmission-based error recovery mechanisms for streaming delivery	17
Annex C	– Content delivery error recovery for content download services.....	18
Appendix I	– Evaluation of CDER mechanisms for IPTV services	19
I.1	Introduction	19
I.2	Evaluation criteria for multicast linear TV	20
I.3	Evaluation criteria for content-on-demand services.....	20
I.4	Evaluation criteria for content download services	20

	Page
Appendix II – Use cases for content delivery error recovery	21
II.1 Linear TV service	21
II.2 Tightly coupled content-on-demand service	23
II.3 Place-shifting service.....	25
Appendix III – Evaluation results and recommended parameter settings for error recovery mechanisms	27
III.1 FEC according to [ETSI TS 102 034]	27
Bibliography.....	30

Recommendation ITU-T H.701

Content delivery error recovery for IPTV services

1 Scope

The ability to deliver high level of service quality to users is an essential aspect of IPTV services, and thus captured in many IPTV-related requirements. As IPTV services can easily be degraded if the media decoders are exposed to impairments such as packet losses, mechanisms are needed to reliably deliver good IPTV service quality in the presence of such defects.

This Recommendation integrates error recovery in the IPTV architecture, describes specific mechanisms and discusses the applicability of the mechanism to IPTV services and network conditions, and provides recommendations and guidance on their use.

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 Y.1541] Recommendation ITU-T Y.1541 (2006), *Network performance objectives for IP-based services*.
- [ITU-T Y.1910] Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture*.
- [ITU-T Y.Sup5] ITU-T Y-series Recommendations – Supplement 5 (2008), *ITU-T Y.1900-series – Supplement on IPTV service use cases*.
- [ARIB STD-B24] ARIB Standard, ARIB STD-B24, *Data Coding and Transmission Specification for Digital Broadcasting*.
- [ATIS-0800005] ATIS-0800005 (2006), *IPTV Packet Loss Issue Report*.
- [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 793] IETF RFC 793 (1981), *Transmission Control Protocol*.
- [IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications*.
- [IETF RFC 5052] IETF RFC 5052 (2007), *Forward Error Correction (FEC) Building Block*.
- [IETF RFC 5053] IETF RFC 5053 (2007), *Raptor Forward Error Correction Scheme for Object Delivery*.

3 Definitions

This Recommendation defines the following terms:

3.1 FEC base layer: Most important FEC layer. In the context of this Recommendation, this refers to the base layer in the FEC as specified in [ETSI TS 102 034].

3.2 FEC enhancement layers: Subsequent FEC layers. In the context of this Recommendation, this refers to the enhancement layers in the FEC as specified in [ETSI TS 102 034].

3.3 FEC layer: 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.

3.4 FEC stream: IP packet stream associated with a media stream that contains redundant data to reconstruct a media stream locally at the IPTV terminal.

3.5 forward error correction (FEC): 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.

3.6 retransmission: Retransmission-based CDER mechanisms use feedback messages to recover from packet losses.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ALC	Asynchronous Layered Coding
AFEC	Adaptive FEC
ARQ	Automatic Repeat Request
ATIS-IIF	Alliance for Telecommunication Industry Solutions – IPTV Interoperability Forum
AVP	Audio-Visual Profile
CBR	Constant Bit Rate
CDER	Content Delivery Error Recovery
DSL	Digital Subscriber Line
DVB	Digital Video Broadcasting
ECG	Electronic Content Guide
EPG	Electronic Program Guide
FEC	Forward Error Correction
FLUTE	File delivery over unidirectional transport
FTP	File Transfer Protocol
ID	Identifier
IDR	Instantaneous Decoder Refresh
IP	Internet Protocol
IPDV	IP Packet Delay Variation
IPER	IP Packet Error Ratio
IPLR	IP Packet Loss Ratio
IPTD	IP Packet Transfer Delay
IPTV	IP Television
MTBA	Mean Time Between Artefacts
NACK	Negative ACKnowledgement
QoE	Quality of Experience

QoS	Quality of Service
RMT	Reliable Multicast Transmission
RTCP	Real-Time Control Protocol
RTP	Real-Time Transport Protocol
RTT	Round-Trip Time
SCP	Service and Content Protection
TCP	Transmission Control Protocol
TF	Terminal Function
TS	Transport Stream
TTS	Timestamped Transport Stream
UDP	User Datagram Protocol
VoD	Video on Demand
XML	eXtensible Markup Language

5 Conventions

None.

6 Introduction

Content delivery error recovery (CDER) is an important aspect for IPTV services. Data being delivered over IP networks may suffer from packet losses. In case of the delivery of video and audio, data errors, such as packet losses or bit errors being delivered to the media decoder, generally degrade the IPTV service quality. Moreover, losses in metadata such as electronic program guides (EPG), electronic content guides (ECG), and interactive user data may cause more severe problems in IPTV services. Therefore, data reliability support is essential to IPTV services.

This Recommendation addresses the requirement that the IPTV architecture provide a mechanism for resiliency of the service provider infrastructure in order to maintain a high QoE for video services [ITU-T Y.Sup5]. It addresses specific realizations of the content delivery error recovery function and the content delivery error recovery client function in the IPTV architecture [ITU-T Y.1910]. Reference point E4 is used to exchange messages for delivering and requesting error recovery information [ITU-T Y.1910].

The support of content delivery error recovery mechanisms is not required for all networks, in particular for networks that can fulfil the desired IPTV service requirements.

In case that a network cannot fulfil the packet loss requirements necessary to achieve the IPTV service requirements, the use of a content delivery error recovery solution is recommended.

Retransmission, forward error correction (FEC), and hybrid combinations of both are known mechanisms for error recovery. When an error recovery scheme and the associated protocol is selected, at least the following aspects should be taken into account:

- 1) type of IPTV service, e.g., linear TV, content-on-demand, content download, EPG distribution, application data;
- 2) type of data delivery mechanisms, e.g., broadcast, multicast, unicast, overlay multicast, or peer-to-peer;
- 3) protocol or processing overhead at senders and receivers;
- 4) network bandwidth overhead aspects.

This Recommendation is structured as follows:

Clause 7 introduces the content delivery error recovery architecture and provides some high-level descriptions of the involved functional blocks and interfaces.

Clause 8 provides an overview on different CDER mechanisms for streaming, i.e., for solutions in which the media stream is distributed in real-time and consumed at the same time.

Clause 9 provides an overview on different CDER mechanisms for content download services, i.e., for solutions in which a media file is distributed to terminals for later consumption.

This Recommendation also contains several annexes that contain specific recommendations for CDER mechanisms. The first release of this Recommendation is restricted to one annex specifying recommended FEC-based error recovery mechanisms for streaming distribution.

It is expected that in future releases, additional annexes will be added to specify recommendations at least on:

- Retransmission-based error recovery mechanisms for streaming delivery.
- Content delivery error recovery mechanisms for content download services.

This Recommendation also includes appendices for background information on the evaluation of CDER mechanisms as well as on configuration of specific CDER mechanisms in IPTV networks.

Copyright International Telecommunication Union/ITU-T

7 Content delivery error recovery architecture

7.1 Content delivery error recovery in IPTV architecture

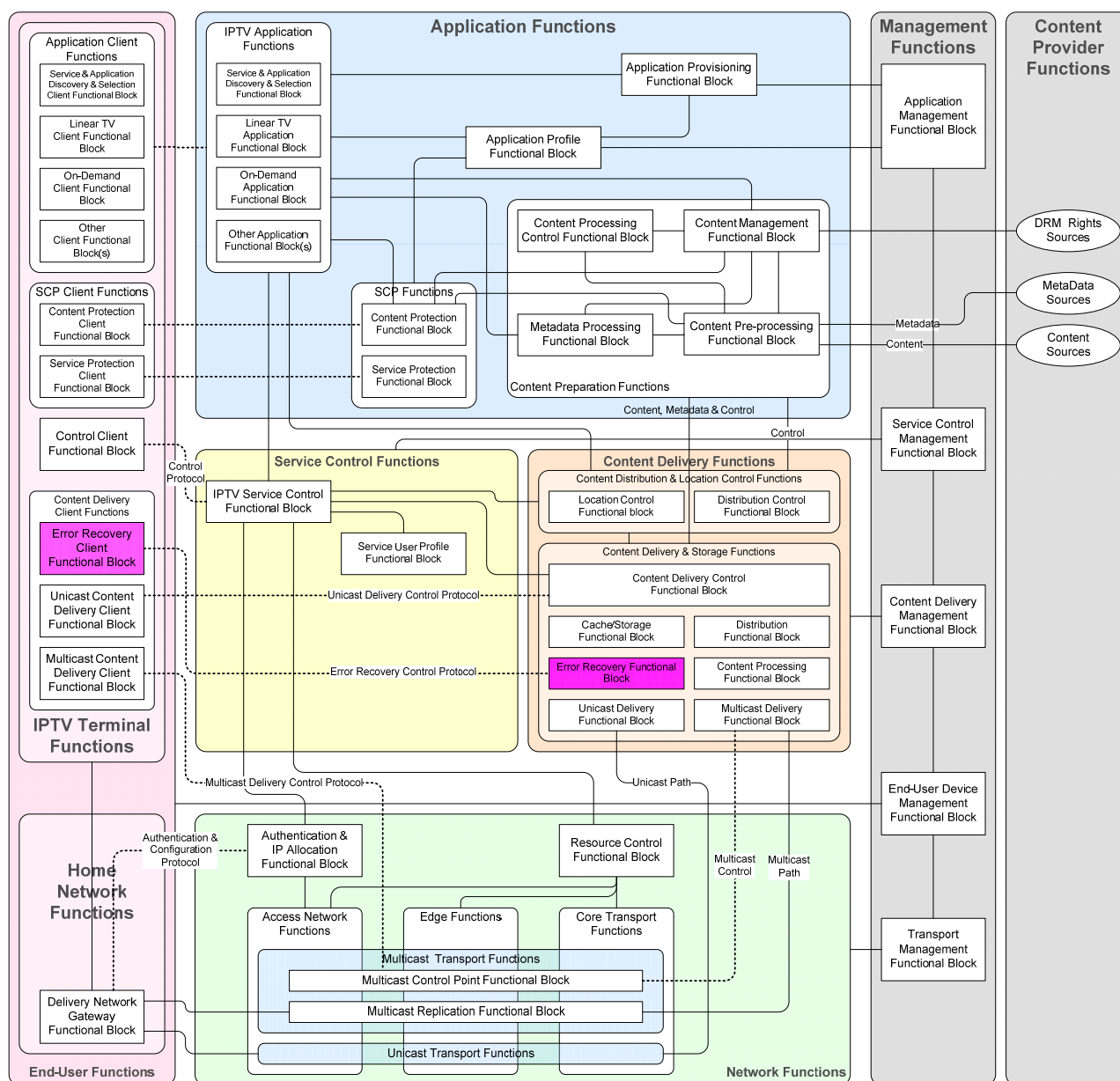


Figure 7-1 – Error recovery functions in IPTV architecture [ITU-T Y.1910]

[ITU-T Y.1910] adopts error recovery as an optional function in the content delivery functions in the IPTV architecture in case that the network functions cannot provide sufficient QoS for IPTV services, as shown in Figure 7-1. The error recovery function consists of the content delivery error recovery functional block and the error recovery client functional block. The configure/control interactions between these two functional blocks is established by an error recovery control protocol.

7.2 Content delivery error recovery functions

Figure 7-2 shows the content delivery error recovery function and error recovery client function decomposed into constituent functional blocks.

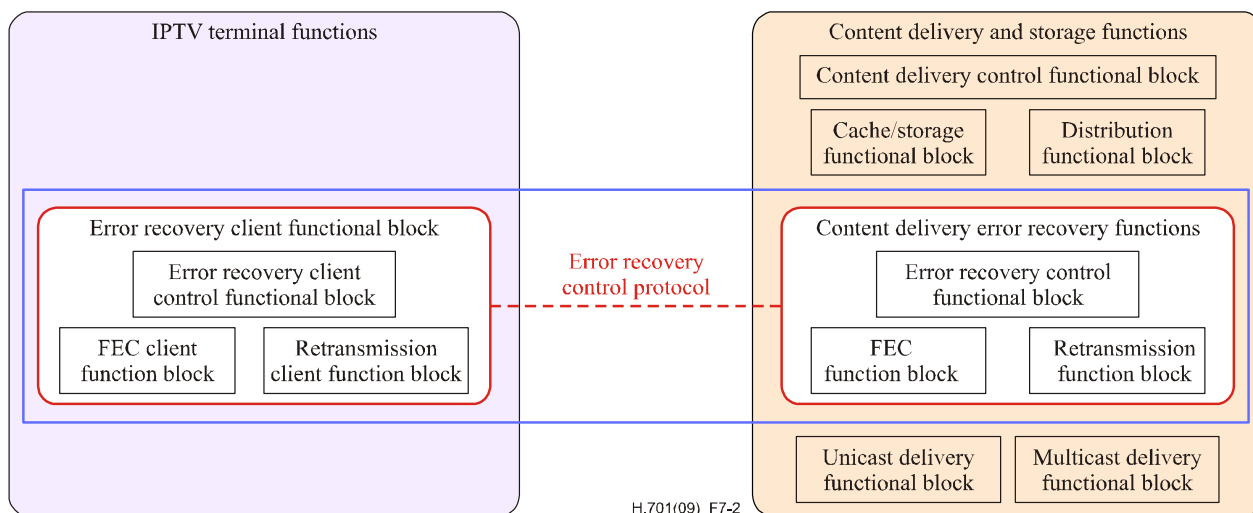


Figure 7-2 – CDER Functions

The constituent functional blocks are described in the following:

- **FEC functional block:** The FEC functional block generates FEC packets from the media data that are sent along with the media data to allow the receiver to correct packet losses in the media data. With this FEC information, the receivers can recover from packet losses locally at the receiver. The FEC may generate packets in layers that can be distinguished by the FEC Client function and can be individually selected using the error recovery control protocol. FEC may be used in unicast and multicast delivery.
- **Retransmission functional block:** The retransmission functional block retransmits lost packets to recover from packet losses on request of the retransmission client functional block through the error recovery control protocol. Retransmission may be unicast or multicast, depending on the distribution of clients reporting the errors.
- **Error recovery control functional block:** The error recovery control functional block controls the behaviour of the FEC functional block and the retransmission functional block. For example, it generates information such that the FEC client or the retransmission client functional block is informed on where to access redundant information, on the syntax and semantics of this information, etc. It also permits to send feedback information, if required.
- **FEC client functional block:** The FEC client functional block receives redundant information generated by the FEC functional block to correct packet losses in the original media data locally.
- **Retransmission client functional block:** The retransmission client functional block receives information generated by the retransmission functional block to correct packet losses in the original media data.
- **Error recovery client control functional block:** The error recovery client control functional block manages the behaviour of the FEC client functional block and retransmission client functional block. It receives configuration/control information generated by the error recovery control functional block, negotiates with the content delivery error recovery function on which CDER mechanism (FEC, retransmission or combination of the two) is available, and among those available, which is suitable for this terminal/service combination. It may also select the appropriate FEC layers.

The support of the CDER functions is not required for all networks, in particular for networks that can fulfil the desired IPTV service requirements. In case that a network cannot fulfil the packet loss requirements necessary to achieve the IPTV service requirements, the use of a content delivery error recovery solution is recommended.