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**Information technology — Enhanced  
communications transport protocol:  
Specification of QoS management for  
duplex multicast transport**

*Technologies de l'information — Protocole de transport de  
communications amélioré: Spécification de la gestion de QoS pour le  
transport duplex en multidiffusion*

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Tel. + 41 22 749 01 11  
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## Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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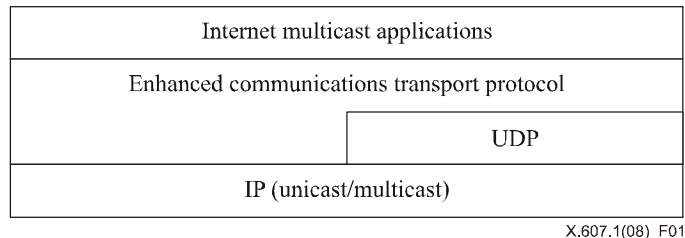
ISO/IEC 14476-4 was prepared by ITU-T (as ITU-T Rec. X.607.1) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by the national bodies of ISO and IEC. The identical text is published as ITU-T Rec. X.607.1 (11/2008).

ISO/IEC 14476 consists of the following parts, under the general title *Information technology — Enhanced communications transport protocol*:

- *Part 1: Specification of simplex multicast transport*
- *Part 2: Specification of QoS management for simplex multicast transport*
- *Part 3: Specification of duplex multicast transport*
- *Part 4: Specification of QoS management for duplex multicast transport*
- *Part 5: Specification of N-plex multicast transport*
- *Part 6: Specification of QoS management for N-plex multicast transport*

## Introduction

This Recommendation | International Standard specifies the Enhanced Communications Transport Protocol (ECTP), which is a transport protocol designed to support Internet multicast applications running over multicast-capable networks. ECTP operates over IPv4/IPv6 networks that have the IP multicast forwarding capability with the help of IGMP and IP multicast routing protocols, as shown in Figure 1. ECTP could possibly be provisioned over UDP.



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**Figure 1 – ECTP Model**

ECTP is designed to support tightly controlled multicast connections in simplex, duplex and N-plex applications. ECTP part 4 QoS management (this Recommendation | International Standard) specifies the quality of service (QoS) management functionality for stable management in the duplex multicast connection. The QoS management functionality consists of QoS negotiation, QoS monitoring and QoS maintenance operations. The procedures of reliability control in duplex connection have been defined in ECTP part 3 (Recommendation ITU-T X.607 | ISO/IEC 14476-3).

In ECTP-3 duplex multicast connection, the participants are classified into one Transport Connection Owner (TC-Owner) and many Transport Services/users (TS-users). TC-Owner will be designated among the TS-users before the connection begins. In the duplex multicast connection, the two types of data transports are supported: multicast data transport from TC-Owner to all the other TS-users and unicast data transport from TS-users to TC-Owner. After the connection is created, TC-Owner can transmit multicast data to the group, whereas each TS-user is allowed to send unicast data to TC-Owner just after it gets a token from the TC-Owner.

For QoS management in the duplex multicast connection, the TC-Owner triggers the connection creation process. Some or all of the enrolled TS-users will participate in the connection and become the designated "active TS-users". The TS-users who are active at this stage are able to participate in negotiating the desired QoS level for the session. In the duplex multicast connection, TS-users can send the data to TC-Owner, which each TS-user negotiates with TC-Owner for a QoS parameter for backward unicast data channel. TC-Owner proposes the target value of QoS parameter for forward multicast data channel and backward unicast data channel. If QoS negotiation is enabled, each TS-user can propose modified values of QoS parameters for forward multicast data channel and backward unicast data channel. TC-Owner arbitrates these modified values of QoS parameters for two types of data transport. These arbitrated values are delivered to TS-users via subsequent Heartbeat (HB) or Join Confirm (JC) packets, and will be used for QoS monitoring and maintenance. Any enrolled TS-user that is not active at this stage may participate in the connection as a late-joiner, but will have to accept the established QoS level.

After the connection is created, TC-Owner begins to transmit multicast data and some of TS-users who get a token from TC-Owner can send unicast data to TC-Owner. While the connection is active, TC-Owner monitors the status of the session via feedback control packets from the active TS-users.

TC-Owner may take a range of actions if network problems (such as severe congestion) are indicated by the feedback received from active TS-users. These actions include adjusting the data transmission rate, suspending multicast data transmission temporarily, or in the last resort, terminating the connection.

ECTP part 4 QoS management Specification can be used by the multicast applications that require supporting various QoS requirements and the corresponding billing/charging models.

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**INTERNATIONAL STANDARD  
RECOMMENDATION ITU-T**

**Information technology – Enhanced communications transport  
protocol: Specification of QoS management  
for duplex multicast transport**

## 1 Scope

This Recommendation | International Standard provides a specification of QoS management for accomplishing desirable QoS for a duplex multicast transport connection. For this purpose, this Specification describes the QoS management operations in duplex multicast transport connection such as QoS negotiation, QoS monitoring and QoS maintenance. This Recommendation | International Standard is an integral part of ECTP-3 (Rec. ITU-T X.607 | ISO/IEC 14476-3). All of the protocol components, including packet formats and protocol procedures specified in Rec. ITU-T X.607 | ISO/IEC 14476-3, are also valid in this Recommendation | International Standard.

## 2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

- Recommendation ITU-T X.601 (2000), *Multi-peer communications framework*.
- Recommendation ITU-T X.602 (2004) | ISO/IEC 16513:2005, *Information technology – Group management protocol*.
- Recommendation ITU-T X.605 (1998) | ISO/IEC 13252:1999, *Information technology – Enhanced Communications Transport Service Definition*.
- Recommendation ITU-T X.606 (2001) | ISO/IEC 14476-1:2002, *Information technology – Enhanced Communications Transport Protocol: Specification of simplex multicast transport*.
- Recommendation ITU-T X.606.1 (2003) | ISO/IEC 14476-2:2003, *Information technology – Enhanced Communications Transport Protocol: Specification of QoS management for simplex multicast transport*.
- Recommendation ITU-T X.607 (2007) | ISO/IEC 14476-3:2008, *Information technology – Enhanced communications transport protocol: Specification of duplex multicast transport*.
- Recommendation ITU-T X.608 (2007) | ISO/IEC 14476-5:2008, *Information technology – Enhanced communications transport protocol: Specification of N-plex multicast transport*.

## 3 Definitions

### 3.1 Terms defined in Rec. ITU-T X.605 | ISO/IEC 13252

This Recommendation | International Standard is based on the concepts developed in Enhanced Communications Transport Service (Rec. ITU-T X.605 | ISO/IEC 13252):

- a) QoS parameters;
- b) QoS negotiation;
- c) QoS arbitration.

### 3.2 Terms defined in Rec. ITU-T X.606 | ISO/IEC 14476-1

This Recommendation | International Standard is described based on the concepts and terms developed in the specification of simplex multicast transport on ECTP-1:

- a) application;
- b) packet;

- c) sender;
- d) receiver;
- e) tree;
- f) parent;
- g) child.

### 3.3 Terms defined in Rec. ITU-T X.606.1 | ISO/IEC 14476-2

This Recommendation | International Standard is described based on the concepts and terms developed in the specification of simplex multicast transport on ECTP-2:

- a) QoS monitoring;
- b) QoS maintenance.

### 3.4 Terms defined in Rec. ITU-T X.607 | ISO/IEC 14476-3

This Recommendation | International Standard is described based on the concepts and terms developed in the specification of duplex multicast transport on ECTP-3:

- a) SU (Sending TS-User)

Some of the ECTP-3 TS-users can send unicast data to the TC-Owner. A sending TS-user (SU) is a TS-user who gets a token from TC-Owner. Only the SU is allowed to send unicast data to TC-Owner. In other words, before sending unicast data, each user must request a token to TC-Owner.

- b) Token

It represents the rights for a TS-user to transmit data. The TS-user who has a token is called a Sending TS-User (SU). The tokens are managed by TC-Owner.

- c) Forward data channel

It represents the multicast data channel from TC-Owner to the group members. TC-Owner sends multicast data to all the other group members over IP multicast address.

- d) Backward data channel

It represents the unicast data channel, in which the data packet flows from an SU to TC-Owner. An SU can send unicast data to TC-Owner over IP unicast address.

## 4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

### 4.1 Packet types

ACK	Acknowledgment
CC	Connection Creation Confirm
CR	Connection Creation Request
CT	Connection Termination Request
DT	Data
HB	Heartbeat
HBACK	Heartbeat Acknowledgment
JC	Late Join Confirm
ND	Null Data
TC	Tree Join Confirm
TGC	Token Get Confirm
TGR	Token Get Request
TRC	Token Return Confirm
TRR	Token Return Request



## 4.2 Miscellaneous

ADN	Active Descendant Number
API	Application Programming Interface
CHQ	Controlled Highest Quality
Diffserv	Differentiated Services
ECTP	Enhanced Communications Transport Protocol
ECTP-5	Enhanced Communications Transport Protocol, part 5
ECTS	Enhanced Communications Transport Services
IP	Internet Protocol
LO	Local Owner
LQA	Lowest Quality Allowed
MSS	Maximum Segment Size
OT	Operating Target
QoS	Quality of Service
RSVP	Resource Reservation Protocol

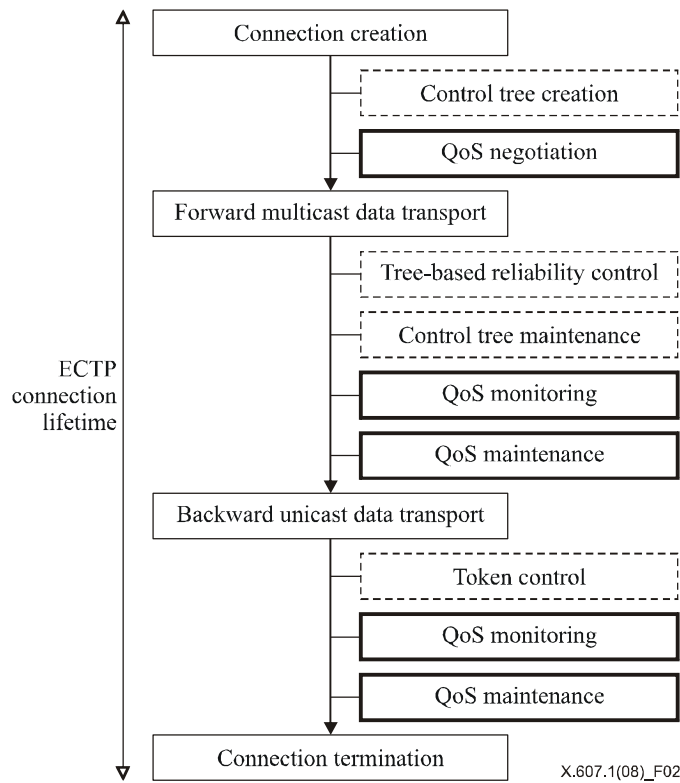
## 5 Overview

This Recommendation | International Standard provides a specification of QoS management for duplex multicast transport connections. This Specification describes the following QoS management operations:

- a) QoS negotiation, including reservation of network resources;
- b) QoS monitoring;
- c) QoS maintenance.

In the connection creation phase, TC-Owner informs TS-users whether QoS management is enabled. If QoS management is enabled, TC-Owner must also specify whether or not QoS negotiation will be performed in the connection. QoS monitoring and maintenance operations are performed only if QoS management is enabled.

Figure 2 illustrates these QoS management operations for the duplex multicast connection. In the figure, the protocol operations marked as dotted lines are specified in Rec. ITU-T X.607 | ISO/IEC 14476-3 (ECTP-3).



**Figure 2 – QoS management in the duplex connection**  
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In this figure, it is noted that the basic control operations of the duplex multicast connection are described in ECTP-3, such as the control tree creation, tree-based reliability control, control tree maintenance for forward multicast channel, and the token control for backward channels in the duplex multicast connection. The QoS monitoring and maintenance operations for forward multicast channel are specified in ECTP-2. In this Specification, the QoS negotiation for the duplex multicast connection and the QoS monitoring and maintenance operations for 'backward unicast channel' will be introduced.

From the requirements of the applications, TC-Owner will determine the target values for each QoS parameter. The procedures of mapping the application's requirements to those target parameter values are outside the scope of this Specification. Application programs could be used to carry out such mappings.

QoS negotiation is performed in the connection creation phase. TC-Owner proposes the desired target values for each QoS parameter for forward multicast data channel and backward unicast data channel to all TS-users by multicast via the CR message. For the throughput parameter, three target values are specified: controlled highest quality (CHQ), operating target (OT) and lowest quality allowed (LQA). For the other parameters, such as transit delay, transit delay jitter, and data loss rate, only two target values are specified: OT and LQA.

If QoS negotiation is enabled, each TS-user can propose modifications to the TC-Owner's proposed parameter values. These modified values will be determined by considering the system capacity at TS-user side and network environments. The following restrictions are imposed for modification of parameter's values by TS-users:

- 1) OT values must not be modified by TS-users;
- 2) the values modified by TS-users must be within LQA and CHQ values proposed by TC-Owner.

The parameter values modified by TS-users are delivered to TC-Owner via CC messages. TC-Owner arbitrates different parameter values for various TS-users by taking a default range of values.

Figure 3 shows an abstract sketch of QoS negotiation that can occur in ECTP-4. From the application's requirements, a set of target QoS parameter values for forward multicast data channel and backward unicast data channel will be configured at TC-Owner. TC-Owner informs TS-users about the target values for forward multicast data channel and backward unicast data channel (step 1). Based on those target values, each TS-user begins to make resource reservations with the help of RSVP or Diffserv (step 2). If QoS negotiation is enabled in the connection, each TS-user may propose modified values for QoS parameters for forward multicast data channel and backward unicast data channel (step 3). From these modified parameter values, TC-Owner determines the arbitrated values (step 4). These arbitrated values are delivered to TS-users via subsequent HB or JC packets, and will be used for QoS monitoring and maintenance.

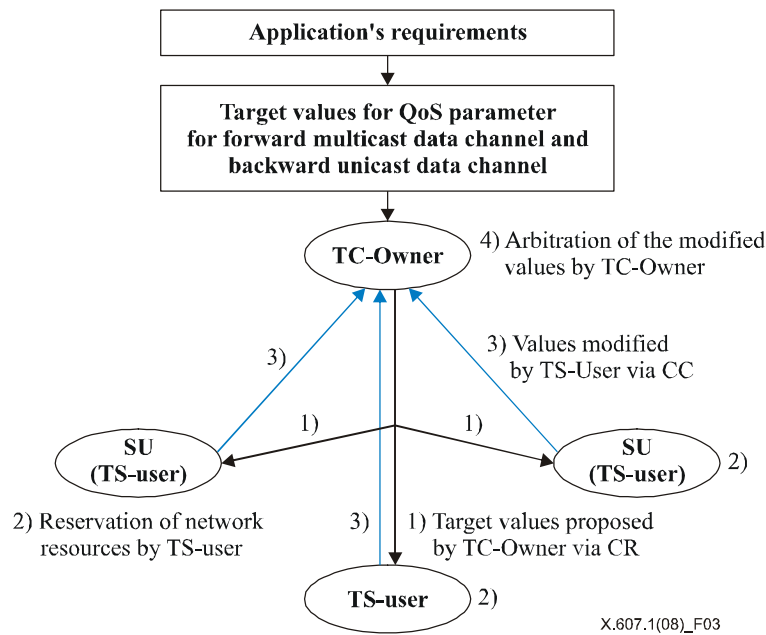


Figure 3 – QoS negotiation in the ECTP duplex connection

After an ECTP connection is created, and consequently if QoS management is enabled, the QoS monitoring and maintenance operations are performed for forward multicast data channel and backward unicast data channel. For QoS monitoring, each TS-user is required to measure the parameter values experienced for forward multicast data channel and TC-Owner is required to measure the parameter values experienced for backward unicast data channel. Based on the measured values and the negotiated values, a TS-user determines a parameter status value for each parameter as an integer: normal (0), reasonable (1), possibly abnormal (2) or abnormal (3). These status values will be delivered to TC-Owner via ACK packets. TC-Owner aggregates the parameter status values reported from TS-users. If a control tree is employed, each parent Local Owner (LO) node aggregates the measured values reported from its children, and forwards the aggregated value(s) to its own parent using ACK packets. In backward unicast data channel, these status values will be delivered to sending TS-user from TC-Owner via HBACK used for retransmission request.

TC-Owner takes QoS maintenance actions necessary to maintain the connection status at a desired QoS level, based on the monitored status values. Specific rules are pre-configured to trigger QoS maintenance actions such as data transmission rate adjustment, connection pause, and resume, troublemaker ejection and connection termination. Those actions will be taken by observing how many TS-users are in the abnormal or possibly abnormal state. In backward unicast data channel, each sending TS-user will take the associated QoS maintenance actions based on the status values contained in the HBACK packets delivered to the sending TS-user from TC-Owner.

## 6 Components for QoS management

This clause describes the ECTP-3 protocol components required for QoS management operations. All of the components are extended from those already defined in Rec. ITU-T X.607 | ISO/IEC 14476-3.

### 6.1 Base header

Figure 4 shows the base header specified in Rec. ITU-T X.607 | ISO/IEC 14476-3 (in case of ECTP-3 over IP).

0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
Next element	Version	CT	Packet type												Checksum																
Source port												Destination port																			
Packet sequence number (PSN)																															
Payload length												F	Reserved	QN	Token ID																

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Figure 4 – Base Header in ECTP-3