
**Information technology — Enhanced
communications transport protocol:
Specification of QoS management for
n-plex multicast transport**

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

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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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 14476-6 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology, Subcommittee SC 6, Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T Rec. X.608.1 (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

ECTP is designed to support tightly controlled multicast connections in simplex, duplex and n-plex applications. This part of ECTP (Recommendation ITU-T X.608.1 | ISO/IEC 14476-6) specifies the quality of service (QoS) management functions for the n-plex multicast transport protocol (ECTP-5: Recommendation ITU-T X.608 | ISO/IEC 14476-5).

In the n-plex multicast connection, the participants include one TC-Owner and many TS-users. TC-Owner will be chosen among the TS-users before the connection begins. TC-Owner is at the heart of multicast group communications. It is responsible for overall connection management by governing the connection creation and termination, multicast data transport, and the late join and leave operations. The multicast data transmissions are allowed by TS-users as well as the TC-Owner. Each TS-user is allowed to send multicast data to the group only if it gets a token from the TC-Owner. That is, the multicast data transmissions of TS-users are controlled by the TC-Owner.

For the stable QoS management of the n-plex multicast connection, this Specification provides the QoS management functions such as QoS negotiation, QoS monitoring and QoS maintenance.

The target QoS parameters are negotiated between the TC-Owner and TS-users before the connection creation. During the connection, the status of the connection is monitored by TS-users, and the monitoring result is delivered to Sending TS-users and the TC-owner via control packets. According to the QoS monitoring result, Sending TS-users may adjust their data transmission rate, and the TC-owner may pause or terminate the connection.

This QoS management Specification can be used in multicast applications that want to support 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 n-plex multicast transport**

1 Scope

This Recommendation | International Standard provides a specification of QoS management for accomplishing a desired quality of service in n-plex multicast transport connections. For this purpose, this Specification describes the QoS management operations in n-plex multicast transport connections such as QoS negotiation, QoS monitoring and QoS maintenance. This Recommendation | International Standard is an integral part of ECTP-5 (Rec. ITU-T X.608 | ISO/IEC 14476-5). All of the protocol components, including packet formats and protocol procedures specified in Rec. ITU-T X.608 | ISO/IEC 14476-5, 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 (Rec. ITU-T X.606 | ISO/IEC 14476-1):

- a) application;
- b) packet;

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- 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 (Rec. ITU-T X.606.1 | ISO/IEC 14476-2).

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

3.4 Terms defined in Rec. ITU-T X.608 | ISO/IEC 14476-5

This Recommendation | International Standard is described based on the concepts and terms developed in the specification of n-plex multicast transport on ECTP-5 (Rec. ITU-T X.608 | ISO/IEC 14476-5).

- a) TCN (TC-Owner):

An n-plex multicast connection has a single TCN. The TCN is responsible for connection management including connection creation/termination, late join, connection maintenance, and token management.

For example, in teleconferencing applications, the TCN may act as the 'conference server', which may be used for control of the conferencing without sending multicast data. In the example of a 'multi-user on-line game' application, the TCN may act as the 'game-control server'.

- b) SU (Sending TS-user):

A TS-user who gets a token from the TCN. Only the SU is allowed to send multicast data to the group. In other words, before sending multicast data, each user must request a token from the TCN.

- c) LO (Local Owner):

For a given subset of participants, an LO becomes a root of a locally configured shared tree in the local group. Each LO is also connected to other LOs in inter-group trees. Each LO will control the tree configuration for the local group. It will also perform error recovery as the parent for the local group.

- d) Token:

It represents the right for a TS-user to transmit multicast data. A TS-user who has a token is called an SU. The tokens are managed by the TC-Owner.

- e) Multicast data channel:

The TCN or an SU can send multicast data to all the other group members over an IP multicast 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
CSR	Connection Status Report
CT	Connection Termination Request
DT	Data
JC	Late Join Confirm
JR	Late Join Request
TGC	Token Get Confirm
TGR	Token Get Request

TSR Token Status Report

4.2 Miscellaneous

ADN Active Descendant Number
 CHQ Controlled Highest Quality
 Diffserv Differentiated Services
 ECTP Enhanced Communications Transport Protocol
 ECTS Enhanced Communications Transport Services
 IP Internet Protocol
 LQA Lowest Quality Allowed
 MSS Maximum Segment Size
 OT Operating Target
 QoS Quality of Service
 RSVP Resource Reservation Protocol

5 Conventions

None.

6 Overview

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

- a) QoS negotiation, including reservation of network resources:

For QoS negotiation, this Specification assumes that a desired QoS level for multicast application service can be expressed in terms of a set of QoS parameters. QoS negotiation is performed via an exchange of control packets between the TCN (TC-owner) and TS-users for the multicast data channel. The TCN proposes the target values of QoS parameters obtained from the application's requirements in order for TS-users to send or receive multicast data, and each TS-user can propose modified values based on its system and/or network capacity and the application's requirements. The TCN arbitrates the modified values proposed by TS-users. Target values for QoS parameters can be used as input parameters for reservation of network resources.

- b) QoS monitoring:

QoS control in ECTP-6 is based on feedback of control packets from TS-users. The feedback messages from TS-users enable the TCN to keep track of the number of TS-users and also to monitor the connection status for the multicast data channel. QoS monitoring is designed to allow TS-users and the TCN to diagnose the connection status in terms of QoS parameter values, and thus to take the necessary actions for maintaining the connection status at a desired QoS level. The monitored connection status will be reported to the application on the TCN side. The information conveyed could provide statistics useful for billing purposes, for example.

- c) QoS maintenance:

Based on feedback information from TS-users, the TCN and SUs (Sending TS-users) take one or more actions so as to maintain the connection status at a desired QoS level. These QoS maintenance actions include adjustment of the data transmission rate, connection pause and resume, troublemaker ejection and connection termination operations. These QoS monitoring and maintenance functions, based on monitored parameter status, provide rate-based congestion control.

In the connection creation phase, the TCN informs TS-users whether QoS management is enabled. If QoS management is enabled, the TCN 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 1 illustrates these QoS management operations for the n-plex multicast connection. In the figure, the protocol operations marked as dotted lines are specified in Rec. ITU-T X.608 | ISO/IEC 14476-5 (ECTP-5).

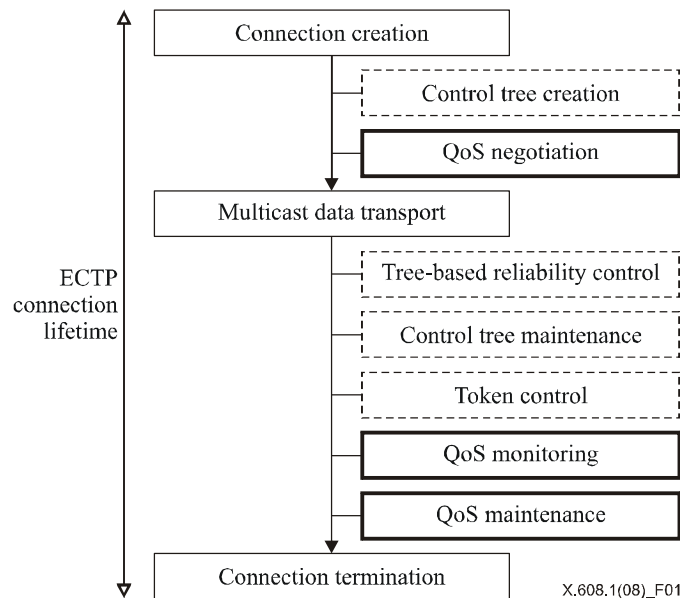


Figure 1 – QoS management in the n-plex connection

In this figure, it is noted that the basic control operations of the n-plex multicast connection are described in ECTP-5, such as control tree creation, tree-based reliability control, control tree maintenance and token control. In this Specification, the QoS negotiation, monitoring and maintenance operations for the n-plex multicast connection will be introduced.

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From the requirements of the applications, the TCN will determine the target values for each QoS parameter. The procedures for mapping the requirements of an application to these 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. The TCN proposes the desired target values for each QoS parameter, used when sending multicast data to TS-users and receiving multicast data from SUs by multicast, via the CR packet. 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 TCN's proposed parameter values. These modified values will be determined by considering the system capacity at the TS-user side and network environment. The following restrictions are imposed for modification of the parameter values by TS-users:

- a) OT values must not be modified by TS-users;
- b) the values modified by TS-users must be within the LQA and CHQ values proposed by the TCN.

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

Figure 2 shows an abstract sketch of QoS negotiation that can occur in ECTP-6. From the requirements of the application, a set of target QoS parameter values for the multicast data channel will be configured at the TCN. The TCN informs TS-users about the target values for sending multicast data to TS-users and receiving multicast data from an SU (step 1). Based on these target values, each TS-user begins to make resource reservations with the help of RSVP [4] [5] or Diffserv [6] (step 2). If QoS negotiation is enabled in the connection, each TS-user may propose modified values for QoS parameters based on its system and/or network capacity and the requirements of the application for the multicast data channel (step 3). From these modified parameter values, the TCN determines the arbitrated values for sending multicast data to other TS-users and receiving multicast data from other TS-users (step 4). These arbitrated values are delivered to TS-users via subsequent TSR or JC packets and will be used for QoS monitoring and maintenance.

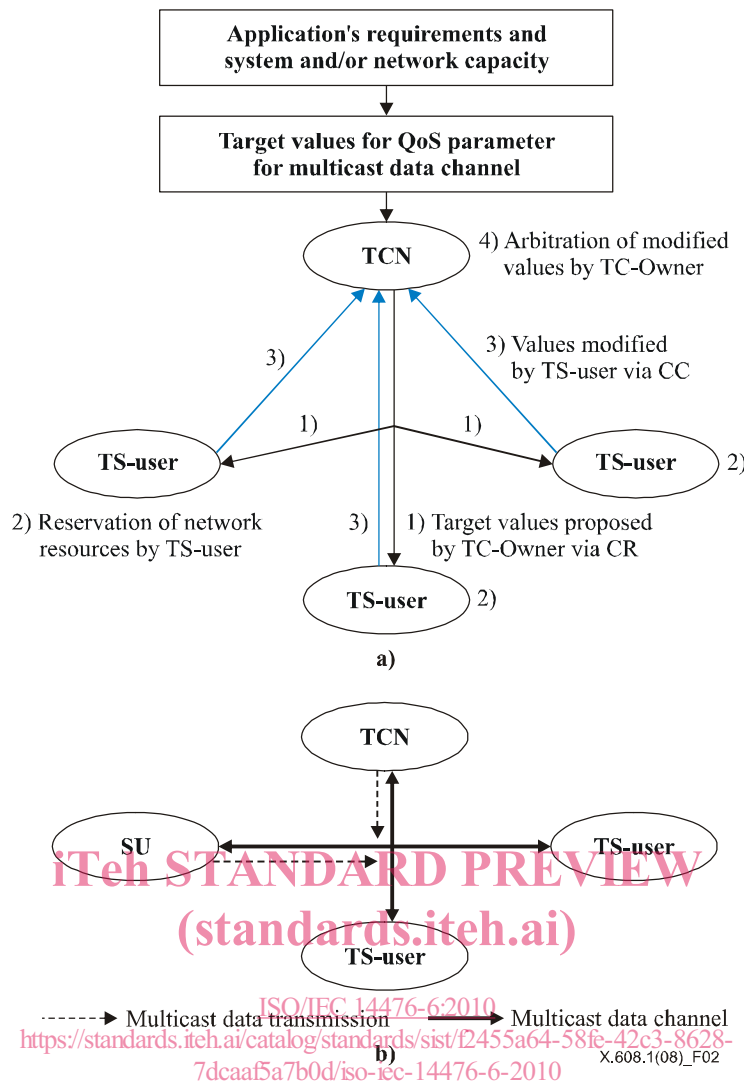


Figure 2 – a) QoS negotiation procedures; b) Multicast data transport in ECTP-5

After an ECTP connection is created and, consequently, if QoS management is enabled, the QoS monitoring and maintenance operations are performed for a multicast data channel. For QoS monitoring, each TS-user is required to measure the QoS parameter values experienced in the multicast data channel. Based on the measured values and the negotiated values, a TS-user determines a 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 the parent node via ACK packets along the control tree. Each TS-user aggregates the parameter status values reported by its child nodes and forwards the aggregated value(s) to its own parent using ACK packets. Finally, these status values are delivered to the SUs and the TCN.

Based on the monitored status values, an SU and the TCN invoke QoS maintenance actions to maintain the connection status at a desired QoS level. 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. These actions will be taken by observing how many TS-users are in an abnormal or possibly abnormal state.

7 Components for QoS management

This clause describes the ECTP-6 protocol components required for QoS management operations. All of the components are extended from those already defined in Rec. ITU-T X.608 | ISO/IEC 14476-5.

7.1 Base header

Figure 3 shows the base header specified in Rec. ITU-T X.608 | ISO/IEC 14476-5 (in case of ECTP-5 over IP). Note that the two 1-bit fields (Q and N) are inserted into the 'Reserved' field of the original base header of ECTP-5.