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

*Technologies de l'information — Protocole de transport de
communications amélioré. Spécification de gestion QoS pour
le transport simplex 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 technical committee are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member 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 shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 14476-2 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.606.1.

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.

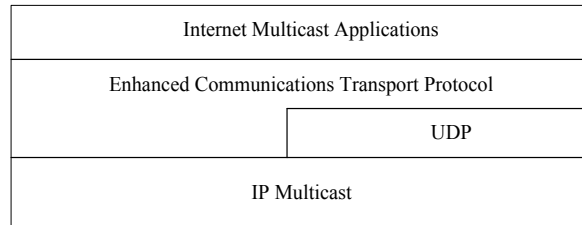


Figure 1 – ECTP model

ECTP is targeted to support tightly controlled multicast connections in simplex, duplex and N-plex applications. This part of ECTP (part 2) specifies the QoS management functions for stable management of the QoS of connection users in a simplex multicast connection. QoS management functionality consists of QoS negotiation, QoS monitoring, and QoS maintenance operations. The protocol procedures for reliability control in simplex multicast transport are defined in ECTP part 1 (ITU-T Rec. X.606 | ISO/IEC 14476-1), which forms an integral part of this Recommendation | International Standard. Further parts of the standard will define control procedures and associated QoS management functions respectively for the duplex case (X.ectp-3 | ISO/IEC 14476-3 and X.ectp-4 | ISO/IEC 14476-4) and for the N-plex case (X.ectp-5 | ISO/IEC 14476-5 and X.ectp-6 | ISO/IEC 14476-6).

In ECTP, all prospective members are enrolled into a multicast group, before a connection or session is created. Those members define an enrolled group. Each receiver in the enrolled group is referred to as an enrolled receiver. In the enrolment process, each member will be authenticated. The group information, including group key and IP multicast addresses and port numbers, will be distributed to the enrolled members during the enrolment process. An ECTP connection is created for these enrolled group members.

The sender is at the heart of multicast group communications. A single sender in the simplex multicast connection is assigned the role of the connection owner, designated top owner (TO) in this Specification. The connection owner is responsible for overall connection management by governing the connection creation and termination, the connection pause and resumption, and the late join and leave operations.

The sender triggers the connection creation process. Some or all of the enrolled receivers will participate in the connection, becoming designated "active receivers". Receivers active at this stage are able to participate in negotiating the desired quality of service for the session. Any enrolled receiver that is not active at this stage may participate in the connection as a late-joiner, but will have to accept the established QoS. An active receiver can leave the connection.

After the connection is created, the sender begins to transmit multicast data. While the connection is active, the sender monitors the status of the session via feedback control packets from the active receivers.

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

This QoS management specification can be used in the multicast applications that want to support various QoS requirements and the corresponding billing/charging models.

**INTERNATIONAL STANDARD
ITU-T RECOMMENDATION**

**Information technology – Enhanced Communications Transport Protocol:
Specification of QoS management for simplex multicast transport**

1 Scope

This Recommendation | International Standard is an integral part of ITU-T Recs X.606.x | ISO/IEC 14476 "ECTP: Enhanced Communications Transport Protocol", which is a family of Protocol Specifications designed to support multicast transport services.

ITU-T Rec. X.606 | ISO/IEC 14476-1 provides a specification of various protocol operations for simplex multicast transport. Those protocol operations include connection management such as connection creation/termination and connection pause/resume, membership management such as late join, user leave and membership tracking, and error control for multicast data transport such as error detection and recovery.

This part of the Recommendation | International Standard provides a specification of QoS management for accomplishing desirable quality of service in simplex multicast transport connection.

This Specification describes the following QoS management operations:

a) *QoS negotiation*

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 exchange of control packets between sender and receivers. Sender proposes the target values of QoS parameters obtained from the application's requirements, and then each receiver can propose modified values based on its system and/or network capacity. Sender arbitrates the modified values proposed by receivers. Target values for QoS parameters can be used as input parameters for reservation of network resources.

b) *QoS monitoring*

QoS control in ECTP is based on feedback of control packets from receivers. The feedback messages from receivers enable the sender to keep track of the number of active receivers and also to monitor the connection status for multicast data transport. QoS monitoring is designed to allow the sender 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 at the sender side. The information conveyed could provide statistics useful for billing purposes, for example.

c) *QoS maintenance*

Based on feedback information from receivers, the sender takes 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.

This Recommendation | International Standard is an integral part of ITU-T Recs X.606.x | ISO/IEC 14476, which has 6 parts. All of the protocol components, including packet formats and protocol procedures specified in ITU-T Rec. X.606 | ISO/IEC 14476-1, 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.

- ITU-T Recommendation X.601 (2000), Multi-peer communications framework.
- ITU-T Recommendation X.605 (1998) | ISO/IEC 13252:1999, *Information technology – Enhanced Communications Transport Service definition*.

- ITU-T Recommendation X.606 (2001) | ISO/IEC 14476-1:2002, *Information technology – Enhanced Communications Transport Protocol: Specification of Simplex Multicast Transport*.

3 Definitions

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

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

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

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

- a) application;
- b) packet;
- c) sender;
- d) receiver;
- e) tree;
- f) parent; and
- g) child.

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3.3 Terms defined in this Recommendation | International Standard

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

- a) **QoS monitoring:** Is the protocol operation that is used to diagnose the current connection status. For QoS monitoring, each receiver is required to measure the experienced parameter values and to report them to sender. Sender aggregates the status information reported from receivers.
- b) **QoS maintenance:** Is the protocol operation that is used to maintain the connection status at a desired QoS level. Sender takes QoS maintenance actions based on the monitored status information.

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
DT	Data
HB	Heartbeat
JC	Late Join Confirm
JR	Late Join Request
LR	Leave Request
ND	Null Data
RD	Retransmission Data

4.2 Miscellaneous

API	Application Programming Interfaces
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

In this Recommendation | International Standard, the key words "MUST", "REQUIRED", "SHALL", "MUST NOT", "SHALL NOT", "SHOULD", "SHOULD NOT", "MAY", and "OPTIONAL" indicate requirement levels for compliant ECTP implementations.

6 Overview

This Recommendation | International Standard provides a specification of QoS management for one-to-many (simplex) multicast transport connections. This Specification describes the following QoS management operations:

- 1) QoS negotiation, including reservation of network resources;
- 2) QoS monitoring; and
- 3) QoS maintenance.

In the connection creation phase, sender informs the receivers whether QoS management is enabled. When QoS management is enabled, sender 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 simplex multicast connection. In the figure, the protocol operations marked as dotted lines are specified in ITU-T Rec. X.600 | ISO/IEC 14476-1.

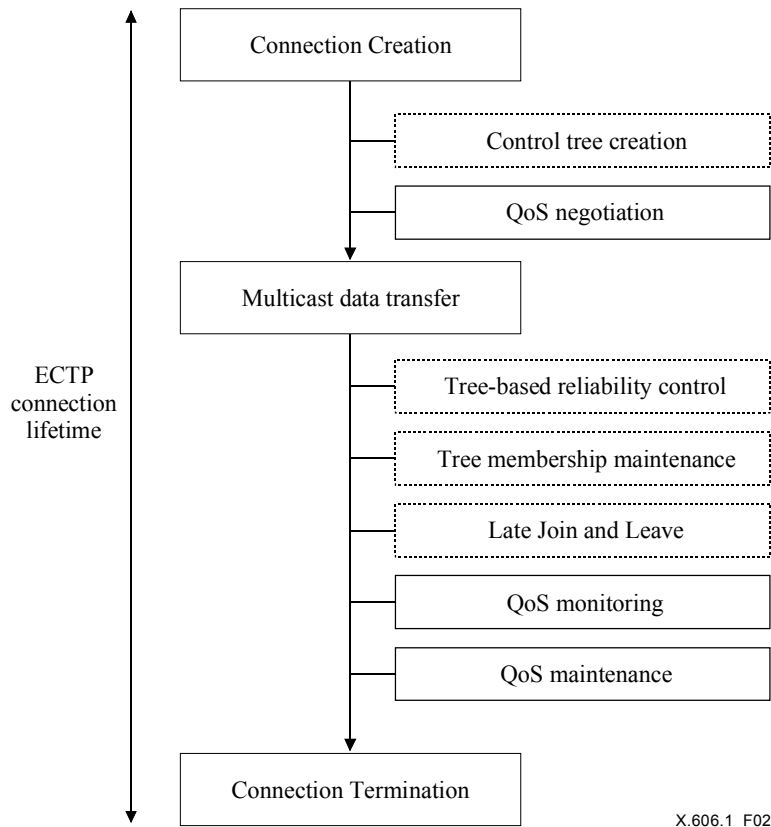


Figure 2 – QoS management in ECTP
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In general, QoS represents the quality of service required for satisfactory reception of application data at a receiver, to achieve desirable audio/video display quality for example. In this Specification, it is assumed that the QoS requirements of an application are expressed in terms of one or more QoS parameters such as throughput, transit delay, transit delay jitter, and data loss rate. Depending on the application's requirements, some of these QoS parameters may not be used in the connection. For example, a non-real time service might not impose the transit delay requirement.

From the requirements of applications, sender will determine the target values for each QoS parameter. How to map from the application's requirements to those target parameter values is outside the scope of this Specification. Application programs could be used to carry out such mappings.

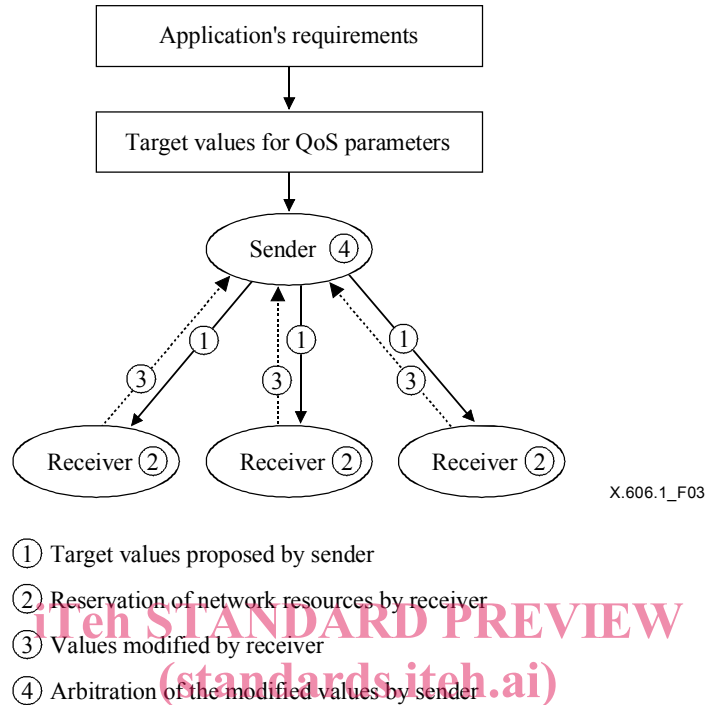
QoS negotiation is performed in the connection creation phase. Sender proposes the desired target values for each QoS parameter to all receivers by multicast. For throughput, three target values are specified: CHQ (controlled highest quality), OT (operating target) and LQA (lowest quality allowed). For 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 receiver can propose modifications to the sender's proposed parameter values. These modified values will be determined by considering the system capacity at the receiver side and network environments. The following restrictions are imposed for modification of parameter values by receivers:

- 1) OT values must not be modified by receivers;
- 2) the values modified by receivers must be within LQA and CHQ values proposed by sender.

The parameter values modified by receivers are delivered to sender via ACK messages. The sender arbitrates different parameter values for various receivers by taking a commonly agreed range of values.

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



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Figure 3 – QoS negotiation
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After an ECTP connection is created, and if QoS management is enabled, the QoS monitoring and maintenance operations are performed for the multicast data transmission. For QoS monitoring, each receiver is required to measure the parameter values experienced. Based on the measured values and the negotiated values, a receiver 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 the sender via ACK packets.

Sender aggregates the parameter status values reported from the receivers. If a control tree is employed, each parent LO node aggregates the measured values reported from its children, and forwards the aggregated value(s) to its own parent using ACK packets.

Figure 4 illustrates the QoS monitoring and maintenance operations described in this Specification.

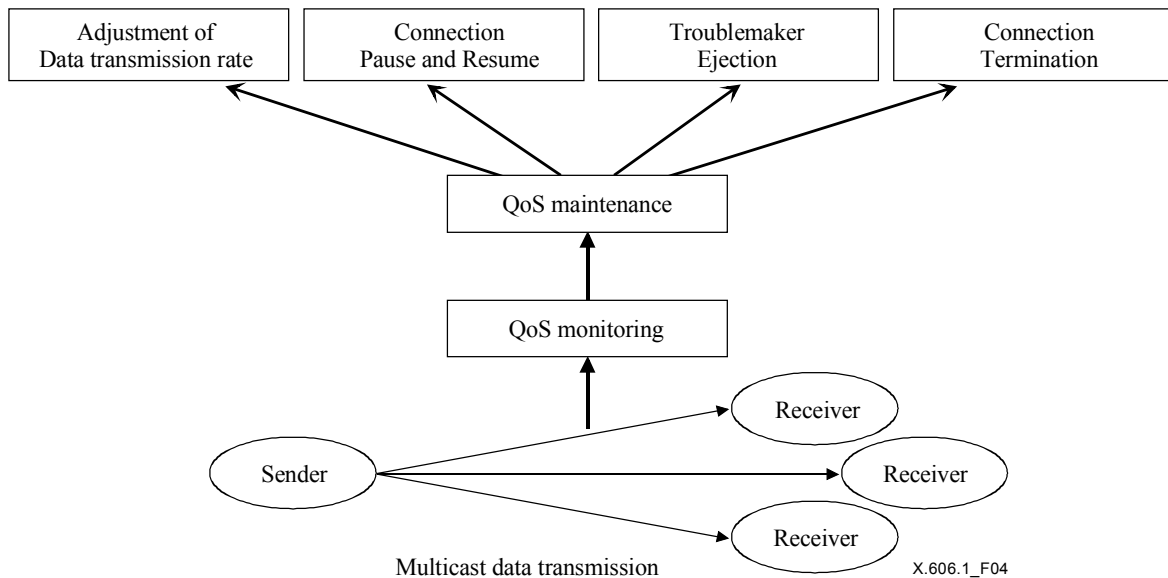


Figure 4 – Conceptual sketch of QoS monitoring and maintenance

Sender 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 receivers are in the abnormal or possibly abnormal state.

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7 Components for QoS management

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This clause describes the ECTP protocol components required for QoS management operations. All the components are extended from those already defined in ITU-T Rec. X.606 | ISO/IEC 14476-1.

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7.1 Connection information element

Figure 5 shows the connection information element specified in ITU-T Rec. X.606 | ISO/IEC 14476-1.

0	8	16	24	31
Next element	Version	Flags	Tree config. option	Maximum tree level
Connection creation time		ACK bitmap size		Reserved

Figure 5 – Connection information element

For QoS management, the ECTP sender specifies the following three fields in the 'Flags' byte:

7	6	5	4	3	2	1	0
Reserved	Retx	N	QoS	CT			

- 1) *QoS* – is a flag bit to indicate whether QoS management is enabled (1) or not (0) in the connection. If this bit is set to '1', all the procedures for QoS management are invoked. The default value is '0'.
- 2) *N (negotiation)* – is a flag bit to indicate whether QoS negotiation is enabled (1) or not (0) in the connection. If this bit is set to '1', each receiver is allowed to propose its own parameter values. The default value is '0'.
- 3) *Retx (retransmission)* – is a flag bit to indicate whether retransmissions by parent are performed (0) or not (1). If this bit is set to '1', the sender or parents need not retransmit RD packets, even if the retransmission requests by ACK packets are received. The default value is '0'.

The QoS bit must be set to "1" (QoS enabled) before the N bit is valid. There are three possible cases.

- a) QoS bit set to "1" and N bit set to "0" indicates that QoS is to be used in the connection, and QoS values will be imposed by the sender. The receivers cannot negotiate it.
- b) Both bits set to "1" indicate that QoS is to be used in the connection, and QoS parameter values may be negotiated between receivers and the sender.
- c) QoS bit set to "0" indicates that QoS is not to be used in the connection. The N bit is not used in this case.

The setting of the Retx (retransmission bit) can be done independently of the setting of the QoS bit. It is expected that real-time live streaming media applications will not need error recovery based on retransmissions, but they need the QoS management functions. Even in this case, ACK packets are still used to convey connection status information.

7.2 QoS parameters

In this Specification, the following four QoS parameters are defined:

- 1) throughput (bytes per second);
- 2) transit delay (millisecond);
- 3) transit delay jitter (millisecond);
- 4) data loss rate (percent).

Throughput represents an amount of application data output over a specific time period. Target throughput means a throughput value required for desirable display of application data. Applications generate multicast data and ECTP sender will transmit them, based on the target throughput value(s). Actual data reception rate at receiver's side will depend on data transmission rate, network conditions and end system capacity, etc.

For throughput, the sender shall configure the following target values:

- 1) CHQ throughput;
- 2) OT throughput;
- 3) LQA throughput.

Among them, the following inequalities must be enforced: $LQA \text{ throughput} \leq OT \text{ throughput} \leq CHQ \text{ throughput}$.

Transit delay represents end-to-end transmission time from a sender to a receiver. For desirable display of multicast data, the sender may configure the following target values:

- 1) OT transit delay;
- 2) LQA transit delay.

Between them, the following inequalities must be enforced: $OT \text{ transit delay} \leq LQA \text{ transit delay}$.

Transit delay jitter represents variations of transit delay values. For desirable display of data, the sender may configure the following target values:

- 1) OT transit delay jitter;
- 2) LQA transit delay jitter.

Between them, the following inequalities must be enforced: $OT \text{ transit delay jitter} \leq LQA \text{ transit delay jitter}$.

Data loss rate is defined as a ratio of the amount of lost data over the amount of totally transmitted data. For desirable display of data, the sender may configure the following target values:

- 1) OT loss rate;
- 2) LQA loss rate.

Between them, the following inequalities must be enforced: $OT \text{ loss rate} \leq LQA \text{ loss rate}$.

7.3 QoS extension element

For QoS management, the QoS extension element is newly defined in this Specification. All the extension elements used in ECTP are listed below.