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Design of Enhanced Communications Transport Service for Multimedia Applications

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멀티미디어 응용을 위한 향상된 트랜스포트 서비스 설계

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ABSTRACT

Two distinct features required in transport service and protocol to meet new multimedia applications requirements are multicast transmission capability and enhanced QoS facility. In this paper, we presents major functions and facilities of enhanced communications transport service definition supporting these requirements. At first, major fundamental issues, that should be handled to design multi-peer communication service and protocol, are resolved and applied to design service definition. Secondly, we proposed several new functions for enhanced transport service such as heterogeneous TC establishment, invitation capability, TC-ownership transfer, restriction of transmit concurrency. The details of proposed enhanced transport service are TC creation, TC invitation, TC join, multicast data transfer, pause of data transfer, resume of data transfer, report of specific status, TC leave, TC termination, TC-ownership transfer, Token transfer services. The proposed transport service was submitted and accepted as a draft text for committee draft of international standard by the international standardization body such as JTC1/SC6 and ITU-T SG 7.

요 약

새로운 멀티미디어 응용 요구 사항을 만족시켜 주기 위해 트랜스포트 서비스 및 프로토콜에 요구되는 주요 기능으로는 멀티캐스트 전송 기능과 향상된 서비스 품질 기능이 있다. 이 논문은 이러한 주요 요구 사항을 만족시켜 줄 수 있도록 설계된 향상된 트랜스포트 서비스의 주요 기능 및 세부 사항들에 대해 기술하고 있다. 먼저, 다자간 통신 서비스 및 프로토콜 설계 시 기본적으로 다루어져야 하는 주요 이슈들이 검토되었고 이 결과가 제안하는 서

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비스 설계에 적용되었다. 둘째, 향상된 트랜스포트 서비스를 위한 새로운 기능들로써 이종 TC 설립, 초청 능력, TC-소유권 이전, 동시 전송 제한 기능 등이 제안되었다. 이 논문에서 제안하는 향상된 트랜스포트 서비스 규격이 제공하는 세부 서비스들로는 TC 생성, TC 초청, TC 참가, 멀티캐스트 데이타 전달, 데이타 전달 멈춤, 데이타 전달 재개, 특정 상태 보고, TC 이탈, TC 종료, TC-소유권 이전, 토큰 전달 서비스가 정의되었다. 제안된 트랜스포트 서비스 규격은 국제표준기구인 JTC1/SC6 및 ITU-T SG7에 제출되어 국제표준으로 제정되기 위한 CD(Committee Draft) 초안으로 채택되었다.

I. Introduction

The variety of emerging multimedia applications requirements and the increasing capability of high speed multi-service networks are imposing new requirements on transport protocol[1]. It is generally accepted that existing transport protocol such as open system interconnection(OSI) transport protocol class 4(TP 4) and transmission control protocol(TCP), designed for unreliable peer-to-peer lower speed networks, will be unable to best exploit the new features such as high bandwidth, multicast capability and quality of service(QoS) management provided by the multi-service networks and meet the various requirements of new multimedia communications applications. The most distinct features required in transport layer are multicast transmission capability to support multiparty cooperative applications and enhanced QoS feature to meet multimedia applications requirements.

There were a number of research activities for developing new transport services and protocols to support these requirements for several years in world-wide[2][3][4][5][6][7]. Owing to the large number of interests on this issue, these activities have been moved into the international standardization body such as ISO/IEC(International Organization for Standardization/International Electrotechnical Commission) JTC1(Joint Technical Committee 1)/SC6(Sub-Committee 6), JTC1/SC21(Sub-Committee 21), and ITU-T (International Telecommunication Union) SG7(Study Group 7) and still a lot of efforts are undertaking to develop new transport service and protocol specifications. During the process of standardization, various scopes for a new transport layer specifications are merged into two projects, ECTS(Enhanced Communications Transport Service) and ECTP(Enhanced Communications Transport Protocol), as a collaborative work for JTC1/SC6/Working Group 7 and ITU-T Question 13/7. Korean experts have been actively participating in the standardization activities for a few years, and recent standardization works for ECTS and ECTP are heavily driven by Korean experts as an ECTS Project Editor and as a Special Rapporteur in the JTC1/SC6 and ITU-T SG7, respectively.

At the early stage of ECTS work, there were big arguments whether merging connection oriented(CO) and connectionless(CL) service or specifying them in separate services[6][8]. In our previous research work, we designed a multi-peer transport service merging CO and CL services, where the type of service is dynamically determined by the transport provider according to the QoS characteristics delivered from the transport service(TS)-users[8]. But there were a little ambiguity in integrating two different services in a single service definition. Therefore, it was agreed that the ECTS shall contain only connection-oriented multicast service[9]. For connectionless service, ITU-T X.214|ISO/IEC 8072/Amd. 1, a specification of connectionless-mode transport multicast service, was recommended.

In this paper, we propose new ECTS definition, which will substitute our previous version of ECTS proposal[9]. At first, we resolved several fundamental issues that are required to design multi-peer communication service and protocol. Secondly, we proposed several new functions for designing enhanced communications transport service. These are heterogeneous transport connection(TC) establishment function by introducing of focal TS-user concept, invitation capability of specific TS-users, TC-ownership transfer function for providing active group integrity(AGI) flexibility, restriction of transmit concurrency for providing scalability, etc. Therefore, the proposed ECTS definition provides the following features to the TS-user: a) the means for a TC-owner to create a TC with other TS-users of the same enrolled group for the purpose of exchanging transport service data units(TSDUs); b) the means for a TS-user to join an existing TC under the constraints of QoS, AGI, and other control conditions; c) the means of transferring TSDUs on a TC under the constraints imposed by QoS; d) the means of transferring TSDUs with no QoS imposed but transit delay; e) the means for a TS-user to leave a TC unconditionally and/or under the constraints of AGI and QoS; f) the means for a TC-owner unconditionally and therefore destructively to terminate a TC.

In section 2, several major issues, required to design multi-peer transport service, are resolved. In section 3, service primitives and parameters are summarized with state transition diagram. In section 4, the details of designed service definition are described. Finally, concluding remarks are presented in section 5.

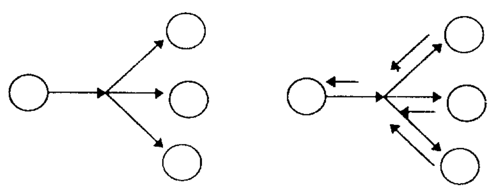
Ⅱ. Resolved Issues for Designing Transport Service

When we are trying to specify multi-peer communication services and protocols, a number of issues such as group definition, group characteristics, multi-peer communication model, phases for multi-peer communication, group addressing, and multicast connection establishment are raised. These issues are discussed for a long time in the middle of standardization work on ECTS and are described in related documents dealing with multi-peer communications framework [10][11][12]. We designed our transport service definition based on the fundamental concepts specified in these framework documents and major outstanding issues considered are described below.

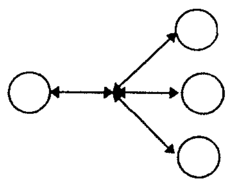
1. Types of Transport Connection(TC)

Transport connection is defined as a multicast connection established among transport service users for the purpose of transferring data. In the case where there are only two participants involved, it reduces to a peer-to-peer connection. The three different types of TC are defined as figure 1: simplex TC, duplex TC, and N-plex TC. In simplex TC, there exist only one sender and all others are receive only. In duplex TC, one TC-participants, called TC-owner, can both send to and receive from all others whereas all other TC-participants can receive only from and send only to the TC-owner. In N-plex TC, any TC-participant is a sender as well as a receiver. At any moment, anyone can send something, and, if someone does so, all others may receive it.

These three TCs defined here are thought to cover all the other types of TC as degenerate cases. For example, a unicast simplex TC is a degenerate case of the simplex TC. An MxN TC can be modeled as a degenerate of the N-plex TC, where some members may announce their intention not to send any data as part of QoS negotiation. All the transport service operations take place per TC basis. According to the QoS negotiation mechanism, a QoS for the TC may be negotiated as a homogeneous or a heterogeneous manner.



(a) Simplex TC (b) Duplex TC



(c) N-Plex TC

Fig. 1 Types of transport connection

2. Group Characteristics

According to the phases of the multi-peer communication, there exists several instances of group. Enrolled group is a group of TS users who can participate in a transport connection, which is identified with a group TSAP address. Active group is a group of TS users which maintain the shared state information required to support the mechanisms of the data transfer phase. That is, it means a group of TS-users who are in the data transfer state after completion of TC establishment phase.

A set of conditions concerning the active group is defined as an AGI, which must be true in order for a TC to enter or remain in the transfer state of the data transfer phase. We defined two AGI conditions, which are AGI policy and AGI population. AGI policy is defined as soft and hard. If soft AGI is selected, the TC is to be suspended when the AGI is violated and the TC is to be restored when the AGI is recovered. If hard AGI is selected, the TC is to be terminated when the AGI is violated. Also five distinct AGI population characteristics are defined : mandatory, minimum, quorum, maximum, atomic. More than one population condition can be used together, for example, mandatory may be used together with quorum.

3. Group Addressing

As mentioned before, the enrolled group is identified by a group transport service access point (GTSAP) address. In our previous work[7][8], we allowed that there exist multiple TCs within a GTSAP and each TC is identified by TC-id that indicates suffix information for the TC. In this case, the addressing scheme might be complicated and becomes incompatible to existing transport services. Another important point that must be considered is the possibility of usage of new transport service definition for the existing TS users including the Internet applications. Therefore, we restricted that an enrolled group should bear one TC. That is, only one TC exist in one GTSAP. The different TC should be assigned individual GTSAP-address. This GTSAP-address can be thought as a set of single TSAP-addresses or concatenation of a group network service access point (GNSAP) address and a transport selector(t-sel). Unlike peer-to-peer communication, the transport selector should be globally unique within the scope of the open system environments for the multi-peer communication. This addressing concept may be possible to map to the multicast addressing scheme of Internet environment.

4. Model of Multicast Service

For managing multicast transport service, we defined a TC-owner that owns the right to create, invite, terminate, and monitor a transport connection. Only the TC-owner is allowed to initiate creation and termination of TC. Also, a focal TS-user that intends to transmit data on a TC and initiates the QoS negotiation of the 1xN transport channel is defined to provide heterogeneous TC establishment feature. Other members of enrolled group is allowed to join and leave to existing TC.

In connection establishment phase, the TS-provider of the TC-owner or the focal TS-user shall arbitrate the different capabilities of each TC-participants to establish an agreed multicast TC among the active group. Not only QoS negotiation but also inspection of AGI conditions among the TC-participants is performed by the TS-provider. However, this model is vulnerable in loss of owner scenario, we introduced new service for ownership transfer among the potential TC-owners. The figure 2 shows an example of multicast TC established on the transport service boundary.

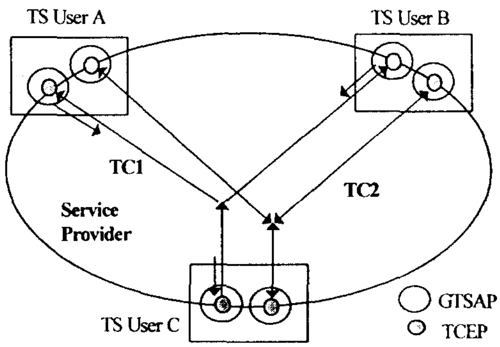


Fig. 2 An example of multicast TC established

5. QoS characteristics

The QoS classes and the possible values that may be imposed or agreed upon are shown in Table 1. Values for some or all of these characteristics may be agreed before the TC is operated. In here, the CHQ (controlled highest quality) value represents an upper limit and LQA(lowest quality acceptable) value represents a lower limit that QoS can be attained. CHQ value is only applied to throughput characteristic.

Table 1. Classification of the QoS characteristics

Characteristic group	Characteristic	QoS values agreed or imposed
TC performance	Throughput	- CHQ value - operating target value - LQA value
	Transit delay	- operating target value - LQA value
	Transit delay jitter	- operating target value - LQA value
TC reliability	Corrupted TSDU error rate	- LQA value
	Lost TSDU error rate	- LQA value
TC ordering	TC ordering	- No ordering - Local ordering - Causal ordering - Partial ordering - Total ordering
Miscellaneous	TC protection	Local matter according to the security policy
	TC precedence	Imposition of: - the order in which TCs are to have their QoS degraded, or - the order in which TCs are to be broken to recover resources

To reach QoS agreements between TS users, one or more QoS values among CHQ, operating target, threshold, and LQA value may be used in QoS negotiation mechanism. The level of agreement reached on that value during the QoS negotiation between the TS-users and the TS-provider will be one of best efforts, compulsory and guaranteed level.

As a result of QoS negotiation, the TC may have different transmit and receive characteristics. The transmit diversity of a TC may be either homogeneous TC wherein all TS-users have agreed to a common set of transmit QoS values, or heterogeneous TC wherein all TS-users don't have agreed to a common set of transmit QoS values. The receive diversity of a TC may be either receivers-wide wherein all receiving TS-users receive the data of a given sending TS-user at the same QoS value, or receiver-selected wherein different receivers may receive the data of the same sending TS-user at different QoS values not better than the transmit QoS.

6. Transmit Concurrency

One of the important issues to be solved is scalability problem in multicast communication protocols. To provide more scalability for the multicast group, transmit concurrency may be controlled by the token that gives a right to send data to the multicast group. Transmit concurrency may be either controlled wherein only senders with a token may transmit data, or uncontrolled wherein all senders may transmit data concurrently. The maximum number of concurrent senders in the controlled mode is specified by number of token.

7. Initial Conditions for Transport Layer Operations

Before the beginning of transport service operations, it is assumed that the GTSAP-address including transport selector is known to the members of enrolled group. Also, the TC-characteristics such as TC-type, QoS, and AGI, transmit concurrency are assumed to have been defined beforehand and known both to the TS users and the TS provider. These might be achieved by the successful completion of the enrollment phase, which is out of scope of transport layer operations.

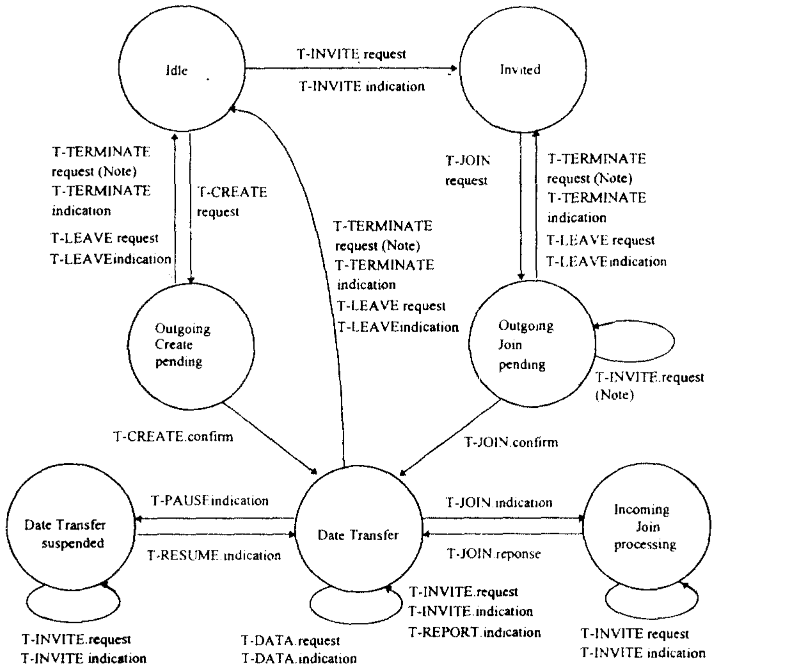
Ⅲ. Service Primitives and Parameters

To provide for multicast capability and enhanced QoS, we defined several service primitives and related parameters at the transport service boundary as shown in Table 2. A primitive issued at one TSAP will, in general, have consequences at the other TSAPs. The possible overall sequences of primitives at a TSAP are defined in the state transition diagram. In the diagram, the Idle state reflects the absence of a relationship between the TS-user and the TC. It is the initial and final state of any sequence, and upon returning to this state, the TS-user may not participate in the TC. Because we distinguish TS-users as TC-owner, including focal TS-user, and non-focal TS-user in our transport service model, there exist two different state transition diagram for each aspects of TS-users as figure 3 and figure 4, respectively. All states except the Data Transfer suspended includes a self-loop branch due to UNITDATA request and UNITDATA indication; UNITDATA request and indication primitives may occur at such states without causing transition to other states.

Table 2. Service primitives and parameters

Service	Primitive	Parameters
TC creation	T-CREATE request	(Called addr, Calling addr, TC-characteristics, TS-user data)
	T-CREATE indication	(Called addr, Calling addr, TC-characteristics, TS-user data)
	T-CREATE response	(Called addr, Responding addr, TC-characteristics, TS-user data)
	T-CREATE confirm	(Called addr, Responding addr, TC-characteristics, TS-user data)
TC invitation	T-INVITE request	(Called addr, Calling addr, TC-characteristics, TS-user data)
	T-INVITE indication	(Called addr, Calling addr, TC-characteristics, TS-user data)
TC join	T-JOIN request	(Called addr, Calling addr, TC-characteristics, TS-user data)
	T-JOIN indication	(Called addr, Calling addr, TC-characteristics, TS-user data)

	T-JOIN response	(Called addr, Responding addr, TC-characteristics, TS-user data)
	T-JOIN confirm	(Called addr, Responding addr, TC-characteristics, TS-user data)
Data transfer	T-DATA request	(TS-user data)
	T-DATA indication	(Calling addr, Status, TS-user data)
	T-UNITDATA request	(Called addr, Calling addr, TC-characteristics, TS-user data)
Pause	T-UNITDATA indication	(Called addr, Calling addr, TC-characteristics, Status, TS-user data)
Resume	T-PAUSE indication	(Reason)
	T-RESUME indication	(Reason)
Report	T-REPORT indication	(Calling addr, Reason, TS-user data)
TC leave	T-LEAVE request	(Called addr, Calling addr, Reason, TS-user data)
	T-LEAVE indication	(Called addr, Reason)
TC termination	T-TERMINATE request	(Reason, TS-user data)
	T-TERMINATE indication	(Reason, TS-user data)
TC-ownership	T-OWNER request	(Called addr, Calling addr, TS-user data)
	T-OWNER indication	(Called addr, Calling addr, TS-user data)
	T-OWNER response	(Called addr, Responding addr, TS-user data)
	T-OWNER confirm	(Called addr, Responding addr, TS-user data)
Token give	T-GIVE request	(Called addr, Calling addr, TS-user data)
	T-GIVE indication	(Called addr, Calling addr, TS-user data)
	T-GIVE response	(Called addr, Responding addr, TS-user data)
	T-GIVE confirm	(Called addr, Responding addr, TS-user data)
Token get	T-GET request	(Called addr, Calling addr, TS-user data)
	T-GET indication	(Called addr, Calling addr, TS-user data)
	T-GET response	(Called addr, Responding addr, TS-user data)
	T-GET confirm	(Called addr, Responding addr, TS-user data)



* Note: This transition applies only to the TC-owner.

Fig. 3 State transition diagram of a TC-owner or a focal TS-user

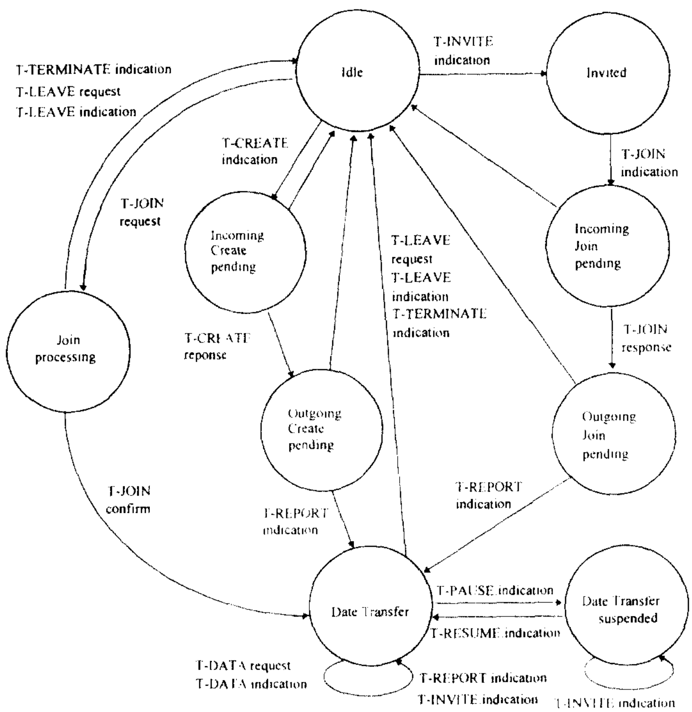


Fig. 4 State transition diagram of a non-focal TS-user

Ⅳ. Detail Design of ECTS

1. TC Creation Service

The TC Creation primitives can be used by the TC-owner to establish a homogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider. TC-characteristics, i.e., AGI and QoS are assumed to have been defined and known both to the TS-users and the TS-provider beforehand. The TC Creation service will further refine the QoS, if necessary, and check the identities of the TC-participants to validate the AGI condition. It is assumed that there exists one and only one TC-owner who possesses the right to create and terminate a TC of a given enrolled group.

The called address parameter conveys a TSAP address that identifies the TS-user(s) expected to participate in the TC being established. The calling address parameter conveys the TSAP address of the TC-owner by whom the TC creation has been requested. The responding address parameter conveys the address of the TSAP of the TS-user to participate in the TC.

The TC-characteristics parameter conveys the AGI, TC-type, transmit concurrency and QoS for the TC. Whereas the AGI parameters are not for negotiation, the QoS values may be changed in the sequel of primitives. The QoS in the request primitive is what proposed by the TC-owner; that in the indication primitive is what modified by the TS-provider; that in the response primitive is what counter-proposed by the responding TS-users; that in the confirm primitive is what arbitrated by the TS-provider. The arbitrated QoS value is notified to the every TC-participants by the REPORT primitive.

The sequence of primitives in a successful homogeneous TC creation is defined by the following time sequence diagram. Note that a CREATE confirm primitive is delivered only to the TC-owner who has previously issue the request primitive and other TS-users are supplied with a report indication primitives. The TC Creation procedure may fail either due to the inability of the TS-provider to establish a TC, due to the unsuccessful negotiation of the QoS, or due to the failure of the AGI condition.

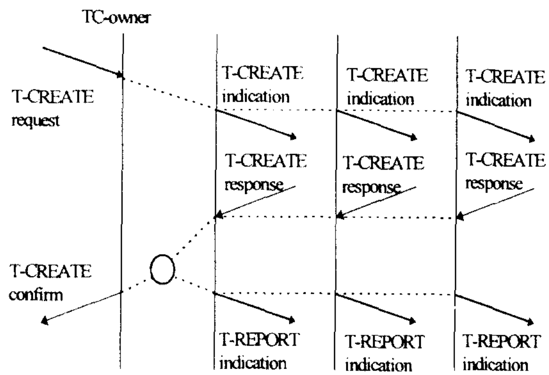


Fig. 5 Successful homogeneous TC Creation

2. TC Invitation Service

The TC Invitation primitives can be used by the TC-owner to invite the TS-users to collectively establishing a heterogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider. A heterogeneous TC is established by individual establishment of multiple simplex TCs, which each simplex TC is established by every focal TS-user through Join primitives. Thus, the TC Invitation service is normally followed by the TC Join service.

TC-characteristics, i.e., AGI and QoS are assumed to have been defined and known both to the TS-users and the TS-provider beforehand. The TC Invitation service does not change the TC-characteristics it conveys. It is assumed that there exists one and only one TC-owner who possesses the right to invoke the Invitation service.

The sequence of primitives in a TC Invitation is defined by the following time sequence diagram. Note that the TC invitation primitives are normally followed each by a JOIN request primitive defined below, thus initiating the Join service by the focal TS-users. The TC invitation procedure may fail either due to the inability of the TS-provider or due to the failure of the AGI condition.

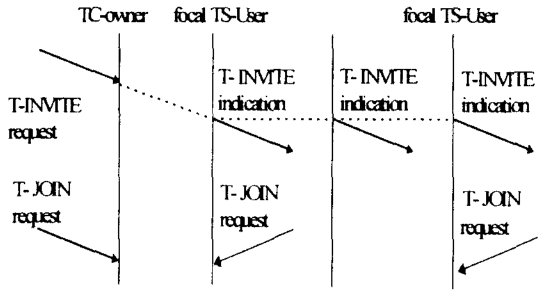


Fig. 6 TC Invitation for establishing heterogeneous TC

3 TC Join Service

The TC Join primitives can be used by the focal TS-user to establish a heterogeneous TC, provided the enrolled TS-users exist and are known to the TS-provider. TC-owner will acts as one of focal TS-users to establish a heterogeneous TC. TC-characteristics, i.e., AGI and QoS are assumed to have been defined and known both to the TS-users and the TS-provider beforehand. The TC Join service will further refine the QoS, if necessary, and check the identities of the TC-participants to validate the AGI condition. The Join service can be used to join existing TC by receive-only TS-users in a heterogeneous TC or by TS-users in a homogeneous TC.

The calling address parameter conveys the TSAP address of the focal TS-user by whom the TC creation has been requested. The responding address parameter conveys the address of the TSAP of the TS-user to participate in the TC and to which TS-user data should be delivered when the TC is in the Data Transfer state.

The sequence of primitives in a successful TC establishment is defined by the following time sequence diagrams. Note that a Join confirm primitive is delivered only to the TS-user who has previously issue the request primitive and other TS-users are supplied with a REPORT primitives. The TC Join procedure may fail either due to the inability of the TS-provider to establish a TC, due to the unsuccessful negotiation of the QoS, or due to the failure of the AGI condition.

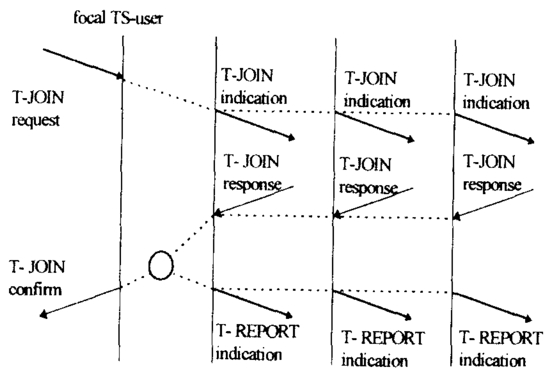


Fig. 7 Successful TC establishment by a focal TS-user

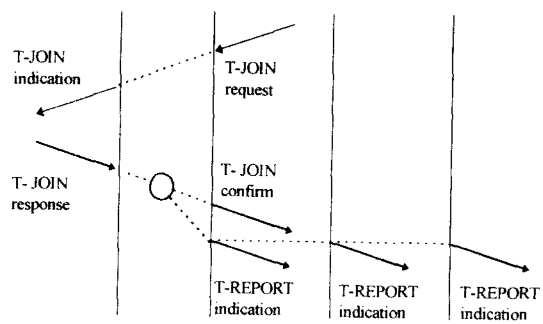


Fig. 8 Successful join to existing TC

4. Data Transfer Service

The Data Transfer service provides for two types of transfer of TSDUs from a sending TS-user to the other receiving TS-user(s). In one type, data transfer takes place over a successfully established TC using T-DATA primitives. In the other type, data transfer takes place at any phase of a TC using T-UNITDATA primitives; it may take place even when no TC is available between the sending and the receiving TS-users. Three different types of data transfer are provided: simplex, duplex, and N-plex multicast data transmission. The data transfer characteristics such as reliability and ordering are managed by the TC-characteristics.

The called address parameter may be present only in T-UNITDATA primitives and conveys a TSAP address that identifies the TS-user(s) expected to received the data sent. The calling address parameter conveys a TSAP address that identifies the TS-user who has sent the data. The TC-characteristics parameter may be present only in T-UNITDATA primitives. All parameters of the TC-characteristics except the transit delay shall be of null value.

The notification of detected but not corrected errors is signaled through the status parameter to the TS-user. The status parameter conveys a notification to the TS-user that a) the TS-user data is corrupted (errors detected but not corrected), or b) the TS-user data is substituted (errors detected and substituted), or c) the TS-user data is of zero length (TSDU lost or corrupted). The TS-user data parameter consists of an integral number of octets greater than or equal to zero and allows the transfer of data from a sending TS-user to the receiving TS-user(s), without modification by the TS-provider. The sequence of primitives in a successful data transfer is defined in the following time sequence diagram.

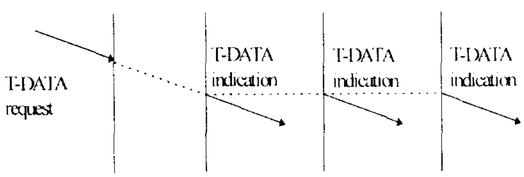


Fig. 9 Data transfer using DATA primitives

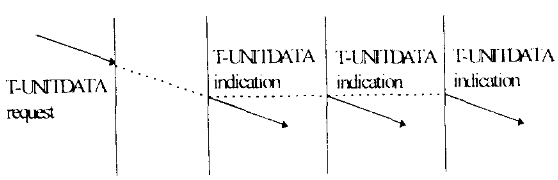


Fig. 10 Data transfer using UNITDATA primitives

5. Pause Service

The Pause service provides for the TS-provider to indicate with the PAUSE indication primitive to the active group TS-user(s) that the TC has entered the state where the data transfer is not allowed. Until the TS-users are notified that TC-characteristics are met again, no T-DATA request primitives may be issued. Data transfer resumes by the Resume service.

The reason parameter gives information indicating the cause of the data transfer suspension. The reason is one of the following: a) temporarily lack of local or remote resources at the TS-provider; b) a QoS parameter temporarily below an agreed LQA level; c) AGI temporarily below the minimum level.

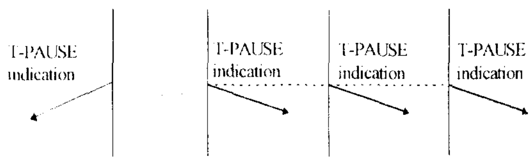


Fig. 11 TS-provider invoked suspension of data transfer

6. Resume Service

The Resume primitives are used to resume the data transfer recovering from the temporarily violated TC-characteristics. After the receipt of the T-RESUME indication primitive, the active group TS-user may restart issuing T-DATA request primitives, or receiving T-DATA indication primitives. The sequence of primitives in the resumption of a previously suspended data transfer is defined in the following time sequence diagram.

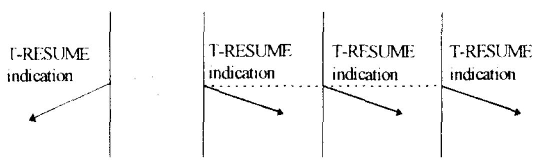


Fig. 12 Sequence of primitives in TS-provider resumption of data transfer

7. Report Service

The Report primitives are used to notify the change or selection of TC-characteristics to the active TS-users during data transfer or in TC establishments. A non-fatal change may be signaled by a REPORT indication primitive, whereas a fatal change will result in a LEAVE or TERMINATE indication.

The calling address parameter conveys the TSAP address of the TS-provider from which the report primitive is originated. The reason parameter gives information indicating the cause of the report. The reason is one of the following: a) minor lack of local or remote resources at the TS-provider; b) detected but not fatal QoS change, e.g., degradation of QoS below some threshold; c) detected but not fatal AGI change. The TS-user data parameter conveys: a) the data of the remote TS-user, or b) the arbitrated TC-characteristics in TC establishments, or c) additional information provided by the TS-provider.

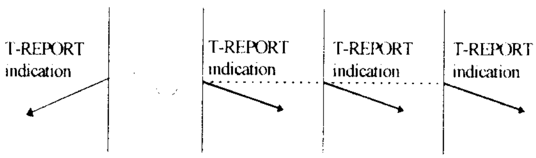


Fig. 13 TS-provider is to give warning or notification during data transfer

8. TC Leave Service

The Leave primitives are used to remove a TS-user from the TC. The leave may be performed: a) by a TS-user to leave the TC; b) by a TS-provider to exclude a TS-user; c) by a TS-user to reject TC Create or TC Join; d) by a TS-provider to reject TC Join.

When a TS-user reject a TC Join request or TC Creation request, the called address parameter in the LEAVE request primitive conveys the TSAP address of the TS-user originating those primitives. And when the TS-user wishes to remove from the TC, the called address parameter in the LEAVE request primitive conveys the group TSAP address that identifies the TC to leave. The called address parameter in the LEAVE indication primitive conveys the TSAP address of the TS-user to be excluded from the TC. The calling address parameter conveys the TSAP address of the TS-user wishing to leave the TC.

The reason parameter gives information on the cause of the leave. The reason is one of the following: a) TS-user invoked, possibly with additional information in the TS-user data parameter; b) TS-provider invoked. This reason may be of a transient or a permanent nature. Examples include: i) a QoS parameter below an agreed LQA level; ii) lack of local or remote resources at the TS-provider; iii) alled address unknown; iv) AGI condition violated. The TS-user data parameter conveys additional TS-user information concerning the Leave request.

The sequence of primitives for Leave service is defined in the following time sequence diagram. If the TS-provider is unable to establish a TC requested by a T-JOIN request, it indicates this to the TS-user by T-LEAVE indication primitive with a reason parameter.

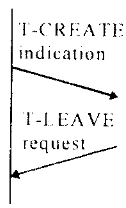


Fig. 14 TS-user rejection of a TC Creation

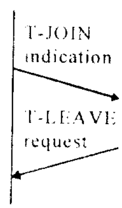


Fig. 15 TS-user rejection of a TC JOIN

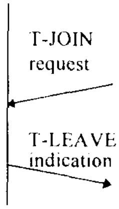


Fig. 16 TS-provider rejection of a TC JOIN attempt

A TS-user may remove itself from the TC by a T-LEAVE request, and every TS-users participating in the TC are informed by the Report primitive.

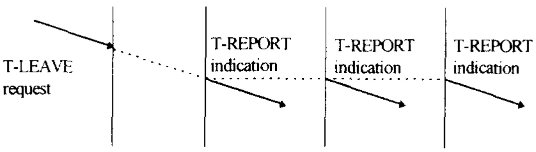


Fig. 17 TS-user invoked Leave

Any TS-user may be expelled from the TC by the TS-provider, and every TS-user participating in the TC is informed by the report primitive.

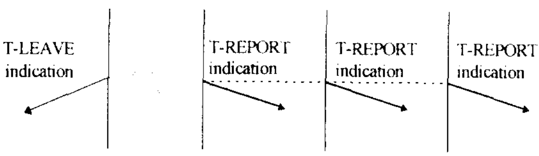


Fig. 18 TS-provider expulsion of a TS-user

9. TC Termination Service

The TC termination primitives are used to terminate a TC. The termination may be initiated by: a) the TC-owner, or b) the TS-provider due to fatal failure of some TC-characteristics. TC termination is permitted at any time regardless of the state of the TC. A request for termination cannot be rejected. The transport service does not guarantee delivery of any TS-user data once the termination procedure is entered.

The reason parameter gives information regarding the cause of the termination. The reason is one of the following: a) TC-owner invoked termination; b) lack of local or remote resource at the TS-provider; c) QoS below an agreed LQA level; d) called address unknown; e) AGI below the minimum level.

If the TS-provider is unable to create a TC due to incomplete TC-characteristics, it issues to the TC-owner a TERMINATE indication primitive with the reason parameter. The sequences of primitives for the TC termination by the TC-owner and by the provider are defined in the following diagram.

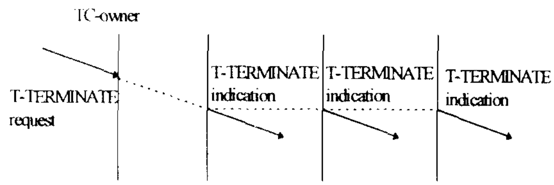


Fig. 19 TC-owner invocation of a TC termination

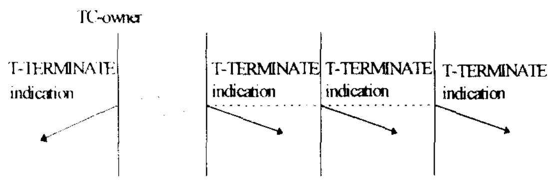


Fig. 20 TS-provider invocation of a TC termination

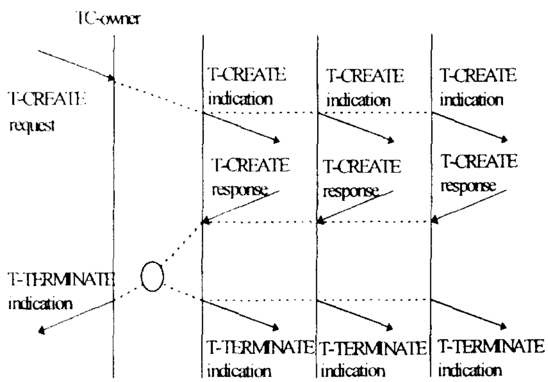


Fig. 21 TS-provider rejection of a TC creation attempt due to incomplete TC-characteristics

10. TC-ownership Service

The TC Owner primitive can be used by the TC-owner and other focal TS-users to pass the TC-ownership. The called address parameter may be a unicast TSAP address designating a specific TS-user or the group TSAP address designating the whole TS-users as candidate TC-owners. The calling address parameter conveys the TSAP address of the current TC-owner. The responding address parameter conveys the address of the TSAP of the TS-user competing for the TC-ownership. The TS-user data parameter allows the transfer of TS-user data among old and new TC-owners. The result of the TC-Ownership service may be conveyed to the TC-participants by the REPORT primitive.

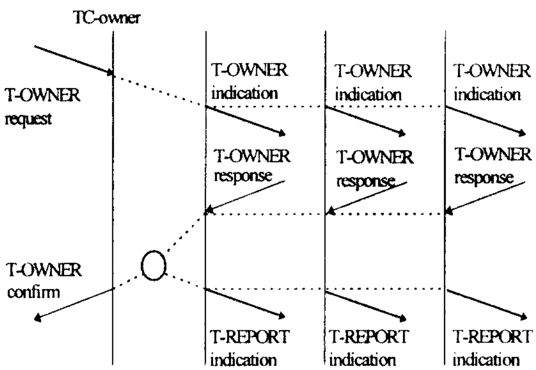


Fig. 22 TC ownership transfer among the TC-owner candidates

11. Token Service

The TC Token primitives can be used by the TC-owner and other sending TS-users to pass around the token(s) for the right to transmit data. Token GIVE primitive can be used to deliver a token to the specified TS-user. Token GET primitive can be used to request a token by the TS-user wish to send data.

The called address parameter may be a TSAP address designating a specific sending TS-user for a Token GIVE primitive and be a TSAP address designating a specific TS-user, who has a Token, for a Token GET primitive. The calling address parameter may be the TSAP address of the TS-users who request Token GIVE or GET service.

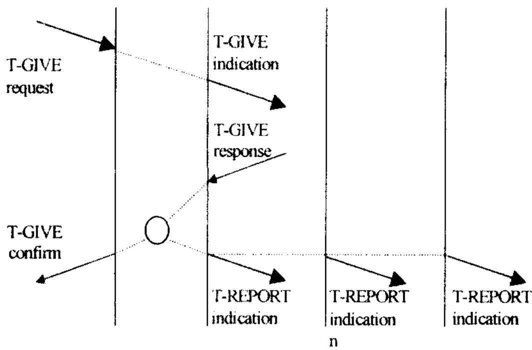


Fig. 23 Token distribution to a specified TS user

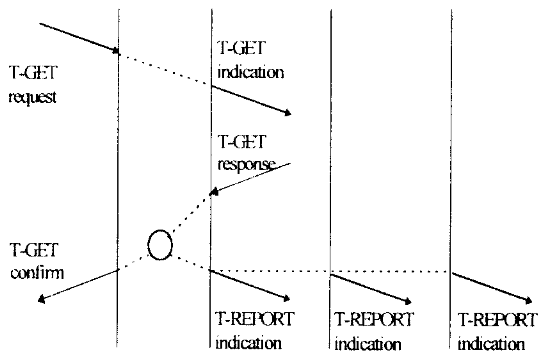


Fig. 24 Token acquisition by a specified TS user

V. Conclusion

In this paper, we proposed enhanced transport service that provides multicast transmission capability and enhanced QoS feature to the TS-users, which are distinct functions required in multimedia age. The major fundamental issues such as types of TC, group characteristics, group addressing, multicast service model, QoS characteristics, transmit concurrency, and initial conditions that should be handled for designing multi-peer communication services and protocols are resolved. And we proposed several new functions such as heterogeneous TC establishment, invitation capability, TC-ownership transfer, restriction of transmit concurrency. The details of enhanced transport service designed are TC creation, TC invitation, TC join, multicast data transfer, pause of data transfer, resume of data transfer, report of specific status, TC leave, TC termination, TC-ownership transfer, Token transfer services.

This proposal was submitted and accepted as a draft text for committee draft(CD) by the international standardization body such as JTC1/SC6 and ITU-T SG7. Adopted draft text will be distributed to the national bodies and liaison organizations of JTC1/SC6 for final CD ballot within this year. At this moment, we are also developing and prototyping enhanced communications transport protocol that supports proposed ECTS definition.

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