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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN –
Resource control protocols

Resource control protocol No. 2 – Protocol at the Rp interface between transport resource control physical entities

ITU-T Recommendation Q.3302.1

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ITU-T Recommendation Q.3302.1

Resource control protocol No. 2 – Protocol at the Rp interface between transport resource control physical entities

Summary

ITU-T Recommendation Q.3302.1 specifies the resource connection initiation protocol for use in carrying resource control requests and responses between transport resource control physical entities within the same domain. This protocol is designed to support signalling along a chain of control elements in an operator's network for a collection of most commonly used QoS models and requirements, including (but not limited to) traffic specification, priority, MPLS labels and Virtual Switching connection information. A multimedia service call traversing the network, which comprises one or more sessions (each having application/user-specific QoS specification), will get desired QoS treatment in the data plane (i.e., the chain of Transport physical entities), through appropriate configuration of the transport physical entities by the transport resource control physical entities.

Source

ITU-T Recommendation Q.3302.1 was approved on 9 March 2007 by ITU-T Study Group 11 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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ITU-T Recommendation Q.3302.1

Resource control protocol No. 2 – Protocol at the Rp interface between transport resource control physical entities

1 Scope

This Recommendation defines the resource connection initiation protocol (RCIP) for signalling control information between peer TRC-PEs (Rp interface) in a single operator's network. The requirements for the Rp interface are defined in clause 8.6 of [ITU-T Y.2111] and in [ITU-T Q.Sup51].

The possible methods of configuration and notification between the transport physical entities (T-PE) and the transport resource control are out of scope of RCIP. RCIP only specifies the control plane signalling among transport resource control physical entities (TRC-PEs) in an operator's network.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.805] ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks*.
- [ITU-T Q.2981] ITU-T Recommendation Q.2981 (1999), *Broadband integrated services digital network (B-ISDN) and broadband private integrated services network (B-PISN) – Call control protocol*.
- [ITU-T Q.Sup51] ITU-T Q-series Supplement 51 (2004), *Signalling requirements for IP-QoS*.
- [ITU-T Y.1291] ITU-T Recommendation Y.1291 (2004), *An architectural framework for support of Quality of Service in packet networks*.
- [ITU-T Y.2111] ITU-T Recommendation Y.2111 (2006), *Resource and admission control functions in Next Generation Networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 connection [ITU-T G.805]: A "transport entity" which consists of an associated pair of "unidirectional connections" capable of simultaneously transferring information in opposite directions between their respective inputs and outputs.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 bearer: Bearer is a connection for the transport of user plane information between users involved in a communication. (Derived from [ITU-T Q.2981])



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3.2.2 bearer control function (BCF): The BCF is a functional entity that performs the resource and admission control functions. (Derived from [ITU-T Q.2981])

NOTE – BCF is identical to RACF, can be PD-FE, TRC-FE, or both.

3.2.3 upstream TRC-PE: The entity which sends the resource request to a downstream TRC-PE.

3.2.4 destination TRC-PE

NOTE – The destination TRC-PE receives a resource request based on service, sent by the previous hop TRC-PE. When it finds out that the destination IP of the media flow belongs to the TRC-PE domain that is under its administration, if the request is a bidirectional one, the destination TRC-PE will deliver the routing result of the resource path from the destination to the source directly to the edge router, and return the response message of the resource path from the source to the destination to the previous hop TRC-PE.

3.2.5 downstream TRC-PE: The entity which receives the resource request from an upstream TRC-PE.

3.2.6 flow information: The flow information is the information necessary to identify an IP data flow, as defined in clause 8.3.3.

3.2.7 IP data stream: A sequence of packets sent to convey communication between the two endpoints identified by the flow information. It is an instance of bearer.

3.2.8 RCIP resource connection: An RCIP resource connection is a control signalling relationship maintained in all TRC-PEs between (and including) the source TRC-PE and the destination TRC-PE in support of a specific IP data stream.

NOTE – The messages sent along the RCIP resource connection can carry one or more pieces of resource reservation information for that IP data stream.

3.2.9 RCIP transport channel: An RCIP transport channel is a signalling transport connection maintained between two TRC-PE peers, within which multiple RCIP resource connections can be multiplexed.

3.2.10 service control function: The SvCF (service control function) is a functional entity that provides value-added service functionality. (Derived from [ITU-T Q.Sup51])

3.2.11 session control function: The SeCF (session control function) is a functional entity that provides the call/session control functionality. (Derived from [ITU-T Q.Sup51])

3.2.12 source TRC-PE: The source TRC-PE receives a resource request based on service, sent by the PD-PE or the source-seeking TRC-PE from the previous hop.

NOTE – The source address of the media flow belongs to the TRC-PE domain that is under its administration.

3.2.13 transport physical entity: The T-PE (transport physical entity) is an entity that performs stream classification, switching and forwarding and is capable of enforcing a QoS guarantee. (Derived from [ITU-T Q.Sup51])

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ACCT	Accept
AUP	RCIP AUdit resPonse
AUR	RCIP AUdit Request
BCF	Bearer Control Function
KA	Keep-Alive

MPLS	MultiProtocol Label Switching
OVE	OVERload indication
PD-PE	Policy Decision Physical Entity
RA	Resource Acceptance message
RACF	Resource Admission Control Functions
RCIP	Resource Connection Initiation Protocol
REJ	resource REJection message
RLP	Resource reLease resPonse message
RLR	Resource reLease Request message
RR	Resource Request message
SCE	Session/Service Control Entity
SF	Switching Function
T-PE	Transport Physical Entity
TRC-PE	Transport Resource Control Physical Entity

5 Protocol design principles

5.1 Introduction

[ITU-T Q.Sup51] describes the control information flows between BCFs as shown in Figure 5-1, and [ITU-T Y.2111] defines the Rp interface between TRC-FE instances within a domain as shown in Figures 5-1 and 5-2. Separation between data plane (transport functions) and control plane (bearer control functions, or BCFs) is an important feature in the NGN and RCIP architectures. BCF interacts with border SCEs and interior T-PEs in order to apply resource reservation made in the control plane to achieve the service in the data plane, and to get feedback from T-PEs or SCEs for (re-)negotiating reservations. The basic protocol architecture for RCIP is shown in Figure 5-1.

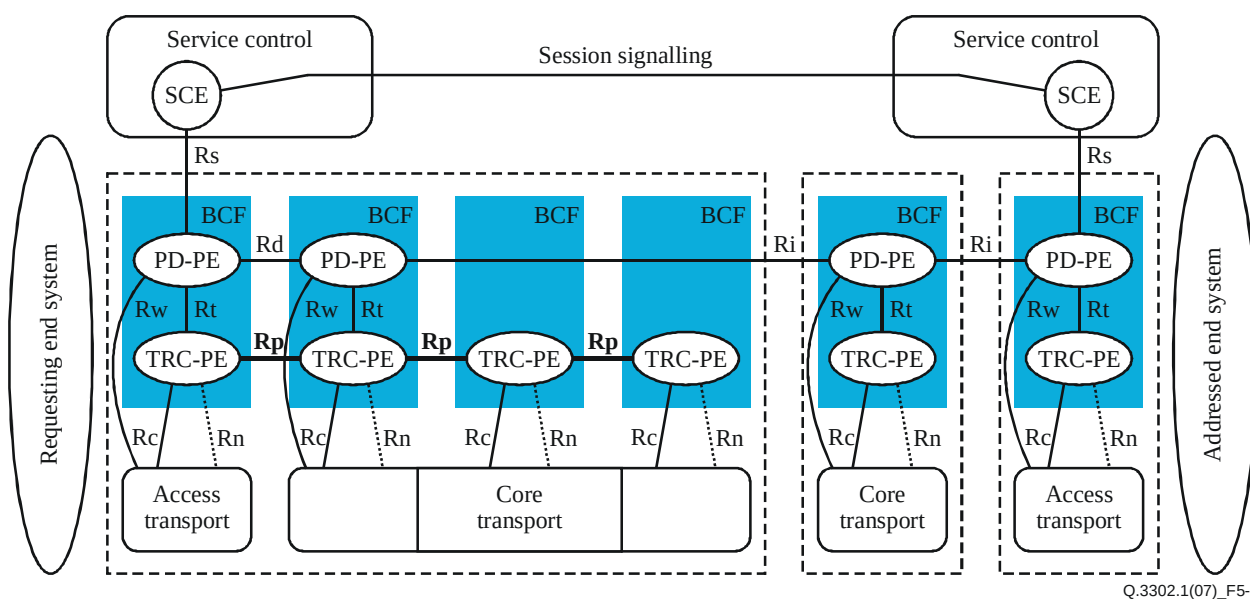


Figure 5-1 – Basic protocol architecture

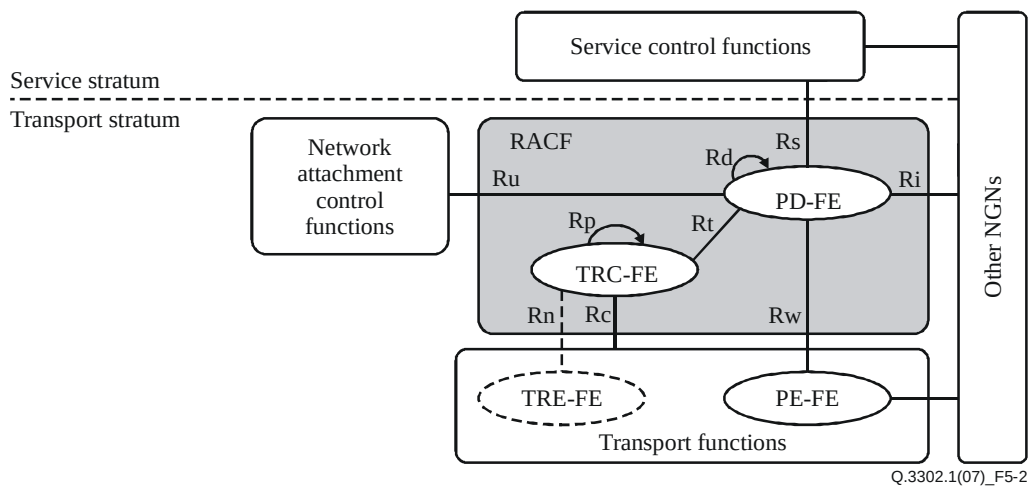


Figure 5-2 (Derived from Figure 5/Y.2111) – Generic resource and admission control functional architecture in NGN

In the IP network, TRC-PE(s) are used to manage all logical bearer networks in all managed areas. In each TRC-PE, the topology and resources in each logical bearer network are recorded and managed respectively.

Internally, RCIP maintains a resource connection for the resource reservation from a source T-PE to a destination T-PE. For example, a RCIP resource connection can reserve resource for a multimedia call which has an audio session and a video session.

Each RCIP resource connection message contains reservation information or control information related to a RCIP resource connection. It is transported reliably over a secure RCIP transport channel which is a half-permanent hop-by-hop communication channel. As RCIP operates within an operator's network, it is assumed that all TRC-PEs have a pre-configured signalling path between any source TRC-PE to the destination TRC-PE pair.

Clause 7.2 of [ITU-T Y.1291] describes the QoS routing of control plan mechanisms, which is an important feature of RCIP.

5.2 Protocol overview

The RCIP protocol is designed to be able to support signalling along a chain of control elements (preconfigured TRC-PEs) in an operator's network for a collection of most commonly used QoS models and requirements, including (but not limited to) traffic specification, priority, MPLS labels and virtual switching connection information. A multimedia service call traversing the network, which comprises one or more sessions (each having application/user-specific QoS specification), will get desired QoS treatment in the data plane (i.e., the chain of T-PEs), through appropriate configuration of the T-PEs by TRC-PEs. The possible methods of configuration and notification between the T-PE and the TRC-PE are out of scope of RCIP. RCIP only specifies the control plane signalling among TRC-PEs in an operator's network.

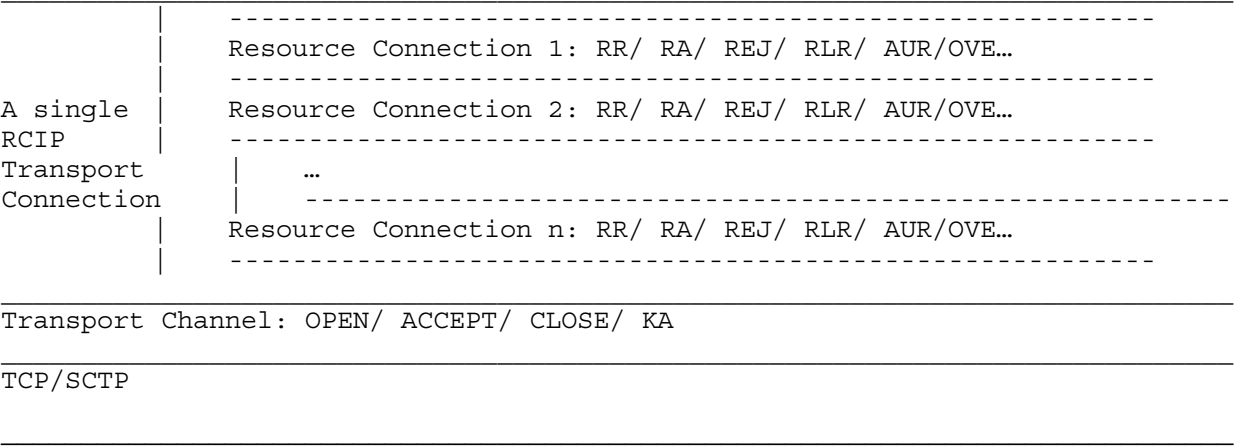
Upon receiving a SCE's request of QoS requirements, a TRC-PE located in the network edge, herein called the source TRC-PE, will initiate resource reservation towards another TRC-PE in the same operator's network where the service call leaves (i.e., destination TRC-PE). The intermediate TRC-PEs perform admission control and if it succeeds, perform appropriate resource reservation until the destination TRC-PE is reached. Upon successful reservation in the destination TRC-PE, a corresponding resource acceptance will be issued, traversing through the same set of TRC-PEs in the reverse direction, confirming the resource reservation request previously made. The reserved resources will be released using an explicit release-response mechanism. Any TRC-PE initializing

resource reservation and any TRC-PE which failed to provide required reservation (e.g., due to a failure in admission control or being pre-empted by new higher-priority resource requests) can issue a release towards the TRC-PE to release the reserved resource.

Between two adjacent RCIP peers, RCIP messages are securely and transparently transmitted over an RCIP transport channel. An RCIP transport channel is established and maintained as a half-permanent virtual circuit, and reused by all traversing RCIP messages (which can belong to any RCIP resource connection).

In addition, RCIP allows asynchronous overload notifications by any TRC-PE. Such a notification is triggered in a TRC-PE due to high processing overloads.

Between two TRC-PE(s) there is one RCIP transport channel. There can be many service messages carried on a single RCIP transport channel. It is shown as below.



RCIP specifies the following message types and objects:

RCIP resource connection message types:

- Resource Request (RR);
- Resource Acceptance (RA);
- Resource Rejection (REJ);
- Resource Release Request (RLR);
- Resource Release Response (RLP);
- Overload Indication (OVE);
- Audit Request (AUR);
- Audit Response (AUP).

RCIP transport channel message types:

- OPEN;
- ACCT;
- CLOSE;
- Keep alive.

RCIP main objects:

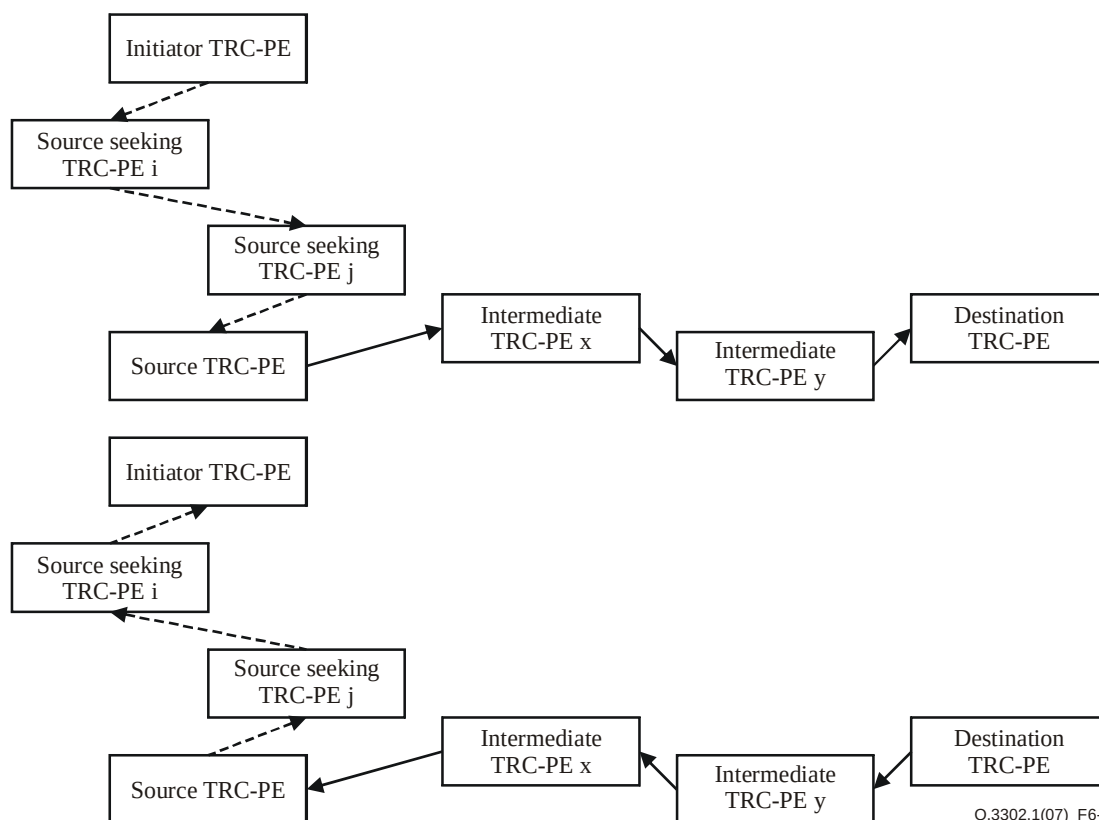
- Connection ID;
- Flow Information;
- Flow Traffic Information;
- LSP Connection Information;
- V-Switching Connection Information;
- Reason Code;
- Overload Indication;
- Result Indication;
- Data Consistency.

Each RCIP message includes header information which specifies the message type. Related to each message type, there are a number of mandatory and optional objects. See clause 7 for details.

6 Basic protocol operation

6.1 Roles of TRC-PE

The roles of TRC-PE [ITU-T Q.Sup51] are shown in Figure 6-1, which is only a sketch map. A TRC-PE can perform one or more of the roles at the same time.



Initiator TRC-PE	The initiator TRC-PE receives a QoS request sent by the SCE through the PD-PE. For the MPLS case it performs service routing, while for the non-MPLS case it performs the identification of the logical path.
Source-seeking TRC-PE	The source-seeking TRC-PE receives a QoS request sent by the previous hop TRC-PE, and queries the "source TRC-PE" route to find out the next hop TRC-PE, to which it will transfer the request. The difference between the source-seeking TRC-PE and the intermediate TRC-PE is that the former transfers a request for resources according to the Managed Area which the source address of the service stream belongs to.
Source TRC-PE	The source TRC-PE receives a resource request based on service, sent by the SCE or the source-seeking TRC-PE from the previous hop. The source address of the media flow belongs to the TRC-PE domain that is under its administration.
Intermediate TRC-PE	The intermediate TRC-PE receives a resource request based on service, sent by the previous hop TRC-PE, queries the TRC-PE route table, provides distribution of resources in the local domain, and transfer the resource request to the next hop TRC-PE.
Destination TRC-PE	The destination TRC-PE receives a resource request based on service, sent by the previous hop TRC-PE. When it finds out that the destination IP of the media flow belongs to the TRC-PE domain that is under its administration, if the request is a bidirectional one, the destination TRC-PE will deliver the routing result of the resource path from the destination to the source directly to the edge router, and return the response message of the resource path from the source to the destination to the previous hop TRC-PE.

Figure 6-1 – Roles of TRC-PE

6.2 REQUEST

The REQUEST operation is used to request reservation of resources between a downstream TRC-PE and an upstream TRC-PE. The REQUEST operation transfers the flow information, and QoS parameter objects, which describe the desired resource to be allocated. After the TRC-PE receives the request, it will calculate the resources and select the route in the corresponding logic bearer network for the media flow according to the source address, destination address and QoS requirements carried in the request. A request is sent in a hop-by-hop fashion. This means that a given reservation is realized via a series of requests between adjacent TRC-PEs, and the given TRC-PE takes the previous TRC-PE as the source of the RR.

Every TRC-PE has two logical TRC-PE routing tables: one is for TRC-PE routing of the source-seeking procedure (can be one hop or multi hops), the other is for TRC-PE routing for resource reservation procedure. In implementation, the two logic routing tables can be combined into one physical table.

The recipient TRC-PE records the addressing identification address of the source TRC-PE so as to correctly send responses and enable the event notification to find the upstream node.

One call may need multiple data streams. For example, a video phone usually needs an audio flow session and a video flow session. In order to establish the QoS connections of all streams in a call at a single attempt of connection, one request needs to carry the QoS requirement information of multiple streams. One RCIP message includes one or more groups of flow information (e.g., 5-tuple), while the RCIP message as a whole corresponds to one call/resource connection (e.g., the video call including both video and audio sessions).

In one request, the network may fail to meet the QoS requirements, but some available resources may still exist. In this case, the SCE can specify in the request whether to accept the services with lower QoS as required. Correspondingly, TRC-PE can also specify it as the information between TRC-PE(s) is from SCE via PD-PE. A request can be partially met.

When necessary, it can remove the resources of existing non-emergency calls/sessions to meet the QoS resources for the emergency call/session. This is achieved by using an urgent flag in the resource request for emergency calls. When there is no available resource in a TRC-PE, the TRC-PE can determine to pre-empt and tear down the low priority resource connection.

In the REQUEST operation, RR (Resource Request) message is used in one direction, and Resource Acceptance message (RA) and Resource Rejection message (REJ) are used in the other direction.

6.3 MODIFY

Some services may need to modify the QoS requirements during the service operation. According to the upstream TRC-PE request, the present TRC-PE modifies the bandwidth, port, protocol type, and so on, except the addresses used for the previous application. Repetitive modifications are enabled.

Bandwidth modification falls under increment modification and decrement modification. Decrement modification is expected to be performed successfully in most cases, while increment modification may fail due to there being insufficient resources to meet the new requirement. When modification fails, one may recover the previous connection or release the service connection. But carrying on with this reservation may be quite difficult to implement.

RR (Resource Request) message with Modify Flag, Resource Acceptance message (RA) and Resource Rejection message (REJ) message are involved in this MODIFY operation.

6.4 AUDIT

In order to synchronize the TRC-PE(s) in the status of a QoS request, the AUDIT operation is defined. This mechanism is used to check the consistency of the RCIP resource connections in peer TRC-PE(s).

The information obtained through the AUDIT operation can be used for the management control process of the TRC-PE(s). Note that the AUDIT operation will not change the status of the existing reserved resources, nor establish the status of the upstream TRC-PE which originates the query.

If the result audit response fails, the corresponding RCIP resource connection shall be released. TRC-PE releases resource locally, sends resource release to the upstream or downstream peer TRC-PE, not including the TRC-PE who sends the audit response.

The AUDIT message contains only one Connection ID Object, so as to allow the audited TRC-PE to feed back the information. AUR (Audit Request) and AUP (Audit Response) messages are involved in this AUDIT operation.

6.5 NOTIFY

The protocol must allow the notification of asynchronous events (from a TRC-PE to another TRC-PE).

The information carried by the NOTIFY operation is usually related to conditions. One example of NOTIFY is unavailable LSP or unavailable downstream TRC-PE due to overload conditions. In such case, the upstream TRC-PE can handle in two ways: to release the call or not. If the call remains, the QoS will be interrupted for the call. OVE (Overload Indication) message is involved in this NOTIFY operation.

6.6 RELEASE

The RELEASE operation is used by the upstream TRC-PE requests to request the downstream TRC-PE for releasing the resource that has been requested for allocation.

RLR (Resource release Request) message and Resource Release Response message (RLP) are involved in RELEASE operation.

6.7 TRC-PE source seeking

In order to hide the network topology of the bearer control layer from the service control layer, the SCE does not need to know where the source TRC-PE for each call is specifically located. The SCE only needs to initiate a request to any TRC-PE and the request will be transferred to the source TRC-PE via the TRC-PE source-seeking TRC-PE process, so that a normal process of resources reservation can be started.

Source seeking is a process to find the source TRC-PE (e.g., IP address, digits from 0 and 9, URL) based on source address of the media flow which request to reserve resource.

There are two ways to complete the process.

One is in a piggyback way, in which the resolution function is integrated within the TRC-PE. The TRC-PE is called the source-seeking TRC-PE and act as the resource reservation request proxies. When a TRC-PE, which is called the initiator TRC-PE, receives a request from SCE, it initiates a Resource Request and forwards it to the source-seeking TRC-PE. The source-seeking TRC-PE is responsible for resolving the source TRC-PE's address and for transmitting the resource request to the source TRC-PE.

The other is an independent way, in which the resolution function is separate from TRC-PE. The resolution function is responsible for resolving the source TRC-PE's address and returning it to initiator TRC-PE. Initiator TRC-PE then initiates a resource request to the source TRC-PE directly. This way is out of the scope of this Recommendation.

RR (Resource Request) message is involved in this TRC-PE source-seeking operation.

7 Basic procedure

7.1 Resource connection establishment

In an IP network supporting MPLS and/or DiffServ, the network administrator can divide the service with QoS requirements into several categories according to the service category or QoS degree. According to the topology and flow rule of each QoS service, the network administrator can use the MPLS LSP technology to preset a route and logical bearer network independent of other services and to set the bandwidth and QoS attribute for each LSP used to

