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Resource control protocols

Resource control protocol no. 2 (rcp2) Protocol at the interface between Transport Resource Control Physical Entities (TRC-PEs) (Rp interface)

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Draft Recommendation ITU-T Q.3322

Resource control protocol no. 2 (rcp2) Protocol at the interface between Transport Resource Control Physical Entities (TRC-PEs) (Rp interface)

Summary

This Recommendation specifies the Resource Connection Initiation Protocol (RCIP) for use to carry resource control requests and responses between Transport Resource Control physical entities within the same domain. This protocol is designed to be able 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.

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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 sub-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 this Recommendation. RCIP specifies control plane signalling among transport resource control physical entities (TRC-PEs) in an operator's network.

Note: This Recommendation supersedes Recommendation ITU-T Q.3302.1 [ITU-T Q.3302.1].

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] Recommendation ITU-T G.805 (2000), *Generic Functional Architecture of Transport Networks*
- [ITU-T Q.2981] Recommendation ITU-T Q.2981 (1999), *Broadband Integrated Services Digital Network (B-ISDN) and Broadband Private Integrated Services Network (B-PISN) call control protocol*
- [ITU-T Q.3302.1] Recommendation ITU-T Q.3302.1 (2007), *Resource control protocol No. 2 – Protocol at the Rp interface between transport resource control physical entities*
- [ITU-T Q.Sup51] ITU-T Supplement Q.Sup51 (2004), *Signalling Requirements for IP QoS*
- [ITU-T T.50] Recommendation ITU-T T.50 (1992), *International Reference Alphabet (IRA) (formerly International Alphabet No. 5 or IA5): Information Technology 7-bit coded Character Set For Information Interchange*
- [ITU-T Y.1291] Recommendation ITU-T Y.1291 (2004), *An architectural framework for support of Quality of Service in packet networks*
- [ITU-T Y.2111] ITU-T Y.2111 (2008), *Requirements and architecture for Resource and admission control in NGN*
- [IETF RFC 1321] IETF RFC 1321 (1992), *The MD5 Message-Digest Algorithm*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms 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: A connection for the transport of user plane information between users involved in a communication. (Derived from [ITU-T Q.2981])

3.2.2 bearer control function (BCF): 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 downstream TRC-PE: The entity which receives the resource request from an upstream TRC-PE.

3.2.5 flow information: Information necessary to identify an IP data flow

3.2.6 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.

3.2.7 RCIP resource connection: 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.

3.2.8 RCIP transport channel: A signalling transport connection maintained between two TRC-PE peers, within which multiple RCIP Resource Connections can be multiplexed.

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

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

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

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

3.2.12 transport physical entity (T-PE): 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	Protocol Connection Establishment Accept; a RCIP message
AH	Authentication Header
AUP	AUdit resPonse; a RCIP message,

AUR	AUdit Request; a RCIP message
BCD	Binary-Coded Decimal
bps	bit per second
BCF	Bearer Control Function
CLOSE	Protocol Connection Establishment Close; a RCIP message
DNS	Domain Name System
ESP	Encapsulation Security Payload
HMAC	Hash-based Message Authentication Code
ID	Identifier
IP	Internet Protocol
KA	Keep-Alive; a RCIP message
kbps	kilobit per second
LSP	Label Switched Path
mbps	megabit per second
MPLS	MultiProtocol Label Switching
OVE	OVERload indication; a RCIP message
PD-PE	Policy Decision Physical Entity
OPEN	Protocol Connection Establishment Open; a RCIP message
QoS	Quality of Service
RACF	Resource Admission Control Functions
RA	Resource Acceptance; a RCIP message
RCIP	Resource Connection Initiation Protocol
REJ	resource REJection; a RCIP message
RLP	Resource reLease resPonse; a RCIP message
RLR	Resource reLease Request; a RCIP message
RR	Resource Request; a RCIP message
SCE	Session/Service Control Entity
SF	Switching Function
T-PE	Transport Physical Entities
TLS	Transport Layer Security
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 which is depicted in Figure 5-1. Rp interface is defined in [ITU-T Y.2111] between TRC-FE instances as shown in Figure 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 session/service control entity s (SCEs) and interior transport physical entities (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.

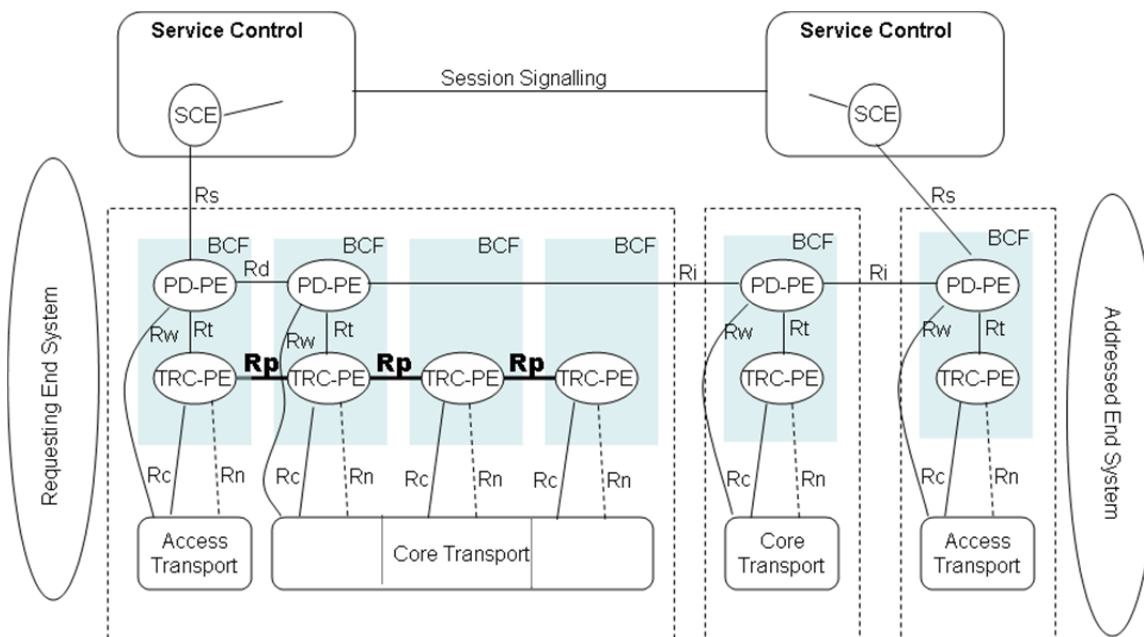
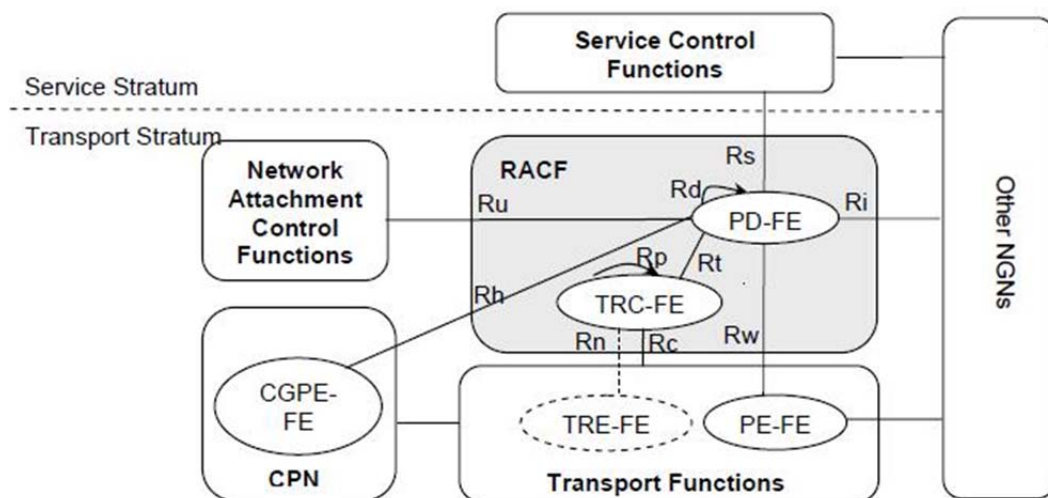


Figure 5-1: Basic protocol architecture



Note: This figure is derived from Figure 5/Y.2111

Figure 5-2: 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 is 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 service 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 and destination TRC-PE pair.

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

5.2 Protocol overview

RCIP protocol (Figure 5-3) 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 specifies 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 by 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 as shown below.

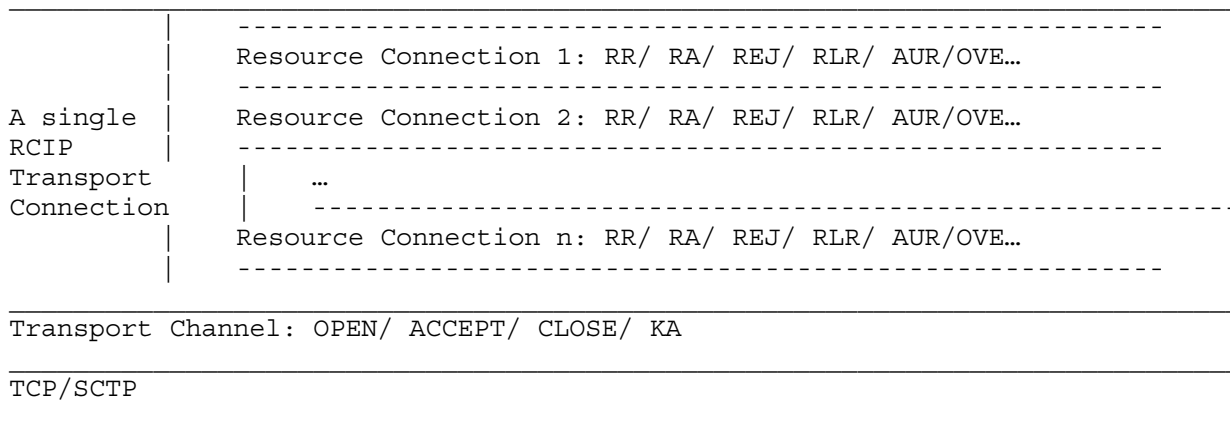


Figure 5-3: RCIP Protocol overview

RCIP specifies the following messages and objects:

RCIP resource connection messages:

- 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 messages:

- Protocol Connection Establishment Open (OPEN)
- Protocol Connection Establishment Accept (ACCT)
- Protocol Connection Establishment Close (CLOSE)
- Keep Alive (KA)

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
- Aggregate resource information

Each RCIP message includes header information which specifies the message. Related to each message, there are a number of mandatory and optional objects as described in clause 7.

5.3 Roles of TRC-PE

The roles of TRC-PE [ITU-T Q.Sup51] are shown in Figure 5-4, which is only a sketch map. A TRC-PE can act as one or more of the roles at the same time.

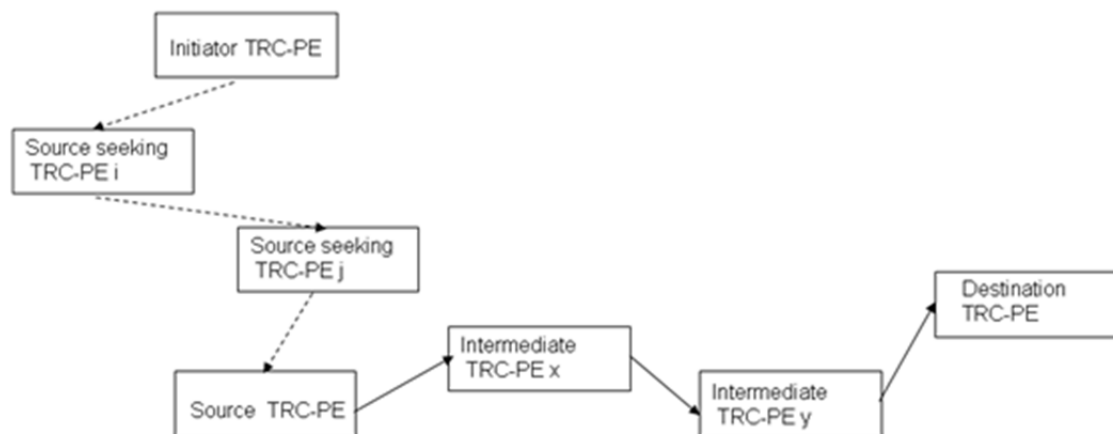


Figure 5-4: Roles of TRC-PE

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 to which the source address of the service message stream belongs.
Source TRC-PE	The source TRC-PE receives a resource request based on the service message, sent by the SCE or the previous hop source seeking TRC-PE. 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 the service message, 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 the service message, 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 bidirectional, 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 a response message of the Resource path from the source to the destination to the previous hop TRC-PE.

6 Basic protocol operation

6.1 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 resources 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 source seeking procedure (and can be one hop or multi hops), the other is for TRC-PE routing for resource reservation procedure. 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, the network 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, TRC-PE can determine to pre-empt, tear down the low priority resource connection.

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

6.2 MODIFY

The MODIFY operation is used, at the request of upstream TRC-PE, to modify the bandwidth, port, or protocol type. Repetitive modifications are allowed. Bandwidth modification falls into decrement modification or increment 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, the previous connection may be recovered or the service connection may be released.

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

6.3 AUDIT

The AUDIT operation is used to synchronize the TRC-PE(s) in the status of a QoS request. The AUDIT operation is a mechanism 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 audit response fails, the corresponding RCIP resource connection shall be released. TRC-PE releases resources 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. The Audit Request (AUR) and Audit Response (AUP) messages are utilized in the AUDIT operation.

6.4 NOTIFY

The NOTIFY operation is used to notify the 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 be handled in two ways: to release the call or not. If the call is not released, QoS will be interrupted for the call.

The Overload Indication (OVE) message is utilized in the NOTIFY operation.

6.5 RELEASE

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

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

6.6 TRC-PE source seeking

The TRC-PE source seeking operation is used 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.

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

There are two ways to complete the source seeking process.

One method is in piggyback way, in which the resolution function is integrated within TRC-PE. The TRC-PE is called source-seeking TRC-PE and act as the resource reservation request proxy. When a TRC-PE, which is called Initiator TRC-PE, receives a request from SCE, it initiates a Resource Request and forwards it to the source-seeking TRC-PE. Source-seeking TRC-PE is responsible to resolve the source TRC-PE's address and transmit the Resource Request to the source TRC-PE.

Another method to complete the process is independent, where the resolution function is separated from TRC-PE. The resolution function is responsible to resolve the source TRC-PE's address and return it to Initiator TRC-PE. Initiator TRC-PE then initiates a Resource Request to the source TRC-PE directly. This method is out of scope for this Recommendation.

Resource Request message (RR) is utilized in the 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 label switched path (LSP) used to constitute a logical bearer network. Thus, QoS in a bearer network level for a media flow can be guaranteed by applying provider-specific resource admission control, path selection. The Best Effort traffic without QoS requirements can be forwarded following traditional IP routing without applying any QoS mechanisms.

In order to establish a RCIP resource connection (i.e. make successful reservation of necessary QoS resources) for a call in a provider network, a resource request is first generated in a source TRC-PE.

The Resource Request (RR) message is sent to a downstream TRC-PE. This message is detected on the downstream TRC-PE. The downstream TRC-PE carries out resource computation, TRC-PE route selection and admission control is according to the topology and resource usage of the logic bearer network [ITU-T Y.2111]. The downstream TRC-PE checks the availability of resources in its local domain and if they are available and preliminarily reserved, the request is passed to the next TRC-PE towards the destination TRC-PE. The previously described procedure is performed in every TRC-PE. When the request has a chain of TRC-PEs, from the destination TRC-PE on, the downstream TRC-PE provides feedback results of resource admission control to upstream while at the same time provides the results of route selection (MPLS multi-layer label representing a given path), flow ID and QoS parameter to the corresponding edge router. On the basis of its received Resource Request (RR) message, the TRC-PE creates a new Resource Request (RR) message which is forwarded to the next TRC-PE.

The same handling process can be implemented at the nearest TRC-PE on the RCIP signalling path until the destination TRC-PE is reached.

On the destination TRC-PE, it is impossible for the last TRC-PE on the signalling path to send a further Resource Request (RR) message, a reply/reject message as acknowledgement is mandatory.

Appendix I provides examples of message flows with unidirectional and bidirectional RCIP resource connection setup.

7.2 Tearing down a resource connection

If a RCIP resource connection is no longer needed or resources are reduced on the connection, the TRC-PE sends a Resource Release Request (RLR) message to the interconnected TRC-PE. When the interconnected TRC-PE receives a RLR, it performs the following actions:

- Decides if resources shall be released,
- Sends a RLR message to other TRC-PEs involved in the connection, releases the actual resources in the node and sends a successful Resource Release Response (RLP) message to the sending TRC-PE of the RLR.

7.3 Overload control

There might be situations where a given TRC-PE is overloaded due to high processing. To ensure timely responses, and to increase the effective throughput at high loads, it is necessary for entities external to the given TRC-PE to reduce the rate of new signalling requests to a level at which throughput can be maximised. The protocol provides a minimal yet effective procedure to achieve

this. The overloaded TRC-PE node could propagate this information to all the neighbouring TRC-PE nodes. The exact behaviour of the TRC-PE node receiving such an indication is implementation specific. However, it is expected to reduce the originating traffic towards the overloaded TRC-PE node until an explicit notification is received, indicating that the overload situation has ceased.

8 Protocol format

8.1 General

RCIP resource connection messages

RCIP transport channel messages

TCP/SCTP

Figure 8-1: RCIP messages exchanged between TRC-PE (s)

This clause describes the message formats and objects exchanged between TRC-PE(s). See Figure 8-1. All fields in an RCIP message **MUST** be transmitted in network byte order.

8.2 RCIP message format

The general RCIP message format is shown in Figure 8-2. Each message is comprised of a message header and message content consisting of one or more objects. See clause 8.2.1 for a description of the message header, and clause 8.4 for a description of the general structure of an object.

Table 8-1 in clause 8.4 lists the object types that are required in each RCIP message type.

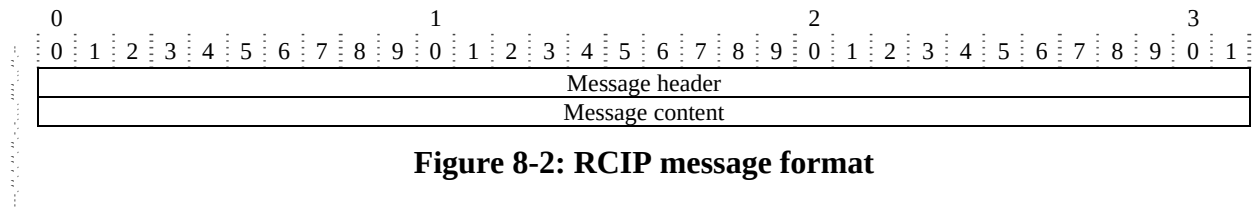


Figure 8-2: RCIP message format

8.2.1 RCIP message header

The Figure 8-3 shows structure of the RCIP message header.

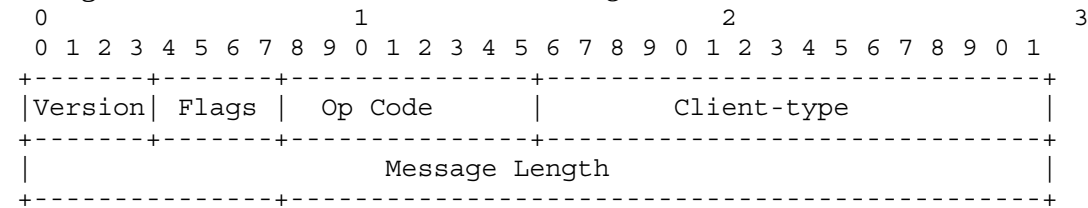


Figure 8-3: RCIP message header

The fields in the header are:

Version: 4 bits

RCIP version number. The current version is 1.

Flags: 4 bits

Defined flag values:

| proxy | modify | converse | urgent |

Reserved: 0.

0x8 Proxy Flag Bit

This flag is set when the message is from the source seeking TRC-PE, not the message towards to the next TRC-PE.

0x4 Modify Flag Bit

This flag is set when the message is modifying the information of the same request or response, e.g. bandwidth modification.

0x2 Converse Flag Bit

This flag is used in Resource Release Request message (RLR). This flag is set when the message is converse RLR, Op Code is 11 = Request for resources to support the service. Converse means that the direction of this RLR is in the converse direction with RR.

0x1 Urgent Flag Bit

This flag is used to represent the priority of the message. When the Urgent Flag is 0, the RCIP resource connection may be released when necessary; when the Urgent Flag is 1, the RCIP resource connection should not be released except in manual reconfiguration.

All other values are reserved and are set to “0”

Note: 0xm indicates hexadecimal notation.

Op Code: 8 bits

0-5: reserved

6 = Protocol Connection Establishment Open (OPEN) message

7 = Protocol Connection Establishment Accept (ACCT) message

8 = Protocol Connection Establishment Close (CLOSE) message

9 = Keep Alive (KA) message

10: reserved

11 = Resource Request (**RR**) message

12 = Resource Acceptance (**RA**) message

13 = Resource **Rejection** (**REJ**) message

14 = Resource Release Request (**RLR**) message

15 = Resource Release Response (**RLP**) message

16 = Overload Indication (**OVE**) message

17 = Audit Request (**AUR**) message

18 = Audit Response (**AUP**) message

Client-type: 16 bits

The Client-type identifies the policy client. Interpretation of all encapsulated objects is relative to the client-type.

0x0 KA

0x1 TRC-PE during source seeking process

0x4 TRC-PE not in the source seeking process

For KA Messages, the client-type in the header MUST always be set to 0 as the KA is used for connection verification (not per client session verification).

For the messages between Source TRC-PE, Intermediate TRC-PE and Destination TRC-PE, the client-type in the header MUST always be set to 0x4.

For the messages between Initiator TRC-PE, Source seeking TRC-PE, and Source TRC-PE, the client-type in the header MUST always be set to 0x1.

Message Length: 32 bits

Size of message is in octets, which includes the standard RCIP header and all encapsulated objects. Messages are required to be aligned on 4 octet boundaries.

If the length is not the integral times of 4 bytes, filling is needed. The filling bits are all set to "0".

When sending to the network, the version is sent first; when receiving from the network, the version is received first.

8.3 RCIP messages

8.3.1 RCIP resource connection messages

8.3.1.1 Resource Request (RR)

The Resource Request (RR) message, indicated by the Op code set to 11, is sent by an upstream TRC-PE to the downstream TRC-PE to request the bearer resource for the RCIP resource connection.

```
Resource Request = <RCIP_HEADER>
                  <Connection ID>
                  1*{Media Profile}
                  [Data Consistency Information]
```

In the Flow Profile Object, if the RR message is bidirectional, both Forward Flow Traffic Descriptor and Backward Flow Traffic Descriptor are carried; if the RR message is unidirectional, either Forward Flow Traffic Descriptor or Backward Flow Traffic Descriptor is carried. Flow Profile contains a profile for a part of resource reservation information including flow ID, flow information, flow traffic descriptor (multiple groups of forward Flow Traffic Descriptor and multiple groups of backward Flow Traffic Descriptor), LSP connection information (needed when Proxy flag is set to 0).

8.3.1.2 Resource Acceptance (RA)

The Resource Acceptance (RA) message, indicated by the Op code set to 12, is sent by a downstream TRC-PE to the upstream TRC-PE in response to the Resource Request message.

```
Resource Acceptance = <RCIP_HEADER>
                     <Connection ID>
                     1*{Media Profile}
                     [Data Consistency Information]
```

8.3.1.3 Resource Rejection (REJ)

The Resource Rejection (REJ) message, indicated by the Op code set to 13, is sent by a downstream TRC-PE to the upstream TRC-PE in rejection response to the Resource Request message.

```
Resource Rejection = <RCIP_HEADER>
                    <Connection ID>
                    {Reason Code}
                    [Data Consistency Information]
```

8.3.1.4 Resource Release Request (RLR)

The Resource Release Request (RLR) message indicated by the Op code set to 14, can be sent from an upstream TRC-PE to the downstream TRC-PE with the Converse Flag set to 0, and can also be sent from a downstream TRC-PE to the upstream TRC-PE with the Converse Flag set to 1.

```
Resource Release Request = <RCIP_HEADER>
                          <Connection ID>
                          {Reason Code}
                          [Data Consistency Information]
```

8.3.1.5 Resource Release Response (RLP)

The Resource Release Response (RLP) message indicated by the Op code set to 15 is sent from a downstream TRC-PE to the upstream TRC-PE, in response to the RLR message with Converse Flag set to 0. There is no response message to the Converse Resource Release Request message, as in this case it is already the abnormal release.

```
Resource Release Response = <RCIP_HEADER>
                          <Connection ID>
                          {Reason Code}
                          [Data Consistency Information]
```

8.3.1.6 Overload Indication (OVE)

The Overload Indication (OVE) message indicated by the Op code set to 16, is sent from a TRC-PE to the peer TRC-PE, including overload and recovery.

```
Overload Indication = <RCIP_HEADER>
                    {Overload Indication}
                    [Data Consistency Information]
```

8.3.1.7 Audit Request (AUR)

The Audit Request (AUR) message indicated by the Op code set to 17 is sent from a TRC-PE to the peer TRC-PE, in order to check whether the RCIP resource connection exists.

```
Audit Request = <RCIP_HEADER>
               <Connection ID>
               [Data Consistency Information]
```

8.3.1.8 Audit Response (AUP)

The Audit Response (AUP) message indicated by the Op code set to 18 is sent from a TRC-PE to the peer TRC-PE, in response to the Audit Request message.

```
Audit Response = <RCIP_HEADER>
```