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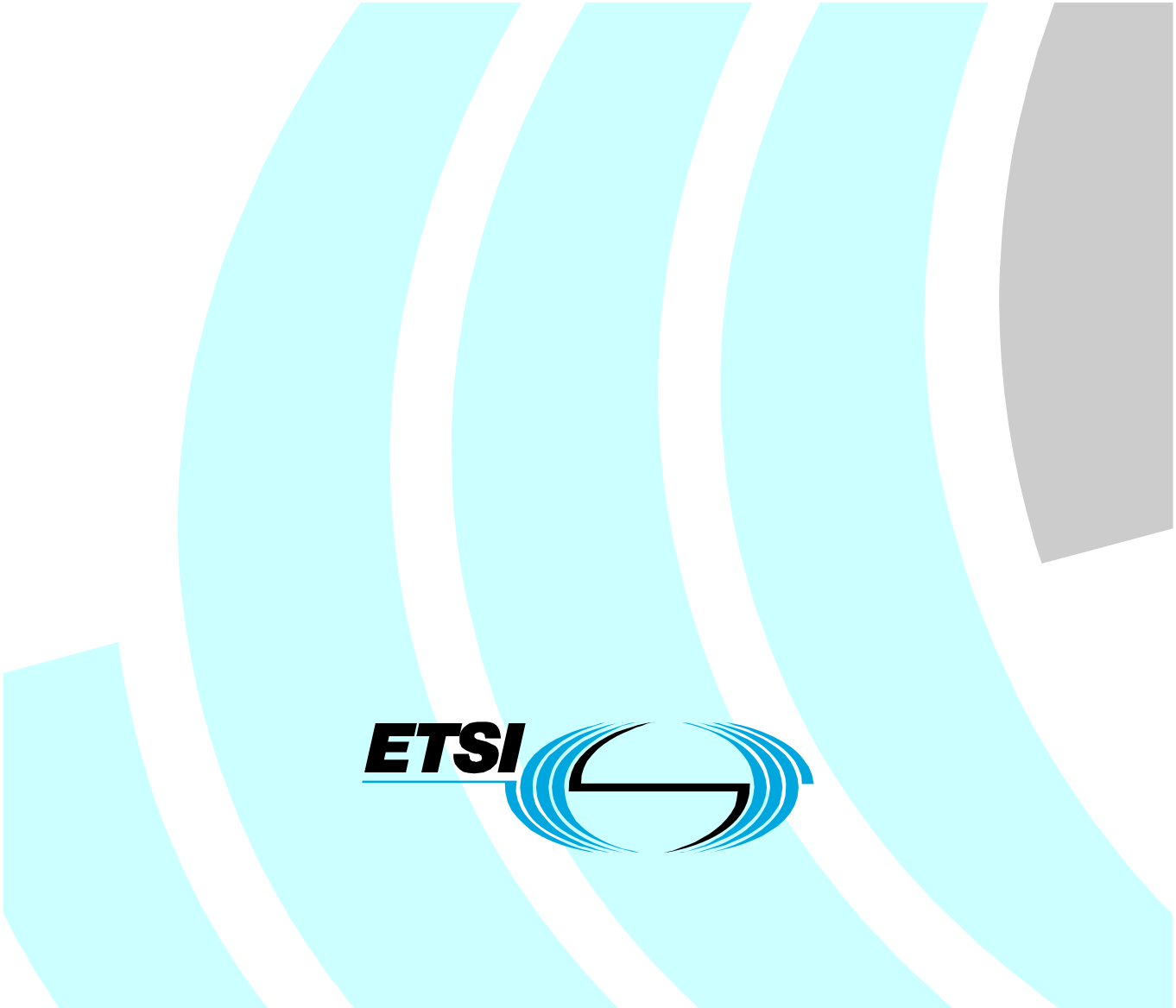
*ETSI Standard*

**Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-System (RACS): Functional Architecture**



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# Contents

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# Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN).

The present document describes the architecture of the Resource and Admission Control Sub-System (RACS) identified in the overall TISPAN NGN architecture.

# 1 Scope

The present document describes the functional architecture of the Resource and Admission Control Subsystem (RACS), for TISPAN NGN Release 3, in line with the service requirements described in TS 181 005 [1], in line with the QoS Requirements described in TS 181 018 [13] and its role in the TISPAN NGN architecture as defined in ES 282 001 [2]. It specifies as well high level stage 2 requirements that are also considered when describing its functional operation.

# 2 References

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## 2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ETSI TS 181 005: "Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN); Service and Capability Requirements".

[2] ETSI ES 282 001: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture".

[3] IETF RFC 3312: "Integration of Resource Management and Session Initiation Protocol (SIP)".

[4] IETF RFC 2475: "An Architecture for Differentiated Service".

[5] ETSI ES 282 004: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture; Network Attachment Sub-System (NASS)".

[6] ETSI TR 180 000: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Terminology".

[7] ETSI TS 123 107: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Quality of Service (QoS) concept and architecture (3GPP TS 23.107)".

[8] ITU-T Recommendation Y.1541: "Network performance objectives for IP-based services".

[9] IETF RFC 3198: "Terminology for Policy-Based Management".

[10] IETF RFC 2753: "A Framework for Policy-based Admission Control".

[11] Broadband Forum: "Policy Control Framework", Draft Working Text WT-134.

[12] Damianou, N. et. al.: "The Ponder policy based management toolkit", August 2002.

[13] ETSI TS 181 018: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Requirements for QoS in a NGN".

[14] ETSI TS 187 001: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN SECurity (SEC); Requirements".

[15] ETSI TS 185 005: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Services requirements and capabilities for customer networks connected to TISPAN NGN".

[16] ETSI TS 123 228: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IMS Multimedia Subsystem (IMS); Functional Architecture".

[17] IETF RFC 2474: "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers".

## 2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area. For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI TS 182 027: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IPTV Architecture; IPTV functions supported by the IMS subsystem".

[i.2] ETSI ES 283 026: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control; Protocol for QoS reservation information exchange between the Service Policy Decision Function (SPDF) and the Access-Resource and Admission Control Function (A-RACF) in the Resource and Protocol specification".

[i.3] ETSI TS 183 017: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control: DIAMETER protocol for session based policy set-up information exchange between the Application Function (AF) and the Service Policy Decision Function (SPDF); Protocol specification".

[i.4] ETSI TS 185 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Customer Network Gateway (CNG) Architecture and Reference Points".

# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 180 000 [6] and the following apply:

**access network policies:** policies which are used to make decisions for resource admission control and are designed to derive the traffic policies to be enforced by the A-RACF

NOTE: Access network policies are constructed using Conditions and Actions that are specifically supported by A-RACFs. An example would be a policy which checks the condition that resources are available and the action to reserve the resource.

**Application Function (AF):** functional entity that offers applications the control of IP bearer resources when required

NOTE: The AF is capable of communicating with the RACS to transfer dynamic QoS-related service information.

**application session:** end-to-end user session, which is setup by an AF (using SIP or another protocol) and requires one or more resource reservations to take place

NOTE: An application session may involve one, two or more end users.

**BGF service:** traffic flow function performed by the BGF Functional Entity on media flows and/or the allocation of BGF resources

**DiffServ:** DiffService networks classify packets into one of a small number of aggregated flows or "classes", based on the DiffService code point (DSCP) in the packet's IP header

**gate:** operates on a unidirectional flow of packets, i.e. in either the upstream or downstream direction

NOTE: A gate consists of a packet classifier, and a gate status (open/closed). When a gate is open, the packets in the flow are accepted. When a gate is closed, all of the packets in the flow are dropped.

**"Last mile" access network segment:** comprises the functional elements that enable communication between a CPN and an Access Node

**local A-RACF policies:** specific Access network policies that are currently active on an A-RACF (may be a subset of all access network policies)

NOTE: Local A-RACF policies are instances of Access network policies.

**local SPDF policies:** specific Service based policies that are currently active on an SPDF (may be a subset of all service based policies)

NOTE: Local SPDF policies are instances of Service based policies.

**media flow:** uni-directional media stream of a particular type, which is specified by two endpoint identifiers, bandwidth and class of service

**NAT:** generic term for Network Address Translation that includes NAT-PT and NA(P)T

**overbooking admission control:** situation whereby the A-RACF considers that different AF-sessions can reserve the same resources bearing in mind that these resources cannot be committed to more than one AF-session at a time

NOTE: This enables optimal resource management in certain service conditions (e.g. Call Hold, Communication waiting).

**path-coupled signalling:** mode of signalling where the signalling messages follow a path that is tied to the data packets

NOTE: Signalling messages are routed only through the nodes that are in the data path.

**policy:** set of rules which govern the choices in behaviour of a system and that comprises conditions and actions, where conditions are evaluated when triggered by an event

NOTE 1: See annex B for further details.

NOTE 2: The content of policies is outside of the scope of the present document.

**QoS classes:** As defined in ITU-T Recommendation Y.1541 [8] and TS 123 107 [7].

**QoS "Push" model:** model where the RACS "pushes" traffic policies to the transport functions to enforce its policy decisions

NOTE: In this model, the CPN does not itself support native application independent QoS procedures.

**QoS "Pull" model:** model where, upon request from the transport processing functions, the RACS provides traffic policies to the transport processing functions

NOTE: The request from the transport processing functions may itself, for example, be triggered by path-coupled requests coming from user equipment and/or transport network elements.

**resource:** allocatable physical network capability

NOTE 1: A resource can be characterized by a set of parameters, including, but not limited to; memory bandwidth forwarding capacity, scheduling capacity, or other.

NOTE 2: Description and measurement metric of a resource is technology dependent.

**resource identifier:** single key or group of keys used to refer to a resource

NOTE: Resource identifiers can be can be the same as or derived from Layer-1 keys (e.g. physical port or reference point), Layer-2 keys (e.g. Ethernet VLAN ID), or Layer-3 keys (e.g. IP-address).

**resource reservation session:** set of one or more media flows, which are reserved for a period of time in order to execute an application session

NOTE: A resource reservation session may be uni-directional or bi-directional.

**service based policies:** policies designed to be enforced by an SPDF

NOTE: Service based policies are constructed using Conditions and Actions that are specifically supported by SPDFs. An example would be a policy in which a condition is the type of service required and the action to request the service from either the A-RACF or BGF.

**traffic policies:** policies for which the execution trigger is the arrival of a data packet, and for which the action(s) constitutes some form of processing of this packet before it is forwarded to another device, are known as traffic policies

**xDSL:** type of access network supported by the NGN, based on the different flavours of the xDSL technology, that have their resources controlled by RACS

## 3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

| | |
|---|---|
| ACP | Admission Control Process |
| ACSR | Authorization based on Contents of the Service Request |
| AF | Application Function |
| AN | Access Network |
| A-RACF | Access-Resource and Admission Control Function |
| ASP | Application Service Provider |
| BC | Broadcast Channel |
| BGF | Border Gateway Function |
| BGS | Border Gateway Services |
| BTF | Basic Transport Functions |
| C-BGF | Core Border Gateway Function |
| CCI | Charging Correlation Information |
| CLF | Connectivity session Location and repository Function |
| CMFE | Coordination of Messages between FEs |
| CND | Customer Network Device |
| CPE | Customer Premise Equipment |
| CPN | Customer Premises Network |
| C-RACF | Core-Resource and Admission Control Function |
| CSCF | Call Session Control Function |
| DHCP | Dynamic Host Configuration Protocol |
| DITP | Derivation and Installation of Traffic Policies |
| DSCP | Differentiated Service Code Point |
| DSFE | Discovery of Subsequent FE |
| e4 | reference point e4 |
| ECF | Elementary Control Function |

| | |
|---|---|
| EFF | Elementary Forwarding Function |
| FDP | Final Decision Point |
| FE | Functional Entity |
| FQDN | Fully Qualified Domain Name |
| GC | Gate Control |
| Gq' | reference point Gq' |
| HMRP | Handling of Media Request Priority |
| HSRP | Handling of Service Request Priority |
| Ia | reference point Ia |
| IBCF | Interconnection Border Control Function |
| I-BGF | Interconnection Border Gateway Function |
| IEEE | Institute of Electrical and Electronics Engineers |
| IETF | Internet Engineering Task Force |
| IMS | IP Multimedia Sub-system |
| IP | Internet Protocol |
| IPMC | IP Packet Marking Control |
| LSP | Label Switched Path |
| MITP | Modification and Installation of new Traffic Policies |
| MLD | Multicast Listener Discovery |
| MPLS | MultiProtocol Label Switching |
| NA(P)T | Network Address and optional Port Translation |
| NANP | NGN Access Network Provider |
| NAPTC | NAPT control and NAT traversal |
| NASS | Network Attachment Sub-System |
| NAT | Network Address Translation |
| NAT-PT | NAT Address Translation and Protocol Translation |
| NCP | NGN Connectivity Provider |
| NGN | Next Generation Network |
| NPAH | Network Policy Assembly Handling |
| OSS | Operations Support Systems |
| P-CSCF | Proxy-CSCF |
| PPP | Point to Point Protocol |
| QMTD | QoS and Priority Mapping - Technology Dependent |
| QMTI | QoS and Priority Mapping - Technology Independent |
| QoS | Quality of Service |
| RACS | Resource and Admission Control Sub-System |
| RCEF | Resource Control Enforcement Function |
| Rd' | Reference point Rd' |
| Re | Reference point Re |
| Rf | Reference point Rf |
| Ri' | Reference point Ri' |
| RLC | Rate Limiting Control |
| Rq | Reference point Rq |
| Rr | reference point Rr |
| RRP | Reservation of Resources Process |
| RTCP | Real Time Control Protocol |
| RTP | Real Time Protocol |
| SBP | Service Based Policy control |
| SDP | Session Description Protocol |
| SIP | Session Initiation Protocol |
| SPDF | Service-based Policy Decision Function |
| SSAP | Storage of Subscriber Access Profile |
| SSBP | Selection of a Service based Policy |
| TCP | Transmission Control Protocol |
| TDDP | Technology Dependent Decision Point |
| TISPAN | Telecommunications and Internet converged Services and Protocols for Advanced Networking |
| TRSF | Topology and Resource Store Function |
| UDP | User Datagram Protocol |
| UE | User Equipment |
| UNI | User-to-Network Interface |
| VC | Virtual Channel |
| VLAN | Virtual Local Access Network |

| | |
|---|---|
| VoIP | Voice over IP |
| VP | Virtual Path |
| VPN | Virtual Private Network |
| x-RACF | Generic Resource and Admission Control Function |

# 4 General description of RACS

## 4.1 Functional overview

### 4.1.1 Global description

RACS is the NGN Subsystem responsible for elements of policy control, resource reservation and admission control. In addition, it also supports core Border Gateway Services (BGS) including Network Address Translator (NAT) mechanisms.

RACS provides policy based transport control services to applications. This enables the request and reservation of transport resources from access and core transport networks within its coverage, which also include points of interconnection between them in order to support e2e QoS.

By offering a set of generic policy based transport control services to applications, RACS ensures that any existing or future application shall be able to request transport resources appropriate to that service as long as it supports the interfaces to RACS defined in this architecture specification.

Moreover, by hiding the interaction between applications and transport resources, RACS also ensures that applications do not need to be aware of the underlying transport networks. As an example, RACS allows any type of real-time multimedia services (VoIP, Videoconferencing, Video on Demand, on-line gaming) to request some particular bandwidth and/or address mediation capabilities for the service from any type of transport network. As the network system responsible for policy based transport control, RACS may have to perform admission control in order to evaluate these requests in the context of predefined policy rules provisioned by the network operator. It may then perform resource reservation provided the request passes the policy tests and appropriate resources are available in the transport network. In this way, RACS offers the operators the means to perform admission control, which may be followed by the installation of bearer service policy rules.

However, situations where admission control come after policy installation, or is not performed at all, are not precluded.

In addition, RACS also provides the means for value-added services to obtain network resources that are necessary to offer services to the end-user.

In terms of session awareness, RACS is resource-reservation session aware but application session agnostic, i.e. it can support transport resource reservations for both session based and non-session based applications.

RACS also provides access to services provided by the Border Gateway Function. Examples of those services are gate control, NAT and hosted NAT transversal.

### 4.1.2 Basic functionalities

RACS offers to applications the following set of functionalities on a one per RACS resource reservation session request basis:

- **Admission Control:** RACS implements Admission Control to the access and aggregation segment of the network. One can imagine various types of admission control going from a strict admission control where any overbooking is to be prevented, to admission control that allows for a certain degree of over subscription or even a trivial admission control where the authorization step is considered sufficient to grant access to the service.

- **Resource reservation:** RACS implements a resource reservation mechanism that permits applications to request bearer resources in the access, aggregation, and core networks.

- **Policy Control:** RACS uses service based local policies to determine how to support requests from applications for transport resources. Based on available information about resource availability and on other policy rules, e.g. priority of the application, RACS determines if a request can be supported, authorizes appropriate transport resources and derives L2/L3 traffic polices to be enforced by the bearer service network elements.
- **NAT transversal:** RACS controls the transversal of far end (remote) NAT.
- **NAT/Gate control:** RACS controls near-end NAT at the borders of the NGN core network and at the border between a core network and an access network.

RACS offers services to applications that may reside in different administrative domains.

### 4.1.3 Restrictions applicable to the present document

- In terms of the present document, the restrictions applicable to the RACS set of features indicated above are listed hereinafter: the interconnection between domains through the Ri' interdomain reference point is limited to scenarios involving only wholesale and roaming between two domains.
- The e2e QoS handling is limited to scenarios involving only wholesale and roaming between two domains.
- The interconnection with CPN is not fully covered and is restricted to informative annex D.
- QoS handling aspects, e.g. QoS monitoring and QoS reporting, are covered only in informative annex E.
- Metro aspects are covered in informative annex D.
- The multicast feature is limited to scenarios involving only a single domain, and diagram flows involving C-RACF are not considered.

## 4.2 Functional Requirements

The functional requirements of the RACS are developed in the present document in line with TS 181 005 [1].

### 4.2.1 R1 Requirements

In the following, the stage 2 requirements applicable to Release 1 are listed.

#### 4.2.1.1 Overall

The overall requirements related to the scope of Release 1 have been identified as:

1) RACS shall only provide policy based transport control services within the access networks and at points of interconnection between core networks. There is no requirement for RACS to provide service coverage for core networks themselves or to customer networks.

2) The RACS shall hold a logical view of the different transport segments within its control. As one example, for xDSL access, this must include at least the last-mile and the aggregation network.

#### 4.2.1.2 Transport Control Service Requests

The requirements related to the transport control of service requests performed by AFs have been identified as:

3) The RACS shall provide policy based transport control services, e.g. policy control, resource reservation, policing, gate control and IP address mediation, to Application Functions (AFs).

4) The RACS services shall be made available to all service control Sub-Systems as well as to the Applications domain.

5) The RACS services shall not be specific to any Application Function (AF) or service Sub-System.

6) The RACS shall be capable of supporting multiple Application Functions (AFs).

7) The RACS shall offer services to Application Functions (AFs) that may reside in different administrative domains.

8) The RACS shall be able to authenticate and authorize the Application Function (AF).

9) RACS shall set the bearer/transport function with network-level attributes that match to the transport control service requests, e.g. bandwidth, QoS, etc.

10) The RACS services shall either be chosen by an Application Function (AF) at a given time for use in the context of the application service provided by the application or be triggered by a transfer processing function.

11) The RACS shall be prepared to support at least eight different priority types defined in such a way that any number of them may be simultaneously active. This number of priorities is envisaged to support different priorities for national usage, e.g. emergency service.

#### 4.2.1.3 Resource Handling

The requirements related to the resource handling, i.e. resource reservation, resource management, etc. have been identified as:

12) The RACS shall provide a mechanism to the Application Function (AF) entity through which it can reserve resources in the access network, i.e. RACS reserves resources on behalf of AFs.

13) The RACS shall be able to react on prioritization request signalled by an Application Function (AF) for transport control by modifying allocated resources.

14) RACS shall support all the following resource reservation scenarios:

- A resource reservation where admission control is only required for the "last-mile" access network segment, but is not required for the aggregation network segment.

NOTE: For the definitions of access network segment, aggregation network segment, and core network segment, please see ES 282 001 [2].

- A resource reservation where admission control is only required for the aggregation network segment, but is not required for the "last mile" access network segment.

- A resource reservation where admission control is required for both "last mile" access network and aggregation network segments.

15) The RACS shall support a versatile set of resource management schemes, suitable for coping with all target deployment architectures:

- a Single-stage resource management model providing resource management services in a mode where reserved resources are immediately available upon successful reservation;

- a Two-stage reserve-commit resource management model that can be leveraged in support of services that aim to support charging per service-invocation and require as such service-theft-prevention solutions;

- an Authorize-reserve-commit resource management model supporting service-based local policy control under coordination of a network-hosted application function.

16) The RACS shall notify the Application Function (AF) in the case that a previously allocated resource must be relinquished. This may be triggered by an administrative decision or by a faulty condition.

17) The RACS shall support requests from Application Functions (AFs) to modify the parameters of their existing transport resource reservations. Requests of this type may result in a new admission control step and/or installing of new L2/L3 traffic policies.

18) The RACS shall provide feedback messages to the Application Function (AF) either approving or rejecting the transport control service reservation, commit or modify requests.

19) The RACS shall support both soft-state and hard-state resource management approaches. Soft-state operation will assure robustness of resource management services in an environment with multiple applications. In both cases:

- granularity of resource reservation, removal, and modification facilities shall be at the level of individual service flows;
- the RACS shall support facilities for the explicit removal of previously established resource reservations;
- the RACS shall support facilities for the explicit modification of previously established resource reservations.

20) The RACS shall provide the necessary functions to support Sub-Systems in the Service Layer that implement a segmented resource management model RFC 3312 [3] An example of such a Sub-System is the IMS, where resource reservation for each participating party in an application session (e.g. multi-party conversational SIP-based sessions) is needed.

#### 4.2.1.4 QoS Management

The requirements related to QoS Management have been identified as:

21) The RACS shall support a "Push" model for initiating policy based transport control service requests. In this model service requests are "pushed" to RACS from the Application Function (AF). RACS services these requests, and if the service requests from the AFs are in line with policies established by the operators and stored in the Sub-System, and if appropriate transport resources are available, then RACS "pushes" requests down to the transport processing functions to obtain the appropriate transport resources.

22) RACS architecture shall ensure QoS aware NGN service delivery by adopting at least one of the following two models for dynamic QoS control:

- **guaranteed QoS:** traffic delivery service with absolute numerical bounds on some or all of the QoS parameters, such as throughput, latency, jitter and loss.

NOTE 1: The bounds may be derived due to physical limits, or due to the enforcement of limits such as those encountered through mechanisms like rate policing. The bounds may result from designating a class of network performance objectives for packet transfer.

- **relative QoS:** traffic delivery service without absolute numerical bounds on the achieved bandwidth, packet delay or packet loss rates.

NOTE 2: The circumstances where certain classes of traffic are handled differently from other classes of traffic, and the classes achieve different levels of QoS, are described.

#### 4.2.1.5 Traffic Handling

The requirements related to the traffic handling have been identified as:

23) The RACS shall not be aware of application session, it shall be aware of a set the media flows in a resource reservation request, which may in turn belong to one or multiple application sessions.

24) The RACS shall support transport control service requests from Application Functions (AF) for uni- and bi-directional, symmetric and asymmetric, unicast and multicast, up- and downstream traffic. However, multicast is not further developed in RACS Release 1.

25) The RACS shall support allocation of resources in the transport network that have different traffic characteristics, for example packet loss.

#### 4.2.1.6 Charging and Overload Control

The requirements related to charging and overload control have been identified as:

26) The RACS shall be able to export charging information and resource reservation session metrics. For Release 1 charging should be limited to off-line charging.

27) The RACS shall support appropriate overload control mechanisms in order to prevent overload within the RACS itself and also within the requesting AFs. This applies to all RACS to AF reference points. However, the overload control mechanism is not further developed in this architecture document.

### 4.2.2 R2 Requirements

In the following, the stage 2 requirements applicable to Release 2 are listed, either as enhancements or as entirely new requirements.

#### 4.2.2.1 Overall

For the present document, no overall requirements have been specifically identified except those mentioned in clause 1, together with the restrictions mentioned there in the bullet item list.

#### 4.2.2.2 Resource Handling

The requirements related to improvements on resource handling have been identified as:

28) The RACS shall provide a mechanism enabling the Application Function (AF) entity to schedule resource reservations, i.e. to reserve resources at a requested time and not immediately after the AF request.

29) Resource admission control should support service changes (i.e. upgrading or downgrading) triggered at the application function level, based upon current network loads and link quality status, as detected by the underlying transport processing functions. As such, the RACS shall provide mechanisms to:

- allow the requestor to ask to be informed in case the amount of resources controlled by RACS are insufficient to complete a QoS request; the QoS request, might however be completed by downgrading either the QoS requested for the new incoming session or the QoS used by a set of existing sessions established by the same subscriber associated with the QoS request;

- inform the requestor that a situation occurred where the amount of resources controlled by RACS are insufficient to complete a QoS request; the QoS request might however be completed by downgrading either the QoS requested for the new incoming session or the QoS used by a set of existing sessions established by the same subscriber associated with the QoS request;

- allow the requestor to indicate whether the QoS of a new request can be downgraded or not, if the RACS concludes that it cannot allocate enough resources to that new request. In this case, and based on the indication received from the requestor, the RACS decides whether to degrade or not the QoS of the new session being requested or the QoS of existing sessions already established by the same subscriber, i.e. if the QoS of the request can be degraded, the RACS performs the mechanism and re-allocates the resources to the QoS request; otherwise, the RACS rejects the QoS request.

#### 4.2.2.3 QoS Management

The enhanced or new requirements related to QoS Management have been identified as:

30) The RACS shall support communication between instances of RACS located in different administrative domains within NGN networks, which enables those RACS instances to interact with each other for the resource reservation over multiple administrative domains.

31) The RACS shall be capable of receiving network triggers originated by multiple Transfer Processing Functions, e.g. to commit previously authorized and reserved resources.

32) The RACS shall support the QoS resource reservation mechanisms described below for initiating policy based transport control requests. In these models, traffic policies are "pushed" from the RACS to the transport functions on receipt of a request from an Application Function (AF) or are "pulled" from the RACS by the underlying network transport elements, on receipt of a QoS request from a UE or from another network transport element i.e.:

- in the "Push" mode, the RACS pushes traffic policies to the transport functions on receipt of a path-decoupled request for resource authorization and/or reservation from an Application Function (AF) or from an interconnected RACS entity;
- in the "Pull" mode, traffic policies are "pulled" by transport functions from the RACS on receipt of path-coupled resource requests. This requires that the user equipment and/or a network element are capable of sending QoS-related requests using a path-coupled signalling mechanism. The subsequent treatment associated to the authorization, admission control, reservation control, and policy enforcement, follows the same principles as those defined for the "Push" mode, except that use may be made of a specific binding mechanism;

  In both cases, RACS only services these requests if they are in line with policies established by the operators and stored in the Sub-System, and if appropriate transport resources are available.

#### 4.2.2.4 e2e QoS Handling

In the present document, the e2e QoS handling is limited to scenarios involving only wholesale and roaming between two domains.

#### 4.2.2.5 Multicast/Unicast Handling

In the present document, the multicast/unicast handling is limited to scenarios involving only a single domain.

The requirements related to improvements on multicast/unicast handling have been identified as:

33) The multicast resource admission control mechanism should make it possible for a service provider to provide authorization and policies for multicast service (e.g. Access Profile).

34) The multicast resource admission control mechanism should make it possible for a service provider to provide multicast service along with other NGN services.

35) The multicast resource control mechanism should support rapid modification of reservations, to support capabilities such as fast channel zapping.

36) The multicast resource admission control mechanism should enable harmonization between unicast and multicast resource admission control.

37) The multicast resource admission control mechanism should make it possible for a service provider to provide charging information for multicast service.

38) The multicast resource admission control mechanism should provide the mechanisms to reuse the resource on the access line when the switch between unicast service and multicast service occurs.

#### 4.2.2.6 Topology and Resource Information Retrieval

The enhanced or new requirements related to topology and resource information retrieval have been identified as:

39) The RACS shall be able to retrieve topology and resource information needed to manage resource reservations in the different transport segments within its control, either:

- from local configurations;
- from multiple external systems;
- from several network entities; or
- from any combination of local configurations, external systems and network entities.

In the case where RACS retrieves information from multiple external systems, and/or several network entities:

- it shall provide a single point of contact for topology and resource information;
- it shall be possible to retrieve topology and resource information through both information "push" and information "pull" from external systems and network entities;
- it shall be possible to transfer topology and resource information from external systems and network entities both as complete information sets and as deltas to previously transferred information by a particular information source.

In the present document, these topology and resource information topics are only covered in annex E.

#### 4.2.2.7 Network Deployment Scenarios

The enhanced or new requirements related to network deployment scenarios have been identified as:

40) The RACS shall support multiple network deployment scenarios in order to allow for different business models. The details about what network deployment scenarios are supported are defined in annex D below.

#### 4.2.2.8 Charging and Overload Control

In the present document, there are no further requirements related with charging and overload control beyond those defined in Release 1. New reference points supporting charging within RACS have been provided.

### 4.2.3 R3 Requirements

In the following, the stage 2 requirements applicable to Release 3 are listed, either as enhancements or as entirely new requirements.

#### 4.2.3.1 Interaction with the CPN

The interaction requirements with the CPN have been identified for Release 3 as.

##### 4.2.3.1.1 Direct control by RACS

41) RACS may interact with the CPN to provide resource and admission control services.

In case the RACS interacts with the CPN described in [15], the requirements in this clause shall apply as follows:

42) The RACS shall have a single point of contact in the CPN.

43) The security requirements described in TS 187 001 [14] shall apply.

NOTE: The relevant procedures and message flows for the interaction with the CPN should follow those described in the present document.

# 5 RACS functional architecture derivation basis

In this clause, the technical issues related to some of the functional requirements identified above, e.g. unicast and multicast, charging, and QoS management, which may have impact in the RACS architecture definition, are described.

## 5.1 Resource Control for Unicast and Multicast

In the present document, the multicast/unicast handling is limited to scenarios involving only a single domain.

When offering IMS and/or non-IMS based services using unicast, the demand for these services can occasionally exceed the capacity offered by the access and aggregation network although this network may be carefully dimensioned. Unexpected usage patterns and/or popularity of specific services introduce an uncertainty complicating any dimensioning task aiming at cost effective network usage. These basic issues related to providing predictable quality for unpredictable services constitutes the motivation for the resource admission control functions provided by RACS. Beyond resource admission control for various unicast services, IPTV services further demands such control also for multicast.

In order to provide an attractive IPTV service, providers offer bundles of TV channels to subscribers with a very large number of channels. By doing so, some of the TV channels remain frequently unwatched. When IPTV traffic is carried over shared network resources along with VoD traffic and Internet traffic, the number of TV channels offered to subscribers may be greater than the number of channels that can be simultaneously carried over the access and aggregation network. In addition, some channels will be watched by more than one user on a given Access Node. Therefore, multicast is likely to be used. It should be noted though that the usage of multicast is also likely to be combined with usage of unicast for IPTV service such as trick mode or other personalized service offerings.

In this configuration, the risk of congestion is high and this will result in the degradation of the QoS being provided, as well as in the difficulty to attend to new service requests. It is therefore of utmost importance to monitor, and prevent this situation if possible. Hence, new mechanisms should be implemented in RACS to achieve this goal.

### 5.1.1 Resource control scenarios

#### 5.1.1.1 Identification of Resources

One aspect of unicast and multicast resource control is the identification of the contended bandwidth resource and the decision whether resource admission control needs to be applied to the identified resource. With reference to figure 1, which is based on ES 282 001 [2], figure 2, three segments for unicast and multicast traffic control can be identified:

1) *Access segment*: User access line bandwidth resource. Examples for unicast resource admission control on the access segment include cases where different and independent IMS and/or non-IMS based services compete for the bandwidth of this segment and may together demand more bandwidth than what is available before or after bandwidth is set aside for active multicast services. Examples for multicast resource admission control on the access segment include cases where the service provider's service-package offering is not tightly tied to the bandwidth of the access segment, thus allowing multiple concurrent multicast and/or unicast streams which overwhelm the available resources of this segment.

2) *Aggregation segment*: Access-node to aggregation node(s) link or Layer-2 topology bandwidth. Examples common for both unicast and multicast resource admission control on the aggregation segment include cases where a peak unicast and/or multicast bandwidth needs to be enforced or where the access network provider sells "unicast and/or multicast bandwidth packages" to service providers as part of a transport wholesale offering.

3) *Core segment*: Core transport and Layer-3 aggregation bandwidth resources. Examples common for both unicast and multicast resource admission control in the core network segment include cases where the provisioned transport bandwidth is insufficient or a peak unicast and/or multicast bandwidth needs to be enforced.

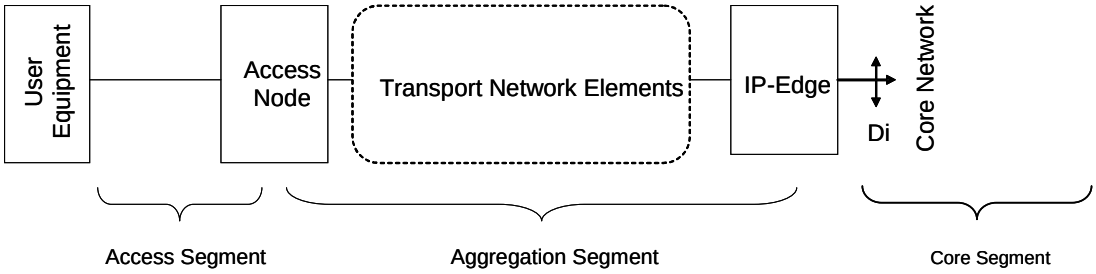



**Figure 1: Network Segments**
**(based on ES 282 001 [2], figure 2b)**

### 5.1.1.2 Multicast Resource Admission Decision Specifics

Multicast resource control is not limited to managing bandwidth resources only, as it also manages the amount of state kept on transport network elements to conduct multicast traffic forwarding. Multicast state management is implementation dependent, and could be required in all of the above mentioned segments.

A generic policy for multicast resource control therefore handles bandwidth resources and state resources jointly.

### 5.1.1.3 Resource Admission Decision Prerequisites

Unicast and Multicast resource admission control has a number of prerequisites which are as follows:

1) Availability of a resource admission control function for the resources in question.

2) The ability of the resource admission control function to receive a trigger resource request event and attribute it to the location/path which is associated with the request, i.e. the congestion point(s).

3) The capability of the resource admission control function to determine what amount of resources the resource request event represents (e.g. description of multicast groups and their corresponding bandwidth requirements). It is assumed that the information contained in the resource request is sufficient to determine the required QoS and state to be kept on a network transport function.

4) The ability of the resource admission control function to determine what resources are available/can be granted on the location/path attributed to the request. This implies knowledge of the topology (including congestion point(s) and the current reservations) of a segment (if more than a single network element or link is handled by a unicast and/or multicast resource admission control function).

5) The optional capability of commencing data plane forwarding only after the resources admission control function has granted the requested resources, and affecting data plane forwarding if conditions change. The decision about the impact of resource admission control outcomes on the transport forwarding functions is part of the service provider/network operator policy. A service provider might decide to offer services on a best effort basis (without any resource guarantees) if the resource admission control function provides a negative result to a request.

6) The ability of the resource admission control function to inform the requesting entity about a negative outcome of a request.

#### 5.1.1.4 Resource Admission Control Approaches

According to the base requirements outlined in clause 5.1.2.2 a multicast resource admission control function is closely linked to the managed resources in question. Typically access network segments together with aggregation network segments (ES 282 001 [2]) comprise multiple resources handled by transport Functional Entities, as well as the links connecting them. Two resource admission control approaches are identified for these segments:

- *Independent Resource Admission Control*: The resource admission control decision is handled by an independent resource admission control Functional Entity (FE), which controls resources within one or more segments.
- *Coordinated Resource Admission Control*: The resource admission control decision is handled by multiple resource admission control FEs that coordinate the admission control for resources to avoid uncontrolled overbooking. Communication between these FEs follows a hierarchical structure involving a top-tier resource admission control function and one or more lower-tier resource admission control functions.

Clause 6.2.2.1.3 provides further details and descriptions on the independent and coordinated resource admission control approaches.

NOTE: IP-Multicast has some embedded "in-band" signalling capabilities, allowing for simple distributed resource admission control mechanisms. Examples include administratively configured state limits for IP-Multicast state. It should be noted that the "in-band" mechanisms available in IP-Multicast are not sufficient to deploy per-user multicast policies (which would include the ability to identify the user and his bandwidth requirements). These "in-band" mechanisms will not be standardized as part of the present document.

#### 5.1.1.5 Multicast Resource Admission Control in the Access Network Domain Transport Nodes

Support for Multicast in the Access Network domain requires that the Transport Network Nodes have multicast capabilities in order for these nodes to offer multicast based services such as IPTV. Moreover, these Transport Network nodes may require interfacing with the RACS for Admission Control and Resource Reservation Requests.

Table 1 describes the roles of the transport processing functions related to multicast based services.

**Table 1: Multicast related Transport Functions**

| BTF | EFF | ECF | RCEF | x-RACF |
|---|---|---|---|---|
| EFF and ECF in the same transport node element | Packet Replication | Processing/Execution of Multicast Protocols | Enforcement of Multicast Traffic Policies | Policy evaluation of multicast policies |
| | | Forwarding of events for policy evaluation | Forwarding of events for policy evaluation | |

#### 5.1.1.6 Unicast/Multicast Resource Reuse in the Access Segment

Unicast/Multicast resource reuse occurs when switching between unicast service and multicast service such as BTV and its trick mode. In order to support the unicast/multicast resource reuse, RACS (including lower tier x-RACF and the top tier x-RACF) needs to receive a message where a mechanism is provided to reuse the resource on access segment. Based on the message received, RACS can reuse the resources previously allocated to the active mode for the other mode.

## 5.2 Charging

The RACS requirements for charging are restricted in Release 1 to providing support for offline charging by the RACS functions that can be located in different administrative domains: the SPDF, A-RACF and AF.

For push mode, the RACS functional entities, SPDF and A-RACF shall be capable of providing the following information for charging purposes:

- Charging Correlation Information (CCI).
- Request Type.
- Requestor Information.
- Subscriber Information.
- Service Priority.
- Media Description.
- Commit ID.
- Time Stamp.
- Reason.

The means to transfer this information is not standardized in the present document.

A Charging Correlation Information (CCI) is a globally unique identifier that may be generated by the SPDF if it was not provided by the AF. This identifier may also be forwarded to the A-RACF.

The Request Type may have the following values: Resource Reservation, Resource Modification and Resource Release.

The Subscriber Information represents the Subscriber-Id and the Globally Unique IP Address present in the request.

The Reason shall represent conditions such as successful, unsuccessful and abnormal conditions.

The charging capabilities in RACS for the present document do not impose any additional charging requirements than those defined for previous releases.

The charging information for pull requests are not standardized in the present document.

## 5.3 QoS Management Functions in Fixed Access Networks

In order to define the RACS architecture it is necessary to identify the possible QoS management functions in fixed access networks. Those functions can be categorized according to their QoS control capabilities and business models. An abstraction is made here of the possible business models in the fixed environment.

To ensure QoS aware NGN service delivery, the following two architectures for dynamic QoS control are considered for RACS:

- **guaranteed QoS:** traffic delivery service with absolute numerical bounds on some or all of the QoS parameters, such as throughput, latency, jitter and loss.

NOTE 1: The bounds may be derived due to physical limits, or due to the enforcement of limits such as those encountered through mechanisms like rate policing. The bounds may result from designating a class of network performance objectives for packet transfer.

- **relative QoS:** traffic delivery service without absolute numerical bounds on the achieved bandwidth, packet delay or packet loss rates.

NOTE 2: The circumstances where certain classes of traffic are handled differently from other classes of traffic, and the classes achieve different levels of QoS, are described.

Support of QoS unaware ("Best Effort") networks as well as support of networks that have statically provisioned QoS differentiation does not require any RACS functionality.

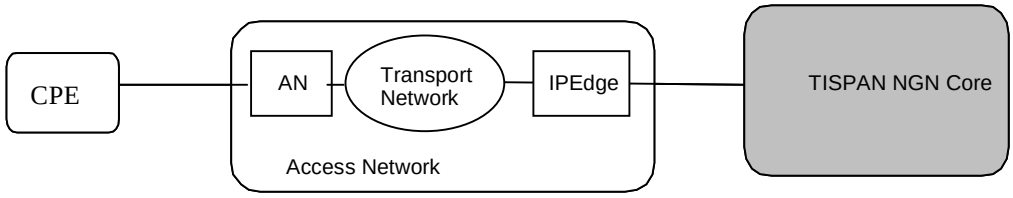



**Figure 2: Access Network Model**

The RACS architecture shall support both QoS control architecture models - guaranteed and relative - allowing the access provider to select the most suitable QoS architecture for their needs.

When relative QoS is used, the QoS differentiation shall be performed at the IP_Edge, e.g. compliant with the DiffService Edge functionality defined in IETF specifications for Differentiated Services (RFC 2475 [4]). Moreover, RACS should take into account the ability of some CPN to provide QoS differentiation, e.g. by applying DiffService marking, and take steps to allow this to have effect only where it is required by operator defined RACS local policies.

For guaranteed QoS control, enforcement of QoS admission control decisions (throughput control and traffic policing) shall be performed in the IP_Edge and may also be performed in the CPN and/or Access Node.

The RACS shall support the "proxy QoS reservation request with policy-push" as a QoS Push resource reservation mechanism, e.g. among others, the one shown in figure 3. In this case, the CPN does not itself support native application independent QoS signalling procedures. When a CPN invokes a specific service of an AF using the NGN signalling (e.g. SIP), the AF will issue a request to the RACS for QoS authorization (policy control) and resource reservation. The AF may extract implicit user requested QoS class from Service Request, e.g. by SIP SDP, based on operator's policy, and send the appropriate QoS class information to RACS.

RACS policy decisions are "pushed" to the policy enforcement point (IP_Edge) in the NGN access (e.g. xDSL).

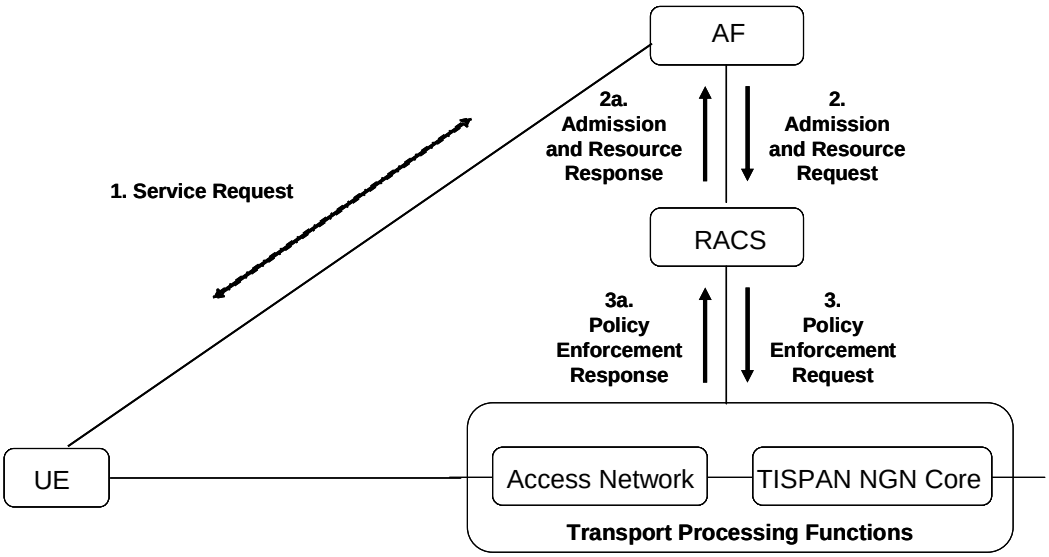



**Figure 3: Example of proxy QoS with policy-push**

In the example indicated in figure 3, and depending on its capabilities, the UE may add an indication of the QoS class in the service request.

NOTE 3: Besides the example depicted in figure 3, other "push" QoS resource reservation mechanism are possible.

The RACS also supports the QoS Pull resource reservation mechanism, e.g. the one depicted in figure 4. This "user requested QoS with policy-pull" mechanism requires that the UE is able to handle Layer 3 QoS signalling capability, and perform a QoS request for its own needs through the use of path-coupled signalling, e.g. RSVP. Similarly the UE may request a service which in turn may cause a QoS Request to be originated from a Transport Function resulting in a Policy Pull request.

The QoS request may be preceded by a previous authorization request, where an authorization token may be returned by RACS in order to perform a binding between the requested QoS for the media flow and the policy decision information to be enforced. This means that steps 1, 2, and 2a, indicated in figure 4 are optional as other binding mechanisms may be used.

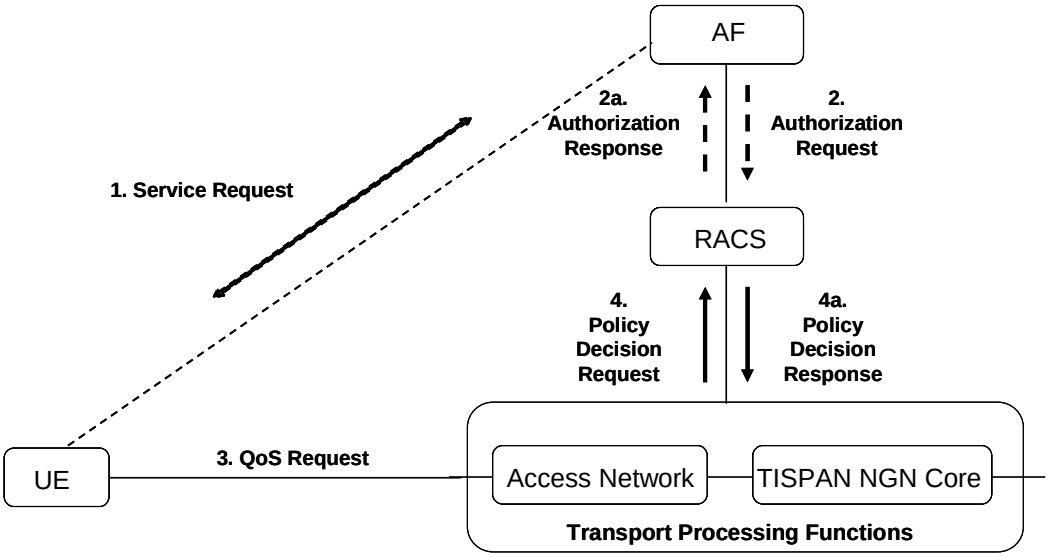



**Figure 4: Example of User requested QoS with policy-pull**

Please refer to annex F for more detailed information on these mechanisms.

## 5.4 Resource Control for QoS Downgrading

QoS downgrading involves the act of adjusting the QoS provided to an existing session (e.g. bandwidth and the time duration for using this bandwidth). This mechanism may be invoked for a certain service by a requestor, either by using the push mode or by using the pull mode, without forcing it to terminate.

When operating in push mode, the requestor is an AF as it is always the service layer that requests this service, although the request can be forwarded to the x-RACF by the SPDF, or it can be forwarded further on the Rr reference point.

QoS downgrading may be required when a new incoming session should be admitted, and there is insufficient subscribed network resources for this new session. The requestor may decide to allow QoS downgrading for one or more existing sessions according to the user service profile, so that the QoS of the existing session(s) level may be degraded in order to free resource for the new incoming session.

Alternatively, the RACS may degrade the QoS of the new incoming session according to an indication received from the requestor.

NOTE: The mechanism is applicable for the access segment although other possible use cases are possible. These are not standardized in the present document.

# 6 RACS functional architecture definition

## 6.1 General

The overall functional architecture of the RACS is shown in figure 5.

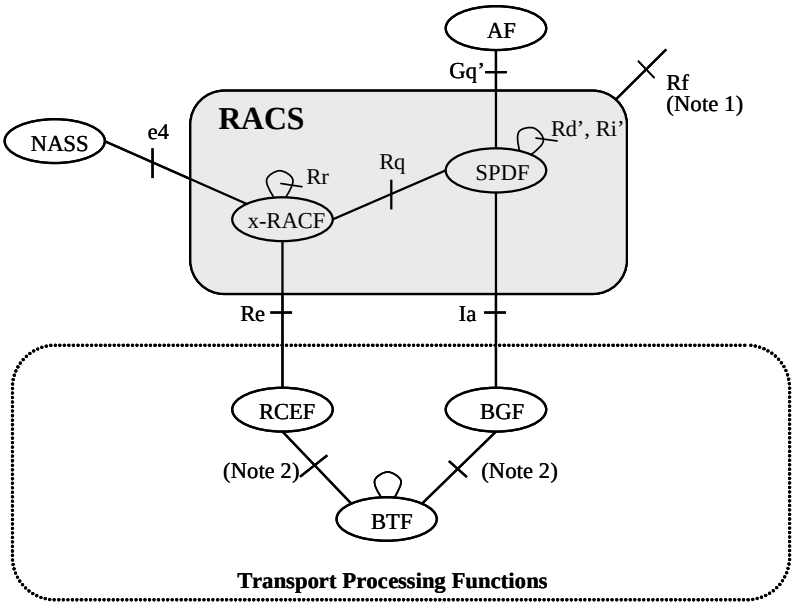



**Figure 5: RACS Functional Architecture**

NOTE 1: The RACS has a Rf reference point in order to send the Charging Information directly to the Charging Functions for some cases, e.g. the pull mode, which is only used for offline charging and is terminated on both x-RACF and SPDF (see clause 6.3.9).

NOTE 2: The relationship between BTF and RCEF as well as BTF and BGF is considered to be an internal relationship within the same physical node and will not be standardized as part of the present document.

NOTE 3: Besides the x-RACF and SPDF, the present document addresses the aspects of the RCEF, BGF and AF that are associated to RACS. The overall functionality related to AF, RCEF and BGF is defined in ES 282 001 [2].

The NGN Service Layer encompasses an Application Function (AF), which offers services that require control of IP bearer resources. Examples of an AF are the P-CSCF and IBCF in the case of IMS. The AF maps the application layer QoS information, e.g. the P-CSCF maps parameters defined in SDP, into QoS request information to be sent via the Gq' reference point to the SPDF.

RACS shall support both Push and Pull QoS resource reservation mechanisms:

- Push mode: RACS authorizes a reserve or a reserve-commit request from AF based on policy rules, performs admission control to requested resources and/or to the subscriber profile and, in case these operations are successful, RACS may instruct RCEF to enforce the policy and resource admission decision. In the case where the AF only issues a reserve request initially, this last step is triggered by a separate commit request from AF.

- Pull mode: Upon reception of a reserve or reserve-commit request from RCEF, RACS performs admission control to requested resources and/or to the subscriber profile. In case the RCEF issues a reserve-commit request, RACS responds with the final policy and resource admission decision to instruct the enforcement. In case the RCEF instead issues a reserve request, the instructions for enforcement will be provided by RACS in the response to the subsequent commit request issued by RCEF.

The SPDF provides the AF with a single point of contact. Two functional specializations of x-RACF (generic Resource Admission Control Function) have been defined: the A-RACF, which is always in the access network, and the C-RACF, which is always in the core network. They both support the resource reservation methods as defined in clause 5.3. The x-RACF may receive requests from the SPDF, from the RCEF or from another x-RACF located in the same Operator Domain. Based on these requests and policy information stored in the x-RACF, the x-RACF may accept or reject these requests for the transport resources within its control.

Please refer to clauses 6.2.2.1.1 and 6.2.2.1.3 for further details on x-RACF specializations and their multiple instantiations, e.g. scope of the network topology view in terms of resources, and NGN layers where they may be found.

Each administrative domain shall have at least one SPDF.

There is only a single type of reference point between RACS instances in different administrative domains. This reference point is between SPDFs.

For resource and admission control the architecture provides a clear separation between layers that allows an application service to run over different access networks without impacting the application capabilities as long as the resources are available. Although x-RACF can be seen as a generic function, it may maintain different instances of resource models, depending on the different types of access.

The RACS (A-RACF) interacts with the Network Attachment Sub-System (NASS) via the e4 reference point.

The x-RACF has a Rf reference point in order to be allowed to send the Charging Information directly to the Charging Functions for some cases, e.g. the pull mode.

The SPDF also has a Rf reference point in order to be allowed to send the Charging Information directly to the Charging Functions for some other cases, e.g. the interconnection between RACS and the negotiation of the variation of the capacity of the quality during an active session.

The RCEF is a Functional Entity that is usually grouped into physical entities designated by IP Edge Node or Access Node, which is accessed via the Re reference point. It is a logical element that belongs to the transport processing functions and enforces the traffic policies by means of which RACS can assure the use of the resources.

As far as the BGF Functional Entity is concerned, please refer to ES 282 001 [2] for definitions on where it is located, i.e.:

- the Core BGF (C-BGF) is located at the boundary between an access network and a core network, at the core network side;
- the Interconnection BGF (I-BGF) is located at the boundary between two core networks.

Table 2 summarizes the services performed by the RCEF, C-BGF and I-BGF, under the control of the RACS.

**Table 2: RACS Elementary Functions associated with RCEF, C-BGF and I-BGF**

| RCEF | C-BGF | I-BGF |
|---|---|---|
| Open/close gates | Open/close gates | Open/close gates |
| Packet marking | Packet marking | Packet marking |
| Resource allocation | Resource allocation (per flow) | Resource allocation (per flow) |
| | NAT | NAT |
| | Hosted NAT traversal | |
| Policing of down/uplink traffic | Policing of down/uplink traffic | Policing of down/uplink traffic |
| | Usage metering | Usage metering |

Different BGF instances may implement different subsets of the services identified in Table 2 based on the operator's policy.

Unless stated explicitly, the remaining text of the present document refers to the term BGF for both C-BGF and I-BGF, regardless of its location in the network.

# 6.2 Functional elements

## 6.2.1 SPDF

### 6.2.1.1 SPDF main functions

The Service Policy Decision Function (SPDF) is a Functional Entity that acts as a final Policy Decision Point for Service-Based Policy control (SBP) for each administrative domain it resides in. It may also communicate with an interconnected SPDF located in an adjacent administrative domain for a reservation request.

The SPDF makes policy decisions by using service policy rules defined by the network operator. The most appropriate service based policy to be applied to a request from an AF or an interconnected SPDF is based on the combined meaning of the Requestor Name, Service Class, Service Priority, Reservation Class, or any other combination of these information elements contained in a transport control service request message received from the AF or from the interconnected SPDF.

The SPDF hides the underlying network topology from applications and from interconnected SPDFs. This allows the SPDF to offer a common view to the AF (e.g. P-CSCF or IBCF) and/or the interconnected SPDF regardless of the underlying network topology and particular access technology in use.

The SPDF may present two different behaviours, depending on whether it is connected or not to the C-BGF Functional Entity located in the core through the Ia reference point:

- when the interconnection exists, as this reference point is considered as intra-domain, the SPDF may only operate in the core in case there is a separation between core and access administrative domains, or in a single domain if there is no such separation. In these cases, it implements all the functionalities identified below;
- when it is not interconnected through this reference point, the SPDF only implements a subset of its functionalities. In particular, it does not implement any of the Elementary Functions indicated in Table 2, designated as BGF services. However, it continues to operate other functionalities, e.g. as a proxy-like entity in terms of transport resource request related signalling, and may reside either in the access as well as in the core administrative domains.

As such, in the remaining text of the present document, it should be noted that when the term SPDF appears associated with a BGF, i.e. only for the core, its behaviour is different from the case where that association is not performed, i.e. either because it is not applicable (in the access) or because it is not simply performed (in the core).

After having received transport control service requests from the AF or from the interconnected SPDF, as well as after having chosen the service policy, authorization is then performed based on a process that involves the checking of the transport control service request against the service based policy.

If the outcome of the authorization is successful and one or more functional entities among x-RACF, BGF and interconnected SPDFs need to be interrogated to serve a request from an AF or an interconnected SPDF, the SPDF maps the QoS requirements and priority received in those transport control service requests into the parameters to be sent in requests to the x-RACF, to the BGF, to the interconnected SPDF, or any combination of those. This resource mediation process is performed according to the rules defined in the above mentioned selected service based policy.

The SPDF performs a coordination function between the AF, the x-RACF, the BGF, the interconnected SPDFs, or any combination of those as further described in clause 6.2.1.7.

Based on a discovery mechanism, the SPDF determines the appropriate entity or entities among x-RACF, BGF and interconnected SPDFs to interrogate in accordance with the required transport capabilities, and with the indication included in the transport control service request received from the AF or from an interconnected SPDF, along with Local Policies.

At the end of the process, the final decision is reported back to the entity that issued the request, i.e. an AF or an interconnected SPDF.

### 6.2.1.2 Summary of SPDF Elementary Functions

This clause contains a table where the above identified elementary functions for the SPDF have been shortly summarized. In addition, information on the type of those elementary functions associated with the behaviour of the SPDF is also indicated in a separated column, i.e. mandatory (M), or conditional (C).

In this table, descriptions related to technology dependent functions refer to functions that require specific knowledge of the link layer technology.

On the other hand, technology independent functions refer to functions that do not require that specific knowledge of the link layer technology because they are related to the IP level.

**Table 3: RACS Elementary Functions associated with SPDF**

| Acronym | Function | Description | Type of EF |
|---|---|---|---|
| FDP | Final Decision Point | Makes the final admission decisions, including priority considerations, in terms of network resources and admission control, based on request from the AF or an interconnected SPDF. | M |
| SSBP | Selection of a service based policy | Choice of the most appropriate service based policy to be applied to the transport control service request based on information included in the transport control service request. | M |
| ACSR | Authorization based on contents of the service request | Checking between the selected service based policy and the contents of the transport control service request, in order to perform initial authorization if match occurs. | M |
| DSFE | Discovery of subsequent FE | Determination of the appropriate x-RACF, BGF, and/or SPDF according to the required transport capabilities, the indication included in the transport control service request, and with local policies. | M (see note 1) |
| CMFE | Coordination of messages between FEs | Coordination function for messages exchanged between an AF, a BGF, a x-RACF and/or interconnected SPDF FEs. | M (see note 1) |
| NAPTC | NAPT control and NAT traversal | Controls network address translation for both near-end NA(P)T and far-end NA(P)T. | C (see notes 2 and 3) |
| QMTI | QoS and Priority Mapping - Technology Independent | Maps the service QoS requirements and priority received from the AF or from the interconnected SPDF to network QoS parameters (e.g. Y.1541 class) and priority,(see note 1). | C (see notes 2 and 3) |
| GC | Gate Control | Controls the opening and closing of a gate, see note 1. | C (see notes 2 and 3) |
| IPMC | IP Packet Marking Control | Decides on the packet marking and remarking of IP flows, (see note 1). | C (see notes 2 and 3) |
| RLC | Rate Limiting Control | Decides on the bandwidth limit of flows (e.g. for policing), (see notes 1 and 2). | C (see notes 2 and 3) |
| HSRP | Handling of service request priority | Ability to indicate a service priority level in the resource reservation request, (see note 1). | C (see notes 2 and 3) |

NOTE 1: In the case there is no Ia reference point, the BGF is not considered as a selectable destination FE.
NOTE 2: This Elementary Function is mandatory for SPDFs that have connection to a BGF through the Ia reference point. The SPDF may then only operate in the core in case there is a separation between core and access administrative domains, or in a single domain if there is no such separation.
NOTE 3: When there is no Ia reference point, this Elementary Function is considered as N/A. The SPDF may then be located either in the access or in the core network.

#### 6.2.1.3 Reference points

The reference point between the AF and SPDF is Gq'. The Gq' enables the NGN Sub-Systems to interact with the Resource and Admission Control Sub-System (RACS) for authorization, resource reservation and Border Gateway Services (BGS).

The reference points between two SPDFs are Ri' and Rd'. They both convey information that is used to reach the desired network elements in the transfer layer.

The Ri' reference point is an inter-domain reference point, i.e. it is used when the AF cannot communicate directly with the SPDF of a certain domain. In this case, a reachable SPDF forwards the information through the Ri' reference point towards another SPDF of a different domain to perform the resource request to the desired network element.

The Rd' reference point is an intra-domain reference point, i.e. it is used when the SPDF of a certain domain cannot communicate directly with a specific underlying network element that is located in the same domain. In this case, the SPDF forwards the information through the Rd' reference point towards another SPDF of the same domain to perform the resource request to the desired network element.

The reference point between the SPDF and the x-RACF is Rq. The SPDF interacts with the x-RACF to ask for an admission control decision for the QoS resources required for the Application session via the Rq reference point. The authorization decision provided by the SPDF to the AF is dependent on the admission control decision taken by the x-RACF.

When there is interconnection between the SPDF and the BGF, and the SPDF is located in the core in case there is a separation between core and access administrative domains, or in a single domain if there is no such separation, the interconnection is performed through the Ia reference point in order to ask services as listed in Table 2. This reference point is used for communication between the SPDF and C-BGF and between the SPDF and I-BGF.

The SPDF shall be able to establish relationships with multiple x-RACFs. These x-RACFs can be all in the same or in different access networks. The SPDF shall have the ability to identify the correct x-RACF when a request is received from the AF.

The Gq' reference point constitutes an interdomain reference point as it allows that the AF and the SPDF are in different administrative domains.

In Release 1 interdomain aspects are not explicitly addressed, e.g. as the SPDF and the A-RACF may be located in different administrative domains, the Rq reference point may be an interdomain reference point.

In the present document, as each administrative domain shall have at least one SPDF, and the reference point between SPDFs is the only type of reference point between RACS instances in different administrative domains, the Rq reference point is always an intradomain reference point.

Use of the Rq reference point as an interdomain reference point as described in R1 should be avoided.

NOTE: Backwards compatibility between implementations according to Release 1and implementations according to releases beyond Release 1is always ensured as long as possible encryption of the Rq reference point performed by the Release 1 FEs for security reasons have an appropriate treatment by the FEs specified in documents related with releases beyond Release 1.

The SPDF also directly interfaces with the Charging Functions via the Rf reference point.

#### 6.2.1.4 User profile

The SPDF does not require access to user profile information.

#### 6.2.1.5 Priority

The AF or the interconnected SPDF can indicate a service priority level to the SPDF. In accordance, the SPDF has the ability to define a service priority level for the resource reservation request sent to the x-RACF. As an example, in the case of an emergency session, the AF or the interconnected SPDF may indicate to the SPDF that the resource is required for an Application priority session and, as a result, the SPDF indicates to the x-RACF a service priority for the requested resource.

#### 6.2.1.6 Service request

Requests from the AF to the RACS over the Gq' reference point, or from an SPDF located in a different administrative domain to the RACS over the Ri' reference point, include information on the service required from RACS, an unique identifier for the requesting application, an unique identifier for the resource reservation session and an indication of the requested priority amongst others (see clause 6.3.1.3.1 for a complete list of information elements). It shall be possible for the AF or for an interconnected SPDF instance to request a different RACS service for each of the flows belonging to a single resource reservation session request.

The key information elements used by an AF or by an interconnected SPDF to specify the services requested from RACS are the Requestor Name and the Service Class (see definitions in clause 6.3.4.3). However, other parameters such as bandwidth also provide additional information about the service requested.

Service information is of local significance to the operators controlling the service and transfer layers respectively, and the definition of the actual values used is outside the scope of standardization.

By combining all the information received from the AF via Gq', or from an interconnected SPDF instance via Ri', with local operator policies, the SPDF can derive the following information:

- whether service is to be requested from the BGF (in case interconnection between them exists), x-RACF, both or neither of them;
- whether service is to be requested from an SPDF located in a different administrative domain;
- transfer layer resources that shall be used for a particular resource reservation, which may include transport network partition, interconnection type (e.g. just in case interconnection exists, where signalling-only interconnection types may not require the insertion of an I-BGF in the media path), or specific interconnect resources to be used (e.g. just in case interconnection exists, by choosing the right I-BGF in the transport domain);
- traffic characteristics to be requested for individual media flows, including QoS parameters, which may be used by the SPDF to in turn request the appropriate filters or packet marking policies to be applied in the BGF (in case interconnection between them exists) and/or to describe to the x-RACF the resource being requested.

#### 6.2.1.7 Coordination function

The SPDF maps requests received from an AF (e.g. P-CSCF, IBCF) into a request sent to an x-RACF, a BGF (in case interconnection between them exists), an interconnected SPDF located in a different administrative domain, or any combination of these Functional Entities.

Moreover, the SPDF also performs the coordination function for messages exchanged between an AF, BGF (in case interconnection exists), x-RACF, an interconnected SPDF, or any combination of those.

A bundle identification, hereafter referred to as Resource Bundle-Id information, is received in every reply granting resources from the x-RACF. The SPDF shall be able to associate this Resource Bundle-Id to the resources reservation session during the existence of this resource reservation session.

In case failure conditions are affecting the x-RACF, the BGF (in case interconnection between them exists), an interconnected SPDF, or any combination of those, the SPDF is capable of performing the necessary coordination for release of the impacted resources (e.g. an event reporting failure in the BGF is reported to the AF and any outstanding x-RACF resources shall also be released). The reference points between the x-RACF, BGF (in case interconnection between them exists) and SPDF, as well as an interconnected SPDF, shall be able to transport information indicating partial or complete failure of a BGF and/or an x-RACF.

The SPDF shall be able to handle reports of abnormal condition from the x-RACF specifying either an individual resource reservation session or a Resource Bundle-Id. In the latter case, all current resource reservation sessions associated to this bundle shall be released.

In addition, the SPDF can autonomously initiate a partial or total release of resources (e.g. administrative action in the SPDF).

The sequence used by SPDF to access the x-RACF, BGF (in case interconnection between them exists) and other SPDFs is a local decision in the SPDF, e.g. the SPDF is able to decide whether to access the x-RACF and then the BGF, or vice versa, or both in parallel. This is valid for request, modification and release. The implementation of this decision is out of the scope of the present document.

For example, for deployments involving the network segment between the RCEF and the C-BGF, and where the Ia interface between the SPDF and the C-BGF exists, the SPDF may need to interrogate the C-BGF before the x-RACF in order to firstly obtain local termination IP addresses and ports. These parameters will be needed when the x-RACF performs resource and admission control for that network segment, and when the RCEF also performs policy enforcement based on them.

#### 6.2.1.8 Charging

The SPDF shall be able to provide charging information for the Request/Modify/Release/Abort commands when necessary.

#### 6.2.1.9 Deployment considerations

Due to the possible business roles in an access environment, the SPDF receiving the request from the AF may be either in the same administrative domain or in a different administrative domain from the terminating x-RACF.

The SPDF permits other instances besides IMS to request and control resources.

NOTE: As for any other functional entity, implementers may choose to combine the SPDF with the AF where this makes sense in the context of the business models, services and capabilities being supported (e.g. in the case of implementations supporting IMS services only). However, if this deployment option is adopted, there are some implications that should be taken into account:

- the service control/application Sub-System that hosts the AF and the SPDF in the RACS Subsystem can no longer belong to two different administrative domains;
- a SPDF (and associated transport network resources) can only serve the service control/application Sub-System that hosts the Application Function (AF) (e.g. an IMS-only NGN network).

#### 6.2.1.10 Overload control

The SPDF provides bi-directional overload control mechanisms, which helps to limit the load on the x-RACF, SPDF, BGF (in case interconnection between them exists) or AF should any of these components experience overload. A full specification of this capability is left as an outstanding issue.

#### 6.2.1.11 Discovery mechanism

The AF can obtain the RACS contact point from the NASS as a FQDN or IP address of the SPDF. Alternatively, in the absence of such a possibility, the AF may have other mechanisms, e.g. local configuration may be used.

The SPDF relies on local configuration to discover the contact points for the x-RACFs and the BGFs (in case interconnection between them exists).

### 6.2.2 Generic Resource Admission Control Function

#### 6.2.2.1 Main functions

The generic Resource Admission and Control Function (x-RACF) is a Functional Entity that acts as a Policy Decision Point (PDP) in terms of subscriber access admission control, as well as in terms of resource handling control.

The generic Resource Admission Control Function receives requests for QoS resources from the SPDF via the Rq reference point, or from the RCEF via the Re reference point, indicating the desired QoS characteristics (e.g. bandwidth).

In Release 1, the Rq reference point may either be an interdomain or an intradomain reference point, whereas for the present document it can only be an intradomain reference point.

In Release 1, in interdomain scenarios, the generic Resource Admission Control Function shall authenticate the SPDF requesting resources. For intradomain scenarios, either in Release 1 or in the present document, the generic Resource Admission Control Function checks if the request matches the requestor's (operator SPDF) profile. Only validated requests for authenticated requesters shall be authorized and retained as input. For further details related to the interdomain and intradomain nature of the Rq reference point in Release 1 and in the present document, please refer to clause 6.3.1.1.

The generic Resource Admission Control Function shall indicate to the requesting entity whether a request for resources is granted or not.

When granting transport resource requests, the generic Resource Admission Control Function may derive and install a L3/L2 traffic policy in the RCEF, which may include indications about the way how traffic control, e.g. gate control, packet marking, or rate limiting control, should be handled. This derivation process is preceded by the mapping of the network QoS parameters, either related to the L3, i.e. IP level that is usually associated with technology independent, or to the L2 that is usually associated with technology dependent, as well as by the inclusion of priority indications on the service and media requests related to specific parameters carried in the above mentioned L3/L2 traffic policies.

Besides the admission control, the resource reservation, and the derivation and installation of L3/L2 traffic policies processes, the generic Resource Admission Control Function may also be involved in aspects related to QoS handling, i.e. monitoring and report of transport resources, which may lead to the modification and enforcement of new L3/L2 traffic policies. In the present document, these QoS aspects are only covered in informative annex E.

#### 6.2.2.1.1 Specializations of x-RACF

Two functional specializations of the generic Resource Admission Control Function are defined in the present document: Access-RACF (A-RACF) and Core-RACF (C-RACF), which can be deployed in different network domains based on the operator's requirements. The main distinction between A-RACF and C-RACF is:

- the A-RACF checks the subscriber QoS profile that may be obtained from the NASS. The A-RACF is deployed in the access network domain, which may require the provisioning of the transport resources on a per subscriber basis;
- the C-RACF does not check the subscriber QoS profile. The C-RACF is deployed in the core transport network domain, which may not provision the transport resources on a per subscriber basis.

NOTE: Please refer to Table 5 in order to get the complete set of differences between the specializations of x-RACFs.

#### 6.2.2.1.2 Reference points applicable to different specializations of x-RACF

Table 3a lists which reference points are applicable to the different specializations of x-RACF.

**Table 3a: Reference points per x-RACF specialization**

| Reference Point | Specialization of x-RACF | |
|---|---|---|
| | A-RACF | C-RACF |
| e4 | applicable (see note) | not applicable |
| Re | Applicable | Applicable |
| Rq | applicable (see note) | applicable (see note) |
| Rf | applicable (see note) | applicable (see note) |
| Rr | applicable | Applicable |
| NOTE: Restrictions for the applicability of this reference point apply when multiple instances of x-RACF are deployed within the same transport segment and/or the same service. See clause 6.2.2.1.3 for details. | | |

NOTE: The Rf reference point is not fully standardized in the present document.

#### 6.2.2.1.3 Multiple instantiations of x-RACF

Multiple instances of xRACF are allowed for the same transport segment and/or service. One or more of those instances may be located within transport network elements.

An x-RACF instance may have a complete or partial view of the network topology and/or resources.

Each x-RACF instance may be involved in resource admission control for unicast services, multicast services, or both (e.g. in case network resources are to be shared between these services).

Coordination of admission control is achieved via the Rr reference point between x-RACF instances. This coordination may be needed to avoid uncontrolled overbooking, to reserve resources spanning multiple transport segments, or both. The Rr reference point is restricted to intradomain usage.

An x-RACF may coordinate resource admission control decisions on a per-request basis, or for multiple requests following a bulk resource coordination approach. The bulk resource coordination approach is used when an x-RACF makes resource admission control decisions independently without consulting other x-RACFs. As multiple x-RACFs may be managing the same resources by the time new transport resource request arrive, the usage of those resources must be coordinated between these instances as specified by bulk resource reservation requests during a previous bulk resource delegation process. This coordination requires the x-RACFs to be aware of the current network topology and the associated available and allocated resources.

An x-RACF instance may coordinate admission control decisions to another x-RACF following one or more of the following procedures:

- as reservation requests arrive to an x-RACF, delegate them to another x-RACF to make the admission control decision for the reservation request (i.e. per-request coordination);
- requesting bulk resources from another x-RACF for the purpose of performing admission control for arriving reservation requests without performing per-request coordination;
- delegating the control of bulk resources to another x-RACF to perform admission control for arriving reservation requests without performing per-request coordination.

Please refer to clause 6.3.8.1.1 for the definition of the types of request and delegation models in the Rr reference point.

Instances of the x-RACF being involved in controlling the same transport resource, e.g. a resource represented by a specific ATM VP, shall be arranged in a tree structure. The top tier x-RACF in this structure is the one interacting with SPDF, and, when applicable, with the Charging functions.

#### 6.2.2.2 Summary of generic Resource Admission Control Function Elementary Functions

This clause contains a table where the above identified elementary functions for the generic Resource Admission Control Function have been shortly summarized. In addition, information on those elementary functions associated with the A-RACF and C-RACF instances is also indicated in two separated columns.

In this table, the descriptions related to technology dependent and to technology independent functions already indicated for Table 3a continue to be applicable.

**Table 4: RACS Elementary Functions associated to generic Resource Admission Control Function**

| Acronym | x-RACF Elementary Function | Description | A-RACF | C-RACF |
|---|---|---|---|---|
| SSAP | Storage of subscriber access profile during attachment | Storage of the subscriber profile after subscriber attachment, including a QoS profile. | O (see note 1) | N/A |
| NPAH R1 | Network Policy Assembly Handling | Authentication and authorization of the FE requesting resources, and check if the request matches the subscriber access requestor's profile, e.g. guaranteeing that the total of the requests match the access capabilities. | M | N/A |
| NPAH R2 | Network Policy Assembly Handling | Authentication and authorization of the FE requesting resources, and check if the request matches the subscriber access requestor's profile, e.g. guaranteeing that the total of the requests match the access capabilities. | O (see note 2) | N/A |
| AAoRFE R3 and beyond | Authentication and authorization of the Requesting FE | Authentication and authorization of the FE requesting resources. | O (see note 2) | O (see note 2) |
| CGRC R3 and beyond | Check global resource capabilities | Check if the total of the requests match the global resource capabilities. | M (see notes 2 and 3) | M (see note 2) |
| ACP | Admission control process | Derivation of a QoS profile and check of the availability of resources for unicast and multicast services. | O (see notes 1 and 4) | O (see note 5) |
| RRP | Reservation of resources process | Resource reservation taking into account the resource management scheme used in the SPDF request, i.e. single-stage resource management, two-stage reserve-commit resource management, or authorize-reserve-commit resource management. | O (see note 1) | M |
| DITP | Derivation and Installation of Traffic Policies | Derive and install of QoS parameters as part of L3/L2 traffic policies. | O | O (see note 6) |
| QMTD | QoS and Priority Mapping - Technology Dependent | Mapping of the network QoS parameters to transport (technology-dependent) QoS parameters. | M | O (see note 6) |
| TDDP | Technology Dependent Decision Point | Makes technology-dependent and resource-based admission decisions for unicast and multicast services. | M | M |
| MITP | Modification and Installation of new Traffic Policies | Actions taken upon QoS handling process, e.g. by monitoring and controlling of access resources. | O | O (see note 6) |
| HMRP | Handling of media request priority | Ability to handle the media priority received in the resource reservation request. | O (see note 1) | M |
| QMTI | QoS and Priority Mapping - Technology Independent | Maps the service QoS requirements and priority received from the AF to network QoS parameters (e.g. Y.1541 class) and priority, (see note 7). | O (see note 1) | O (see note 6) |
| GC | Gate Control | Controls the opening and closing of a gate, (see note 7). | M | M |
| IPMC | IP Packet Marking Control | Decides on the packet marking and remarking of traffic flows, (see note 7). | M | M |

| Acronym | x-RACF Elementary Function | Description | A-RACF | C-RACF |
|---|---|---|---|---|
| RLC | Rate Limiting Control | Decides on the bandwidth limit of traffic flows (e.g. for policing), (see notes 7 and 8). | M | M |
| HSRP | Handling of service request priority | Ability to indicate a service priority level in the resource reservation request, (see note 7). | O (see note 1) | M |
| PPS | Policy based path selection | Ability to choose the best appropriate path for the requested service flow according to network policy, the requestor class, the quality requirements and network resource status, and to indicate the selected path to the RCEF. | O (see note 9) | O (see note 9) |

NOTE 1: If multiple instances of A-RACF are being involved in controlling the same transport resource, the EFs marked with this note 2 are **all** mandatory for at least one of the A-RACF instances. This also ensures the backward compatibility of the present document with Release 1.
NOTE 2: The Rq reference point is intradomain for the present document.
NOTE 3: In the case of A-RACF, the process implies the check if the request matches the subscriber access requestor's profile, e.g. guaranteeing that the total of the requests match the access capabilities.
NOTE 4: In the case of A-RACF, the QoS profile is associated with the subscriber access requestor's profile.
NOTE 5: In the case of C-RACF, the QoS profile is associated with the QoS requirement of the admission request used to identify the required resources.
NOTE 6: If there is no policy enforcement, i.e. if only pre-defined static policies are used, this Elementary Function is not applicable; otherwise, it is optional.
NOTE 7: This Elementary Function is common to the SPDF and to the generic Resource Admission Control Function.
NOTE 8: In the case of generic Resource Admission Control Function, this functionality may take the form of a parameter that belongs to a L2/L3 traffic policy (DITP).
NOTE 9: The network policy maybe derived from service based policy or pre-defined by the network operators. The PPS should determine the appropriate (virtual) path (e.g. VPN) for the requested service flow based on the network policy, the requestor class, the quality requirements and network resource status. Admission control should also be performed for the requested service flow. The sequence of admission control and policy-based path selection should be an implementation option. At last, the PPS should indicate to the RCEF the appropriate virtual path for the accepted service flow.

### 6.2.2.3 A-RACF

#### 6.2.2.3.1 A-RACF main functions

The Access-Resource Admission and Control Function (A-RACF) is a functional instance of the generic Resource Admission Control Functional Entity (generic Resource Admission Control Function) that is deployed over access network domains. The main functions of A-RACF are the same as those indicated for the generic Resource Admission Control Function in Table 4 of clause 6.2.2.2.

#### 6.2.2.3.2 Reference points

The A-RACF interfaces with the NASS via the e4 reference point.

The e4 reference point is used for Connectivity session Location and repository Function (CLF) in the Network Attachment Sub-System (NASS) to send network attachment information and the subscriber access profile information to the A-RACF.

The A-RACF also interfaces with the SPDF via the above mentioned Rq reference point, and with the RCEF via the Re reference point.

The Rr reference point is an intra-domain reference point between A-RACF instances. It is used to delegate and/or coordinate admission decisions between A-RACF instances that share responsibility for a given network segment.

The A-RACF also interfaces with the Charging Functions via the Rf reference point.

#### 6.2.2.4 C-RACF

##### 6.2.2.4.1 C-RACF main functions

The Core-Resource Admission and Control Function (C-RACF) is a functional specialization of the generic Resource Admission Control Functional Entity that resides in the core transport network domains. The main functions of C-RACF are the same as generic Resource Admission Control Function as described in clause 6.2.2.2. The elementary functions supported by C-RACF are a subset of the generic Resource Admission Control Function shown in Table 4.

##### 6.2.2.4.2 Reference points

The C-RACF interfaces with the SPDF via the Rq reference point, and with the RCEF via the Re reference point.

In addition, the C-RACF also interfaces with the Charging Functions via the Rf reference point.

Finally, C-RACF may also interface with another C-RACF via the Rr reference point.

#### 6.2.2.5 Admission control process

##### 6.2.2.5.1 A-RACF

The A-RACF performs admission control for the access and aggregation segment following an admission control procedure involving one or two steps depending on the operator's policy:

1) **Subscriber access profile-based checking:** The A-RACF checks that the amount of requested bandwidth is compatible with the corresponding portion of the subscriber access profile, which may be received from the NASS over the e4 reference point, and the amount of bandwidth remaining in this envelope taking into account existing reservations.

2) **Resource admission control:** If the admission control request references resources under the control of the particular A-RACF instance which received the request, this A-RACF instance verifies that the available resources are compatible with the requested resources taking into account existing reservations. Resource admission control performed by an A-RACF can involve correlating session information from multiple subscribers sharing the same resources. The resource request will include information which will allow the identification of the appropriate resource(s). Please refer to clause 6.2.2.1.3 for details on the procedures in case multiple A-RACF instances exist.

NOTE 1: Step 1 and Step 2 may give different results in case of nomadism or in case resources are shared between multiple subscribers. The second step will typically involve checking transport resources in the access segment (e.g. bandwidth allocated to an ATM VC) and in the aggregation segment (e.g. bandwidth allocated to a VLAN or an ATM VP).

NOTE 2: Further details on admission control scenarios are provided in annex C.

The NASS informs the A-RACF when a subscriber attaches to the network. The subscriber access profile received from NASS (ES 282 004 [5]) over the e4 reference point consists:

- Subscriber attachment info: Subscriber ID, Physical Access ID, Logical Access ID, Access Network Type and Globally Unique IP Address.
- QoS Profile Information (optional): Transport Service Class, UL Subscribed Bandwidth, DL Subscribed Bandwidth, Maximum Priority, Media Type and Requestor Name. The QoS Profile may contain one or more sets of information elements.
- Initial Gate Setting (optional): List of Allowed Destinations, UL Default Bandwidth, DL Default Bandwidth.

On the other hand, the SPDF provides the following information that is relevant to A-RACF procedures when it receives a request via the Rq reference point:

- Subscriber Id or IP address.
- Requestor Name/Service Class.
- Media Description.
- Service Priority.

The Physical Access ID, Logical Access ID and Access Network Type allow A-RACF to bind the Subscriber Id and/or its IP address to the topology information of the access and aggregation networks hosted in A-RACF.

The A-RACF uses the Initial Gate Setting, the capabilities of the elements in the data plane as well as access network policies, defined by the operator, to derive the initial traffic policies that must be installed in the RCEF.

When a resource request is received from the SPDF, based on the Subscriber Id and/or the IP address, the A-RACF identifies the subscriber access profile previously received from the NASS.

Local configuration, in the form of a default or static configuration, shall determine the behaviour of the A-RACF if the QoS profile was not received from NASS, but subscriber access profile-based checking is activated.

The A-RACF first matches the Requestor Name in order to identify one or more QoS profile that applies to the request. In case more than one profile is identified, the A-RACF further matches the Media Type and Transport Service Class as received over Rq and in the QoS Profile.

A request over Rq may be denied if no information element set matches the request in accordance with local policies. In this process the Maximum Priority parameter (e4) is compared with the Media Priority parameter (Rq).

The A-RACF shall deny a request from the SPDF if it is not permitted by the selected QoS profile in accordance with local policies.

If the request is permitted by the QoS profile, the A-RACF shall verify whether it is compatible with the resources available in the access and aggregation segments.

An A-RACF instance may forward requests to other instances of A-RACF over the Rr reference point.

The request from the SPDF will be permitted only if all media can be accepted in all A-RACF instances. In A-RACF, a request cannot be partially accepted. When granting such requests an A-RACF may install a traffic policy in the RCEF.

The A-RACF returns the result of the admission control process to the SPDF, which may include a Resource Bundle-Id representing the group to which the granted resource belongs.

NOTE 3: The way the Resource Bundle-Id is defined is a local policy in the A-RACF. It represents a set of resources reservation sessions grouped together by A-RACF policies (e.g. represent the usage of a certain device in the transport network). The Resource Bundle-Id may represent a bundle of resources reservation session.

The A-RACF may perform overbooking admission control if it receives an indication to do so from the SPDF, and if normal admission control fails due to lack of resources on the Layer 2 resource for the transport service class concerned by the request. The A-RACF acts as follows:

- The A-RACF considers if resources are already reserved or committed by another Application session for the same Layer 2 resource.
- The A-RACF considers the sum of resources available on this Layer 2 resource plus the resources reserved or committed by any of this(ese) other Application (s) session(s) and verifies whether the requested resources do not exceed this amount.
- If it is the case, the admission control is granted provided that only one Application session commits the same resources at a time; otherwise the A-RACF shall deny the request.

#### 6.2.2.5.2 C-RACF

The C-RACF performs admission control for the core segment following an admission control procedure involving one optional step that depends on the operator's policy:

- **Resource admission control:** If the admission control request references resources under the control of the particular C-RACF instance which received the request, this C-RACF instance verifies that the available resources are compatible with the requested resources taking into account existing reservations. Resource admission control performed by a C-RACF can involve correlating session information due to resources sharing. The resource request will include information, which will allow the identification of the appropriate resource(s).

The SPDF provides the following information that is relevant to C-RACF procedures when it receives a request via the Rq reference point:

- IP Realm Identifier.
- Requestor Name/Service Class.
- Media Description.
- Service Priority.

A C-RACF instance may forward requests to other instances of C-RACF over the Rr reference point.

The request from the SPDF will be permitted only if all media can be accepted in all C-RACF instances. In C-RACF, a request cannot be partially accepted. When granting such requests a C-RACF may install a traffic policy in the RCEF.

The C-RACF returns the result of the admission control process to the SPDF, which may include a Resource Bundle-Id representing the group to which the granted resource belongs.

NOTE: The way the Resource Bundle-Id is defined is a local policy in the C-RACF. It represents a set of resources reservation sessions grouped together by C-RACF policies (e.g. represent the usage of a certain device in the transport network). The Resource Bundle-Id may represent a bundle of resources reservation session.

### 6.2.2.6 Installation of policies

Traffic policies installed in the RCEF may result in traffic conditioning mechanisms being applied to L2 and/or L3 in the transport data plane. The list below provides some examples of traffic conditioning mechanisms in RCEF that are installed on request from x-RACF by means of generic transport policies:

- pure L2 QoS mechanisms, e.g. VP/VC based for ATM networks, DLCI based for FR networks, or VLAN tag for Ethernet;
- intermediate L2/L3 QoS mechanisms, e.g. MPLS;
- pure L3 QoS mechanisms, e.g. DiffServ;
- L3 over L2 QoS mechanisms, e.g. DiffService over ATM or FR;
- L3 over intermediate L2/L3, e.g. DiffService and MPLS seamless integration.

In the context of the present document, x-RACF shall deal with both L2 and L3 policies. The use of L2/L3 policy types by RCEF could be achieved by allocating a particular Id to each policy. In that case, RCEF would have to perform a certain policy based on its own interpretation of the L2/L3 parameters, or of the L2/L3 parameters combined with others, included in pre-defined/provisioned traffic policies. The x-RACF could also explicitly specify the L2/L3 traffic polices to RCEF.

As such, for both L2 and L3 policies, x-RACF shall be capable of:

- providing an explicit description of the traffic policies to be applied; and
- attaching a pre-defined traffic policy to the media flow(s). In this case the x-RACF provides a policy-id, which will be translated by the RCEF into specific traffic policies to be applied.

For guaranteed QoS, the x-RACF may enforce its admission control decision by setting L2/L3 QoS traffic policies in the RCEF via the Re reference point to police the subscriber traffic.

NOTE: In the case of A-RACF, QoS policies may be set in the Access Node (AN) and/or the CPN but the mechanism to do so is outside the scope of the present document.

For relative QoS, the x-RACF "pushes", via the Re reference point, an IP QoS policy that updates dynamically the QoS differentiation parameters (e.g. DiffService QoS parameters in the RCEF).

#### 6.2.2.7 Charging

The x-RACF shall be able to provide charging information for the Request/Modify/Release/Abort commands when necessary.

#### 6.2.2.8 Abnormal condition handling

The x-RACF relinquishes all resource related to the affected resource reservation sessions. The x-RACF may also indicate when a bundle of resources are no longer available, if applicable.

The x-RACF may inform those other Functional Entities, if possible, which have been involved in the creation of the resource reservation.

#### 6.2.2.9 Deployment considerations

The architecture allows multiples instances of x-RACF in the same access network. In this case, multiple x-RACF instances controlling the same resources shall operate in a coordinated manner according to procedures described in clause 6.2.2.1.3.

#### 6.2.2.10 Overload control

The x-RACF may provide an overload control mechanism towards the SPDF, which helps to limit the load on the x-RACF should the x-RACF components experience overload. A full specification of this capability is left as an outstanding issue.

#### 6.2.2.11 Discovery Mechanism

The following text is only applicable to the A-RACF specialization.

When multiple A-RACF instances are present and arranged in a hierarchical structure, the top tier A-RACF provides the e4 reference point and can identify lower tier A-RACFs based on the association between user location information (e.g. logical or physical access id acquired from NASS via e4) and the corresponding lower tier A-RACF id configured in the top tier A-RACF.

NOTE: The discovery mechanism to be applied to the C-RACF Functional Entity is outside the scope of the present document.

### 6.2.3 BGF

#### 6.2.3.1 BGF main functions

The BGF is a packet-to-packet gateway for user plane media traffic. The BGF performs both policy enforcement functions and NAT functions under the control of the SPDF in each of the network segments: access, aggregation and core. An overview of the services provided by BGF is given in Table 2.

NOTE: Static forwarding functions may be inserted in the IP path. How many functions are inserted and whether each function is acting on user plane media traffic, signalling traffic or both is a matter for each operator to decide. These functions are not visible to the RACS and are therefore outside the scope of the present document.

The BGF has a policy enforcement function that interacts through the Ia reference point with the SPDF and is under the control of the SPDF. The BGF operates on micro-flows, i.e. on individual flows of packets belonging to a particular application session. The BGF's policy enforcement function is a dynamic gate that can block individual flows or allow authorized flows to pass. For an admitted flow the SPDF instructs the BGF to open/close its gate for the particular flow, i.e. to allow the admitted flow to pass through the BGF.

Possible resources that are managed by the BGF includes the handling of a pool of IP addresses/ports and bit rate on the BGF reference points.

#### 6.2.3.2 BGF parameters

Unidirectional micro-flows are specified by the SPDF towards the BGF in terms of a flow classifier including the standard 5-tuple (source IP address, destination IP address, source port, destination port, protocol). Elements of the 5-tuple that are unknown to the SPDF may be wild-carded by the SPDF in the instructions to the BGF.

Per admitted micro-flow, the SPDF may instruct the BGF to apply policies (e.g. traffic-conditioning filter) that limit the throughput of the flow to an admitted level indicated by the SPDF.

The usage of the BGF shall allow different combinations of parameters. As such, it shall be possible:

- to control the following services: address latching, NAT, QoS marking, bandwidth limiting and usage metering;
- to provide media address and port information both towards and from the BGF for NAT control;
- to provide mid-session updates related to NAT control and bandwidth policing over the reference point;
- to indicate if RTP is used as media transport protocol, in which case the NAT must be able to establish both RTP and RTCP flows;
- to provide an address independent media session identifier, since the address information may change during the media session.

#### 6.2.3.3 Reference points

The reference point between the SPDF and the BGF is Ia.

#### 6.2.3.4 Addressing latching

When a NAT device is located between a UE and the BGF, the remote media IP address/port information provided using signalling information (e.g. a SDP body in a SIP message) cannot be used by the BGF to send media towards the user (instead, the media must be sent towards a specific IP address/port of the entity providing the NAT functionalities, reserved for the UE).

In the present document, address latching corresponds to determining the address on which the BGF listens for media on the local IP address/port the BGF has reserved for the remote UE as requested from SPDF. When media is received the BGF stores the IP address/port value from where the media was received (IP address/port of the entity providing the NAT functionality), and uses that information when forwarding media towards the UE. The NAT providing entity then forwards the media to the actual IP address/port of the UE.

#### 6.2.3.5 Abnormal conditions handling

The BGF notifies the SPDF when it detects a network failure condition whereby it can no longer support the previously agreed services, and that will lead to the release of a previously allocated resources.

#### 6.2.3.6 Overload control

The BGF may provide an overload control mechanism towards the SPDF, which helps to limit the load on the BGF should the BGF components experience overload. A full specification of this capability is left as an outstanding issue.

## 6.2.4 RCEF

### 6.2.4.1 RCEF main functions

When operating in the QoS Push mode, the Resource Control Enforcement Function (RCEF) performs policy enforcement functions for unicast and/or multicast after installation of traffic policies under the control of the x-RACF. Depending on the policy enforcement request, RCEF either enforces the policy autonomously (i.e. without involving other functional entities) or in conjunction with the BTF (e.g. trigger transport control actions).

When operating in the QoS Pull mode, the Resource Control Enforcement Function (RCEF) also performs policy enforcement for unicast and/or multicast, after:

- having received a request from the BTF;
- having generated events, e.g. query for resources, which trigger a policy evaluation in the x-RACF based on the information received from the BTF;
- having received installation of traffic policies under the control of the x-RACF.

The RCEF is managed by the RACS through the Re reference point. The definition of the reference point between the RCEF and the BTF is outside the scope of the present document.

The RCEF is usually located in a Transport Network node Element, and may exist in Access Network Domains as well as in Core Network Domains.

### 6.2.4.2 Reference points

The traffic policies for both unicast as well as multicast data are provided by the x-RACF to the RCEF through the Re reference point. Events which are to trigger a policy evaluation are sent by RCEF via the Re reference point to x-RACF.

RCEF may also interact with BTF to enforce policies which impact data forwarding behaviour, such as data replication for multicast traffic.

### 6.2.4.3 RCEF parameters

Unidirectional micro-flows are specified by the x-RACF towards the RCEF in terms of a flow classifier including the standard 5-tuple (source IP address, destination IP address, source port, destination port, protocol). Elements of the 5-tuple that are unknown to the x-RACF may be wild-carded by the x-RACF in the instructions to the SPDF.

In addition, it shall be possible:

- to provide mid-session updates over the Re reference point;
- to allocate a particular Id to each policy in order to use L2/L3 policy types by RCEF;
- to provide an address independent media session identifier, since the address information may change during the media session.

## 6.2.5 Application Function (AF)

### 6.2.5.1 AF main functions

This clause looks at requirements on Application Functions (AFs) related to controlling bearer resources. The AF is not a stand-alone functional entity of the NGN architecture. It is a convenient short cut to represent the functionality that exists in some Service Control Sub-Systems and Applications to interact with the RACS when the QoS push Model is used (e.g. through a P-CSCF, or an IBCF).

The AF is expected to perform the operations when requesting resources following the push model, as defined in clause 6.1, indicated below.

The AF shall provide information to the SPDF to identify media flows to express the service expected from RACS and the bandwidth that needs to be authorized and allocated for those flows. Bandwidth requirements shall be complemented with class based service information indicating service expectations such as QoS characteristics, which transfer layer resources that should be used, and whether service from BGF (in case interconnection between SPDF and BG exists), x-RACF, or both is requested. This class-based information may also capture predefined traffic characteristics. Resource priority requirements may also be supplied.

The AF shall indicate whether the media should be enabled (i.e. gate opened) when resources are allocated. Alternatively, the AF may request that the gate be opened later, after resources are committed.

The AF shall be capable of issuing reservation modification and release messages that contain the same reservation information as provided in the initial reservation request and commit messages previously issued to establish the reservation. The AF shall further be capable of updating time limited reservations through reservation modification messages and through reservation refresh messages. These capabilities of the AF enable RACS to recreate reservation states that have been lost. For example, where RACS implements asynchronous replication for resilience, a backup instance of RACS may not hold proper states for all active reservations when becoming active. The missing states can then be recreated from the information provided by the AF in any subsequent message for those reservations.

Still in case where an interconnection between SPDF and BGF exists, and where a NAT function is required, the AF shall request address-mapping information and shall do any modifications that may be required to address information within application signalling (e.g. SDP).

Under the same interconnection assumption, where support of a hosted NAT is required, the AF shall request address latching, since the remote media IP address/port information provided within application signalling (e.g. SDP) cannot be used to send media towards the UE behind the NAT.

The AF shall provide overload control capabilities, which enable the AF to reduce its resource request rate when overload is detected within the RACS. Also, the AF may request that the RACS reduces its rate of notifications to the AF, in case of overload within the AF. A full specification is left as an outstanding issue.

The AF may be capable of operating in a mode of operation by means of which the AF request resources for media flows belonging to a single application session per resource request.

The AF may be capable of operating in any or all of the following modes of operation:

- the mode where a single resource reservation request per application session is issued by the AF;
- the mode of operation where multiple independent resource reservation requests per application session are issued either from a single or multiple AFs, where each independent request is intended to reserve a different set of resources within the network.

The AF is entitled to use Subscriber-Id and/or an IP address to identify to RACS the resource being requested. The decision of what information is provided to RACS depends on the type of application and it is outside of the scope of the present document.

When following the pull model as defined in clause 6.2.2.1.3, the AF is expected to operate as indicated below. The AF may provide information to the SPDF to authorize consecutive reservation requests from transport functions. This information may include bandwidth requirements, indications of service expectations such as QoS characteristics, and which transfer layer resources that should be used.

A particular instance of an AF, the IBCF, is located in interconnection scenarios between two operators domains and performs interconnect functions as described in TS 123 228 [16]. Transport control service requests are sent to the SPDF and, based on information contained in this request, as well as on local operator policies, the decision as to whether or not media level interconnection is required (i.e. an I-BGF shall be inserted or not in the media path) for a particular session is taken by RACS.

Another instance of an AF, the P-CSCF, is located in the IMS subsystem and is also described in TS 123 228 [16]. In this case, the decision to include or not a C-BGF in the media path is taken by RACS, i.e. by the SPDF, upon analysis of information issued in transport control service requests from the P-CSCF, as well as of local operator policies.

#### 6.2.5.2 Reference points

The Application Function (AF) interacts with the SPDF via the Gq' reference point. It makes requests for bearer resources and may receive notifications when resources are reserved and released.

#### 6.2.5.3 Charging

The AF shall be able to provide charging information for the Request/Modify/Release/Abort commands when necessary.

#### 6.2.5.4 Abnormal conditions handling

Abnormal conditions are reported by the SPDF indicating that the current reservations are no longer valid. The AF behaviour that follows is application dependent and the RACS does not make any assumption on that. The abnormal condition information is sent to the AF after all resource session and state information is cleared in RACS.

### 6.2.6 BTF

Please refer to [2] for the normative specification of the Basic Transport Function (BTF).

## 6.3 RACS reference points

### 6.3.1 Rq reference point (SPDF - x-RACF)

#### 6.3.1.1 Functional requirements

The Rq reference point provides interaction between the SPDF and the x-RACF functional building blocks of the RACS architecture. The Rq requirements are classified in functional and non-functional elements.

The x-RACF provides facilities for topology-aware resource reservation, resource reservation tracking, and a resource-constraint-based admission control service that shall be addressed through the Rq reference point.

The Rq reference point is used for QoS resource reservation information exchange between the SPDF and the x-RACF. Via the Rq reference point the SPDF issues requests for resources in the access and aggregation networks, indicating IP QoS characteristics.

In Release 1 inter-domain aspects are not explicitly addressed. As the SPDF and the A-RACF may be located in different administrative domains, the Rq reference point may be an interdomain reference point.

For the present document, as each administrative domain shall have at least one SPDF, and the reference point between SPDFs is the only type of reference point between RACS instances in different administrative domains, the Rq reference point is always an intradomain reference point.

Use of the Rq reference point as an inter-domain reference point as described in R1 should be avoided.

NOTE: Backwards compatibility between implementations of both releases is always ensured as long as possible encryption of the Rq reference point performed by the Release 1 FEs for security reasons, has an appropriate treatment by the present document FEs.

Following functional requirements are directly derived from the role and position of the Rq reference point in the RACS.

##### 6.3.1.1.1 Resource management mechanisms

The Rq reference point shall support a versatile set of resource management schemes, suitable for coping with all target deployment architectures, as stipulated and defined in the present document. In this context, the following resource management schemes must be supported:

- proxies resource reservation with "policy-push";
- support for all the scenarios defined in RACS functional architecture:
  - QoS request initiated by Application Function;
  - QoS request initiated by CPN through the application layer signalling with QoS negotiation extensions;
- flexibility for evolution in future NGN releases;

- the Rq reference point shall provide subsequent resource management models in support of these requirements:

  - Single-stage resource management model, providing resource management services in a mode where reserved resources are immediately available upon successful reservation.

  - Two-stage reserve-commit resource management model that can be leveraged in support of services that aim to support charging per service-invocation, and require as such service-theft-prevention solutions.

  - Authorize-reserve-commit resource management model, supporting service-based local policy control under coordination of a network-hosted application function.

#### 6.3.1.1.2 Service model

The services provided for each of the resource reservation models shall offer the following capabilities:

- the service model shall allow resource reservation for an individual application session that can involve multiple media flows. A media flow may be uni-directional or bi-directional (combining in effect two uni-directional flows);

- the resource management model established through the Rq reference point shall support atomicity of resource management services at the level of an application session. This implies support for collective reservation, release, and modification of resource requirements for all the media flows that belong to the application session;

- a resource requirement budget can be established for each individual service flow of the application session;

- mid-session modification of previously established resource reservations shall be supported for individual service sessions in an atomic manner (e.g. in support of service session modifications that have to be accommodated on behalf of SIP re-invite). Atomicity shall be guaranteed, per mid-session modification, across all changes that are in order for the individual media flows of the session, including:

  - modification (increase or reduction) of resource requirements reserved on behalf of selected individual media flows;

  - release of resources previously reserved on behalf of a selected individual media flows;

  - creation of new resource reservation on behalf of new individual media flows that are added to the service session;

- collective release of all resources for an application session.

#### 6.3.1.1.3 Duration semantics

In terms of duration semantics, the resource management model supported by the Rq reference point shall support both soft-state and hard-state resource management approaches along with the following functions:

- for both approaches Rq shall support facilities for explicit removal of previously established resource reservation;

- for both approaches Rq shall support facilities for explicit modification of previously established resource reservation;

- granularity of removal and modification facilities shall be at the level of individual flow reservations;

- Time Limited hard-state with update possibilities;

- Resource Modification Request primitive must be capable of carrying information needed to create reservation states. This means that all parameters provided in Reservation Request message must be possible to include in Reservation Modify primitive. Thereby the x-RACF can rely on states kept in SPDF to support seamless fail over instead of replicating soft state reservations.

#### 6.3.1.1.4 Audit and synchronization support

The only mechanism for synchronization over Rq supported in the present document implies the use of soft-state reservation.

The Rq does not support any audit mechanism in the present document.

#### 6.3.1.1.5 Report facilities for unsolicited events

The Rq reference point shall support facilities for indicating, on a per request basis, relevant events such as revocation of established resource reservations.

### 6.3.1.2 Non-functional requirements

The Rq reference point shall support the non-functional requirements indicated in clauses 6.3.1.2.1 and 6.3.1.2.2.

#### 6.3.1.2.1 Reliability requirements

The Rq reference point shall provide mechanisms to ensure reliability of all communication performed over the interface.

#### 6.3.1.2.2 Security requirements

The security requirements for RACS are described in TS 187 001 [14].

### 6.3.1.3 Information exchanged over the Rq Reference Point

NOTE: The current clause, as well as clause 6.3.4, are not completely aligned with Rq stage 3 (ES 283 026 [i.2]) and Gq' stage 3 (TS 183 017 [i.3]). However, alignment is outside the scope of the present document.

#### 6.3.1.3.1 Resource Reservation Request

The resource reservation request message is used to request resources and is sent by the SPDF to the x-RACF. The SPDF knows the address of the x-RACF entity based on local configuration data. The Resource Request contains the following information elements.

**Table 5: Resource Reservation Request - Information Elements**

| **Resource Request (SPDF -> x-RACF)** | |
|---|---|
| Application Function Identifier | Global unique Identifier for the application function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Application Function Identifier. |
| Subscriber-ID (optional) | It identifies the subscriber attached to the access network (see note 1). |
| Globally Unique IP Address (optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network (see note 1). |
| Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| Address Realm | The addressing domain in which the IP address is significant (see note 2). |
| Requestor Name | Identifies the RACS client requesting the resources (e.g. name of an ASP or group of ASPs). In the case of A-RACF, this name corresponds to the Requestor Name in a QoS profile provided by NASS (see note 3). |
| Service Class | Service class requested by the SPDF. It reflects the service relationship between the x-RACF and SPDF owners. The set of Service Classes that are offered to an SPDF is an administrative matter. |
| Service Priority (optional) | The priority associated to the service request that defines the handling precedence by the receiving entity. |
| Charging Correlation Information (CCI) (optional) | Globally unique identifier for charging correlation purposes. |
| Duration of Reservation (optional) | Duration of the reservation requested by the client. |

| Resource Request (SPDF -> x-RACF) | |
|---|---|
| Authorization package ID (optional) | Identifier of an authorization context for the session. In the case of a multicast reservation, the identified context provides information on the multicast channels allowed or not allowed during the session and their respective QoS requirements. |
| Media Description | The media description. |
| Requestor Name | Identifies the RACS client requesting the resources (e.g. name of an ASP or group of ASPs). In the case of A-RACF, this name corresponds to the Requestor Name in a QoS profile provided by NASS (see note 3). |
| Media Type | The pre-defined type of the media for each flow (e.g. Video). |
| Media Id | Identifier for the specific media. |
| Media Priority (optional) | The priority associated to the media to be used in the admission control process in x-RACF. |
| Traffic Flow Parameters | The traffic flow description of the media. |
| Direction | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| IP Addresses | Source and Destination IP addresses (Ipv4, Ipv6) and Address Realm that each address belongs to (see note 4). |
| Ports | Source and Destination Port Numbers (see note 5). |
| Protocol | Protocol Id (e.g. UDP, TCP). |
| Bandwidth | The maximum request bit rate. |
| Reservation Class (optional) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional) | Identifies the forwarding behaviour to be applied to the particular flow (see note 6). |
| Commit Id | Identify if request is to be committed. |
| Overbooking request indicator (optional) | Indicates that the x-RACF may process the resource request in overbooking mode. |

NOTE 1: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.
NOTE 2: It makes the assigned IP address unique, for example it can be a VPN-id.
NOTE 3: In case the Requestor Name is present both at command level and at media component level, the Requestor Name at media component level takes precedence.
NOTE 4: An IP address prefix is supported.
NOTE 5: Port Ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.
NOTE 6: In the case of A-RACF, transport Service Class is also part of the QoS profile provided by NASS.

#### 6.3.1.3.2 Resource Modification Request

The resource modification request message is sent by the SPDF to the x-RACF in order to modify current resource allocation. The address information necessary to contact the x-RACF may be received from AF or from an interconnected SPDF in the spdf-transparent-information (the SPDF may have other means to retrieve the x-RACF address). The Resource Modification Request message contains the following information elements.

**Table 6: Resource Modification Request - Information Elements**

| Resource Modification Request (SPDF -> x-RACF) (see note) | |
|---|---|
| Application Function Identifier | Global unique Identifier for the application function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Application Function (AF) Identifier. |
| Requestor Name | Identifies the RACS client requesting the resources (e.g. name of an ASP or group of ASPs). In the case of A-RACF, this name corresponds to the Requestor Name in a QoS profile provided by NASS. |
| Service Class | Service class requested by the SPDF. It reflects the service relationship between the x-RACF and SPDF owners. The set of Service Classes that are offered to an SPDF is an administrative matter. |
| Duration of Reservation (optional) | Duration of the reservation requested by the client. |
| Charging Correlation Information (optional) | Globally unique identifier for charging correlation purposes. |
| Service Priority (optional) | The priority associated to a service request that defines the handling precedence by the receiving entity. |
| Authorization package ID (optional) | Identifier of an authorization context for the session. In the case of a multicast reservation, the identified context provides information on the multicast channels allowed or not allowed during the session and their respective QoS requirements. |
| Media Description | The media description. |
| Media Type | The pre-defined type of the media for each flow (e.g. Video). |
| Media Id | Identifier for the specific media. |
| Media Priority (optional) | The priority associated to the media to be used in the admission control process in x-RACF. |
| Traffic Flow Parameters | The traffic flow description of the media. |
| Direction | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| IP Addresses | Source and Destination IP addresses (Ipv4, Ipv6) and Address Realm that each address belongs to. |
| Ports | Source and Destination Port Numbers. |
| Protocol | Protocol Id (e.g. UDP, TCP). |
| Bandwidth | The maximum request bit rate. |
| Reservation Class (optional) | The particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional) | Identifies the forwarding behaviour to be applied to the particular flow. |
| Commit Id | Identify if request is to be committed. |
| NOTE: Only the Bandwidth inside the Traffic Flow Parameter element can be modified. | |

#### 6.3.1.3.3 Resource Request/Modification Confirmation

The resource reservation confirmation message is used to acknowledge the resource reservation or modification by x-RACF. In case the request cannot be fulfilled, the appropriate cause is returned to the SPDF. In case of an unsuccessful modification, the BGF also informs if the previous reservation was kept. The Resource Req/Modification Confirmation message contains the following information elements.

**Table 7: Resource Confirmation - Information Elements**

| **Resource Request/Modification Confirmation (x-RACF -> SPDF) (see note)** | |
|---|---|
| Application Function Identifier | Global unique Identifier for the application function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Application Function Identifier. |
| Resource Bundle-Id (optional) | Represents a set of resource reservation sessions grouped together by x-RACF policies. It shall be possible to represent a hierarchy of resources in the resource Bundle-Id associated to that particular RACS resource reservation session. |
| Duration of Reservation Granted (optional) | Duration of the reservation granted by x-RACF. |
| Overbooking confirmation indicator (optional) | Indicates that the reservation has been achieved by the x-RACF with overbooking. |
| Result | The result of the request. |
| NOTE: The optional parameters are not present in case of an unsuccessful result. | |

#### 6.3.1.3.4 Resource Release Request

The resource reservation release message is used by the SPDF to relinquish the resource reservation in x-RACF. A parameter indicates if acknowledgement is expected by the SPDF from the x-RACF. The Resource Release Request message contains the following information elements.

**Table 8: Resource Release - Information Elements**

| **Resource Release Request (SPDF-> x-RACF)** | |
|---|---|
| Application Function Identifier | Global unique Identifier for the application function instance. |
| Resource Reservation Session ID | The reference is a unique session identifier in the scope of the Application Function Identifier (see note). |
| NOTE: The presence of a wildcard in the session part of the reference indicates that all resources identified associated to the Application Function Identifier shall be released, otherwise only the specific session is released (it implies all media in the session). | |

#### 6.3.1.3.5 Abort Resource Reservation

The abort reservation message is used by the x-RACF to indicate to the SPDF that the resource previously reserved is lost. The message may transport an indication for more than one reservation. The abort reservation message contains the following information elements.

**Table 9: Abort Reservation- Information Elements**

| **Abort Reservation (x-RACF -> SPDF) (see note)** | |
|---|---|
| Application Function Identifier | Global unique Identifier for the application function instance. |
| Resource Reservation Session ID | The reference is a unique Resource Reservation session identifier in the scope of the Application Function Identifier (see note). |
| Resource Bundle-Id (optional) | It represents a set of resource reservation sessions grouped together by x-RACF policies. It shall be possible to represent a hierarchy of resources in the resource Bundle-Id associated to that particular RACS resource reservation session. |
| Time Stamp | The time when the resources were lost. |
| Cause | The cause that lead to the lost of the reservation. |
| NOTE: A single message shall be able to carry multiples blocks. | |

## 6.3.2 e4 reference point (A-RACF - NASS)

This is the reference point between the A-RACF and the Customer Location Function (CLF) of the network attachment Sub-System (NASS). The reference point e4 is described in ES 282 004 [5].

## 6.3.3 Ia Reference Point (SPDF - BGF)

This is the reference point between the SPDF and the BGF. This reference point is internal to the administrative domain. The following requirements apply to the reference point.

### 6.3.3.1 Functional Requirements

The functional requirements for the Ia reference point are presented below in itemized lists.

#### 6.3.3.1.1 Control of NAT, Hosted NAT traversal and Gating

1) Request of the NAT binding (two terminations, each containing an IP address, port and IP version) to receive and transmit the media flows; information about the allocated bindings must be returned to the requestor.

2) Indicate, in the NAT binding request, the remote source and destination media parameters for each media flow, including possible wildcarding of specific media parameters (in case the information is not known by the controlling node).

3) Indicate, in the NAT binding request, the IP address/port latching for specific terminations (if the information cannot be retrieved from signalling data, the data is known to be incorrect, etc.).

4) Indicate, in the NAT binding request, the media transport protocol (RTP, T.38, MSRP, etc.) for each media flow in order for the BGF to be able to perform protocol specific functions (e.g. dual-port reservation for RTP/RTCP, proper statistics collection, etc.).

5) Indicate, in the NAT binding request, if the media flow is uni- or bi-directional (in case of uni-directional, also indicate the specific direction).

6) Request mid-session modification of media parameters, including a possible request for new IP address/port latching.

#### 6.3.3.1.2 Transport Protocol Type Policing

1) Request L4 protocol type policing.

2) Request mid-session modification of L4 protocol type policing.

#### 6.3.3.1.3 Bandwidth control

1) Request allocation of bandwidth resources needed for a specific media flow.

2) Indicate, in the bandwidth allocation request, the bandwidth policing information.

3) Request mid-session bandwidth modification.

#### 6.3.3.1.4 QoS marking

1) Indicate QoS marking values (e.g. DiffServ/DSCP) for each egress media flow.

#### 6.3.3.1.5 Usage metering and statistics reporting

Report media flow specific usage metering information (octets of sent data, etc.), when flow is released and during mid-session, if requested.

#### 6.3.3.1.6 Resource state synchronization

Given that resource state synchronization is a required function in order to recover from different failure scenarios, the reference point shall allow:

1) Reporting of BGF state change (due to rebooting, network failure, HW failure, etc.).

2) Requesting and Reporting of the current BGF resource state.

### 6.3.3.2 Non-Functional Requirements

The Ia reference point shall support the following non-functional requirements.

#### 6.3.3.2.1 Reliability requirements

The Ia reference point shall provide a mechanism to guarantee reliability of all communication performed over the reference point.

#### 6.3.3.2.2 Security requirements

The security requirements for RACS are described in TS 187 001 [14].

### 6.3.3.3 Information exchanged over the Ia Reference Point

The Ia reference point connects the SPDF and the BGF Functional Entities, where the latter is a packet-to-packet gateway for user plane media traffic that performs the BGF services indicated in Table 2 under the control of the first FE. The set of commands or messages with the correspondent information that may be exchanged are described hereinafter.

NOTE: Complete alignment between stage 2 and stage 3 is outside the scope of the present document.

#### 6.3.3.3.1 BGF Service Request

The BGF Service Request message adds a termination to a context and contains the following Information Elements.

**Table 10: BGF Service Request - Information Elements**

| **BGF Service Request (SPDF -> BGF)** | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Media | This Information Element identifies and describes the media to be used. |
| Stream (optional) | This parameter identifies and describes the stream to be used. |

| BGF Service Request (SPDF -> BGF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Local Control (optional) | |
| mode (conditional, see note 1) | The stream mode attribute specifies the mode of transmission that should be considered for the stream, e.g. send only, receive only, send and receive, inactive. |
| dscp (conditional, see note 1) | The Differentiated Services Code Point attribute corresponds to the 6-Bit Differentiated Services field of the IP header, as defined in [i.2]. |
| mpls (conditional, see note 1) | Idem for the definition of MPLS labels. |
| vlan (conditional, see note 1) | Idem for the definition of VLAN tag values. |
| saf (conditional, see note 1) | The Remote Source Address Filtering attribute indicates whether source address filtering shall be enforced. |
| spf (conditional, see note 1) | The Remote Source Port Filtering attribute indicates whether source port filtering shall be enforced. |
| sam (conditional, see note 1) | The Remote Source Address Mask attribute indicates which source addresses are accepted for packets received by the termination. |
| spr (conditional, see note 1) | The Remote Source Port attribute indicates the allocated source port value for packets received by the termination. |
| sprr (conditional, see note 1) | The Remote Source Port Range attribute specifies the incoming stream source port(s) in terms of a range (start port, end port) that filtering is applied to. All of the ports within the range and including the start and end port shall be filtered. |
| rsb (conditional, see note 1) | The RTCP Allocation Specific Behaviour attribute indicates whether or not an RTCP flow and an associated port are automatically associated with an RTP flow. |
| esas (conditional, see note 1) | The Explicit Source Address Setting attribute indicates if special handling of the source address of packets sent by the termination is required. |
| lsa (conditional, see note 1) | The Local Source Address attribute indicates the source address to be used in packets sent by the termination. |
| esps (conditional, see note 1) | The Explicit Source Port Setting attribute indicates if special handling of the source port of packets sent by the termination is required. |
| lsp (conditional, see note 1) | The Local Source Port attribute indicates the source port to be used in packets sent by the termination. |
| db (conditional, see note 1) | The Data Block attribute indicates the Requesting Originating entity (Recovery) Information data block. |
| pdr (conditional, see note 1) | The Peak Data Rate attribute indicates the peak data rate in bytes per second that is permitted for the stream. |
| mbs (conditional, see note 1) | The Maximum Burst Size attribute indicates the maximum burst size in bytes for the stream. |
| dvt (conditional, see note 1) | The Delay Variation Tolerance attribute indicates the delay variation tolerance for the Stream in tenths of microseconds. |
| sdr (conditional, see note 1) | The Sustainable Data Rate attribute indicates the sustainable data rate in bytes per second that is permitted for the stream. |
| pol (conditional, see note 1) | Policing is to be applied at the termination for incoming traffic, if this attribute is set. |
| realm (optional) | The IP Realm Identifier attribute indicates to which packet network the media represented by the termination belongs to. |
| Statistics (optional, see note 2) | |
| dur | This attribute specifies the duration of time the termination has been active. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |

| BGF Service Request (SPDF -> BGF) | |
|---|---|
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| Local Info | Set of attributes associated with the sending Functional Entity. |
| IP address | Local L3 information related with the IP address. |
| port (conditional, see note 1) | Local L4 information related with port assignment. |
| media information (conditional, see note 1) | Local L4+ information related with, e.g. if a RTCP port is assigned, what media type is transported, what payload type is used, etc. |
| transport behaviour (conditional, see note 1) | Bearer related information denoting if the BGF should act transport aware and/or media aware, i.e. shall it ensure the correct transport protocol and/or be media contents aware. |
| bandwidth policing (conditional, see note 1) | Bearer related information denoting if BGF shall perform bandwidth policing or not, and which attribute values shall be used to perform it. |
| Remote Information (conditional, see note 1) | Set of attributes associated with the receiving Functional Entity. |
| IP address | Remote L3 information related with the IP address. |
| port (conditional, see note 1) | Remote L4 information related with port assignment. |
| media information (conditional, see note 1) | Remote L4+ information related with, e.g. if a RTCP port is assigned, what media type is transported, what payload type is used, etc. |
| transport behaviour (conditional, see note 1) | Bearer related information denoting if the BGF should act transport aware and/or media aware, i.e. shall it ensure the correct transport protocol and/or be media contents aware. |
| bandwidth policing (conditional, see note 1) | Bearer related information denoting if BGF shall perform bandwidth policing or not, and which attribute values shall be used to perform it. |
| Signals (optional) | This Information Element identifies and describes the type of signals used in the context. |
| Latch (optional) | This parameter specifies the address latching listening process. |
| napt tp (optional) | This attribute specifies the NAPT traversal processing. |
| Events (optional) | This Information Element specifies the type of events processed in the context. |
| Cause (optional) | This parameter reports the occurrence of a generic cause error event. |
| Ipstop (optional) | This parameter reports the detection of an IP flow stop. |
| dt (optional) | This attribute reports the detection time. |
| dir (optional) | This attribute reports the direction of the IP flow. |
| Netfail (optional) | This parameter reports the detection of a network failure. |
| Qualert (optional) | This parameter reports the detection of a loss of quality in the connection that may generate an alert. |
| th (optional) | This attribute reports the occurrence of a pre-defined threshold. |
| Cr (optional) | This parameter denotes the occurrence of a situation that should be conditionally reported. |
| si | Identifier of the specific statistic that should be conditionally reported. |

| BGF Service Request (SPDF -> BGF) | |
|---|---|
| dur (optional) | This attribute indicates the time span over which the statistic should be monitored, and in which other conditions may trigger a report of the statistic. |
| per (optional) | Period attribute that characterizes the specific statistic to be reported. |
| max (optional) | Maximum attribute that characterizes the specific statistic to be reported. |
| min (optional) | Minimum attribute that characterizes the specific statistic to be reported. |
| nor (optional) | Normal attribute that characterizes the specific statistic to be reported. |
| Hangterm | This parameter denotes that a termination has been hung. |
| timer | This attribute denotes the duration of the time interval associated with the process. |
| NOTE 1: The use of this parameter/attribute depends on the availability of relevant parameters/attributes for the termination, e.g. the remote address, as well as the local and remote ports, which leads to the use of different procedures in each case that may require it or not. | |
| NOTE 2: The SPDF may request any supported statistic. | |

#### 6.3.3.3.2 BGF Service Confirmation

The BGF Service Confirmation message is used by the BGF to reply a confirmation to the SPDF denoting the activation of a termination in a specific context. The BGF Service Confirmation message contains the following Information Elements.

**Table 11: BGF Service Confirmation - Information Elements**

| BGF Service Confirmation (BGF -> SPDF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Media | This Information Element identifies and describes the media to be used. |
| Stream (optional) | This parameter identifies and describes the stream to be used. |

| BGF Service Confirmation (BGF -> SPDF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Local Info | Set of parameters associated with the sending Functional Entity. |
| IP address | Local L3 information related with the IP address. |
| port (conditional, see note 1) | Local L4 information related with port assignment. |
| media information (conditional, see note 1) | Local L4+ information related with, e.g. if a RTCP port is assigned, what media type is transported, what payload type is used, etc. |
| transport behaviour (conditional, see note 1) | Bearer related information denoting if the BGF should act transport aware and/or media aware, i.e. shall it ensure the correct transport protocol and/or be media contents aware. |
| bandwidth policing (conditional, see note 1) | Bearer related information denoting if BGF shall perform bandwidth policing or not, and which attribute values shall be used to perform it. |
| NOTE: The use of this parameter/attribute depends on the availability of relevant parameters/attributes for the termination, e.g. the remote address, as well as the local and remote ports, which leads to the use of different procedures in each case that may require it or not. | |

#### 6.3.3.3.3 BGF Service Modify Request

The BGF Service Modify Request message modifies the properties of a termination. Its contents are the same as those expressed for the BGF Service Request message with the exceptions indicated in the following table, where the use of additional Information Elements is specified.

**Table 12: BGF Service Modify Request - Additional Information Elements**

| BGF Service Modify Request (SPDF -> BGF) | |
|---|---|
| Media (see notes 1, 2, 3 and 4) | This Information Element identifies and describes the media to be used. |
| Events (optional, see note 5) | This Information Element specifies the type of events processed in the context. |
| Mit (optional) | This parameter specifies the maximum inactivity timer related with detecting failure of entities by message silence. |
| Audit (conditional, see note 6) | This Information Element identifies and describes the audit process that the Requesting Originating entity wants to be performed. |
| Media (conditional, see note 6) | This parameter identifies and describes the media to be used. |
| Stream (conditional, see note 6) | This attribute identifies and describes the stream to be used. |
| Stream ID | The identifier of one traffic stream. |
| Statistics (conditional, see notes 3 and 6) | |
| dur | This attribute specifies the duration of the time interval used for statistics report. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |

| BGF Service Modify Request (SPDF -> BGF) | |
|---|---|
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| NOTE 1: All the parameters indicated in the BGF Service Request message for the Media Information Element are also applicable to the BGF Service Modify message. | |
| NOTE 2: The use of the parameters associated with the Local Control parameter depends on the availability of relevant parameters for the termination, e.g. the remote address, as well as the local and remote ports, which leads to the use of different procedures in each case that may require it or not. | |
| NOTE 3: The SPDF may request any supported statistic. | |
| NOTE 4: The statistics parameter may be used in association with the media parameter but only in the case the Modify Request message performs the addition of a new stream to a specific media. | |
| NOTE 5: Besides the Mit, all the parameters indicated in the BGF Service Request message for the Events Information Element are also applicable to the BGF Service Modify message. | |
| NOTE 6: This parameter may only be used in case the BGF Modify Request message performs the deletion of a specific stream that belongs to a specific media. | |

#### 6.3.3.3.4 BGF Service Modify Confirmation

The BGF Service Modify Confirmation message is used by the BGF to reply a confirmation to the SPDF denoting the accomplishment of a modification previously solicited for a termination in a specific context. The BGF Service Modify Confirmation message contains the following Information Elements.

**Table 13: BGF Service Modify Confirmation - Information Elements**

| BGF Service Modify Confirmation (BGF -> SPDF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Media | This Information Element identifies and describes the media to be used. |
| Stream (optional) | This parameter identifies and describes the stream to be used. |

| BGF Service Modify Confirmation (BGF -> SPDF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Statistics (see note 1) | |
| dur | This attribute specifies the duration of the time interval used for statistics report. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| Local Information | Set of parameters associated with the sending Functional Entity. |
| IP address | Local L3 information related with the IP address. |
| port (conditional, see note 1) | Local L4 information related with port assignment. |
| media information (conditional, see note 1) | Local L4+ information related with, e.g. if a RTCP port is assigned, what media type is transported, what payload type is used, etc. |
| transport behaviour (conditional, see note 1) | Bearer related information denoting if the BGF should act transport aware and/or media aware, i.e. shall it ensure the correct transport protocol and/or be media contents aware. |
| bandwidth policing (conditional, see note 1) | Bearer related information denoting if BGF shall perform bandwidth policing or not, and which attribute values shall be used to perform it. |
| NOTE 1: The SPDF may request any supported statistic.<br>NOTE 2: The use of this parameter/attribute depends on the availability of relevant parameters/attributes for the termination, e.g. the remote address, as well as the local and remote ports, which leads to the use of different procedures in each case that may require it or not. | |

### 6.3.3.3.5 BGF Service Audit Request

The BGF Service Audit Request message requests the current values of properties, events, signals and statistics associated with terminations. This message may also request that the returned values be filtered based on specified selection criteria. The BGF Service Audit Request message contains the following Information Elements.

**Table 14: BGF Service Audit Request - Information Elements**

| BGF Service Audit Request (SPDF -> BGF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |

| BGF Service Audit Request (SPDF -> BGF) | |
|---|---|
| Audit | This Information Element identifies and describes the audit process that the Requesting Originating entity wants to be performed. |
| Media | This parameter identifies and describes the media to be used. |
| Stream | This attribute identifies and describes the stream to be used. |
| Stream ID | The identifier of one traffic stream. |
| Statistics (see note) | |
| dur | This attribute specifies the duration of the time interval used for statistics report. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| NOTE: The SPDF may request any supported statistic. | |

#### 6.3.3.3.6 BGF Service Audit Response

The BGF Service Audit Response message returns the possible values of properties, events, signals and statistics associated with terminations. The BGF Service Audit Response message contains the following Information Elements.

**Table 15: BGF Service Audit Response - Information Elements**

| BGF Service Audit Reservation (BGF -> SPDF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Media | This Information Element identifies and describes the media to be used. |
| Stream | This parameter identifies and describes the stream to be used. |

| BGF Service Audit Reservation (BGF -> SPDF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Statistics (see note) | |
| dur | This attribute specifies the duration of the time interval used for statistics report. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| NOTE: The SPDF may request any supported statistic. | |

#### 6.3.3.3.7 BGF Service Notify Request

The BGF Service Notify Request message is used by the SPDF to demand to be reported by the BGF on the occurrence of specific events. The BGF Service Notify Request message contains the following Information Elements.

**Table 16: BGF Service Notify Request - Information Elements**

| BGF Service Notify Request (SPDF -> BGF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Observed Events | This Information Element is supplied within this message to inform on which event(s) were detected. |
| Ipstop | This parameter asks for the notification of the detection of an IP flow stop. |
| dt | This attribute specifies the detection time. |
| dir | This attribute specifies the direction of the IP flow. |
| Cr | This parameter asks for the notification of the occurrence of a situation that should be conditionally reported. |
| si | This attribute identifies the specific statistic that should be conditionally reported. |
| Hangterm | This parameter asks for the notification of a hanging termination occurrence. |
| dur | This attribute denotes the duration of the time interval associated with the process. |

#### 6.3.3.3.8 BGF Service Notify Indication

The BGF Service Notify Indication message allows the BGF to report the occurrence of events as previously solicited by the SPDF. The BGF Service Notify Indication message contains the following Information Elements.

**Table 17: BGF Service Notify Indication - Information Elements**

| BGF Service Notify Indication (BGF -> SPDF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Observed Events | This Information Element is supplied within this message to inform on which event(s) were detected. |
| Ipstop | This parameter reports the detection of a IP flow stop. |
| dt | This attribute reports the detection time. |
| dir | This attribute reports the direction of the IP flow. |
| Cr | This parameter denotes the occurrence of a situation that should be conditionally reported. |
| si | This attribute identifies the specific statistic that has occurred and is being reported. |
| val | This attribute denotes the value of the statistic being reported. |
| Hangterm | This parameter denotes that a termination has been hung. |
| dur | This attribute denotes the duration of the time interval associated with the process. |

#### 6.3.3.3.9 BGF Service Release Request

The BGF Service Release Request message disconnects a termination from its context and returns statistics on the termination's participation in the context. The BGF Service Release Request message contains the following Information Elements.

**Table 18: BGF Service Release Request - Information Elements**

| BGF Service Release Request (SPDF -> BGF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Audit | This Information Element identifies and describes the audit process that the Requesting Originating entity wants to be performed. |
| Media | This parameter identifies and describes the media to be used. |
| Stream | This attribute identifies and describes the stream to be used. |

| BGF Service Release Request (SPDF -> BGF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Statistics (see note) | |
| dur | This attribute specifies the duration of time the termination has been active. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| NOTE: The SPDF may request any supported statistic. | |

### 6.3.3.3.10 BGF Service Release Confirmation

The BGF Service Release Confirmation message is used by the BGF to reply a confirmation to the SPDF denoting the deactivation of a termination in a specific context. The BGF Service Release Confirmation message contains the following Information Elements.

**Table 19: BGF Service Release Confirmation - Information Elements**

| BGF Service Release Confirmation (BGF -> SPDF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Context | A context is an association between a certain number of terminations. |
| Context ID | The identifier of a specific context in the scope of a given Requesting Originating Function instance. |
| Termination ID | The identifier of a specific termination within a given context. |
| Priority | The priority provides information about a certain precedence handling for a context. |
| Emergency | An indicator for an emergency call provided to allow a preference handling. |
| Media (optional) | This Information Element identifies and describes the media to be used. |
| Stream (optional) | This parameter identifies and describes the stream to be used. |

| BGF Service Release Confirmation (BGF -> SPDF) | |
|---|---|
| Stream ID | The identifier of one traffic stream. |
| Statistics (see note) | |
| dur | This attribute specifies the duration of time the termination has been active. |
| os | This attribute specifies the number of octets sent. |
| or | This attribute specifies the number of octets received. |
| dp | This attribute specifies the number of discarded packets. |
| ps | This attribute specifies the number of packets sent. |
| pr | This attribute specifies the number of packets received. |
| pl | This attribute specifies the measured packet loss. |
| jit | This attribute specifies the measured jitter. |
| delay | This attribute specifies the measured delay. |
| NOTE: The SPDF may request any supported statistic. | |

## 6.3.4 Gq' Reference Point (AF - SPDF)

### 6.3.4.1 Functional Requirements

The Gq' reference point allows the AF to request resources from the RACS. Since the SPDF functional entity can only request policy enforcement from other elements in the RACS, the resource reservations performed over Gq' will result, if authorized by the SPDF, in derivative resource reservations and/or service requests over the reference points associated with the SPDF, i.e. Rq, Ia, Rd', and/or Ri'.

Functional requirements over Gq' are therefore a combination of the requirements over the Rq, Ia, Rd', and Ri' reference points, described in later clauses. However, it should be noted that the Gq' reference point is not a simple aggregation of functions resulting in separate information flows for Rq-related, Ia-related, Rd'-related, and Ri'-related requests; the Gq' reference point also allows for reservations and modifications relevant to Rq, Ia, Rd' and Ri', to be requested by AFs as a single atomic request, which the SPDF can then split into separate requests and coordinate accordingly depending on the service requested (see clause 6.2.1.7 on the SPDF coordination, and annex H for session modification procedures).

### 6.3.4.2 Non-Functional Requirements

Non-functional requirements for the Gq' reference point on reliability and security are the same as those defined for the Rq reference point in clause 6.3.1.2.

### 6.3.4.3 Information exchanged over the Gq' Reference Point

Resource reservation requests over Gq' shall be expressed using the same information elements as those over the Rq and Ia (see clauses 6.3.1 and 6.3.3), with the exceptions listed in Table 20.

**Table 20: Information Elements with specific meaning in Gq'**

| | |
|---|---|
| Service Class | Service class requested by the AF. It reflects the service relationship between the AF and SPDF owners. The set of Service Classes that are offered to an AF is an administrative matter. |
| Resource Bundle-Id | Not transported over Gq'. |

NOTE: Information elements exchanged over Gq' are described here as equivalent to those over Rq and Ia. However, the actual values given to these parameters at service execution may be different across each of these reference points, depending on mappings performed by the SPDF to requests coming from Application Functions according to the operator's local policies.

## 6.3.5 Ri' Reference Point (SPDF-SPDF inter-domain)

### 6.3.5.1 Functional Requirements

The Ri' Reference Point provides a means for interaction between two SPDF in different operators domains.

The Ri' Reference Point allows the SPDF in one Originating Domain to trigger Admission Control in the Interconnected Domain. The Ri' Reference Point further allows the Interconnected Domain to communicate the Result of the Admission Control in the Interconnected Domain back to the Originating Domain.

The Ri' Reference Point is the single point of contact to a given Domain, hiding the details of the Topology and Functional Entities within that given Domain.

#### 6.3.5.1.1 Resource management mechanisms

The Ri' Reference Point shall support the same resource management schemes as defined for the Rq and Gq' reference point (see clause 6.3.1.1.1).

#### 6.3.5.1.2 Service model

The services provided for each of the resource reservation models shall offer the following capabilities:

- The service model shall allow resource reservation for an individual application session that can involve multiple media flows. A media flow may be uni-directional or bi-directional (combining in effect two uni-directional flows).
- The resource management model established through the Ri' Reference Point supports a granularity of resource management services at the level of:
  - originating and destination interconnected domains in both directions;
  - application functions.

This model applies to the initial reservation, to the modification, and to the release request.

In the case of the AF granularity, the Ri' reference point is used when an AF cannot communicate directly with the RACS of a certain domain but requires reservation of resources in this domain. The RACS in the originating domain relays the AF requests through the Ri' reference point towards the RACS in the destination domain.

The resource management model shall further offer the following capabilities:

- a resource requirement budget can be established for each individual service flow of the Application Session;
- mid-session modification of previously established resource reservations shall be supported for individual service sessions, i.e. the following mechanisms shall be supported:
  - modification (increase or reduction) of resource requirements reserved on behalf of selected individual media flows;
  - release of resources previously reserved on behalf of a selected individual media flows;
  - creation of new resource reservation on behalf of new individual media flows that are added to the service session.

#### 6.3.5.1.3 Duration semantics

In terms of duration semantics, the resource management model supported by the Ri' reference point shall support both soft-state and hard-state resource management approaches along with the following functions:

- For both approaches Ri' shall support facilities for explicit removal of previously established resource reservation.
- For both approaches Ri' shall support facilities for explicit modification of previously established resource reservation.
- The same granularity levels than those described in clause 6.3.5.1.2 shall be available for both approaches.

#### 6.3.5.1.4 Audit and Synchronization support

Audit and Synchronization mechanisms on the Ri' reference point shall be aligned with those offered on the Gq' reference point.

#### 6.3.5.1.5 Report facilities for unsolicited events

The Ri' Reference Point shall support facilities for indicating relevant events such as revocation of established resource reservations.

### 6.3.5.2 Non-Functional Requirements

#### 6.3.5.2.1 Reliability requirements

The Ri' reference point shall provide mechanisms to ensure reliability of all communication performed over the reference point.

#### 6.3.5.2.2 Security requirements

The security requirements for RACS are described in TS 187 001 [14].

### 6.3.5.3 Information exchanged over the Ri' Reference Point

In the case AF granularity is used as the resource management model, the information exchange over the Ri' reference point shall express the same type of resource requests as those indicated for the Gq' reference point including the additions indicated on Table 21, i.e. reservation, modification, termination, as well as notification request and notification indication including the case of abort of resources.

As such, the same type of stage 2 messages will be used and the same type of information elements for the Gq' reference point will be exchanged, except for those related with the NA(P)T procedure, which will not be required between inter-domain SPDFs.

NOTE: Coverage of the resource management model handling related with the originating and destination interconnected domains in both directions is missing. However, alignment will not be accomplished in the present document.

## 6.3.6 Rd' Reference Point (SPDF-SPDF intra-domain)

### 6.3.6.1 Functional Requirements

The Rd' Reference Point provides a means for interaction between two SPDF located in the same operator domain.

The Rd' Reference Point allows the SPDF in one domain to trigger Admission Control in the same domain. The Rd' Reference Point further allows that domain to communicate the Result of the Admission Control back to the Originating SPDF of the same domain.

#### 6.3.6.1.1 Resource management mechanisms

The Rd' Reference Point shall support the same resource management schemes as defined for the Rq and Gq' reference point (see clause 6.3.1.1.1).

#### 6.3.6.1.2 Service model

The services provided for each of the resource reservation models shall offer the following capabilities:

- the service model shall allow resource reservation for an individual application session that can involve multiple media flows. A media flow may be uni-directional or bi-directional (combining in effect two uni-directional flows);
- the resource management model established through the Rd' Reference Point supports a granularity of resource management services at the level of application functions.

This model applies to the initial reservation, to the modification, and to the release request.

In the case of the AF granularity, the Rd' reference point is used when an AF cannot communicate directly with a certain SPDF but requires reservation of resources that can be reached by that SPDF. The originating SPDF relays the AF requests through the Rd' reference point towards the destination SPDF.

The resource management model shall further offer the additional capabilities specified in clause 6.3.5.1.2.

#### 6.3.6.1.3 Duration semantics

As specified in clause 6.3.5.1.3.

#### 6.3.6.1.4 Audit and Synchronization support

As specified in clause 6.3.5.1.4.

#### 6.3.6.1.5 Report facilities for unsolicited events

As specified in clause 6.3.5.1.5.

### 6.3.6.2 Non-Functional Requirements

#### 6.3.6.2.1 Reliability requirements

As specified in clause 6.3.5.2.1.

#### 6.3.6.2.2 Security requirements

As specified in clause 6.3.5.2.2.

### 6.3.6.3 Information exchanged over the Rd' Reference Point

In the case AF granularity is used as the resource management model, the information exchange over the Rd' reference point shall be as specified in clause 6.3.5.3.

As such, the same type of stage 2 messages will be used and the same type of information elements for the Gq' reference point will be exchanged, including those related with the NA(P)T procedure.

## 6.3.7 Re Reference Point (x-RACF - RCEF)

### 6.3.7.1 Functional Requirements

The RCEF entity ensures facilities for the enforcement of L2/L3 traffic policies defined by the access network provider that are communicated by the x-RACF through the Re reference point.

The Re reference point is used for controlling the L2/L3 traffic policies performed in the transport plane, as requested by the resource management mechanisms, i.e. gating, packet marking, traffic policing and mid-session updates functionalities.

According to the common approach adopted, the RACS reference points present functional and non-functional requirements.

In clauses 6.3.7.1.1.1 to 6.3.7.1.1.4, the functional requirements for the Re reference point will be described.

#### 6.3.7.1.1 Policy Enforcement Management

##### 6.3.7.1.1.1 Installation of Policies

After successful authorization of QoS resources, the Re reference point shall allow the x-RACF to install traffic policies in RCEF, in order to enable traffic conditioning in the transport plane.

The installation of a new policy for a particular flow or a group of flows may or may not result in the replacement of a policy previously installed. A confirmation for this request is also required.

In the context of the present document, x-RACF shall deal with both L2 and L3 policies. The use of L2/L3 policy types by RCEF could be achieved by allocating a particular Id to each policy. In that case RCEF would have to perform a certain policy based on its own interpretation of the L2/L3 parameters, or of the L2/L3 parameters combined with others, included in pre-defined/provisioned traffic policies. The x-RACF could also explicitly specify the L2/L3 traffic polices to RCEF.

NOTE: The information flow routing in case an x-RACF does not have direct access to a particular RCEF is outside the scope of the present document.

As such, for both L2 and L3 policies, x-RACF shall be capable of:

- providing an explicit description of the traffic policies to be applied; and
- attaching a pre-defined traffic policy to the media flow(s). In this case the x-RACF provides a policy-id, which will be translated by the RCEF into specific traffic policies to be applied.

The specific controls that may be requested are indicated in clauses 6.3.7.1.1.1.1 to 6.3.7.1.1.1.3.

#### 6.3.7.1.1.1.1 Gating

This functionality is performed by the RCEF in the transport plane. The decision of applying Gate Control is dependent on the request that indicates if the associated gate should be opened or closed, as well as on local policies stored in the x-RACF. This command allows the x-RACF to enable or disable IP flows.

#### 6.3.7.1.1.1.2 Packet marking

This functionality is usually associated with the appliance of QoS differentiation mechanisms involving the DiffService Edge Function.

Where the associated parameters for the DiffService Edge Function, i.e. classifiers, meters, packet handling actions, may be statically or dynamically configured on the RCEF.

#### 6.3.7.1.1.1.3 Traffic policing

This functionality shall consist of the inspection of each packet performed by the RCEF in order to enforce the decision of the x-RACF. This inspection shall lead to a packet handling action, in terms of packets matching or not the classification, which will result in packets being forwarded or silently discarded.

### 6.3.7.1.1.2 Removal of Policies

This mechanism shall be initiated by the x-RACF. Upon reception of this message, the RCEF shall release all the resources associated with an existing traffic policy.

### 6.3.7.1.1.3 Revoke of policies indication

This mechanism shall be initiated by the RCEF every time an external event occurs denoting that the access information is no longer valid. The RCEF shall notify the x-RACF accordingly, and shall release all the resources associated with an existing reservation.

### 6.3.7.1.1.4 Audit and synchronization support

Not standardized in the present document.

## 6.3.7.2 Non-functional requirements

### 6.3.7.2.1 Reliability requirements

Not standardized in the present document.

### 6.3.7.2.2 Security requirements

The security requirements for RACS are described in TS 187 001 [14].

### 6.3.7.3 Information exchanged over the Re Reference Point

#### 6.3.7.3.1 Information exchanged by using the push mode

##### 6.3.7.3.1.1 Policy Enforcement Install Request

The Policy Enforcement Install Request message is used by the x-RACF to activate one or several Policy Rules, or to install and activate one or several Policy Rules in the RCEF. The Policy Enforcement Install Request message contains the following information elements.

**Table 21: Policy Enforcement Install Request - Information Elements**

| Policy Enforcement Install Request (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Installation (see note 1) | The Policy Rule description, which is used to activate and install a new Policy Rule as instructed from the x-RACF to the RCEF. |
| Policy Rule Definition (see note 2) | The Policy Rule definition. |
| Policy Rule ID | The identifier of a new Policy Rule to be activated at the RCEF. |
| Direction (see note 3) | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| Flow control (see note 3) | Enables or disables the opening of a gate to a particular flow. |
| IP Addresses (see note 3) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 4). |
| Ports (see note 3) | Source and Destination Port Numbers (see note 5). |
| Protocol (see note 3) | Protocol Id. |
| Bandwidth (optional, see note 3) | The maximum request bit rate. |
| Reservation Class (optional, see note 3) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional, see note 3) | Identifies the forwarding behaviour to be applied to the particular flow (see note 6). |
| Precedence | Indicates the precedence that a Policy Rule should take when related to others. |
| Report Type | Indicates the type of reporting that the RCEF is supposed to provide to the x-RACF. |
| Policy Rule ID | The identifier of a pre-defined Policy Rule to be activated at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of pre-defined Policy Rules to be activated at the RCEF. |
| Subscriber-ID (optional, see notes 7 and 8) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 7 and 8) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 9). |
| Physical Access ID (conditional, see notes 8 and 10) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (conditional, see notes 8 and 10) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |

| Policy Enforcement Install Request (x-RACF -> RCEF) | |
|---|---|
| Called Station ID (conditional, see note 8) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (conditional, see note 8) | The identifier of a traffic class to be associated with a policy rule. |
| NOTE 1: There must be at least one Information Element of this type present in the message.<br>NOTE 2: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included.<br>NOTE 3: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.<br>NOTE 4: An IP address prefix is supported.<br>NOTE 5: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.<br>NOTE 6: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS.<br>NOTE 7: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 8: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.<br>NOTE 9: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 10: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them. | |

#### 6.3.7.3.1.2 Policy Enforcement Modification Request

The Policy Enforcement Modification Request message is used by the x-RACF to perform one or several of the following operations in the Transport Resource: to activate a pre-defined, but not yet activated, Policy Rule; or to install and activate a new Policy Rule; or to modify Policy Rule(s) previously installed and activated; or to deactivate and remove Policy Rule(s) previously activated. The Policy Enforcement Modification Request message contains the following information elements.

**Table 22: Policy Enforcement Modification Request - Information Elements**

| Policy Enforcement Modification Request (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Removal (optional, see note 1) | This Information Element s used to remove Policy Rules. |
| Policy Rule ID | The identifier of the Policy Rule to be removed at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of Policy Rules to be removed at the RCEF. |
| Policy Rule Modification (optional, see note 1) | The Policy Rule description, which is used to modify or deactivate a previously activated Policy Rule, or to install and activate a new one. |
| Policy Rule Definition (see notes 2 and 3) | The Policy Rule definition. |

| Policy Enforcement Modification Request (x-RACF -> RCEF) | |
|---|---|
| Policy Rule ID | The identifier of a Policy Rule to be activated at the RCEF. |
| Direction (see note 4) | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| Flow control (see note 4) | Enables or disables the opening of a gate to a particular flow. |
| IP Addresses (see note 4) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 5). |
| Ports (see note 4) | Source and Destination Port Numbers (see note 6). |
| Protocol (see note 4) | Protocol Id. |
| Bandwidth (optional, see note 4) | The maximum request bit rate. |
| Reservation Class (optional, see note 4) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional, see note 4) | Identifies the forwarding behaviour to be applied to the particular flow (see note 7). |
| Precedence | Indicates the precedence that a Policy Rule should take when related to others. |
| Report Type | Indicates the type of reporting that the RCEF is supposed to provide to the x-RACF. |
| Policy Rule ID (optional) | The identifier of a pre-defined Policy Rule to be activated at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of pre-defined Policy Rules to be activated at the RCEF. |
| Subscriber-ID (optional, see notes 8 and 9) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 8 and 9) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 10). |
| Physical Access ID (optional, see notes 9 and 11) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (optional, see notes 9 and 11) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (optional, see note 9) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (optional, see note 9) | The identifier of a traffic class to be associated with a policy rule. |

NOTE 1: One or several Information Elements of this type may be present in the message.
NOTE 2: If modification and/or installation of new Policy Rules are sought, there must be at least one Information Element of this type present in the message.
NOTE 3: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included.
NOTE 4: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.
NOTE 5: An IP address prefix is supported.
NOTE 6: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.
NOTE 7: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS.
NOTE 8: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.
NOTE 9: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.
NOTE 10: It makes the assigned IP address unique, for example it can be a VPN-id.
NOTE 11: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them.

6.3.7.3.1.3 Policy Query Request

The Policy Query Request message is used by the x-RACF to query the RCEF for the supported list of Policy Rules, or for the list of Policy Rules currently associated with a given Transport Resource, or for the details associated with particular Policy Rule(s). The Policy Query Request message contains the following information elements.

**Table 23: Policy Query Request - Information Elements**

| Policy Query Request (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Subscriber-ID (conditional, see notes 1, 2, 3, 4 and 5) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (conditional, see notes 1, 2, 3, 4 and 5) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 6). |
| Physical Access ID (conditional, see notes 2, 3, 4, 5 and 7) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (conditional, see note 2, 3, 4, 5 and 7) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (conditional, see notes 2, 3, 4 and 5) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (conditional, see notes 2, 3, 4 and 5) | The identifier of a traffic class to be associated with a policy rule. |
| Policy Rule ID (conditional, see notes 3, 4 and 5) | The identifier of a Policy Rule, which details the x-RACF requests to be supplied by the RCEF. |
| Policy Rule Group ID (conditional, see notes 3, 4 and 5) | The identifier of a set of Policy Rules, which details the x-RACF requests to be supplied by the RCEF. |
| NOTE 1: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | |
| NOTE 2: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers. | |
| NOTE 3: In order to query the RCEF for the list of Policy Rules supported by the RCEF, the x-RACF shall not include any Transport Resource Classifier, and shall not include any Policy Rule. | |
| NOTE 4: In order to query the RCEF for the list of Policy Rules currently associated with a given Transport Resource, the x-RACF shall include the Transport Resource Classifier, and shall not include any Policy Rule. | |
| NOTE 5: In order to query the RCEF for the details about particular Policy Rule(s), the x-RACF shall include the Transport Resource Classifier and the Policy Rule(s) for which details are requested. | |
| NOTE 6: It makes the assigned IP address unique, for example it can be a VPN-id. | |
| NOTE 7: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them. | |

#### 6.3.7.3.1.4 Policy Enforcement Installation/Modification Confirmation

The Policy Enforcement Installation/Modification Confirmation message is used by the RCEF in response to a Policy Enforcement Install Request, or in response to a Policy Enforcement Modification Request message previously sent by the x-RACF. The Policy Enforcement Installation/Modification Confirmation message contains the following information elements.

**Table 24: Policy Enforcement Installation/Modification Confirmation - Information Elements**

| Policy Enforcement Installation/Modification Confirmation (RCEF -> x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Result (conditional, see notes 1 and 2) | The result according to the type of the request. |
| NOTE 1: This Information Element is not generated by the RCEF in response to a policy removal request performed in Policy Enforcement Modification Request message.<br>NOTE 2: This Information Element is always generated and returned in the remaining cases, i.e. in response to Policy Enforcement Installation Request messages, or in response to Policy Enforcement Modification Request messages sent by the x-RACF to activate a pre-defined, but not yet activated, Policy Rule; or to install and activate a new Policy Rule; or to modify Policy Rule(s) previously installed and activated; or to deactivate Policy Rule(s). | |

#### 6.3.7.3.1.5 Policy Query Confirmation

The Policy Query Confirmation message is used by the RCEF in response to a Policy Query Request message previously sent by the x-RACF. The Policy Query Confirmation message contains the following information elements.

**Table 25: Policy Query Confirmation - Information Elements**

| Policy Query Confirmation (RCEF -> x-RACF) | | |
|---|---|---|
| Request Originating Function Identifier | | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Definition (conditional, see notes 1, 2 and 3) | | The Policy Rule definition corresponding to the requested policy or set of policies by the x-RACF. |
| | Policy Rule ID | The identifier of a Policy Rule to be reported by the RCEF. |
| | Direction (see note 4) | Direction of the flow. |
| | Flow Id | Identifier for the specific flow. |
| | Flow control (see note 4) | Enables or disables the opening of a gate to a particular flow. |
| | IP Addresses (see note 4) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 5). |
| | Ports (see note 4) | Source and Destination Port Numbers (see note 6). |
| | Protocol (see note 4) | Protocol Id. |
| | Bandwidth (optional, see note 4) | The maximum request bit rate. |
| | Reservation Class (optional, see note 4) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| | Transport Service Class (optional, see note 4) | Identifies the forwarding behaviour to be applied to the particular flow (see note 7). |
| | Precedence | Indicates the precedence that a Policy Rule takes when related to others. |
| | Report Type | Indicates the type of reporting that the RCEF provides to the x-RACF. |
| Policy Rule ID (conditional, see notes 2, 8 and 9) | | The identifier of a Policy Rule, which details the x-RACF requests to be supplied by the RCEF. |
| Policy Rule Group ID (conditional, see notes 2, 8 and 9) | | The identifier of a set of Policy Rules, which details the x-RACF requests to be supplied by the RCEF. |
| Result | | The result according to the type of the request. |

| Policy Query Confirmation (RCEF -> x-RACF) |
|---|
| NOTE 1: If Transport Resource Classifier(s) has(have) been specified, and Policy Rule IDs or Policy Rule Group IDs have been included in the Policy Query Request message, and as long as the former(s) is (are) associated with the latter(s) each Policy Rule defined by this Information Element, which corresponds to each Policy Rule ID or to each Policy Rule Group ID, is returned. |
| NOTE 2: There may be one or several Information Element of this type present in the message. |
| NOTE 3: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included. |
| NOTE 4: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows. |
| NOTE 5: An IP address prefix is supported. |
| NOTE 6: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard. |
| NOTE 7: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS. |
| NOTE 8: If Transport Resource Classifier(s), but no Policy Rule IDs or Policy Rule Group IDs was (were) specified in the received Policy Query Request message, the set of Policy Rule Name(s) and Policy Rule Group Name(s) Information Element(s) currently activated for the corresponding Transport Resource Classifier(s) is (are) returned. |
| NOTE 9: If no Transport Resource Classifier(s), and no Policy Rule IDs was (were) specified in the received Policy Query Request message, the set of Policy Rule Name(s) and Policy Rule Group Name(s) Information Element(s) known by the RCEF is (are) returned. |

#### 6.3.7.3.1.6 Policy Enforcement Release Request

The Policy Enforcement Release Request message is used by the x-RACF to deactivate and remove all Policy Rule(s) previously activated on a given Transport Resource. The Policy Enforcement Release Request message contains the following information elements.

**Table 26: Policy Enforcement Release Request - Information Elements**

| Policy Enforcement Release Request (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Subscriber-ID (optional, see notes 1 and 2) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 1 and 2) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 3). |
| Physical Access ID (optional, see notes 2 and 4) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (optional, see notes 2 and 4) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (optional, see note 2) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (optional, see note 2) | The identifier of a traffic class to be associated with a policy rule. |

| Policy Enforcement Release Request (x-RACF -> RCEF) | |
|---|---|
| Policy Rule ID (optional, see note 5) | The identifier of a pre-defined Policy Rule to be deactivated at the RCEF. |
| Policy Rule Group ID (optional, see note 6) | The identifier of a set of pre-defined Policy Rules to be deactivated at the RCEF. |
| NOTE 1: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 2: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.<br>NOTE 3: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 4: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them.<br>NOTE 5: In the case of pre-defined Policy Rules on the RCEF (e.g. identified by the Policy Rule ID Information Element), the x-RACF is only authorized to perform its deactivation.<br>NOTE 6: In the case of a set of pre-defined Policy Rules on the RCEF (e.g. identified by the Policy Rule Group ID Information Element), the x-RACF is only authorized to perform its deactivation. | |

#### 6.3.7.3.2 Information exchanged by using the pull mode

##### 6.3.7.3.2.1 Policy Decision Install Request

The Policy Decision Install Request message is used by the RCEF to activate one or several traffic policies not previously defined, or to activate a pre-defined traffic policy, or to activate a set of pre-defined traffic policies. The Policy Decision Install Request message contains the following information elements.

**Table 27: Policy Decision Install Request - Information Elements**

| Policy Decision Install Request (RCEF -> x-RACF) | | |
|---|---|---|
| Request Originating Function Identifier | | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Traffic Descriptor | | This Information Element identifies and describes the flow. |
| | Direction (see note 1) | Direction of the flow. |
| | Flow Id | Identifier for the specific flow. |
| | Flow control (see note 1) | Enables or disables the opening of a gate to a particular flow. |
| | IP Addresses (see note 1) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 2). |
| | Ports (see note 1) | Source and Destination Port Numbers (see note 3). |
| | Protocol (see note 1) | Protocol Id. |
| Subscriber-ID (conditional, see notes 4 and 5) | | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (conditional, see notes 4 and 5) | | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| | Assigned IP Address | The IP address of the attached user. |
| | Address Realm | The addressing domain in which the IP address is significant (see note 6). |

| Policy Decision Install Request (RCEF -> x-RACF) | |
|---|---|
| Physical Access ID (conditional, see notes 5 and 7) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (conditional, see notes 5 and 7) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (conditional, see note 5) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (conditional, see note 5) | The identifier of a traffic class to be associated with a policy rule. |
| NOTE 1: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.<br>NOTE 2: An IP address prefix is supported.<br>NOTE 3: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.<br>NOTE 4: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 5: In order to identify the Transport Resources to which the Policy Rule applies, the RCEF shall include at least one of these Transport Resource Classifiers.<br>NOTE 6: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 7: The x-RACF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them. | |

#### 6.3.7.3.2.2 Policy Decision Modification Request

The Policy Decision Modification Request message is used by the RCEF to request the modification of traffic policies previously activated. During the modification procedure, and upon decision of the x-RACF, a traffic policy previously activated may be modified or deactivated, or a new one may be installed and activated. The Policy Decision Modification Request message contains the following information elements.

**Table 28: Policy Decision Modification Request - Information Elements**

| Policy Decision Modification Request (RCEF -> x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Modification (optional, see note 1) | The Policy Rule description, which is used to indicate which previously activated Policy Rule should be modified or deactivated, or which new one should be installed and activated. |
| Policy Rule Definition (see notes 2 and 3) | The Policy Rule definition. |

| Policy Decision Modification Request (RCEF -> x-RACF) | |
|---|---|
| Policy Rule ID | The Policy Rule description, which is used to modify or deactivate a previously activated Policy Rule, or to install and activate a new one. |
| Direction (see note 4) | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| Flow control (see note 4) | Enables or disables the opening of a gate to a particular flow. |
| IP Addresses (see note 4) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 5). |
| Ports (see note 4) | Source and Destination Port Numbers (see note 6). |
| Protocol (see note 4) | Protocol Id. |
| Bandwidth (optional, see note 4) | The maximum request bit rate. |
| Reservation Class (optional, see note 4) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional, see note 4) | Identifies the forwarding behaviour to be applied to the particular flow (see note 7). |
| Precedence | Indicates the precedence that a Policy Rule should take when related to others. |
| Report Type | Indicates the type of reporting that the RCEF is supposed to provide to the x-RACF. |
| Policy Rule ID (optional) | The identifier of a pre-defined Policy Rule in the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of pre-defined Policy Rules in the RCEF. |
| Subscriber-ID (optional, see notes 8 and 9) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 8 and 9) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 10). |
| Physical Access ID (optional, see notes 9 and 11) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (optional, see notes 9 and 11) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (optional, see note 9) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (optional, see note 9) | The identifier of a traffic class to be associated with a policy rule. |

NOTE 1: One or several Information Elements of this type may be present in the message.
NOTE 2: If modification and/or installation of new Policy Rules are sought, there must be at least one Information Element of this type present in the message.
NOTE 3: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included.
NOTE 4: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.
NOTE 5: An IP address prefix is supported.
NOTE 6: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.
NOTE 7: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS.
NOTE 8: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.
NOTE 9: In order to identify the Transport Resources to which the Policy Rule applies, the RCEF shall include at least one of these Transport Resource Classifiers.
NOTE 10: It makes the assigned IP address unique, for example it can be a VPN-id.
NOTE 11: The x-RACF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them.

#### 6.3.7.3.2.3 Policy Decision Deactivation Request

The Policy Decision Deactivation Request message is used by the RCEF to deactivate all traffic policies previously activated. The Policy Decision Deactivation Request message contains the following information elements.

**Table 29: Policy Decision Deactivation Request - Information Elements**

| Policy Decision Deactivation Request (RCEF -> x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Subscriber-ID (conditional, see notes 1 and 2) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (conditional, see notes 1 and 2) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 3). |
| Physical Access ID (conditional, see notes 2 and 4) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (conditional, see notes 2 and 4) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (conditional, see note 2) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (conditional, see note 2) | The identifier of a traffic class to be associated with a policy rule. |
| NOTE 1: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 2: In order to identify the Transport Resources to which the Policy Rule applies, the RCEF shall include at least one of these Transport Resource Classifiers.<br>NOTE 3: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 4: The x-RACF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them. | |

#### 6.3.7.3.2.4 Policy Decision Install Response

The Policy Decision Install Response message is used by the x-RACF, upon a reception of an explicit request from the RCEF, to activate one or several Policy Rules, or to install and activate one or several Policy Rules. The Policy Decision Install Response message contains the following information elements.

**Table 30: Policy Decision Install Response - Information Elements**

| Policy Decision Install Response (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Installation (see note 1) | The Policy Rule description, which is used to activate and install a new Policy Rule as instructed from the x-RACF to the RCEF. |
| Policy Rule Definition (see note 2) | The Policy Rule definition. |

| Policy Decision Install Response (x-RACF -> RCEF) | |
|---|---|
| Policy Rule ID | The identifier of a new Policy Rule to be activated at the RCEF. |
| Direction (see note 3) | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| Flow control (see note 3) | Enables or disables the opening of a gate to a particular flow. |
| IP Addresses (see note 3) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 4). |
| Ports (see note 3) | Source and Destination Port Numbers (see note 5). |
| Protocol (see note 3) | Protocol Id. |
| Bandwidth (optional, see note 3) | The maximum request bit rate. |
| Reservation Class (optional, see note 3) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional, see note 3) | Identifies the forwarding behaviour to be applied to the particular flow (see note 6). |
| Precedence | Indicates the precedence that a Policy Rule should take when related to others. |
| Report Type | Indicates the type of reporting that the RCEF is supposed to provide to the x-RACF. |
| Policy Rule ID | The identifier of a pre-defined Policy Rule to be activated at the RCEF. |
| Policy Rule Group ID | The identifier of a set of pre-defined Policy Rules to be activated at the RCEF. |
| Subscriber-ID (optional, see notes 7 and 8) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 7 and 8) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 9). |
| Physical Access ID (conditional, see notes 8 and 10) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (conditional, see notes 8 and 10) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (conditional, see note 8) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (conditional, see note 8) | The identifier of a traffic class to be associated with a policy rule. |

NOTE 1: There must be at least one Information Element of this type present in the message.
NOTE 2: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included.
NOTE 3: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.
NOTE 4: An IP address prefix is supported.
NOTE 5: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.
NOTE 6: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS.
NOTE 7: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.
NOTE 8: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.
NOTE 9: It makes the assigned IP address unique, for example it can be a VPN-id.
NOTE 10: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them.

#### 6.3.7.3.2.5 Policy Decision Modification Response

The Policy Decision Modification Response message is used by the x-RACF, upon a reception of an explicit request from the RCEF, to modify traffic policies previously activated, or to install and activate new ones. During the modification procedure, and upon decision of the x-RACF, a traffic policy previously activated may be modified or deactivated, or a new one may be installed and activated. The Policy Decision Modification Response message contains the following information elements.

**Table 31: Policy Decision Modification Response - Information Elements**

| Policy Decision Modification Response (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Removal (optional, see note 1) | This Information Element s used to remove Policy Rules. |
| Policy Rule ID | The identifier of the Policy Rule to be removed at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of Policy Rules to be removed at the RCEF. |
| Policy Rule Modification (optional, see note 1) | The Policy Rule description, which is used to modify or deactivate a previously activated Policy Rule, or to install and activate a new one. |
| Policy Rule Definition (see notes 2 and 3) | The Policy Rule definition. |
| Policy Rule ID | The identifier of a Policy Rule to be activated at the RCEF. |
| Direction (see note 4) | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| Flow control (see note 4) | Enables or disables the opening of a gate to a particular flow. |
| IP Addresses (see note 4) | Source and Destination IP addresses and Address Realm that each address belongs to (see note 5). |
| Ports (see note 4) | Source and Destination Port Numbers (see note 6). |
| Protocol (see note 4) | Protocol Id. |
| Bandwidth (optional, see note 4) | The maximum request bit rate. |
| Reservation Class (optional, see note 4) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional, see note 4) | Identifies the forwarding behaviour to be applied to the particular flow (see note 7). |
| Precedence | Indicates the precedence that a Policy Rule should take when related to others. |
| Report Type | Indicates the type of reporting that the RCEF is supposed to provide to the x-RACF. |
| Policy Rule ID (optional) | The identifier of a pre-defined Policy Rule to be activated at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of pre-defined Policy Rules to be activated at the RCEF. |
| Subscriber-ID (optional, see notes 8 and 9) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 8 and 9) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 10). |

| Policy Decision Modification Response (x-RACF -> RCEF) | |
|---|---|
| Physical Access ID (optional, see notes 9 and 11) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (optional, see notes 9 and 11) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (optional, see note 9) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (optional, see note 9) | The identifier of a traffic class to be associated with a policy rule. |
| NOTE 1: One or several Information Elements of this type may be present in the message.<br>NOTE 2: If modification and/or installation of new Policy Rules are sought, there must be at least one Information Element of this type present in the message.<br>NOTE 3: If Policy Rules for each direction need to be specified, several Policy Rule definitions must be included.<br>NOTE 4: These Information Elements describe the flow. Zero, one or several of them may be included in the Policy Rule definition, in order to associate a given Policy Rule with IP Flows.<br>NOTE 5: An IP address prefix is supported.<br>NOTE 6: Port ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.<br>NOTE 7: In the case of A-RACF, Transport Service Class is also part of QoS profile provided by NASS.<br>NOTE 8: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 9: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.<br>NOTE 10: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 11: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them. | |

#### 6.3.7.3.2.6 Policy Decision Deactivation Response

The Policy Decision Deactivation Response message is used by the x-RACF, upon a reception of an explicit request from the RCEF, to communicate the decision about which traffic policies should be deactivated. The Policy Decision Deactivation Response message contains the following information elements.

**Table 32: Policy Decision Deactivation Response - Information Elements**

| Policy Decision Deactivation Response (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Policy Rule Removal (optional, see note 1) | This Information Element s used to remove Policy Rules. |
| Policy Rule ID | The identifier of the Policy Rule to be removed at the RCEF. |
| Policy Rule Group ID (optional) | The identifier of a set of Policy Rules to be removed at the RCEF. |
| Subscriber-ID (optional, see notes 2 and 3) | It identifies the subscriber attached to the access network. |
| Globally Unique IP Address (optional, see notes 2 and 3) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address of the attached user. |
| Address Realm | The addressing domain in which the IP address is significant (see note 4). |

| Policy Decision Deactivation Response (x-RACF -> RCEF) | |
|---|---|
| Physical Access ID (optional, see notes 3 and 5) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (optional, see notes 3 and 5) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Called Station ID (optional, see note 3) | Identifies the layer 2 address of the Transport Resource on the RCEF. For use with IEEE 802 type access, the Called-Station-Id may contain a MAC address. |
| Traffic Class ID (optional, see note 3) | The identifier of a traffic class to be associated with a policy rule. |
| Policy Rule ID (optional, see note 6) | The identifier of a pre-defined Policy Rule to be deactivated at the RCEF. |
| Policy Rule Group ID (optional, see note 7) | The identifier of a set of pre-defined Policy Rules to be deactivated at the RCEF. |
| NOTE 1: One or several Information Elements of this type may be present in the message.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 3: In order to identify the Transport Resources to which the Policy Rule applies, the x-RACF shall include at least one of these Transport Resource Classifiers.<br>NOTE 4: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 5: The RCEF should be able to identify the bearer resources according to the Logical Access ID, or to the Physical Access ID, or to a combination of them.<br>NOTE 6: In the case of pre-defined Policy Rules on the RCEF (e.g. identified by the Policy Rule ID Information Element), the x-RACF is only authorized to perform its deactivation.<br>NOTE 7: In the case of a set of pre-defined Policy Rules on the RCEF (e.g. identified by the Policy Rule Group ID Information Element), the x-RACF is only authorized to perform its deactivation. | |

#### 6.3.7.3.3 Information exchanged by using both QoS mechanisms

This clause specifies the messages that should be explicitly used for subscription of events and corresponding events notification purposes.

In addition, these procedures may also be implicitly accomplished by including the related Information Elements, i.e. Trigger Event, Timestamp, and Policy Rule Report, in relevant messages associated with both the push and pull mechanisms, which were specified in former clauses.

##### 6.3.7.3.3.1 Event Subscription Request

The Event Subscription Request message is used when the x-RACF explicitly requests to be notified upon the occurrence of a particular event. The Event Subscription Request message contains the following information elements.

**Table 33: Event Subscription Request - Information Elements**

| Event Subscription Request (x-RACF -> RCEF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Trigger Event (see note 1) | This Information Element indicates that the x-RACF requests to be notified upon occurrence of certain events. |
| NOTE 1: By using this Information Element, the x-RACF may request to be notified of certain events (e.g. bearer failure/recovery, need for resource re-evaluation). | |

#### 6.3.7.3.3.2 Event Notification Indication

The Event Notification Indication message is used by the RCEF to notify the occurrence of particular events. The Event Notification Indication message contains the following information elements.

**Table 34: Event Notification Indication - Information Elements**

| Event Notification Indication (RCEF -> x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Trigger Event | This Information Element indicates that a certain event has occurred on the RCEF. |
| Timestamp | This Information Element indicates the moment the event occurred (in seconds since January 1, 1900, 00:00 UTC). |
| Policy Rule Report | The report containing the details of the occurrence. |
| Policy Rule ID (optional, see note 1) | The identifier of a specific Policy Rules where a certain event has occurred. |
| Policy Rule Group ID (optional, see note 1) | The identifier of a set specific Policy Rules where a certain event has occurred. |
| Policy Rule Status (see note 2) | This Information Element describes the status of one or a group of Policy Rules. |
| NOTE 1: The RCEF shall include at least one Information Element of this type order to indicate which Policy(ies) Rule(s) is(are) impacted by the corresponding Event(s). | |
| NOTE 2: This Information Element describes the type of occurrence (e.g. a certain Policy Rule(s) or a set of Policy Rule(s) have been successfully installed (for those provisioned from the x-RACF) or activated (for those pre-provisioned in RCEF); or have been removed (for those provisioned from x-RACF) or have become inactive; or, for some reason (e.g. loss of bearer), already installed or activated Policy Rule(s) is (are) temporarily disabled. | |

## 6.3.8 Rr Reference Point (x-RACF - x-RACF intra-domain)

### 6.3.8.1 Functional Requirements

The Rr reference point is used for QoS resource reservation between x-RACF instances of RACS within a single administrative domain. The Rr reference point allows one x-RACF to delegate resource admission responsibility of performing admission control to another x-RACF.

#### 6.3.8.1.1 Overall features

The following overall features shall be supported by the Rr reference point:

- resource admission control shall be applicable for unicast service, multicast service, or both;
- modification of an existing reservation shall be possible, e.g. increase or decrease of a bulk reservation.

##### 6.3.8.1.1.1 Types of request

The following types of request levels shall be supported by the Rr reference point:

- **per-request level**, which is coupled to reservation requests arriving over Rq or Re, i.e. by using the QoS push mode or the QoS pull mode, and is only applicable to the unicast service, NOT to the multicast service;
- **bulk request level**, which is decoupled and independent from reservation requests arriving over Rq or Re although they may result from their processing.

#### 6.3.8.1.1.2 Delegation Models

The RACS may operate according to a model where admission decisions require coordination with another x-RACF functional entity. The following delegation models shall be supported by the Rr reference point:

- request model, where one x-RACF instance solicits the admission decision and resource reservation (e.g. initial reservation, modification, release) from another x-RACF instance that is also responsible for the admission control of those resources within that network segment. The request model can only operate with the per-request level, and does not require an explicit pre-delegation process of responsibilities;

- delegated model, where one x-RACF instance explicitly delegates responsibility for a bulk of resources to another x-RACF instance, which thereby becomes responsible for the admission control for those resources without the need to further involve the other instance. The communication between these two x-RACF instances occur when:

    1) one of the x-RACF instances, responsible for the admission decision for a bulk of resources, decides to delegate the responsibility for some of these resources to the other x-RACF;

    2) one of the x-RACF instances decides to increase or decrease the amount of delegated bulk resources based on the network policy and resource utilization, in which case it sends a request to the other x-RACF for resource availability checking and synchronization purpose, and where the originating instance may either be a top-tier or a lower-tier x-RACF.

While in the request model there is no need for an explicit delegation procedure, the delegated model requires pre-agreement of admission responsibility referred to as pre-delegation process, i.e. initialization and configuration of the amount of bulk resources each instance is responsible for. The pre-delegation process may be accomplished through the exchange of Rr messages between two x-RACF instances as described in case 1) above, where the originating instance may either be a top-tier or a lower-tier x-RACF as well. The pre-delegation process may also be accomplished through static provisioning, in which case is outside the scope of the present document.

Moreover, when the pre-delegation process is performed using Rr messages, delegation instructions shall include admission decision criteria derived from the applicable subset of the user access profile (e.g. Reservation Class) and/or applicable access network policies. The admission decision criteria specify the parameters used to decide if a particular reservation request can be accepted.

### 6.3.8.1.2 Resource management mechanisms

The Rr Reference Point shall support the following resource management schemes:

- Delegation and interaction of resource admission control and reservation between x-RACF instances.

- Support for all the scenarios defined in RACS functional architecture:

    - QoS request initiated by Application Function;

    - QoS request initiated by CPN through the application layer signalling with QoS negotiation extensions;

    - QoS Request initiated by Transport Processing Functions.

- The Rr reference point shall support subsequent resource management models in support of these requirements:

    - Single-stage resource management model, providing resource management services in a mode where reserved resources are immediately available upon successful reservation.

    - Two-stage reserve-commit resource management model that can be leveraged in support of services that aim to support charging per service-invocation, and require as such service-theft-prevention solutions.

    - Authorize-reserve-commit resource management model, supporting service-based local policy control under coordination of a network-hosted application function.

#### 6.3.8.1.3 Service model

The services provided for each of the resource reservation models shall offer the following capabilities:

- The service model shall allow resource reservation for one or several media flows. The media flows may be part of an application session that can involve multiple media flows. A media flow may be uni-directional or bi-directional (combining in effect two uni-directional flows).
- The resource management model established through the Rr reference point shall support collective reservation, release, and modification of resource requirements for a group of media flows. This group of media flows may for example be associated with an application session.
- A resource requirement budget can be established for each individual service flow.
- Mid-session modification of previously established resource reservations shall be supported for individual service sessions, i.e. the following mechanisms must be supported:
  - Modification (increase or reduction) of resource requirements reserved on behalf of selected individual media flows.
  - Release of resources previously reserved on behalf of a selected individual media flows.
  - Creation of new resource reservation on behalf of new individual media flows that are added to the service session.

#### 6.3.8.1.4 Duration semantics

In terms of duration semantics, the resource management model supported by the Rr reference point shall support both soft-state and hard-state resource management approaches along with the following functions:

- For both approaches the Rr Reference Point shall support facilities for explicit removal of previously established resource reservation.
- For both approaches the Rr Reference Point shall support facilities for explicit modification of previously established resource reservation.
- The same granularity levels than those described in clause 6.3.8.1.2 shall be available for the soft-state and hard-state approaches.
- Resource Modification Request primitive must be capable of carrying information needed to create reservation states. This means that it must be possible to include all parameters of the Reservation Request in the Modification Request. The x-RACF can rely on states kept in AF to support seamless fail over instead of replicating soft state reservations.

#### 6.3.8.1.5 Audit and Synchronization support

For the request model of the Rr reference point, Audit and Synchronization mechanisms on the Rr Reference Point shall be aligned with those offered on the Rq Reference Point.

For the delegated model of the Rr reference point, Audit and Synchronization mechanisms are supported as follows.

In case the delegating x-RACF detects there is a possibility for the delegating x-RACF and the delegated x-RACF to hold inconsistent information of the delegated resources (e.g. the amount of the delegated resources), the delegating x-RACF sends a Resource Delegation Push message to the delegated x-RACF. If the delegated x-RACF cannot find the relevant information of delegated resources in its storage with the same identifier of the delegated resources provided by the Resource Delegation Push message, the delegated x-RACF shall treat the information of delegated resources in this message as newly provisioned and shall update the stored information accordingly. Otherwise, the delegated x-RACF shall update the information of the delegated resources according to the message. The delegated x-RACF then sends a Resource Delegation Push Response message to the delegating x-RACF.

In case the delegated x-RACF detects there is a possibility for the delegating x-RACF and the delegated x-RACF to hold inconsistent information of the delegated resources (e.g. the amount of the delegated resources), the delegated x-RACF sends a Resource Delegation Query message to the delegating x-RACF. The delegating x-RACF then sends to the delegated x-RACF a Resource Delegation Query Response message with the queried information. In case the delegating x-RACF cannot find the relevant information of the delegated resources in its storage with the same identifier provided by the Resource Delegation Query message or is not delegating the resources to the delegated x-RACF, the delegating x-RACF shall set the amount of delegated resources to zero. The delegated x-RACF shall update the information of the delegated resources in its storage according to the Resource Delegation Query Response message. In case the amount of delegated resources is zero, the delegated x-RACF shall remove the relevant information of the delegated resources.

#### 6.3.8.1.6 Report facilities for unsolicited events

The Rr Reference Point shall support facilities for indicating relevant events such as revocation of established resource reservations.

### 6.3.8.2 Non-Functional Requirements

#### 6.3.8.2.1 Reliability requirements

The Rr reference point shall provide mechanisms to ensure reliability of all communication performed over the Reference Point.

#### 6.3.8.2.2 Security requirements

The security requirements for RACS are described in TS 187 001 [14].

### 6.3.8.3 Information exchanged over the Rr Reference Point

#### 6.3.8.3.1 Information exchanged over the Rr Reference Point for request model

##### 6.3.8.3.1.1 Resource Reservation Request

The Resource Reservation Request message is used to request resources and is sent from one x-RACF (e.g. in a central location) to another x-RACF (e.g. in AN). The originating x-RACF can obtain the location information of another x-RACF based on configuration or derive it from the resource mapping. This message is intended for the support of the request model. The Resource Request contains the following information elements.

**Table 35: Resource Reservation Request - Information Elements**

| Resource Request (Originating x-RACF -> Terminating x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating Function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Subscriber-ID (Optional) | It identifies the subscriber attached to the access network (see note 1). |
| Globally Unique IP Address (Optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network (see note 1). |
| Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| Address Realm | The addressing domain in which the IP address is significant (see note 2). |
| Requestor Name (Optional) | Identifies the RACS client requesting the resources (e.g. name of an ASP or group of ASPs). In the case of A-RACF, this name corresponds to the Requestor Name in a QoS profile provided by NASS. |
| Service Class (Optional) | Service class requested by the RACS client. |
| Service Priority (optional) | The priority associated to the service request that defines the handling precedence by the receiving entity. |
| Charging Correlation Information (CCI) (optional) | Globally unique identifier for charging correlation purposes. |
| Duration of Reservation (Optional) | Duration of the reservation requested by the client. |

| Resource Request (Originating x-RACF -> Terminating x-RACF) | |
|---|---|
| Physical Access ID (Optional) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Media Description (Conditional, see note 6) | The media description. |
| Media Type | The pre-defined type of the media for each flow (e.g. Video). |
| Media Id | Identifier for the specific media. |
| Media Priority (Optional) | The priority associated to the media to be used in the admission control process in terminating x-RACF. |
| Traffic Flow Parameters | The traffic flow description of the media. |
| Direction | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| IP Addresses | Source and Destination IP addresses (Ipv4, Ipv6) and Address Realm that each address belongs to (see note 3). |
| Ports | Source and Destination Port Numbers (see note 4). |
| Protocol | Protocol Id (e.g. UDP, TCP). |
| Bandwidth | The maximum request bit rate. |
| Reservation Class (Optional) (see note 5) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (Optional) (see note 5) | A particular index that Identifies the forwarding behaviour to be applied to the particular flow. |
| Commit Id (Optional) | Identify if request is to be committed. |
| Overbooking request indicator (Optional, see note 6) | Indicates that the terminating x-RACF may process the reservation request in overbooking mode. |
| NOTE 1: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 2: It makes the assigned IP address unique, for example it can be a VPN-id.<br>NOTE 3: An IP address prefix is supported.<br>NOTE 4: Port Ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard.<br>NOTE 5: In the case of A-RACF, transport Service Class is also part of QoS profile provided by NASS.<br>NOTE 6: The Overbooking Request Indicator is only applicable to per flow request as optional parameter. | |

#### 6.3.8.3.1.2 Resource Modification Request

The Resource Modification Request message is used to modify current resource allocation from originating x-RACF to terminating x-RACF. This message is intended for the support of the request model. The Resource Modification Request message contains the following information elements.

**Table 36: Resource Modification Request - Information Elements**

| Resource Modification Request (Originating x-RACF -> Terminating x-RACF) (see note 1) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier (see note 2). |
| Requestor Name (Optional) | Identifies the RACS client requesting the resources (e.g. name of an ASP or group of ASPs). In the case of A-RACF, this name corresponds to the Requestor Name in a QoS profile provided by NASS. |
| Service Class (Optional) | Service class requested by the RACS client. |
| Charging Correlation Information (optional) | Globally unique identifier for charging correlation purposes. |
| Service Priority (Optional) | The priority associated to a service request that defines the handling precedence by the receiving entity. |
| Duration of Reservation (Optional) | Duration of the reservation requested by the client. |
| Physical Access ID (Optional) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of the port, VP and/or VC carrying the traffic. |

| Resource Modification Request (Originating x-RACF -> Terminating x-RACF) (see note 1) | |
|---|---|
| Media Description (Conditional) | The media description. |
| Media Type | The pre-defined type of the media for each flow (e.g. Video). |
| Media Id | Identifier for the specific media. |
| Media Priority (optional) | The priority associated to the media to be used in the admission control process in terminating x-RACF. |
| Traffic Flow Parameters | The traffic flow description of the media. |
| Direction | Direction of the flow. |
| Flow Id | Identifier for the specific flow. |
| IP Addresses | Source and Destination IP addresses (Ipv4, Ipv6) and Address Realm that each address belongs to (see note 3) |
| Ports | Source and Destination Port Numbers (see note 4). |
| Protocol | Protocol Id (e.g. UDP, TCP). |
| Bandwidth | The maximum request bit rate. |
| Reservation Class (Optional) | A particular index that identifies a set of traffic characteristics of the flow (e.g. burstiness and packet size). |
| Transport Service Class (optional) | A particular index that Identifies the forwarding behaviour to be applied to the particular flow. |
| Commit Id | Identify if request is to be committed. |
| NOTE 1: Only the Bandwidth inside the Traffic Flow Parameter element can be modified.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis.<br>NOTE 3: An IP address prefix is supported.<br>NOTE 4: Port Ranges are supported and can be defined by specifying the minimum and maximum value or by using a wildcard. | |

#### 6.3.8.3.1.3 Resource Request/Modification Confirmation

The Resource Reservation Confirmation message is used to acknowledge the resource reservation or modification. In case the request cannot be fulfilled, the appropriate cause is returned to the originating x-RACF. In case of an unsuccessful modification, the terminating x-RACF also informs if the previous reservation was kept. The Resource Req/Modification Confirmation message contains the following information elements.

**Table 37: Resource Confirmation - Information Elements**

| Resource Req/Modification Confirmation (Terminating x-RACF -> Originating x-RACF) (see note) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating function instance. |
| Resource Reservation Session ID | The reference is a unique resource reservation session identifier in the scope of the Request Originating Function Identifier. |
| Duration of Reservation Granted (optional) | Duration of the reservation granted by terminating x-RACF. |
| Overbooking confirmation indicator (optional) | Indicates that the terminating x-RACF may process the resource request in overbooking mode. |
| Result | The result of the request. |
| NOTE: The optional parameters are not present in case of an unsuccessful result. | |

#### 6.3.8.3.1.4 Resource Release Request

The Resource Reservation Release message is used by the Originating x-RACF to relinquish the resource reservation in Terminating x-RACF. A parameter indicates if acknowledgement is expected by the Originating x-RACF from the Terminating x-RACF. The Resource Release Request message contains the following information elements.

**Table 38: Resource Release - Information Elements**

| Resource Release Request (Originating x-RACF-> Terminating x-RACF) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating function instance. |
| Resource Reservation Session ID (see note) | The reference is a unique session identifier in the scope of the Request Originating Function Identifier (see note). |
| NOTE: The presence of a wildcard in the session part of the reference indicates that all resources identified associated to the Request Originating Function Identifier shall be released, otherwise only the specific session is released (it implies all media in the session). | |

#### 6.3.8.3.1.5 Abort Resource Reservation

The abort reservation message is used by the terminating x-RACF to indicate to the Originating x-RACF that the resource previously reserved is lost. The message may transport an indication for more than one reservation. The Abort Reservation message contains the following information elements.

**Table 39: Abort Reservation - Information Elements**

| Abort Reservation (Terminating x-RACF -> Originating x-RACF) (see note) | |
|---|---|
| Request Originating Function Identifier | Global unique Identifier for the Request Originating function instance. |
| Resource Reservation Session ID | The reference is a unique Resource Reservation session identifier in the scope of the Request Originating Function Identifier (see note). |
| Time Stamp | The time when the resources were lost. |
| Cause | The cause that lead to the lost of the reservation. |
| NOTE: A single message shall be able to carry multiples blocks. | |

### 6.3.8.3.2 Information exchanged over the Rr Reference Point for delegated model

#### 6.3.8.3.2.1 Resource Delegation Request

The Resource Delegation Request message is used to request resource and is sent from the delegated x-RACF to the delegating x-RACF. This message is only applicable for the delegated model of the Rr reference point. The Resource Delegation Request contains the following information elements.

**Table 40: Resource Delegation Request - Information Elements**

| Resource Delegation Request (Delegated x-RACF -> Delegating x-RACF) | |
|---|---|
| Delegated x-RACF Identifier | Global unique Identifier for the Delegated x-RACF instance. |
| Session ID | The reference is a unique session identifier in the scope of the Delegated x-RACF Identifier. |
| Direction of the bulk reservation (Optional) | Direction of the requested bulk of resources. |
| Physical Access ID (Optional, see note 1) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional, see note 1) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Physical Aggregation ID (Optional, see note 1) | The identifier of the physical resource in the aggregation network to which the bulk resource is processed. |
| Logical Aggregation ID (Optional, see note 1) | The identifier of the logical resource in the aggregation network to which the bulk reservation is processed. |
| Bandwidth | The requested data rate for delegation. It can be larger or smaller than the data rate previously delegated. |
| Subscriber-ID (Optional) | It identifies the subscriber attached to the access network (see note 2). |
| Globally Unique IP Address (Optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| Address Realm | The addressing domain in which the IP address is significant. |
| Reservation Class (Optional) | A particular index that identifies a set of traffic characteristics of the requested resources (e.g. burstiness and packet size). |
| Transport Service Class (Optional) | Identifies the forwarding behaviour to be applied to requested resources. |
| NOTE 1: Either physical/logical access Ids or physical/logical aggregation Ids may be present in the bulk resource reservation.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | |

#### 6.3.8.3.2.2 Resource Delegation Confirmation

The Resource Delegation Confirmation message is used to acknowledge the Resource Delegation Request. The Resource Delegation Confirmation message contains the following information elements.

**Table 41: Resource Delegation Confirmation - Information Elements**

| Resource Delegation Confirmation(Delegating x-RACF -> Delegated x-RACF) | |
|---|---|
| Delegated x-RACF Identifier | Global unique Identifier for the Delegated x-RACF instance. |
| Session ID | The reference is a unique session identifier in the scope of the Delegated x-RACF Identifier. |
| Result | The result of the request. |
| Direction of the bulk reservation (Optional) | Direction of the requested bulk resources. |
| Physical Access ID (Optional, see note 1) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional, see note 1) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Physical Aggregation ID (Optional, see note 1) | The identifier of the physical resource in the aggregation network to which the bulk resource is processed. |
| Logical Aggregation ID (Optional, see note 1) | The identifier of the logical resource in the aggregation network to which the bulk reservation is processed. |
| Bandwidth (Optional) | The delegated data rate. |
| Subscriber-ID (Optional) | It identifies the subscriber attached to the access network (see note 2). |
| Globally Unique IP Address (Optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |

| Resource Delegation Confirmation(Delegating x-RACF -> Delegated x-RACF) | | |
|---|---|---|
| | Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| | Address Realm | The addressing domain in which the IP address is significant. |
| Reservation Class (Optional) | | A particular index that identifies a set of traffic characteristics of the requested resources (e.g. burstiness and packet size). |
| Transport Service Class (Optional) | | Identifies the forwarding behaviour to be applied to requested resources. |
| NOTE 1: Either physical/logical access Ids or physical/logical aggregation Ids may be present in the bulk resource reservation.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | | |

#### 6.3.8.3.2.3 Resource Delegation Push

The Resource Delegation Push message is used to delegate resource during and after the pre-delegation process, and is sent from the delegating x-RACF to the delegated x-RACF. This message is only applicable for the delegated model of the Rr reference point. The Resource Delegation Push contains the following information elements.

**Table 42: Resource Delegation Push - Information Elements**

| Resource Delegation Push(Delegating x-RACF -> Delegated x-RACF) | | |
|---|---|---|
| Delegating x-RACF Identifier | | Global unique Identifier for the Delegating x-RACF instance. |
| Session ID | | The reference is a unique session identifier in the scope of the Delegating x-RACF Identifier. |
| Direction of the bulk reservation (Optional) | | Direction of the delegated bulk of resources. |
| Physical Access ID (Optional, see note 1) | | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional, see note 1) | | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Physical Aggregation ID (Optional, see note 1) | | The identifier of the physical resource in the aggregation network to which the bulk resource is processed. |
| Logical Aggregation ID (Optional, see note 1) | | The identifier of the logical resource in the aggregation network to which the bulk reservation is processed. |
| Bandwidth | | The delegating data rate. It can be larger or smaller than the data rate previously delegated. |
| Subscriber-ID (Optional) | | It identifies the subscriber attached to the access network (see note 2). |
| Globally Unique IP Address (Optional) | | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| | Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| | Address Realm | The addressing domain in which the IP address is significant. |
| Reservation Class (Optional) | | A particular index that identifies a set of traffic characteristics of the requested resources (e.g. burstiness and packet size). |
| Transport Service Class (Optional) | | Identifies the forwarding behaviour to be applied to requested resources. |
| NOTE 1: Either physical/logical access Ids or physical/logical aggregation Ids may be present in the bulk resource reservation.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | | |

#### 6.3.8.3.2.4 Resource Delegation Push Response

The Resource Delegation Push Response message is used to acknowledge the Resource Delegation Push. The Resource Delegation Push Response message contains the following information elements.

**Table 43: Resource Delegation Push Response- Information Elements**

| Resource Delegation Push Response(Delegating x-RACF -> Delegated x-RACF) | |
|---|---|
| Delegated x-RACF Identifier | Global unique Identifier for the Delegated x-RACF instance. |
| Session ID | The reference is a unique session identifier in the scope of the Delegated x-RACF Identifier. |
| Result | The result of the request. |

#### 6.3.8.3.2.5 Resource Delegation Query

The Resource Delegation Query message is used to query the delegated resource and is sent from the delegated x-RACF to the delegating x-RACF. This message is only applicable for the delegated model of the Rr reference point. The Resource Delegation Query contains the following information elements.

**Table 44: Resource Delegation Query - Information Elements**

| Resource Delegation Query (Delegated x-RACF -> Delegating x-RACF) | |
|---|---|
| Delegated x-RACF Identifier | Global unique Identifier for the Delegated x-RACF instance. |
| Session ID | The reference is a unique session identifier in the scope of the Delegated x-RACF Identifier. |
| Direction of the bulk reservation (Optional) | Direction of the requested bulk of resources. |
| Physical Access ID (Optional, see note 1) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional, see note 1) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Physical Aggregation ID (Optional, see note 1) | The identifier of the physical resource in the aggregation network to which the bulk resource is processed. |
| Logical Aggregation ID (Optional, see note 1) | The identifier of the logical resource in the aggregation network to which the bulk reservation is processed. |
| Subscriber-ID (Optional) | It identifies the subscriber attached to the access network (see note 2). |
| Globally Unique IP Address (Optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| Address Realm | The addressing domain in which the IP address is significant. |
| Reservation Class (Optional) | A particular index that identifies a set of traffic characteristics of the requested resources (e.g. burstiness and packet size). |
| Transport Service Class (Optional) | Identifies the forwarding behaviour to be applied to requested resources. |
| NOTE 1: Either physical/logical access Ids or physical/logical aggregation Ids may be present in the bulk resource reservation.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | |

#### 6.3.8.3.2.6 Resource Delegation Query Response

The Resource Delegation Query Response message is used to acknowledge the Resource Delegation Query. The Resource Delegation Query Response message contains the following information elements.

**Table 45: Resource Delegation Query Response - Information Elements**

| Resource Delegation Query Response(Delegating x-RACF -> Delegated x-RACF) | |
|---|---|
| Delegated x-RACF Identifier | Global unique Identifier for the Delegated x-RACF instance. |
| Session ID | The reference is a unique session identifier in the scope of the Delegated x-RACF Identifier. |
| Result | The result of the request. |
| Direction of the bulk reservation (Optional) | Direction of the requested bulk resources. |
| Physical Access ID (Optional, see note 1) | The identifier of the physical access to which the user equipment is connected. |
| Logical Access ID (Optional, see note 1) | The identifier of the logical access used by the attached user equipment. In the xDSL case, the Logical Access ID may explicitly contain the identifier of VP and/or VC carrying the traffic. |
| Physical Aggregation ID (Optional, see note 1) | The identifier of the physical resource in the aggregation network to which the bulk resource is processed. |
| Logical Aggregation ID (Optional, see note 1) | The identifier of the logical resource in the aggregation network to which the bulk reservation is processed. |
| Bandwidth (Optional) | The delegated data rate. |
| Subscriber-ID (Optional) | It identifies the subscriber attached to the access network (see note 2). |
| Globally Unique IP Address (Optional) | Globally Unique address that corresponds to the UNI associated to the subscriber attached to the network. |
| Assigned IP Address | The IP address (Ipv4 or Ipv6). |
| Address Realm | The addressing domain in which the IP address is significant. |
| Reservation Class (Optional) | A particular index that identifies a set of traffic characteristics of the requested resources (e.g. burstiness and packet size). |
| Transport Service Class (Optional) | Identifies the forwarding behaviour to be applied to requested resources. |
| NOTE 1: Either physical/logical access Ids or physical/logical aggregation Ids may be present in the bulk resource reservation.<br>NOTE 2: The Subscriber-ID parameter is only applicable when interacting with an A-RACF, in which case at least one of these parameters (Subscriber-ID, Global Unique IP Address) shall be provided when the request is performed on a per subscription basis. | |

## 6.3.9 Rf Reference Point (SPDF-Charging Functions and x-RACF-Charging Functions)

NOTE: The Rf reference point is not standardized in the present document.

# 6.4 RACS Flows: Interaction Procedures

This clause describes the RACS flows between Functional Entities, necessary to accomplish several scenarios that involve interaction procedures.

NOTE: In scenarios where both an x-RACF and a BGF are involved, the sequence used by the SPDF to access the x-RACF and the BGF is a SPDF local decision. The SPDF is able to decide whether to access x-RACF and then BGF, or vice versa, or both in parallel, depending on the input coming from the AF, in particular for those cases, where the it may need to obtain firstly the IP address and ports from the C-BGF. This is valid for request, modification and release flows.

### 6.4.1 Subscriber Attaches to the Access Network

The NASS is responsible for notifying the A-RACF when a subscriber attaches to the network. The NASS provides to A-RACF an association between Subscriber ID/IP address, the bearer used in the access network and additional subscriber access information.

Figure 6 presents the associated procedure.

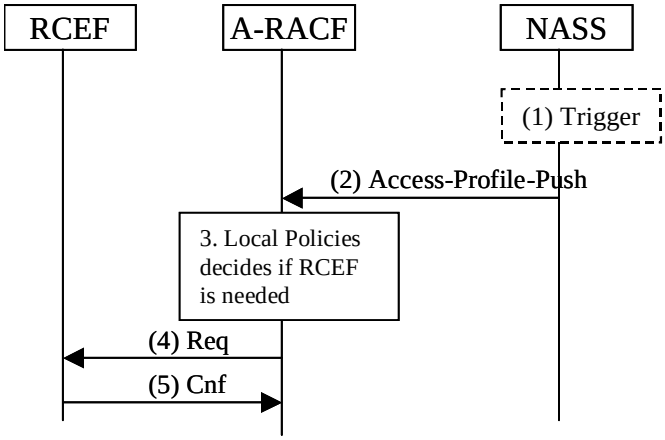



**Figure 6: Subscriber attaches to the access network**

1) The NASS accepts a request from a user equipment device to obtain bearer resources to attach to the access network or a modification on a subscriber's access profile that has been previously "pushed" to the RACS by NASS occurs.

2) The NASS sends Access-Profile-Push to inform A-RACF. When multiple A-RACF instances are present in the form of hierarchical structure, the NASS interacts with the top tier A-RACF instance as the single point of contact for Access-Profile-Push.

3) Based on Local Policies in the A-RACF and the information received from the NASS, the A-RACF decides if any traffic policy needs to be installed, changed or removed. The application of the new local policies will apply to new SPDF requests whereas the current reservations are optionally handled according to previous local policies.

4) The A-RACF requests the RCEF to install traffic policies (depending on step 3)). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with co-located RCEF to install traffic policies.

5) The RCEF confirms the installation of the traffic policies (depending on step 4)).

### 6.4.2 Request Resource

#### 6.4.2.1 Request Resource by using the push mode

##### 6.4.2.1.1 Admission control using push mode when only one x-RACF is involved

This clause provides the flows for resource reservation request from the AF towards the SPDF. Based on SPDF policies, the SPDF decides to contact the x-RACF, the BGF or both.

This procedure is applicable when only one x-RACF is exclusively involved in managing given resources.

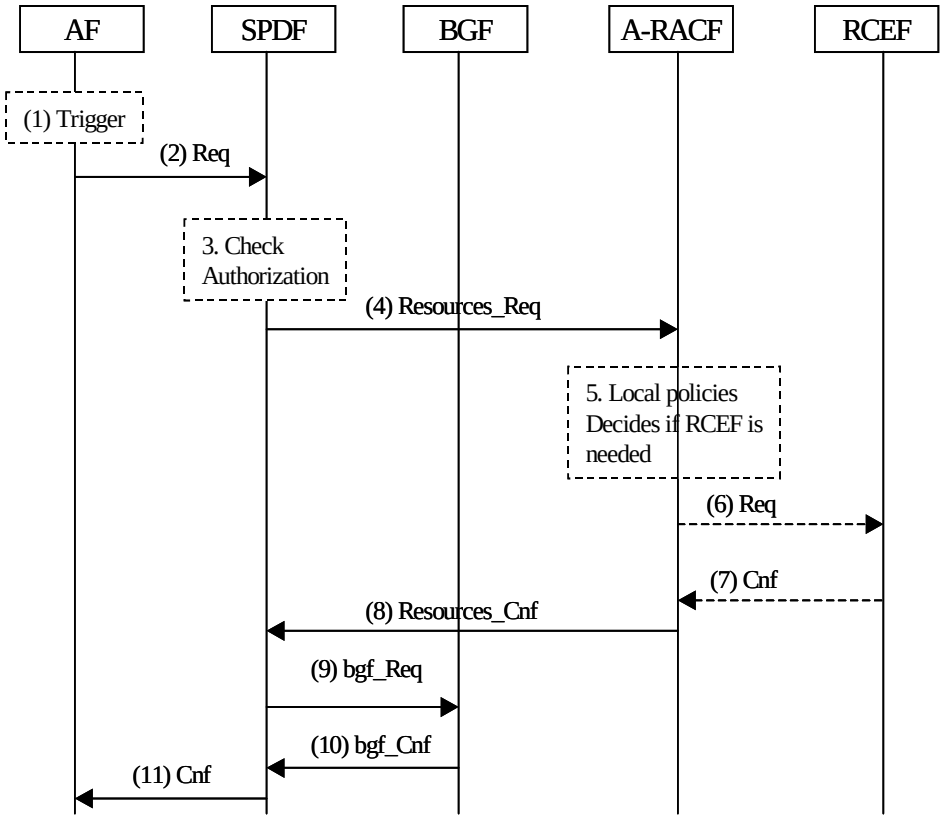



**Figure 7: Admission control using push mode when only one x-RACF is involved**

1) An AF session initiation message is received from UE, generated in AF itself, or another AF. The AF identifies that this session requires resources in the transport network in order to support the associated media flows.

2) The AF sends a unicast or multicast service request information to the SPDF.

3) The SPDF authorizes the request. This process consists of verifying if the required resources for the AF session, present in the service request, are consistent with operator policy rules defined in the SPDF for that particular AF.

4) In case the service is authorized, the SPDF determines how to serve the request. It may be required to send Resources-Request to allocated resources of the A-RACF and/or bgf-Request request to BGF. When multiple x-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier x-RACF instance as the single point of contact for resource admission control. The SPDF uses the local policies and the parameters in the request in order to take the decision. Therefore, steps 5) to 8) and/or 9) and 10) may not be performed depending on the SPDF decision.

5) The x-RACF maps the request from SPDF into the internal network topology. The x-RACF performs authorization and admission control based on access network policies. The x-RACF also decides if there are traffic policies to be installed in the RCEF.

6) The x-RACF evaluates the availability and, if successful, reserves resources and requests the RCEF to install the traffic policies to be applied to the associated flows (depending on step 5)).

7) The RCEF confirms the installation of the traffic policies (depending on step 6)). For multicast services, traffic policies authorize the delivery of the multicast flow(s). Multicast replication follows as needed.

8) The x-RACF sends Resource-Confirmation to inform the SPDF if the resources are reserved.

9) The SPDF has determined that serving this request requires sending a request to the appropriate BGF and therefore the SPDF sends a bgf_Request to the BGF.

10) The BGF performs the requested service (e.g. allocates the necessary resources to insert a RTP relay function) and confirms the operation to the SPDF.

11) The SPDF forwards the result to the AF.

NOTE: The multicast replication process is handled by the transport processing functions. RACS only indicates in the traffic policy whether the requested flow by a user is authorized. If the requested flow is authorized, the transport processing functions will replicate it when required.

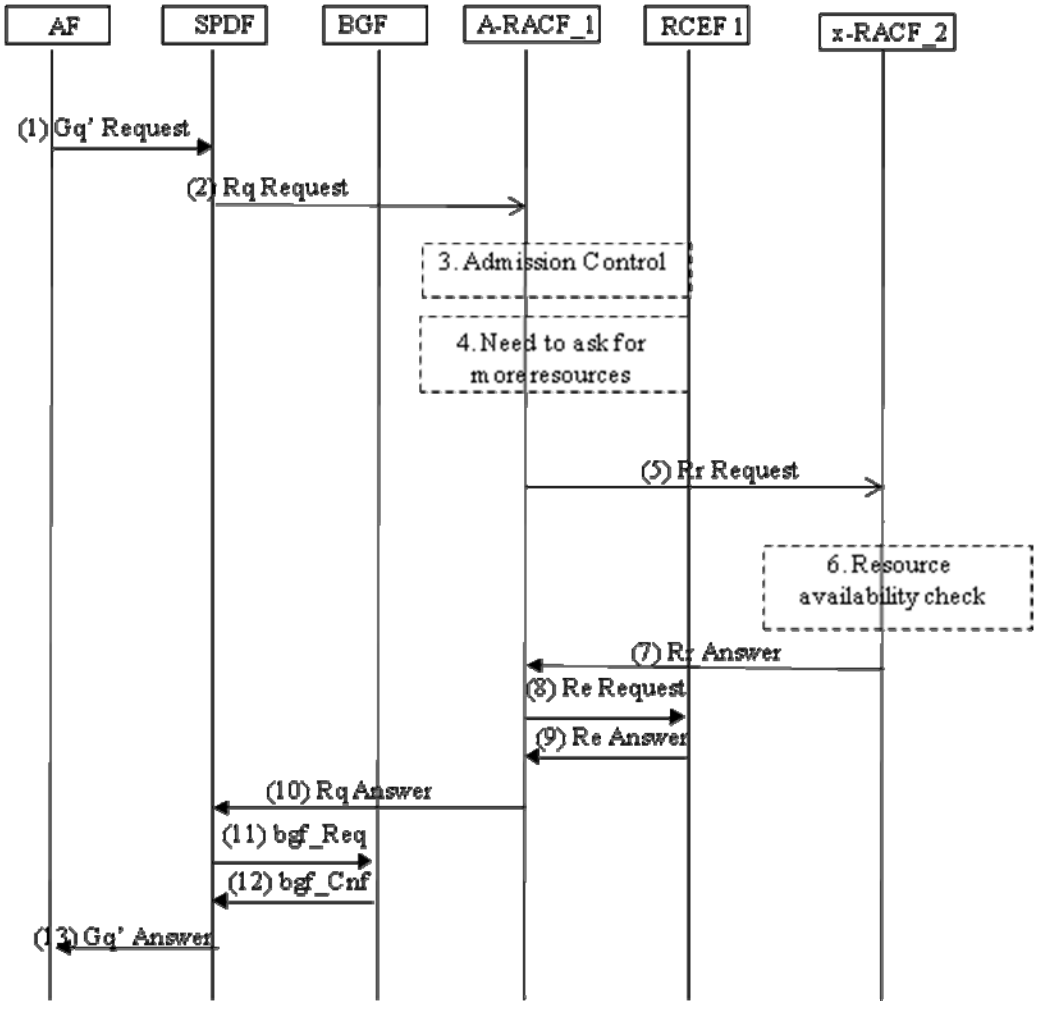
#### 6.4.2.1.2 Admission control using push mode when multiple x-RACFs are involved

The procedure described in this clause is used for performing admission control in push mode, and is applicable when multiple x-RACFs are involved.

##### 6.4.2.1.2.1 Use of request bulk resources

The Rr Reference Point allows x-RACF instances to synchronize with each others. In this example, as one of the x-RACFs has not enough resources for handling the request, it uses the interface to ask for more resources from the other x-RACF (see clause 6.2.2.1.3, second bullet item).

The corresponding signalling flow is represented in figure 8.




NOTE: The above flow uses the single-stage reservation model.

**Figure 8: Admission control using push mode when multiple x-RACFs are involved and requesting bulk resources is used**

1) The AF contacts the SPDF.

2) From the point of view of the SPDF, a single x-RACF instance is visible: this is x-RACF_1. This simplifies the dispatching decision, since the SPDF only needs to be aware of x-RACF_1. For this reason, the SPDF contacts x-RACF_1.

3) x-RACF_1 performs admission control.

4) and 5) x-RACF_1 decides that it has not enough resources and asks for more from x-RACF_2.

6) x-RACF_2 verifies resource availability and decides whether to delegate more resources as requested to x-RACF_1 or not.

7) x-RACF_2 returns its decision to x-RACF_1 (assumed to be granted in this example signalling flow).

8) and 9) x-RACF_1 performs Policy Installation towards RCEF 1.

10) x-RACF_1 returns a single answer to the SPDF (assumed to be granted in this example signalling flow).

11) and 12) SPDF interacts with the BGF.

13) SPDF returns the answer to the AF.

#### 6.4.2.1.2.2 Use of Rr request model

The Rr Reference Point allows x-RACF instances to synchronize with each others. In this example, it is used to perform the Rr request model where one x-RACF performs admission control in its own segment and solicits further admission control to be performed by another x-RACF in another segment (see clause 6.2.2.1.3, first bullet item, and clause 6.3.8.1.1.2).

The corresponding signalling flow is represented in figure 9.

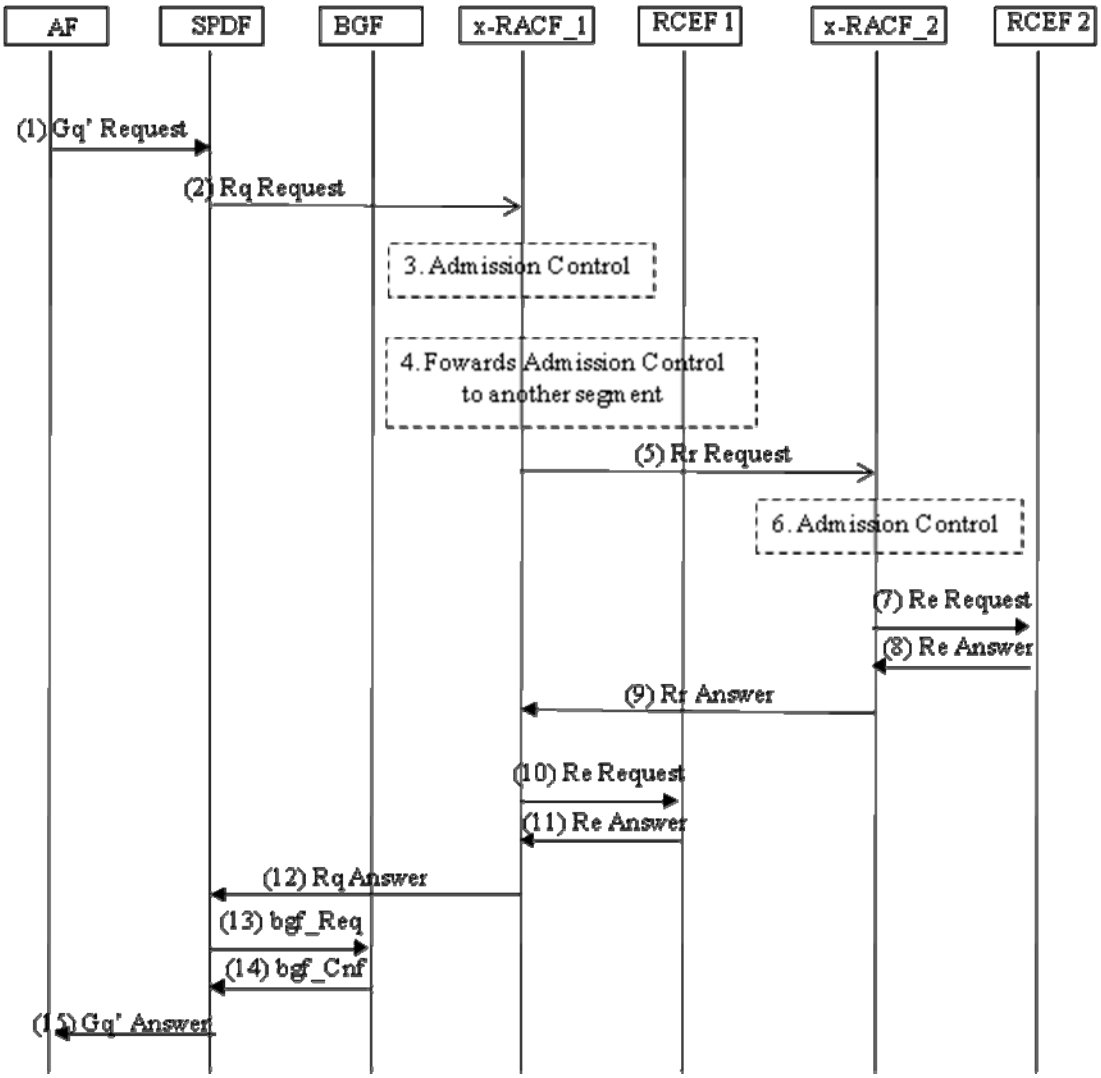



**Figure 9: Admission control using push mode when multiple x-RACFs are cooperating as in the Rr request model**

1) The AF contacts the SPDF.

2) From the point of view of the SPDF, a single x-RACF instance is visible: this is x-RACF_1. This simplifies the dispatching decision, since the SPDF only needs to be aware of x-RACF_1. For this reason, the SPDF contacts x-RACF_1.

3) x-RACF_1 performs admission control for its own segment.

4) and 5) x-RACF_1 forwards the request to x-RACF_2 that handles another segment for further admission control.

6) x-RACF_2 performs admission control in its own segment.

7) and 8) x-RACF_2 performs Policy Installation towards RCEF 2.

9) x-RACF_2 returns its decision to x-RACF_1 (assumed to be granted in this example signalling flow).

10) and 11) x-RACF_1 performs Policy Installation towards RCEF 1.

12) x-RACF_1 returns a single answer to the SPDF (assumed to be granted in this example signalling flow).

13) and 14) SPDF interacts with the BGF.

15) SPDF returns the answer to the AF.

### 6.4.2.2 Request Resource by using the pull mode

#### 6.4.2.2.1 Admission control using pull mode when only one x-RACF is involved

The procedure described in this clause is used for performing admission control using pull mode (e.g. the admission control is triggered from the network).

This procedure is applicable when only one x-RACF is exclusively involved in managing given resources.

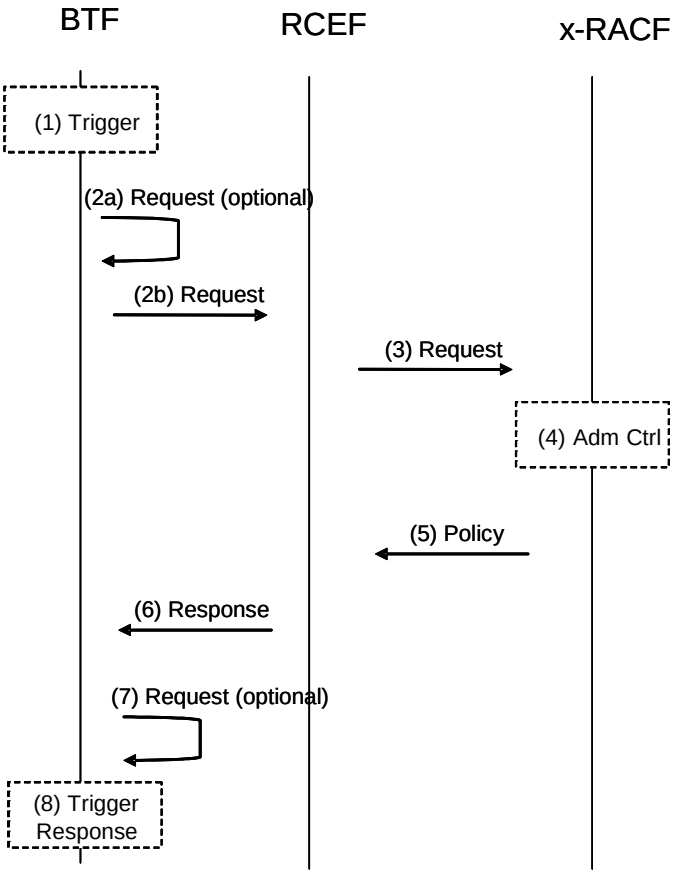



**Figure 10: Admission control using pull mode when only one x-RACF is involved in managing the same resources**

1) The BTF receives a trigger for requesting access to resources. This trigger may come, for example, from a CND or from another BTF.

2a) Optionally the BTF forwards the request to another BTF. This usually happens when the BTF is not co-located with an RCEF capable of interacting with an x-RACF.

2b) The BTF forwards the request to the RCEF.

3) The RCEF builds a reservation request and sends it to the x-RACF.

4) The x-RACF performs the admission control; this applies to the network segment and the associated resources which it has responsibility for (e.g. for a x-RACF instance deployed in the AN, the admission control may only be for the access segment while for another x-RACF instance deployed on a platform separate form any traffic forwarding device may perform the admission control for both the access and aggregation segments).

5) The x-RACF enforces the appropriate policy in the RCEF.

6) The RCEF sends to the BTF the response to its request.

7) Optionally the BTF forwards the request to another BTF. This allows for further admission control processes applying other network segments (e.g. after performing admission control in the access segment, admission control in the aggregation segment may be needed as well).

8) Depending on the type of trigger received in the first place by the BTF, the BTF may optionally send a response to that trigger.

NOTE 1: The standardization of steps 2a, 2b, 6 and 7 is outside the scope of the present document.

NOTE 2: Steps 3 and 5 are to be considered as Re interactions when RCEF and x-RACF are located in different nodes. If RCEF and x-RACF are co-located, the standardization of this interaction is outside the scope of the present document.

#### 6.4.2.2.2 Admission control using pull mode when multiple x-RACFs are involved

The procedure described in this clause is used for performing admission control in pull mode (e.g. the admission control is triggered from the network).

This procedure is applicable when multiple x-RACFs are involved in managing the same resources.

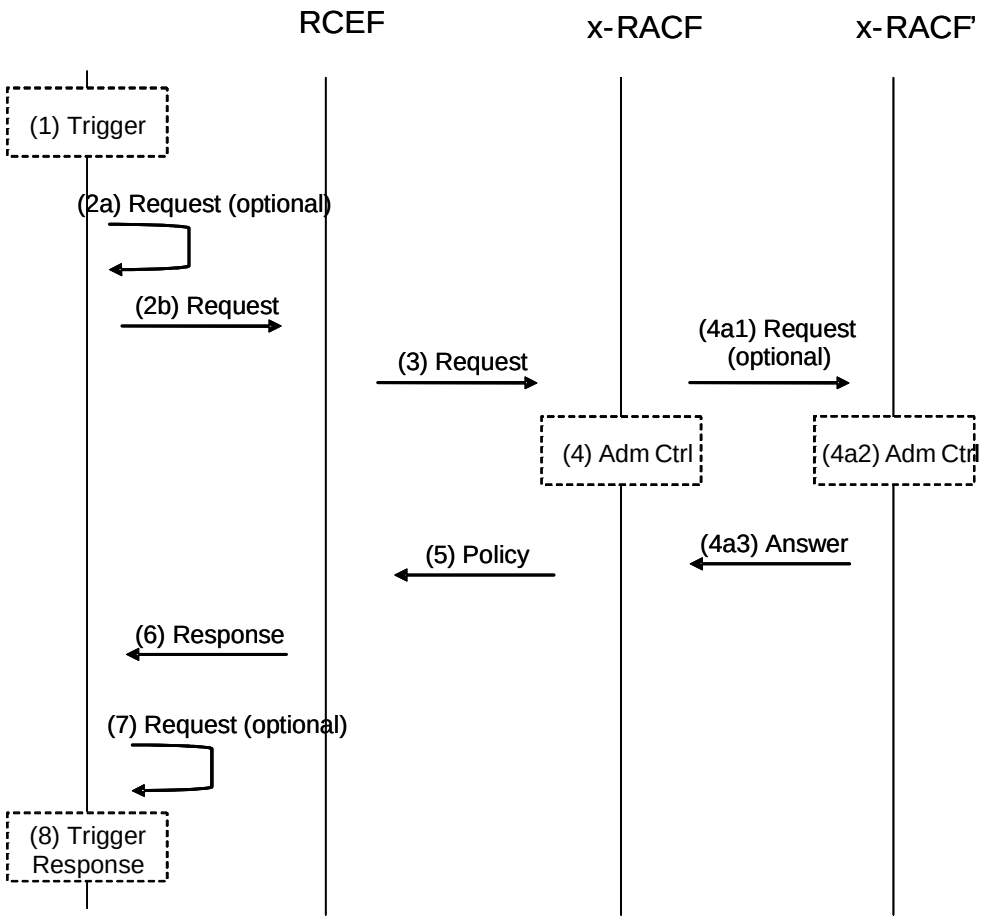



**Figure 11: Admission control using pull mode when multiple x-RACFs are involved in managing the same resources**

1) The BTF receives a trigger for requesting resources. This trigger may come, for example, from a CND or from another BTF.

2a) Optionally the BTF forwards the request to another BTF. This usually happens when the BTF is not co-located with an RCEF capable of interacting with an x-RACF.

2b) The BTF forwards the request to the RCEF.

3) The RCEF builds a reservation request and sends it to the x-RACF.

4) The x-RACF performs the admission control; this applies to the network segment and the associated resources which it has responsibility for (e.g. for a x-RACF instance deployed in the AN, the admission control may only be for the access segment while for another x-RACF instance deployed on a platform separate form any traffic forwarding device may perform the admission control for both the access and aggregation segments).

4a) The x-RACF may interact with another x-RACF' (prime). The interaction (4a1) then triggers an admission control decision in x-RACF' (4a2) followed by an answer to the interaction request (4a3). This step may be decoupled from reservation requests arriving to the first x-RACF from the RCEF.

5) The x-RACF enforces the appropriate policy in the RCEF.

6) The RCEF sends to the BTF the response to its request.

7) Optionally the BTF forwards the request to another BTF. This allows for further admission control processes applying other network segments (e.g. after performing admission control in the access segment, admission control in the aggregation segment may be needed as well).

8) Depending on the type of trigger received in the first place by the BTF, the BTF may optionally send a response to that trigger.

NOTE 1: The standardization of steps 2a, 2b, 6 and 7 is outside the scope of the present document.

NOTE 2: Steps 3 and 5 are to be considered as Re interactions when RCEF and x-RACF are located in different nodes. If RCEF and x-RACF are co-located, the standardization of this interaction is outside the scope of the present document.

#### 6.4.2.3 Request resource by combining push and pull mode

This clause provides the flow for resource reservation request in push mode from the AF towards the SPDF, that triggers, via x-RACF and RCEF, on-path signalling on BTF and the corresponding pull-mode reservation.

In the flow two different instances of x-RACF, RCEF and BTF are shown:

- x-RACF_1 and RCEF_1 represent the functional entities that trigger the on-path signalling on BTF_1;
- RCEF_2 and BTF_2 represent the functional entities that send and receive on-path signalling and interact with x-RACF_2 for pull mode resource reservation.

No further assumptions are made on the deployment scenarios (e.g. location in the network of x-RACFs, RCEFs and BTFs).

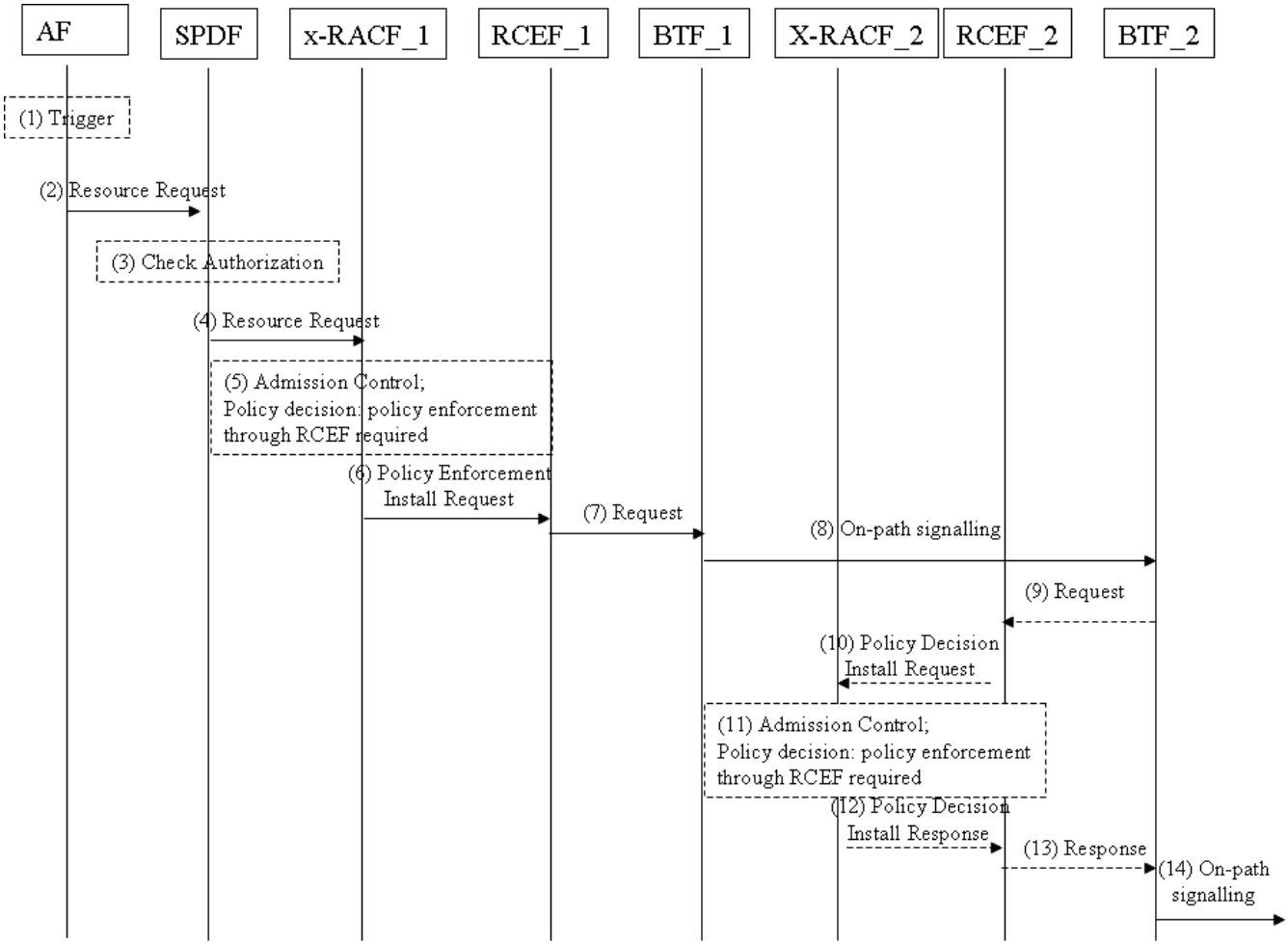



**Figure 12: Resource reservation combining push and pull mode - Part 1**

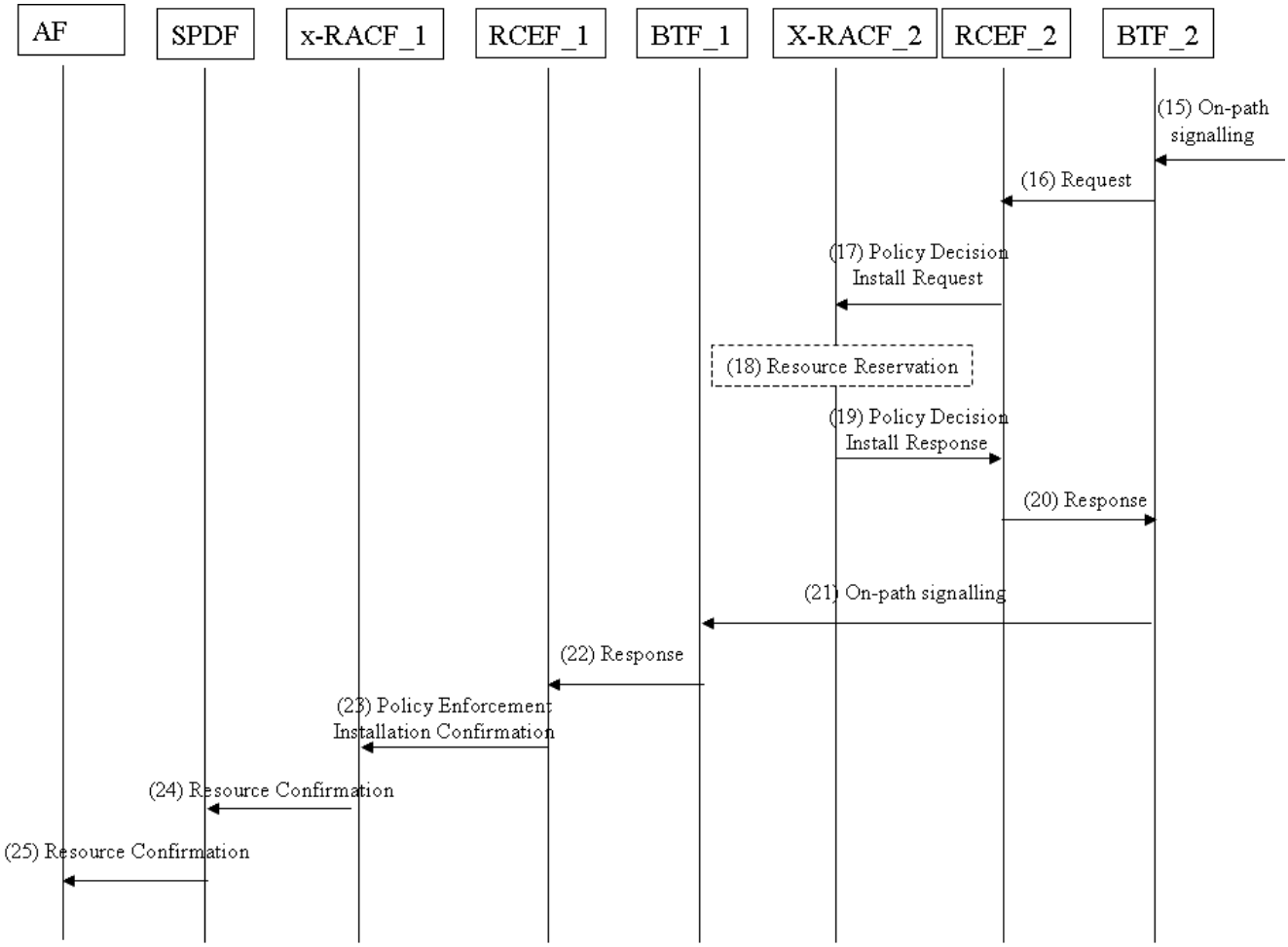



**Figure 13: Resource reservation combining push and pull mode - Part 2**

1) An AF session initiation message is received from UE, generated in AF itself, or another AF. The AF identifies that this session requires resources in the transport network in order to support the associated media flows.

2) AF sends a service request information to the SPDF.

3) SPDF authorizes the request. This process consists of verifying if the required resources for the AF session, present in the service request, are consistent with operator policy rules defined in the SPDF for that particular AF.

4) In case the service is authorized, the SPDF determines how to serve the request. If SPDF determines that resource allocation through x-RACF is needed, SPDF sends a resource request to x-RACF-1. When multiple x-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier x-RACF instance as the single point of contact for resource admission control. The SPDF uses the local policies and the parameters in the request in order to take the decision. Therefore, steps 4) to 23) may not be performed depending on the SPDF decision.

5) x-RACF_1 performs authorization and admission control based on access network policies. The x-RACF_1 also decides if there are traffic policies to be installed in the RCEF. When multiple A-RACF instances are present in the form of hierarchical structure the Rr mechanisms specified in clause 6.3.8 apply. In these cases the decision taken by the top tier A-RACF (R) is based on the contents of the reply returned by the lower-tier A-RACF (R).

6) x-RACF_1 evaluates the availability and, if successful, reserves resources and requests the RCEF_1 to install the traffic policies to be applied to the associated flows (depending on step 5).

7) RCEF_1 sends the request to BTF_1.

8) BTF_1 initiates on-path signalling towards the destination specified in the request.

9) (optional) BTF_2 sends the request to RCEF_2.

NOTE: Steps 9) to 13) represents the authorization phase for the on-path signalling request. They are optional and not further standardized in the present document.

10) (optional) RCEF_2 requests for an authorization to x-RACF_2.

11) (optional) x-RACF_2 performs the authorization of the reservation request; this applies to the network segment and the associated resources which it has responsibility for.

12) (optional) x-RACF_2 confirms the authorization to RCEF_2.

13) (optional) RCEF_2 sends to BTF_2 the response to its request.

14) BTF_2 forwards on-path signalling.

15) BTF_2 receives the on-path signalling response.

16) BTF_2 sends the request to RCEF_2.

17) RCEF_2 requests resource reservation from x-RACF_2.

18) x-RACF_2 performs admission control and resource reservation; this applies to the network segment and the associated resources which it has responsibility for.

19) x-RACF_2 replies to RCEF.

20) RCEF_2 sends to BTF_2 the response to its request.

21) On-path signalling from BTF_2, received by BTF_1.

22) BTF_1 sends the response to RCEF_1.

23) RCEF_1 sends the response to x-RACF_1.

24) x-RACF_1 sends the response to inform the SPDF that the resources are reserved.

25) SPDF forwards the result to AF.

## 6.4.3 Request Resource Wholesale/Retail Scenario

### 6.4.3.1 Request Resource with access to the A-RACF in the retail domain

This clause provides the flows for resource reservation request for wholesale/nomadism scenario. In this network deployment option, the NCP performs its own Admission Control decisions related to the access user profile and the available resources on the access network segment (ES 282 001 [2]). The NANP performs Admission Control decisions based on the NCP's profile and available resources over the aggregation network segment.

Based on SPDF(R) policies, the SPDF(R) wants to establish contact with the BGF(R), the A-RACF(R) and contacts the SPDF(W) in the wholesale NANP. Based on SPDF(W) policies, the SPDF(W) decides to contact the A-RACF(W) in the wholesale network, replies to the SPDF(R) which then establishes contact with the BGF(R) and with A-RACF (R).

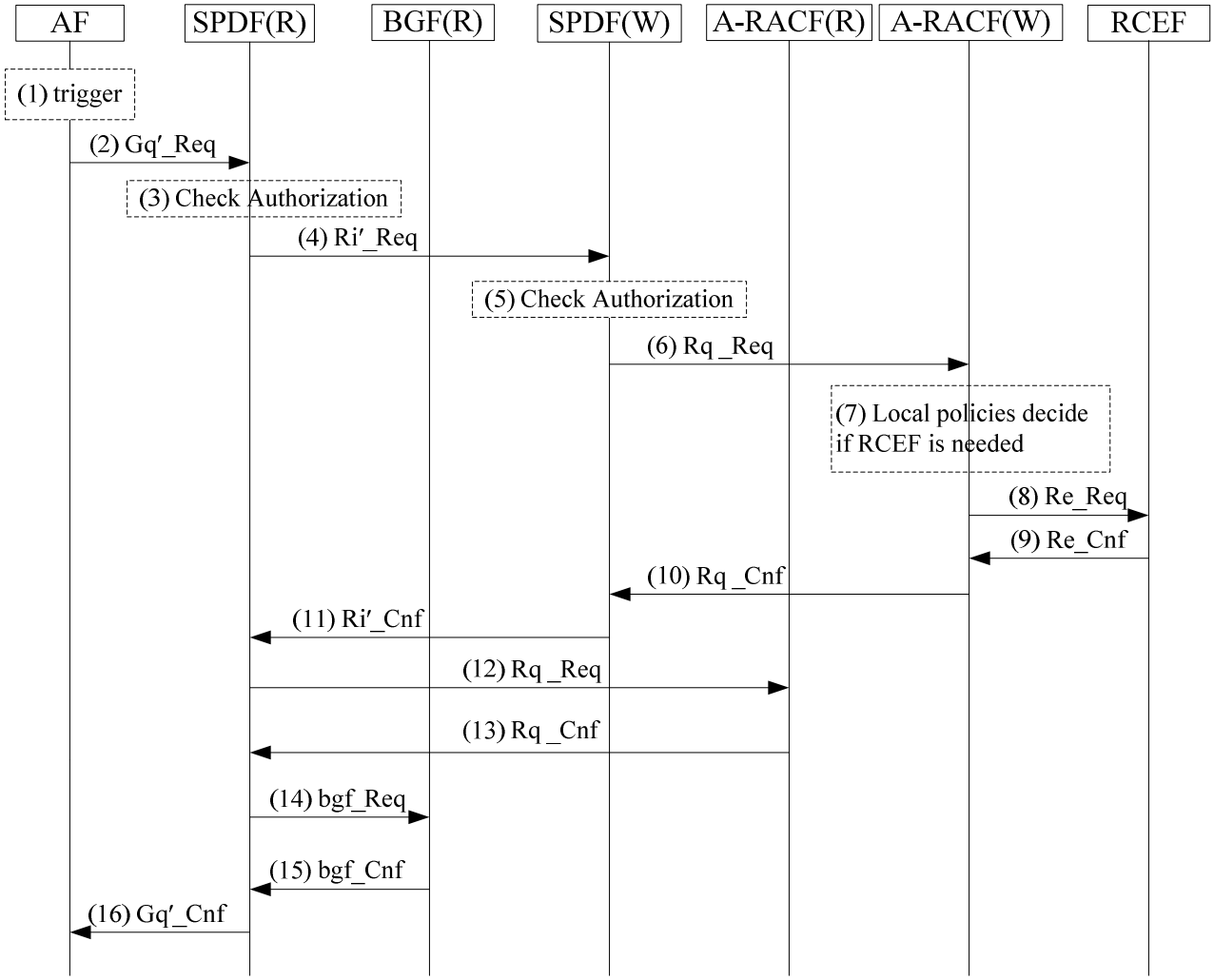



**Figure 14: Request Resource wholesale/nomadism with access to A-RACF in the retail domain**

1) An AF session initiation message is received or generated in AF. The AF identifies that this session requires resources in the transport network in order to support the associated media flows.

2) The AF sends a service request to the SPDF(R).

3) The SPDF(R) authorizes the request. This process consists of verifying if the required resources for the AF session, present in the service request, are consistent with operator policy rules defined in the SPDF(R) for that particular AF. It may be required to send resource request to allocated resources of the A-RACF(R). The SPDF(R) uses the local policies and the parameters in the request in order to take the decision. Therefore, steps 12) to 13) may not be performed depending on the SPDF(R) decision.

4) As the SPDF(R) does not own the resources in the transport network, the service request is sent further to the SPDF(W).

5) The SPDF(W) authorizes the request. This process consists of verifying if the required resources for the SPDF(R) session, present in the service request, are consistent with operator policy rules defined in the SPDF(W) for that particular SPDF(R).

6) In case the service is authorized, the SPDF(W) determines how to serve the request. It may be required to send resource request to allocated resources of the A-RACF(W). The SPDF(W) uses the local policies and the parameters in the request in order to take the decision. Therefore, steps 7) to 10) may not be performed depending on the SPDF(W) decision. When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier A-RACF(W) instance being the single point of contact for policy and resource admission control.

7) The A-RACF(W) maps the request from SPDF(W) into the internal network topology. The A-RACF(W) performs authorization and admission control based on access network policies. The A-RACF(W) also decides if there are traffic policies to be installed in the RCEF. When multiple A-RACF instances are present in the form of hierarchical structure, the Rr mechanisms specified in clause 6.3.8 apply. In these cases the decision taken by the top tier A-RACF(W) is based on the reply returned by the lower-tier A-RACF (W).

8) The A-RACF(W) requests the RCEF to install the traffic policies to be applied to the associated flows (depending on step 7)). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF(W) may interact with co-located RCEF to install traffic policies.

9) The RCEF confirms the installation of the traffic policies (depending on step 8)).

10) The A-RACF(W) sends resource confirmation to inform the SPDF(W) if the resources are reserved.

11) The SPDF(W) sends the result of the resource reservation to the SPDF(R).

12) The SPDF(R) sends resources request to allocated resources of the A-RACF(R). When multiple A-RACF instances are present in the form of hierarchical structure the Rr mechanisms specified in clause 6.3.8 apply. In these cases the decision taken by the top tier A-RACF(R) is based on the reply returned by the lower-tier A-RACF (R).

13) The A-RACF(R) confirms the operation to the SPDF(R).

14) The SPDF(R) determines that whether this service request requires sending a request to the appropriate BGF(R). Therefore, steps 14) and 15) may not be performed depending on the SPDF(R) decision.

15) The BGF(R) performs the requested service (e.g. allocates the necessary resources to insert a RTP relay function) and confirms the operation to the SPDF.

16) The SPDF(R) forwards the result to the AF.

#### 6.4.3.2 Request Resource without access to the A-RACF in the retail domain

This clause provides the flows for resource reservation request from the AF towards the SPDF(R) in the retail network when there is no NAT in the NANP network. Based on SPDF(R) policies, the SPDF(R) wants to establish contact with the BGF, and contacts the SPDF(W) in the wholesale NANP. Based on SPDF(W) policies, the SPDF(W) decides to contact the A-RACF(W) in the wholesale network, replies to the SPDF(R) which then establishes contact with the BGF(R).

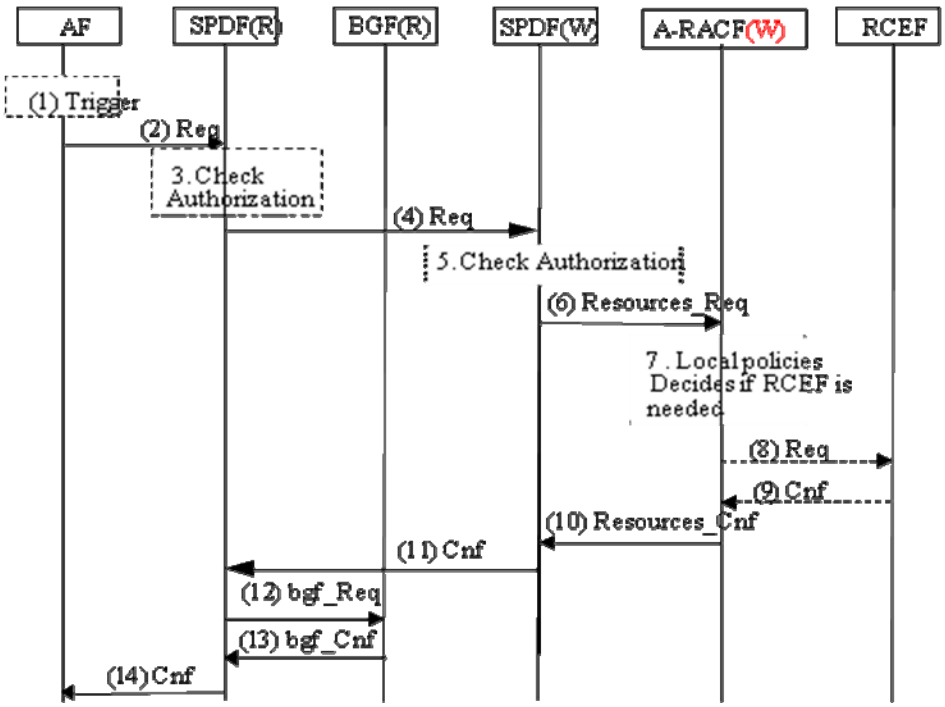



**Figure 15: Request resource wholesale without access to A-RACF in the retail domain**

1) An AF session initiation message is received or generated in AF. The AF identifies that this session requires resources in the transport network in order to support the associated media flows.

2) The AF sends a service request to the SPDF(R).

3) The SPDF(R) authorizes the request. This process consists of verifying if the required resources for the AF session, present in the service request, are consistent with operator policy rules defined in the SPDF(R) for that particular AF.

4) As the SPDF(R) does not own the resources in the transport network, the service request is sent further to the SPDF(W).

5) The SPDF(W) authorizes the request. This process consists of verifying if the required resources for the SPDF(R) session, present in the service request, are consistent with operator policy rules defined in the SPDF(R) for that particular SPDF(R).

6) In case the service is authorized, the SPDF(W) determines how to serve the request. It may be required to send Resources-Request to allocated resources of the A-RACF(W). The SPDF(W) uses the local policies and the parameters in the request in order to take the decision. Therefore, steps 7) to 10) may not be performed depending on the SPDF(W) decision. When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF (W) contacts the top tier A-RACF(W) instance being the single point of contact for policy and resource admission control.

7) The A-RACF(W) maps the request from SPDF(W) into the internal network topology. The A-RACF(W) performs authorization and admission control based on access network policies. The A-RACF(W) also decides if there are traffic policies to be installed in the RCEF. When multiple A-RACF(W) instances are present in the form of hierarchical structure, the Rr mechanisms specified in clause 6.3.8 apply. In these cases the decision taken by the top tier A-RACF(W) is based on the reply returned by the lower-tier A-RACF (W).

8) The A-RACF(W) requests the RCEF to install the traffic policies to be applied to the associated flows (depending on step 7). When multiple A-RACF(W) instances are present in the form of hierarchical structure, the A-RACF(W) may interact with co-located RCEF to install traffic policies.

9) The RCEF confirms the installation of the traffic policies (depending on step 8)).

10) The A-RACF(W) sends Resource-Confirmation to inform the SPDF(W) if the resources are reserved.

11) The SPDF(W) sends the result of the resource reservation to the SPDF(R).

12) The SPDF(R) determines that whether this service request requires sending a request to the appropriate BGF. Therefore, steps 12) and 13) may not be performed depending on the SPDF(R) decision.

13) The BGF(R) performs the requested service (e.g. allocates the necessary resources to insert a RTP relay function) and confirms the operation to the SPDF (R).

14) The SPDF(R) forwards the result to the AF.

## 6.4.4 Release Resource

### 6.4.4.1 Release Resource Request by using the push mode

This clause provides the flows for resource release in A-RACF as well as a service termination in the Border Gateway Function (BGF).

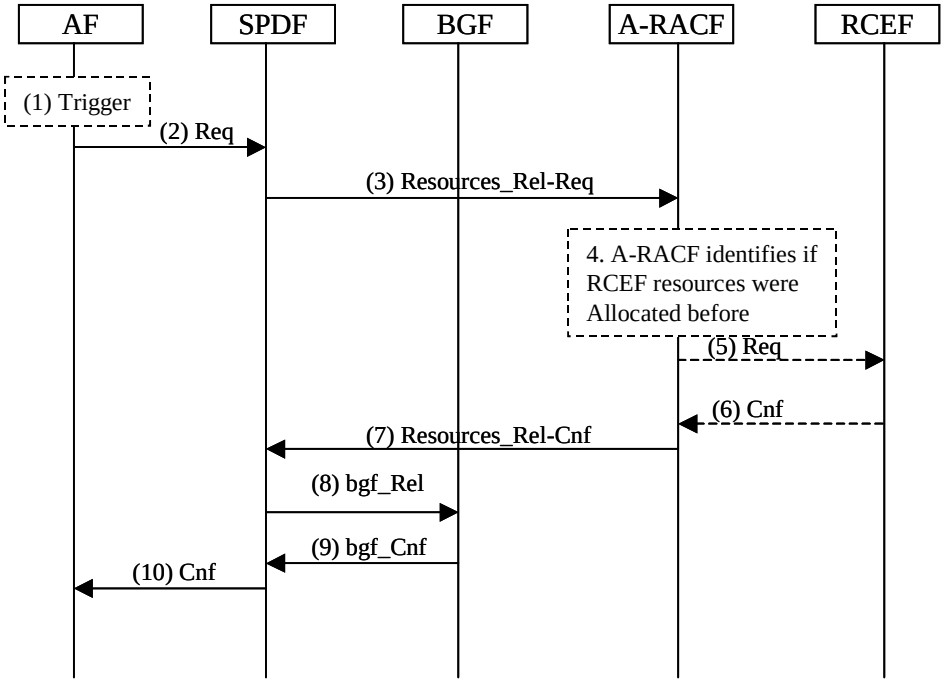



**Figure 16: Release resource by using the push mode**

1) An AF session release message is received or generated in AF. The AF identifies that the associated resources shall be released.

2) The AF sends a request to the SPDF to relinquish the resources previously allocated.

3) The SPDF determines that serving this request requires sending a Resources-Release to A-RACF and/or to request the termination of the BGF service (s). Steps 4) to 7) and/or 8) to 9) may not be performed. When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier A-RACF instance for resource release operations.

4) The A-RACF releases all associated resources. The A_RACF checks if there are traffic policies to be removed from the RCEF. When multiple A-RACF instances are present in the form of hierarchical structure and are involved in reserving resources for the original reservation request from the AF, the top tier A-RACF instance forwards the request to other A-RACF instances to request the resource release.

5) The A-RACF requests the RCEF to remove the associated traffic policies (depending on 4). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with co-located RCEF to remove the associated traffic policies.

6) The RCEF confirms the removal of the traffic policies (depending on step 5)).

7) The A-RACF informs the SPDF that the resources were relinquished.

8) The SPDF determines that a release request is to be sent to the appropriate BGF.

9) The BGF terminates the service (s) and confirms the operation to the SPDF.

10) The SPDF forwards the result to the AF.

### 6.4.4.2 Release Resource Request by using the pull mode

#### 6.4.4.2.1 Resource Release using pull mode when only one x-RACF is involved

The procedure described in this clause is used for release of multicast resources after performing admission control using pull mode (e.g. the admission control is triggered from the network).

This procedure is applicable when only one x-RACF is involved in managing given resources.

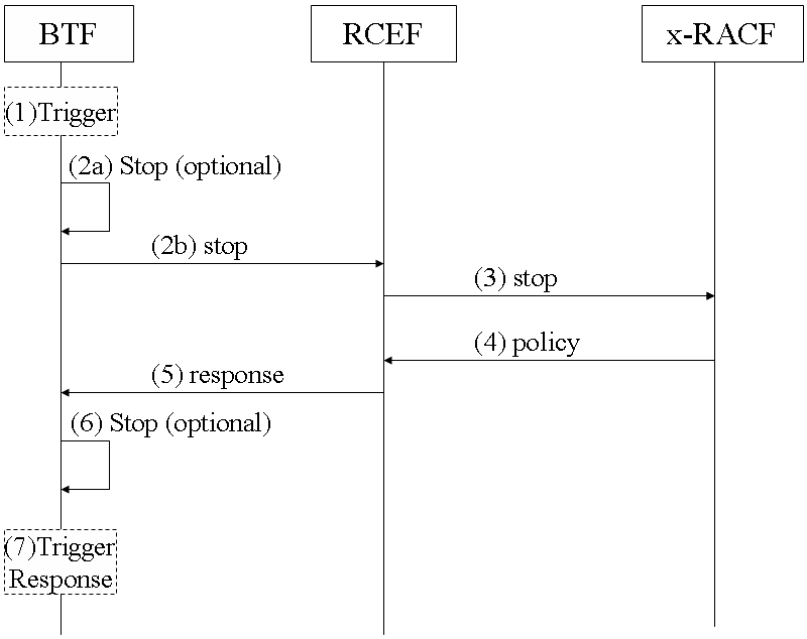



**Figure 17: Resource Release using pull mode when only one x-RACF is involved**

1) The BTF receives or generates a trigger for stopping the use of the resources. This trigger may come, for example, from a CND or from another BTF.

2a) Optionally the BTF forwards the request to another BTF. This usually happens when the BTF is not co-located with an RCEF capable of interacting with an x-RACF.

2b) The BTF forwards the request to the RCEF.

3) The RCEF builds a multicast stop request and sends it to the x-RACF. The x-RACF performs the resource release, which is applicable to the network segment and the associated resources it has responsibility for. As an example, for an x-RACF instance deployed in the AN, the resource release may only be for the access segment while, for another x-RACF instance deployed on a separate platform, any traffic forwarding device may perform the resource release for both the access and aggregation segments.

4) The x-RACF enforces the appropriate policy in the RCEF.

5) The RCEF sends to the BTF the response to its request.

6) BTF stops multicast replication. Optionally the BTF forwards the stop request to another BTF. This allows for further resource release processes applying to other network segments (e.g. after performing resource release in the access segment, resource release in the aggregation segment may be needed as well).

7) Depending on the type of trigger received in the first place by the BTF, the BTF may optionally send a response to that trigger.

NOTE 1: The standardization of steps 2a), 2b), 6) and 7) is outside the scope of the present document.

NOTE 2: Steps 3) and 4) are to be considered as Re interactions when RCEF and x-RACF are located in different nodes. If RCEF and x-RACF are co-located, the standardization of these interactions is outside of the scope of the present document.

#### 6.4.4.2.2 Resource release using pull mode when multiple x-RACFs are involved

The procedure described in this clause is used for release of multicast resources after performing admission control in pull mode (e.g. the admission control is triggered from the network).

This procedure is applicable when multiple x-RACFs are involved in managing given resources.

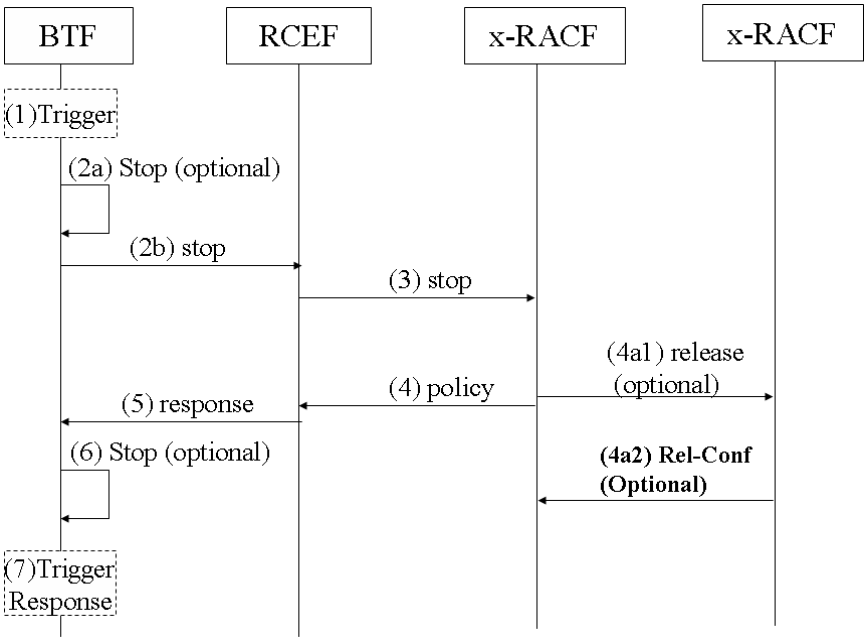



**Figure 18: Resource Release using pull mode when multiple x-RACFs are involved**

1) The BTF receives or generates a trigger for stopping the use of the resources. This trigger may come, for example, from a CND or from another BTF.

2a) Optionally the BTF forwards the request to another BTF. This usually happens when the BTF is not co-located with an RCEF capable of interacting with an x-RACF.

2b) The BTF forwards the request to the RCEF.

3) The RCEF builds a multicast stop request and sends it to the x-RACF. The x-RACF releases the resource, which is applicable to the network segment and the associated resources it has responsibility for. As an example, for a x-RACF instance deployed in the AN, the resource release may only be for the access segment while, for another x-RACF instance deployed on a separate platform, any traffic forwarding device may perform the resource release for both the access and aggregation segments.

4a1/4a2) The x-RACF may interact with another x-RACF' (prime). The release policies may be timeout triggered, or otherwise the release process may be performed at once, i.e. either just some portion or the entire set of allocated resources. Based on the release policies saved in the x-RACF, when a specific policy is matched and if another x-RACF (x-RACF') is also involved, an interaction (4a1) with that FE is initiated in order to release the additional resources allocated to x-RACF'. An internal resource release process is then triggered in x-RACF', which is followed by an answer to x-RACF (4a2). The number of times interaction 4a1 can be triggered, as well as how much resources are released each time, is based on the release policy.

4) The x-RACF enforces the appropriate policy in the RCEF.

5) The RCEF sends to the BTF the response to its request.

6) BTF stops multicast replication. Optionally the BTF forwards the stop request to another BTF, which allows for further resource release processes applying to other network segments (e.g. after performing resource release in the access segment, resource release in the aggregation segment may be needed as well).

7) Depending on the type of trigger received in the first place by the BTF, the BTF may optionally send a response to that trigger.

NOTE 1: The standardization of steps 2a), 2b), 6) and 7) is outside the scope of the present document.

NOTE 2: Steps 3) and 5) are to be considered as Re interactions when RCEF and x-RACF are located in different nodes. If RCEF and x-RACF are co-located, the standardization of these interactions is outside of the scope of the present document.

### 6.4.5 Commit Resources procedure

This procedure is triggered by an AF session signalling message received at the AF, or an internal action at the AF. The "Commit Resources" procedure is optional and is only needed if the AF had previously ordered the SPDF to reserve resources without a commit.

The decision where the commit is ultimately performed is based on the SPDF policies.

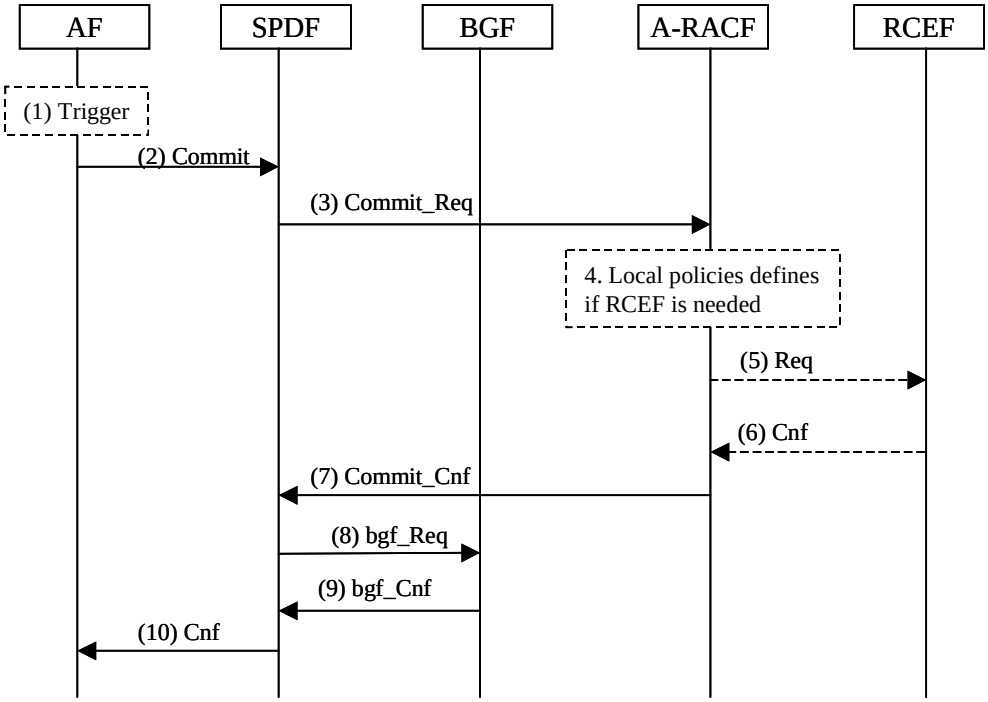



**Figure 19: Commitment of resources**

1) An AF session signalling message is received at the AF, or an internal action at the AF triggers the need to enable the transport of the media flow in the access network associated with the application.

2) The Application Function (AF) sends a Commit request to the SPDF.

3) The SPDF sends a Commit-Request message to the A-RACF and/or to the BGF to open the "gate". The decision is based on local policies. Whether steps 4) to 7) and 8) and 9) are executed is dependent on this decision. When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier A-RACF instance for resource commitment operations.

4) The A-RACF receives the Commit-Request message. One possible decision of A-RACF is to explicitly open the "gate" in the transport network. This corresponds to the installation of a particular traffic policy in the RCEF. When multiple A-RACF instances are present in the form of hierarchical structure, the top tier A-RACF instance forwards the request to other A-RACF instances to request the resource commitment in case those instances are in control of resources referenced in the request (i.e. the top tier A-RACF has delegated resources to other A-RACF instances).

5) The A-RACF sends a request to install the traffic policies in the RCEF (depending on 4). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with co-located RCEF to install traffic policies.

6) The RCEF reports to the A-RACF the installation of the traffic policies (depending on 5).

7) The A-RACF reports to the SPDF that the Commit-Request was successfully performed.

8) The SPDF may also (or alternatively) need to perform gate control at the BGF. In such a case the BGF sends a bgf_Request to the BGF.

9) The BGF reports to the SPDF that the action was performed.

10) The SPDF reports to the AF that the Commit was performed.

## 6.4.6 Resource Modification Request

### 6.4.6.1 Resource Modification Request by using the push mode

This procedure is used when the AF session signalling decides to modify the AF session by using the push mode. An update of a previous reservation is requested from the SPDF.

Figure 20 is applicable to both access sides of a session establishment.

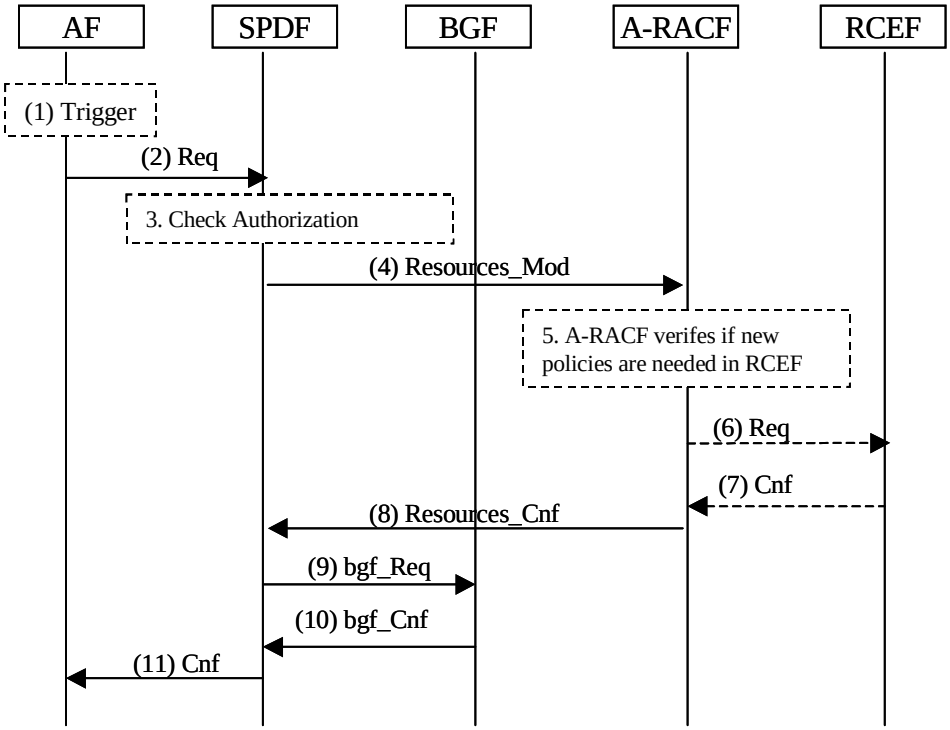



**Figure 20: Resource Modification Request by using the push mode**

1) An AF session modification results in the need to change the existing resource reservation.

2) The AF sends the service request information to the SPDF.

3) The SPDF shall authorize the request with the modified parameters. This authorization consists of verifying if the modified QoS resources for the AF session, present in the session description, are consistent with the operator policy rules defined in the SPDF. The SPDF determines if serving this request requires sending a Resources-Request to A-RACF and/or bgf-Request request for BGF service(s). Whether steps 4) to 8) and/or 9) and 10) are executed is dependent on this decision.

4) The SPDF has determined that serving this request requires sending a Resources-Modification message to the A-RACF. When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier A-RACF instance for resource modification operations.

5) The A-RACF performs admission control based on access network policies with the new QoS parameters. When multiple A-RACF instances are present in the form of hierarchical structure and are involved in reserving resources for the original reservation request from the AF, the top tier A-RACF instance forwards the request to other instances to request the resource modification.

6) The A-RACF may request the RCEF to modify the installed traffic policies that are applied to the associated resource reservation session flows. When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF(W) may interact with co-located RCEF to install traffic policies.

7) The RCEF confirms the modification of the traffic policies (depending on step 6)).

8) The A-RACF informs the SPDF that the resources requested are reserved.

9) The SPDF checks if there are also service (s) to be modified in BGF. If yes, a bgf-Request is sent to the BGF.

10) The BGF modifies the service (s) and confirms the operation to the SPDF.

11) The SPDF sends the confirmation to the AF.

#### 6.4.6.2 Resource Modification Request by using the pull mode

This procedure is used when the AF session signalling decides to modify the AF session by using the pull mode. An update of a previous reservation is requested from the SPDF.

Figure 21 is applicable to both access sides of a session establishment.

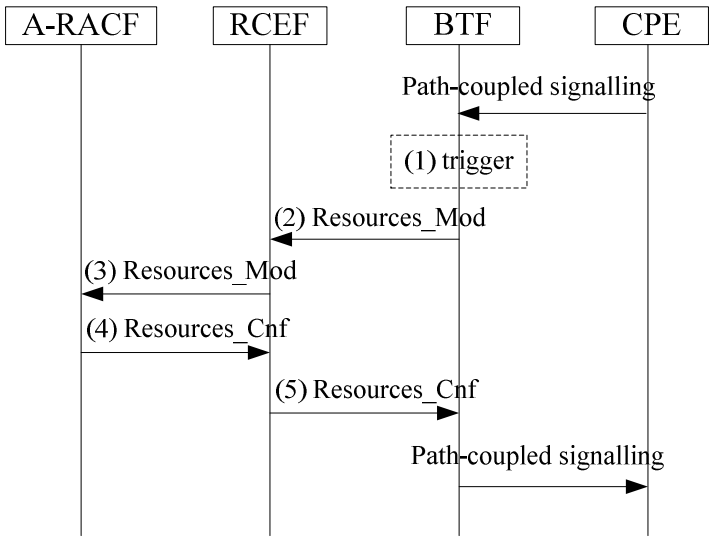



**Figure 21: Resources Modification Request by using the pull mode**

1) The resource modification request is usually triggered by a request indicated through the signalling from the CPN to modify the authorized resource for the given flow.

2) The BTF transfers the resource modification request to the RCEF.

3) The RCEF forwards the request to the A-RACF.

4) The A-RACF checks the authorization and admission control based on access network policies with the new QoS parameters. The A-RACF may request the RCEF to modify the installed traffic policies. The A-RACF sends the response information to the RCEF.

5) The RCEF sends the response to the BTF.

### 6.4.7 RACS Retrieves Access Profile from NASS

When A-RACF processes a resource reservation request received from the SPDF, the user's access profile may not be available.

Depending on Local Policies, the A-RACF may "pull" the Access-Profile from the NASS. This procedure is also applicable to the A-RACF recovery via data synchronization with NASS.

Figure 22 presents the associated procedure.

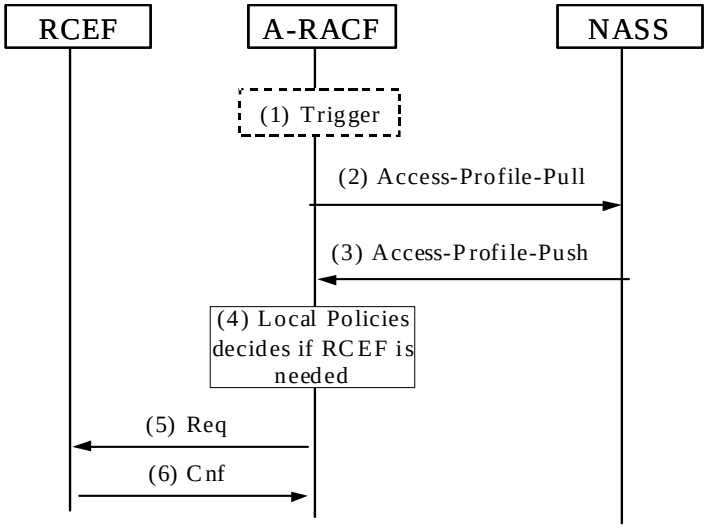



**Figure 22: Access Profile Retrieval**

1) This trigger represents the situations where the A-RACF needs the subscriber's access profile and this information is not locally available.

2) The A-RACF sends Access-Profile-Pull message to the NASS for retrieving Access Profile Information. When multiple A-RACF instances are present in the form of hierarchical structure, the top tier A-RACF instance sends Access-Profile-Pull message to the NASS.

3) The NASS sends the subscriber associated access profile to the A-RACF using Access-Profile-Push message.

4) Based on the local policies of A-RACF and the information received from the NASS, the A-RACF decides if any traffic policy needs to be installed in the RCEF.

5) The A-RACF requests the RCEF to install the appropriate traffic policies to be applied (depending on step 4)). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with co-located RCEF to install traffic policies.

6) The RCEF confirms the installation of the traffic policies.

### 6.4.8 Subscriber Detaches from the access network

This procedure presents the flows for the case where the NASS notifies the A-RACF that a certain binding is no longer valid.

NOTE: A similar flow can also represent an internal event in the A-RACF, for example a management decision. In this case the message from the NASS to the A-RACF is not present.

The A-RACF sends a notification towards the AF that the resource reservation is revoked and all associated resources are released.

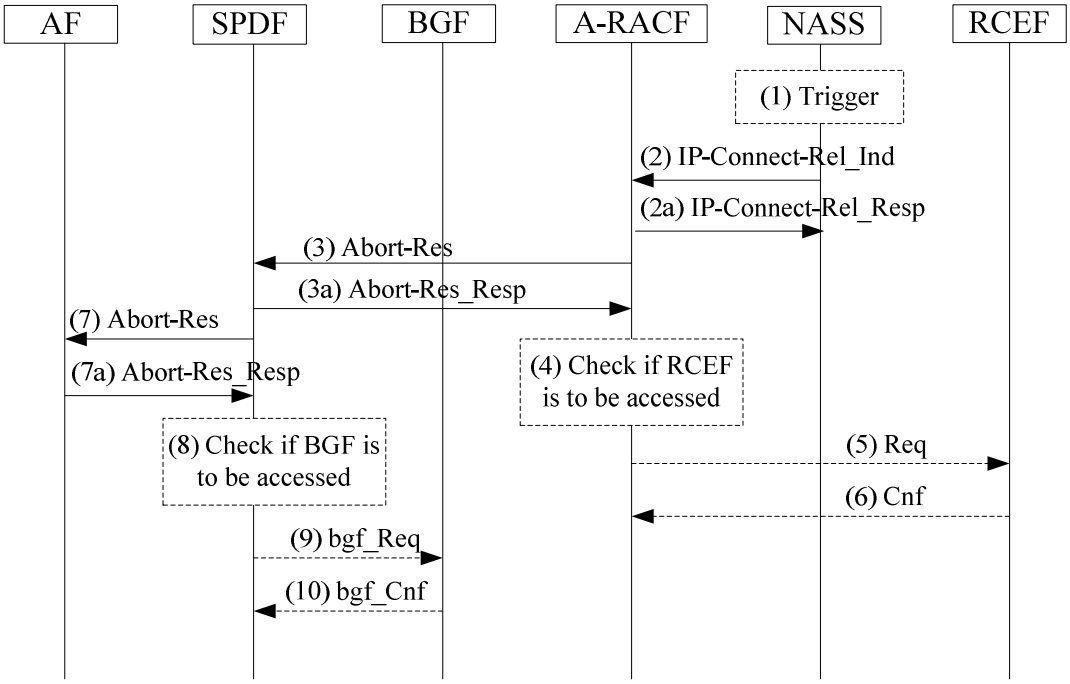



**Figure 23: Subscriber detachment**

1) The NASS decides that a bearer path is to be released (e.g. the end user equipment sends a release request for the bearer path to NASS).

2) The NASS informs the A-RACF that the access information is no longer valid by sending an IP-Connectivity-Release-Indication. When multiple A-RACF instances are present in the form of hierarchical structure, the NASS sends an IP-Connectivity-Release-Indication to the top tier A-RACF.

2a) The A-RACF responds to the NASS.

3) The A-RACF needs to relinquish all resources associated to the IP address/Subscriber-Id. In case there are still outstanding reservations, the A-RACF also notifies the SPDF. When multiple A-RACF instances are present in the form of hierarchical structure, the top tier A-RACF instance needs to notify other A-RACF instances to check if outstanding reservations exist.

3a) The SPDF responds to the A-RACF.

4) The A-RACF checks if there are resources to be released in the RCEF. Whether steps 5) and 6) are executed is dependent on this decision. When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with the co-located RCEF in steps 5) and 6).

5) The A-RACF sends a request to the RCEF for the removal of existing policies.

6) The RCEF confirms the removal of existing policies.

7) The SPDF reports to the AF that the existing reservation was revoked.

7a) The AF responds to the SPDF.

8) The SPDF checks if there are resources to be released in the BGF. The execution of steps 9) and 10) are depending on this decision.

9) The SPDF sends a request to the BGF for the removal of allocated resources.

10) The BGF confirms the removal of allocated resources.

## 6.4.9 Abnormal event from the RCEF

This procedure is used when the A-RACF receives an indication from the RCEF that a certain traffic policy can no longer be sustained. The A-RACF sends a notification towards the AF that the resource reservation was revoked and all associated resources are released.

Figure 24 presents the associated procedure.

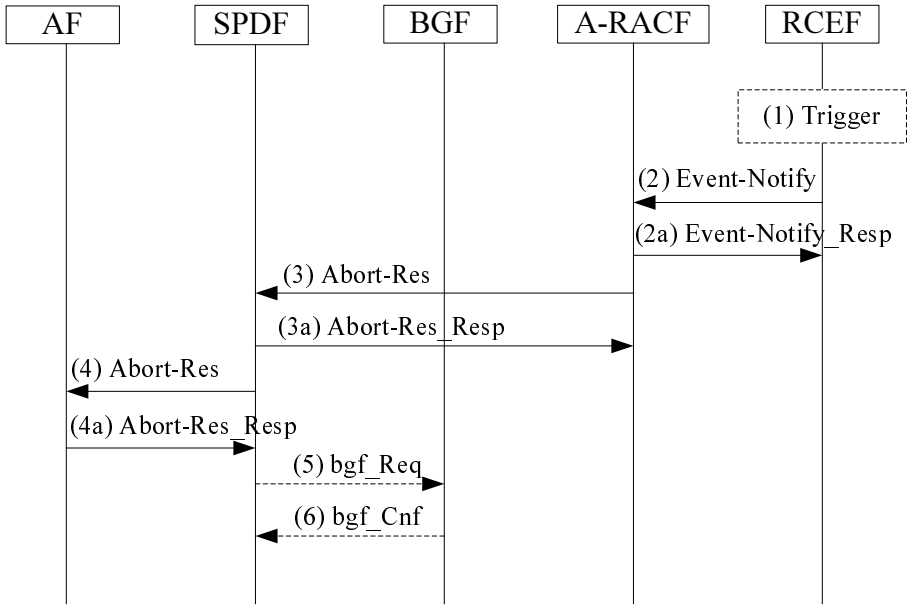



**Figure 24: Abnormal event reported by the RCEF**

1) The RCEF decides that it can no longer support the previously installed traffic policies (e.g. problem in the reference point).

2) The RCEF informs A-RACF that the traffic policies can no longer be applied via an Event-Notify. When multiple A-RACF instances are present in the form of hierarchical structure, the RCEF may interact with collocated A-RACF via an event-notify. This co-located A-RACF also informs the top tier A-RACF.

2a) The A-RACF sends the response to the RCEF.

3) The A-RACF needs to relinquish all associated resources. In case there are outstanding reservations, the A-RACF notifies the SPDF by sending Abort-Res. When multiple A-RACF instances are present in the form of hierarchical structure, the top tier A-RACF instance notifies the SPDF based on the results of all A-RACF instances.

3a) The SPDF sends the response to the A-RACF.

4) The SPDF reports to the AF that the resources were lost by sending Abort-Res.

4a) The AF responds to the SPDF.

5) The SPDF checks if there are resources to be released in the BGF. If yes, the SPDF sends a request to the BGF for the removal of allocated resources.

6) The BGF confirms the removal of allocated resources.

## 6.4.10 Report of BGF Events

The BGF is capable of providing dynamic information about the traffic associated to certain media. As such, applications can request RACS to be notified about certain events, for example the level of traffic usage or media activity.

In the scenario the event is reported to the AF as previously requested.

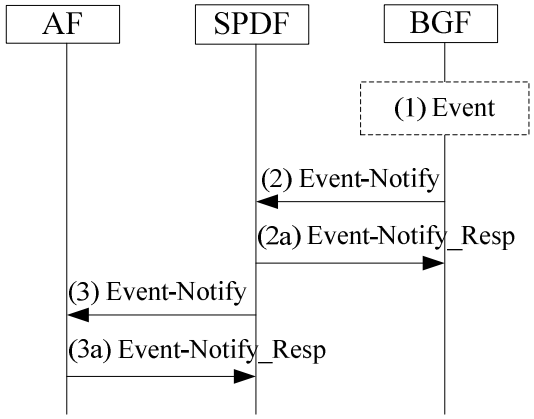



**Figure 25: Report of BGF events**

1) The BGF identifies a certain traffic condition needs to be reported in accordance with a service previously requested by the SPDF.

2) The BGF sends the event notification to the SPDF.

2a) The SPDF sends the response to the BGF.

3) The SPDF forwards the event notification to the respective AF.

3a) The AF responds to the SPDF.

## 6.4.11 Indication of a BGF Service Failure (Autonomous Release of BGF)

The BGF notifies the SPDF when it detects a condition that leads to the release of previously allocated resources.

Figure 26 presents the particular case where the A-RACF is accessed.

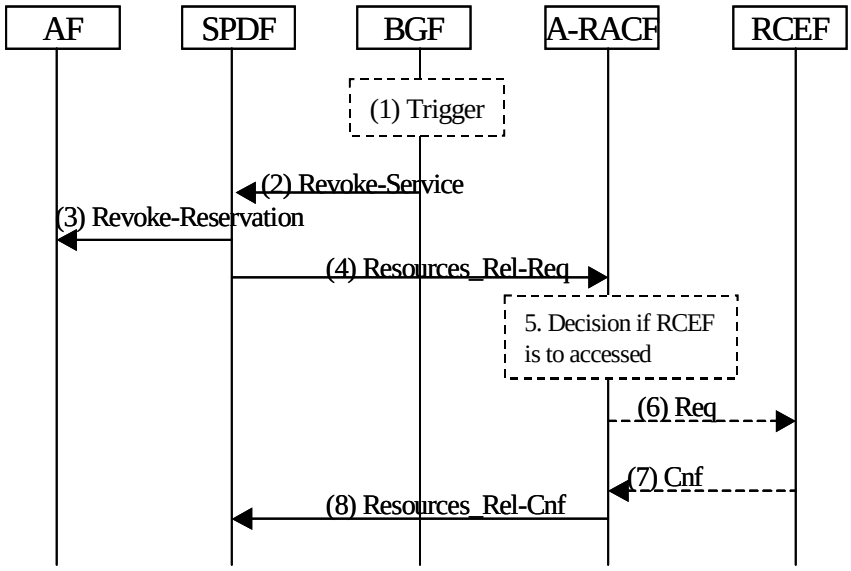



**Figure 26: BGF service failure**

1) The BGF detects a failure that affects an existing service (e.g. reference point failure).

2) The BGF informs the SPDF that the policies can no longer be applied via Revoke-Service. The SPDF verifies that there are resources to be released in A-RACF. Whether steps 4) to 7) are executed is dependent on this decision.

3) The SPDF reports to the AF that the resources of the resource reservation were revoked.

4) The SPDF requests the A-RACF to release the associated resources (depending on step 2)). When multiple A-RACF instances are present in the form of hierarchical structure, the SPDF contacts the top tier A-RACF instance for resource modification operations.

5) The A-RACF needs to relinquish all resources associated to the associated resource reservation session. The A-RACF checks if there are traffic policies to be removed in the RCEF. When multiple A-RACF instances are present in the form of hierarchical structure and are involved in reserving resources for the original reservation request from the AF, the top tier A-RACF instance forwards the request to other A-RACF instances to request the resource release.

6) The A-RACF contacts the RCEF (depending on step 5)). When multiple A-RACF instances are present in the form of hierarchical structure, the A-RACF may interact with co-located RCEF to remove the associated traffic policies.

7) The RCEF replies to the A-RACF.

8) The A-RACF replies to the SPDF with information that the resources are released.

# Annex A (informative): Binding Information in RACS, NASS and AF

The example here described uses an xDSL access line to illustrate the use of Subscriber-Id and @IP as binding information. The PPP and DHCP methods are used in a multi-VC environment to illustrate some capabilities offered by the NGN access. It is not the purpose of this annex to limit any other deployment. The same example could also illustrate the Ethernet case by replacing VCs by VLANs.

In this example, "Customer C" has a contract with Access Service Provider S to provide a broadband service.

Figure A.1 gives an example of the usage of the NASS/RACS/AF binding identities. This is a particular implementation that does not preclude other mappings.

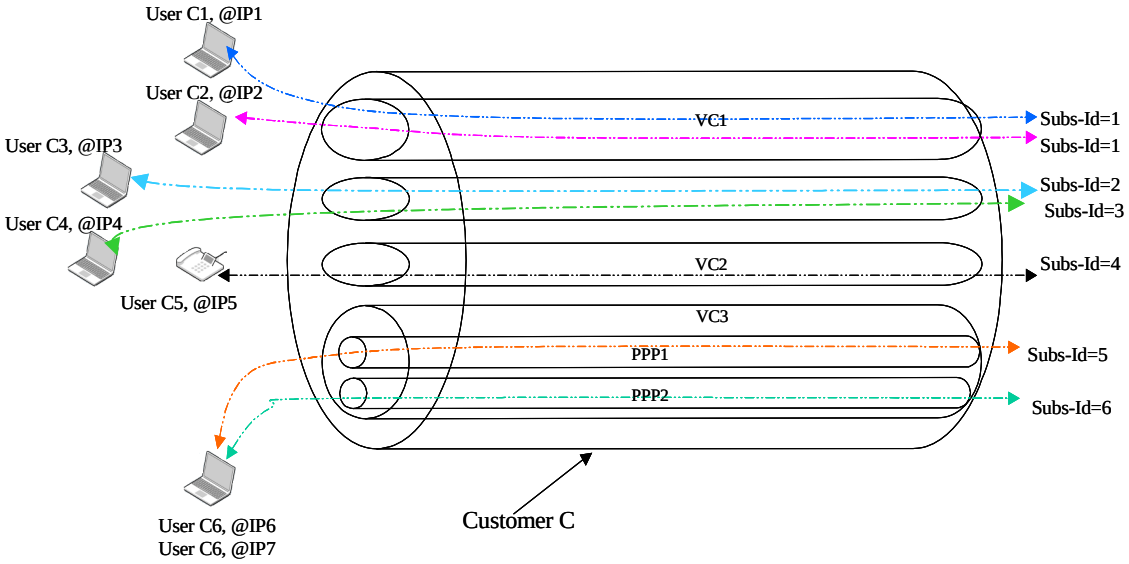



**Figure A.1: Example of use of NASS/RACS/AF binding identities**

The following consideration applies to the architecture model applied in the access network. It is a particular implementation to illustrate the possibilities of address mapping in NASS.

- Subscriber-ID and or @IP identifies the service bearer resource granted by the network to UE. In the case of PPP, it may identify the bearer (PPP tunnel) that is granted to the end user when the attachment procedure is finished. In case of DHCP, it is expected that Subscriber-ID is derived from the identity of the Client C.
- When an UE attaches to the network, NASS sends to the A-RACF the Subscriber-ID associated to this bearer together with the respective @IP. Different PPP sessions can share the same VC which results that every PPP session may have a different Subscriber-ID, even though those PPP session are over the same VC in the last mile (it does not precludes that the same Subscriber-Id is used). The model allows to the same UE to start multiple PPP sessions.
- When the AF queries the Location of the user to NASS, the AF obtains the same Subscriber-ID as the one sent before by NASS to A-RACF.
- The AF can use the @IP and/or Subscriber-ID to reserve resources from RACS. The SPDF does not modify this parameter.

# Annex B (informative): Policy nomenclature for RACS

This annex contains tutorial information on generic policy nomenclature as a basis for the work on RACS.

## B.1 Overview

The main motivation leveraging policies within a system is to support dynamic adaptability of behaviour by changing policy without recoding or stopping a system. This also implies that it should be possible to dynamically update the policy rules interpreted by distributed entities to modify their behaviour. RACS, as a system which processes events, is an example of a generic policy control Sub-System. This clause outlines key terms related to policy and policy control. Additional details can be found e.g. in RFC 3198 [9] ("Terminology for Policy-Based Management") and RFC 2753 [10] and which outlines "a Framework for Policy-based Admission Control", including definitions for terms like Policy Enforcement Points (PEP) and Policy Decision Points (PDP), which are evolved towards a more granular definition of policy here. Other industry fora such as the BroadBand Forum also define policy control frameworks (see BroadBand Forum [11]).

## B.2 Policy Terminology

### B.2.1 Policy

A policy is a set of rules which governs the choices in behaviour of a system. A policy comprises conditions and actions, where conditions are evaluated when triggered by an event. A policy is attached to a target and in the context of a target, if a condition evaluates to true, then the associated actions are executed. A system that supports the execution of policies exposes methods to provision, update and delete these policies. Further, it provides methods to activate and deactivate policies against the targets of policy supported by the system. The execution of policies may result in the provisioning or activation of policies on interconnected systems. This is known as policy delegation.

### B.2.2 Conditions

A condition in its most general form is any expression that can evaluate to true or false. A condition is often referred to as a match criterion (i.e. if a specific criterion is met/matched, then the associated action(s) will execute).

### B.2.3 Actions

Actions within a policy are generally domain specific. For example, there could be some actions that are applicable to executing a security related policy and there could be some actions that are applicable to executing a QoS/bandwidth-management policy (e.g. guaranteeing minimum rate or low latency behaviour).

### B.2.4 Events

As noted earlier, the notion of an event provides the trigger for evaluating a condition. In some contexts the trigger mechanism for evaluating a condition (i.e. an event) can be implicit and thus an explicit event cannot be observed. For example, when a policy applies to traffic traversing a network device (e.g. a traffic policing feature is applied to traffic identified by a certain 5-tuple), the condition is typically some match criterion based on the value(s) of some field(s) in a packet and the implicit triggering event is the arrival of a packet (i.e. the condition is evaluated on each packet at the time of arrival of the packet). In other contexts, however, it is important to have an explicit event to trigger the evaluation of a condition because in the absence of such a trigger there is no basis for knowing when to evaluate the condition.

# B.3 Types of Policy

## B.3.1 Authorization Policy

Authorization policies define what services or resources a subject (i.e. user or management agent) can access (see also Damianou, N. et. al [12]) and which actions a subject can perform. One differentiates between positive authorization policies, which specify sets of permitted actions, and negative authorization policies, which correspondingly define forbidden actions. If one or more active authorization policies are in scope for the received request, these policies are executed and any associated actions conditionally invoked. Policy processing entities commonly allow for explicit provisioning and storage of authorization policies as manageable entities.

Within RACS, SPDF as well as A-RACF are examples of entities which implement authorization policies. When an authorization request is received by either SPDF or A-RACF, the SPDF or A-RACF will determine and execute all applicable policies.

## B.3.2 Obligation Policy

Obligation policies are event-triggered condition-action rules [12]. Obligation policies allow for performing a wide range of management-type of actions such as the allocation of bandwidth resources for a particular flow or the release of certain resources in case of failure scenarios (e.g. abnormal condition or overload condition event reported from BGF to SPDF). Actions within an obligation policy can include sub-obligation policies which can be processed locally or remotely. Sub-obligation policies can be activated as an action of the containing policy or can be embedded conditions/actions that are executed within the scope of an event processed by the containing policy.

## B.3.3 Traffic Policy

NOTE: See definition in clause 3.1.

## B.3.4 Control Policy

Policies for which the execution trigger is an explicit control-plane event (e.g. a signalling event, a timer expiry event, etc.) and for which the action(s) does not entail the processing of a forwarded data packet, are known as control policies.

# Annex C (informative): Admission control scenarios

This annex contains tutorial information on admission control scenarios in order to better understand the third bullet item indicated in clause 6.2.2.5.1 of A-RACF Functional Entity.

## C.1 Example of the handling of Connection Oriented network in the aggregation segment

The example described hereinafter constitutes a scenario that shows how A-RACF performs resource admission control in Connection Oriented network types.

In the broadband access network, the Network Access Provider performs the pre-provision of the network by creating logical channels (e.g. VP/VC, VLAN, MPLS LSP) between the AN and the IP_Edge by allocating bandwidth to these channels in advance based on network policy, making use of e.g. NMS, remote login or local configuration. All the logical channel information and related bandwidth parameter are stored or reported to A-RACF. Each logical channel bears a transport class so that every AN-IP_Edge pair has a full set of channels to connect each other. This information is used by the AN and by the IP_Edge to perform QoS flow classification and mapping to L2 logical channels. When AN has not the ability to do flow classification, the CPN can be considered instead to perform the L3 to L2 mapping, and in that case the policy can be provisioned by NMS or by other controller.

Also, both the AN and the IP_Edge may perform DiffService QoS policy control and other Layer 2 switches located between the AN and the IP_Edge may either also perform DiffService control or just do cross connection. These Layer 2 switches, even though may have the DiffService capability, may not perform bandwidth control, i.e. they may just schedule packets by transport priority, e.g. SP- strict priority. The bandwidth control is only performed at edge node (AN, IP_Edge) to permit flexible change of network policy. Moreover, the Layer 2 switches mainly perform Layer 2 connection data packets forwarding, and can be un-touched after the system has been setup.

After having received a QoS request from the AF, via the SPDF, and user's profile has been verified and passed, the A-RACF first selects an appropriate channel considering user's location information, transport class and IP_Edge selection information. The A-RACF subsequently evaluates whether to accept the outstanding request by comparing free quota associated to this channel and the requested quota, as well as by checking all the pre-provisioned access network policies Imposed by physical topology resource restriction. The A-RACF may dynamically derive and install L2/L3 traffic policies to the AN and the IP_Edge in order to authorize more or less bandwidth to an explicit transport class. The action is triggered by event notification, as indicated in access network policies or by resource usage status. Depending on the provider's choice, the control signalling granularity between the A-RACF and the transport processing functions can be transport class based or flow based.

# Annex D (informative): Network deployment scenarios

The TISPAN NGN architecture does not define business models but needs to support multiple network deployment scenarios in order to accommodate current as well future business models in industry. This annex provides a summary of the network deployment scenarios supported by the current RACS release, which have been used to derive architectural requirements.

## D.1 Resource control scenarios according to distribution of Service-based Policy Decision and Admission Control Functions

### D.1.1 Single NGN operator performs Service-based Policy Decision and Admission Control Functions

#### D.1.1.1 Scenario Overview

This network deployment scenario supports the model where a single operator plays both the NGN Access Network and NGN Connectivity Provider roles and therefore performs all Service-based Policy Decision and Admission Control functions required.

Figure D.1 depicts this network deployment scenario.

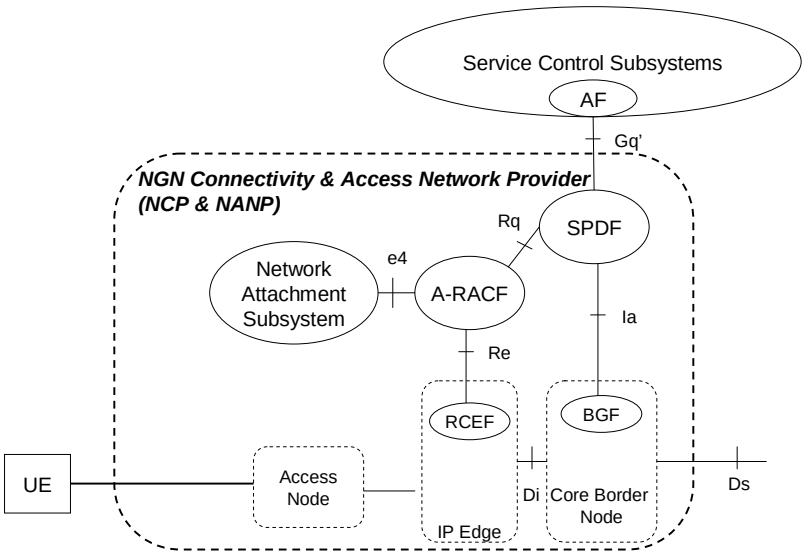



**Figure D.1: Single NGN operator performs Service-based Policy Decision and Admission Control Functions**

#### D.1.1.2 Business Need

This scenario is currently implemented in multiple NGN operators' networks.

### D.1.1.3 Mapping to TISPAN Architecture: RACS requirements

This scenario was already supported in TISPAN RACS R1 and therefore does not impose any additional requirements to the current TISPAN RACS architecture.

### D.1.1.4 Technical Analysis

#### D.1.1.4.1 Functional Element Analysis

No new functional elements are required.

#### D.1.1.4.2 Elementary Functions Analysis

No new or modified elementary functions are required.

#### D.1.1.4.3 Reference Point Analysis

No new reference points are required.

## D.1.2 Service-based Policy Decision function handled in two domains

### D.1.2.1 Scenario Overview

This network deployment scenario supports the model where two different operators play the roles of NGN Access Network Provider and NGN Connectivity Provider.

In this scenario the NGN Connectivity Provider performs some Service-based policy control itself in order to police requests from different application functions but relies on the NGN Access Network Provider to perform all Admission Control functions including:

- Admission Control based on access user profile.
- Admission Control based on available resources over the last mile (access network segment, ES 282 001 [2]).
- Admission Control based on SP profile.
- Admission Control based on available resources over the aggregation network segment.

It should be noted that the NGN Access Network Provider also performs some Service-based policy control itself in order to police requests coming from different NGN Connectivity Providers.

Figure D.2 depicts this network deployment scenario.

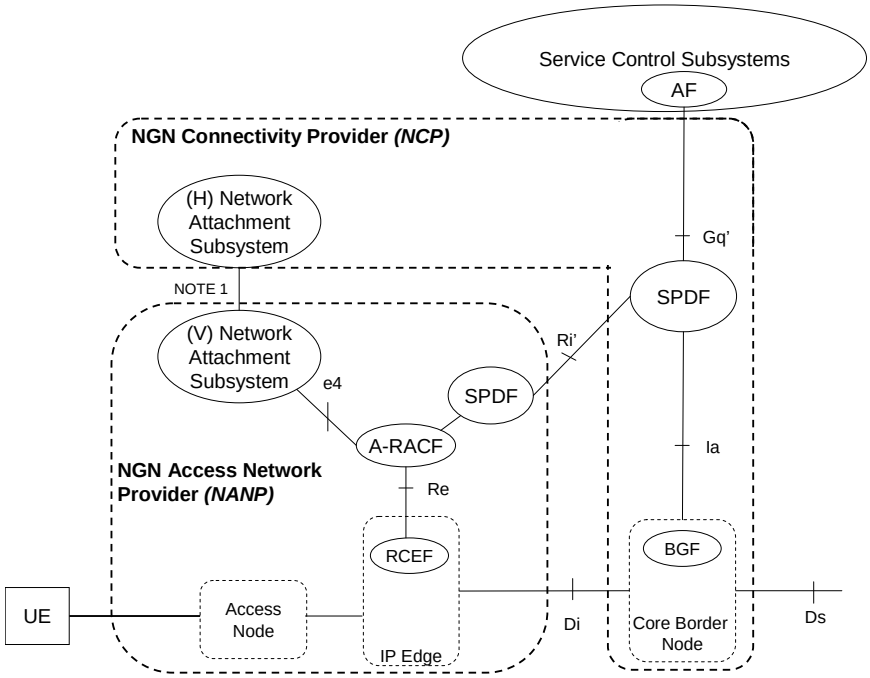



**Figure D.2: Service-based Policy Decision Function handled in two domains**

NOTE: The distribution of NASS functional elements across these two domains is outside the scope of the present document. More detail can be found in ES 282 004 [5].

## D.1.2.2 Business Need

This scenario is one possible way in which NGN operators are considering implementing wholesale and nomadism business models.

## D.1.2.3 Mapping to TISPAN Architecture: RACS requirements

This scenario requires support for inter-SPDF communication so that RACS functions related to access and aggregation networks can be distributed across domains. The inter-SPDF communication required by this scenario is limited to delegation of Admission Control decisions across access and aggregations networks.

## D.1.2.4 Technical Analysis

### D.1.2.4.1 Functional Element Analysis

No new functional elements are required. However, SPDF is now required to communicate to adjacent SPDFs via the reference point Ri'.

### D.1.2.4.2 Elementary Functions Analysis

No new elementary functions are required.

### D.1.2.4.3 Reference Point Analysis

The new reference point Ri' as specified in clause 6.3.5 is required.

It should be noted that the use of Ri' in the current TISPAN RACS release is limited to the access-network related scenarios described in this annex. Ri' does not provide support for core-to-core interconnect scenarios where coordination of admission control decisions over separate core transport networks may be required.

## D.1.3 Service-based Policy Decision and Admission Control functions distributed across two domains

### D.1.3.1 Scenario Overview

This network deployment scenario supports the model where two different operators play the roles of NGN Access Network Provider and NGN Connectivity Provider.

In this network deployment option, the NCP performs its own Admission Control decisions related to the access user profile and the available resources on the access network segment, ES 282 001 [2]. The NANP performs Admission Control decisions based on the NCP's profile and available resources over the aggregation network segment.

Figure D.3 depicts this network deployment scenario.

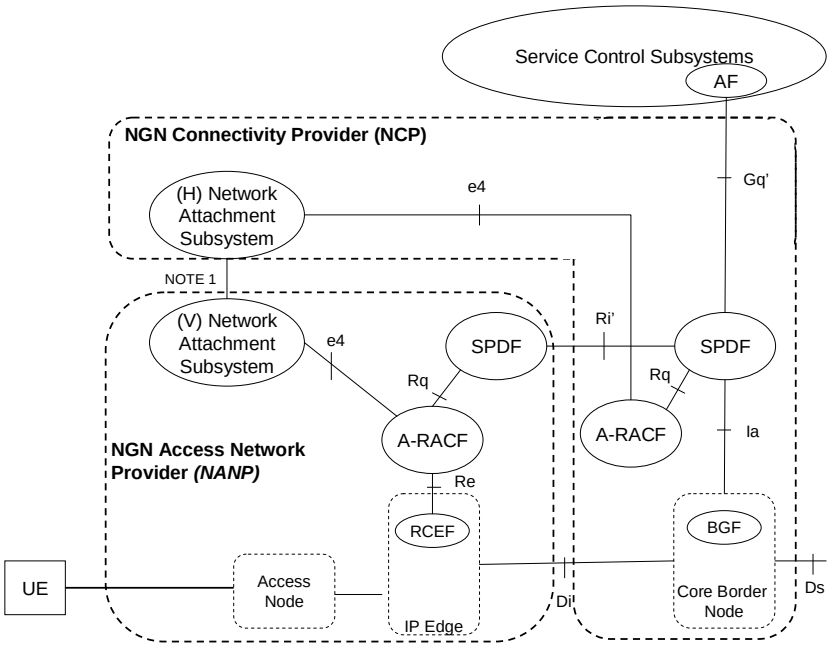



**Figure D.3: Service-based Policy Decision and Admission Control functions distributed across two domains**

NOTE: The distribution of NASS functional elements across these two domains is outside the scope of the present document. More detail can be found in ES 282 004 [5].

### D.1.3.2 Business Need

This scenario is one possible way in which NGN operators are considering implementing wholesale and nomadism business models.

### D.1.3.3 Mapping to TISPAN Architecture: RACS requirements

This scenario requires support for inter-SPDF communication so that RACS functions related to access and aggregation networks can be distributed across domains. The inter-SPDF communication required by this scenario is limited to delegation of Admission Control decisions across access and aggregation networks.

### D.1.3.4 Technical Analysis

#### D.1.3.4.1 Functional Element Analysis

No new functional elements are required. However, SPDF is now required to communicate to adjacent SPDFs via the reference point Ri' and to perform coordination of requests/responses via Ri' (from adjacent SPDFs) and requests/responses via Rq (from local A-RACF) belonging to a single resource reservation request over Gq'.

#### D.1.3.4.2 Elementary Functions Analysis

No new elementary functions are required.

#### D.1.3.4.3 Reference Point Analysis

It should be noted that the use of Ri' in the current TISPAN RACS release is limited to the access-network related scenarios described in this annex. Ri' does not provide support for core-to-core interconnect scenarios where coordination of admission control decisions over separate core transport networks may be required.

## D.2 Resource control scenarios for Multicast and Unicast

This clause outlines a number of deployment scenarios for the RACS if Unicast and Multicast admission control are both required. Deployment scenarios are understood as different options on how an operator chooses to instantiate functional entities of RACS as well as related functional entities in physical devices. These scenarios are optional and depend on the deployment context of the network operator.

### D.2.1 Independent scenario - Unicast and Multicast admission control are separated

#### D.2.1.1 Scenario Overview

For the "Independent Scenario", separate (and independent) instances of x-RACF are deployed for Unicast and for multicast. In this deployment scenario, resources are administratively split across unicast and multicast. x-RACF instance(s) handling Unicast and the x-RACF instances handling Multicast operate independently from each other and thus do not require any communication between them. Thus resources need to be partitioned across Unicast and Multicast.

NOTE: For illustration purposes, there could for example be a single instance of x-RACF for unicast and multiple instances of x-RACF for multicast, geographically distributed for enhanced multicast admission control scalability. In this deployment scenario, resources are administratively split across unicast and multicast.

#### D.2.1.2 Business Need

Not applicable.

#### D.2.1.3 Mapping to TISPAN Architecture: RACS requirements

The "Independent Scenario" does not require any additional functional elements for the TISPAN Architecture. It requires that RACS functions and transport functions related to RACS are supporting Multicast (this includes e.g. support of Multicast in x-RACF and RCEF).

#### D.2.1.4 Technical Analysis

##### D.2.1.4.1 Functional Element Analysis

No new functional elements are required, though existing RACS functions (x-RACF and SPDF) as well as related transport functions (e.g. RCEF) need to be multicast aware.

##### D.2.1.4.2 Elementary Functions Analysis

Those elementary functions impacted by multicast need to be extended to support multicast as well.

##### D.2.1.4.3 Reference Point Analysis

No new reference points are required.

### D.2.2 Synchronized Scenario

#### D.2.2.1 Scenario Overview

Similar to the "Independent Scenario", Unicast and Multicast admission control are handled by different instances of x-RACF. Different from the "Independent Scenario", the different instances of x-RACF cooperate with each other in the "Synchronized Scenario". The x-RACF instance(s) handling Unicast communicate(s) with the x-RACF instances handling Multicast in order to synchronize their view on resource utilization and availability. Therefore resources can be shared across Unicast and Multicast. Information exchange across x-RACF instances is required. The synchronization between x-RACF instances can be achieved at various granularity allowing different trade-offs between the level of synchronization overhead and the efficiency of resource sharing across Unicast and Multicast.

NOTE: For illustration purposes, there could for example be a single instance of x-RACF for Unicast and Multiple instances of x-RACF for multicast, geographically distributed for enhanced multicast admission control scalability.

#### D.2.2.2 Business Need

Not applicable.

#### D.2.2.3 Mapping to TISPAN Architecture: RACS requirements

The "Synchronized Scenario" does not require any additional functional elements for the TISPAN Architecture. It requires that RACS functions and transport functions related to RACS are supporting multicast (this includes e.g. support of multicast in x-RACF and RCEF). Given that different instances of x-RACF need to synchronize their state, a new x-RACF - x-RACF reference point is required.

#### D.2.2.4 Technical Analysis

##### D.2.2.4.1 Functional Element Analysis

No new functional elements are required, though existing RACS functions (x-RACF and SPDF) as well as related transport functions (e.g. RCEF) need to be multicast aware. The different instances of x-RACF handling Multicast and Unicast need to be able to cooperate/synchronize with each other (see also clause D.2.2.4.3 on the requirement of a new x-RACF - x-RACF reference point).

##### D.2.2.4.2 Elementary Functions Analysis

Those elementary functions impacted by multicast need to be extended to support multicast as well.

#### D.2.2.4.3 Reference Point Analysis

A new reference point x-RACF - x-RACF is required.

## D.2.3 Integrated scenario - Integrated Unicast and Multicast Admission Control

### D.2.3.1 Scenario Overview

The "Integrated scenario" describes a deployment where both multicast and Unicast admission control are jointly managed by the same single or multiple instance(s) of x-RACF. For the "Integrated Scenario", x-RACF will typically be a functional instance of A-RACF, given that both - unicast and multicast admission control are handled by the x-RACF instance. If multiple instances of x-RACF are deployed a particular resource is only handled by an instance of x-RACF, i.e. resources are never controlled by more than a single instance of x-RACF. In this deployment scenario, each instance of x-RACF handles both Unicast and Multicast. It allows sharing of resource across Unicast and Multicast. No communication is needed between x-RACF instance(s).

NOTE: The scenario relies on the use of the same x- RACF instance for both Unicast and Multicast. For illustration purposes, there could for example be multiple instances of x-RACF geographically distributed. Resources are completely shared across Unicast and Multicast.

### D.2.3.2 Business Need

Not applicable.

### D.2.3.3 Mapping to TISPAN Architecture: RACS requirements

The "Independent Scenario" does not require any additional functional elements for the TISPAN Architecture. It requires that RACS functions and transport functions related to RACS are jointly supporting Multicast and Unicast (this includes e.g. support of multicast in x-RACF and RCEF).

### D.2.3.4 Technical Analysis

#### D.2.3.4.1 Functional Element Analysis

No new functional elements are required, though existing RACS functions (x-RACF and SPDF) as well as related transport functions (e.g. RCEF) need to be multicast aware.

#### D.2.3.4.2 Elementary Functions Analysis

Those elementary functions impacted by multicast need to be extended to support multicast as well.

#### D.2.3.4.3 Reference Point Analysis

No new reference points are required.

# D.3 Resource control scenario for Metro Network

## D.3.1 Scenario Overview

This network deployment scenario supports the Admission Control functions and resource control in metro network.

Figure D.4 depicts this network deployment scenario.

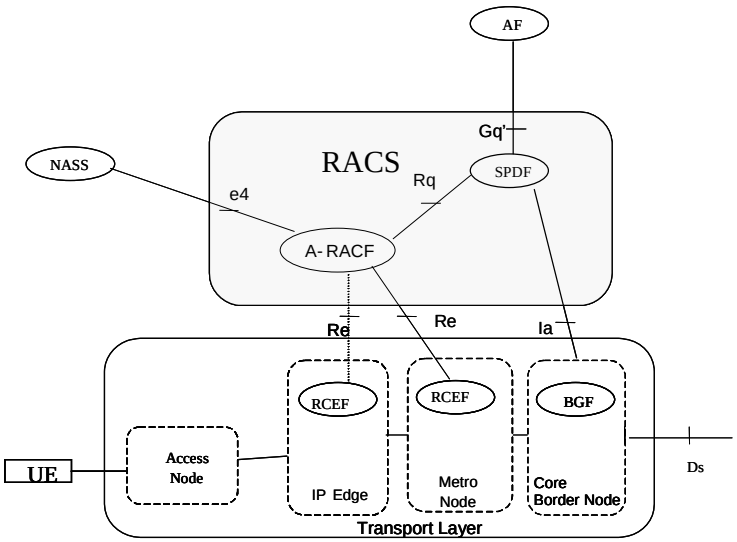



**Figure D.4: Resource Control Functions for Metro Network**

## D.3.2 Business Need

This scenario is currently implemented in many NGN operators' networks which have metro networks.

## D.3.3 Mapping to TISPAN Architecture: RACS requirements

This metro controlling scenario does not require any additional functional elements for the TISPAN Architecture. However, the following extensions are needed for metro control.

- Metro Network resource control functions should be evaluated for inclusion into x-RACF.
- RCEFs are deployed to the metro nodes for resource controlling.
- x-RACF communicates with RCEFs in metro nodes through the Re reference point.

## D.3.4 Technical Analysis

### D.3.4.1 Functional Element Analysis

No new functional elements are required. But some function extensions in x-RACF and RCEF are required for metro controlling.

The function extensions for metro control are not standardized within the present document.

### D.3.4.2 Elementary Functions Analysis

No new or modified elementary functions are required.

### D.3.4.3 Reference Point Analysis

The Re reference point is used by RACS for controlling metro nodes, and it may need extension for metro control.

This issue is not standardized within the present document.

## D.4 Resource control scenario for CPNs

This annex describes possible scenarios for the interconnection of RACS with the CPN.

The standardization of such scenarios is out of the scope of this release.

### D.4.1 Scenario Overview

This network deployment scenario supports the arrangement for admission control and resource control in the CPN, triggered by the RACS.

Several use cases lead to different possible interconnection types.

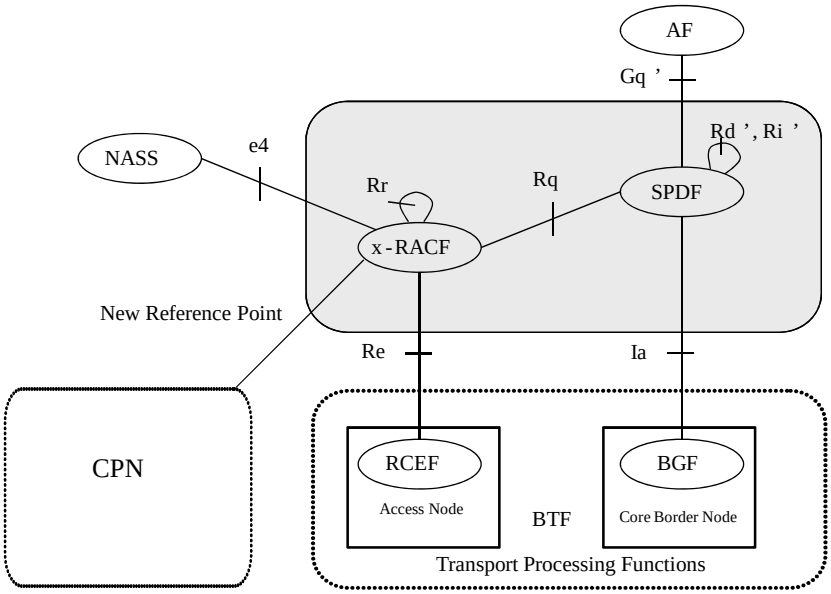



**Figure D.5: Resource Control Scenario for the CPN connecting to an x-RACF**

In the scenario depicted in figure D.5, the CPN connects to an x-RACF using a new reference point. Since the A-RACF has access to the NASS, subscriber profile information can be used before interacting with the CPN. The entity within the CPN that is connected to this reference point may act either similar to an A-RACF that implicitly connects to CPN-internal RCEF-like instances or similar to an RCEF. Whether this entity maps to existing CNG functions identified in TS 185 003 [i.4] (e.g. CNG-PCF) or new CNG functions is outside the scope of this annex. Depending on the mapping, there may be the need to define one or more new reference points between CPN and RACS.

## D.4.2 Business Need

Interconnection of the CPN with the RACS allows the RACS to arrange for resource reservations inside the CPN and on the access line that connects the CPN to the access node. Resource reservation inside the CPN is needed for end-to-end resource reservation. Resource reservation on the access line may be needed in case the access node's resources are not managed by the RACS. Policy enforcement on the upstream traffic originating from the CPN may be required.

## D.4.3 Mapping to TISPAN Architecture: RACS requirements

The RACS may interconnect with a functional entity in the CPN that acts either similar to an RCEF as described in clause 6.3.7.1.1.1 of the present document or similar to an A-RACF that does not connect to subtended A-RACFs as described in clause 6.2.1.2 of the present document.

## D.4.4 Technical Analysis

This clause is outside the scope of the present document.

### D.4.4.1 Functional Element Analysis

This clause is outside the scope of the present document.

### D.4.4.2 Elementary Functions Analysis

This clause is outside the scope of the present document.

### D.4.4.3 Reference Point Analysis

This clause is outside the scope of the present document.

# Annex E (informative): Topology and Resource Management Use Cases and Elementary Functions

This annex contains tutorial information on use cases for Topology and Resource Management and related Elementary Function definitions as indicated in requirement of clause 4.2.2.6 item 39.

## E.1 Topology and Resource Management Use Cases

### E.1.1 Initial RACS Start-up

When a RACS is deployed for the first time, it has to load relevant topology and resource data from external systems in the carrier network. This use case is illustrated by the following scenario.

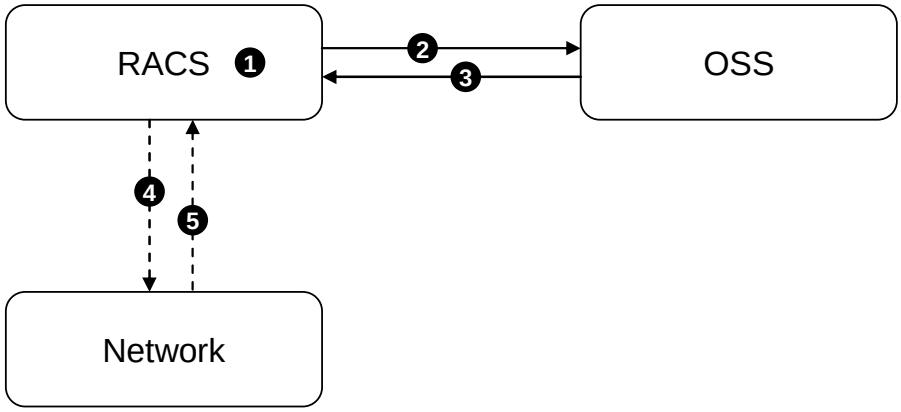



**Figure E.1: Initial RACS start-up**

Key:

1) RACS is started.

2) RACS contacts OSS requesting topology and resource data.

3) OSS sends current topology and resource data to RACS.

4) RACS initiates a network auto-discovery procedure based on data received from OSS, as represented in the next clause (optional).

5) RACS receives auto-discovered configuration data from network, as represented in the next clause (optional).

## E.1.2 Network Auto-Discovery

The RACS may be capable of auto-discovering some or all of its element and topology information. Auto-Discovery may be a singular activity (e.g. the operator clicks a button asking for RACS to auto-discover the topology) or it may be an ongoing activity (e.g. the RACS periodically initiates re-discovery procedures to update its internal knowledge of the network). In either case, auto-discovery relies on the ability of the RACS to query specific network elements and systems to obtain element and topology information. The procedure, which may be applicable to several situations including the one indicated in the first use case, is represented in figure E.2.

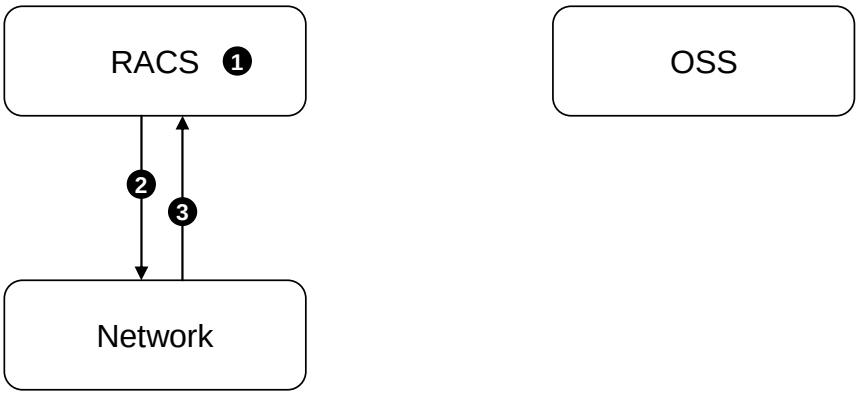



**Figure E.2: Network auto-discovery procedure**

Key:

1) RACS determines that it needs to auto-discover network data.

2) RACS initiates auto-discovery procedure based on local data.

3) RACS receives auto-discovered configuration data from network.

## E.1.3 Managing Network Elements

NGN network operators will periodically add new network elements to their network to scale subscriber and service capabilities. As new network elements are added, the RACS has to be made aware of their presence. This situation is represented in figure E.3.

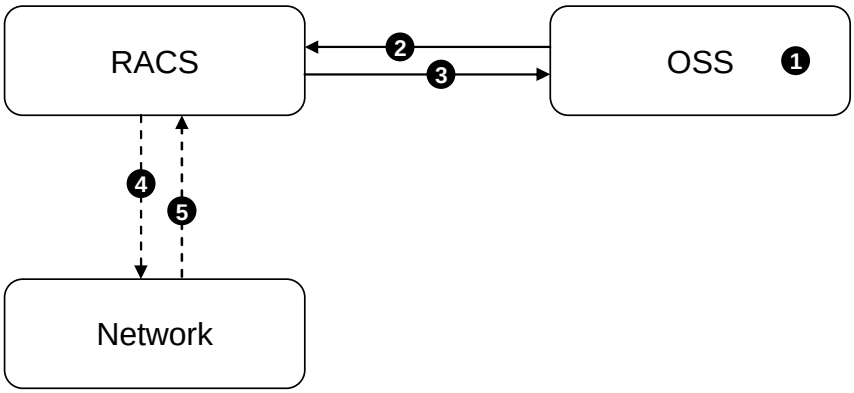



**Figure E.3: Managing network elements**

Key:

1) A network element is added/modified/removed from OSS.

2) OSS notifies RACS of the change.

3) RACS confirms change receipt.

4) RACS initiates a network auto-discovery procedure based on data received from OSS, see clause E.1.2 (optional).

5) RACS receives auto-discovered configuration data from network, see clause E.1.2 (optional).

## E.1.4 Managing Network Topology

NGN network operators will update network topology to reflect changes in the existing network configuration as well as during roll-out of new network elements. As the network topology is updated, the RACS has to be made aware of the changes. Changes may occur in the topology of the network (e.g. an AN is connected to a new IP_Edge device) or the resource associated with that topology (e.g. the VP capacity between an IP_Edge and AN is changed). This use case may be represented as follows.

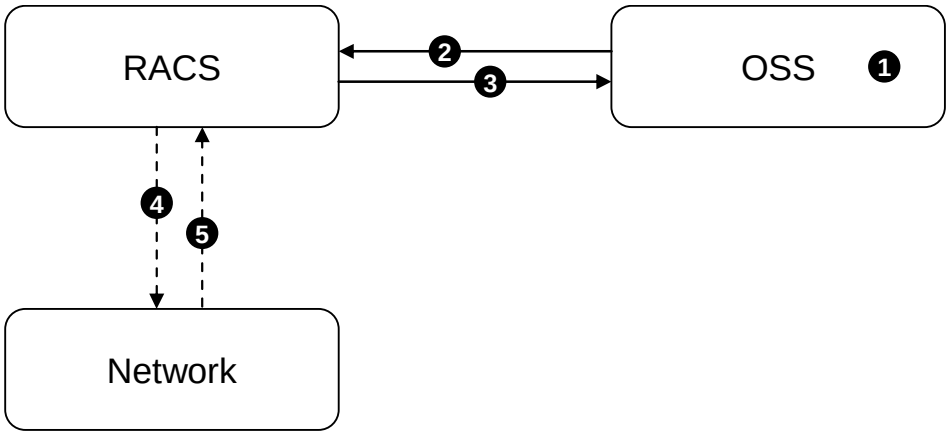



**Figure E.4: Managing network topology**

Key:

1) A network link is added/modified/removed from OSS.

2) OSS notifies RACS of the change.

3) RACS confirms change receipt.

4) RACS initiates a network auto-discovery procedure based on data received from OSS, see E.1.2 (optional).

5) RACS receives auto-discovered configuration data from network, see clause E.1.2 (optional).

## E.1.5 Real-Time Monitoring

Events within the network may temporarily change the element and topology information needed by RACS. As opposed to provisioning and auto-discovery, monitoring deals with temporary changes to the network such as the transient failure/restart of a network link or element. The RACS notification of that change may be performed directly or through the OSS system.

### E.1.5.1 Real-time Monitoring (Network Integration)

In this case, RACS is directly notified by the network and may perform a network auto-discovery procedure.

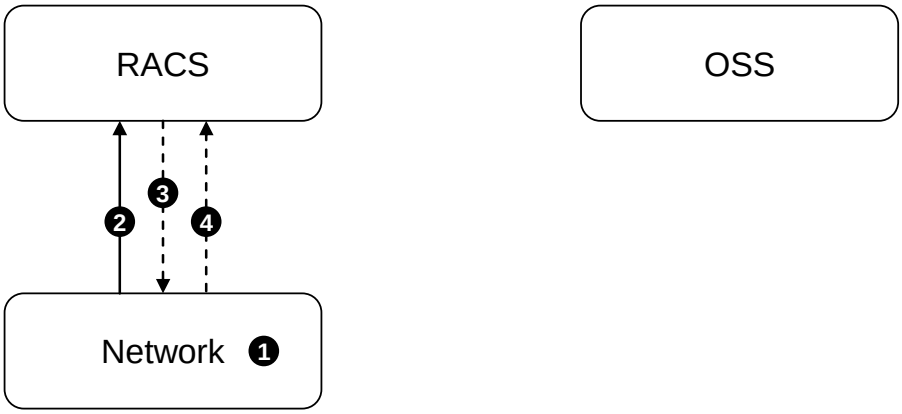



**Figure E.5: Real-time monitoring performed by network integration**

Key:

1) An event occurs within the network that modifies the state of one or more network resources.

2) Network notifies RACS that state has been updated.

3) RACS initiates a network auto-discovery procedure based on data received from network, see clause E.1.2 (optional).

4) RACS receives auto-discovered configuration data from network, see clause E.1.2 (optional).

### E.1.5.2 Real-time Monitoring (OSS Integration)

In this case, RACS is notified through the OSS and may perform a network auto-discovery procedure.

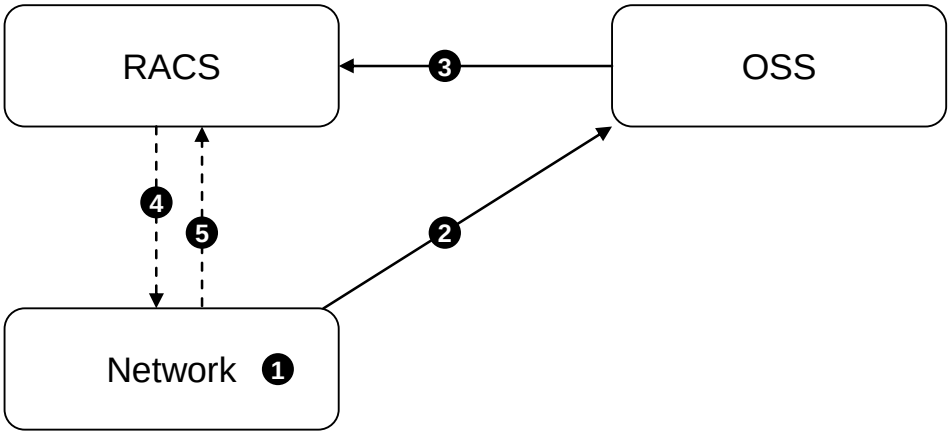



**Figure E.6: Real-time monitoring performed by OSS integration**

Key:

1) An event occurs within the network that modifies the state of one or more network resources.

2) Network notifies OSS of event.

3) OSS notifies RACS that state of network has been updated.

4) RACS initiates a network auto-discovery procedure based on data received from network, see clause E.1.2 (optional).

5) RACS receives auto-discovered configuration data from network, see clause E.1.2 (optional).

### E.1.5.3 OSS-based Monitoring

In this case, RACS is notified through the OSS, which interrogates the network to obtain further information.

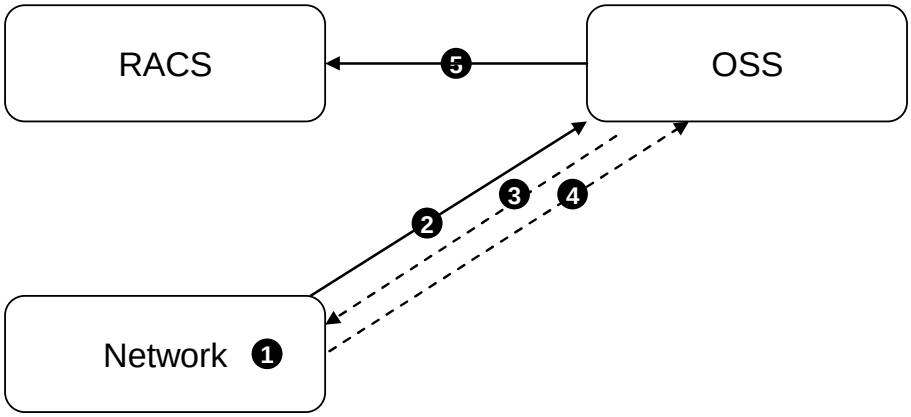



**Figure E.7: Real-time OSS-based monitoring**

Key:

1) An event occurs within the network that modifies the state of one or more network resources.

2) Network notifies OSS of event.

3) OSS requests additional information about current state of network.

4) OSS receives additional information about current state of network.

5) OSS notifies RACS that state of network has been updated.

## E.1.6 Just-In-Time Information Pull

When RACS is processing a Multimedia Authorization request, it may not have the topology information required to process the decision. The RACS can asynchronously load additional topology data from the OSS in order to continue processing the request. The following diagram illustrates this use case.

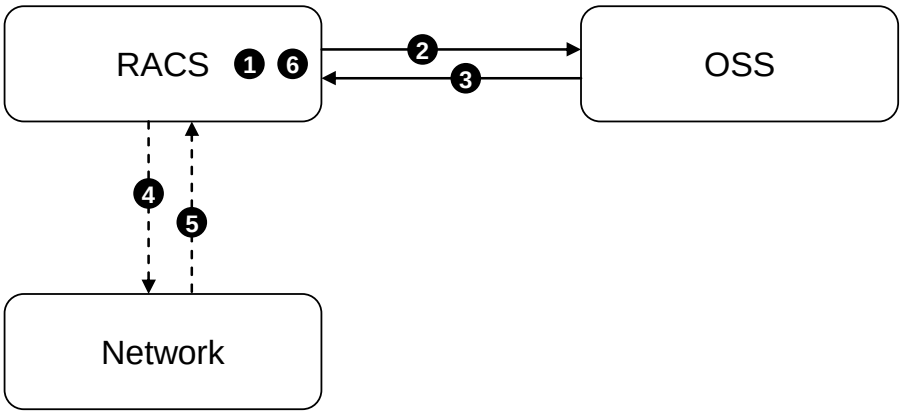



**Figure E.8: Just in time information pull**

Key:

1) RACS is processing a Multimedia Authorization request but determines that it is lacking information to process the request.

2) RACS contacts OSS requesting topology and resource data.

3) OSS sends current topology and resource data to RACS.

4) RACS initiates a network auto-discovery procedure based on data received from OSS, see E.1.2 (optional).

5) RACS receives auto-discovered configuration data from network, see E.1.2 (optional).

6) RACS continues processing the Multimedia Authorization request.

## E.2 Topology and Resource Management Elementary Functions

This clause describes the Elementary Functions that may be considered as associated with the above mentioned use cases for Topology and Resource Management. These Elementary Functions may be applicable to x-RACF or other RACS Functional Entities, e.g. the Provisioning EF is also applicable to the SPDF.

### E.2.1 Provisioning Elementary Function

The Provisioning EF provides facilities for an external system to inform the RACS of static element and network topology data. The Provisioning EF may operate in Pull or Push mode. When operating in Pull mode, the RACS will contact an external system to request a download of static element and topology data. When operating in Push mode, external systems will asynchronously notify the RACS of changes to the static element and topology data.

Provisioning is a mandatory capability of RACS.

### E.2.2 Discovery Elementary Function

The Discovery EF uses information received during Provisioning to learn additional data about the network environment. Network Discovery procedures may be initiated by a Provisioning event (e.g. new data provisioned to the RACS triggers a Network Discovery activity), a scheduled event (e.g. Network Discovery executes periodically according to operator defined configuration) or other internal events (e.g. a fault notification to the RACS causes it to initiate re-discovery activity).

Discovery is an optional, but highly desirable capability.

### E.2.3 Partitioning Elementary Function

The Partitioning EF manages the distribution of provisioned and discovered data across RACS entities (e.g. x-RACFs). The Partitioning EF may be used during Provisioning, Discovery and Monitoring to determine the set of Functional Entities that should receive an update. For example, the operator may specify that "IP_Edge Device #1" is assigned to "x-RACF #1".

The Partitioning EF is only required if the RACS employs a single point of contact for receiving provisioning and/or discovery information. If a RACS deployment has multiple points of contact (e.g. each x-RACF has its own provisioning service), then the partitioning activity is assumed to be part of an external system (e.g. OSS) that determines which entity to send updates to.

### E.2.4 Monitoring Elementary Function

The Monitoring EF tracks real-time changes to the state of provisioned and/or discovered information. The Monitoring EF receives notifications from external systems and updates the internal state of the resources affected by the event (e.g. mark a link or element as "up/down").

Monitoring is an optional, but highly desirable capability.

# E.3 Topology and Resource Management Architectural Models

The deployment of the TRSF capability may be performed using Centralized or Distributed Models as architectural basis.

## E.3.1 Centralized Model

In the centralized model, the TRSF is integrated in the RACS Sub-System. This single entity is responsible by the implementation of the Provisioning, Partitioning, Discovery and Monitoring Elementary Functions. The TRSF provides a single view of the network that is shared by the other RACS entities, and also provides a single point of contact for the OSS to communicate with RACS.

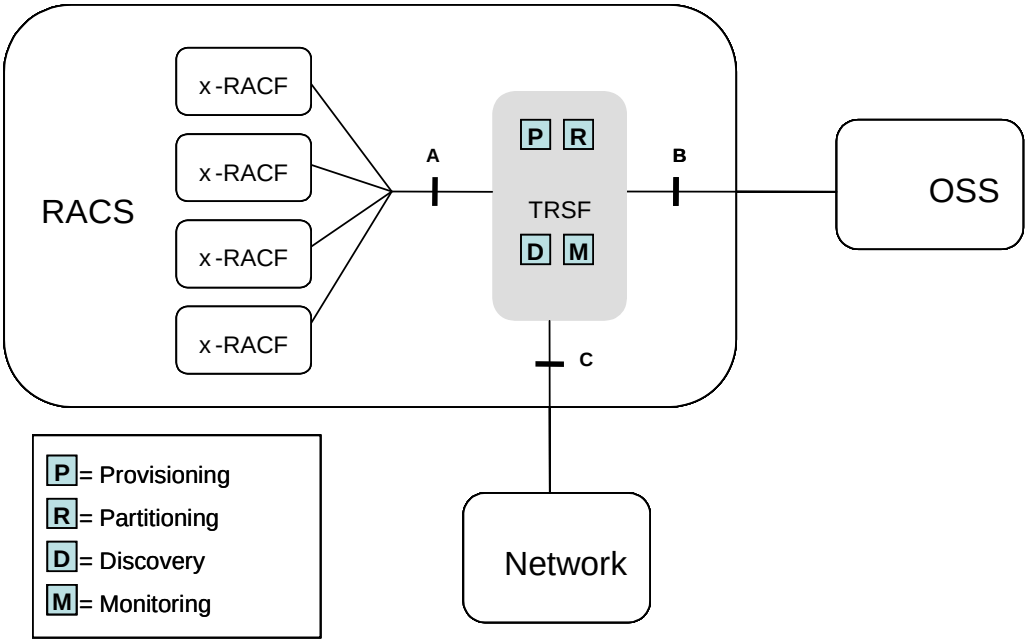



**Figure E.9: TRSF deployment based in a centralized model with integration in RACS**

In this model, the reference point "B" is the reference point between the OSS and the RACS. When the TRSF receives information over the "B" reference point it may optionally discover additional information from the network. The TRSF uses the history of information received over "B" as well as the discovered information from "C" to provide a complete and consistent view of the network over the reference point "A".

This centralized model may also be implemented by having as a basis an architecture where the functions of the TRSF are part of the OSS. This model is depicted below.

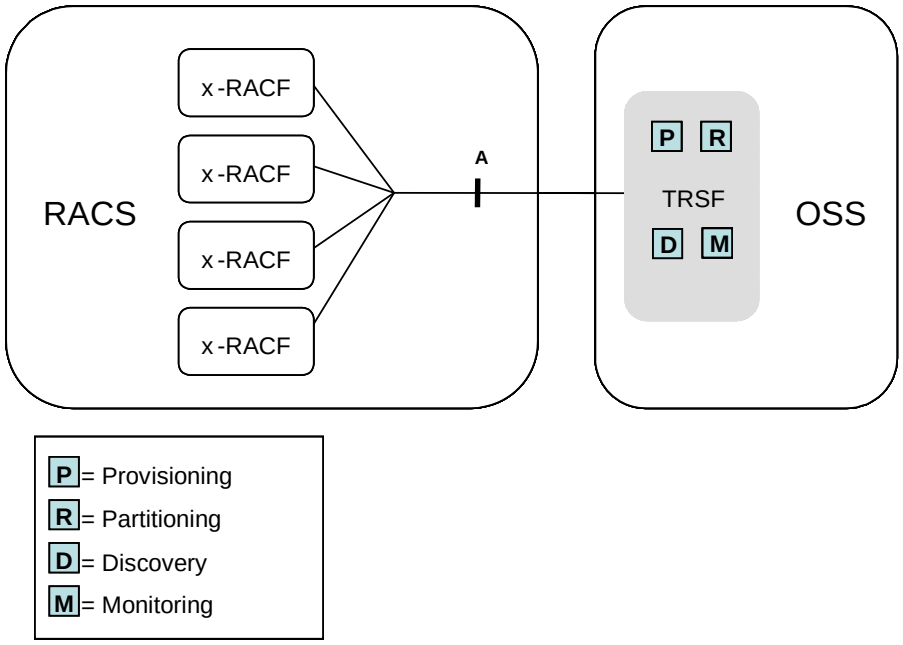



**Figure E.10: TRSF deployment based in a centralized model with integration in OSS**

In this model, the "A" reference point is the reference point between the OSS and the RACS. If this model is employed, the mechanisms by which the OSS maintains a current view of the network are outside the scope of RACS. However, RACS still requires the "A" reference point to provide each x-RACF Functional Entity with a complete and consistent view of the network.

## E.3.2 Distributed Model

In the distributed model, each RACS Functional Entity handles its own Provisioning, Discovery and Monitoring elementary functions. The OSS in this model has to provide the partitioning elementary function, as it has to understand how requests should be routed to individual RACS entities. Each RACS Functional Entity has its own view of the network which is kept consistent independent of the operation of the other RACS components.

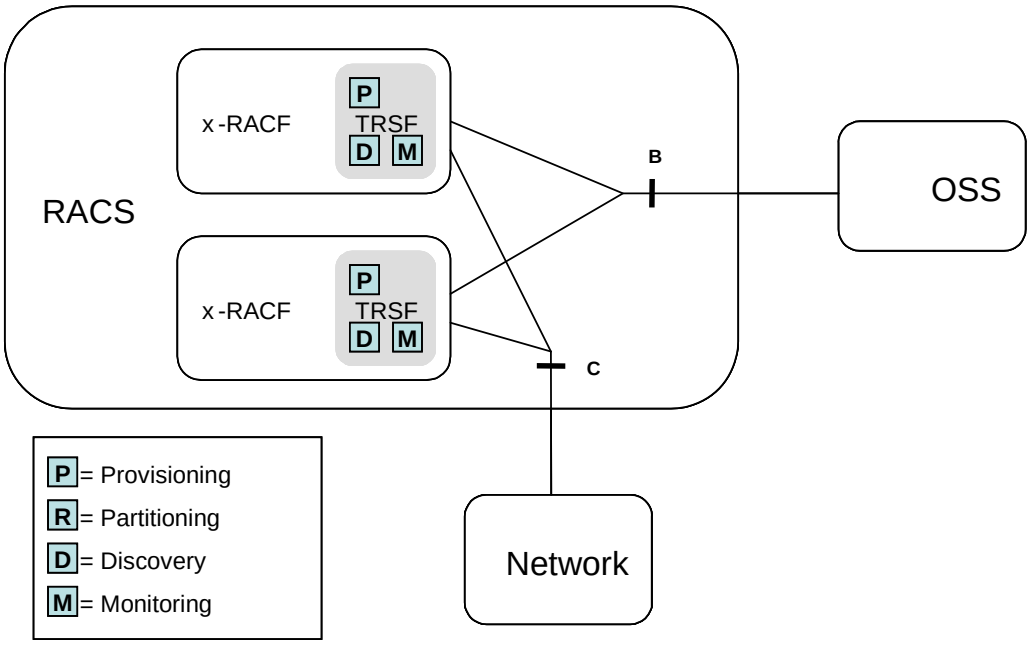



**Figure E.11: TRSF architecture based in a distributed model**

In this model, the "B" reference point is the reference point between the OSS and the RACS. However unlike the Centralized model, the OSS is presented with multiple "B" enabled endpoints. This means that the OSS has to be aware of how topology information should be distributed amongst RACS Functional Entities. This also means that the TRSF function does not require a partitioning functional area.

Each x-RACF Functional Entity in this model will perform its own auto-discovery and monitoring over the "C" reference point.

# Annex F (informative): Architectural scenarios for supporting unicast and multicast

This annex outlines a number of possible Multicast architectural scenarios for RACS to support Multicast Resource Admission Control. It should be noted that these scenarios do not represent an exhaustive list. Information flows drawn from it are shown in annex G which are the candidates for inclusion in the formal RACS flows on multicast.

## F.1 Example of an NGN Access Network Architecture for support of Multicast Resource Admission Control

The Transport Network Nodes require some functions in order for Resources Admission Control to support multicast and for these nodes to offer multicast based services such as IPTV. These Transport Network nodes may require interfacing with the RACS for Admission Control and Resource Reservation Requests and have support specific multicast transport functions for example IGMP Snooping.

Figure F.1 describes an example of an NGN Access Network Architecture, the Transport Network Nodes and their associated Multicast Functions and reference points required from Transport Network Nodes to the RACS NGN Subsystem.

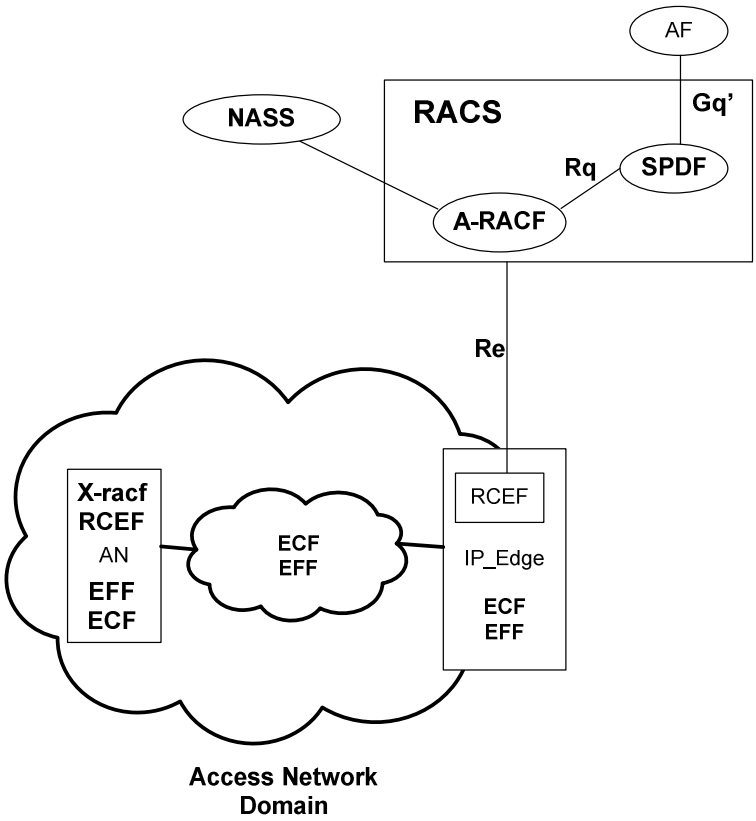



**Figure F.1: Example of an NGN Access Network Domain Architecture with Transport Node Elements and supporting Functions required for Multicast Resource and Admission Control**

All Transport Network Nodes in the Access Network Domain have to be Multicast Aware, and therefore all Transport Network Nodes have to support the Elementary Forwarding Function (EFF). The Access Node could also support the x-RACF Functional instance which enables the AN to query the RACS to verify if sufficient resources are available and make policy decisions on multicast traffic. The x-RACF functional instance may also be used to update the RACS of resources being consumed for Multicast based services. The Elementary Control Function (ECF) in the IP_Edge Node or Access Node is where IGMP and Multicast Listener Discovery (MLD) are terminated for Multicast Group Management in the Access Network Domain. The IP_Edge Node may also query the RACS to verify if sufficient resources are available for a requested Multicast Service and may update the RACS of resources being consumed in the Access Network domain.

# F.2 Scenario for supporting multicast in push mode

This scenario supports the model where push mode is used.

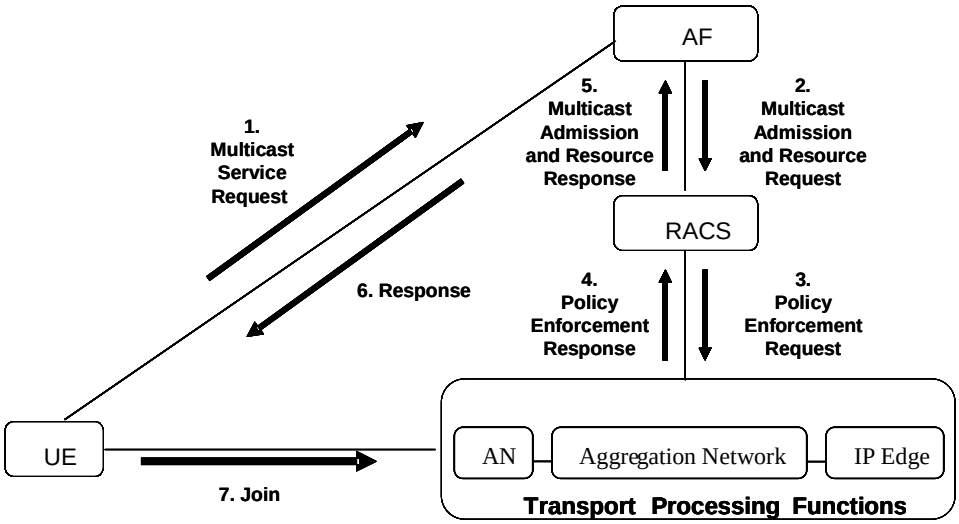



**Figure F.2: Multicast in push mode**

1) UE requests a multicast service from AF.

2) The AF issues a request to the RACS for multicast admission control and resource reservation.

3) The RACS performs multicast admission control, and resource reservation based on access network policies and resource status. RACS also decides if there are Multicast traffic policies to be installed, and pushes policy enforcement requests to the transport network element(s).

4) The transport network element(s) confirm the installation of the Multicast traffic policies and act according to the policies.

5) The RACS forwards the result of Multicast Admission Control and Resource reservation to the AF.

6) UE receives multicast service response from AF.

7) UE sends a multicast join message to request a multicast flow.

NOTE: RACS may perform admission control and reserve resources using either a centralized or distributed model:

- For a centralized model, RACS needs to maintain the multicast topology, identify and reserve resources and install multicast traffic policies to appropriate network elements.
- For the distributed model, RACS may provide messages to trigger transport network element in order to allow the transport network element to send path coupled signalling (e.g. IGMP) and to reserve resources link by link.

# F.3 Scenario for supporting multicast with UE requested QoS policy-pull mode

This scenario supports the model where pull mode is used.

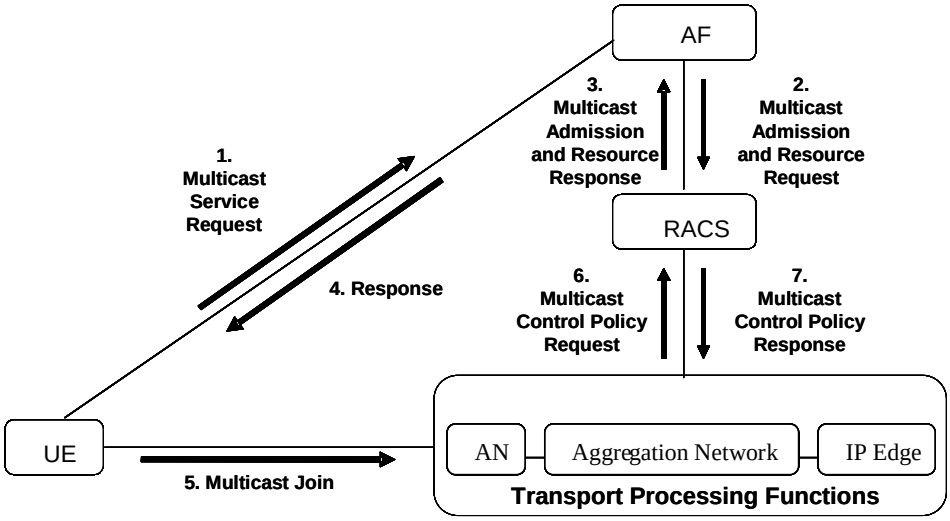



**Figure F.3: Multicast with UE requested QoS policy-pull mode**

1) UE requests a multicast service from AF.

2) The AF issues a request to the RACS for Multicast Admission control and Resource Reservation.

3) The RACS performs Multicast Admission control and resource reservation based on access network policies and resource status.

4) UE receives multicast service response from AF (see note).

5) UE sends a multicast join message to join a multicast group.

6) The ECF/RCEF in transport network element receives the join message and requests the Multicast traffic policies from RACS.

7) The RACS confirms the Policy decision, and installs the Multicast traffic policies to the transport network elements.

NOTE: Step 4 may be followed by several sets of steps 5 to 7.

# F.4 Scenario for supporting service authorization control when multicast uses the pull mode

This scenario supports the model where pull mode is used, and the RACS perform service authorization control. (Including when RACS is implemented in the transport network element).

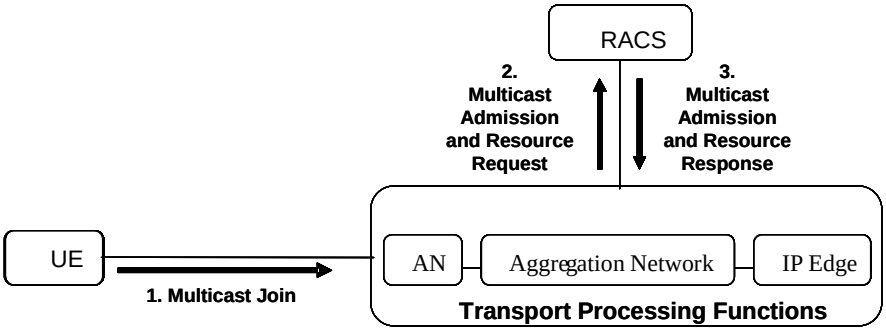



**Figure F.4: Service authorization control when multicast uses the pull mode**

1) UE sends a multicast join message to request a multicast flow.

2) The ECF/RCEF in transport network element acquires parameters (e.g. QoS and/or gate settings) according to the multicast group received from UE (see note 1), and issues a request to the RACS for multicast admission control and resource reservation (see note 2).

3) The RACS performs (see note 1) multicast admission control and resource reservation based on access network policies and resource status. Then confirms the policy decision, and enforces the Multicast traffic policies to the transport network elements.

NOTE 1: Multicast service authorization control may be performed by RACS either implemented in transport network element or in standalone server which locates outside transport layer.

NOTE 2: Service-based policies involving the SPDF are outside the scope of the present document.

# Annex G (informative): Information flows for supporting unicast and multicast

This annex outlines a number of flow diagrams that represent several unicast and multicast scenarios. The flows are intended to be regarded as informative as they only depict examples of possible solutions for those situations, but do not prevent other implementations.

Moreover, some flows assume functional and architectural capabilities not supported by the present document, which implies unresolved technical issues that are for further study and resolution in a future release. In those cases the flow depicts one of many possible evolution paths of the RACS architecture, and may or may not be supported in a future release once the technical issues are resolved.

## G.1 Information flows for enabling and disabling the multicast service

### G.1.1 Control flow for enabling multicast service

A service package is a set of elementary services - an elementary service is for instance a multicast channel, interactive channel, mosaic - that a user may subscribe to. All service elements (e.g. channels) in one service package take the same service authorization and charging policy.

NOTE 1: Service package has been described in TS 182 027 [i.1], clause 7.1. Here the service package takes the same definition but applies to not only IMS-based IPTV but also non IMS-based IPTV multicast service.

The following flow shows the procedure for enabling multicast service in RACS. The AF activates the service package via RACS, and then the UE initiates multicast request messages for joining/leaving channels within the service package.

NOTE 2: This information flow only applies to access and aggregation network.

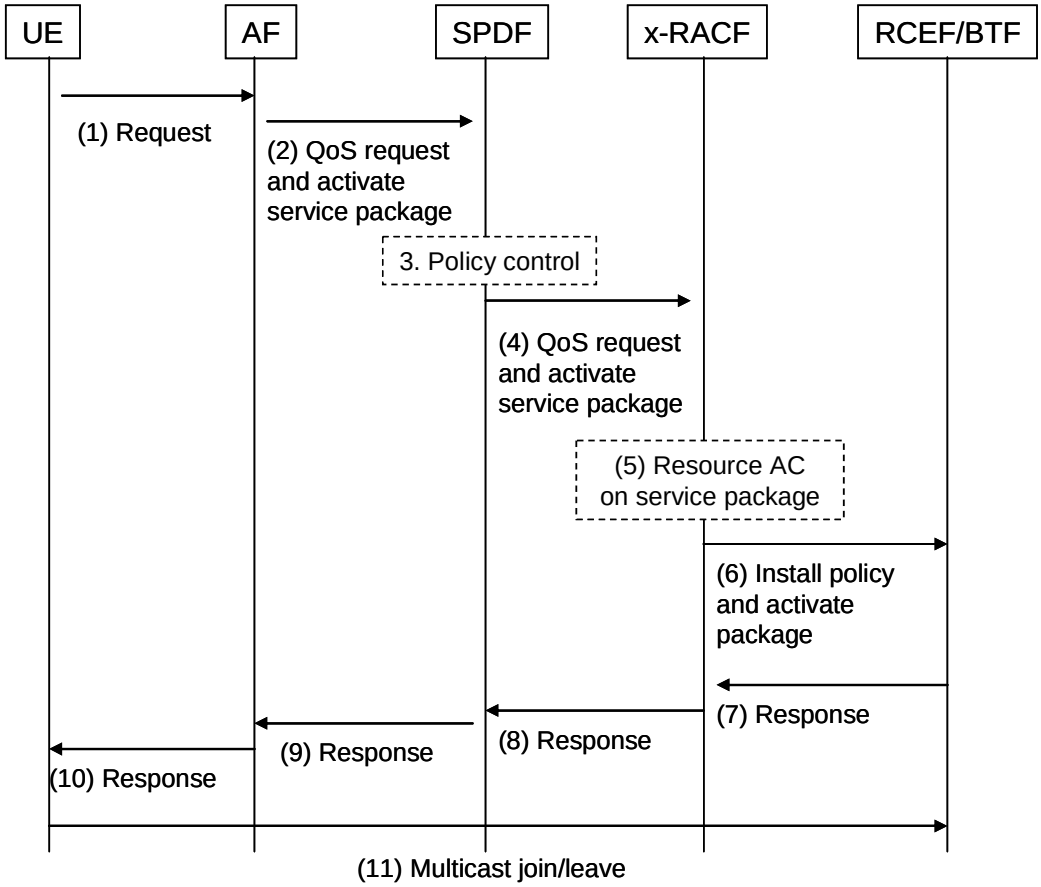



**Figure G.1: Enable of the multicast service**

1) The UE initiates a session request to one service package which contains one or more multicast flows.

2) AF authorizes and accepts the request, and sends request to SPDF to request network resource and meantime indicate SPDF to activate the service package for the UE.

3) SPDF performs service-based policy control on the service package.

4) SPDF sends request to x-RACF to reserve resource and activate the service package.

5) x-RACF may performs resource admission control on both access and aggregation segment for the service package. (e.g. x-RACF may reserve the summed bandwidth of all channels contained in the service package in aggregation segment and the maximum bandwidth among the channels in access segment).

6) x-RACF contacts RCEF/BTF in transport node to install policies and activate the service package.

7) RCEF/BTF sends response to x-RACF.

8) x-RACF sends response to SPDF.

9) SPDF sends response to AF.

10) AF sends response to UE to inform it that the requested service package can be consumed.

11) UE initiates multicast join/leave request messages to consume the channels within the service package.

NOTE 1: Step 5 is optional because admission control may also be performed using Pull mode.

NOTE 2: Step 6 is optional because operator may also select x-RACF in a standalone server to perform multicast service authorization control.

NOTE 3: This flow does not regulate how to do channel changing.

## G.1.2 Control flow for disabling multicast service

The following flow shows the procedure for disabling multicast service in RACS. The AF deactivates the service package via RACS.

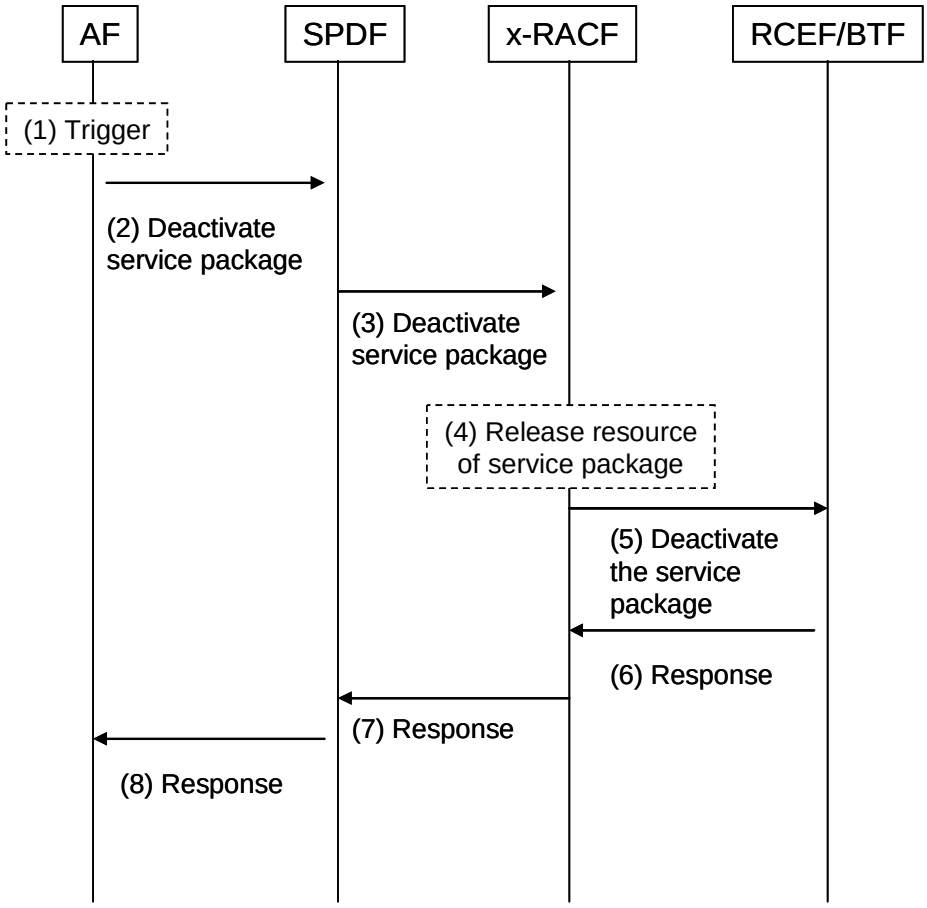



**Figure G.2: Disable of the multicast service**

1) AF gets a trigger to disable one service package of one user (e.g. user request or session keep-alive test failed).

2) AF sends request to SPDF to deactivate the service package of the user.

3) SPDF sends request to x-RACF to deactivate the service package.

4) x-RACF authorizes the request and release related resource of access/aggregation segment.

NOTE: For aggregation segment, x-RACF does not release the resource when there are other users consuming the same service package.

5) x-RACF contacts RCEF/BTF in transport element to deactivate the service package of the user.

6) RCEF/BTF deactivates the service package for the user and responses to x-RACF.

7) x-RACF sends response to SPDF.

8) SPDF sends response to AF.

# G.2 Information flows for supporting multicast in pull mode

The information flows in this clause of this annex have been recognized as technically correct. For the next releases, the issue to be resolved for allowing the contents of this clause to be inserted in the normative text is the clarification of the relationships between the elementary functions and the functional entities involved and the physical nodes (AN and IP_Edge).

## G.2.1 Request Resource in the pull mode

This clause provides an example of how a request for resources can be performed by using the pull mode mechanism.

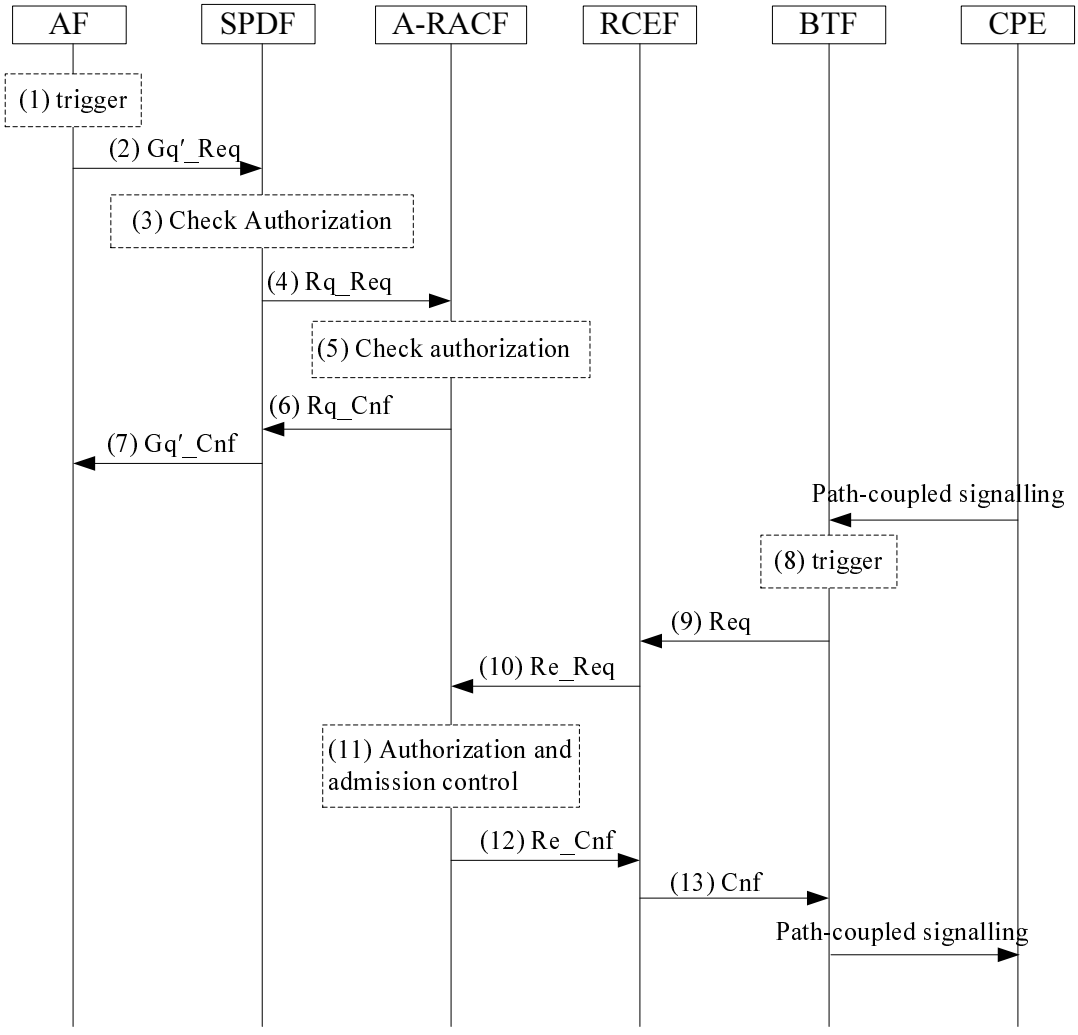



**Figure G.3: Request resource (Pull Mode)**

1) The resource initiation request is usually triggered by a service establishment signalling message.

2) The AF sends a service request to the SPDF.

3) The SPDF authorizes the request. This process consists of verifying if the required resources, present in the service request, are consistent with operator policy rules defined in the SPDF for that particular AF.

4) In case the service is authorized, the SPDF determines how to serve the request. It may be required to send the request to allocated resources of the A-RACF. The SPDF uses the local policies and the parameters in the request in order to take the decision.

5) The A-RACF maps the request from the SPDF into the internal network topology. The A-RACF performs authorization based on access network policies.

6) If the resources are authorized, the A-RACF confirms the operation to the SPDF.

7) The SPDF forwards the result to the AF.

8) The CPN initiates an explicit request for resource reservation directly to the transport functions through a dedicated path-coupled transport signalling. A resource decision request is usually triggered by a request indicated through the signalling from the CPN to reserve the required QoS resource for a given flow.

9) The BTF forwards the request to the RCEF. The BTF has to be able to filter duplicate or malicious request messages, especially if the transport signalling is refreshed periodically.

10) Based on the request from the BTF, the RCEF sends a request to the A-RACF to pull the admission control decisions from it.

11) The A-RACF checks the authorization, and evaluates the availability, if successful, reserves resources.

12) The A-RACF confirms the operation to the RCEF.

13) The RCEF sends the response to the BTF.

## G.2.2 Multicast stream in pull mode when a A-RACF is present in the AN

This scenario describes Admission Control for Multicast in case an A-RACF is present in AN.

In this scenario, it is assumed that the content is present in the IP_Edge. If the content is in the AN steps 9 to 18 are not required.

The following functional elements are involved:

- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs admission control for multicast. Its scope is limited to the access segment.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the IP_Edge. A-RACF_2 performs admission control for multicast. Its scope is limited to the aggregation segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.

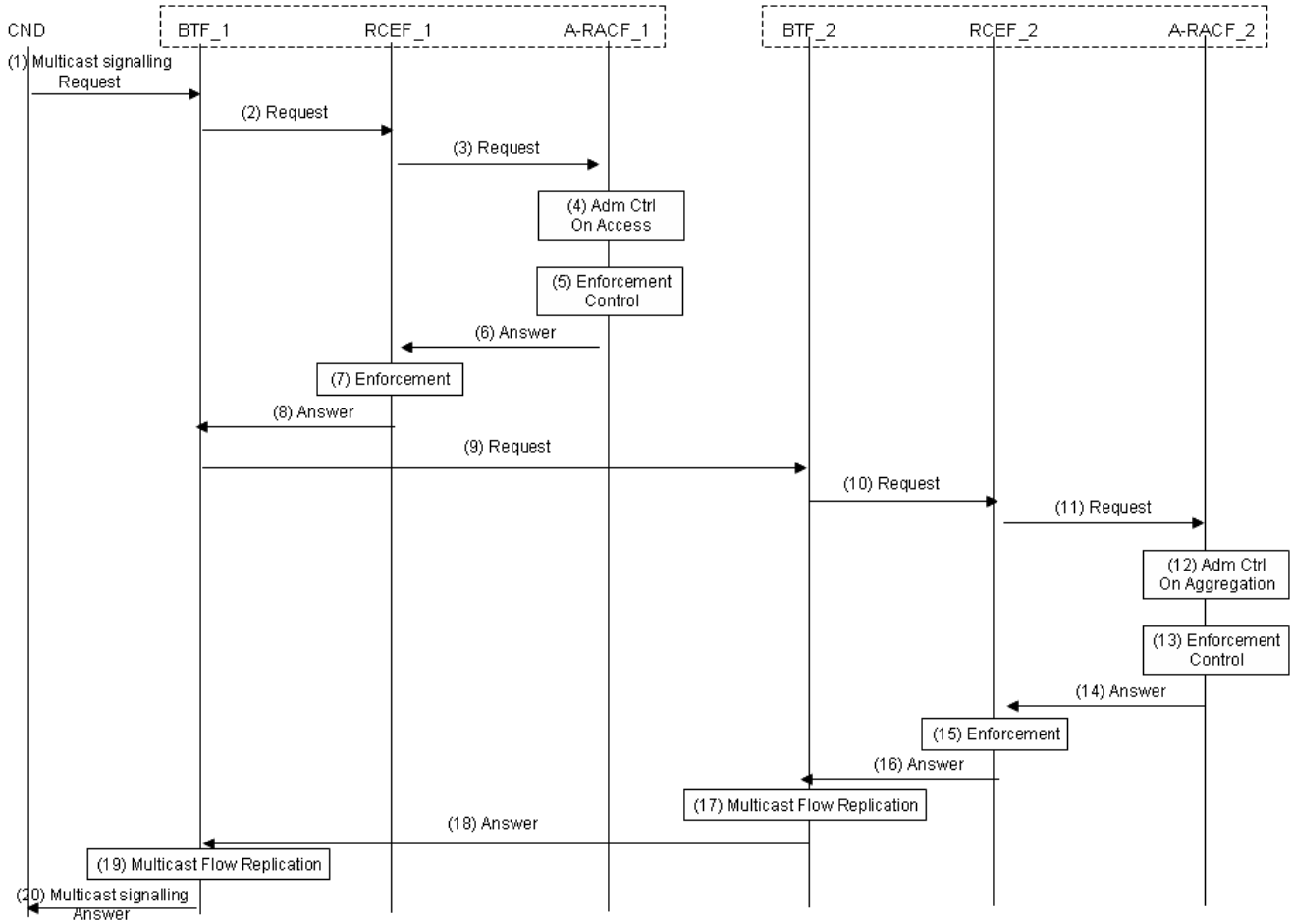



**Figure G.4: Multicast stream in pull mode when a A-RACF is present in the AN**

1) CND issues a BC request.
2) BTF_1 triggers RCEF_1.
3) RCEF_1 requests admission control and policy decision to A-RACF_1.
4) A-RACF_1 performs admission control in the access.
5) A-RACF_1 determines the policies to be installed in RCEF_1.
6) A-RACF_1 communicates the policies to RCEF_1.
7) RCEF_1 installs the policies.
8) RCEF_1 answers to BTF_1.
9) BTF_1 triggers BTF_2.
10) BTF_2 triggers RCEF_2.
11) RCEF_2 requests admission control and policy decision to A-RACF_2.
12) A-RACF_2 performs admission control in the aggregation.
13) A-RACF_2 determines the policies to be installed in RCEF_2.
14) A-RACF_2 communicates the policies to RCEF_2.
15) RCEF_2 installs the policies.
16) RCEF_2 answers to BTF_2.

17) BTF_2 replicates the flow.

18) BTF_2 answers to BTF_1.

19) BTF_1 replicates the flow.

20) BTF_1 answers to CND.

## G.2.3 Multicast stream in pull mode when a A-RACF is not present in the AN and the content is in the IP_Edge

This scenario describes Admission Control for Multicast in case an A-RACF is not present in AN and the content is in the IP_Edge.

In this scenario, it is assumed that the content is present in the IP_Edge.

The following functional elements are involved:

- BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the IP_Edge. A-RACF_2 performs admission control for multicast. Its scope spans both access and aggregation segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.

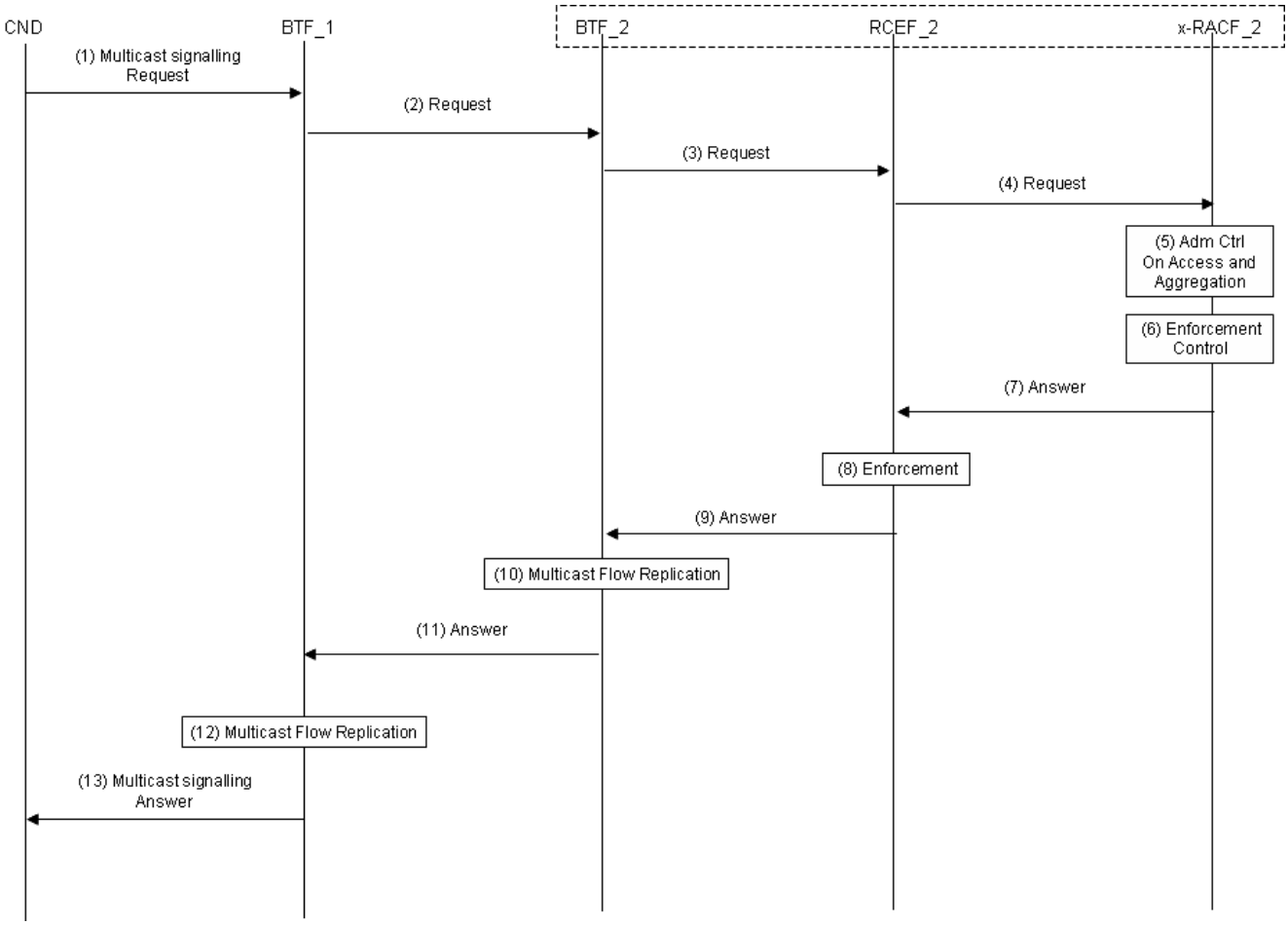



**Figure G.5: Multicast stream in pull mode when a A-RACF is not present in the AN and the content is in the IP_Edge**

1) CND issues a BC request.
2) BTF_1 triggers BTF_2.
3) BTF_2 triggers RCEF_2.
4) RCEF_2 requests admission control and policy decision to A-RACF_2.
5) A-RACF_2 performs admission control in the access and in the aggregation.
6) A-RACF_2 determines the policies to be installed in RCEF_2.
7) A-RACF_2 communicates the policies to RCEF_2.
8) RCEF_2 installs the policies.
9) RCEF_2 answers to BTF_2.
10) BTF_2 replicates the flow.
11) BTF_2 answers to BTF_1.
12) BTF_1 replicates the flow.
13) BTF_1 answers to CND.

### G.2.4 Multicast stream in pull mode when a A-RACF is not present in the AN and the content is in the AN

This scenario describes Admission Control for Multicast in case an A-RACF is not present in AN and the content is in the AN.

In this scenario, it is assumed that the content is present in the AN.

The following functional elements are involved:

- BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the IP_Edge. A-RACF_2 performs admission control for multicast. Its scope spans both access and aggregation segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.

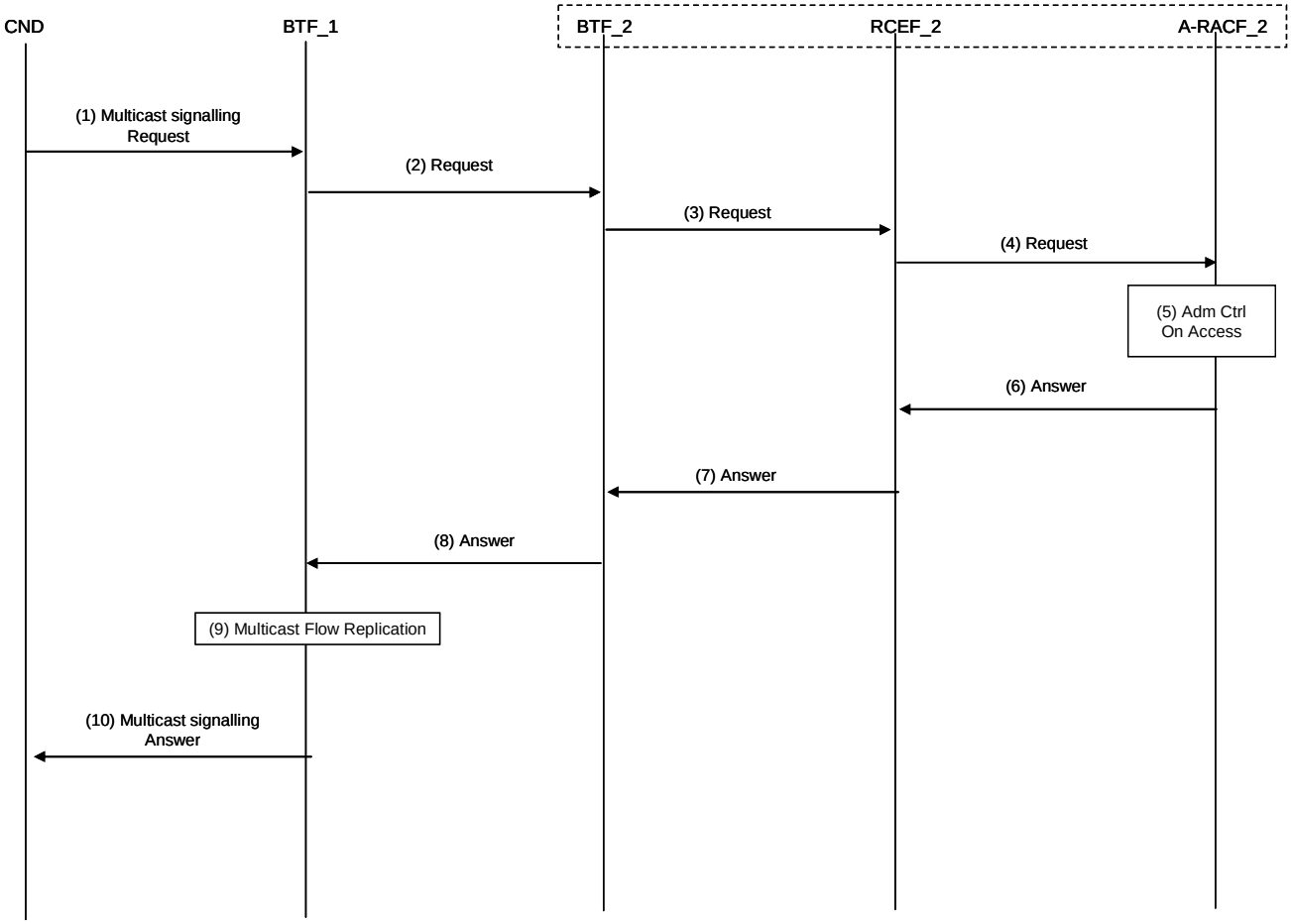



**Figure G.6: Multicast stream in pull mode when a A-RACF is not present in the AN and the content is in the AN**

1) CND issues a BC request.
2) BTF_1 triggers BTF_2.
3) BTF_2 triggers RCEF_2.
4) RCEF_2 requests admission control to A-RACF_2.
5) A-RACF_2 performs admission control in the access.
6) A-RACF_2 answers to RCEF_2.
7) RCEF_2 answers to BTF_2.
8) BTF_2 answers to BTF_1.
9) BTF_1 replicates the flow.
10) BTF_1 answers to CND.

## G.2.5 Multicast Admission Control for the Access Segment only

In this scenario, Multicast content is pre-distributed up to the Access Node.

The following functional entities are involved:

- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs Admission Control for Multicast only. Its scope spans the Multicast resources in Access Segment.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.

NOTE: The interactions between BTF_1, RCEF_1 and A-RACF_1 are internal and may be different from illustrated.

The signalling flow for a Multicast Request is illustrated in the figure below (internal interactions are illustrated as dashed lines).

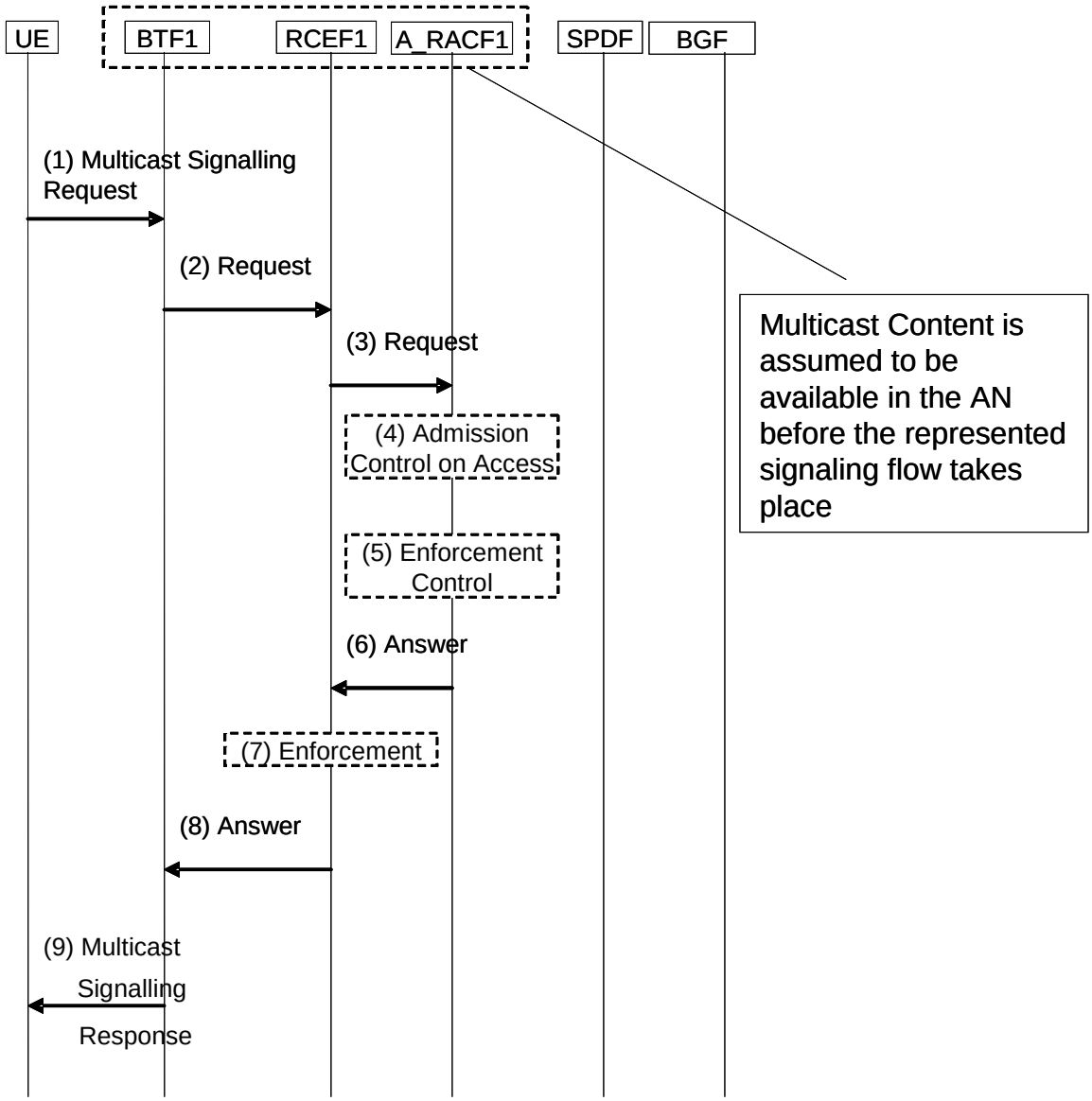



**Figure G.7: Multicast Admission Control for the Access Segment only**

1) BTF_1 receives a multicast signalling request.
2) BTF_1 triggers RCEF_1.

3) RCEF_1 requests a Policy Decision from A-RACF_1.

4) A-RACF_1 performs Admission Control on the Access Segment.

5) A-RACF_1 determines the Policy to be installed on RCEF_1.

6) A-RACF_1 answers to RCEF_1.

7) RCEF_1 installs the policy.

8) RCEF_1 answers to BTF_1.

9) BTF_1 provides multicast signalling response.

## G.2.6 Multicast Admission Control when the maximum bandwidth associated with Multicast service is over-provisioned in the aggregation segment and beyond

In this scenario, it is assumed that:

- Multicast content is not pre-distributed up to the Access Node.
- Admission Control for Resources for the Multicast service does not need to be performed in the Aggregation segment or beyond. This may be the case, for example, if the maximum bandwidth associated with Multicast service is over-provisioned in the aggregation segment and beyond.

The following functional entities are involved:

- A-RACF_1 is an A-RACF deployed on the AN. A-RACF_1 performs Admission Control for Multicast only. Its scope spans the Multicast resources in Access Segment.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.

NOTE 1: The interactions between BTF_1, RCEF_1 and A-RACF_1 are internal, and may be different from the illustrated.

NOTE 2: The interactions between BTF_2 and RCEF_2 are internal, and may be different from the illustrated.

NOTE 3: For simplicity, the Multicast signalling answer steps are not shown in figure G.11.

The signalling flow for a Multicast Request is illustrated in figure G.8 (internal interactions are illustrated as dashed lines).

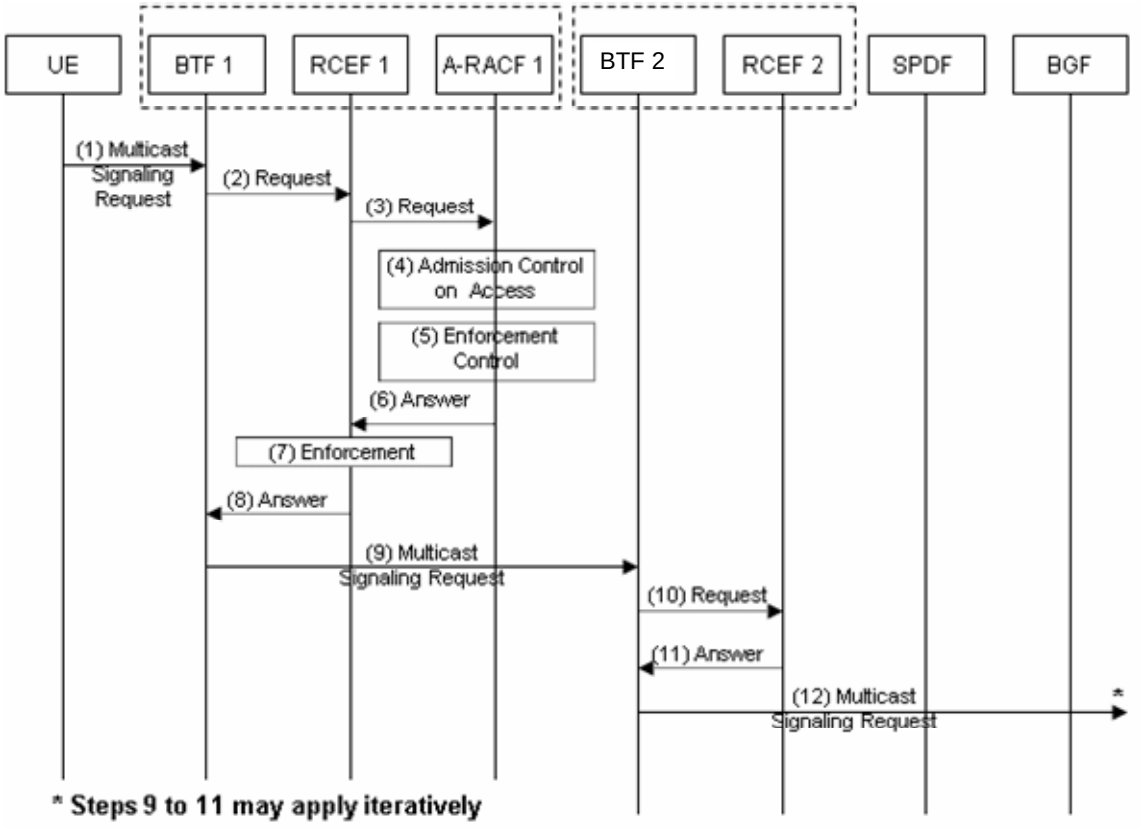



**Figure G.8: Multicast Admission Control when the maximum bandwidth associated with Multicast service is over-provisioned in the aggregation segment and beyond**

1) BTF_1 receives a multicast signalling request.

2) BTF_1 triggers RCEF_1.

3) RCEF_1 requests a Policy Decision from A-RACF_1.

4) A-RACF_1 performs Admission Control on the Access Segment.

5) A-RACF_1 determines the Policy to be installed on RCEF_1.

6) A-RACF_1 answers to RCEF_1.

7) RCEF_1 installs the policy.

8) RCEF_1 answers to BTF_1.

9) BTF_1 forwards the multicast signalling request to BTF_2.

10) BTF_2 triggers RCEF_2. The corresponding policy is assumed to be present in RCEF_2.

11) RCEF_2 answers to BTF_2.

12) If needed, BTF_2 forwards the multicast signalling request to the next BTF. Steps 9, 10 and 11 may be applied iteratively.

# G.3 Information flows for supporting multicast in mixed push and pull mode

The information flows in this clause have been recognized as technically correct. For the next releases the issue to be resolved for allowing the contents of this clause to be inserted in the normative text is the clarification of the relationships between the elementary functions and the functional entities involved and the physical nodes (AN and IP_Edge).

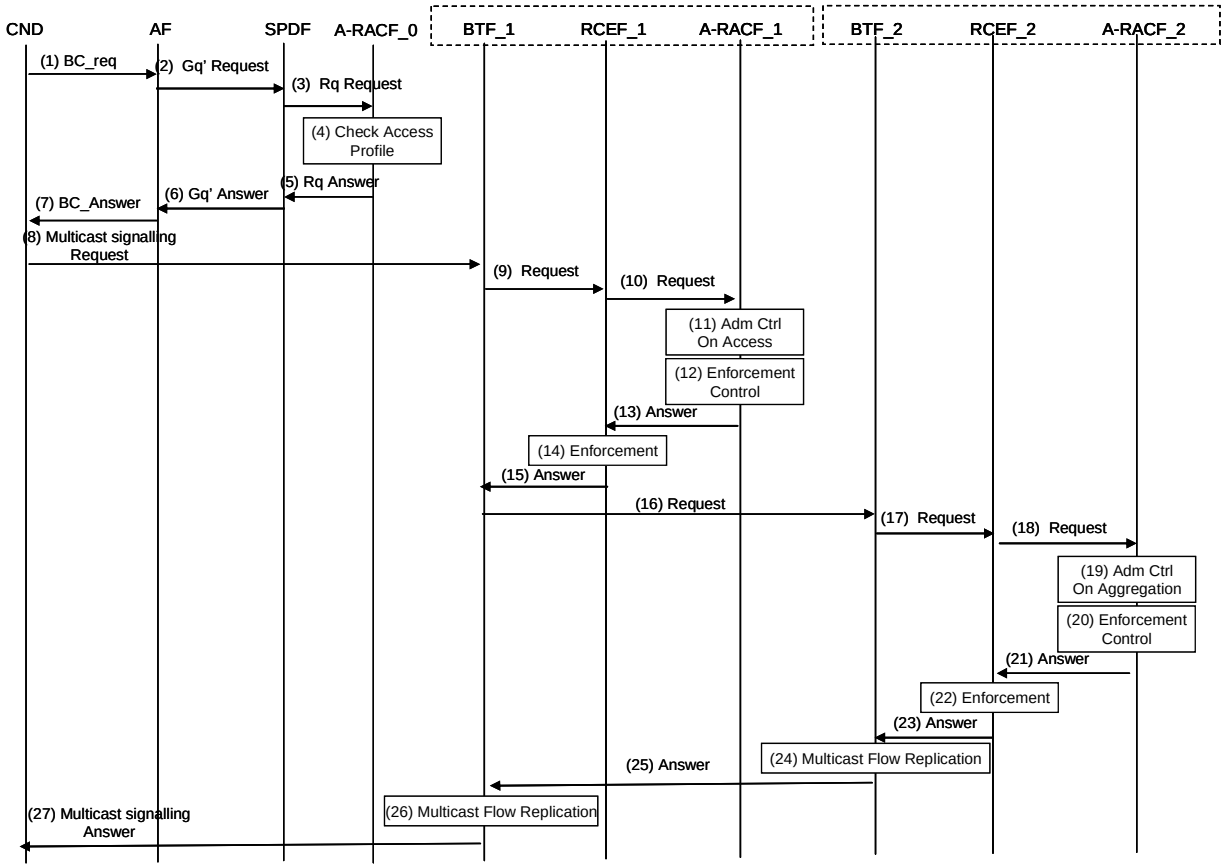
## G.3.1 Multicast stream in mixed push and pull mode when a A-RACF is present in the AN

This scenario describes Admission Control for Multicast in mixed push and pull mode in case an A-RACF is present in AN and the content is in the IP_Edge.

In this scenario, it is assumed that the content is present in the IP_Edge. If the content is in the AN steps from 16 to 25 are not required.

The following functional elements are involved:

- A-RACF_0 is a centralized A-RACF; A-RACF_0 performs the authorization of the request by checking the access profile.
- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs admission control for multicast. Its scope is limited to the access segment.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the Ip_Edge; A-RACF_2 performs admission control for multicast. Its scope is limited to the aggregation segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.




NOTE: In this scenario, the AF is assumed to be a trusted application.

**Figure G.9: Multicast stream in mixed push and pull mode when a A-RACF is present in the AN**

1) CND issues a BC request.
2) AF triggers the SPDF.
3) SPDF triggers A-RACF_0.
4) A-RACF_0 authorizes the request by checking the access profile.
5) A-RACF_0 answers to the SPDF.
6) SPDF answers to the AF.
7) AF answers to the CND.
8) CDN issues a Multicast signalling Request.
9) BTF_1 triggers RCEF_1.
10) RCEF_1 requests admission control and policy decision to A-RACF_1.
11) A-RACF_1 performs admission control in the access.
12) A-RACF_1 determines the policies to be installed in RCEF_1.
13) A-RACF_1 communicates the policies to RCEF_1.
14) RCEF_1 installs the policies.
15) RCEF_1 answers to BTF_1.
16) BTF_1 triggers BTF_2.

17) BTF_2 triggers RCEF_2.

18) RCEF_2 requests admission control and policy decision to A-RACF_2.

19) A-RACF_2 performs admission control in the aggregation.

20) A-RACF_2 determines the policies to be installed in RCEF_2.

21) A-RACF_2 communicates the policies to RCEF_2.

22) RCEF_2 installs the policies.

23) RCEF_2 answers to BTF_2.

24) BTF_2 replicates the flow.

25) BTF_2 answers to BTF_1.

26) BTF_1 replicates the flow.

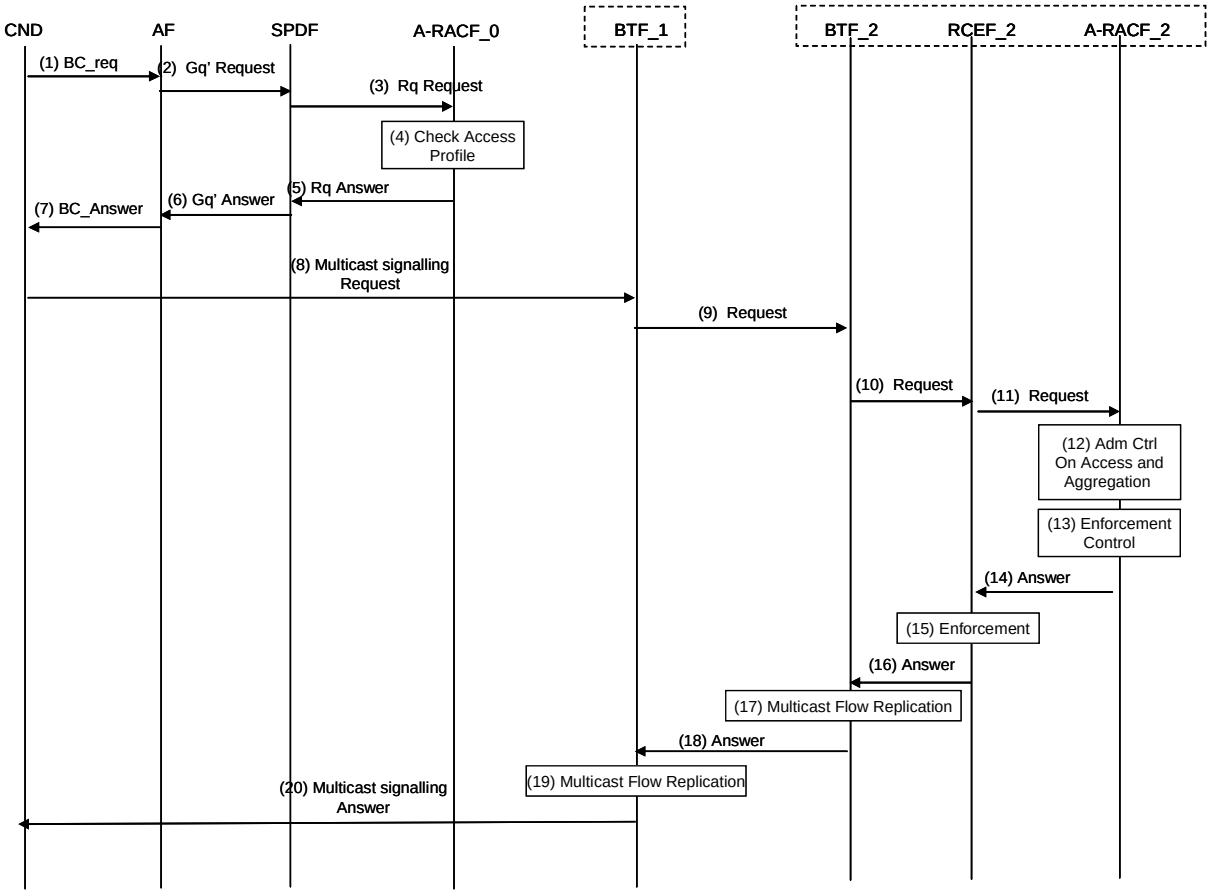
27) BTF_1 answers to CND.

## G.3.2 Multicast stream in mixed push and pull mode when a A-RACF is not present in the AN and the content is in the IP_Edge

This scenario describes Admission Control for Multicast in mixed push and pull mode in case an A-RACF is not present in AN and the content is in the IP_Edge. In this scenario, it is assumed that the content is present in the IP_Edge.

The following functional elements are involved:

- A-RACF_0 is a centralized A-RACF; A-RACF_0 performs the check of the access profile.
- BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the IP_Edge; A-RACF_2 performs admission control for multicast. Its scope spans both access and aggregation segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.




NOTE: In this scenario, the AF is assumed to be a trusted application.

**Figure G.10: Multicast stream in mixed push and pull mode when an A-RACF is not present in the AN**

1) CND issues a BC request.
2) AF triggers the SPDF.
3) SPDF triggers A-RACF_0.
4) A-RACF_0 performs the check of the access profile.
5) A-RACF_0 answers to the SPDF.
6) SPDF answers to the AF.
7) AF answers to the CND.
8) CDN issues a Multicast signalling Request.
9) BTF_1 triggers BTF_2.
10) BTF_2 triggers RCEF_2.
11) RCEF_2 requests admission control and policy decision to A-RACF_2.
12) A-RACF_2 performs admission control in the access and in the aggregation.
13) A-RACF_2 determines the policies to be installed in RCEF_2.
14) A-RACF_2 communicates the policies to RCEF_2.
15) RCEF_2 installs the policies.

16) RCEF_2 answers to BTF_2.

17) BTF_2 replicates the flow.

18) BTF_2 answers to BTF_1.

19) BTF_1 replicates the flow.

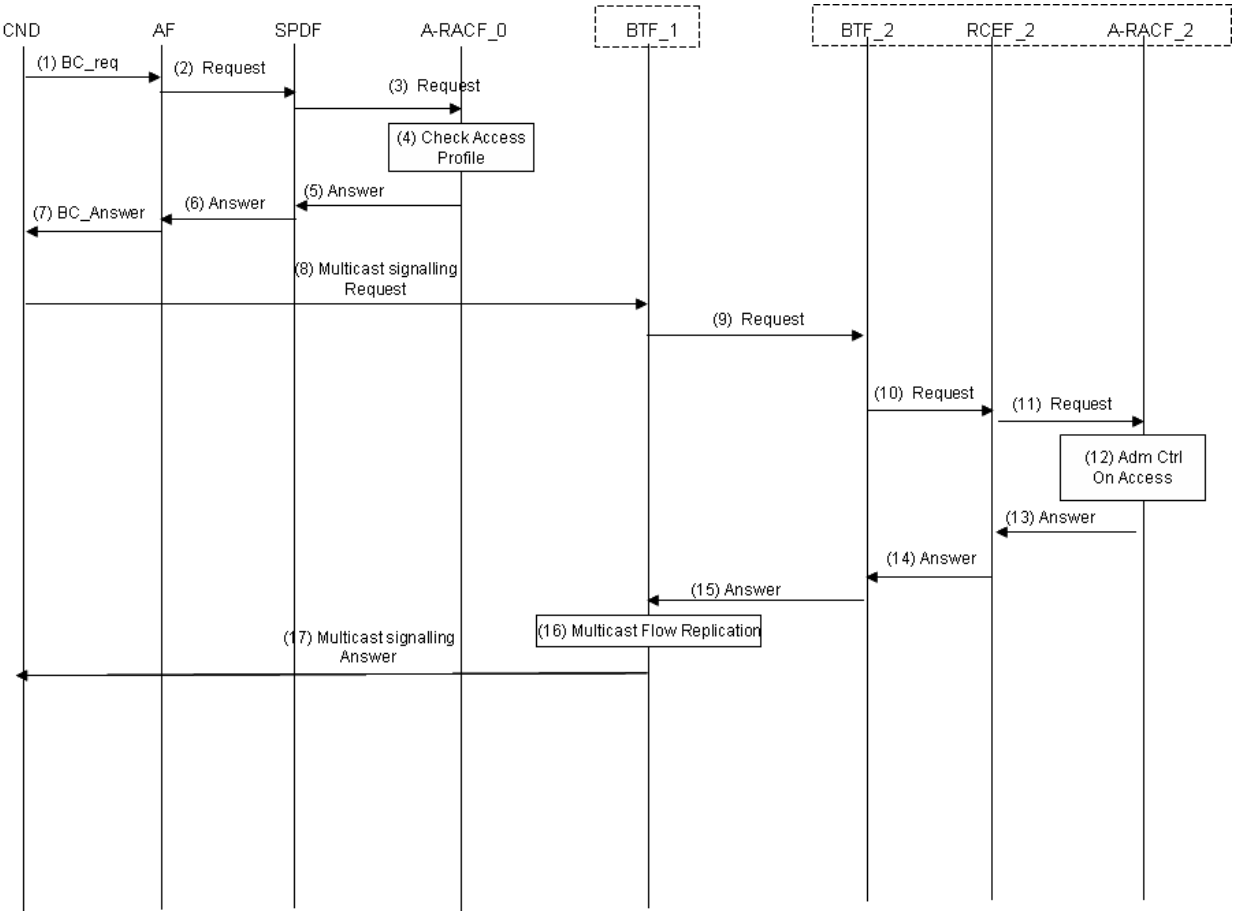
20) BTF_1 answers to CND.

### G.3.3 Multicast stream in mixed push and pull mode when a A-RACF is not present in the AN and the content is in the AN

This scenario describes Admission Control for Multicast in mixed push and pull mode in case an A-RACF is not present in AN and the content is in the AN. In this scenario, it is assumed that the content is present in the AN.

The following functional elements are involved:

- A-RACF_0 is a centralized A-RACF; A-RACF_0 performs the check of the access profile.BTF_1 is deployed in the AN.
- A-RACF_2 is an A-RACF deployed in the IP_Edge; A-RACF_2 performs admission control for multicast. Its scope is limited to the access segment.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.




NOTE: In this scenario, the AF is assumed to be a trusted application.

**Figure G.11: Multicast stream in mixed push and pull mode when a A-RACF is not present in the AN and the content is in the AN**

1) CND issues a BC request.
2) AF triggers the SPDF.
3) SPDF triggers A-RACF_0.
4) A-RACF_0 performs the check of the access profile.
5) A-RACF_0 answers to the SPDF.
6) SPDF answers to the AF.
7) AF answers to the CND.
8) CDN issues a Multicast signalling Request.
9) BTF_1 triggers BTF_2.
10) BTF_2 triggers RCEF_2.
11) RCEF_2 requests admission control to A-RACF_2.
12) A-RACF_2 performs admission control in the access.
13) A-RACF_2 answers to the RCEF_2.
14) RCEF_2 answers to BTF_2.
15) BTF_2 answers to BTF_1.

16) BTF_1 replicates the flow.

17) BTF_1 answers to CND.

# G.4 Information flows for supporting combined unicast and multicast together with resource handling

## G.4.1 Unicast and multicast services do NOT share resources on the Access Segment

This scenario describes Admission Control for Unicast and Multicast, in case Multicast and Unicast do not share the same resources in the Access Segment.

In this scenario, it is assumed that:

- Unicast and Multicast service are associated with dedicated transport resources in the Access segment.
- Unicast and Multicast service are associated with dedicated transport resources in the Access segment.

The following functional elements are involved:

- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs Admission Control for Multicast only. Its scope is limited to the Multicast resources in Access Segment.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.
- A-RACF_0 is an A-RACF performing Admission Control for Unicast only. Its scope spans the Unicast resources in Access Segment and in the Aggregation Segment.

NOTE: The interactions between BTF_1, RCEF_1 and the A-RACF_1 are internal and may be different from illustrated. The interactions between BTF_2 and RCEF_2 are internal and may be different from illustrated.

The signalling flows for a Unicast Request and a Multicast Request are illustrated in figure G.15, where internal interactions are illustrated as dashed lines.

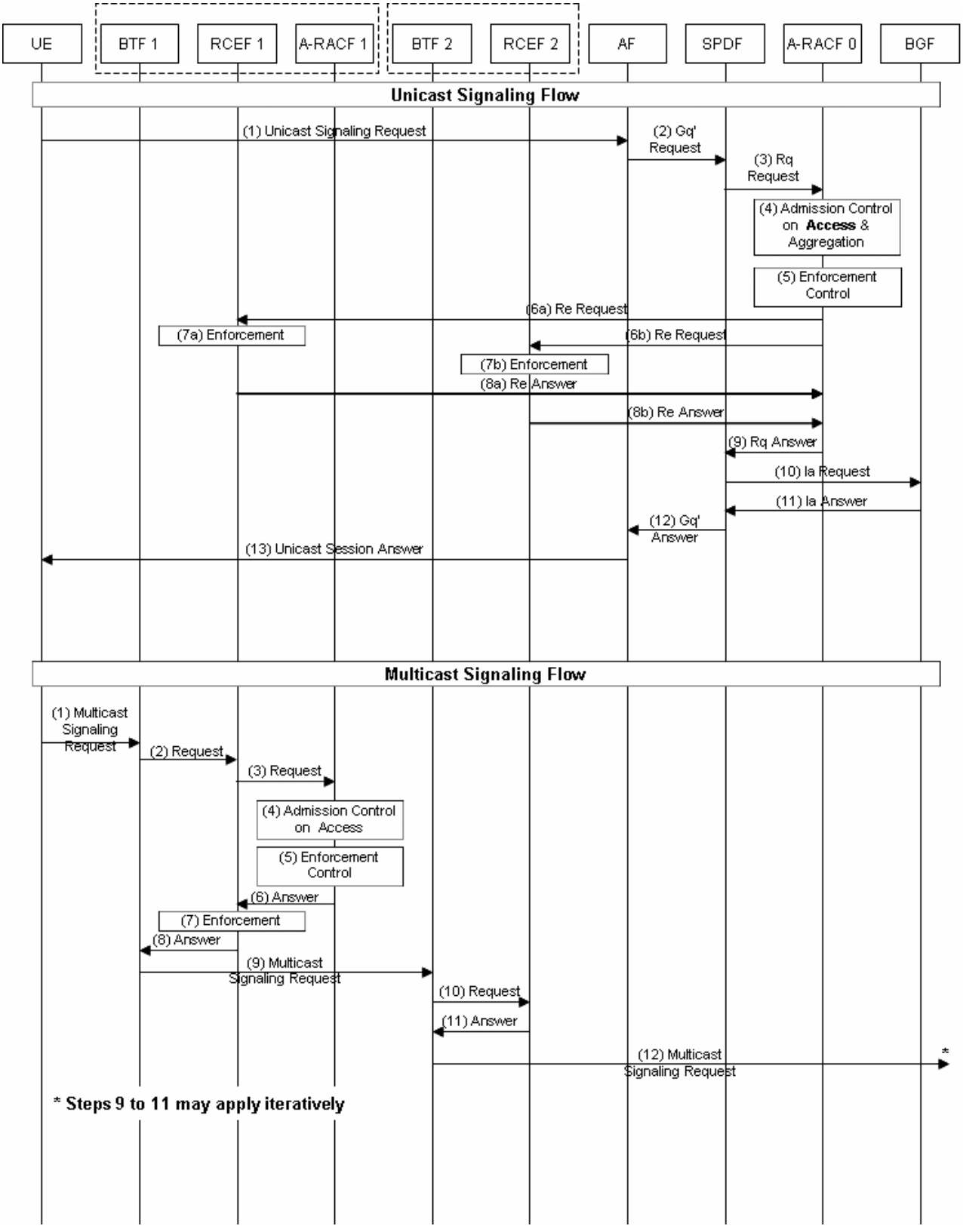



**Figure G.12: Unicast and multicast services do NOT share resources on the Access Segment**

**Unicast Signalling Flow:**

1) The AF receives a Unicast Signalling Request.

2) The AF contacts the SPDF.

3) From the point of view of the SPDF, a single x-RACF instance is visible: this is A-RACF_0.

4) A-RACF_0 performs admission control for the Access and Aggregation segments.

5) A-RACF_0 performs enforcement control.

6a) and 6b) A-RACF_0 instructs RCEF_1 and RCEF_2 for enforcement operations.

7a) and 7b) Policy Enforcement.

8a) and 8b) Answers from RCEF_1 & RCEF_2 to A-RACF_0.

9) Answer from A-RACF_0 to SPDF.

10) and 11) SPDF interacts with the BGF.

12) Answer from SPDF to the AF.

13) Answer from the AF to the UE.

**Multicast Signalling Flow:**

1) The AF receives a Unicast Signalling Request.

2) BTF1 triggers RCEF1.

3) RCEF1 requests admission control and policy decision from A-RACF_1.

4) A-RACF_1 performs admission control in the access segment.

5) A-RACF_1 determines the policies to be installed in RCEF_1.

6) A-RACF_1 communicates the policies to RCEF_1.

7) RCEF_1 enforces the policies.

8) RCEF_1 answers to BTF_1.

9) BTF_1 triggers BTF_2.

10) BTF_2 triggers RCEF_2.

11) RCEF_2 answers to BTF_2.

12) Steps 9 to 11 may apply recursively.

## G.4.2 Unicast and multicast applications share resources on the Access Segment

This scenario describes Admission Control for Unicast and Multicast, in case Multicast and Unicast share the same resources in the Access Segment.

In this scenario, it is assumed that:

- Unicast and Multicast service share the same transport resource in the Access segment.
- Unicast and Multicast service have different transport resources in the Aggregation segment.
- Admission Control for Resources for the Multicast service does not need to be performed in the Aggregation segment or beyond.

The following functional elements are involved:

- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs Admission Control for the Access Segment for both Multicast and Unicast.
- RCEF_1 is deployed in the AN.

- BTF_1 is deployed in the AN.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.
- A-RACF_0 is an A-RACF performing Admission Control for Unicast in the Aggregation Segment only. It relies on A-RACF1 for Admission Control of the Unicast service over the Access Segment.

In the presented scenario, A-RACF_1 performs admission control for multicast on the Access Segment without consulting A-RACF_0. Unicast and Multicast services share the same transport resource on the Access Segment: as such, the actual available bandwidth in the Access Segment is not known by A-RACF_0.

For this reason, whenever Admission Control for Unicast is required for the Access Segment, A-RACF_0 has to delegate this Admission Control step to A-RACF_1. A-RACF_0 cannot grant a Unicast request before A-RACF_1 has indicated whether sufficient resources are available in the Access Segment.

The signalling flows for a Unicast Request and a Multicast Request are illustrated in figure G.16, where internal interactions are illustrated as dashed lines:

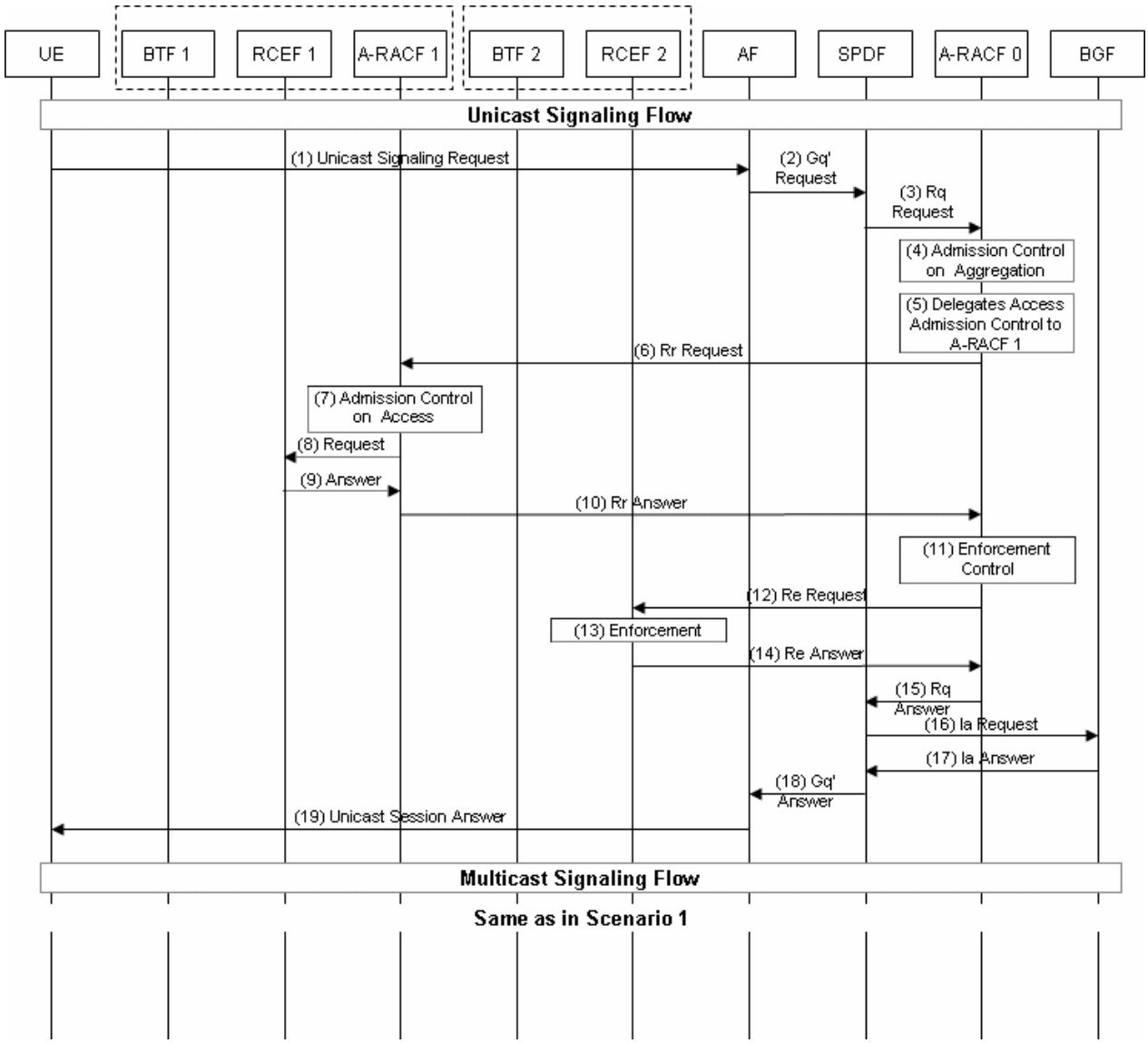



**Figure G.13: Unicast and multicast applications share resources on the Access Segment**

**Unicast Signalling Flow:**

1) The AF receives a Unicast Signalling Request.

2) The AF contacts the SPDF.

3) From the point of view of the SPDF, a single x-RACF instance is visible: this is A-RACF_0. This simplifies the dispatching decision, since the SPDF only needs to be aware of A-RACF_0. For this reason, the SPDF contacts A-RACF_0.

4) A-RACF_0 performs admission control for Aggregation segment.

5) and 6) A-RACF_0 delegates admission control for the access Segment to A-RACF_1.

7) A-RACF_1 verifies the resource availability in the Access Segment.

8) and 9) A-RACF_1 interacts with RCEF_1.

10) A-RACF_1 returns its decision to A-RACF_0 (Assumed to be granted in this example signalling flow).

11) A-RACF_0 performs enforcement control.

12), 13) and 14) A-RACF_0 interacts with RCEF_2 for enforcement.

15) A-RACF_0 returns a single answer to the SPDF (Assumed to be granted in this example signalling flow).

16) and 17) SPDF interacts with the BGF.

18) SPDF returns the answer to the AF.

19) The AF returns the answers to the UE.

**Multicast Signalling Flow:**

The same as the steps of multicast applications in clause G.5.1.

## G.4.3 Unicast and multicast applications share resources on the Access Segment

This scenario describes Admission Control for Unicast and Multicast, in case Multicast and Unicast share the same resources in the Access Segment.

In this scenario, it is assumed that:

- Unicast and Multicast service share the same transport resource in the Access segment.
- Unicast and Multicast service have different transport resources in the Aggregation segment.
- Admission Control for Resources for the Multicast service does not need to be performed in the Aggregation segment or beyond.

The following functional elements are involved:

- A-RACF_1 is an A-RACF deployed in the AN. A-RACF_1 performs Admission Control for the Access Segment for Multicast only.
- RCEF_1 is deployed in the AN.
- BTF_1 is deployed in the AN.
- RCEF_2 is deployed in the IP_Edge.
- BTF_2 is deployed in the IP_Edge.

- A-RACF_0 is an A-RACF performing Admission Control for Unicast in the Aggregation Segment and in the Access Segment. It is further handling Admission Control for Multicast in the Access Segment through delegating an Admission Control budget to A-RACF_1. A-RACF_0 is hence aware of resource reservations in both the Aggregation and Access segment.

It should be noted that it is assumed that all desired multicast streams are already present at the AN. Hence, BTF_2 and RCEF_2 need not to be involved in processing each multicast service request originating from the UE.

In the presented scenario, A-RACF_1 performs admission control for multicast on the Access Segment without consulting A-RACF_0. Unicast and Multicast services share the same total budged, i.e. transport resource, on the Access Segment. At each point in time, this total budget is strictly divided between the A-RACF_1 and the A-RACF_0 by that the A-RACF_1 is given a share of the total budget to be used for Multicast Admission Control from A-RACF_0. This share of the total budget is dynamically adapted using the Rr reference point.

An optional initialization signalling flow for installing a resource budget into A-RACF_1 is illustrated in figure G.14. Alternatives to this initialization signalling flow is to provisioning the initial resource budget to A-RACF or to entirely rely on the negotiations of steps 3.1 and 3.2 in the unicast and multicast signalling flows respectively (i.e. when A-RACF_1 and A-RACF_0 adapts the total budget in them between). Figure G.14 shows signalling flows for a Unicast Request and a Multicast Request. It should be noted that steps 3.1 and 3.2 in both the Unicast Signalling Flow and the Multicast Signalling Flow are invoked only when he shared resource budget for the Access segment needs to be adapted (i.e. when part of this budget should be moved from A-RACF_0 to A-RACF_1 or vice versa).

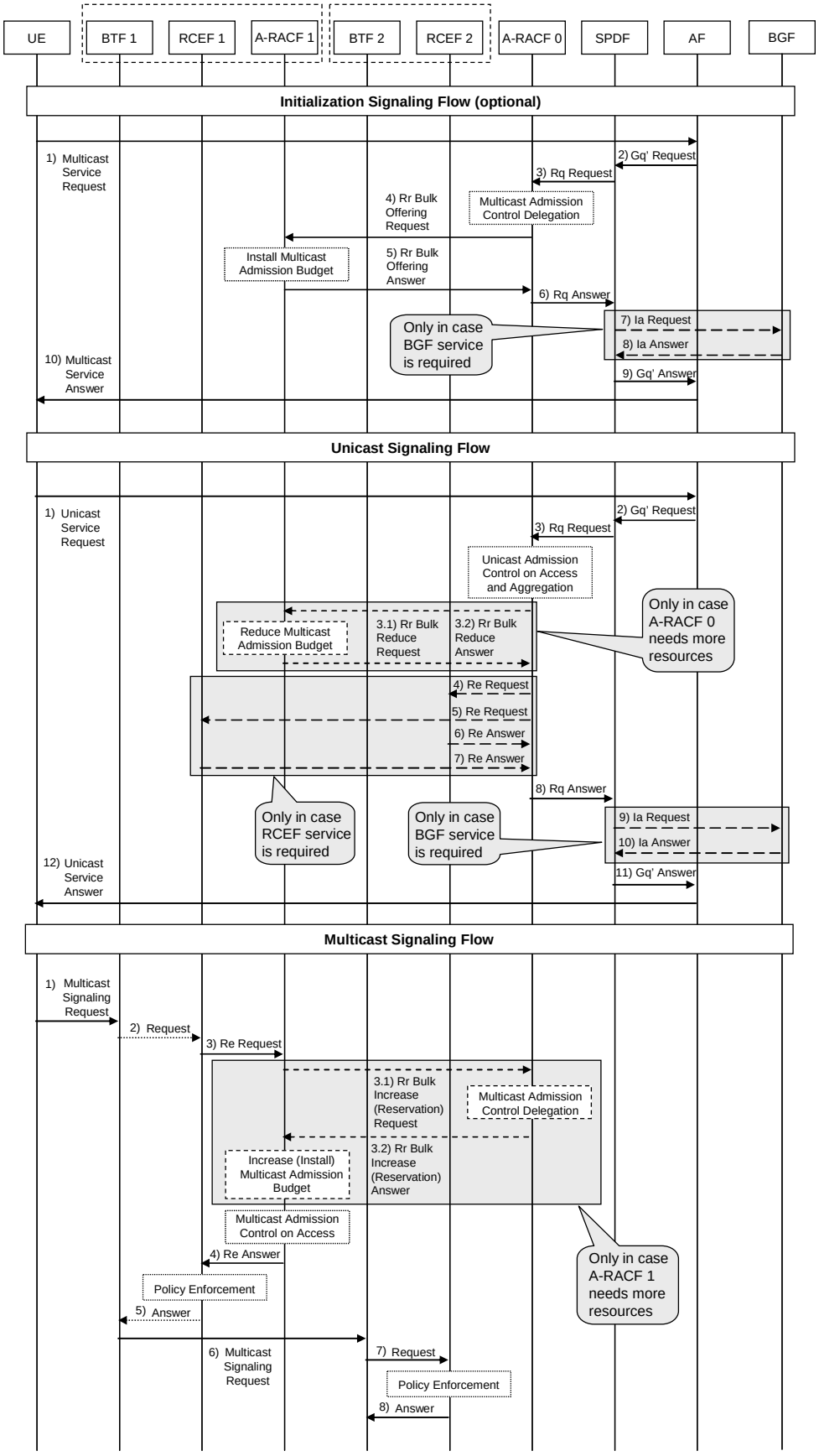



**Figure G.14: Signalling Flows for Unicast and multicast applications sharing resources on the Access Segment**

**Steps in Initialization Signalling Flow**

This signalling flow is optional. As an alternative the multicast admission control budget can be installed using local configuration (i.e. provisioned into A-RACF_1) and thereafter adapted as part for the Multicast Signalling Flow and/or the Unicast Signalling Flow. As an additional alternative the multicast admission control budget can be both initialized and adapted as part of the Multicast Signalling Flow and/or the Unicast Signalling Flow:

1) The UE requests initialization of a multicast service from the AF. This step may involve application layer authorization. The AF may further complement the request with application layer profile information for the user requesting the service before issuing a request to RACS (e.g. determining the amount of bulk bandwidth needed).

2) The AF requests the multicast service to be initialized. In this request the Service Class information element is used to indicate that the request is to initialization a multicast service. The requested bulk bandwidth corresponds to the expected demand for the most common usage. This bandwidth may be adapted as part of the Multicast Signalling Flow and/or the Unicast Signalling Flow.

3) SPDF derives the Rq request from the message in step 2.

4) The bulk bandwidth originally requested by the AF is offered to A-RACF_1 by A-RACF_0.

5) A-RACF_1 acknowledges that it has received the offered bulk bandwidth and is ready to use it for multicast admission requests arriving from RCEF_1.

6) A-RACF_0 replies to the SPDF that the bulk bandwidth is ready to be used in service multicast admission control requests.

7) In case BGF service is required, the SPDF requests those services from the BGF. It should be noted that this requests could also occur before the interaction with A-RACF_0 and A-RACF_1, or in parallel.

8) Reply from the BGF that the requested services are now available.

9) The SPDF replies to the AF to inform of that all requested initialization is performed in RACS.

10) AF informs the UE of the requested multicast service is now ready to be used.

**Steps in Unicast Signalling Flow**

It should be noted that this signalling flow is exactly the same as for release 1 from the perspective of the AF and the SPDF. The additional operations are limited to the A-RACF.

1) The UE requests a unicast service from the AF. This could be a request for an IMS session where the AF is instantiated by a P-CSCF, or a non-IMS service with another type of AF.

2) The AF requests the unicast service from RACS.

3) The SPDF derives the Rq request from the message in step 2.

   3.1) In case A-RACF_0 cannot admit the requested bandwidth immediately based on the resources it is currently in charge over, it issues a request to A-RACF_1 asking if it is willing to reduce its multicast resource budget.

   3.2) Based on local policies and/or current usage of multicast resources A-RACF_1 determines whether or not it can reduce its multicast resource budget. In this example, A-RACF_1 answers back to A-RACF_0 returning the desired resources for them to be used for the requested unicast service.

4) In case RCEF_1 service is needed for the requested service, A-RACF_0 issues a request to that entity.

5) RCEF_1 replies back to A-RACF_0.

6) In case RCEF_2 service is needed for the requested service, A-RACF_0 issues a request to that entity.

7) RCEF_2 replies back to A-RACF_0.

8) A-RACF_0 replies to the SPDF.

9) In case BGF service is required, the SPDF requests those services from the BGF. It should be noted that this requests could occur before the interaction with A-RACF_0 and A-RACF_1, or in parallel.

10) Reply from the BGF that the requested services are now available.

11) The SPDF replies to the AF.

12) The AF replies to the UE.

**Steps in Multicast Signalling Flow**

It should be noted that this signalling flow does not involve any interaction with any AF, the SPDF or the BGF.

1) The UE requests a multicast service from BTF_1. This request can be an IGMP join or a request made using a different mechanism.

2) BTF_1 derives the request to RCEF_1 from step 1.

3) RCEF_1 derives the request to A-RACF_1 from step 2.

   3.1) In case A-RACF_1 cannot admit the requested bandwidth immediately based on the resources it is currently in charge over, it issues a request to A-RACF_0 asking if it is willing to provided more bandwidth to the multicast resource budget over which A-RACF_1 is in charge.

   3.2) Based on local policies and/or current usage of unicast resources A-RACF_1 determines whether or not it can provide more bandwidth to the multicast resource budget owned by A-RACF_1. In this example, A-RACF_1 answer back to A-RACF_0 providing the desired resources for them to be used for the requested multicast service.

4) A-RACF_1 replies to RCEF_1 whereby it can activate the needed policy enforcement.

5) RCEF_1 replies to BTF_1.

6) BTF_1 forwards the multicast service request to BTF_2.

7) BTF_2 requests policy enforcement from RCEF_2.

8) RCEF_2 activates the requested policy enforcement and replies back to BTF_2.

# Annex H (informative): Session modification procedures

This annex describes a procedure for modifying the parameter of established connections, as indicated in requirement of clause 4.2.1.3. The RACS executes these procedures based on the specification of clause 6.4.6.1.

## H.1 The status of the connection during the session modification

In the session initiation procedure, network resources are reserved based on the Session Initiation Request (e.g. SDP offer), and are committed/released based on the Session Initiation Response (e.g. SDP answer). Based on this policy, network resources should be managed as table H.1 in the session modification procedure.

**Table H.1: The status of the connection during the session initiation/session modification**

| | | | The connection before session modification (Initial connection) | The connection after session modification (Modified connection) |
|---|---|---|---|---|
| Session Initiation | Request (Offer) | | Reserved | N/A |
| | Response (Answer) | Accepted | Committed | N/A |
| | | Rejected | Released | N/A |
| Session Modification | Request (Offer) | | ---- | Reserved (see note) |
| | Response (Answer) | Accepted | Released | Committed |
| | | Rejected | ---- | Released |
| NOTE: The resource reservation should be executed if the additional resources are required for the modified connection. If the additional resources are not required, the resource reservation does not need to be executed because the resources for the modified connection have already been committed for the initial connection. | | | | |

In the session modification procedure, the connection is switched from the initial connection to the modified connection. This means that the initial connection becomes the modified connection after the session modification procedure, and does not mean that two independent connections are managed simultaneously.

When the Session Modification Request is sent from the UE, the network resources for the initial connection should be kept active and the network resources for the modified connection should be reserved.

Additionally, when the Session Modification Response (Accepted) is sent from the UE, the network resources for the initial connection should be released and the network resources for the modified connection should be committed.

On the other hand, when the Session Modification Response (Rejected) is sent from the UE, the reserved network resources for the modified connection should be released.

To achieve above procedures, the RACS needs to know whether the received Resource Modification Request sent from the AF is preliminary (e.g. the Resource Modification Request is created based on the Session Modification Request) or the result of successful negotiation (e.g. based on Session Modification Response (Accepted)) or the result of failed negotiation (e.g. based on Session Modification Response (Rejected)).

## H.2 The session modification procedure

The use cases of modifying the parameter of established connections are as follows:

a) During the setup, the UE first connects toward a media server providing an early announcement (e.g. how much the connection costs per minute, an instruction to a user to input pass code, music while ringing), and later connects toward the terminating end-user's device including all the media.

b) The bandwidth may change as the two codecs, i.e. one for early announcement and the other for the regular media, may be different.

This clause shows the example of the procedure of a). In figure H.1, the UE_a first connects toward the UE_b1 (e.g. a media server providing an early announcement), and later connects toward the UE_b2 (e.g. the terminating end-user's device including all the media). Figure H.2 shows the procedure of session modification.

In figure H.1 and figure H.2, the AS and the UE_b1 may be implemented in the same physical entity. In such a case, the AF_b1, the SPDF_b1, the A-RACF_b1, the BGF_b1, and the RCEF_b1 may not exist.

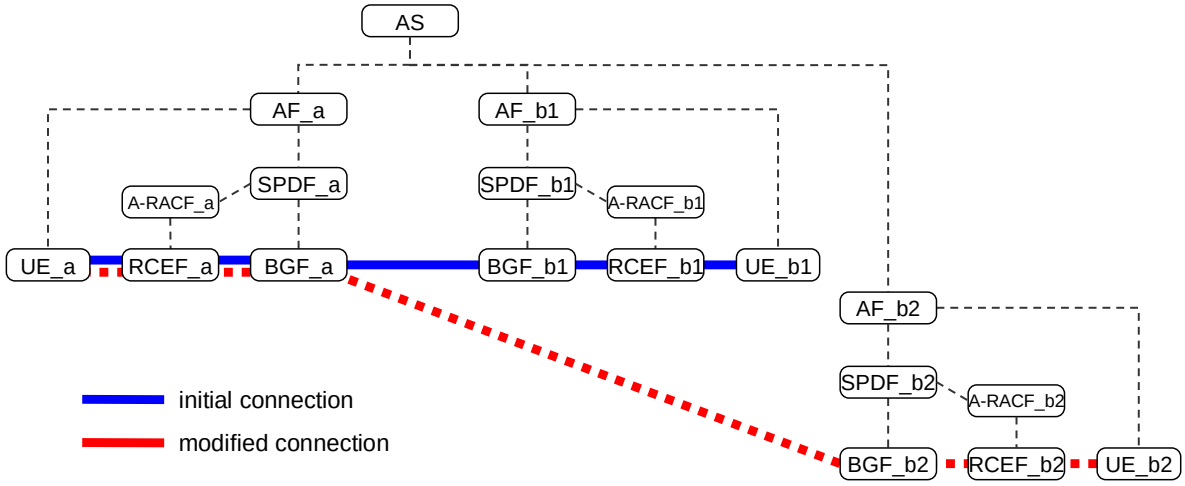
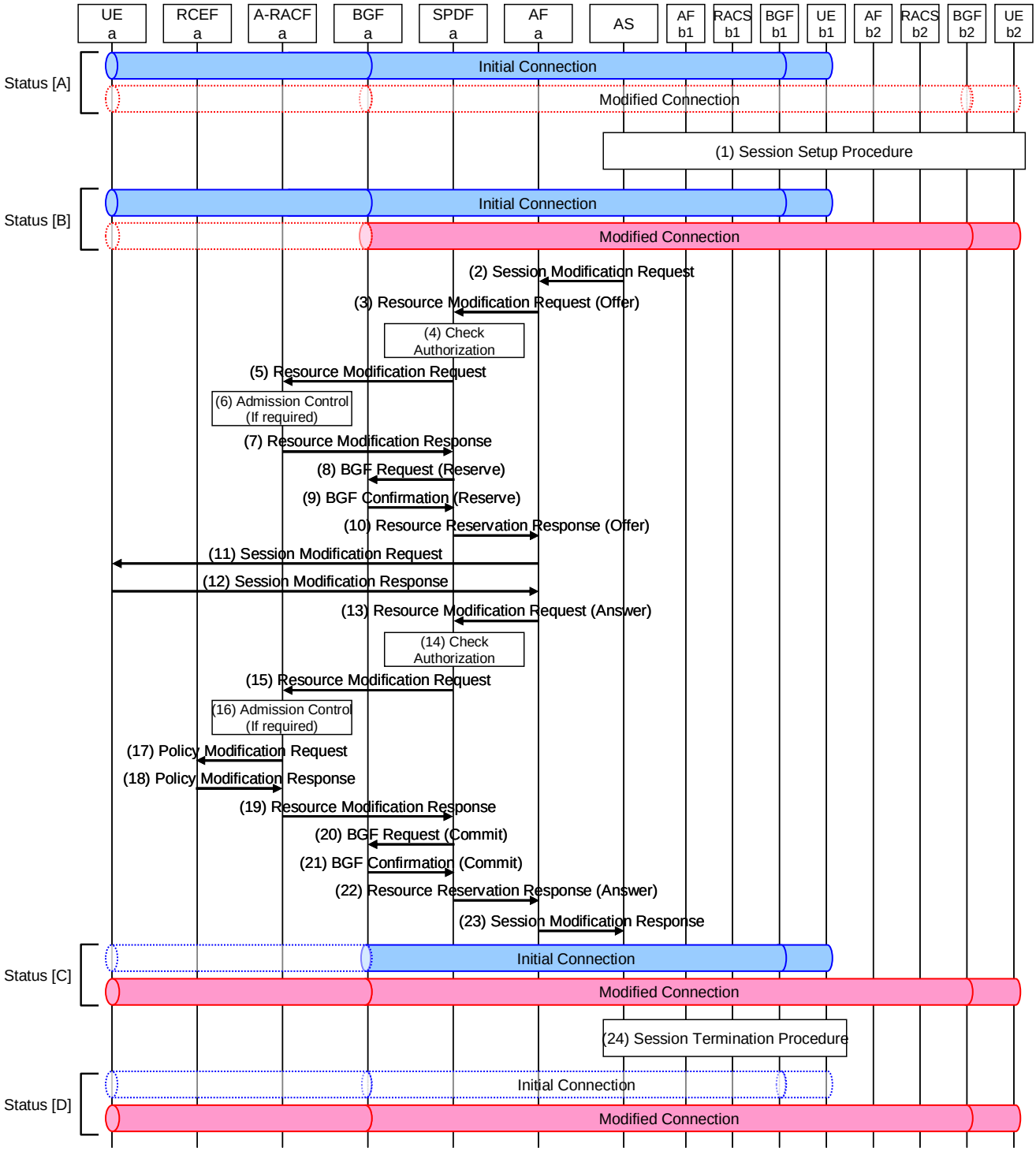



**Figure H.1: Session modification architecture**




NOTE: For simplicity, some functions are omitted.

**Figure H.2: Session modification procedure**

Status (A): The initial connection has been established between UE_a and UE_b1.

1) The AS executes the session setup procedure, and the modified connection is established between BGF_a and UE_b2. In the case where the AS and the UE_b1 are implemented in the same physical entity, the AS can know when to trigger this procedure because the AS can interact with the UE_b1 directly. Otherwise, the AS may trigger this procedure based on its own policy (e.g. set period) which had been configured in advance.

Status (B): The initial connection is active between UE_a and UE_b1. The modified connection is active between BGF_a and UE_b2.

2) The AS send session modification request to the AF_a to deactivate the initial connection between the UE_a and the BGF_a, and to activate the modified connection between the UE_a and the BGF_a. In this request, modified network parameters (IP address, port, bandwidth, etc) are specified.

3) The AF_a creates the Resource Reservation Request based on the received Session Modification Request. In this request, modified network parameters and the intention of this request (offer) are specified. The AF_a sends this request to the SPDF.

4) The SPDF_a authorizes the request with the modified network parameters. This authorization consists of verifying if the modified QoS resources for the AF session, present in the session description, are consistent with the operator policy rules defined in the SPDF.
The SPDF_a determines if serving this request requires sending a Resource Modification Request to the A-RACF_a and/or BGF_a Request for BGF service(s). Whether steps 5 to 7 and/or 8 and 9 are executed is dependent on this decision.

5) The SPDF_a sends the Resource Modification Request to the A-RACF.

6) The A-RACF_a executes the admission control if the additional resources are required for the modified connection,

7) The A-RACF_a sends the Resource Modification Response to the SPDF_a.

8) The SPDF_a checks if there are also service (s) to be modified in BGF_a. If yes, the BGF_a Request is sent to the BGF_a to reserve modified connection.

9) The BGF_a modifies the service (s) and confirms the operation to the SPDF_a.

10) The SPDF_a sends the Resource Reservation Response to the AF_a. During this moment, the initial connection is kept active, and the modified connection is not active.

11) The AF_a sends the Session Modification Request to the UE_a.

12) The UE_a sends the Session Modification Response to the AF_a.

13) The AF_a sends the Resource Reservation Request to the SPDF_a. In this request, modified network parameters and the intention of this request (answer) are specified.

14) The SPDF_a authorizes the request with the modified network parameters. The SPDF_a determines if serving this request requires sending a Resource Modification Request to the A-RACF_a and/or BGF_a Request for BGF_a service(s). Whether steps 15 to 19 and/or 20 and 21 are executed is dependent on this decision.

15) The SPDF_a sends the Resource Modification Request to the A-RACF_a.

16) The A-RACF_a executes the admission control if required.

17) The A-RACF_a may send the Policy Modification Request to the RCEF_a to request the RCEF_a to modify the installed traffic policies that are applied to the associated resource reservation session flows.

18) The RCEF_a sends the Policy Modification Response to the A-RACF_a to confirm the modification of the traffic policies (depending on 17).

19) The A-RACF_a sends the Resource Modification Response to the SPDF_a to inform the SPDF_a that the resources requested are committed.

20) The SPDF_a checks if there are also service (s) to be modified in BGF_a. If yes, the BGF_a Request is sent to the BGF_a to commit modified connection.

21) The BGF_a modifies the service (s) and confirms the operation to the SPDF_a.

22) The SPDF_a sends the Resource Reservation Response to the AF_a.

23) The AF_a sends the Session Modification Response to the AS.

Status (C): The initial connection is active between BGF_a and UE_b1. The modified connection is active between UE_a and UE_b2.

24) The AS triggers the session termination procedure, and the initial connection is terminated between BGF_a and UE_b1.

Status (D): The initial connection is completely removed. The modified connection is active between UE_a and UE_b2.

# Annex I (informative): Change history

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **WG Doc.** | **CR** | **Rev** | **CAT** | **Title/Comment** | **Current Version** | **New Version** |
| 05-06-08 | 17bTD163 | 001 | | B | The solution of policy control in the access network<br>§6.3.7.1.1.1 | 2.0.0 | 3.0.1 |
| 02-07-08 | 18WTD208 | 002 | | F | Correction to RCEF behaviour for installation of policies,<br>§6.3.7.1.1.1 | 3.0.1 | 3.0.2 |
| 02-07-08 | 18WTD173 | 003 | | B | Handling of reuse of multicast/unicast resources,<br>§§4.2.2.5 and 5.1.1.6 | 3.0.1 | 3.0.2 |
| 02-07-08 | 18WTD316 | 004 | | F | RACS R2 Member Vote resolution<br>Annex G.3.5, and G.3.6 | 3.0.1 | 3.0.2 |
| 07-07-08 | | | | | All CRs approved at TISPAN#18 | 3.0.2 | 3.1.1 |
| 26-09-08 | 18bTD113 | 005 | | D | Proposal of text deletion in 6.4.2.2<br>§6.4.2.2 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD114 | 006 | | D | Editorial modifications to text related with policy enforcement mechanisms,<br>§6.3.7.1.1.1, §6.2.2.6 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD228 | 007 | | F | RCEF enhancements for policy push mode,<br>§6.2.4.1 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD118 | 008 | | B | Proposal for reinstatement of text related to C-RACF,<br>§6.2.2.1.1, §6.2.2.1.2, §6.2.2.2, §6.2.2.4.1, §6.2.2.5.2, §6.2.2.6, §6.2.2.7, §6.2.2.8, §6.2.2.9, §6.2.2.10 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD126 | 009 | | B | Consideration about resource control of CPN Gateway,<br>§1, §4.2.3 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD214 | 010 | | B | Proposal of information messages for the Re reference point in the push mode,<br>§6.3.7.3.1 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD215 | 011 | | B | Proposal of information messages for the Re reference point in the pull mode<br>§6.3.7.3.2 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD216 | 012 | | B | Proposal of information messages for the Re reference point related to report of events<br>§6.3.7.3.3 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD238 | 013 | | B | Requestor of QoS Downgrading,<br>§5.4 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD239 | 014 | | B | Initiator of QoS Downgrading,<br>§4.2.2.2, §5.4 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD227 | 015 | | F | Correction of AF-Identification placement in Gq'/Rq information flow,<br>§6.3.1.3.1 | 3.1.1 | 3.1.2 |
| 26-09-08 | 18bTD241 | 016 | | B | Asynchronous bandwidth release in Rr,<br>§6.3.8.1.1, §6.3.8.3.6, §6.3.8.3.8, §6.3.8.3.9 | 3.1.1 | 3.1.2 |
| 13-11-08 | | | | | CRs 005 to 016 TB approved at TISPAN#19 | 3.1.2 | 3.2.0 |
| 28-11-08 | 19bTD030r2 | 017 | | B | Information exchanged over the Ia ref point related with BGF service request<br>§§6.3.3.3, 6.3.3.3.1 and 6.3.3.3.2 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD031r2 | 018 | | B | Information exchanged over the Ia ref point related with BGF service modify<br>§§6.3.3.3.3 and 6.3.3.3.4 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD032r2 | 019 | | B | Information exchanged over the Ia ref point related with BGF service audit<br>§§6.3.3.3.5 and 6.3.3.3.6 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD033r1 | 020 | | B | Information exchanged over the Ia ref point related with BGF service notify<br>§§6.3.3.3.7 and 6.3.3.3.8 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD034r2 | 021 | | B | Information exchanged over the Ia ref point related with BGF service release<br>§§6.3.3.3.9 and 6.3.3.3.10 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD035r1 | 022 | | B | Proposal of text for information exchange in the Ri' ref point<br>§6.3.5.3 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD036r3 | 023 | | B | Proposal of text for subclause 6.3.6 (Rd' Reference Point)<br>§6.3.6 | 3.2.0 | 3.2.1 |
| 28-11-08 | 19bTD029r1 | 024 | | B | Proposal for C-RACF EFs on Table 5<br>§6.2.2.2 | 3.2.0 | 3.2.1 |
| 23-0109 | 19tTD190r3 | 025 | | B | Clarification of BTF - RCEF interaction/BTF behaviour for policy enforcement<br>§§6.2.4.1 and 6.2 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD055r2 | 026 | | D | Editorial enhancement to the first two subclauses of x-RACF<br>§§6.2.2.1 and 6.2.2.1.1 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD056r3 | 027 | | B | Applicability of subclauses 6.2.2.x to C-RACF<br>§§6.2.2.1.3, 6.2.2.4.1, 6.2.2.6, 6.2.2.7, 6.2.2.8, 6.2.2.9, 6.2.2.10 and 6.2.2.11 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD057r2 | 028 | | B | Applicability of further subclauses 6.2.y to C-RACF<br>§§6.2.4 and 6.2.5 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD122r2 | 029 | | B | Admission Control Process for C-RACF<br>New §6.2.2.5.2 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD058r2 | 030 | | B | Reference points associated with C-RACF<br>§§6.2.2.1.2 and new 6.2.2.4.2 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD068r2 | 031 | | F | Clarification on Rr features<br>§§6.3.8.1.1, 6.3.8.1.1.1 and 6.3.8.1.1.2 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD193r3 | 032 | | B | RACS CPN interaction requirements<br>§§2.1 and 4.2.3 | 3.2.1 | 3.2.2 |
| 23-01-09 | 19tTD194r4 | 033 | | B | RACS CPN interaction, network deployment scenarios<br>New annex D.4 | 3.2.1 | 3.2.2 |
| 25-02-09 | 20WTD051r1 | 034 | | D | Editorial amendments to the text of Ri' (6.3.5)<br>§6.3.5 | 3.2.2 | 3.2.3 |
| 25-02-09 | 20WTD052r1 | 035 | | D | Editorial enhancements to the text of Rd' (6.3.6)<br>§6.3.6 | 3.2.2 | 3.2.3 |
| 25-02-09 | 20WTD053r2 | 036 | | B | Further alignment of existing text with C-RACF (6.1 and 6.2.1.x) | 3.2.2 | 3.2.3 |

| Change history | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date** | **WG Doc.** | **CR** | **Rev** | **CAT** | **Title/Comment** | **Current Version** | **New Version** |
| | | | | | §§6.1, 6.2.1.1, 6.2.1.3, 6.2.1.5, 6.2.1.6, 6.2.1.7, 6.2.1.9, 6.2.1.10 and 6.2.1.11 | | |
| 25-02-09 | 20WTD054r1 | 037 | | B | Further alignment of existing text with C-RACF (6.3.1.x)<br>§§6.3.1, 6.3.1.1, 6.3.1.1.3, 6.3.1.3.1, 6.3.1.3.2, 6.3.1.3.3, 6.3.1.3.4 and 6.3.1.3.5 | 3.2.2 | 3.2.3 |
| 25-02-09 | 20WTD050r3 | 038 | | B | Clarification on the Rf reference point<br>§§6.1, 6.2.2.1.2 and new 6.3.9 | 3.2.2 | 3.2.3 |
| 25-02-09 | 20WTD055r2 | 039 | | B | Further alignment of existing text with C-RACF (6.3.7.1.x)<br>§§6.3.7, 6.3.7.1, 6.3.7.1.1.1, 6.3.7.1.1.1.1, 6.3.7.1.1.1.3, 6.3.7.1.1.2 and 6.3.7.1.1.3<br>§§6.3.7.3.1.1, 6.3.7.3.1.2, 6.3.7.3.1.3, 6.3.7.3.1.6, 6.3.7.3.2.1, 6.3.7.3.2.2, 6.3.7.3.2.3, 6.3.7.3.2.4, 6.3.7.3.2.5 and 6.3.7.3.2.6<br>§§6.3.7.3.1.1, 6.3.7.3.1.2, 6.3.7.3.1.5, 6.3.7.3.2.2, 6.3.7.3.2.4 and 6.3.7.3.2.5 | 3.2.2 | 3.2.3 |
| 25-02-09 | 20WTD056r2 | 040 | | B | Further alignment of existing text with C-RACF (6.3.8.x)<br>§§6.3.8.3.1, 6.3.8.3.2, 6.3.8.3.6, 6.3.8.3.7, 6.3.8.3.8 and 6.3.8.3.9 | 3.2.2 | 3.2.3 |
| 10-03-09 | | | | | CRs 017 to 040 TB approved at TISPAN#20 | 3.2.3 | 3.3.0 |
| 20-03-09 | 20bTD033r1 | 041 | | B | Message coordination by SPDF<br>§6.2.1.7 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD034r3 | 042 | | B | Clarification of IBCF as AF<br>§§2.1, 6.2.5.1 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD052r1 | 043 | | B | Messages for the Rr reference point<br>§6.3.8.3 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD143r2 | 044 | | F | Procedure of modifying established connections<br>Annex H | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD032r3 | 045 | | B | Need for clarification on SPDF<br>§§6.1, 6.2.1.1, 6.2.1.2, 6.2.1.3, 6.2.1.6, 6.2.1.7, 6.2.1.10, 6.2.1.11, 6.2.5.1 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD035r2 | 046 | | B | Amendments to §6.4<br>§6.4 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD074r3 | 047 | | B | Global improvements<br>§§6.2.2.1.1, 6.2.3.2, 6.2.4.3 | 3.3.0 | 3.3.1 |
| 20-03-09 | 20bTD078r4 | 048 | | B | Annex on CPN-RACS<br>Annex D.4 | 3.3.0 | 3.3.1 |
| 09-06-09 | 21WTD051r2 | 049 | | D | Proposal for scope of the RACS R3 stage 2<br>§1 | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD052r2 | 050 | | D | Restrictions applicable to the RACS R3 stage 2 document<br>§4.1 | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD020r1 | 051 | | D | Modification in request resource Wholesale/Retail Scenario<br>§§6.4.3.1, 6.4.3.2 | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD021r1 | 052 | | C | Information Flow for push and pull<br>§6.4.2.3, Annex G | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD225r2 | 053 | | B | Introduction of BTF into RACS<br>§§2.1, 6.2, 6.2.4, 6.2.6 | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD078r1 | 054 | | B | Proposal for a new structure in 6.4.2.1 and 6.4.2.2<br>§§6.4.2.1, 6.4.2.2, Annex G | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD079r1 | 055 | | D | Proposal for amendments to 6.4.4.2.1 and 6.4.2.2.2<br>§§6.4.4.2.1, 6.4.4.2.2, Annex G | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD203r1 | 056 | | B | Audit and Synchronization Mechanisms for the Rr reference point<br>§§6.3.8.1.5, 6.3.8.3.2.5, 6.3.8.3.2.6 | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD053r2 | 057 | | D | Proposal of editorial amendments<br>§§2.1, 4.1, 6.2.1.3, Annex B, Annex D | 3.3.1 | 3.3.2 |
| 09-06-09 | 21WTD054r2 | 058 | | F | Checklist of Editor's Notes | 3.3.1 | 3.3.2 |
| | | | | | Publication | 3.3.2 | 3.4.1 |
| | | | | | Re-publication after editorial corrections | 3.4.1 | 3.4.2 |

# History

| Document history | | |
|---|---|---|
| V1.1.1 | June 2006 | Publication |
| V2.0.0 | May 2008 | Publication |
| V3.4.1 | September 2009 | Publication |
| V3.4.2 | April 2010 | Publication |
| | | |