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SERIES Q: SWITCHING AND SIGNALLING

Signalling requirements and protocols for the NGN – Resource control protocols

Resource control protocol No. 3 – Protocols at the Rw interface between a policy decision physical entity (PD-PE) and a policy enforcement physical entity (PE-PE): Overview

ITU-T Recommendation Q.3303.0

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Resource control protocol No. 3 – Protocols at the Rw interface between a policy decision physical entity (PD-PE) and a policy enforcement physical entity (PE-PE): Overview

Summary

Interface Rw defines an interface between a policy decision physical entity (PD-PE) and a policy enforcement physical entity (PE-PE). There are a number of signalling alternatives for Rw, each is defined in a protocol-specific Recommendation in the Q.3303.x-series of Recommendations.

ITU-T Recommendation Q.3303.0 provides a protocol-independent introduction, describing the common material, which is relevant for all protocol specific signalling solutions.

Source

ITU-T Recommendation Q.3303.0 was approved on 6 November 2007 by ITU-T Study Group 11 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1 Scope

Interface Rw defines an interface between a policy decision physical entity (PD-PE) and a policy enforcement physical entity (PE-PE). There are a number of signalling alternatives for Rw, defined in protocol-specific Recommendations in the Q.3303.x-series of Recommendations.

This Recommendation provides a protocol-independent introduction, describing the common material, which is relevant for all protocol specific signalling solutions. In particular, the scope of this Recommendation includes the following aspects:

– overview;

– Rw reference model;

– functional elements and capabilities.

2 References

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

[ITU-T Q.3300] ITU-T Recommendation Q.3300 (2008), *Architectural framework for the Q.33xx series of Recommendations*.

[ITU-T Y.2012] ITU-T Recommendation Y.2012 (2006), *Functional requirements and architecture of the NGN release 1*.

[ITU-T Y.2111] ITU-T Recommendation Y.2111 (2006), *Resource and admission control functions in Next Generation Networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 policy decision physical entity (PD-PE) [ITU-T Q.3300]: The PD-PE is an implemented instance of the policy decision functional entity (PD-FE) identified in [ITU-T Y.2111].

3.1.2 policy enforcement physical entity (PE-PE) [ITU-T Q.3300]: The PE-PE is an implemented instance of the policy enforcement functional entity (PE-FE) identified in [ITU-T Y.2111].

3.1.3 transport resource control physical entity (TRC-PE) [ITU-T Q.3300]: A device that implements the transport resource control functional entity (TRC-FE) as defined in clause 7.2.3.3 of [ITU-T Y.2111].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BGW Border Gateway
BRAS Broadband Remote Access Server
CDMA Code Division Multiple Access
CNPS Core Network Path Selection
CMTS Cable Modem Termination System
COPS Common Open Policy Service
DSL Digital Subscriber Line
DSLAM DSL Access Multiplexer
FDP Final Decision Point
FWMS Firewall Working Mode Selection
GC Gate Control
GGSN Gateway GPRS Support Node
GPRS General Packet Radio Service
IP Internet Protocol
IPMC IP Packet Marking Control
MG Media Gateway
NAPT Network Address and Port Translation
NAPTC NAPT Control
NAT Network Address Translation
NS Network Selection
PDG Packet Data Gateway
PDP Packet Data Protocol
PDSN Packet Data Serving Node
QMTI QoS Mapping – Technology Independent
QoS Quality of Service
RLC Rate Limiting Control
SCE Service Control Entity
SCF Service Control Function
TCP Transmission Control Protocol
UDP User Datagram Protocol
UE User Equipment
VLAN Virtual LAN

VPN Virtual Private Network

WLAN Wireless Local Area Network

5 Conventions

None.

6 Rw interface

6.1 Overview

As defined in the stage 2 specifications [ITU-T Y.2111] and [b-ITU-T Q-Sup.51], the Rw interface is used for information exchange to apply policy decisions between the PD-PE and the PE-PE that may reside in various transport devices, e.g., BGW, DSLAM/BRAS and GGSN/PDSN.

The Rw interface shall be an intra-operator interface. One PD-PE instance may be able to serve more than one PE-PE instance, and one given PE-PE instance may interact with more than one PD-PE instance. For any individual session, one PD-PE instance shall make the final policy decisions in a single operator domain.

The Rw interface shall be understood by the both sides of PD-PE and PE-PE which means PD-PE shall know which protocol is bound with the given PE-PE. The binding relationship can be static using dedicated well-known transport ports.

In the case when PE-PE resides in various transport devices, we can use other port value (outside the well-known port range), which is a subject of a mutual agreement (= provisioning) between PE-PE and PD-PE. Alternatively, we can establish a binding relationship between PE-FE and PD-FE according to the terminal type.

The Rw interface allows the PD-PE to *push* the admission decisions to the PE-PE. It also allows the PE-PE to *request* admission decisions when path-coupled resource reservation mechanisms are in use. The PD-PE may specify:

– resources to be reserved and/or committed for media flows;

– QoS handling such as packet marking and policing to use;

– gate control (opening/closing) for a media flow;

– insertion of a NAPT function, requesting the necessary address mapping information;

– resource usage information request and report for a media flow;

– dynamic firewall working mode selection for a media flow;

– technology-independent core network ingress/egress path information for a media flow.

The following provides a brief description of the information exchange requirements for the Rw interface.

– *Request-response "transactions"*:

  The interface must allow the PD-PE or the PE-PE respectively to request an action to be performed by the PE-PE or the PD-PE respectively and get a response (that can be correlated with the request) in return.

  NOTE 1 – Some terms like "transaction", "message", "action", "command" and others are used in a generic manner in this Recommendation. These terms may have a protocol-specific meaning, and if they do, they will be defined in the relevant Q.3303.x-specific protocol Recommendation.

– *Notifications*:

  The interface must allow for the notification of asynchronous events (from the PE-PE to the PD-PE).

– *Reliable delivery*:

The interface should provide reliable delivery of messages.

– *Capabilities*:

The PD-PE must be able to determine capabilities when requesting resources and other transport plane functions from the PE-PE.

– *Security*:

All messages between the PD-PE and the PE-PE should be authenticated such that requests to the PE-PE from unauthenticated sources will not be performed and such that notifications sent from the PE-PE to the PD-PE came from an authenticated PE-PE source.

– *One-to-many/many-to-one*:

Two modes shall be supported:

1) One-to-many mode, a PD-PE shall be able to communicate with multiple PE-PEs.
2) Many-to-one mode, multiple PD-PEs shall be able to make requests to a given PE-PE.

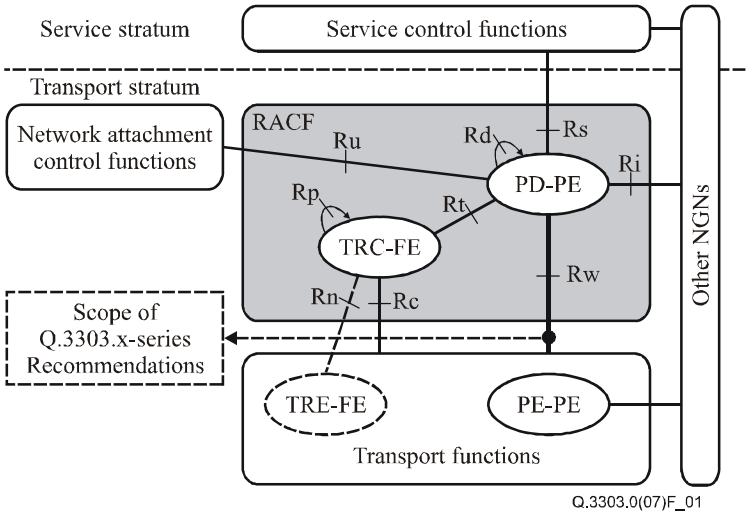
NOTE 2 – This mode is not supported when using COPS (ITU-T Rec. Q.3303.1).

NOTE 3 – This mode requires the support of virtual MGs when using H.248 (ITU-T Rec. Q.3303.2).

For either mode, only a single PD-PE shall make a request to a given PE-PE for a particular session.

6.2 Rw reference model

The Rw interface, as shown in Figure 1, is defined between the PD-PE and the PE-PE.



NOTE – Figure derived from Figure 1 of [ITU-T Q.3300], which was taken from Figure 5 of [ITU-T Y.2111].

Figure 1 – Rw reference model

6.3 Functional elements and capabilities

6.3.1 Policy decision physical entity (PD-PE)

6.3.1.1 Summary

The PD-PE coordinates the resource requests from the SCE and/or the PE-PE, and makes policy decisions using a collection of information as described below. The PD-PE requests the resource availability information and resource admission control from the TRC-PE. Finally, the PD-PE shall request the policy enforcement operations to the PE-PE via the Rw interface. The functionality of the PD-PE is further detailed in clause 7.2.3 of [ITU-T Y.2111].

The PD-PE should be able to support both push mode and pull mode according to the configuration of network operator and/or the access network type in the process of resource reservation, gate control and policy enforcement. In the push mode, the PD-PE takes the initiative in pushing down policy decisions to the PE-PE upon receipt of a request from the SCE; in the pull mode, the PD-PE should re-authorize and retrieve policy decisions upon receipt of a request from the PE-PE. The push mode is typically used in transport networks that do not support or require transport signalling for establishing network resources dynamically on behalf of, or directly by, an individual service session of the UE, e.g., DSL broadband access and Ethernet. The pull mode is typically used in transport networks that support or require the use of transport signalling to establish the network resource dynamically on behalf of or directly by an individual service session of the UE, e.g., GPRS.

In addition, the PD-PE may provision the static policy configuration onto the PE-PE upon the triggers of network policies, conditions and resource status.

The dynamic policy decisions are produced by the PD-PE according to the following information:

– Service information received from the SCE. It consists of:
  - Media type.
  - Application service class.
  - Priority.
  - QoS information (e.g., requested bandwidth).
– Transport subscription profile. It consists of:
  - Maximum bandwidth per subscription (uplink/downlink).
  - Subscribed network service class.
  - Reservation priority.
– Service-based network policies, non-exhaustive examples such as:
  - Mapping rules to network service class.
  - Maximum sessions per network service class.
  - Time of day.
  - Source control mode (i.e., push or pull mode).
– Transport resource availability and admission decision information received from the TRC-PE.

The *static* policy configuration may be triggered by certain conditions, e.g.,

– Network policies, e.g., time of day.
– Resource utilization.
– Network configuration.
– Transport subscription.

6.3.1.2 More details

NOTE – The text in this clause is identical to that of clause 7.2.3.2 of [ITU-T Y.2111] with the following exceptions:

a) "functional entities" (FE) were replaced by "physical entities" (PE);

b) "reference point" was replaced by "interface".

The PD-PE handles the QoS resource requests received from the SCE via the Rs interface or from PE-PE via the Rw interface. The PD-PE contains the following functions:

– *Final decision point (FDP)*: This function first checks the QoS resource request based on service information, network policy rules and transport subscription information, and then

interacts with the TRC-PE via the Rt interface to detect and determine the requested QoS resource within the involved access and/or core transport networks.

- The FDP makes the final admission decision for media flows of a given service based on network policy rules, service information, transport subscription information and decision on resource availability.
- The FDP indicates the loss of connectivity: It informs the SCE that the connectivity of the transport resource previously granted is lost. The SCE may request PD-PE to relinquish all resources associated with the session.

– *QoS mapping – Technology independent (QMTI)*: This function maps the service QoS parameters and priority received from the SCE via the Rs interface to network QoS parameters (e.g., Y.1541 class) and priority based on the network policy rules.

– *Gate control (GC)*: This function controls PE-PE to install and enforce the final admission decisions via the Rw interface (e.g., opening or closing the gate). The action to pass or drop IP packets is based on a set of IP gates (packet classifiers, e.g., IPv4 5-tuple) and transport interface identification information (e.g., VLAN/VPN ID) as needed.

– *IP packet marking control (IPMC)*: This function takes decisions on packet marking and remarking of flows. The marking may consider the priority of the flow and traffic engineering parameters.

– *NAPT control and NAT traversal (NAPTC)*: This function interacts with PE-PE and SCE to provide the address binding information for NAPT control and NAT traversal as needed.

– *Rate limiting control (RLC)*: This function makes decisions on the bandwidth limits of flows (e.g., for policing).

– *Firewall working mode selection (FWMS)*: This function selects the working mode of the firewall based on the service information. Four packet inspection modes could be identified (static packet filtering, dynamic packet filtering, stateful inspection, deep packet inspection, see also clause 7.2.4.1 of [ITU-T Y.2111]).

– *Core network path selection (CNPS)*: This function chooses the core network ingress and/or egress path for a media flow based on the service information and technology independent policy rules at the involved PD-PE.

– *Network selection (NS)*: This function locates core networks that are involved to offer the requested QoS resource. It locates the PE-PE instances that are involved to enforce the final admission decisions.

The PD-PE shall make the final policy decisions based on the service information (e.g., service type, flow description, bandwidth and priority), transport network information (e.g., resource admission result and network policy rules) and transport subscription information (e.g., maximum upstream/downstream capacity). The policy decision shall provide sufficient information to make the PE-PE perform the resource control operation (e.g., gate opening/closing, bandwidth allocation/rate limiting, packet marking, traffic policing/shaping, NAPT and address latching). The policy decisions may be composed of flow identifier, IP addresses, bandwidth, gate status, time/volume limit, traffic descriptor, etc.

The PD-PE can be stateful or stateless depending on the complexity of the specific network environment, application characteristics and deployment architecture.

– The stateless PD-PE only maintains the transaction state information, e.g., state held for the duration of a request-response operation. In order to be stateless, the PD-PE shall generate the resource control session information for each resource control request from the SCF, which can be stored in the SCE, TRC-PE or PE-PE and used to retrieve the state information together with pertinent information flows.

– The stateful PD-PE may maintain a variety of resource control session information within PD-PE, such as the session duration, the resource control session information (e.g., the association between SCE and PD-PE, PD-PE and TRC-PE, PD-PE and PE-PE), the resource reservation limit (e.g., time limit/volume limit), resource reservation status (i.e., authorized, reserved or committed) and physical/logical connection ID.

6.3.2 Policy enforcement physical entity (PE-PE)

6.3.2.1 Summary

The PE-PE supports policy enforcement and flow-based charging. It provides the IP media flow handling and QoS control, packet filtering, marking and policing, rate limiting, flow detection and counting, NAPT and media relay, as well as online and offline charging interactions.

The PE-PE should support both pull mode and push mode. In the pull mode, it shall interact with the transport signalling (e.g., PDP context in the GPRS case) to perform the resource reservation.

The PE-PE should allow the IP media flow to pass through with appropriate treatment if and only if the corresponding gate is open. If the PE-PE receives an Authorization token and Flow Id(s) from a UE, the PE-PE shall report them to the PD-PE over the Rw interface. A default gate may be established for each UE during the initialization process to allow the default traffic (e.g., best effort) to pass through.

The PE-PE is located at the network device (e.g., GGSN/PDSN in the GPRS/CDMA case, PDG in the WLAN case, DSLAM or BRAS in the xDSL case, CMTS in the cable network case and border gateway in general).

6.3.2.2 More details

NOTE – The text in this clause is identical to clause 7.2.4.1 of [ITU-T Y.2111], with the following exceptions:

a) "functional entities" (FE) were replaced by "physical entities" (PE);

b) "reference point" was replaced by "interface".

The PE-PE enforces the network policy rules instructed by the PD-PE on a per-subscriber and per-IP flow basis. It should be able to perform the following functions based on flow information such as classifier (e.g., IPv4 5-tuple) and flow direction, as well as transport interface identification information (e.g., VLAN/VPN identifier and LSP label) as needed. The functions of the PE-PE include:

– Opening and closing gate: enabling or disabling packet filtering for an IP media flow.

  A gate is unidirectional, associated with a media flow in either the upstream or downstream direction. When a gate is open, all of the packets associated with the flow are allowed to pass through; when a gate is closed, all of the packets associated with the flow are blocked and dropped.

– Rate limiting and bandwidth allocation.

– Traffic classification and marking.

– Traffic policing and shaping.

– Mapping of IP-layer QoS information onto link layer QoS information based on predefined static policy rules (e.g., setting 802.1p priority values).

– Network address and port translation.

– Media relay (i.e., address latching) for NAT traversal.

– Collecting and reporting resource usage information (e.g., start-time, end-time, packets and octets of sent and received data).

– Packet-filtering-based firewall: inspecting and dropping packets based on predefined static security policy rules and gates installed by PD-PE.

  There are four packet inspection modes for packet-filtering-based firewall:

  - Static packet filtering:

    Inspecting packet header information and dropping packets based on static security policy rules. This is the default packet inspection mode applied for all flows.

  - Dynamic packet filtering:

    Inspecting packet header information and dropping packets based on static security policy rules and dynamic gate status.

  - Stateful inspection:

    Inspecting packet header information as well as TCP/UDP connection state information and dropping packets based on static security policy rules and dynamic gate status.

  - Deep packet inspection:

    Inspecting packet header information, TCP/UDP connection state information and the content of payload together, and dropping packets based on static security policy rules and dynamic gate status.

Bibliography

[b-ITU-T Q-Sup.51] ITU-T Q-series Recommendations – Supplement 51 (2004), *Signalling requirements for IP-QoS.*

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