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COPS Usage for Policy Provisioning

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Abstract

This document introduces a new client type for the COPS protocol to support policy provisioning. This new client type uses is independent of the type of policy and it is based on the concept of named PIBs (Policy Information Bases).

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1 Introduction

The IETF RSVP Admission Policy (RAP) WG has defined the COPS (Common Open Policy Service) protocol [COPS] as a scalable protocol that allows policy servers (PDPs) to communicate policy decisions to network devices (PEP). COPS was designed to support multiple types of policy clients.

COPS is a query/response protocol that supports two common models for policy control: Outsourcing and Provisioning.

The Outsourcing model addresses the kind of events at the PEP that require instantaneous policy decision (authorization). The PEP, being aware that it must perform a policy decision. However, being unable to carry the task itself, the PEP delegates responsibility to an external policy server (PDP). For example, in [COPS-RSVP] when a reservation message arrives, the PEP is aware that it must decide whether to admit or reject the request. It sends a specific query to the PDP, and in most case, waits for a decision before admitting the outstanding reservation.

The Provisioning model, on the other hand, makes no assumptions of such direct 1:1 correlation between PEP events and PDP decisions. The PDP may proactively provision the PEP reacting to external events (such as user input), PEP events, and any combination thereof (N:M correlation). Provisioning may be performed in bulk (e.g., entire router QoS configuration) or in portions (e.g., updating a DiffServ marking filter).

Network resources are provisioned based on relatively static SLAs (Service Level Agreements) at network boundaries. While the Outsourcing model is dynamically paced by the PEP in real-time, the Provisioning model is paced by the PDP in somewhat flexible timing over a wide range of configurable aspects of the PEP.

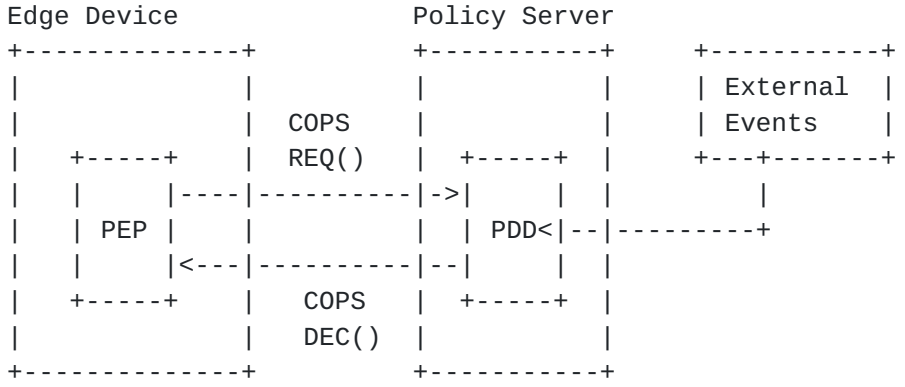


Figure 1: COPS Provisioning Model

In COPS-PR, policy requests describe the PEP and its configurable parameters (rather than an operational event). If a change occurs in these basic parameters, an updated request is sent. Hence, requests are issued quite infrequently. Decisions cannot be mapped directly to requests, and are issued mostly when the PDP responds to external events or PDP events (policy/SLA updates).

This draft describes a new client type ("Provisioning") for COPS to support policy provisioning. This new client type is independent of the type of policy (QoS, VPNs, Security, etc.) and it is based on the concept of PIBs (Policy Information Bases [PIB]).

The Examples used in this document are biased toward QoS Policy Provisioning in a Differentiated Services (DiffServ) environment. However, the COPS-PR client type can be used for other types of provisioning policies under the same framework.

1.1 Why not SNMP?

SNMP is a very popular network management protocol. One may question using COPS-PR, rather than extending SNMP for policy provisioning.

There are several aspects intrinsic to SNMP that prevents it from being a successful policy protocol.

SNMP uses a transactional model, and does not support the concept of long term Client/Server connection. As a by product, servers may not know that devices failed and vice versa. A hello polling may be a cumbersome replacement, however it may not solve the problem if a device may reboot in between polling messages.

The SNMP transactional model allows multiple servers to simultaneously modify state of a network device. Given that SNMP does not have resource locking facilities, a policy server would have to constantly poll and verify that no other networking management software or humans changed ANY of the configured resources.

SNMP is based on UDP and is thus unreliable. The lack of reliability is unacceptable for a policy protocol [RAP]. Provisioning policy is assumed quite large and diverse. It is desired that a provisioning protocol would be based on state sharing between client and server such that only differential updates are sent. Such state sharing requires a reliable transport mechanism.

Last, SNMP was not designed as a real-time operations protocol. Its trap mechanism is inefficient and cumbersome and there is no performance guarantees.

COPS was designed to overcome these shortcomings, based on the requirements defined in [RAP]. It has a single connection between client and server, it guarantees only one server updates the policy configuration at any given time (and these are locked, even from console configuration, while COPS is connected to a server). COPS uses reliable TCP transport and thus uses a state sharing/synchronization mechanism and exchanges differential updates only. If either the server or client are rebooted (or restarted) the other would know about it quickly. Last, it is defined as high priority (real-time) mechanism for the PEP device.

The COPS protocol is already used for policy control over RSVP. It is highly desirable to use a single policy control protocol for Quality of Service (QoS) mechanisms (if possible), rather than invent a new one for each type of policy problem.

At the same time, useful mechanisms from SNMP were adopted. COPS-PR uses a named Policy Information Base (PIB) which the model of SMI and MIB and BER [BER] data encoding. This allows reuse of experience, knowledge, tools and some code from the SNMP world.

1.2 Interaction between the PEP and PDP

When a device boots, it opens a COPS connection to its Primary PDP. When the connection is established, the PEP sends information about itself to the PDP in the form of a configuration request. This information includes client specific information (e.g., hardware type, software release, configuration information). During this phase the client may also specify the maximum COPS-PR message size supported.

In response, the PDP downloads all provisioned policies which are currently relevant to that device. On receiving the provisioned policies, the device maps them into its local QoS mechanisms, and installs them. If conditions change at the PDP such that the PDP detects that changes are required in the provisioned policies currently in effect, then the PDP sends the changes (installs and/or deletes) in policy to the PEP, and the PEP updates its local QoS mechanisms appropriately.

If, subsequently, the configuration of the device changes (board removed, board added, new software installed, etc.) in ways not covered by policies already known to the PEP, then the PEP sends this unsolicited new information to the PDP. On receiving this new information, the PDP sends to the PEP any additional provisioned policies now needed by the PEP.

2 Policy Information Base (PIB)

This section defines data format for Provisioning Named ClientSI objects (Named Client Specific Information). COPS-PR data is a

collection of policy-rules each identified by Policy Rule Identification (PRID). The PRID is a globally unique name (hence, "named ClientSI"), which describes the representation (format) and semantics of the policy rule.

COPS-PR uses a named Policy Information Base (PIB) as its global name space of provisioning policy. The PIB name space is common to both the PEP and The PDP. The PIB can be described as a tree where the branches of the tree represent classes (types) of policy rules (PRC), while the leaves represent instances (contents) of policy rules (PRI). There may be multiple instances of rules (PRI) for any given rule type (PRC). For example, if one wanted to install multiple access control filters, the PRC would represent a generic access control filter type, and each PRI would represent an actual access control filter to be installed).

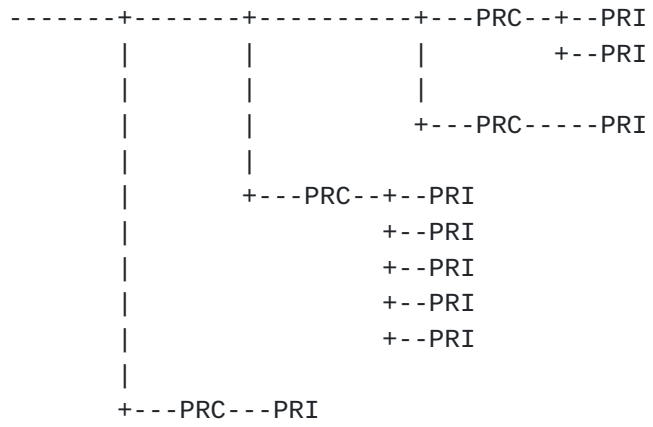


Figure 2: The PIB Tree

The provisioning PIB is based on SMI and MIBs. The decision to use this format as a basis opens-up the possibility of reusing SMI and MIB knowledge, experience, and tools. Unlike COPS-RSVP its sibling, COPS-PR requires a named structure to identify the type and purpose of unsolicited policy information "pushed" to the client policy.

PRIs and PRCs are uniquely identified by PRIDs. PRIDs have a hierarchical structure of the form 1.3.4.2.7, where the first part identifies the PRC (e.g., 1.3.4) and the last part identifies the instance (e.g. 2.7).

The policy tree names all the policy rule classes and instances and this creates a common view of the policy organization between the client (PEP) and the server (PDP). The PIB data on its own is self-descriptive such that the receiving PEP understands the required provisioning.

Consider the following example, of a set of FILTERs for marking

traffic with a certain diff-serv code point (DSCP). Each filter has

the following attributes: Protocol number, source address, source port, destination address, destination port, and DSCP value to set. Lets assume that the class FILTER's PRID is "$.1", where $ represents some prefix in the policy tree to which the class FILTER belongs. A first filter would have a PRID of $.1.1, the second $.1.2, etc.

Given that most provisioning operations require multiple attributes, COPS-PR does not support operations on individual attributes within a PRC class (e.g., source port). Instead, updates and deletions are performed on PRC granularity.

2.1 A Description of the PIB

The PIB is described using SMI and PIBs. SMI and PIBs are defined based on the ASN.1 data definition language [ASN1]. To simplify the implementation and re-use the SNMP encoding/decoding code, the wire representation of the policy information (PRIDs and BPDs) must follow BER encoding [BER].

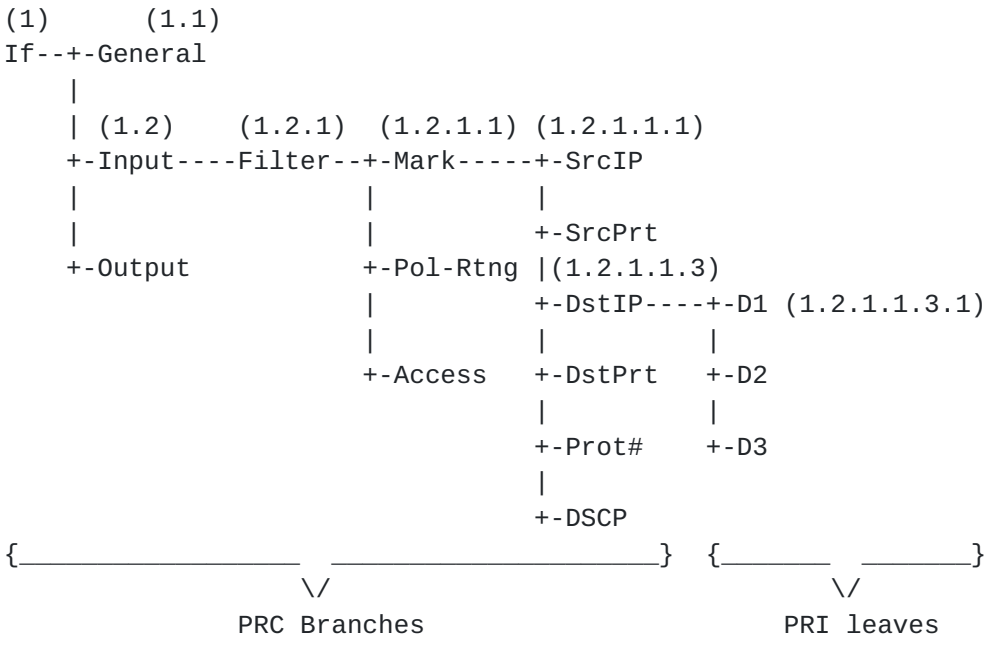


Figure 3: A PIB Example for DiffServ Marking Filter

Figure 3 describes a simple example of a possible PIB tree for DiffServ Marking Filter. The numbers in brackets represent the location of the PRC or PRI in the tree. The PRID of Filter2 (which includes DstIP=D2) would be 1.2.1.1.2 (Notice that the last digit of the PRCs (which describes the rule attributes) is dropped since COPS-PR purposely blocks operations on individual attributes).

2.2 COPS Operations Supported for a Policy Rule Instance

A policy rule instance is made of multiple attributes (PRIs) and is identified by a PRID. The following COPS operations are supported on for a policy rule instance:

o Install This operation creates or updates a named instance of a PRC. It accepts two parameters: a PRID to name the PRI, and a PBD with the new/updated values.

o Remove - This operation is used to delete an instance of a PRC. It accepts one parameter, a PRID, to name the instance to be deleted.

Message Content

The COPS protocol provides for different COPS clients to define their own "named", i.e. client-specific, information for various messages. This section describes the messages exchanged between a COPS server (PDP) and COPS Policy Provisioning clients (PEP) that carry client-specific data objects.

Request (REQ) PEP -> PDP

The REQ message is sent by policy provisioning clients to issue a 'config request' to the PDP. The Client Handle associated with the REQ message originated by a provisioning client must be unique for that client but otherwise has no protocol significance at this time.

The config request message serves as a request from the PEP to the PDP for provisioning policy data which the PDP may have for the PEP, such as access control lists, etc. This includes policy the PDP may have at the time the REQ is received as well as any future policy data or updates.

The config request message may include provisioning client information to provide the PDP with client-specific configuration or capability information about the PEP. This information from the client assists the server in deciding what types of policy that the PEP can install and enforce. The format of the Provisioning ClientSI data is described in the policy information base (see below).

The policy information supplied by the PDP must be consistent with the named decision data defined for the policy provisioning client. The PDP responds to the config request with a DEC message containing any available provisioning policy data.

The REQ message has the following format:

```
<Request> ::= <Common Header>
              <Client Handle>
              <Context = config request>
```

Decision (DEC) PDP -> PEP

The DEC message is sent from the PDP to a policy provisioning client in response to the REQ message received from the PEP. The Client Handle must be the same Handle that was received in the REQ message.

The DEC message is sent as an immediate response to a config request with the solicited decision flag set. Subsequent DEC messages may also be sent at any time after the original DEC message to supply the PEP with additional/updated policy information. Updated policy data carried in DEC message is correlated with the previous DEC by matching the policy ID information in the provisioning client decision data.

Each DEC message may contain multiple decisions. This means a single message can install some policies and delete others. In general a COPS-PR decision message should contain at most one or more deletes followed by one or more install decisions. This is used to solve a precedence issue, not a timing issue: the delete decision deletes what it specifies, except those items that are installed in the same message.

A COPS-PR DEC message contains a single "transaction", i.e. either all the decisions in a DEC message succeed or they all fail. This allows the PDP to delete some policies only if other policies can be installed in their place. The DEC message has the following format:

```
<Decision Message> ::= <Common Header>
                       <Client Handle>
                       [<Decision(s)>]+ | <Error>

<Decision> ::= <Context>
               <Decision: Flags>
               [<Named Decision Data: Provisioning >]
```

For each decision on the DEC message, the PEP performs the operation specified in the Flags field on the Named decision data. For the policy provisioning clients, the format for this data is defined in the context of the Policy Information Base (see below). In response to a DEC message, the policy provisioning client sends a RPT message back to the PDP to inform the PDP of the action taken.

3.3 **Report State (RPT)** PEP -> PDP

The RPT message is sent from the policy provisioning clients to the PDP to report accounting information associated with the provisioned policy, or to notify the PDP of changes in the PEP (Report-Type =

'Accounting') related the provisioning client.

RPT is also used as a mechanism to inform the PDP about the action taken at the PEP, in response to a DEC message. For example, in response to an 'Install' decision, the PEP informs the PDP if the policy data is installed (Report-Type = 'Installed') or not (Report-Type = 'Not Installed').

The RPT message may contain provisioning client information such as accounting parameters or errors/warnings related to a decision. The data format for this information is defined in the context of the policy information base (see below). The RPT message has the following format:

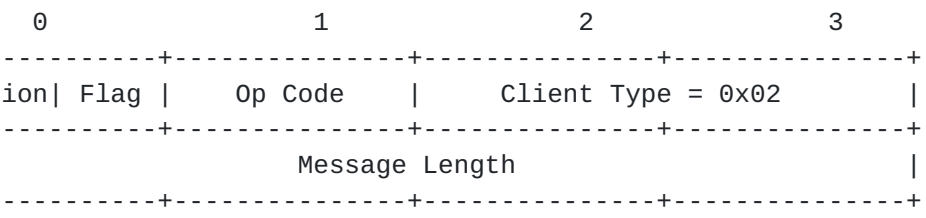
```
<Report State> ::= <Common Header>
                   <Client Handle>
                   <Report Type>
                   [<Named ClientSI: Provisioning >]
```

4 COPS-PR Protocol Objects

We define a new COPS client type for the policy provisioning client:

Client Type = 2; Policy Provisioning Client

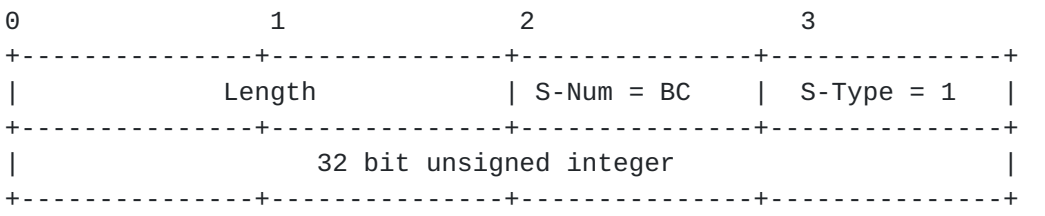
COPS messages sent between a Policy Provisioning client and a COPS server contain a COPS Common Header with this Policy Provisioning Client type specified:



The COPS Policy Provisioning client uses several new COPS protocol objects that carry named client-specific information. This section defines those new objects.

COPS-PR classifies policy data according to "bindings", where a binding consists of a Policy Rule Identifier and the Policy Rule Instance data, encoded within the context of the provisioning policy information base (see next section).

The format for these new objects is as follows:



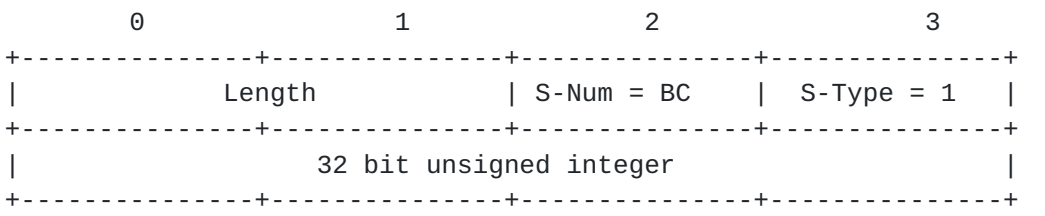
S-Num and S-Type are similar to the C-Num and C-Type used in the base COPS objects. The difference is that S-Num and S-Type are used only for ClientSI specific objects.

Length is a two-octet value that describes the number of octets (including the header) that compose the object. If the length in octets does not fall on a 32-bit word boundary, padding must be added to the end of the object so that it is aligned to the next 32-bit boundary before the object can be sent on the wire. On the receiving side, a subsequent object boundary can be found by simply rounding up the previous stated object length to the next 32-bit boundary.

4.1 Binding Count (BC)

S-Num = 1, S-Type = 1, Length = 8.

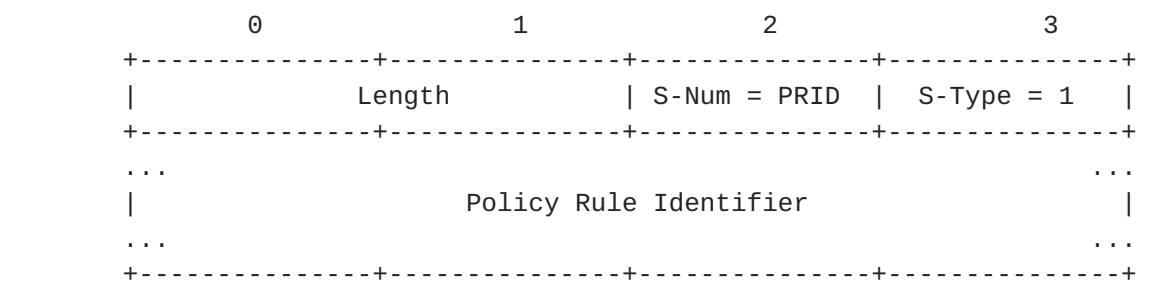
This object specifies the number of Bindings that are contained in the message.



4.2 Policy Rule Identifier (PRID)

S-Num = 2, S-Type = 1, Length = variable.

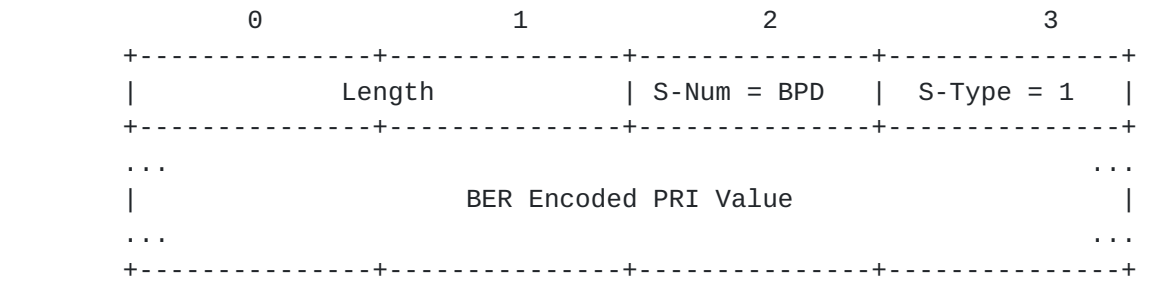
This object is used to carry the identifier, or PRID, of a Policy Rule Instance.



4.3 BER Encoded Policy Instance Data (BPD)

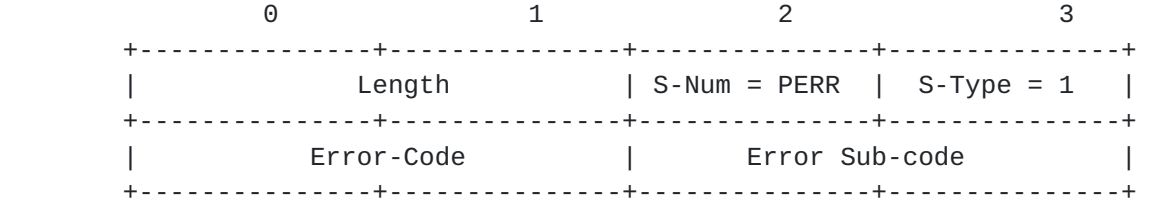
S-Num = 3, S-Type = 1, Length = variable.

This object is used to carry the BER encoded value of a Policy Data Instance.



4.4 Provisioning Error Object (PERR)

S-Num = 4, S-Type = 1, Length = 8.



The provisioning error object has the same format as the Error object in COPS [COPS], except with C-Num and C-Type replaced by the S-Num and S-Type values shown.

The policy provisioning client also adds the following error code:

Error Code 14 = Provisioning Error

5 COPS-PR Client-Specific Data Formats

This section describes the format of the named client specific information for the COPS policy provisioning client. ClientSI

formats are defined for named decision data, request data and report

data. The actual content of the data is defined by the policy information base for the provisioning client type (see below).

5.1 Named Decision Data

The Named Decision Data for the policy provisioning client consists of two types of decisions: Install and Remove, used with the 'Install' and 'Remove' Command-Code, respectively, in the COPS Decision Object. The data, in general, is composed of one or more bindings. Each binding associates a PRID object and a BPD object. The PRID object is always present in both install and remove decisions, the BPD object MUST be present in the case of an install decision and MUST NOT be present in the case of a remove decision.

The format for the provisioning client named decision data is as follows:

```
< Decision: Named Data> ::= <Install Decision> |
                            <Remove Decision>

<Install Decision>    ::= <BC> <PRID> <BPD> [<PRID> <BPD>]+

<Remove Decision>     ::= <BC> <PRID> [<PRID>]+
```

5.2 ClientSI Request Data

The provisioning client request data will use same bindings as described above. The format for this data is as follows:

```
<ClientSI: Named Request> ::= <BC> <PRID> <BPD> [<PRID> <BPD>]+
```

5.3 Policy Provisioning Report Data

The provisioning client report data is used in the RPT message in conjunction with the accompanying COPS Report Type object. Report types can be 'Commit' or 'No-Commit' indicating to the PDP that a particular set of provisioning policies has been either successfully or unsuccessfully installed/removed on the PEP. The provisioning report data consists of the bindings described above and global and specific error/warning information.

Specific errors are associated with a particular policy rule. In a 'Commit' RPT message, a specific error is an indication of a warning related to a specific policy that has been installed, but that is not fully implemented (e.g., its parameters have been approximated). In a 'No Commit' RPT message, this is an error code specific to a binding.

Global errors are not tied to a specific PRID. In a 'Commit' RPT

message, a global error is an indication of a general warning at the

PEP level (e.g., memory low). In a 'No Commit' RPT message, this is an indication of a general error at the PEP level (e.g., memory exhausted).

In the case of a 'No Commit' the PEP MUST report at least the first error and should report as many errors as possible.

<ClientSI: Named Report> ::= [<global-error>] [report]+

<global-error> ::= <Error>

<report> ::= <PRID> <specific-error>
[<BC>[<PRID><BPD>[<PRID><BPD>]+]]

<specific-error> ::= <Error>

6 Common Operations

This section describes, in general, typical exchanges between a PDP and Policy Provisioning COPS client.

First, a TCP connection is established between the client and server and the PEP sends a Client-Open message with the Client-Type = 2, Policy Provisioning client. If the PDP supports the provisioning client type, the PDP responds with a Client-Accept (CAT) message. If the client type is not supported, a Client-Close (CC) message is returned by the PDP to the PEP, possibly identifying an alternate server that is known to support the policy for the provisioning client type.

After receiving the CAT message, the PEP can send requests to the server. The REQ from a policy provisioning client contains a COPS 'Configuration Request' context object with and, optionally, any relevant client specific information for the PEP. The config request message from a provisioning client serves two purposes. First, it is a request to the PDP for any provisioning configuration data which the PDP may currently have for the PEP, such as access control filters, etc. Also, the config request is a request to asynchronously send policy data to the PEP, as the PDP decides is necessary. This asynchronous data may be new policy data or an update to policy data sent previously.

The PDP has Policy Provisioning policy configuration information for the client, that information is returned to the client in a DEC message containing the Policy Provisioning client policy data within the COPS Decision object. If no filters are defined, the DEC message will simply specify that there are no filters using the "NULL Decision" Decision Flags object. The PEP MUST specify a client handle in the request message. The PDP MUST process the client

handle and copy it in the decision message. This is to prevent the PEP from timing out the REQ and deleting the Client Handle.

The PDP can then add new policy data or update existing state by sending subsequent DEC message(s) to the PEP, with the same Client Handle. The PEP is responsible for removing the Client handle when it is no longer needed, for example when the interface goes down, and informing the PDP that the handle is to be deleted.

For Policy Provisioning purposes, access state, and access requests to the policy server can be initiated by other sources besides the PEP. Examples of other sources include attached users requesting network services via a web interface into a central management application, or H.323 servers requesting resources on behalf of a user for a video conferencing application. When such a request is accepted, the edge device affected by the decision (the point where the flow is to enter the network) must be informed of the decision. Since the PEP in the edge device did not initiate the request, the specifics of the request, e.g. flowspec, packet filter, and PHB to apply, must be communicated to the PEP by the PDP. This information is sent to the PEP using the Decision message containing Policy Provisioning client specific data objects in the COPS Decision object as specified. Any updates to the state information, for example in the case of a policy change or call tear down, is communicated to the PEP by subsequent DEC messages containing the same Client Handle and the updated Policy Provisioning request state. Updates can specify that policy data is to be deleted or installed.

The PEP acknowledges the DEC message and action taken by sending a RPT message with a "Commit" or "No-Commit" Report-Type object. This serves as an indication to the PDP that the requestor (e.g. H.323 server) can be notified that the request has been accepted by the network. If the PEP needs to reject the DEC operation for any reason, a RPT message is sent with a Report-Type of value "No-Commit" and optionally a Client Specific Information object specifying the policy data that was rejected. The PDP can then respond to the requestor accordingly.

The PEP can report to the PDP the local status of any installed request state when appropriate. This information is sent in a Report-State (RPT) message with the "Accounting" flag set. The state being reported on is referenced by the Client Handle associated with the request state and the client specific data identifier. Finally, Client-Close (CC) messages are used to cancel the corresponding Client-Open message. The CC message informs the other side that the client type specified is no longer supported.

7 Fault Tolerance

When communication is lost between PEP and PDP, the PEP attempts to re-establish the TCP connection with the PDP it was last connected to. If that server cannot be reached, then the PEP attempts to connect to a secondary PDP, assumed at this time to be manually configured at the PEP.

When a connection is finally re-established, either with the primary PDP or a secondary PDP, the PEP should provide the last PDP address of the PDP for which it is still caching decisions. Based on this information, the PDP may request the PEP to re-synch its current state information (SSQ message). If no decisions are being cached on the PEP (due to reboot or TTL timeout of state) the PEP must not included the last PDP address information. If after re-connecting, the PDP does not request the synchronization, the client can assume the server recognizes it and the current state at the PEP is correct. Any changes state changes which occurred at the PEP while connection was lost must be reported to the PDP in a RPT message. If re-synchronization is requested, the PEP should reissue its configuration requests and the PDP should delete the appropriate PRCs on the PEP (thus, removing all previous decisions below the PRC, effectively resetting all state, and reverting to some static or preconfigured decisions).

While the PEP is disconnected from the PDP, the request state at the PEP is to be used for policy decisions. If the PEP cannot re-connect in some pre-specified period of time (TTL: Time To Live, see Section 3.3), the request state is to be deleted and the associated Handles removed. The same holds true for the PDP; upon detecting a failed TCP connection, the time-out timer is started for the request state associated with the PEP and the state is removed after the specified period without a connection.

7.1 Security Considerations

The use of COPS for Policy Provisioning introduces no new security issues over the base COPS protocol. The use of IPSEC between PDP and PEP, as described in [COPS] is sufficient.

8 References

[COPS] Boyle, J., Cohen, R., Durham, D., Herzog, S., Raja, R., Sastry, A., "The COPS (Common Open Policy Service) Protocol", IETF <draft-ietf-rap-cops-05.txt>, December 1998.

[RAP] Yavatkar, R., et al., "A Framework for Policy Based Admission Control",IETF <draft-ietf-rap-framework-01.txt>, November, 1998.

[E2E] Bernet, Y., Yavatka,r R., Ford, P., Baker, F., Nichols, K., Speer, M., "A Framework for End-to-End QoS Combining RSVP/Intserv and Differentiated Services", IETF <draft-ietf-DiffServ-rsvp-01.txt>, November 1998.

[RSVP] Braden, R., Zhang, L., Berson, S., Herzog, S., and Jamin, S., "Resource Reservation Protocol (RSVP) Version 1 Functional Specification", IETF RFC 2205, Proposed Standard, September 1997.

[ASN1] Information processing systems - Open Systems Interconnection, "Specification of Abstract Syntax Notation One (ASN.1)", International Organization for Standardization, International Standard 8824, December 1987.

[BER] Information processing systems - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1), International Organization for Standardization. International Standard 8825, (December, 1987).

[RFC2475] S. Blake, D. Black, M. Carlson, E. Davies, Z. Wang, W. Weiss, "An Architecture for Differentiated Service," RFC 2475, December 1998.

[PIB] M. Fine, K. McCloghrie, S. Hahn, K. Chan, A. Smith, "An Initial Quality of Service Policy Information Base for COPS-PR Clients and Servers", draft-mfine-cops-pib-00.txt, February 1999.

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Appendix A : A DiffServ COPS-PR Example

TBD