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Diameter Application To Transfer PCN Data From Edge Nodes To a
Centralized Decision Point
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Abstract

Pre-congestion notification (PCN) is a technique for maintaining QoS for inelastic flows in a Diffserv domain. The PCN architecture requires that egress nodes send regular reports of PCN-defined measurements to a decision point. It requires further that the decision point occasionally be able to request certain measurements from ingress nodes. The decision point can be located in different places in the network. This memo defines a Diameter application to support communications between the ingress and egress nodes and a Diameter server acting as a PCN decision point.

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PCN Data Collection

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1. Introduction

The objective of Pre-Congestion Notification (PCN) is to protect the quality of service (QoS) of inelastic flows within a Diffserv domain [[RFC2475](#)] in a simple, scalable and robust fashion. Admission control allows decisions on whether to admit or reject a new flow request, and (in abnormal circumstances, such as router failure) to provide flow termination of already admitted flows. These two mechanisms together aim to protect the QoS properties of previously admitted flows. To achieve this, the overall rate of the PCN traffic is metered on every link in the PCN domain, and PCN packets are appropriately marked when certain configured rates are exceeded. These configured rates are below the rate of the link thus providing notification before any congestion occurs ("pre-congestion notification"). The level of marking allows decisions to be made about whether to admit or terminate. A more detailed description of the architecture can be found in [[RFC5559](#)].

Marking statistics are gathered by egress nodes on a per-ingress-egress aggregate basis. If multipath routing is in use, egress nodes may also send a list of individual flows along with the marking statistics, if these flows have experienced an elevated level of pre-congestion.

The reported statistics are processed to determine whether new flows can be admitted to the aggregate over the next measurement interval and whether some flows should be terminated to protect QoS for the remainder. (Flow termination is expected to be relatively infrequent, typically a result of network failure.) The admission

state is based on a congestion level estimate (CLE), which the decision node derives from the statistics that the egress node passes to the decision point. The decision to terminate flows is made on the basis of a different criterion, also derived from those statistics. For further details see [[I-D.SM-edge-behaviour](#)] and [[I-D.CL-edge-behaviour](#)].

[2.](#) Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[RFC2119](#)].

[3.](#) Procedures

The following subsections discuss the processing requirements placed upon the various participating Diameter nodes by the PCN Data

Collection application.

[3.1.](#) Egress Node Behaviour

The egress node measures the traffic from a particular ingress node, and calculates either two or three flow rates (octets per second) at the ingress-egress-aggregate level, based on the PCN markings of the packets it receives and the edge node behaviour that has been deployed. The three rates are the PCN-unmarked rate (NM-Rate), the PCN-threshold-marked rate (ThM-Rate), and the PCN-excess-traffic-marked rate (ETM-Rate). The ThM-Rate is collected for the CL edge node behaviour [[I-D.CL-edge-behaviour](#)], but not for the SM edge node behaviour [[I-D.SM-edge-behaviour](#)]. The egress node calculates these rates and reports them to the decision point every 100 to 500 ms.

The CL and SM edge node behaviour specifications also provide an option for the egress node to calculate a congestion level estimate (CLE), equal to the ratio of PCN-marked to total PCN traffic received in the interval. The egress node reports the calculated CLE to the decision point along with the basic traffic rates.

The CL and SM edge node behaviour specifications provide a further

option for report suppression when the calculated CLE is below a reporting threshold for two or more successive reporting periods. It is RECOMMENDED that the operator configure egress nodes to activate the CLE reporting and report suppression options, to minimize the reporting traffic volume in the network and the the processing load at the decision point.

For the CL mode only, when multipath routing is in effect, the egress node may be configured to collect identifiers of flows that experienced PCN-excess-traffic-marking during the measurement interval along with the calculated traffic rates.

The egress node MUST use a Congestion Report Request (CRR) command to send the calculated rates and the flow identifiers, when applicable, to the decision node. The Event-Timestamp AVP MUST be present within the CRR, and MUST indicate the ending time of the latest measurement period represented by the information within the message. At least one instance of the Aggregate-PCN-Egress-Data AVP MUST be present. Multiple instances of this AVP MAY be present, but each instance MUST report on a different ingress-egress-aggregate.

[3.2.](#) Decision Point Behaviour

If the decision point receives an Congestion-Report-Request (CRR) identified as belonging to the PCN Data Collection application, it MUST acknowledge the message with a Congestion-Report-Answer (CRA).

The decision point usage of the information provided by PCN-Congestion-Info and PCN-Excess-Flow-Info AVPs is described in the applicable edge behavior specification ([\[I-D.SM-edge-behaviour\]](#) or [\[I-D.CL-edge-behaviour\]](#)).

The decision point MAY send a Measurement-Poll-Request (MPR) to the ingress node for a specific ingress-egress-aggregate for which flow termination appears to be required. The decision point will make the decision about sending the MPR depending on the content of the CRR relating to the ingress-egress-aggregate concerned. The decision point SHOULD copy the Event-Timestamp AVP it received in the CRR to the MPR.

If the decision point receives a successful Measurement-Poll-Answer message, it uses the information contained in the PCN-Sent-Info AVP

to determine how much traffic to terminate, as described in [[I-D.SM-edge-behaviour](#)] or [[I-D.CL-edge-behaviour](#)].

[3.3.](#) Ingress Node Behaviour

When an ingress node receives an MPR, it MUST generate a Measurement-Poll-Answer message containing an instance of the PCN-Sent-Info AVP. The I-E-Aggregate-Id within the PCN-Sent-Info AVP MUST be the same as received in the MPR, and the I-E-Aggregate-Sent-Rate MUST be a rate measured for that aggregate. If Event-Timestamp is present in the MPR, the measurement upon which I-E-Aggregate-Sent-Rate is based SHOULD be that for a period after the time given by Event-Timestamp. In any case, Event-Timestamp MUST be present in the MPA, and if it is, MUST give the end-time of the measurement period upon which I-E-Aggregate-Sent-Rate is based.

[4.](#) Diameter PCN Data Collection Application

[4.1.](#) Advertising Application Support

Clients, servers, and proxies supporting the PCN Data Collection application MUST advertise support by including the value <AID> in the Auth-Application-Id of Congestion-Report-Request (CRR), Congestion-Report-Answer (CRA), Measurement-Poll-Request (MPR), and Measurement-Poll-Answer (MPA) messages.

[4.2.](#) Session Management

Diameter sessions for this application are implicitly terminated. An implicitly terminated session is one for which the server does not maintain session state information. The client does not need to send any re-authorization or session termination requests to the server.

The Diameter base protocol includes the Auth-Session-State AVP as the mechanism for the implementation of implicitly terminated sessions.

The client (server) SHALL include in its requests (responses) the Auth-Session-State AVP set to the value NO_STATE_MAINTAINED (1), as described in [RFC 3588](#) [[RFC3588](#)]. As a consequence, the server does not maintain any state information about this session and the client does not need to send any session termination request. Neither the

Authorization-Lifetime AVP nor the Session-Timeout AVP SHALL be present in requests or responses.

[4.3.](#) Commands

The PCN Data Collection application defines four new commands, Congestion-Report-Request(CRR), Congestion-Report-Answer(CRA), Measurement-Poll-Request (MPR) and Measurement-Poll-Answer (MPA).

[4.3.1.](#) Congestion-Report-Request (CRR) Command

The egress node sends the Congestion-Report-Request (CRR) command, indicated by the Command-Code field set to <CC1> and the Command Flags' 'R' bit set, to report PCN marking statistics and possibly individual flow identifiers. Multiple reports for different ingress-egress-aggregates MAY be included in the same message, as described in [Section 3.1](#).

Message format:

```
<CRR> ::= < Diameter Header: CC1, REQ, PXY >
          < Session-Id >
          { Auth-Application-Id }
          { Auth-Session-State }
          { Origin-Host }
          { Origin-Realm }
          { Destination-Realm }
          * ( Aggregate-PCN-Egress-Data )
            ( Event-Timestamp ]
            [ Destination-Host ]
          * [ Proxy-Info ]
          * [ Route-Record ]
          * [ AVP ]
```

At least one instance of the Aggregate-PCN-Egress-Data AVP MUST be present. The value of the Session-Id AVP MUST be unique and SHOULD be set according to the recommendations in [Section 8.8 of RFC 3588](#) [[RFC3588](#)].

[4.3.2.](#) Congestion-Report-Answer (CRA) Command

The decision point uses the Congestion-Report-Answer (CRA) command, indicated by the Command-Code field set to <CC1> and the Command Flags' 'R' bit cleared, to acknowledge a Congestion-Report-Request command sent by an egress node. The Congestion-Report-Answer command contains the same Session-Id as the corresponding request. The Event-Timestamp AVP MUST be present and MUST contain the value received in the CRR that is being acknowledged.

Message format:

```
<CRA> ::= < Diameter Header: CC1, PXY >
         < Session-Id >
         { Auth-Application-Id }
         { Auth-Session-State }
         { Result-Code }
         { Origin-Host }
         { Origin-Realm }
         ( Event-Timestamp )
         [ Error-Message ]
         [ Error-Reporting-Host ]
         [ Failed-AVP ]
         * [ Proxy-Info ]
         * [ AVP ]
```

[4.3.3.](#) Measurement-Poll-Request (MPR) Command

The decision point sends the Measurement-Poll-Request (MPR) command, indicated by the Command-Code field set to <CC2> and the Command Flags' 'R' bit set, to request that an ingress node report the rate at which PCN- marked traffic has been forwarded to a given ingress-egress aggregate, measured over a time period constrained as described in [Section 3.3](#). The value of the Session-Id AVP MUST be unique and SHOULD be set according to the recommendations in [Section 8.8 of RFC 3588 \[RFC3588\]](#). The I-E-Aggregate-Id AVP MUST be present. The Event-Timestamp AVP SHOULD be present.

Message format:

```
<MPR> ::= < Diameter Header: CC2, REQ, PXY >
          < Session-Id >
          { Auth-Application-Id }
          { Auth-Session-State }
          { Origin-Host }
          { Origin-Realm }
          { Destination-Realm }
          { I-E-Aggregate-Id }
          [ Destination-Host ]
          [ Event-Timestamp ]
          * [ Proxy-Info ]
          * [ Route-Record ]
          * [ AVP ]
```

[4.3.4.](#) Measurement-Poll-Answer (MPA) Command

The ingress node sends the Measurement-Poll-Answer (MPA) command, indicated by the Command-Code field set to <CC2> and the Command Flags' 'R' bit cleared, in response to an MPR sent by the decision point. The Session-Id MUST be copied from the MPR to which the MPA is responding. The PCN-Sent-Info and Event-Timestamp AVPs MUST be present.

Message format:

```
<MPA> ::= < Diameter Header: CC2, PXY >
          < Session-Id >
          { Auth-Application-Id }
          { Auth-Session-State }
          { Result-Code }
          { Origin-Host }
          { Origin-Realm }
          { PCN-Sent-Info }
          ( Event-Timestamp )
          [ Error-Message ]
          [ Error-Reporting-Host ]
          [ Failed-AVP ]
          * [ Proxy-Info ]
          * [ AVP ]
```

[4.4.](#) Attribute Value Pairs (AVPs)

This section describes the AVPs specific to the PCN Data Collection application. The 'M' bit MUST be set and the 'V' bit MUST NOT be set for all of these AVPs when used in the PCN Data Collection application.

[4.4.1.](#) I-E-Aggregate-Id AVP

The I-E-Aggregate-Id AVP (AVP code <AVP1>) is of type Grouped and identifies a specific aggregate.

The I-E-Aggregate-Id AVP has the following format:

EDITOR'S NOTE: may need to add something that works for MPLS.

```
I-E-Aggregate-Id ::= < AVP Header: AVP1 >
                    [ PCN-Ingress-Node-Address ]
                    [ PCN-Egress-Node-Address ]
                    [ VLAN-ID-Range ]
                    * [ AVP ]
```

[4.4.2.](#) PCN-Ingress-Node-Address AVP

The PCN-Ingress-Node-Address AVP (AVP code <AVP2>) is of type Grouped and contains the address of a PCN-Ingress-Node.

The PCN-Ingress-Node-Address AVP has the following format:

```
PCN-Ingress-Node-Address ::= < AVP Header: AVP2 >
                             [ Framed-IP-Address ]
                             [ Framed-IPv6-Prefix ]
```

[4.4.3.](#) PCN-Egress-Node-Address AVP

The PCN-Egress-Node-Address AVP (AVP code <AVP3>) is of type Grouped and contains the address of a PCN-Egress-Node.

The PCN-Egress-Node-Address AVP has the following format:

```
PCN-Egress-Node-Address ::= < AVP Header: AVP3 >
                             [ Framed-IP-Address ]
                             [ Framed-IPv6-Prefix ]
```

[4.4.4.](#) Framed-IP-Address AVP

The Framed-IP-Address AVP is defined in the NASREQ application ([RFC 4005](#) [[RFC4005](#)]).

[4.4.5.](#) Framed-IPv6-prefix AVP

The Framed-IPv6-prefix AVP is defined in the NASREQ application ([RFC 4005](#) [[RFC4005](#)]).

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[4.4.6.](#) VLAN-ID-Range AVP

The VLAN-ID-Range AVP, defined in `ietf-dime-qos-attributes` [`I-D.ietf-dime-qos-attributes`], is of type Grouped and specifies the VLAN range to match.

[4.4.7.](#) Aggregate-PCN-Egress-Data AVP

The PCN-Congestion-Info AVP (AVP code <AVP4>) is of type Grouped. It identifies an ingress-egress aggregate, reports the current value of the PCN-unmarked, PCN-excess-traffic-marked, and optionally, PCN-threshold- marked traffic rates and the CLE, and MAY identify zero or more flows experiencing excess-traffic-marking.

The PCN-Congestion-Info AVP has the following format:

```
Aggregate-PCN-Egress-Data ::= < AVP Header: AVP4 >
                               { I-E-Aggregate-Id }
                               { NM-Rate }
                               { ETM-Rate }
                               [ ThM-Rate ]
                               [ CLE-Value ]
                               * [ Classifier ]
                               * [ AVP ]
```

[4.4.8.](#) NM-Rate AVP

The NM-Rate AVP (AVP code <AVP5>) is of type Unsigned32. It gives the calculated rate of receipt of PCN-unmarked traffic in octets per second for a given ingress-egress-aggregate.

[4.4.9.](#) ETM-Rate AVP

The ETM-Rate AVP (AVP code <AVP6>) is of type Unsigned32. It gives the calculated rate of receipt of excess-traffic-marked traffic in octets per second for a given ingress-egress-aggregate.

[4.4.10.](#) ThM-Rate AVP

The ThM-Rate AVP (AVP code <AVP7>) is of type Unsigned32. It gives the calculated rate of receipt of threshold-marked traffic in octets per second for a given ingress-egress-aggregate.

[4.4.11.](#) CLE-Value AVP

The CLE-Value AVP (AVP code <AVP8>) is of type Unsigned32. It gives the calculated ratio of traffic rates of PCN-marked traffic to total PCN traffic received at the egress node, multiplied by 1000 and

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truncated, for a given ingress-egress-aggregate. By construction, the value of the CLE-Value AVP ranges from 0 to 1000.

[4.4.12.](#) Classifier AVP

The Classifier AVP (AVP Code 511) is a grouped AVP that consists of a set of attributes that specify how to match a packet. The Classifier AVP is defined in [[RFC5777](#)]. In the present specification its purpose is to identify a flow that is experiencing excess-traffic-marking.

[4.4.13.](#) PCN-Sent-Info AVP

The PCN-Sent-Info AVP (AVP code <AVP9>) is of type Grouped. It provides the estimated rate of flow of PCN traffic in octets per second that the ingress node has admitted to a given ingress-egress-aggregate.

The PCN-Sent-Info AVP has the following format:

```
PCN-Sent-Info ::= < AVP Header: AVP9 >
                { I-E-Aggregate-Id }
                { I-E-Aggregate-Sent-Rate }
                * [ AVP ]
```

4.4.14. I-E-Aggregate-Sent-Rate AVP

The I-E-Aggregate-Sent-Rate AVP (AVP code <AVP10>) is of type Unsigned32. It gives the estimated rate of flow of PCN traffic in octets per second that the ingress node forwarded to the identified ingress-egress aggregate, calculated for the measurement period ending at the time given by the Event-Timestamp AVP.

4.5. AVP Occurrence Tables

The following table presents the AVPs defined in this document and their occurrences in Diameter messages. Note that AVPs that can only be present within a Grouped AVP are not represented in this table.

The table uses the following symbols:

0: The AVP MUST NOT be present in the message.

1: One instance of the AVP MUST be present in the message.

1+: One or more instances of the AVP MUST be present in the message.

| AVP Name | Command-Code | | | |
|---------------------------|--------------|-----|-----|-----|
| | CRR | CRA | MPR | MPA |
| Aggregate-PCN-Egress-Data | 1+ | 0 | 0 | 0 |
| PCN-Sent-Info | 0 | 0 | 0 | 1 |
| I-E-Aggregate-Id | (*) | 0 | 1 | (*) |

(*): Note that the I-E-Aggregate-Id AVP appears alone in the MPR command and is contained within the Aggregate-PCN-Egress-Data grouped AVP (CRR command) and the PCN-Sent-Info grouped AVP (MPA command).

5. IANA Considerations

Upon publication of this memo as an RFC, IANA is requested to assign values as described in the following sections.

5.1. Diameter Application Identifier

An application identifier for Diameter PCN Data Collection (<AID>, [Section 4.1](#)) must be assigned according to the policy specified in [Section 11.3 of \[RFC3588\]](#).

5.2. Diameter Command Codes

Codes must be assigned for the following commands according to the policy specified in [\[RFC3588\], Section 11.2.1](#):

- o Congestion-Report-Request (CRR) and Congestion-Report-Answer (CRA) (<CC1>, [Section 4.3.1](#) and [Section 4.3.2](#)).
- o Measurement-Poll-Request (MPR) and Measurement-Poll-Answer (MPA) (<CC4>, [Section 4.3.3](#) and [Section 4.3.4](#)).

5.3. Attribute-Value Pairs

Codes must be assigned for the following AVPs using the policy specified in [\[RFC3588\], Section 11.1.1](#):

- o I-E-Aggregate-Id (<AVP1>, [Section 4.4.1](#))
- o PCN-Ingress-Node-Address (<AVP2>, [Section 4.4.2](#))
- o PCN-Egress-Node-Address (<AVP3>, [Section 4.4.3](#))
- o Aggregate-PCN-Egress-Data (<AVP4>, [Section 4.4.7](#))
- o NM-Rate (<AVP5>, [Section 4.4.8](#))
- o ETM-Rate (<AVP6>, [Section 4.4.9](#))

- o ThM-Rate (<AVP7>, [Section 4.4.10](#))
- o CLE-Value (<AVP8>, [Section 4.4.11](#))
- o PCN-Sent-Info (<AVP9>, [Section 4.4.13](#))
- o I-E-Aggregate-Sent-Rate (<AVP10>, [Section 4.4.14](#)).

[6.](#) Security Considerations

The following sections discuss the security threats against the Diameter PCN Data Collection application and describe some countermeasures.

[6.1.](#) Traffic Security

Application traffic MUST be secured as specified in [RFC 3588](#) [[RFC3588](#)] (i.e., through the use of (preferably) TLS or IPsec). In the absence of appropriate protection, all manner (including man-in-the-middle) of attacks are possible, potentially resulting in the inappropriate termination and non-admittance of flows.

[6.2.](#) Device Security

Compromise of an ingress node by an attacker could result in the inappropriate refusal of admittance to valid flows, while the compromise of an egress node could allow the termination of valid flows.

Compromise of the decision point could result in both denial of admission to new flows and termination of existing flows, enabling an attacker to essentially control PCN traffic on the affected network.

[7.](#) References

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[7.1.](#) Normative References

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[Appendix A](#). [Appendix A](#). Related Work in ITU-T

The ITU-T is doing work to exploit the PCN technology in an environment where the decisions are made by a central policy decision point (decision point) [[Q.3303.3](#)], which needs the information generated by PCN marking to support per-flow decisions on admission and termination. This memo defines a Diameter application to transfer the information from edge nodes to the decision point. Egress node reports are sent by the egress node acting as client to the decision point acting as server. Data generated at the ingress node are needed only when flow termination is required. They are requested by the decision point acting as client and sent in responses by the ingress node acting as server. The decision point thus acts both as client and as server in the same application. The Rw application [[RFC5431](#)] provides a precedent for such an application.

The PCN Data Collection application is related to existing ITU-T applications as follows:

- o The Rs application allows application-level functions to request flow admission for individual application flows.
- o The Rw application provides the control linkage between a Policy Decision Point and an ingress router, to pass down decisions on flow admission following either the push or the pull model. The Rw application also passes flow termination decisions.

As can be seen from this brief description, the PCN Data Collection application defined in this memo is complementary to the Rw application. Within the strict terms of the ITU-T architecture, it is a realization of a different interface, the Rc interface. However, the PCN Data Collection application is intended for use in any of a number of architectures based on a centralized policy decision element.

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