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**Port Control Protocol (PCP) Extension for Port Set Allocation
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Abstract

This document defines an extension to PCP allowing clients to manipulate sets of ports as a whole. This is accomplished by a new MAP option: PORT_SET.

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1. Introduction

This section describes a few (and non-exhaustive) envisioned use cases. Note that the PCP extension defined in this document is generic and is expected to be applicable to other use cases.

1.1. Lightweight 4over6

In the Lightweight 4over6 [[I-D.ietf-softwire-lw4over6](#)] architecture, shared global addresses can be allocated to customers. It allows moving the Network Address Translation (NAT) function, otherwise accomplished by a Carrier-Grade NAT (CGN) [[RFC6888](#)], to the Customer-Premises Equipment (CPE). This provides more control over the NAT function to the user, and more scalability to the ISP.

In the lw4o6 architecture, the PCP-controlled device corresponds to the lwAFTR, and the PCP client corresponds to the lwB4. The client sends a PCP MAP request containing a PORT_SET option to trigger shared address allocation on the lwAFTR. The PCP response contains the shared address information, including the port set allocated to the lwB4.

1.2. Applications Using Port Sets

Some applications require not just one port, but a port set. One example is a Session Initiation Protocol (SIP) User Agent Server (UAS) [[RFC3261](#)] expecting to handle multiple concurrent calls, including media termination. When it receives a call, it needs to signal media port numbers to its peer. Generating individual PCP MAP requests for each of the media ports during call setup would introduce unwanted latency. Instead, the server can pre-allocate a set of ports such that no PCP exchange is needed during call setup.

Using PORT_SET, an application can manipulate port sets much more efficiently than with individual MAP requests.

Another example of an application using port sets is that of a busy back-to-back PCP server/client [[I-D.cheshire-recursive-pcp](#)], handling many requests per second. It could benefit from PORT_SET by obtaining ports from upstream in big chunks. Then it would manage those chunks like port pools from which it would allocate to downstream clients. That could be more efficient than obtaining ports from upstream with individual MAP requests.

1.3. Firewall Control

Port sets are often used in firewall rules. For example, defining a range for RTP [[RFC3550](#)] traffic is common practice. The MAP request

can already be used for firewall control. The PORT_SET option brings the additional ability to manipulate firewall rules operating on port sets instead of single ports.

1.4. Discovering Stateless Port Set Mappings

A MAP request can be used to discover a stateless mapping. Similarly, a MAP request with a PORT_SET request can be used to discover a stateless port set mapping. Hence, PORT_SET is applicable for port set mapping discovery in Stateless NAT44 [[I-D.tsou-stateless-nat44](#)].

2. Terminology

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 [[RFC2119](#)].

3. The need for PORT_SET

Multiple MAP requests can be used to manipulate a set of ports, having roughly the same effect as a single use of a MAP request with a PORT_SET option. However, use of the PORT_SET option is more efficient when considering the following aspects:

Network Traffic: A single request uses less network resources than multiple requests.

Latency: Even though MAP requests can be sent in parallel, we can expect the total processing time to be longer for multiple requests than a single one.

Client-side simplicity: The logic that is necessary for maintaining a set of ports using a single port set entity is much simpler than that required for maintaining individual ports, especially when considering failures, retransmissions, lifetime expiration, and re-allocations.

Server-side efficiency: Some PCP-controlled devices can allocate port sets in a manner such that data passing through the device is processed much more efficiently than the equivalent using individual port allocations. For example, a CGN having a "bulk" port allocation scheme (see [[RFC6888](#)] [section 5](#)) often has this property.

Server-side scalability: The number of mapping entries in PCP-controlled devices is often a limiting factor. Allocating port sets in a single request can result in a single mapping entry being used, therefore allowing greater scalability.

Therefore, while it is functionally possible to obtain the same results using plain MAP, the extension proposed in this document allows greater efficiency, scalability, and simplicity, while lowering latency and necessary network traffic. In a nutshell, PORT_SET is a necessary optimization.

In addition, PORT_SET supports parity preservation. Some protocols (e.g. RTP [[RFC3550](#)]) assign meaning to a port number's parity. When mapping sets of ports for the purpose of using such kind of protocol, preserving parity can be necessary.

4. The PORT_SET Option

Option Name: PORT_SET

Number: TBD

Purpose: To map sets of ports.

Valid for Opcodes: MAP

Length: 3 bytes

May appear in: Both requests and responses

Maximum occurrences: 1

NOTE TO IANA (to be removed prior to publication as an RFC): The number is to be assigned by IANA in the range 128-191 (i.e., optional to process and created via Standards Action).

The PORT_SET Option indicates that the client wishes to reserve a set of ports. The requested number of ports in that set is indicated in the option.

The PORT_SET Option is formatted as shown in Figure 1.

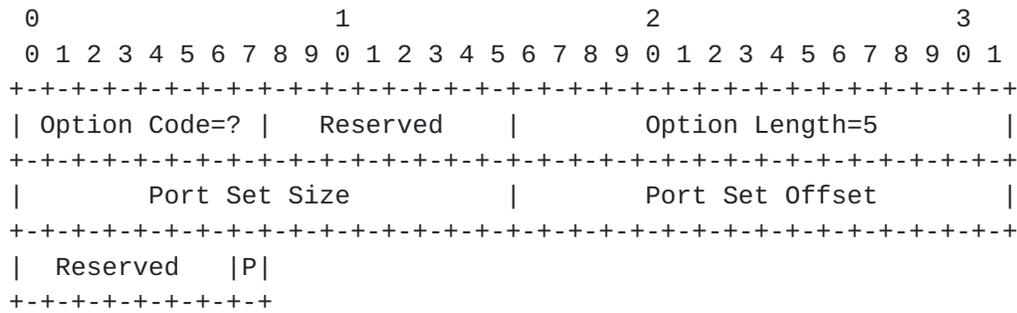


Figure 1: PORT_SET Option

The fields are as follows:

Port Set Size: Number of ports requested. MUST NOT be zero.

Port Set Offset: In a request, this field MUST be set to zero by the client and MUST be ingored by server. In a response, this field indicates the offset, starting from the Internal Port, of the port set mapped by the server.

P: 1 if parity preservation is requested, 0 otherwise.

NOTE: In its current form, PORT_SET does not support allocating discontinuous port sets. That feature could be added in the future depending on input from the working group.

The Internal Port Set is defined as being the range of Port Set Size ports starting from Internal Port + Port Set Offset. The External Port Set is respectively defined as being the range of Port Set Size ports starting from the Assigned External Port. The two ranges always have the same size (i.e., the Port Set Size returned by the server).

4.1. Client Behavior

To retrieve a set of ports, the PCP client adds a PORT_SET option to its PCP MAP request. If port preservation is required, the PCP Client MUST set the parity bit (to 1) to ask the server to preserve the port parity (i.e., the Assigned External Port and Internal Port have the same parity). The PCP client MUST indicate a suggested Port Set Size. A non-null value MUST be used. The client MUST set the Port Set Offset field to zero.

The PCP Client MUST NOT include more than one PORT_SET option in a MAP request. If several port sets are needed, the PCP client MUST issue as many MAP requests each of them include a PORT_SET option. These individual MAP requests MUST include distinct Internal Port.

If the PCP Client does not know the exact number of ports it requires, it may then set the Port Set Size to 0xffff, indicating that it is willing to accept as many ports as the server can offer.

If the PORT_SET option is not supported by the server, the PCP client will receive a response with no PORT_SET option, which is the operation of a PCP server that does not support PORT_SET. That response will map one port. To map its other desired ports, the PCP client will then have to issue individual MAP requests with no PORT_SET option to achieve similar functionality.

4.2. Server Behavior

In addition to regular MAP request processing, the following checks are made upon receipt of a PORT_SET option with non-zero Requested Lifetime:

- o If multiple PORT_SET options are present in a single MAP request, a MALFORMED_OPTION error is returned.
- o If the Port Set Size is zero, a MALFORMED_OPTION error is returned.

If the PREFER_FAILURE option is present and the server is unable to map all ports in the requested External Port Set or is unable to preserve parity ($P = 1$), the CANNOT_PROVIDE_EXTERNAL error is returned.

If the PREFER_FAILURE option is absent, the server MAY map fewer ports than the value of Port Set Size from the request. It MUST NOT map more ports than the client asked for. The Internal Port Set always begins from the Internal Port indicated by the client and extends for a number of ports less than or equal to the requested Port Set Size.

If the requested port set cannot be fully satisfied, the PCP server SHOULD map as many ports as possible, and SHOULD map at least one port (which is same behavior as if PORT_SET is set to 1).

If the server ends up mapping only a single port, for any reason, the PORT_SET option MUST NOT be present in the response.

If the PREFER_FAILURE option is absent and port parity preservation is requested ($P = 1$), the server MAY preserve port parity. In that case, the External Port is set to a value having the same parity as the Internal Port.

If the mapping is successful, the MAP response's Assigned External

Port is set to the first port in the External Port Set, and the PORT_SET option's Port Set Size is set to number of ports in the mapped port set. The Port Set Offset field is set such that the first port in the Internal Port Set is equal to Internal Port + Port Set Offset.

4.3. Port Set Renewal and Deletion

Port set mappings are renewed and deleted as a single entity. That is, the lifetime of all port mappings in the set is set to the Assigned Lifetime at once.

A client attempting to refresh or delete a port set mapping MUST include the PORT_SET option in its request.

4.3.1. Overlap Conditions

Port set map requests can overlap with existing single port or port set mappings. This can happen either by mistake or after a client becomes out of sync with server state.

If a server receives a MAP request, with or without a PORT_SET option, that tries to map one or more internal ports or port sets belonging to already existing mappings, then the request is considered to be a refresh request applying those mappings. Each of the matching port or port set mappings is processed independently, as if a separate refresh request had been received. The processing is as described in [Section 15 of \[RFC6887\]](#), with the updated nonce check behavior described in Section 3 of [\[I-D.cheshire-pcp-unsupp-family\]](#). The server sends a Mapping Update message for each of the mappings.

Example: suppose internal port 100 is mapped to external port 100 and port set 101-199 is mapped to external port set 201-299. The server receives a MAP request with Internal Port = 100, External Port = 0, and a PORT_SET option with Port Set Size = 100. The request's Mapping Nonce is equal to those of the existing single port and port set mappings. This request is therefore treated as a two refresh requests, the first one applying to the single port mapping and the second one applying to the port set mapping. The server updates both mapping's lifetimes as usual then sends two Mapping Update messages: the first one contains Internal Port = 100, External Port = 100, and no PORT_SET option, while the second one contains Internal Port = 101, External Port = 201, and a PORT_SET option with Port Set Size = 99.

Note (to be removed before publication): It is possible to enumerate mappings with this mechanism. Is it a problem, security- or other-wise?

5. Operational Considerations

It is totally up to the PCP server to determine the port-set quota for each PCP client. In addition, when the PCP-controlled device supports multiple port-sets delegation for a given PCP client, the PCP client MAY re-initiate a PCP request to get another port set when it has exhausted all the ports within the port-set.

If the PCP server is configured to allocate multiple port-set allocation for one subscriber, the same Assigned External IP Address SHOULD be assigned to one subscriber in multiple port-set requests.

To optimize the number of mapping entries maintained by the PCP server, it is RECOMMENDED to configure the server to assign the maximum allowed port set in a single response. This policy SHOULD be configurable.

The failover mechanism in MAP [[section 14 in \[RFC6887\]](#)] and [[I-D.boucadair-pcp-failure](#)] can also be applied to port sets.

6. Security Considerations

It is believed that no additional security considerations beyond those discussed in [[RFC6887](#)] apply to this extension.

7. IANA Considerations

IANA shall allocate a code in the range 1-63 for the new PCP option defined in [Section 4](#).

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