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Learn NAT64 PREFIX64s using PCP
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Abstract

This document defines a new PCP Option/OpCode to learn the Prefix64(s) used by a PCP-controlled NAT64 device to build IPv4-embedded IPv6 addresses. This Option/OpCode is needed for successful communications when IPv4 addresses are used in referrals (e.g., SIP).

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1. Introduction

This document defines a new PCP Option/OpCode [I-D.ietf-pcp-base] to inform PCP Clients about the Prefix64 [RFC6052] used by a PCP-controlled NAT64 device [RFC6146].

This Option is required to help establishing communications between IPv6-only hosts and remote IPv4-hosts. An illustration example is shown in Figure 1. In this example, NAT64 is co-located with a PCP server while IPv6-only SIP UA interacts with a PCP Client.

In Figure 1, the PCP Client issues a PCP MAP request with PORT_RESERVATION_OPTION to reserve a pair of ports preserving parity and contiguity [I-D.boucadair-pcp-rtp-rtcp]. A pair of ports and an external IPv4 address are then returned by the PCP server to the requesting PCP Client. This information is used by the IPv6-only SIP UA to build its SDP offer which contains exclusively IPv4 addresses (especially in the "c=" line, the port indicated for media port is the external port assigned by the PCP server). The INVITE request including the SDP offer is then forwarded by the NAT64 to the Proxy Server which will relay it to the called party (i.e., IPv4-only SIP UA) (Steps (1) to (3)). IPv4-only SIP UA accepts the offer and sends back its SDP answer in a "200 OK" message which is relayed by the SIP Proxy Server and NAT64 until being delivered to IPv6-only SIP UA (Steps (4) to (6)). At the end of this process, IPv4-only SIP UA can send media streams to the IPv4 address/port as indicated in the SDP offer while IPv6-only SIP UA can not send media streams as only IPv4 addresses are present in the SDP answer.

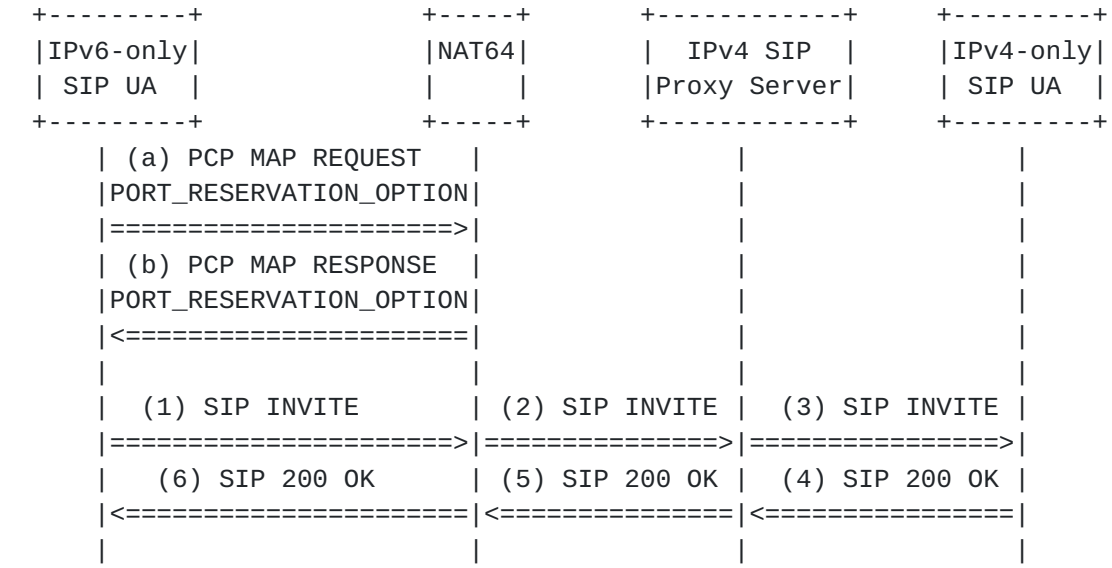

Figure 1

A solution is proposed in Section 4 and Section 5.

2. Use Cases

This issue is not specific to SIP but it is valid for all applications using IP addresses in referrals. The option/OpCode defined in this document can be used in various schemes as listed below (the list is not exhaustive):

- For hosts with DNS64 capability, added to the host's stub-resolver. The stub resolver on the host will try to obtain (native) AAAA records and if it they are not found, the DNS64 function on the host will query for A records and then synthesizes AAAA records. Using the PREFIX64 PCP Option, the host's stub-resolver can learn the prefix used for IPv6/IPv4 translator and synthesize AAAA records accordingly.

- As Peer-to-Peer (P2P) communications for real-time communication is becoming popular with RTCWEB (e.g., P2P for Media, data channels for file transfer etc), this option can be used to help for NAT64 traversal. SIP is only one example among those protocols.

- Can be used for any application using referrals.

3. 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 [RFC2119].

4. PREFIX64 Option

4.1. Format

The format of PREFIX64 PCP Option is depicted in Figure 2.

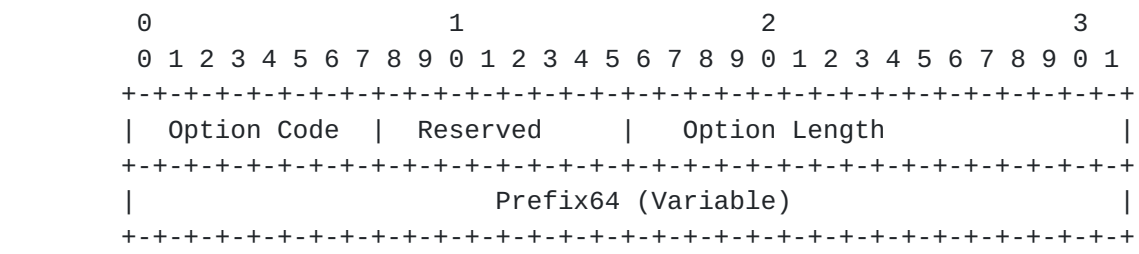

Figure 2: Prefix64 PCP Option

The description of the fields is as follows:

- Option Code: To be assigned by IANA.

- Option Length: Indicates in octets the length of the Prefix64. Allowed values are 4, 5, 6, 7, 8, or 12 [RFC6052].

- Prefix64: This field identifies the IPv6 unicast prefix to be used for constructing an IPv4-embedded IPv6 address from an IPv4 address. The address synthesize MUST follow the guidelines documented in [RFC6052].

  Option Name: PREFIX64
  Number: To be assigned by IANA.
  Purpose: Learn the prefix used by the NAT64 to build IPv4-embedded IPv6 addresses. This is be used by a host for local address synthesis (e.g., when IPv4 address is present in referrals).
  Valid for Opcodes: MAP
  Length: Variable
  May appear in: request, response.
  Maximum occurrences: 1

4.2. Behaviour

A PCP Client MAY include a PREFIX64 PCP Option in a MAP request to learn the IPv6 prefix used by an upstream PCP-controlled NAT64 device. When enclosed in a MAP request, PREFIX64 MUST be set to ::/96.

A PCP Server controlling a NAT64 SHOULD be configured to return the value of the Prefix64 used to build IPv4-embedded IPv6 addresses to requesting PCP Clients. When allowed, PREFIX64 PCP Option conveys the value of Prefix64.

A PCP Server controlling a NAT64 SHOULD inject a PREFIX64 PCP Option in MAP responses even if the option is not listed in the associated request.

Upon receipt of the PREFIX64 PCP Option, the host embedding the PCP Client uses Prefix64 for local address synthesize [RFC6052].

A PCP Client SHOULD associate each received Prefix64 with the PCP Server from which the Prefix64 information was retrieved.

5. GET_PREFIX64 OpCode

Discussion: Both PREFIX64 option and OpCode are maintained in this version of the document. Based on the WG inputs, both or only one of them will be maintained.

This OpCode allows to retrieve a list of Prefix64s configured on the PCP-controlled NAT64 (see Figure 3). "Prefix64/IPv4 Prefix Count" indicates the number of Prefix64 prefixes included in the response. Each Prefix64 is associated with an IPv4 prefix. "Prefix64/IPv4 Prefix Count" field MUST be set to 0 in a request and MUST be set to the number of included {Prefix64, IPv4 subnet} in a response.

This allows to return in the same response the list of configured PREFIX64s per IPv4 prefix range.

An IPv4 prefix is represented as "IPv4 Address/IPv4 Prefix Length". IPv6 Prefix Length field indicates in bits the length of the Prefix64; allowed values are 32, 40, 48, 56, 64 and 96. Prefix64 field MUST be set to ::/96 in a request and MUST be set to the value of the Prefix64 used to construct IPv4-embedded IPv6 addresses for a given IPv4 subnet. a wildcard "IPv4 Address/IPv4 Prefix Length" means the associated Prefix64 is valid for any IPv4 address.

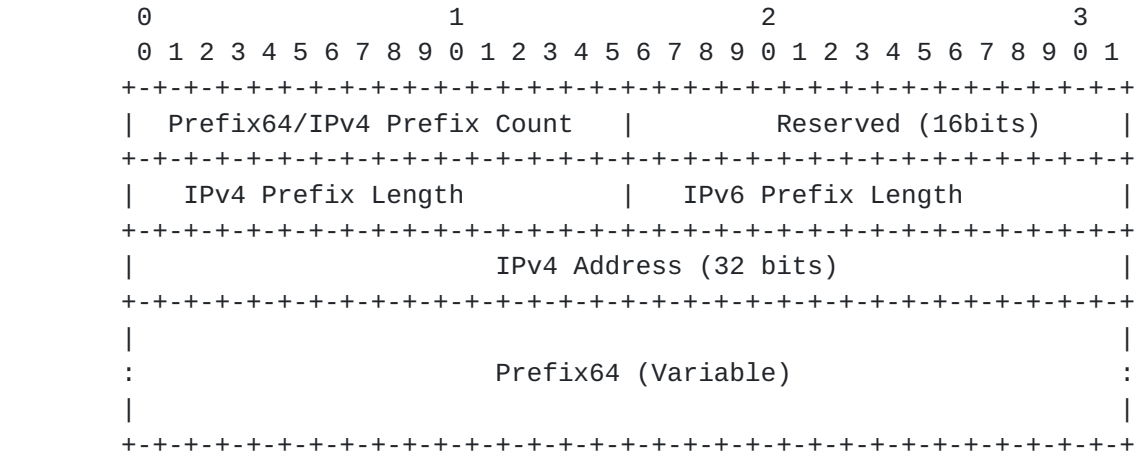

Figure 3: GET_PREFIX64 Opcode

A server MUST be configured to accept or ignore this OpCode. At receipt of a request, if it is configured to accept this OpCode, the PCP Server controlling a NAT64 MUST return the list of configured Prefix64s for each IPv4 subnet. If a single Prefix64 is configured for all IPv4 addresses, a wildcard IPv4 prefix MUST be returned in the response together with the configured Prefix64.

Retrieved Prefix64s are used locally to construct IPv4-embedded IPv6 addresses. If several Prefix64s are discovered, if the destination IPv4 address matches an IPv4 prefix in the list, the associated Prefix64 is used to construct the corresponding IPv6 address.

6. Flow Examples

6.1. Examples with PREFIX64 PCP Option

Figure 4 shows an example of the use of the option defined in Section 4.

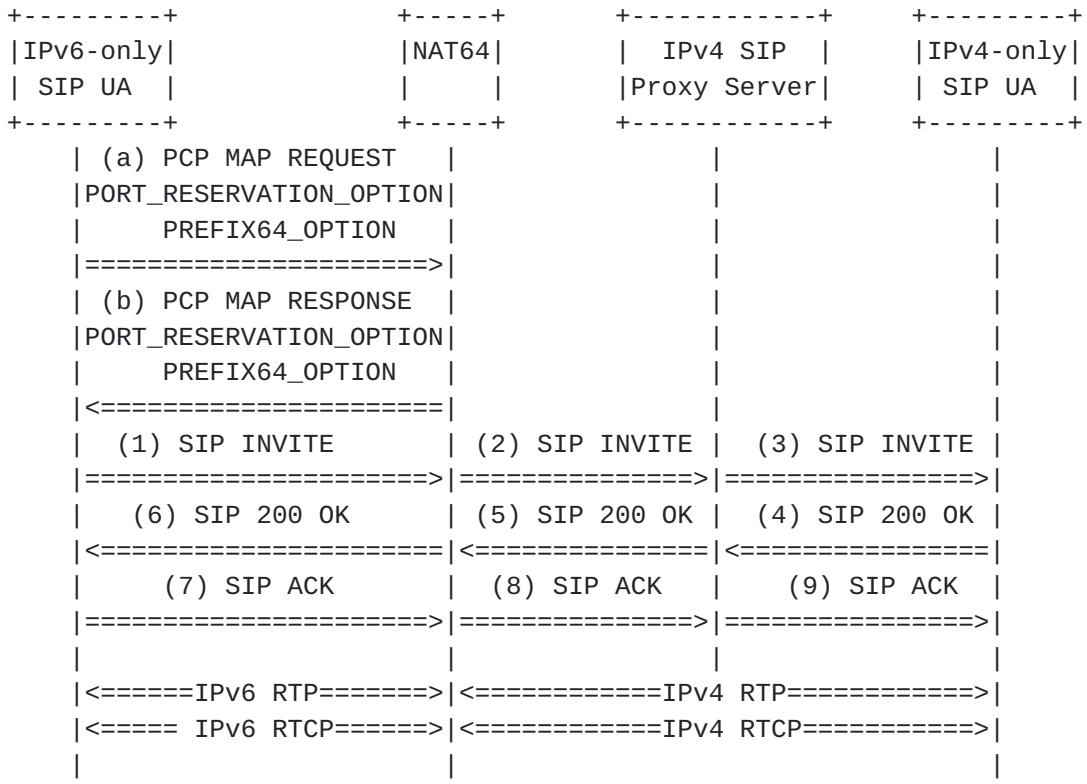

Figure 4: Example of IPv6 to IPv4 SIP initiated Session

In Steps (a) and (b), the IPv6-only SIP UA retrieves a pair of ports

to be used for RTP/RTCP, the external IPv4 address and the Prefix64 to be used to build IPv4-embedded IPv6 addresses. The retrieved IPv4 address and port numbers are used to build the SDP offer in Step (1) while Prefix64 is used to construct a corresponding IPv6 address of the IPv4 address enclosed in the SDP answer made by the IPv4-only SIP UA (Step 6). RTP/RTCP flows are exchanged between an IPv6-only SIP UA and an IPv4-only UA without requiring any ALG at the NAT64 and no particular function to be supported by the IPv4-only SIP Proxy Server to help establishing the session (e.g., Hosted NAT traversal).

Now when the session is initiated from IPv4 SIP UA (see Figure 5): Steps (a) and (b), the IPv6-only SIP UA retrieves a pair of ports to be used for RTP/RTCP, the external IPv4 address and the Prefix64 to be used to build IPv4-embedded IPv6 addresses. These two steps can be delayed until receiving the INVITE message (Step 3).

> It is recommended to pre-reserve a pair of port to optimize the required session establishment delay.

The retrieved IPv4 address and port numbers are used to build the SDP answer in Step (4) while Prefix64 is used to construct a corresponding IPv6 address of the IPv4 address enclosed in the SDP offer made by the IPv4-only SIP UA (Step 3). RTP/RTCP flows are exchanged between an IPv6-only SIP UA and an IPv4-only UA without requiring any ALG at the NAT64 and no particular function to be supported by the IPv4-only SIP Proxy Server to help establishing the session (e.g., Hosted NAT traversal).

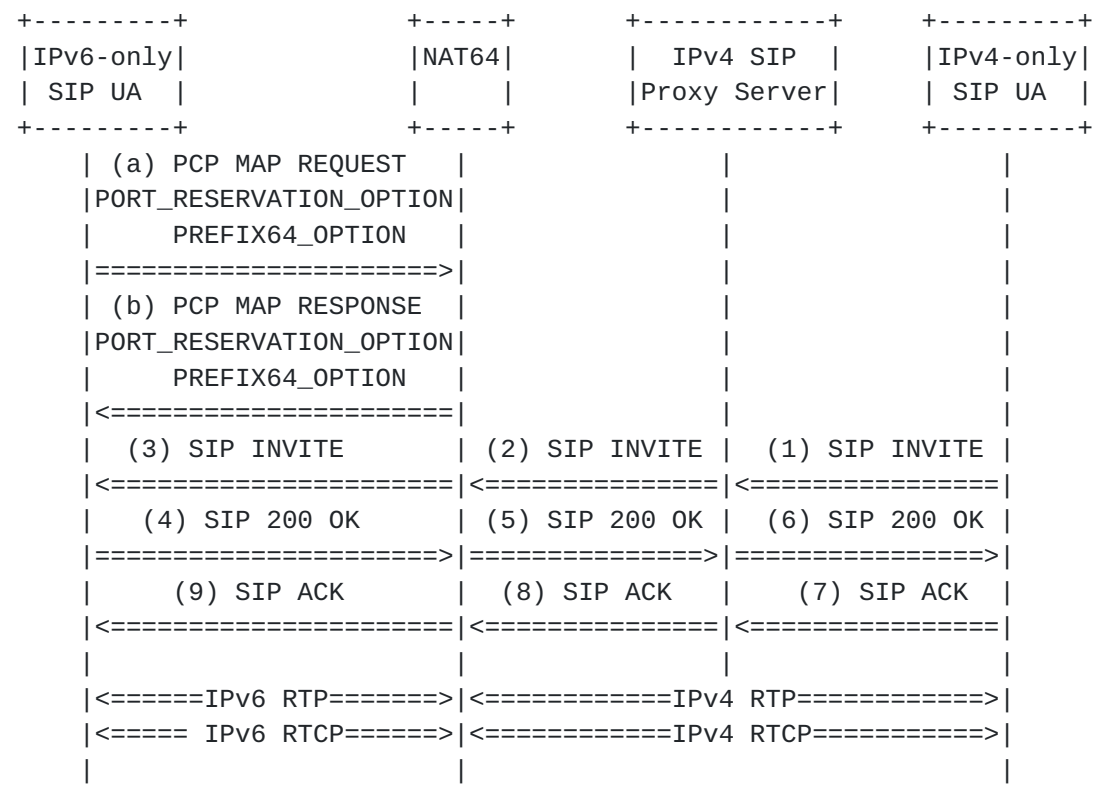

Figure 5: Example of IPv4 to IPv6 SIP initiated Session

6.2. Examples with GET_PREFIX64 OpCode

Figure 6 shows an example of the use of the OpCode defined in Section 5.

Unlike previous examples, two requests are needed to place this session: Steps (a) and (b) are used to retrieve the list of {IPv4 subnet, Prefix64::/n} while Steps (c) and (d) are used to reserve a pair of port and learn the assigned IPv4 address. The remaining steps are similar to Figure 4.

The order of sending the requests is shown for illustration purposes. Another order to issue the request may be adopted, e.g.,

1. GET_PREFIX64 and MAP requests can be sent simultaneously.

2. GET_PREFIX64 request can be sent after MAP returned an IPv4 external IP address.

3. GET_PREFIX64 request can be issued at the bootstrap of the application. No need to issue the request for each new session.

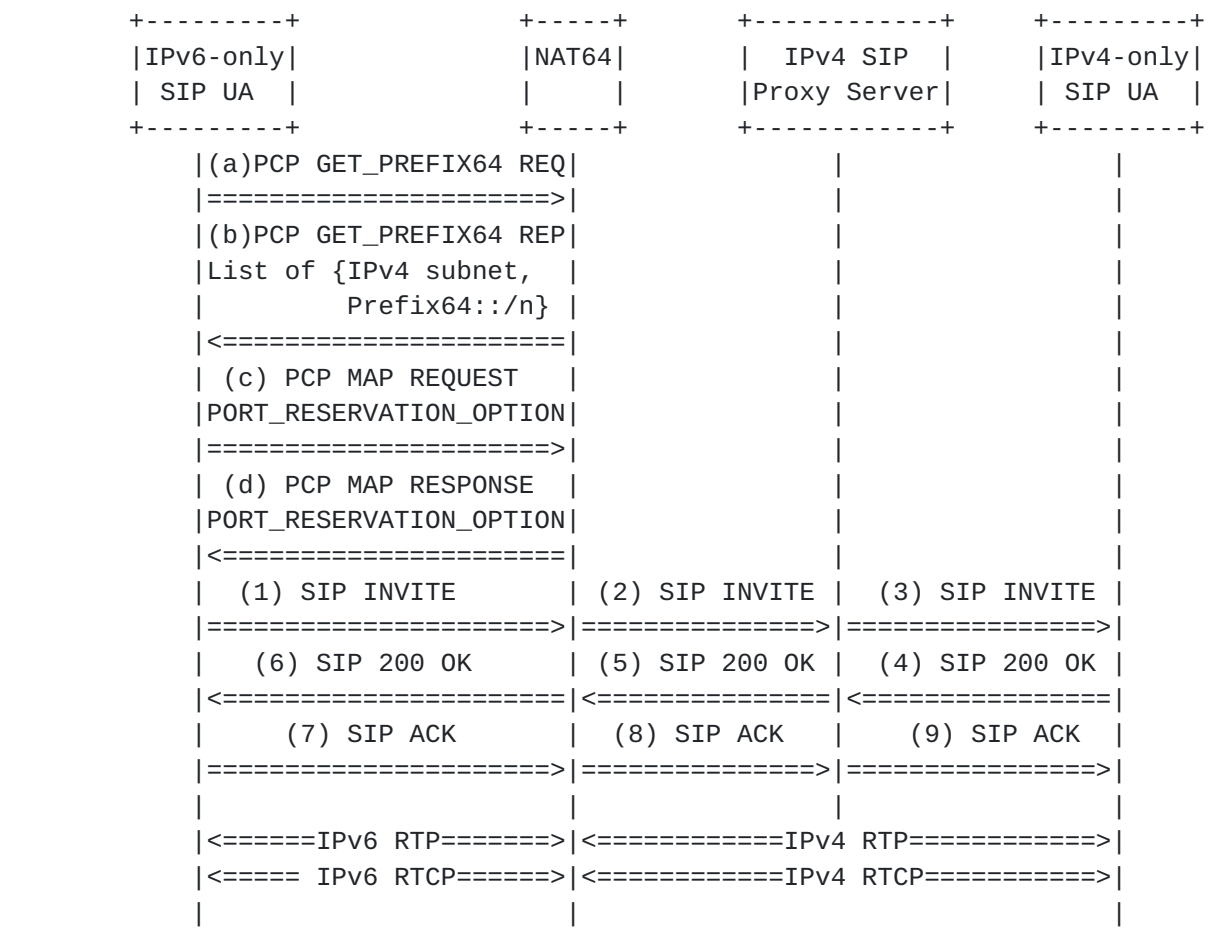

Figure 6: Example of SIP Initiated Session

In the example shown in Figure 7, once the IPv6-only Client discovered the IPv4 address of the remote IPv4-only server, it retrieves the PREFIX64 to be used to build an IPv4-embedded IPv6 address for that server. This is achieve using GET_PREFIX64 PCP OpCode (Steps (a) and (b)). The client uses PREFIX64 to construct an IPv6 address and then initiates a TCP connection (Steps (1) to (4)).

The usage shown in Figure 7 depicts a typical usage of GET_PREFIX64 PCP OpCode when a DNS64 capability is embedded in the host.

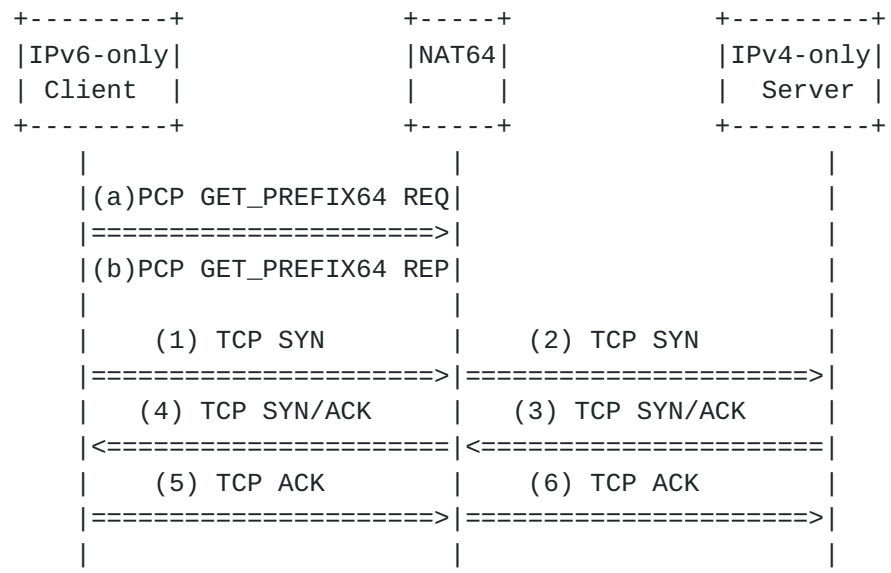

Figure 7: Example of TCP Session

7. IANA Considerations

This document request a new PCP OpCode:

GET_PREFIX64

This document request a new PCP option:

PREFIX64

8. Security Considerations

This document does not introduce any security issue in addition to what is taken into account in [I-D.ietf-pcp-base].

9. Acknowledgements

Many thanks to S. Perreault , R. Tirumaleswar, T. Tsou, D. Wing and J. Zhao for the comments and suggestions.

10. References

10.1. Normative References

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