          Port Range Configuration Options for PPP IPCP
             draft-boucadair-pppext-portrange-option-02

Abstract

   This memo defines two IPCP (IP Configuration Protocol, [RFC1332])
   Options to be used in the context of Port Range solutions. IPCP is
   the configuration protocol used when PPP (Point-to-Point Protocol,
   [RFC1661]) is deployed.

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].

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1. Introduction

Recently, within the context of IPv4 address depletion, several
solutions have been submitted to the IETF to propose viable
alternative solutions to Carrier Grade NAT (CGN).

[I-D.boucadair-port-range] is an example of these solutions which
propose to share the same (public) IP address among several devices
and to constrain the values used as port sources to a limited set of
values. These solutions do not require an additional NAT level in
the service provider's domain. Several means may be used to convey
Port Range information.

This memo defines new IPCP options to be used to carry Port Range
information. IPCP has been widely used to convey configuration
information such as IP Compression Protocol [RFC3241][RFC3544] or IP-
Address [RFC1332].

Concretely, this document defines the notion of Port Mask which is
generic and flexible. Several allocation schemes may be implemented
when using a Port Mask. This document proposes a basic mechanism
that allows the allocation of a unique port range to a requesting
client. These options can be used in port range based solutions
(e.g., [I-D.boucadair-port-range]) or in a CGN-based solution to
bypass the NAT (i.e., for transparent NAT traversal and avoid
involving several NAT in the path) or to delegate one or a set of
ports to the requesting client (e.g., avoid ALG (Application Level
Gateway) or for port forwarding purposes).

IPv4 address exhaustion is only provided as an example of the usage
of the PPP IPCP Options defined in this memo. Other usages may be
considered in the future.

2. Port Range Options

This section defines the Port Range IPCP Options.

2.1. Terminology

To differentiate between a Port Range containing a contiguous span of
port numbers and a Port Range with non contiguous port numbers, the
following denominations are used:

o Contiguous Port Range: a set of port values which form a
   contiguous sequence.

   o Non Contiguous Port Range: a set of port values which does not
      form a contiguous sequence.

   Moreover, unless explicitly mentioned, Port Mask refers to the couple
   (Port Range Value, Port Range Mask).

   This memo uses the same terminology as per [RFC1661].

2.2. Description

   The Port Range Options are used to specify one range of ports
   (contiguous or not contiguous) pertaining to a given IP address.
   Concretely, these options are used to notify a remote peer about the
   Port Mask to be applied when selecting a port value as a source port.
   The Port Range Option is used to infer a set of allowed port values.
   A Port Mask defines a set of ports that all have in common a subset
   of pre-positioned bits. This set of ports is also called Port Range.
   Two port numbers are said to belong to the same Port Range if and
   only if, they have the same Port Mask.

   A Port Mask is composed of a Port Range Value and a Port Range Mask:

   o The Port Range Value indicates the value of the significant bits
      of the Port Mask. The Port Range Value is coded as follows:

      * The significant bits may take a value of 0 or 1.

      * All the other bits (a.k.a., non significant ones) are set to 0.

   o The Port Range Mask indicates, by the bit(s) set to 1, the
      position of the significant bits of the Port Range Value.

   These IPCP Configuration Options provide a way to negotiate the Port
   Range to be used on the local end of the link. It allows the sender
   of the Configure-Request message to state which Port Range associated
   with a given IP address is desired, or to request the peer to provide
   the configuration. The peer can provide this information by NAKing
   the options, and returning a valid Port Range (i.e., (Port Range
   Value, Port Range Mask)).

   IPCP Port Range Value and Port Range Mask MUST be supported
   simultaneously.

   When the server assigns only shared IP addresses, the peer must
   include Port Range Options in its request. If not, 0.0.0.0 is
   assigned by the server to that peer.

   When a peer issues a request enclosing IPCP Port Range Options, and

if the server does not support these options, Port Range Options are
rejected by the server.

The formats of these IPCP Options are provided in Figure 1 and
Figure 2.

The format of Port Range Value IPCP Option is illustrated in Figure 1

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Type      |    Length     |       Port Range Value        |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
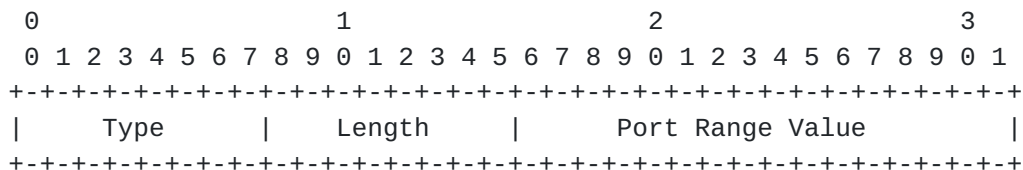

                 Figure 1: Format of the PRV IPCP Option

o Type: To be assigned (See Section 3).

o Length: This field includes the length of the overall option
   including the Type, Length and the PRV. It must be set to 4 bytes

o Port Range Value (PRV): PRV indicates the value of the significant
   bits of the Port Mask. By default, no PRV is assigned.

The format of Port Range Mask IPCP Option is illustrated in Figure 2:

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Type      |    Length     |       Port Range Mask         |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
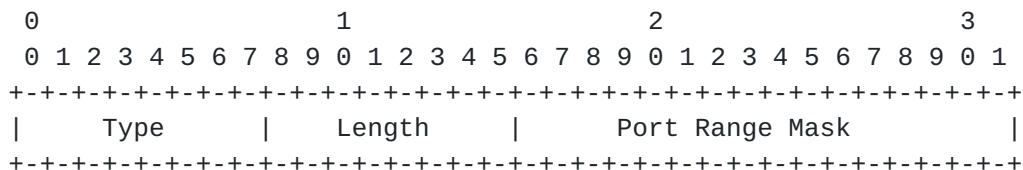

                 Figure 2: Format of the PRM IPCP Option

o Type: To be assigned (See Section 3).

o Length: This field includes the length of the overall option
   including Type, Length and PRV fields. It must be set to 4 bytes.

o Port Range Mask (PRM): Port Range Mask indicates the position of
   the bits which are used to build the Port Range Value. By
   default, no PRM value is assigned. The 1 values in the Port Range
   Mask indicate by their position the significant bits of the Port
   Range Value.

Figure 3 provides an example of the resulting Port Range:

- Port Range Mask is set to 0001010000000000 (5120) and

- Port Range Value is set to 0000010000000000 (1024).


```
     0                       1
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0|  Port Range Mask
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
            |   |
            |   | (two significant bits)
            v   v
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0|  Port Range Value
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+


    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |x x x 0 x 1 x x x x x x x x x x|  Usable ports (x may take a value of 0
or 1).
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
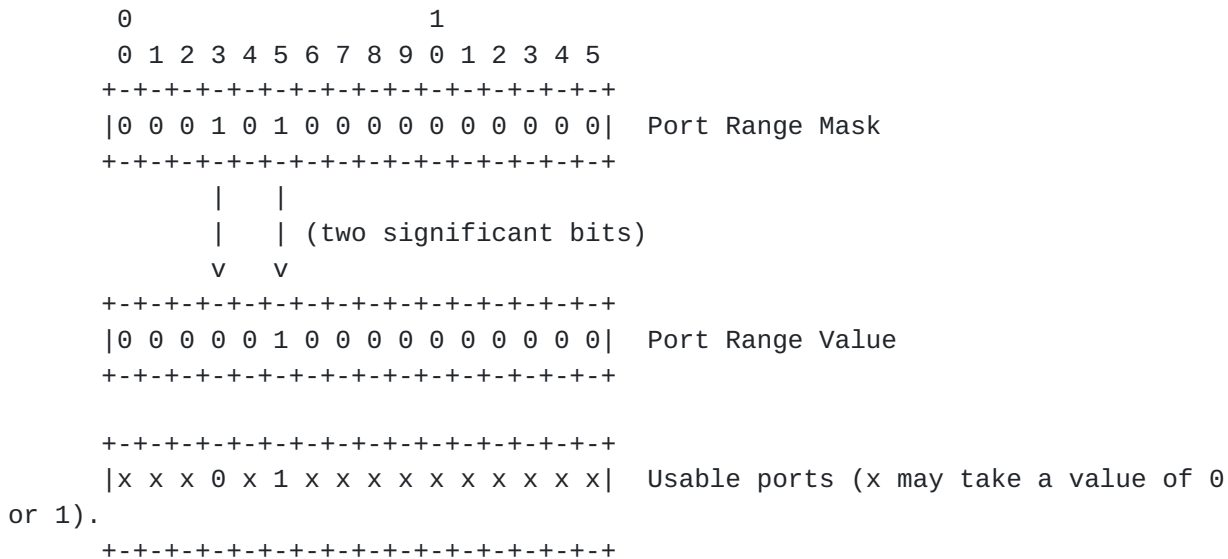

           Figure 3: Example of Port Range Mask and Port Range Value

   Port values belonging to this Port Range must have the 4th bit (resp.
   the sixth one), from the left, set to 0 (resp. 1). Only these port
   values will be used by the peer when enforcing the configuration
   conveyed by PPP IPCP.

2.3. Illustration Examples

2.3.1. Overview

   These flows provide examples of the usage of IPCP to convey Port
   Range Options. As illustrated in Figure 4, IPCP messages are
   exchanged between a Host and a BRAS (Broadband Access Server).

   1. The first example illustrates a successful IPCP exchange;

   2. The second example shows the IPCP exchange that occurs when Port
       Range Options are not supported by the server;

   3. The third example shows the IPCP exchange that occurs when Port
       Range Options are not supported by the client;

   4. The fourth example shows the IPCP exchange that occurs when Port
       Range Options are not supported by the client and a non null IP
       (i.e., an address different from 0.0.0.0) address is enclosed in

          the first configuration request issued by the peer.

2.3.2. **Successful** Flow: Port Range Options supported by both the
         Client and the Server

   The following message exchange (i.e., Figure 4) provides an example
   of successful IPCP configuration operation when Port Range IPCP
   Options are used.

     +-----+   +-----+
     | Host| | BRAS|
     +-----+   +-----+
        | |
        | (1) IPCP Configure-Request |
        | IP ADDRESS=0.0.0.0 |
        | PORT RANGE VALUE=0 |
        | PORT RANGE MASK=0 |
        |===>|
        | |
        | (2) IPCP Configure-Nak |
        | IP ADDRESS=a.b.c.d |
        | PORT RANGE VALUE=80 |
        | PORT RANGE MASK=496 |
        |<===|
        | |
        | (3) IPCP Configure-Request |
        | IP ADDRESS=a.b.c.d |
        | PORT RANGE VALUE=80 |
        | PORT RANGE MASK=496 |
        |===>|
        | |
        | (4) IPCP Configure-Ack |
        | IP ADDRESS=a.b.c.d |
        | PORT RANGE VALUE=80 |
        | PORT RANGE MASK=496 |
        |<===|
        | |

                      Figure 4: Successful flow

   The main steps of this flow are listed below:

      (1) The Host sends a first Configure-Request which includes the
      set of options it desires to negotiate. All these Configuration
      Options are negotiated simultaneously. In this example,
      Configure-Request carries information about IP-address, Port Range

Value and Port Range Mask Options. In this example, IP-address
Option is set to 0.0.0.0, Port Range Value is set to 0 and Port
Range Mask is set to 0.

(2) BRAS sends back a Configure-Nak and sets the enclosed options
to its preferred values. In this example: IP-Address Option is
set to a.b.c.d, Port Range Value is set to 80 and Port Range Mask
is set to 496.

(3) The Host re-sends a Configure-Request requesting IP-address
Option to be set to a.b.c.d, Port Range Value to be set to 80 and
Port Range Mask to be set to 496.

(4) BRAS sends a Configure-Ack message

As a result of this exchange, Host is configured to use as local IP
address a.b.c.d and the following 128 contiguous Port Ranges
resulting of the Port Mask (Port Range Value == 0, Port Range Mask ==
496):

- from 80 to 95

- from 592 to 607

- ...

- from 65104 to 65119

2.3.3. Port Range Options not supported by the Server

This example (Figure 5) depicts an exchange of messages when the BRAS
does not support IPCP Port Range Options.

```
        +-----+                                      +-----+
        | Host|                                      | BRAS|
        +-----+                                      +-----+
           |                                            |
           |            (1) IPCP Configure-Request      |
           |                IP ADDRESS=0.0.0.0          |
           |                PORT RANGE VALUE=0          |
           |                PORT RANGE MASK=0           |
           |===========================================>|
           |                                            |
           |            (2) IPCP Configure-Reject       |
           |                PORT RANGE VALUE=0          |
           |                PORT RANGE MASK=0           |
           |<===========================================|
           |                                            |
           |            (3) IPCP Configure-Request      |
           |                IP ADDRESS=0.0.0.0          |
           |===========================================>|
           |                                            |
           |            (4) IPCP Configure-Nak          |
           |                IP ADDRESS=a.b.c.d          |
           |<===========================================|
           |                                            |
           |            (5) IPCP Configure-Request      |
           |                IP ADDRESS=a.b.c.d          |
           |===========================================>|
           |                                            |
           |            (6) IPCP Configure-Ack          |
           |                IP ADDRESS=a.b.c.d          |
           |<===========================================|
           |                                            |
```

          Figure 5: Failed flow: Port Range Options not supported by the
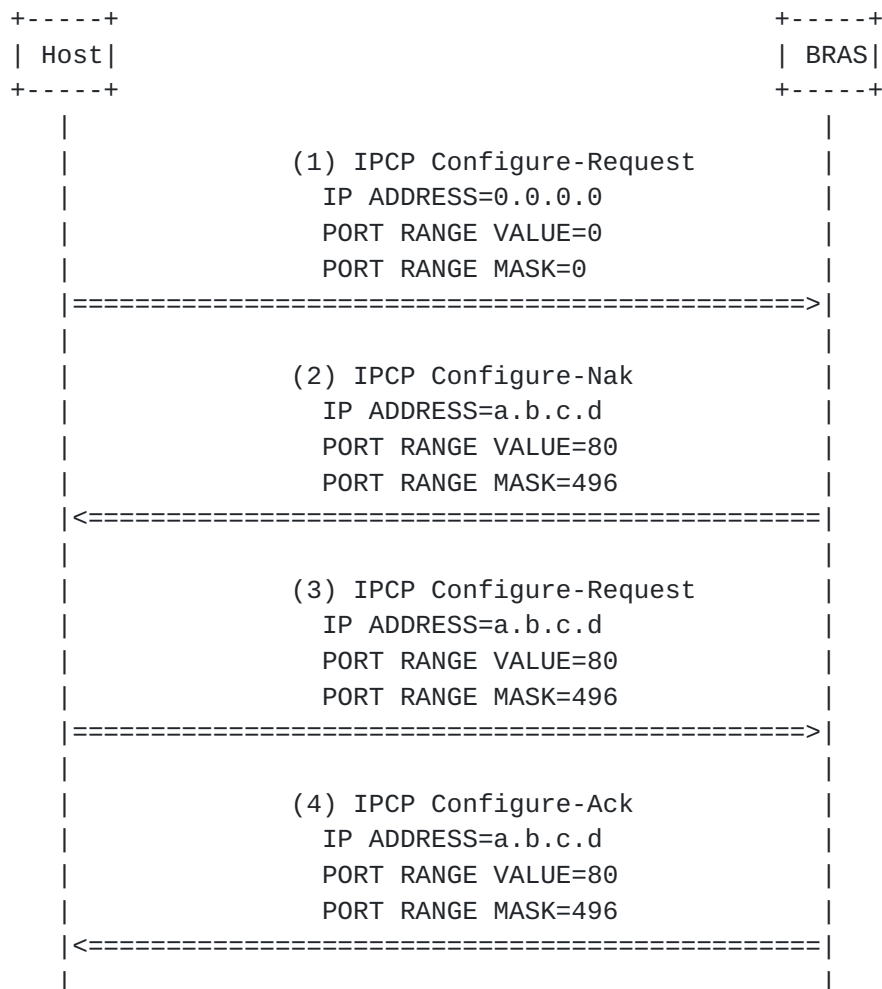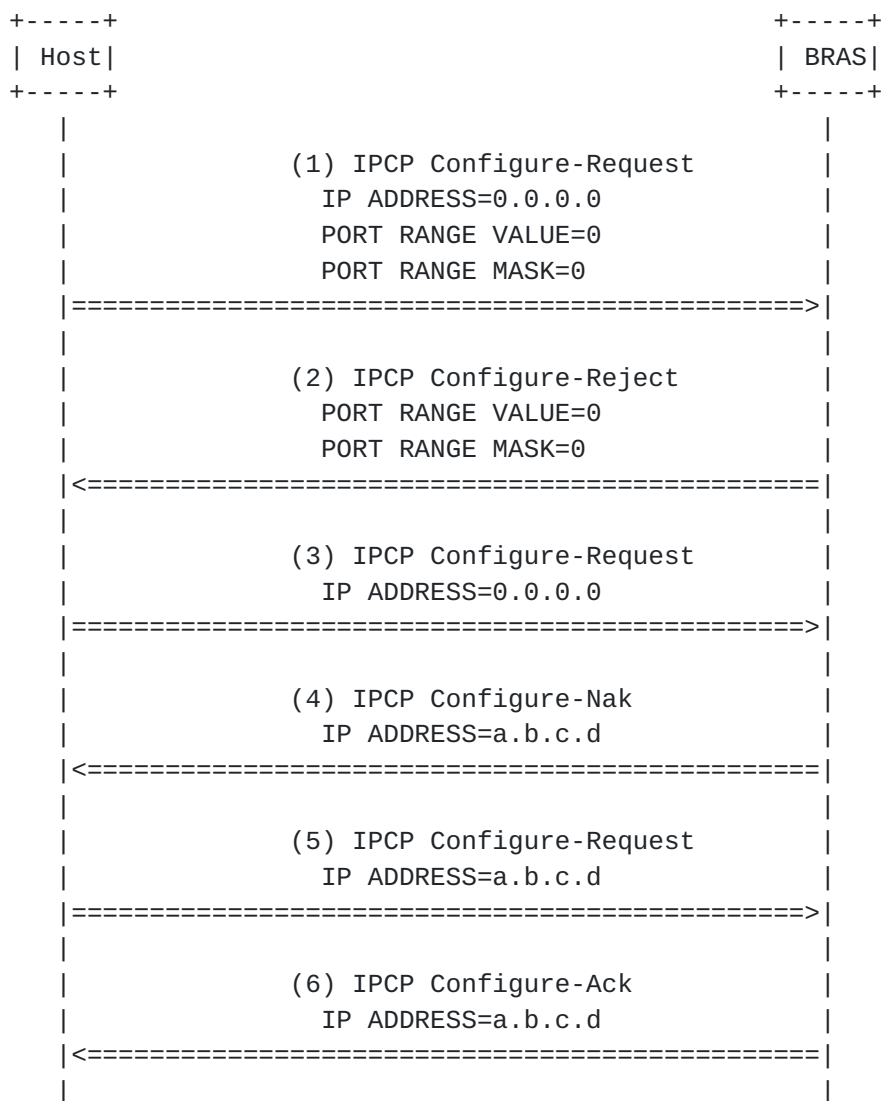   server

      The main steps of this flow are listed hereafter:

         (1) The Host sends a first Configure-Request which includes the
         set of options it desires to negotiate. All these Configuration
         Options are negotiated simultaneously. In this example,
         Configure-Request carries the codes of IP-address, Port Range
         Value and Port Range Mask options. In this example, IP-address
         Option is set to 0.0.0.0, Port Range Value is set to 0 and Port
         Range Mask is set to 0.

         (2) BRAS sends back a Configure-Reject to decline Port Range Value
         and Port Range Mask options.

(3) The Host sends a Configure-Request which includes only the
codes of IP-Address option. In this example, IP-Address Option is
set to 0.0.0.0.

(4) BRAS sends back a Configure-Nak and sets the enclosed option
to its preferred value. In this example: IP-Address Option is set
to a.b.c.d.

(5) The Host re-sends a Configure-Request requesting IP-Address
Option to be set to a.b.c.d.

(6) BRAS sends a Configure-Ack message.

As a result of this exchange, Host is configured to use as local IP
address a.b.c.d. This IP address is not a shared IP address.

2.3.4. Port Range Options not supported by the Client

This example (Figure 6) depicts exchanges when only shared IP
addresses are assigned to end-user's devices. The support of IPCP
Port Range Options is MANDATORY.

```
   +-----+                                          +-----+
   | Host|                                          | BRAS|
   +-----+                                          +-----+
      |                                                |
      |              (1) IPCP Configure-Request        |
      |                   IP ADDRESS=0.0.0.0           |
      |===============================================>|
      |                                                |
      |              (2) IPCP Configure-Ack            |
      |                   IP ADDRESS=0.0.0.0           |
      |<===============================================|
      |                                                |
```
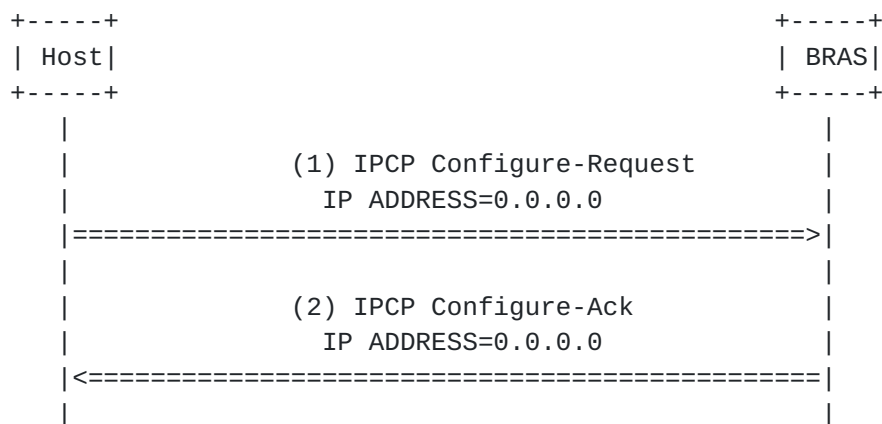
Figure 6: Port Range Options not supported by the Client

The main steps of this flow are:

(1) The Host sends a Configure-Request requesting IP-Address
Option to be set to 0.0.0.0 and without enclosing Port Range
Options.

(2) BRAS sends a Configure-Ack message and sets the IP address to
0.0.0.0 since only shared IP addresses are assigned.

As a result of this exchange, Host is configured to use as local IP
address 0.0.0.0. Host is not able to access the service.

If in the first Configure-Request, a valid IP address is enclosed,
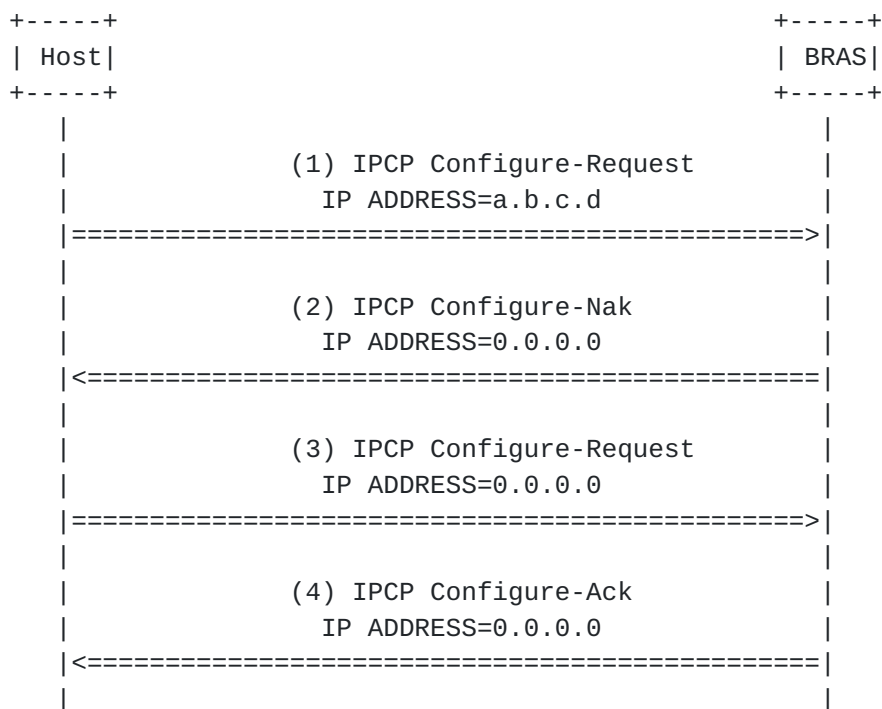the following exchange (Figure 7) should be experienced:

```
   +-----+                                        +-----+
   | Host|                                        | BRAS|
   +-----+                                        +-----+
      |                                              |
      |              (1) IPCP Configure-Request      |
      |                   IP ADDRESS=a.b.c.d          |
      |=============================================>|
      |                                              |
      |                 (2) IPCP Configure-Nak        |
      |                   IP ADDRESS=0.0.0.0          |
      |<=============================================|
      |                                              |
      |              (3) IPCP Configure-Request       |
      |                   IP ADDRESS=0.0.0.0          |
      |=============================================>|
      |                                              |
      |                 (4) IPCP Configure-Ack        |
      |                   IP ADDRESS=0.0.0.0          |
      |<=============================================|
      |                                              |
```

       Figure 7: Port Range Options not supported by the Client (2)

   The main steps of this flow are described below:

      (1) The Host sends a Configure-Request requesting IP-Address
      Option to be set to a.b.c.d and without enclosing Port Range
      Options.

      (2) BRAS sends a Configure-Nak and sets the enclosed option to its
      preferred value. In this example: IP-Address Option is set to
      0.0.0.0 since only shared IP addresses are assigned.

      (3) The Host re-sends a Configure-Request requesting IP-Address
      Option to be set to 0.0.0.0.

      (4) BRAS sends a Configure-Ack message and confirms to set the IP
      address to 0.0.0.0.

   As a result of this exchange, Host is configured to use as local IP

address 0.0.0.0. Host is not able to access the service.

3. IANA Considerations

This document requests IANA to assign numbers for the following IPCP
Options:

- Port Range Value Option

- Port Range Mask Option

4. Security Considerations

This document does not introduce any security issue in addition to
those related to PPP. Service providers should use authentication
mechanisms such as CHAP [RFC1994] or PPP link encryption [RFC1968].

5. Acknowledgements

The authors would like to thank Christian JACQUENET for his review
and inputs.

6. References

6.1. Normative References

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6.2. Informative References

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Authors' Addresses

   Mohamed Boucadair (editor)
   France Telecom
   3, Av Francois Chateau
   Rennes 35000
   France

   Email: mohamed.boucadair@orange-ftgroup.com

   Pierre Levis
   France Telecom

   Email: pierre.levis@orange-ftgroup.com

   Jean-Luc Grimault
   France Telecom

   Email: jeanluc.grimault@orange-ftgroup.com

   Alain Villefranque
   France Telecom

   Fax:
   Email: alain.villefranque@orange-ftgroup.com