Dynamic Port Range Re-Assignments for Address Sharing

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Abstract

This document proposes an extension regarding dynamic port range re-
assignment to an IPv4 address sharing framework (SHARA), to overcome
IPv4 address shortage. It allows an entity which is responsible for address and port distribution to apply a more flexible handling of already assigned port ranges. An adjustment of number of ports per customer according to the current consumption pattern is possible with this enhancement.

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1. Introduction

The IETF starts discussing a scheme for enlarging the usable IP address space in [I-D.ymbk-aplus] or [I-D.boucadair-port-range] using parts of the port numbers, similar to what Network Address Translators (NAT) do. This allows to assign the same IP address to several customers or hosts. The IP address together with the port bits extension differentiate the routing and forwarding of that communication.

So far within the IETF DHCP extensions [I-D.boucadair-dhc-port-range] and PPP extensions [I-D.boucadair-pppext-portrange-option] to assign IP addresses and port ranges to hosts and sites have been proposed. However, since the deployments are very different for different users, customers with several users etc., more means for managing port assignments appear to be required. Measurements showed that different clients need different range sizes at different times [flow-counting].

This implies that dynamic port range assignment seems to be needed for

- assigning clients larger port ranges when the current one becomes too small,
- assigning clients smaller port ranges, when the current one is underused,
- changing clients port ranges for reducing fragmentation of the port space,
- balancing port consumption for a shared IPv4 address.

The existing means are sufficient to assign and re-assign port ranges. However, a client cannot immediately switch from one port range to another one, because most applications cannot change port numbers while using them. Without interrupting existing connections, a client can only start allocating new ports in a new range and wait until ports in an old range are not used anymore. Consequently, a client needs to wait until applications have closed all ports in the old port range. Existing means allow to assign more than one port ranges to a client ([I-D.boucadair-port-range]), but not to identify one or more ranges that should not be used anymore by the client.

2. Requirements Language

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

3. Dynamic port range re-assignments

This draft proposal provides a way for a port range assignment server
to tag a port range with an attribute that signals the client not to
allocate any more ports in this range. Such a signal can be sent
when a server signals more than one port range to a client. A most
simple implementation would be adding a flag to one or more port
ranges during the (re-)assignment process that marks these ranges as
not to be used anymore. A client receiving the signal would then
stop allocating port numbers in the marked ranges. When the client
does not use an address range anymore, it signals back that the port
range is not in use anymore and can be re-assigned. This can be done
individually for each range as soon as it is not used anymore or at
once when all marked ranges are not used anymore.

The method can also be used for reducing (trimming) already assigned
port ranges. For this purpose, the server divides the single port
range into two or more consecutive port ranges and re-assigns the
single port range as a set of port ranges to the client with one or
more of the port ranges marked as not to be used anymore. Again, the
client would signal back that one or more ranges are not used
anymore.

This new technique allows to postpone the deallocation of port ranges
until the respective ports are closed (lazy deallocation). The
client has the possibility to actively confirm the release of port
ranges.

4. Usage scenario

The following usage scenario describes the impact of the proposed
method from the initialization phase till final deallocation of port
ranges.

A broadband operator manages IP address and port range manager for
broadband access provisioning at a BRAS (Broadband Remote Access
Server). The client would be a home router, a single host or the
gateway of a large enterprise, allocating port numbers when acting as
NAT for the respective devices.
4.1. Initialization

When a client requests an IP address with a port range including the number of ports, the BRAS assigns it and signals the assigned port range to the client. The port range specified by the client could be a preferred port range indicated by a minimum value and a maximum value or just the number of ports.

4.2. Detecting the change point

While the client is using the port range, several reasons may occur that make it desirable to change the port assignment.

- The client may observe that there are only few unused numbers left in the used range and that it may soon happen that no further ports would be available for requesting applications. In order to avoid this situation, the client requests an assignment of more port numbers at the BRAS.
- A user can actively close all ports in anticipation of an exceeding demand of ports from new applications to be started. All ports are released voluntarily in expectation of goodwill to get a larger port range assigned.
- The BRAS may monitor usage of port numbers by the clients and detect that there are only a few unused port numbers left in the range assigned to the client. It decides to assign a wider range to the client before port numbers run out.
- The BRAS may detect that the client is only using a small part of the port range assigned to him and decide to assign the client a smaller port range.
- The BRAS may identify a need to re-assign the port range of the client in order to reduce fragmentation of the port space.

Therefore, the port range change request can be both client and server initiated.

4.3. Assigning a new port range

The BRAS sends a message to the client. The message contains two port ranges, the originally assigned one with a mark not to use it anymore and a new range to be used from now on.

Optionally, it can also give a time until when the old port range is still valid, before it will definitely expire.
4.4. Ongoing port consumption

The client only allocates new port numbers of the new range.

4.5. Final deallocation of a port range

Either the BRAS detects that no port number of the initial port range is in use anymore (through monitoring) and signals to the client that the initially assigned range is not anymore assigned to the client.

Or the client send an explicit signal that it is not using the initial range anymore and the BRAS can assign it to other clients.

Alternatively, the client can carry out a partial release of a requested port range, hence splitting the port range in used and unused ports.

5. Location of the address and port manager

In the above usage scenario it is implied that the IP address and port range management service is supplied with a BRAS. Alternatively, the IP address and port range manager can be located at a MSAN (Multi Service Access Node), DSLAM (Digital Subscriber Line Access Multiplexer), or any other infrastructure equipment.

5.1. Mobile networks

The scheme might also apply to mobile networks, where the server is located on the SGSN (Serving GPRS (General Packet Radio Service) Support Node) or GGSN (Gateway GPRS Support Node), and the client on a user equipment.

6. Signaling

The signaling between client and server can be done through different protocols including DHCP extensions, PPP extensions, Web Services, TR-069, or a novel protocol for address and port pool management.

7. Fragmentation

According to [I-D.boucadair-pppext-portrange-option] and [I-D.boucadair-dhc-port-range] it is possible to assign more than one port range to a customer (using a port mask and a port locator). It is expected that continuous port range allocation will be the preferred procedure. However, together with the introduced technique
to enlarge or to reduce individual port ranges the port range manager might have to deal with heavily fragmented port mapping tables. Besides administration overhead this may lead to problems if new continuous port ranges are requested. Dynamic port range re-assignment provides a technique that can both amplify and rectify this problem.

8. Service Management

As already mentioned in [I-D.levis-behave-ipv4-shortage-framework] a management station assigns the number of ports to the customer upon preconfigured policies which might depend on the individual contract with the customer or on the customer’s usage profile.

8.1. Server policy

The process on the BRAS for deciding on how many ports to give away is based on policies configured into the BRAS from a management station. That might depend on the customer status. Good customers, customer paying more, might request higher numbers. It can also depend on the current level of free addresses and ports. When there are only a few ports left the IP address and port range manager might be more restrictive with port allocations. In general, the mechanisms described above in the usage scenario requires configuration on the BRAS to behave in one or the other way, also including the configuration of the client.

8.2. Client policy

The policies will also be configured into the client. Those policies tell the client how large of a space he is allowed to request, and at what usage level the client should ask for more port space. For example, that can be if only 80% of the ports are used, the client asks already for more, or the client only asks for more if he fully used up his space.

9. Open issues

Dynamic port range re-assignment has several open issues to be solved or clarified:

- Modifications are required to both the DHCP and the PPP protocol in addition to the extensions described in [I-D.boucadair-dhc-port-range] and [I-D.boucadair-pppext-portrange-option] respectively.
o What strategy should be chosen to solve a potential port mapping table fragmentation?

o The constant port monitoring which the port range manager has to carry out might impose problems.

o How to handle expiration timers when requesting port ranges to be cleared?

o The processing of port overflow caused by exceeding port number requests might become a delicate problem. If available port numbers for a specific IPv4 address do not match a client’s request it would be necessary to assign a new IPv4 address.

Eventually, the price to be paid for more flexible port range management is complexity.

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11. IANA Considerations

This document includes no request to IANA.

12. Security Considerations

TBD.

13. References

13.1. Normative References

13.2.  Informative References

[I-D.boucadair-dhc-port-range]

[I-D.boucadair-port-range]

[I-D.boucadair-pppext-portrange-option]

[I-D.levis-behave-ipv4-shortage-framework]

[I-D.ymbk-aplusp]

[flow-counting]
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