IETF 122 – 6lo

Path-Aware Semantic Addressing (PASA) for Low power and Lossy Networks

~~draft-ietf-6lo-path-aware-semantic-addressing-09~~

~~draft-ietf-6lo-path-aware-semantic-addressing-10~~

draft-ietf-6lo-path-aware-semantic-addressing-11

L. Iannone, G. Li, D. Lou, P. Liu, R. Long, K. Makhijani, P. Thubert

IETF 122 – Bangkok

Since IETF 121

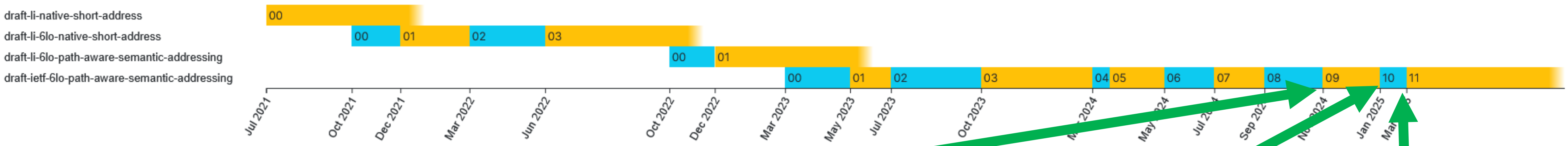
Path-Aware Semantic Addressing (PASA) for Low power and Lossy Networks

draft-ietf-6lo-path-aware-semantic-addressing-11

Status | IESG evaluation record | IESG writeups | Email expansions | History

Versions:

00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11



draft-ietf-6lo-path-aware-semantic-address-09.txt
November 2024
Main changes: Update GAAO Option Examples

draft-ietf-6lo-path-aware-semantic-address-10.txt
January 2025
Main changes: Address Shepherd's review (Thanks Carles!) & comment from Brian Carpenter (Thanks)

draft-ietf-6lo-path-aware-semantic-address-11.txt
March 2025
Main changes: Authorship update due to IESG rule

Main Content Changes -09

```
    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     | Status/PfxLen |    Opaque     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |C|F| P | I |Rsd|  PASA  AAF    |      Assignment   Lifetime    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
   ...            Registration Ownership Verifier (ROVR)           ...
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                     Figure 12: NS GAAO option example.
```

The requester MUST indicate its role as indicated in Section 9. If the node acts as a PASA Router it means that the address will be further delegated. Otherwise, if the node acts as a PASA Host, the address will not be further delegated. The parent, acting as IPv6 ND Registrar will process the received GAAO message and act according to [I-D.iannone-6lo-nd-gaao], and the corresponding GAAO message for the NA packet is generated. The NA message will carry the GAAO message with the AAF field set to the PASA TAAF value (See Section 11). The C-bit of the GAAO message MUST be set in order to request confirmation of address usage through explicit registration. The returning GAAO message will carry as well the PASA address that the parent assigns to its child using the procedures described in Section 6. The PASA address is appended to the GAAO message (see Figure 13).

```
    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     |    PfxLen     |    Opaque     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |C|F| P | I |Rsd|  PASA  TAAF   |      Assignment   Lifetime    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
   ...            Registration Ownership Verifier (ROVR)           ...
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    |                        Address/Prefix                         |
    |                          (128 bits)                           |
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                     Figure 13: NA GAAO option example.
```

```
    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     | Status/PfxLen |    Opaque     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |C|          Reserved           | TAAF |    Assignment   Lifetime    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
   ...            Registration Ownership Verifier (ROVR)           ...
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                     Figure 12: NS GAAO option example.
```

The requester MUST indicate its role as indicated in Section 9. If the node acts as a PASA Router it means that the address will be further delegated. Otherwise, if the node acts as a PASA Host, the address will not be further delegated. The parent, acting as IPv6 ND Registrar will process the received GAAO message and act according to [I-D.iannone-6lo-nd-gaao], and the corresponding GAAO message for the NA packet is generated. The NA message will carry the GAAO message with the AAF field set to the PASA TAAF value (see Section 11). The C-bit of the GAAO message MUST be set in order to request confirmation of address usage through explicit registration. The returning GAAO message will carry as well the PASA address that the parent assigns to its child using the procedures described in Section 6. The PASA address is appended to the GAAO message (see Figure 13).

```
    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     |    PfxLen     |    Opaque     |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |C|          Reserved           | TAAF |    Assignment   Lifetime    |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
   ...            Registration Ownership Verifier (ROVR)           ...
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    |                           Address                             |
    |                          (128 bits)                           |
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

                     Figure 13: NA GAAO option example.
```

No changes in the document structure

- Just updated example referring to GAAO option to be inline with the its new simplified format.

Main Content Changes -10 (I)

12. Reliability Considerations

Because PASA uses algorithmically generated addresses, based on the network topology, nodes do not generate and store forwarding table entries in the normal case. They are limited to have a default gateway and the ND table. One of the potential issues is the risk of renumbering of addresses in case of topology changes. Because of the applicability domain of PASA, the common case of topology change is known in advance and can be planned, so to reduce disruption due to renumbering (see Section 4).

Another case is temporary link failures or node temporary failures, where the network is still able to provide connectivity through alternative links, which is strictly related to the underlying technology, the network topology, the deployed redundancy, and the expected reliability. Failures may raise the issue of topology changes and re-numbering. Such issues can be avoided, or at least mitigated, following the procedures in [RFC8505] and [I-D.iannone-6lo-nd-gaao] keeping state in non-volatile memory.

Reliability of external connectivity, with more than one node functioning as gateway, can be achieved in several ways. One simple solution is to use a multi topology approach, where each gateway acts as a root for a logically independent topology, identified via a different prefix. The multiple topologies can either be used at the same time or with a primary/backup policies. This solution is particularly suitable in case the PASA domain is multihomed.

12. Deployments Considerations

12.1. Topology Changes

Because PASA uses algorithmically generated addresses, based on the network topology, nodes do not generate and store forwarding table entries in the normal case. They are limited to have a default gateway and the ND table. One of the potential issues is the risk of renumbering of addresses in case of topology changes. Topology changes due to PASA Hosts joining and leaving have no real impact. It is just a matter to allocate new addresses, or re-use addresses previously assigned to PASA Host that left the network.

More structural changes, where PASA Routers are added or removed have more impact. However, because of the applicability domain of PASA, the common case of topology change is known in advance and can be planned, so to reduce disruption due to renumbering (see Section 4). Adding PASA Routers simply creates new branches in the logical tree and is not a disruptive operation. However, removing a PASA Router may require to partial renumbering the network, depending on the position of the PASA Router that is removed, and it may just involve a small branch of the tree.

12.2. Reliability

Another type of topology change is the case of temporary link failures or temporary node failures, where the network is still able to provide connectivity through alternative links, which is strictly related to the underlying technology, the network topology, the deployed redundancy, and the expected reliability. Failures may raise the issue of topology changes and re-numbering. Such issues can be avoided, or at least mitigated, following the procedure in Section 5.7 of [RFC8505] and keeping state in non-volatile memory.

Reliability of external connectivity, with more than one node functioning as gateway, can be achieved in several ways. One simple solution is to use a multi topology approach, where each gateway acts as a root for a logically independent topology, identified via a different prefix. The multiple topologies can either be used at the same time or with a primary/backup policy. This solution is particularly suitable in case the PASA Domain is multihomed.

- Added considerations about topology changes, hence created a "deployment considerations" that covers topology changes and reliability aspects.
- Topology Changes
  - PASA Hosts joining/leaving are easily handled, just allocate addresses
  - PASA Routers joining/leaving may involve more structural change with partial renumbering (e.g. renumbering a sub-branch). The applicability domain of PASA allows to plan PASA Routers topology changes in advance, reducing disruption due to renumbering.
- Reliability
  - Small updates

Main Content Changes -10 (II)

```
*  For the first child, which is a router:

      TAAF('router', 0, 0) = '1'(root address) + b(0) + '0'
                           = '1' + '' + '0'
                           = '10'

   Index 'r' is increased by one and is now equal to 1 (r = 1).

*  For the second child, which is a host:

      TAAF('host', 1, 0) = '1'(root address) + b(0) + '1'
                         = '1' + '' + '1'
                         = '11'

   Index 'h' is increased by one and is now equal to 1 (h = 1).
```

```
*  For the first child, which is a router:

      TAAF('router', 0, 0) = '1'(root address) + b(0) + '0'
                           = '1' + '' + '0'
                           = '10'

   Index 'r' is increased by one after its value '0' has been used in
   the expression and is now equal to 1 (r = 1).

*  For the second child, which is a host:

      TAAF('host', 1, 0) = '1'(root address) + b(0) + '1'
                         = '1' + '' + '1'
                         = '11'

   Index 'h' is increased by one after its value '0' has been used in
   the expression and is now equal to 1 (h = 1).
```

```
PASA Root:  The PASA root node is the router responsible for the
   management of the whole PASA network and routing/forwarding both
   internal and external traffic.  It uses the an Address Assignment
   Function (AAF) and performs the address assignment for its
   children.  The root node functions as gateway between the PASA
   domain and the Internet, acting as what [RFC8505] names 6LBR
   (6LowPAN Border Router).

PASA Host:  A PASA Host is a node with no children (i.e., a leaf), it
   is what [RFC8505] names 6LN (6LowPAN Node).  This node does not
   perform the address Assignment Function.  It merely requests an
   address from its selected parent.

PASA Router:  A PASA Router is an internal node, different from the
   PASA Root, acting as a router, hence as what [RFC8505] names 6LR
   (6LowPAN Router).  Before acting as a router it will act as a PASA
   Host by acquiring an address.  Then, similar to the PASA Root, it
   uses the Address Assignment Function (AAF) and performs the
   address assignment for its children.  According to
   [I-D.iannone-6lo-nd-gaao] and [RFC8505], PASA Routers are expected
   to store in non-volatile memory state about address registration
   and assignment.

Address Assignment Function (AAF):  As defined in
   [I-D.iannone-6lo-nd-gaao].
```

```
PASA Root:  The PASA Root is the router responsible for the
   management of the whole PASA network and routing/forwarding both
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PASA Host:  A PASA Host is a node with no children (i.e., a leaf), it
   is what [RFC8505] names 6LN (6LowPAN Node).  This node does not
   perform the AAF.  It merely requests an address from its selected
   parent.

PASA Router:  A PASA Router is an internal node, different from the
   PASA Root, acting as a router, hence as what [RFC8505] names 6LR
   (6LowPAN Router).  Before acting as a router, it will act as a
   PASA Host by acquiring an address.  Then, similar to the PASA
   Root, it uses the AAF and performs the address assignment for its
   children.  According to [I-D.ietf-6lo-nd-gaao] and [RFC8505], PASA
   Routers are expected to store in non-volatile memory state about
   address registration and assignment.

PASA Domain:  A network limited domain [RFC8799] in which PASA is
   deployed.

Address Assignment Function (AAF):  As defined in
   [I-D.ietf-6lo-nd-gaao].
```

- Refined text for clarity in several places thanks to Shepherd’s review.

Main Content Changes -10 (III)

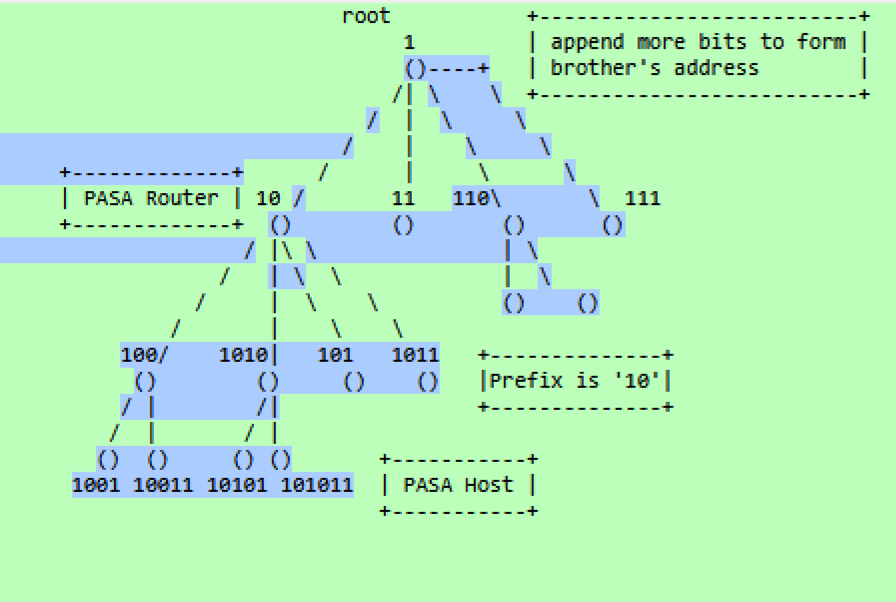
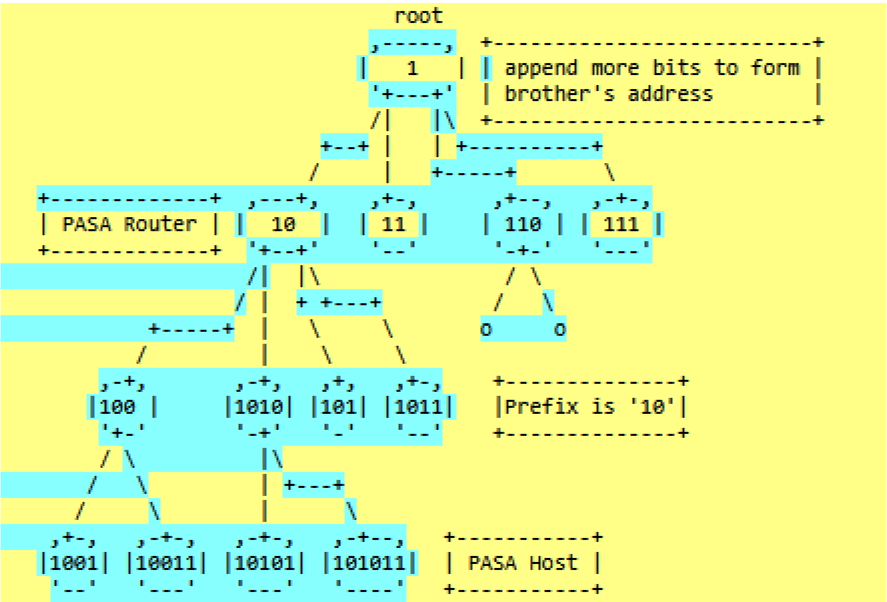


Figure 6: An example of PASA Tree Addresses Assignment Function.



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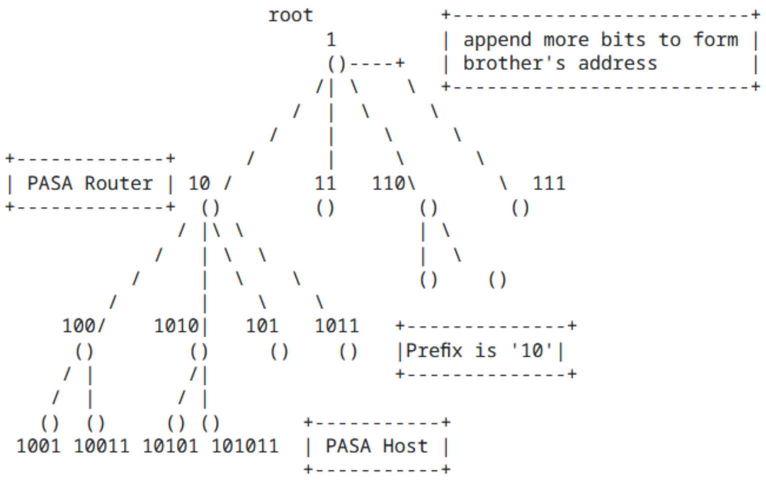

Figure 6: An example of PASA Tree Addresses Assignment Function.

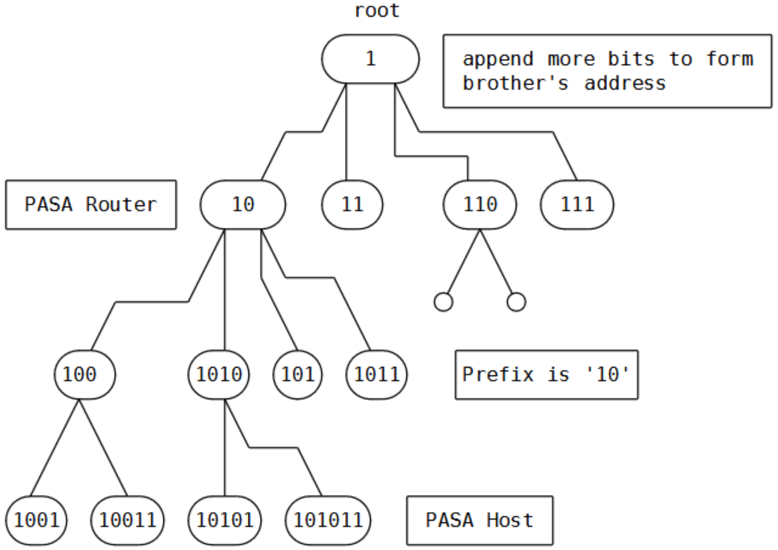

Figure 6: An example of PASA Tree Addresses Assignment Function.

- Updated ascii art for SVG support in all figures.

Next Steps

- Hand over to Éric ;-)

THANKS!