Reliability Considerations of Path-Aware Semantic Addressing

draft-li-6lo-pasa-reliability

IETF 116 – Yokohama
Since IETF 115

Reliability Considerations of Path-Aware Semantic Addressing
draft-li-6lo-pasa-reliability-01

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Main Content

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Main content/structure not changed:
• A general introduction to the problem
• Possible solution alternatives
  • See rest of the presentation
• Some considerations about failure detection and recovery
• Some considerations about resiliency

• But quite some:
  • Rewriting for clarification
  • Fix examples bugs
  • Align text with main specs
Solutions Alternatives

• Pre-requisite
  • Presence of redundant links
  • Some not actively used
  • Active links forming a tree
  • All nodes have a secondary parent
    • Except root node
    • Alternative parent is connected through a non actively used link

• Multi-Address:
  • using multiple addresses per node, one for each alternative parent (logically creating multiple topologies)

• Single-Address:
  • using one single address per node, store the addresses of alternative parents/children
Multi-address: Primary Topology

xxx1: PASA Host
xxx0: PASA Router
Multi-address: Secondary Topology

xxx1: PASA Host
xxx0: PASA Router
Each node in the PASA only has two addresses built using the same AF but different roots (1 and 01).

Each node except the root has at least 2 parents (primary and secondary).

Forwarding done following only primary address (and topology).

Each node maintains a redirect table if something has to be tunneled via secondary topology.
Multi-address: Link Failure

- Each node in the PASA only has two addresses built using the same AF but different roots (1 and 01).
- Each node except the root has at least 2 parents (primary and secondary).
- Forwarding done following only primary address (and topology).
- Each node maintains a redirect table if something has to be tunneled via secondary topology.

xxx1: PASA Host
xxx0: PASA Router
Multi-address: Link Failure

Install rule: Dst prefix 100 => encaps to 0101 through 01

- Downstream node (w.r.t. failure) 100 to notify root to send through secondary topology
  - Either via encapsulation
  - Or routing state created by ICMP message

ICMP: Primary 100 up-link broken; tunnel my secondary address 0101

xxx1: PASA Host
xxx0: PASA Router
Multi-address: Link Failure

ICMP: Hop-by-Hop message down-link to 100 broken (necessary for middle nodes)

- Downstream node (w.r.t. failure) 100 to notify root to send through secondary topology
  - Either via encapsulation
  - Or routing state created by ICMP message

- Upstream node (w.r.t. failure) 10 notify broken link so that all nodes between the root and itself will install a redirect rule to send to the root

xxx1: PASA Host
xxx0: PASA Router
Downstream node (w.r.t. failure) 100 to notify root to send through secondary topology
- Either via encapsulation
- Or routing state created by ICMP message

Upstream node (w.r.t. failure) 10 notify broken link so that all nodes between the root and itself will install a redirect rule to send to the root

Optimization: Downstream node to notify sub-tree to use secondary topology

ICMP: Consider using your secondary address

xxx1: PASA Host
xxx0: PASA Router
Multi-address: Communication in case of Link Failure

From 11 to 1001:
1. Packet is transmitted from 11 to 1 (on the primary tree).
2. Because of the redirect entry, 1 encapsulates packet toward 0101 and transmits it to 01 (root secondary).
3. 01 will use PASA stateless forwarding to transmit the packet to 010 (on the secondary tree).
4. 010 will use PASA stateless forwarding to transmit the packet to 0101 (on the secondary tree).
5. 0101 will decapsulate, note the destination is on the primary tree, use the PASA stateless forwarding to transmit the packet to 1001 (on the primary tree).

From 1001 to 11:
1. Packet is transmitted from 1001 to 100 (on the primary tree).
2. Because 100 knows the upstream link is broken it encapsulates the packet with source 0101 and destination 01 (root primary tree) then transmits the packet to 010 (on the secondary tree).
3. 010 will use PASA stateless forwarding to transmit the packet to 01 (on the secondary tree).
4. 01 will decapsulate and see that packet is destined a node in the primary tree and transmits it to 1.
5. 1 will use the PASA stateless forwarding to transmit the packet to 11 (on the primary tree).
Multi-Address: Forwarding Operation

**PASA Router**

Packet Received

- Is there a redirect rule that applies?
  - Yes → Forward according to rule
  - No →

- Is there an encapsulation rule that applies?
  - Yes → Encapsulate according to rule
  - No →

PASA Native Forwarding

END

**PASA Root**

Packet Received

- Is there an encapsulation rule that applies?
  - Yes → Encapsulate according to rule
  - No →

PASA Native Forwarding

Forward to Alternative Root

END
Single Address: Topology Building

- Single PASA domain + Locally store alternative parents/children

xxx1: PASA Host
xxx0: PASA Router
Single Address: Topology Building

- Locally store alternative parents/children

 xxx1: PASA Host
 xxx0: PASA Router
Single Address: Link Failure

ICMP: Link to 100 broken

Dst prefix 100 Unreachable
Find Alternative path

xxx1: PASA Host
xxx0: PASA Router
Single Address: Communication in case of Link Failure

From 1101 to 1001:
1. The packet is transmitted from node 1101 to the root 1, using PASA stateless forwarding.
2. Root 1 computing an alternative path 1 -> 110 -> 100 -> 1001.
   - PASA forwarding does not allow to go first through node 110 and then node 100, the root 1 will encapsulate the addresses of node 110 and node 100 in an extension header so to perform segmented routing.
3. Once the packet reaches 100, the segment routing extension is dropped, and the packet is sent to its destination 1001 by using PASA native forwarding.

From 1001 to 1101:
1. The packet is transmitted from node 1001 to node 100 using PASA native forwarding.
2. Because of the failed link, node 100 sends the packet to an alternative parent node.
3. PASA native forwarding is used then. In this example, the resulting path is: 100 -> 110 -> 1101.
   - If the alternative parent is in the same sub-tree like the destination, the packet is forwarded downward to the right child, otherwise it is sent upward to the its own parent. This goes on recursively until the packet reaches the root in the worst case, where it is then sent downward to the correct forwarder child, until it reaches the destination.

xxx1: PASA Host
xxx0: PASA Router
Single-Address: Forwarding Operation

**PASA Router**

- Received Packet
  - Perform PASA Forwarding
    - Outgoing Link working?
      - Yes
      - Send the Packet to the Alternative Parent
      - Down/Up Link Failure?
        - Down
          - Redirect to Root
          - END
        - Up
        - Is the a redirect rule due to broken links
          - Yes
            - Encapsulate to alternative path
            - END
          - No
            - Performing PASA native forwarding

**PASA Root**

- Received Packet
  - Is the a redirect rule due to broken links
    - Yes
      - Encapsulate to alternative path
      - END
    - No
      - Performing PASA native forwarding
      - END
## Multiple Addresses vs Single Address

<table>
<thead>
<tr>
<th>Approach</th>
<th>Root State</th>
<th>Forwarder State</th>
<th>Robustness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Addresses</td>
<td>Low (redirect rule)</td>
<td>Low (redirect rule)</td>
<td>Lower for multiple failures (limited knowledge)</td>
</tr>
<tr>
<td>Single Address</td>
<td>High (topology)</td>
<td>Low (neighborhood)</td>
<td>Higher for multiple failures (root to find feasible path)</td>
</tr>
</tbody>
</table>
Next Steps

• Any question/comment welcome!
  • Update the draft based on comments and remarks
  • Any new contributor welcome

• Better align examples

• Refine wording
  • Clarification
  • NSA relic

• Security Considerations to be added

• See you @ IETF 117