Numbering Exchange Protocol (NEP)
Specification
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Abstract

This document specifies Numbering Exchange Protocol (NEP).

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1. Introduction

- Numbering Exchange Protocol (NEP) is an Interior Gateway Protocol (IGP) that delivers IP packets between routers in the same Autonomous System (AS).

- NEP chooses its best path based on a composite metric of:
  a. Highest total bandwidth (for faster transmission).
  b. Number of hops (for less processing).
  c. Lowest total delay (for faster delivery).

- NEP uses a numbering method between routers that provides a fast topology exchange and learning process.

2. Numbering Exchange Protocol (NEP)

- The following figure shows 6 interconnected routers within an AS as follows:

```
  12, 3000, 30  22, 2500, 15
  22, 1500, 25  31, 2000, 10
  31, 1000, 20  63, 8000, 100

|----------------------| 3 |----------------------|
|                     | * |                     |
| 22, 4000, 60        | 10| 22, 3000, 20        |
| 41, 1000, 20        |   | 31, 2000, 10        |
| 52, 1100, 220 ^     |   | 22, 3000, 20        |
| 62, 6000, 90        |   | 31, 2000, 10        |

* 6 *----------------------* 4 *----------------------* 2 *----------------------* 1 *
|                     | * |                     | * |                     |
| 70 * 40 * 10        | 10| 11, 3000, 10        |
| 5000                 | 1000                   | 22, 4000, 20        |
| v 32, 5000, 20      | v 2000                 | v 64, 11000, 110    |

|----------------------| 5 |----------------------|
|                     | * |                     |
| 22, 2100, 240       |   | 42, 3100, 210        |
| 32, 1100, 220 v     |   | 43, 6000, 40         |
| 41, 100, 200        |   | 64, 11000, 110       |
| 62, 5100, 270       |   | 64, 11000, 110       |

* 11, 3000, 10        | 10| 11, 3000, 10        |
| 22, 4000, 20        |   | 32, 5000, 20        |
| 31, 2000, 10        |   | 64, 11000, 110      |

* 11, 3000, 10        | 10| 11, 3000, 10        |
| 22, 4000, 20        |   | 32, 5000, 20        |
| 31, 2000, 10        |   | 64, 11000, 110      |

- Each link has two numeric values:
  - Upper value represents the link delay.
  - Lower value represents the link bandwidth.

- Each NEP router advertises the topology information as follows:
  - rh, b, d
Where \( r \) represents the NEP router RID.
\( h \) represents the number of hops to reach that router.
\( b \) represents the link bandwidth.
\( d \) represents the link delay.
- Each router within an Autonomous System (AS) must be configured with a unique number called Router ID (RID).

* RID: 32-bit decimal number that uniquely identifies a router within an AS.

  The RID has the following format: Y.Y.Y.Y

- Each router advertises its RID first to its neighboring routers using Hello messages.

- Each router advertises all the interconnected RIDs, total bandwidth, number of hops, and total delay to the neighboring router.

- Each router calculates the best path to each router using the following values:
  a. Total bandwidth.
  b. Number of hops.
  c. Total delay.

- The best NEP path from the local router to every other router from the collected advertised information has the following:
  a. Highest total bandwidth.
  b. Lowest number of hops that corresponds to the highest total bandwidth.
  c. Lowest total delay.

- The NEP metric is calculated using the following formula:

  *******************************************************
  * Metric = [-----------------------------] x 10^7 *
  * (No. of Hops * Total-Delay) *
  * Total-BW *
  *******************************************************

- The best metric has the lowest value.

- Each NEP router sends an Echo message of each of its interface to the neighboring router, the time taken by the message to be sent and received over the link divided by 2 determines the link delay.

- The Echo message is sent by every router every 10 seconds (by default).

- The link delay value is updated every 10 seconds on every advertised message that contains the 3 values that can be used to determine the best path from the NEP router to other routers.
NEP Loop Prevention:

- NEP uses a loop free mechanism by discarding the advertised topology information that has a higher metric than the existing stored entry for the same RID to prevent looping.

- When an NEP router receives an advertised topology information to a specific router, it checks its own topology table, if there is no entry listed for that RID contained in the advertised message, it adds it to its own topology table.

- If more than one message received to the same RID, the NEP router calculates the metric for each one of them and store the one with the lowest metric for that router.

For example:

a) Router 1 will have 3 messages to the destination router 4 as follows:

2: 42, 4000, 50 ==> Metric = 250,000 (discarded)
3: 42, 3000, 30 ==> Metric = 200,000 (added)
5: 42, 3100, 210 ==> Metric = 1,354,839 (discarded)

The message from router 3 has the lowest metric to the destination router 4 so this route through router 3 will be added to the routing table and other routes will be discarded.

b) Router 1 will have 3 messages to the destination router 6 as follows:

2: 63, 9000, 120 ==> Metric = 400,000 (discarded)
3: 63, 8000, 100 ==> Metric = 375,000 (added)
5: 63, 8100, 260 ==> Metric = 1,037,037 (discarded)

The message from router 2 has the lowest metric to the destination router 6 so this route through router 2 will be added to the routing table and other routes will be discarded.

Router 1 Routing Table:

<table>
<thead>
<tr>
<th>Destination Router</th>
<th>Metric</th>
<th>Next-hop Router</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100,000</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>50,000</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>200,000</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>33,333.33</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>375,000</td>
<td>3</td>
</tr>
</tbody>
</table>

Note:- In case of two or more equal metrics for the same destination, the routes are added to the routing table and traffic is balanced between these routes.
Security Considerations

Acknowledgments

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References

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