Neighbor Management Policy for 6LoWPAN

Signaling and Policy guidelines


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Why Neighbor Management?

• Challenges
  • Unknown network size, unknown Node density
  • Constrained networks with limited neighbor cache
    • Density is higher than neighbor cache size

• Expectation of neighbor management
  • Improved network stability, reduced churn in routing adjacencies
  • Once the neighbor is accepted, the associated resources are guaranteed

• Trivial Neighbor Management policies
  • Evict LRU entry for new insertion when table is full
  • First come first serve

• Protocol agnostic policy
  • Even though the draft references RPL and PANA extensively, the proposed policy is routing protocol and key management protocol agnostic

NCE = Neighbor Cache Entry
Holistic approach towards neighbor management

- An example security-enabled 6LoWPAN/RPL network
  - Key management protocols before RPL network formation
    - PANA as example, used by Wi-SUN
  - Draft explains neighbor management differences with respect to RPL storing as well as non-storing mode of operations

- Cases where neighbor table update happens
  - Relay based signaling during authentication
    - PRE selection by PaC, usually involves discovery messaging. No std procedure for PRE discovery.
    - PRE needs to add PaC as nbr since it will act as relay till the auth process completes
    - Note that post-auth-success, PaC may choose some other node as RPL parent
  - RPL’s parent selection using DIO messaging
  - RPL’s routing child node
  - Implicit vs explicit signaling
    - Implicit signaling in Storing MOP for NCE
    - Explicit signaling required in Non-Storing MOP

PRE = PANA Relay Element
PaC = PANA Client
MOP = Mode of Operation
Neighbor Management Operations

• **Insertion**
  • Problem with simple logic (If table space is available: insert)
    • RPL's DIO storm in dense network may overwhelm neighbor cache
    • Same parent chosen by all the nodes resulting in nbr cache containing only routing child entries
    • Similarly PRE discovery may result in the same PRE been made use of by several PaCs.

• **Eviction**
  • Issues with eviction
    • An routing child eviction may have ripple effect on all grand-childs
    • Similarly if a PaC NCE is added on PRE, then early eviction may result in neighbor churn.
  • Evicting non-preferred parent NCE is usually possible without much implications
    • For e.g. on receiving DAO, one can evict a “low-priority” parent entry from neighbor cache

• **Reinforcement**
  • NCEs needs to be reinforced
    • Reinforcement can be done by passive/active hearing or by explicit probing. *Draft does not define how to do this.*
  • Reinforcement allows the link quality estimation to be updated, eventually helping in eviction decision
Clearing unused Neighbor table entries

• Important that unused NCEs be reclaimed soon
• For storing MOP, route invalidation is important since routing entries are mapped to NCEs
• For Non-storing MOP,
  • since there is no route invalidation procedure, the child node needs to deregister using NS(lifetime=0)
• PRE neighbors
  • After authentication is successful, the PRE auth entries can be removed
  • However there is no way of explicit identification of auth finish
  • Usually reachability timeout will remove such entries. For neighbors added for authentication, the reachability timer can be reduced to a lower value.
Signaling recommendation for Neighbor management

- As far as possible use implicit mechanism for neighbor entry addition
  - Use DIO/DAO messaging to populate NCEs in case of storing MOP
  - In case of Non-storing MOP, DAO flows end to end, thus explicit NDP signaling in the form of NS/NA is required.
- Implicit mechanism works only if there is a way to send negative status if NCE addition fails
  - For e.g. in case of PANA, there is no way (currently) for PRE to respond back with negative status
  - Thus explicit NDP signaling is involved to populate neighbor cache entries which can also signal failure if needed.
Proposed guidance for reservation based policy

- **Basic principles**
  - Reservation of routing direct child entries
  - Reservation of relay element entries
  - Parent node's entries can be inserted at will and can occupy reserved entries
    - Because parent entries could be evicted if necessary, unlike routing direct childs and relay element entries
  - Insertion reason (RPL_parent, RPL_child, Other) is attached with every NCE

- **Graceful rejection of DAO/PANA messages**
  - NACK for rejecting DAO
  - Negative status in NDP NA response
Issues with implicit/reactive policy

• Limitations of reactive policy
  • Scenario: A parent whose nbr cache is full sends a DIO ...
  • A child node may still select this parent node since DIO does not signal NCE metric
  • Thus there would be an additional signaling to reject this parent node
  • Worse, in the future, the child node may again select the same parent based on new DIO from the parent node.

• The same problem applies while PRE discovery...

• Guidance:
  • A proactive approach to signal NCE metric
  • For example, metric containers can be shared between RPL and PRE discovery messaging
    • Can RPL metrics containers (RFC 6551) be reused by another protocol?
Discussions

• WG Adoption
  • As a general protocol agnostic guidance for nbr mgmt...
• Contiki implementation ongoing...

Thank You