Neighbor Management Policy for 6LoWPAN

Signaling and Policy guidelines

https://tools.ietf.org/html/draft-jadhav-lwig-nbr-mgmt-policy-00

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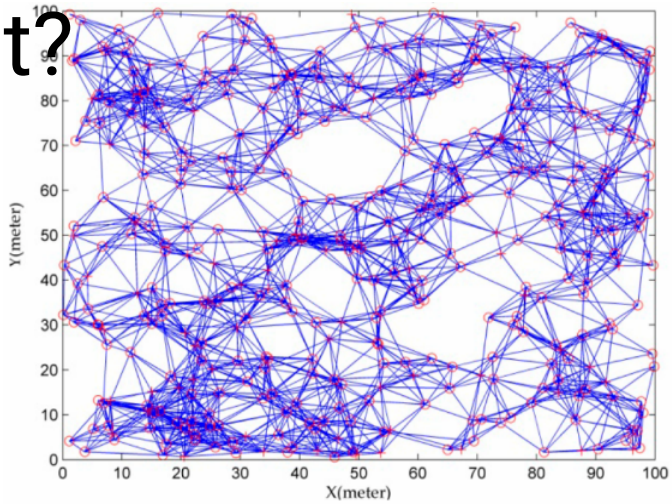
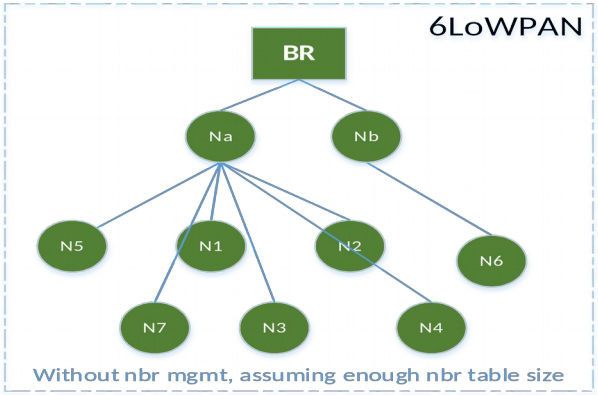
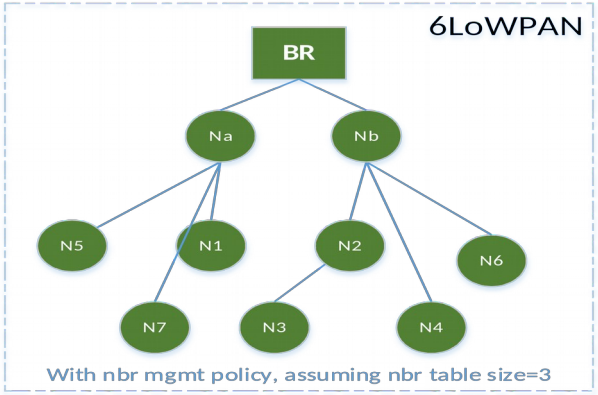
IETF98

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



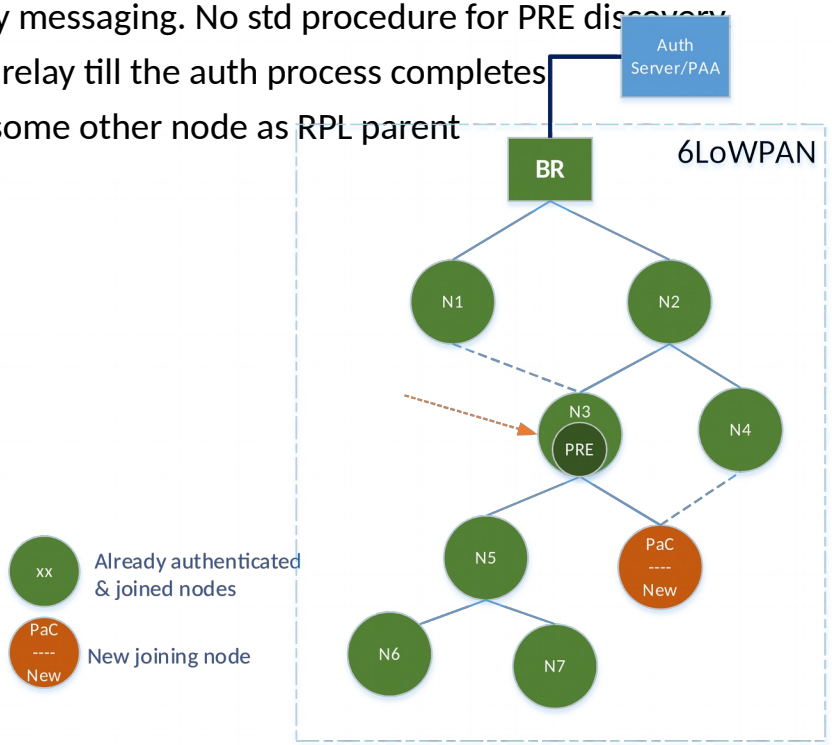




NCE = Neighbor Cache Entry

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

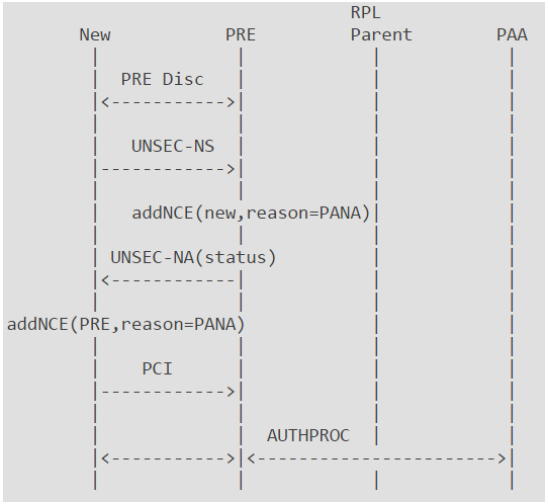
Clearing unused Neighbor table entries

- 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.

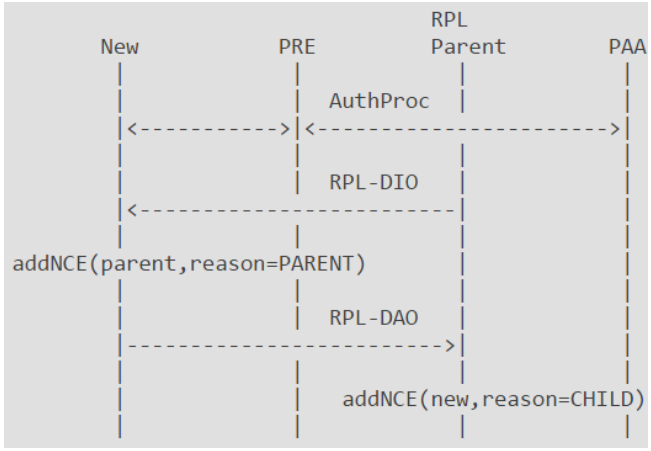
Signaling recommendation for Neighbor management

- 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.

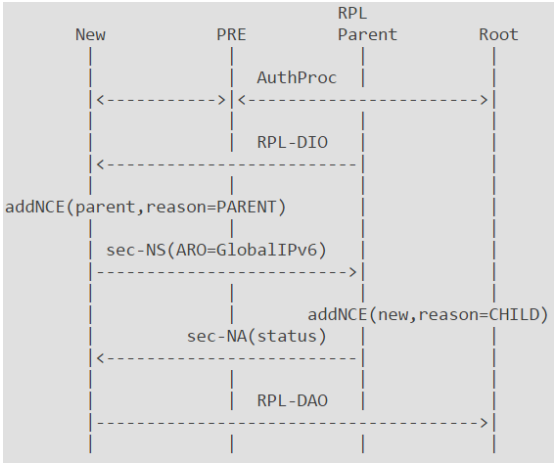
PRE Discovery



Storing MOP

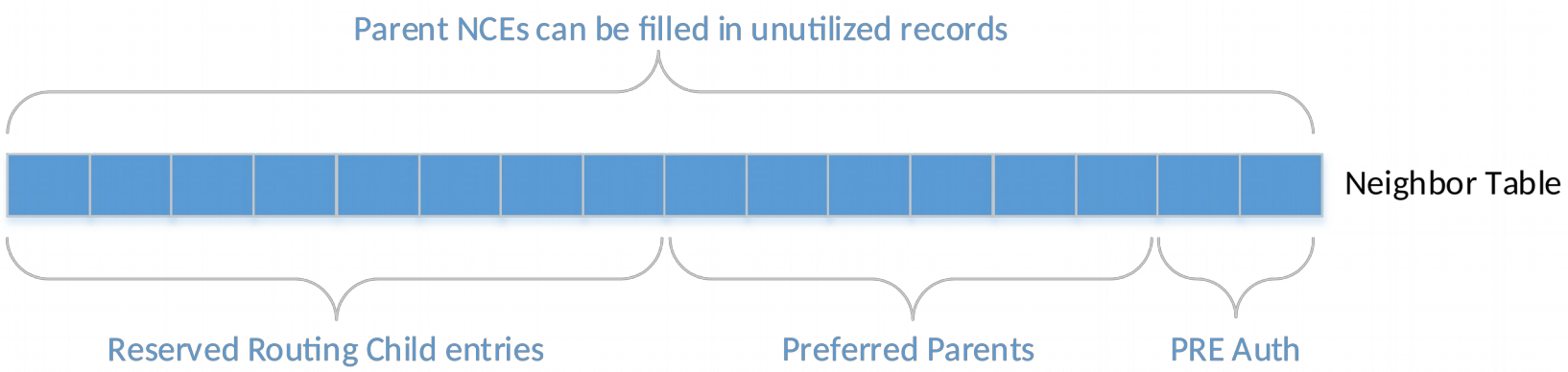


Non-Storing MOP



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