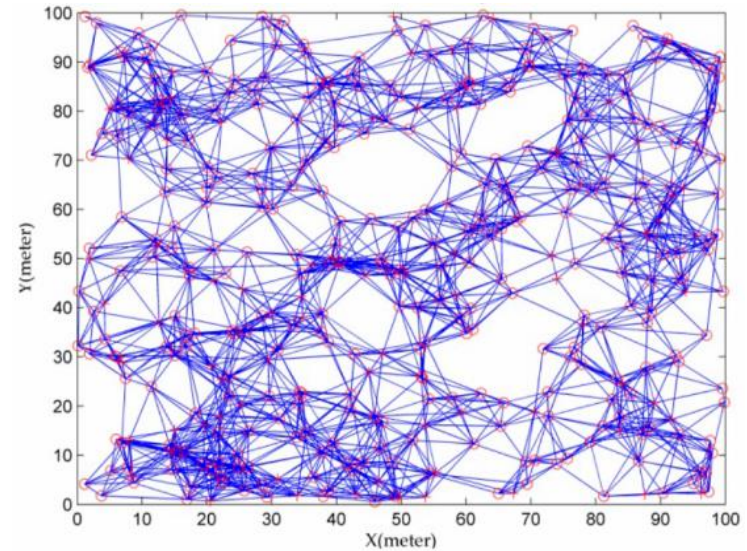


Neighbor Management Policy for 6LoWPAN: Issues, state-of-art, recommendations

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Why Neighbor Management?

- Challenges
 - Unknown network size , unknown Node density
 - Constrained networks with limited neighbor table cache
- Current Neighbor Management policies
 - Evict LRU entry [Contiki]
 - First come first serve [RiOT]
- Expectation of neighbor management
 - Deterministic behavior, should not result in route downtime.
 - Finally the network should be formed with any node density.



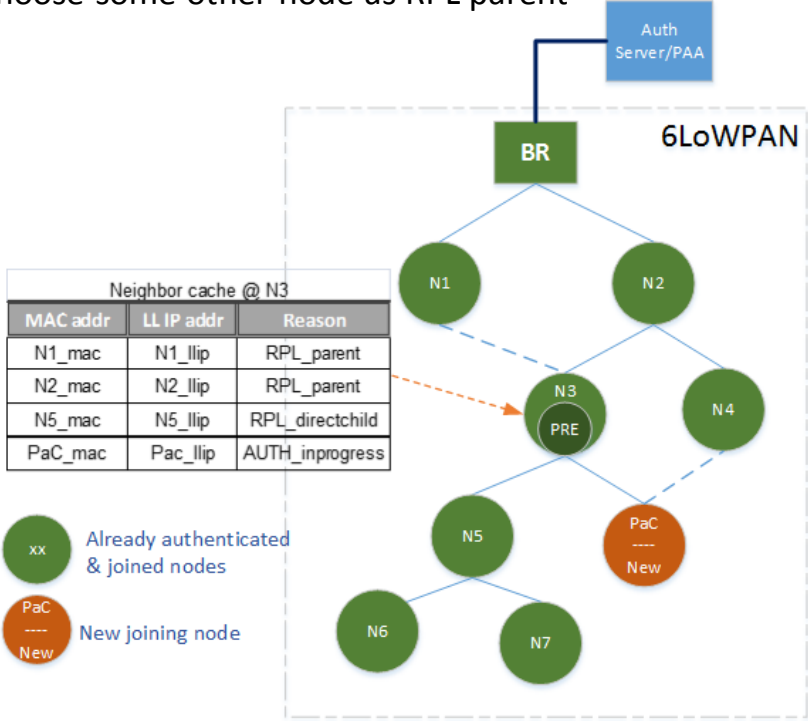
Literature Analysis

[1]On Link Estimation in Dense RPL deployment – Dawans et.al.

[2]Taming the underlying challenges of reliable multihop routing in sensor networks – Woo et.al.

Holistic approach towards neighbor management

- An example security-enabled 6LoWPAN/RPL network
 - Key management protocols before RPL network formation
 - PANA based example, used by Wi-SUN
- Cases where neighbor table update happens,
 - Relay based signaling during authentication
 - PRE selection by PaC, usually involves discovery messaging
 - PRE needs to add PaC as a neighbor since it will act as security forwarder till the authentication process completes
 - Note that post-authentication-success, PaC may choose some other node as RPL parent
 - RPL's parent selection using DIO messaging
 - RPL's routing direct child node
 - Using DAO messaging
 - Note RPL_directchild



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
 - Parent selection procedure may result in a single parent been chosen by all the nodes resulting in neighbor cache containing only routing direct child entries.
 - Similarly PRE discovery may result in the same PRE been made use of by several PaC.

• Eviction

- Issues with eviction
 - A routing direct child is difficult to evict since in storing-mode it will have ripple effect i.e. all grand-children also have to change path in turn.
 - Similarly if a PaC is added to neighbor cache, then early eviction may result in neighbor churn.
- Evicting non-preferred parent information is usually possible without much immediate implications
 - For e.g. on receiving DAO, one can evict a "least-effective" parent entry from neighbor table
 - Effectiveness of a parent entry may be determined by factor such as link quality.

• Reinforcement^[1]

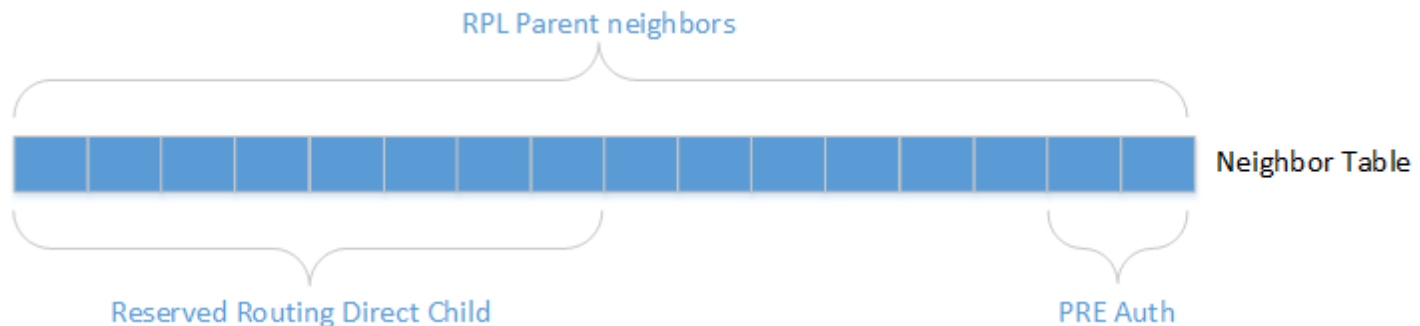
- The selected links in neighbor cache needs to be reinforced
 - Reinforcement can be done on passive/active hearing
- Reinforcement allows the link quality estimation to be updated, eventually helping in eviction decision

Clearing unused Neighbor table entries

- Important that unused neighbor table entries be cleared soon.
- Route invalidation is important since routing entries are mapped to neighbor entries
- PRE neighbors
 - After authentication is successful, the PRE auth entries can be removed.
 - However there is no way of explicit identification of the finish of auth
 - Usually reachability timeout will remove such entries. For neighbors added during authentication, the reachability timer can be reduced to a lower value.

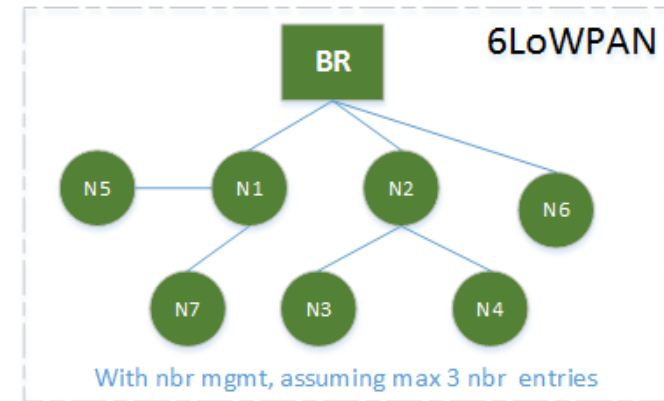
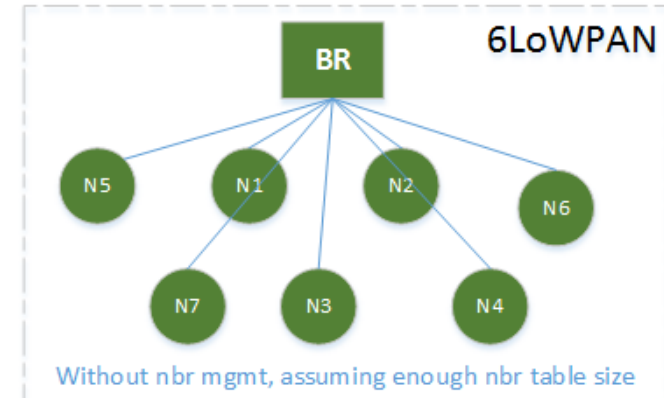
Recommendations

- Basic principles
 - Reservation of routing direct child entries
 - Note that these are for direct child routing entries only.
 - 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
- Graceful rejection of DAO/PANA messages
 - NACK for rejecting DAO
 - PANA client requests can be rejected by PAR message with Result-Code AVP



Impact of neighbor management policy

- A neighbor management policy may result in the increase of convergence time
- Eventually the hops in the network will increase
 - Resulting in more over-the-air packets
- Everything is a trade-off :
 - The overall outcome of the neighbor management policy is to have a deterministic (but may not be optimal) behavior.



Discussions

- Did you meet the same problems in your implementations ? If so, how do you tackle them?
- Plan: a draft submission on this topic short after IETF97
 - collaborators welcome