

Exploiting Packet Replication and Elimination in Complex Tracks in LLNs

draft-papadopoulos-paw-pre-reqs-01

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Outline

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- \Rightarrow Motivation
- \Rightarrow PRE Functions
- \Rightarrow PRE Requirements
- \Rightarrow Alternative Parent Selection modes
- \Rightarrow Recent Results

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Toward Robust and Deterministic Communication

Motivation :

- \Rightarrow Reliable communication
- \Rightarrow Ultra-low jitter performance



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Wireless Topology of 2 hops

D



Overhearing

Overhearing :

- \Rightarrow Wireless medium is broadcast
- ⇒ any neighbor of a transmitter may overhear a transmission





Packet Replication

Replication :

⇒Data packet is transmitted to both Default & "Alternate" Parent





Packet Elimination

Elimination :

⇒ Discard the duplicated packet "previously received packet"



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1. Related to Alternative Parent Selection

- ⇒ The routing protocol SHOULD be extended to allow for each node to select AP(s) in addition to the DP. This enables packet replication to multiple parents;
- ⇒ Considering that the Packet Replication procedure significantly increases the traffic in a network, when proposing solutions for Alternative Parent Selection, they should be efficient enough to mitigate the potential uncontrolled packet duplications;
- ⇒ The topology SHOULD be defined when proposing solutions for Alternative Parent Selection. For instance, the ladder topology should be defined explicitly e.g., number of parallel paths, density.

2. Related to Propagated Information

⇒ Nodes MUST have a way of receiving the required information for efficient Alternative Parent Selection.

• As an example, it is possible to use and extend the RPL DODAG Information Object (DIO) Control Message to allow nodes to propagate information about themselves to potential children. For instance, "RPL DAG Metric Container (MC) Node State and Attribute (NSA) object type extension" focuses on extending the DAG Metric Container by defining a new type-length-value (TLV), entitled Parent Set (PS) which can be carried in the Node State and Attribute (NSA) object.

3. Related to Promiscuous Overhearing

- ⇒ The MAC implementation MUST be able to disable MAC address filtering to accept the overheard frame;
- ⇒ The 6top Protocol specification MUST be extended to indicate disabling MAC filtering in a receiving cell;
 - This can be achieved by reserving a bit in the 6P CellOptions Bitmap (Section 6.2.6 [RFC8480]) for this purpose
- ⇒ The overhearing node can be configured with the timeslot set to shared reception, thus, there will be no acknowledgement from it. However, there is the security issue that needs to be considered. Since the overhearing case implies that it is not possible to have per-pair keying, there MUST be a key that the overhearing node will be aware of. Hence, the Minimal Security Framework for 6TiSCH specification should consider such a scenario.

4. Related to Packet Elimination

⇒ To perform Packet Elimination the packet copies MUST contain a sequence number which allows identifying the copies.

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Alternative Parent Selection

One possible option is to select the Alternative Parent as the one having *common ancestor*

Common Ancestor (CA) modes



Common Ancestor : **Strict** mode





Common Ancestor : **Medium** mode

$PP(PP) \in PS(AP)$



Common Ancestor : **Soft** mode

$PS(PP) \subseteq PS(AP)$



Common Ancestor : Probabilities

Probability of finding an Alternative Parent



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PRE Recent Results

ТЅСН	Single- path	Multi-path
Scheduling	Centralized	Centralized
EB period	4 sec	4 sec
Timeslot length	10 ms	10 ms
Slotframe length	345 Timeslots	345 Timeslots
Nº of channels	1	1
Nº of RTX	1 RTX, 4 RTX, 8 RTX	1 RTX

Simulation		Тороlogy	
Duration	Until 1000 pkts	Topology	Multi-hop
Data traffic	1 pkt/18 sec	Nº of nodes	32
Routing	RPL	Nº of layers (L)	5
Parent set size	6	Nº of sources	1
PS_{MC} size (M)	3	Link quality	70% - 100%



PRE Recent Results : PDR



PRE Recent Results : Traversed nodes & TX packets



PRE Recent Results : Jitter



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more of PRE

Adaptive CA mode

- \Rightarrow Reduce the :
 - $\,\circ\,$ Number of Traversed Nodes
 - $\ensuremath{\circ}$ Transmitted packets
- \Rightarrow More results

Adaptive CA mode : when Strict mode is applied



Adaptive CA mode : when Medium mode is applied



Adaptive CA mode : when Soft mode is applied



PRE Recent Results : PDR



PRE Recent Results : Traversed nodes & TX packets



PRE Recent Results : Delay and Jitter



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Road Forward

 \Rightarrow We received and addressed reviews from Xavi, many thanks!

• We are looking for more reviews

○ Maybe, we are missing more requirements ... ☺

 \Rightarrow Implementation Status \rightarrow code (or partial code) is available here :

o Contiki NSA extension https://github.com/ariskou/contiki/tree/draftkoutsiamanis-roll-nsa-extension

 O Wireshark dissectors (for the optional TLV, i.e., PS): https://code.wireshark.org/review/gitweb?p=wireshark.git;a=commit;h=e2f6b a229f45d8ccae2a6405e0ef41f1e61da138

 \Rightarrow Shall we push the results to github repository?



Thanks!

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