

Collision Prevention in Distributed 6TiSCH Networks

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- IEEE802.15.4e & 6top

- Collisions in Dedicated cells

Proposed Mechanism

- Criteria

- Using 6top Transactions Collect neighbor's cells

- Avoid Table

- Adding the Cell Buffer

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- Simulator

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Wireless Sensor Networks

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- ▶ Main contributions are : low power, low cost.
- ▶ IEEE802.15.4 one of the main standard for those Networks

General introduction

IEEE802.15.4

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- ▶ The low layers of the network (i.e., PHY and MAC)

General introduction

IEEE802.15.4

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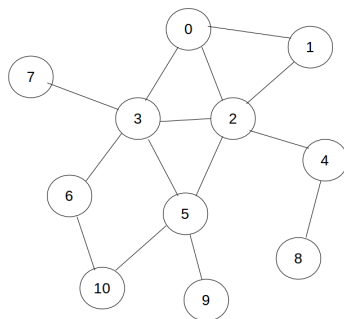
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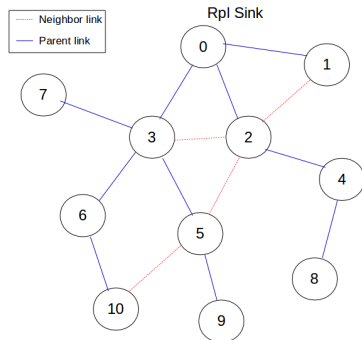


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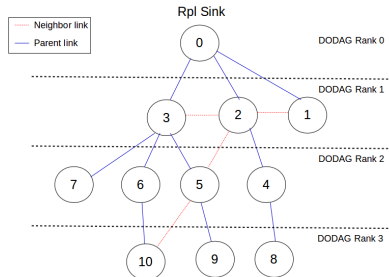


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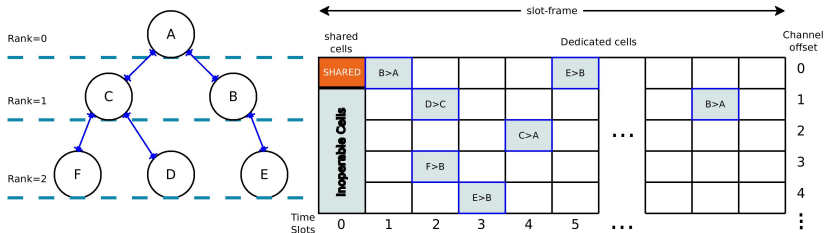


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IEEE802.15.4

IEEE802.15.4e TSCH

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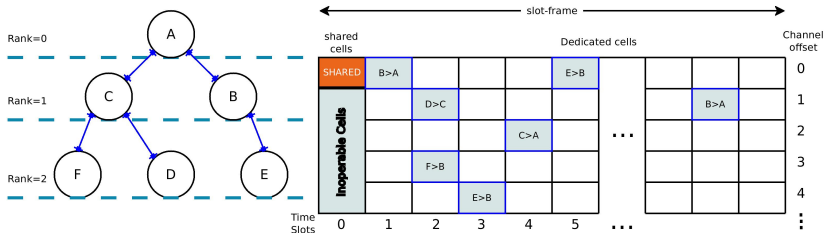


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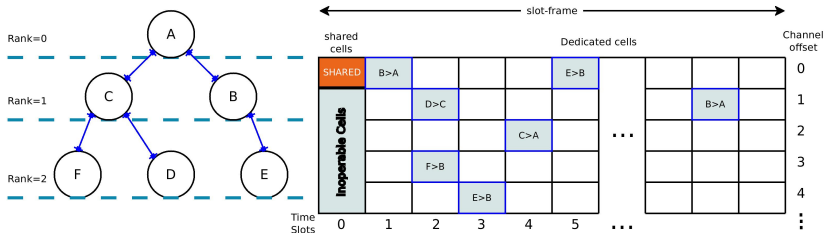


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- ▶ Two types of cells: dedicated and shared.

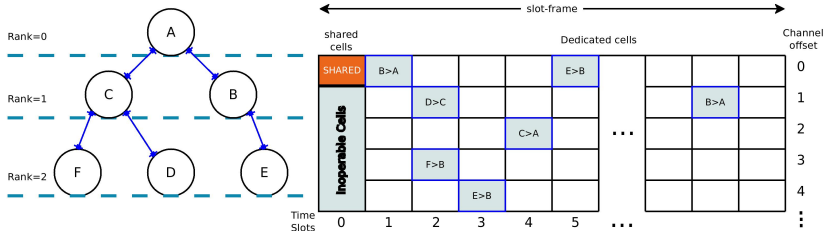


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- ▶ Managed in centralized or distributed way.

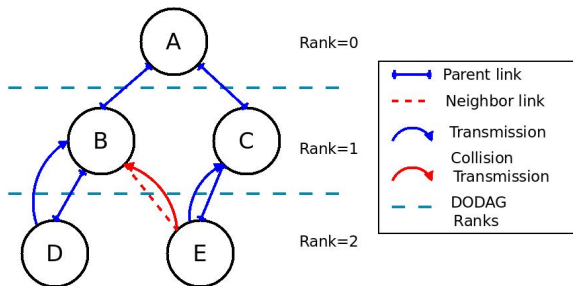


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Collision in the Dedicated Cells

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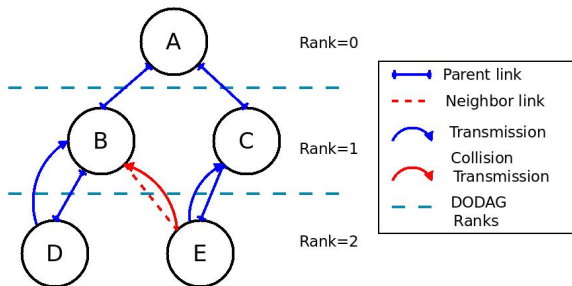


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- ▶ Collision free dedicated cells.
- ▶ Collisions in distributed approach .

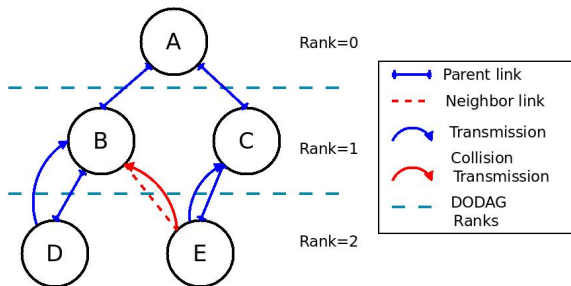


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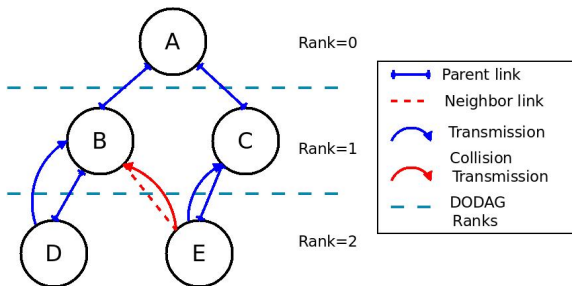


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Collision in the Dedicated Cells

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- ▶ Collision free dedicated cells.
- ▶ Collisions in distributed approach .
- ▶ Lack of central entity.
- ▶ Collision are very expensive in Wireless sensor Networks.



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Project Objectives

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- ▶ Modifying the Cell reserving process without introducing new overhead on the network
- ▶ Creating a flexible mechanism, compatible with all scheduling functions

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- ▶ 6top contains the scheduling function.

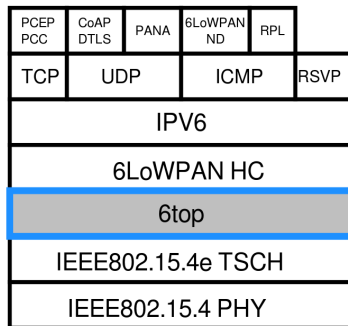
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- ▶ 6TiSCH purpose is the Integration of IPv6 and TSCH.
- ▶ 6TiSCH operation (6top) is a sublayer of 6TiSCH.
- ▶ 6top contains the scheduling function.
- ▶ 6top is responsible for the cell addition and deletion.

IEEE802.15.4e and 6top

6top

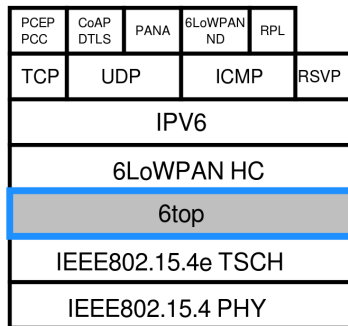
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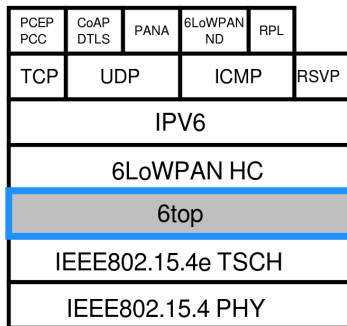
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IEEE802.15.4e and 6top

6top

- ▶ Orchestrates all communications using the TSCH schedule.
- ▶ Allows the nodes to request for new TSCH cells.
- ▶ 6top enables the distributed scheduling in 6TiSCH network.



IEEE802.15.4e and 6top

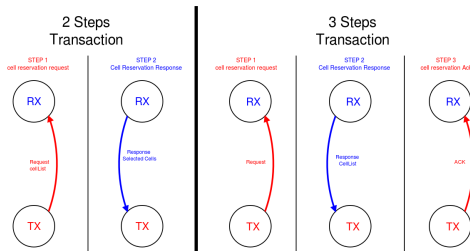
IEEE802.15.4e & 6top

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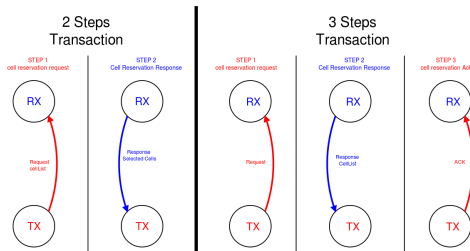
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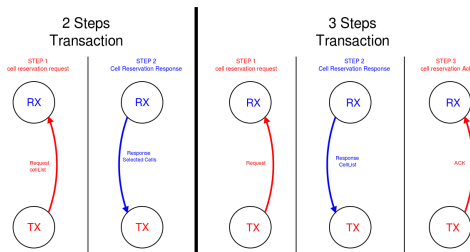
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- ▶ 6top transactions: negotiation to Add/Delete/Relocate cells.
- ▶ Two types: 2-step and 3-step.
- ▶ The transaction is done in the shared slot.
- ▶ The transaction will be received by the neighbor nodes by dropped due to MAC filtering of the messages.



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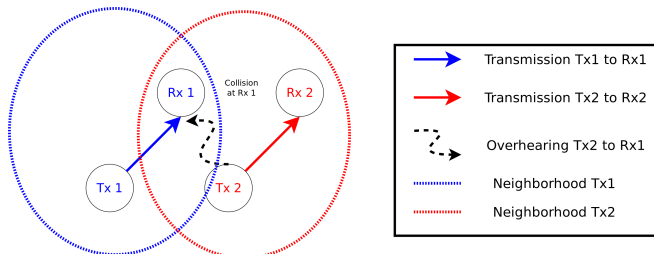
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6top and Collisions

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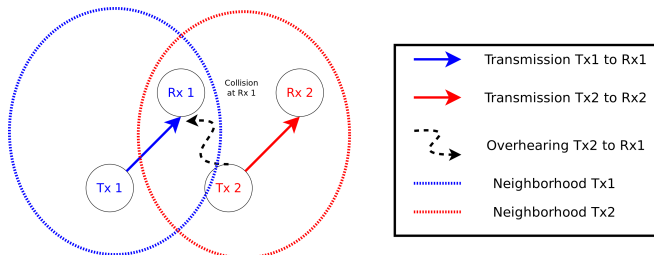
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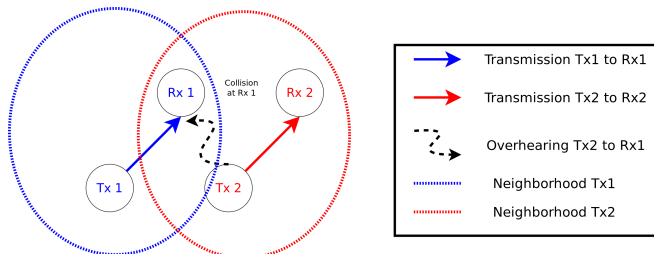
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- ▶ Scheduling function cell selection does not consider the neighbor's cells.
- ▶ If another neighbor node is using the same cell a collision will occur.
- ▶ Collisions are expensive.



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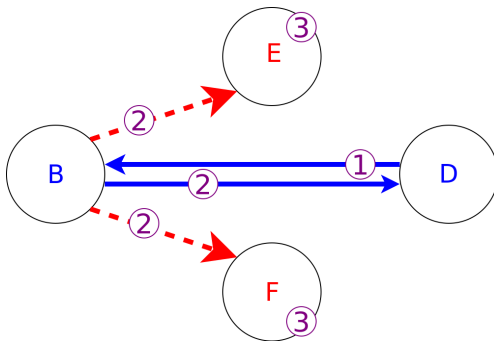
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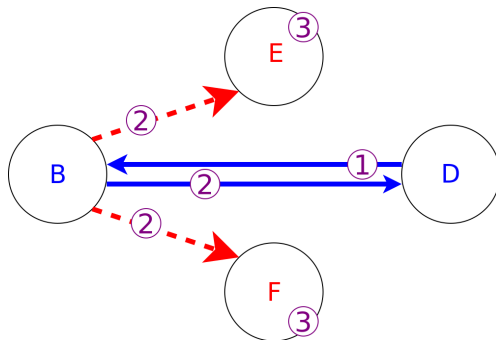
Using 6top Transactions Collect neighbor's cells

- D will transmit an Add request to B.



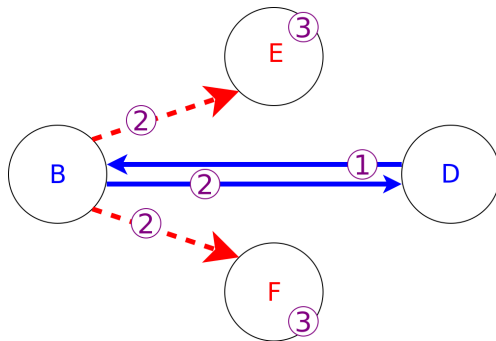
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Using 6top Transactions Collect neighbor's cells

- ▶ D will transmit an Add request to B.
- ▶ B will reply with the Add Response that will contain the cells.
- ▶ The Add Response is transmitted in the shared cell, E & F will receive and extract the cells.



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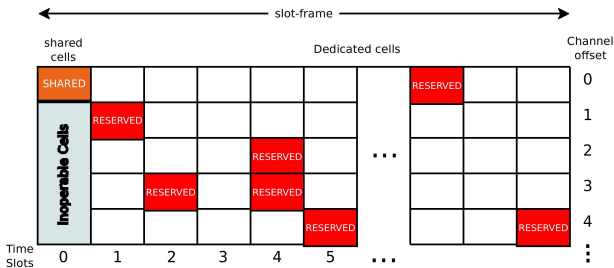
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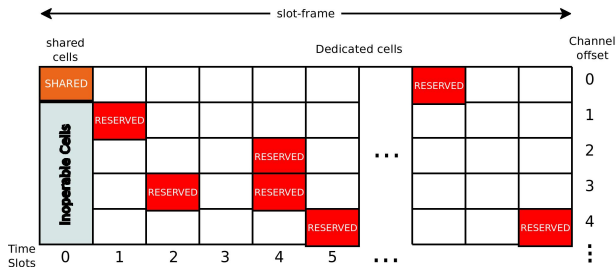
Avoid Table

- ▶ The cells reserved by neighbors will be saved by a structure similar to TSCH table.



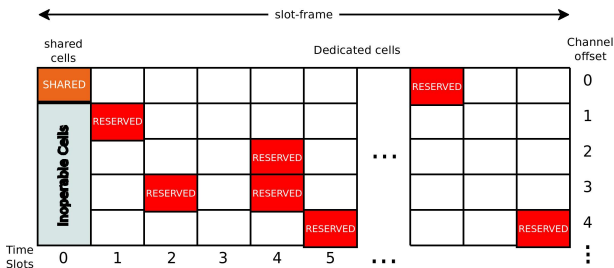
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- ▶ 6top will manage this table.



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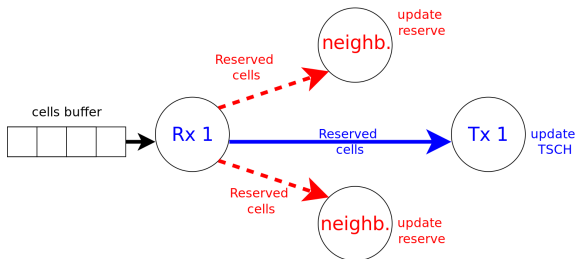
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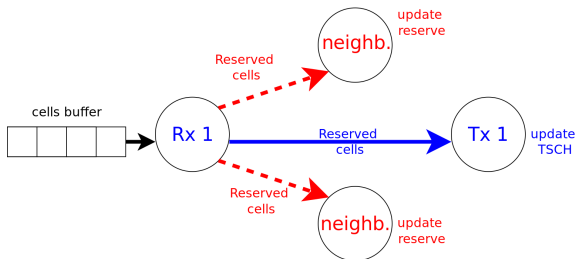
Cell Buffer

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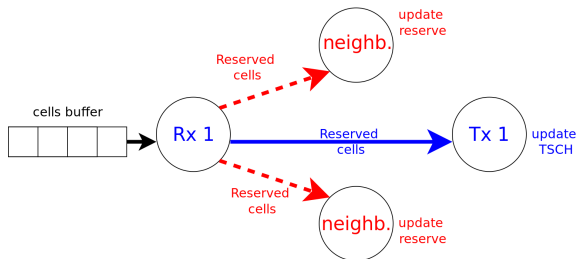
Cell Buffer

- ▶ The assumption of 100% successful delivery is not realistic.
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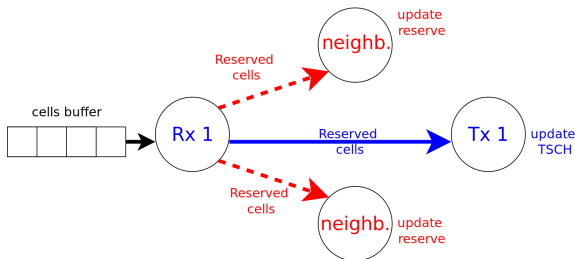
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- ▶ The loss of the transaction increase the probability of collisions.
- ▶ By saving the reserved cells in a buffer, and sending the buffer this probability can be reduced.



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Cell Buffer

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- ▶ p is the probability of successful transmission.
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- ▶ we end up with the following equation using binomial distribution:

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- ▶ According to this equation, and by taking the worst case scenario a buffer of length 10 can assure us 95% of success

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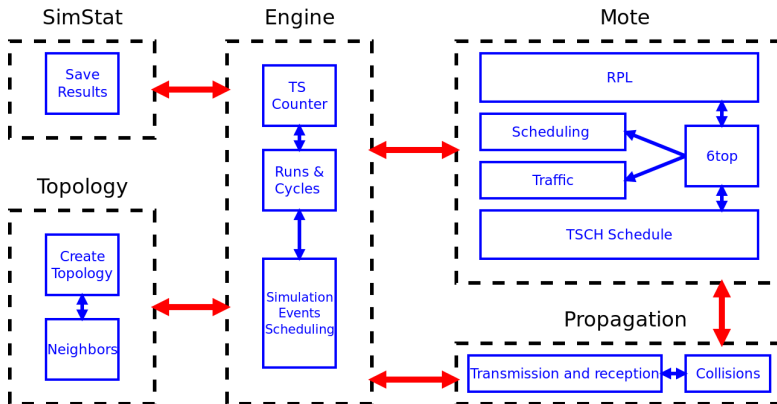


Figure: Simulator Architecture

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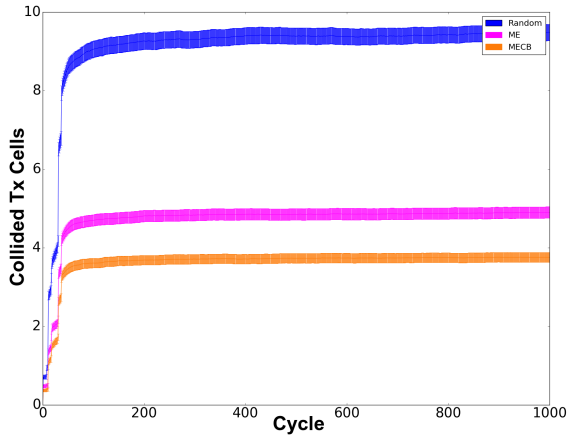


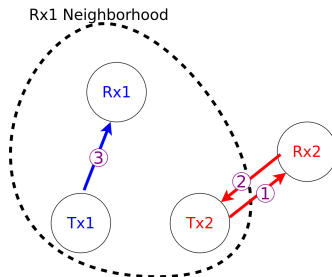
Figure: Simulation of the Number of Collided Tx Cells as Function of Cycle Number (Time)

Cell Buffer

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- ▶ Special Case That Induce Collisions.



Comparison with Housekeeping

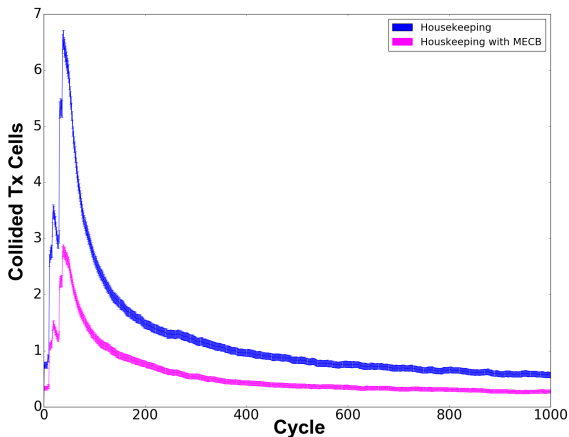


Figure: Simulation of the Number of Collided Tx Cells as Function of Cycle Number (Time) - comparison with the housekeeping approach

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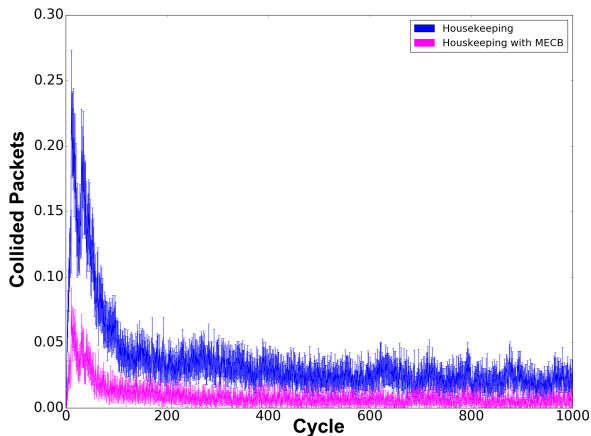


Figure: Simulation of the Number of Collided Packets as Function of Cycle Number (Time) - comparison with the housekeeping approach

Summary

- ▶ Our implementation introduce **no overhead** in the network.
- ▶ The implementation **achieved 60% reduction** in the number of collided Tx cells and **70% reduction** of the Collided Packets.
- ▶ The Combination of Our approach and Housekeeping accomplish an **almost collision free dedicated cells**.
- ▶ Outlook
 - ▶ Our goal is to reach a place where we have collision free network, using more complex methods.
 - ▶ Our perspective in this project was work on 6top, but our next steps is to study the effects of traffic in the protocols performances.

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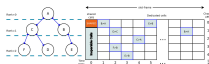
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IEEE802.15.4e TSCH

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- Extension of the Medium Access Control (MAC) Layer.
- Time-slotted Channel Hopping (TSCH) is based on time frequency multiplexing.
- Two types of cells: dedicated and shared.
- Managed in centralized or distributed way.



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6top and Collisions

6top

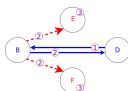
- Nodes have no information about the neighbors.
- Scheduling function call selection does not consider the neighbor's cells.
- If another neighbor node is using the same cell a collision will occur.
- Collisions are expensive.



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Using 6top Transactions Collect neighbor's cells

- D will transmit an Add request to B.
- B will reply with the Add Response that will contain the cells.
- The Add Response is transmitted in the shared cell, E & F will receive and extract the cells.



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Simulator Architecture

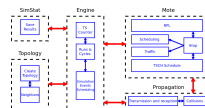
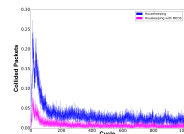


Figure: Simulator Architecture

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Related Work Results comparison



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Thanks for your attention!
Questions?