Collision Prevention in Distributed 6TiSCH Networks

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Outline

Introduction & Background
- General Introduction
- IEEE802.15.4 Protocols
- Project challenges & Objectives

Proposed Mechanism
- Using 6top Transaction
- Avoid Table
- Cell Buffer

Simulator and Results
- Simulator
- Results

Summary and Contributions

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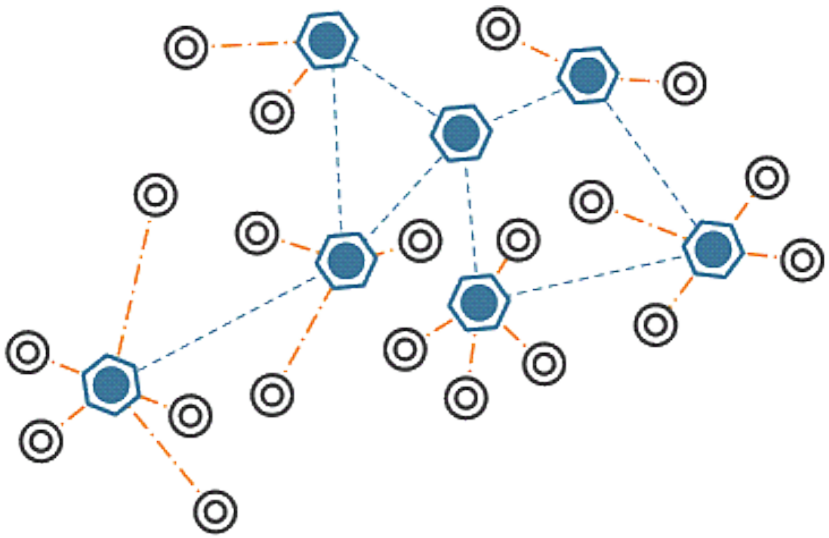
IoT & Wireless Sensor Networks

- Network technologies and IoT.



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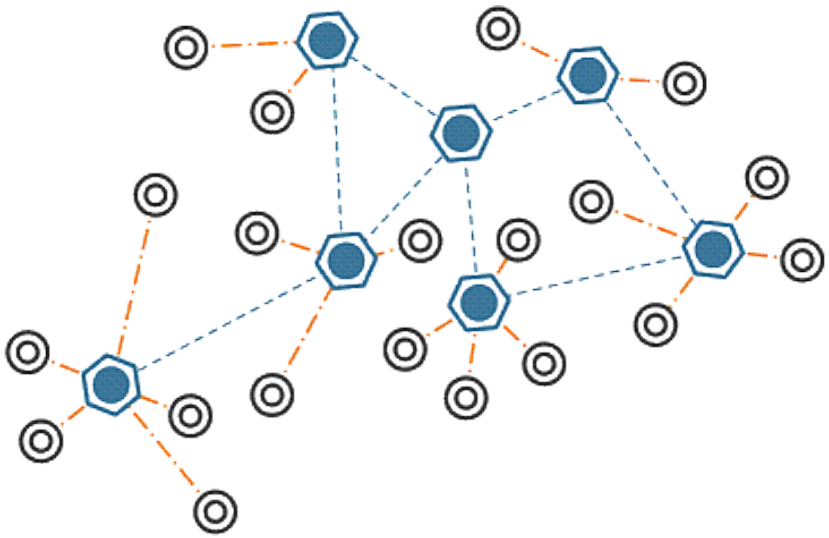
- Network technologies and IoT.
- WSN: standardization of IoT nodes communication.



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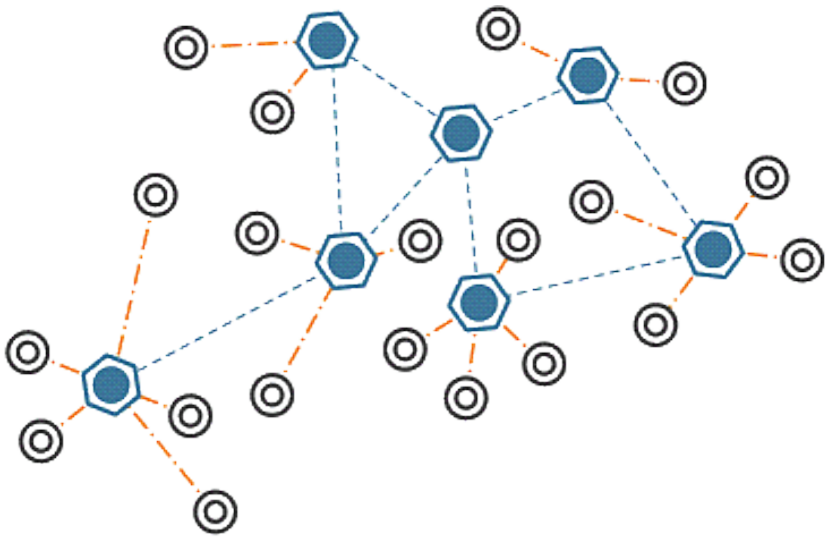

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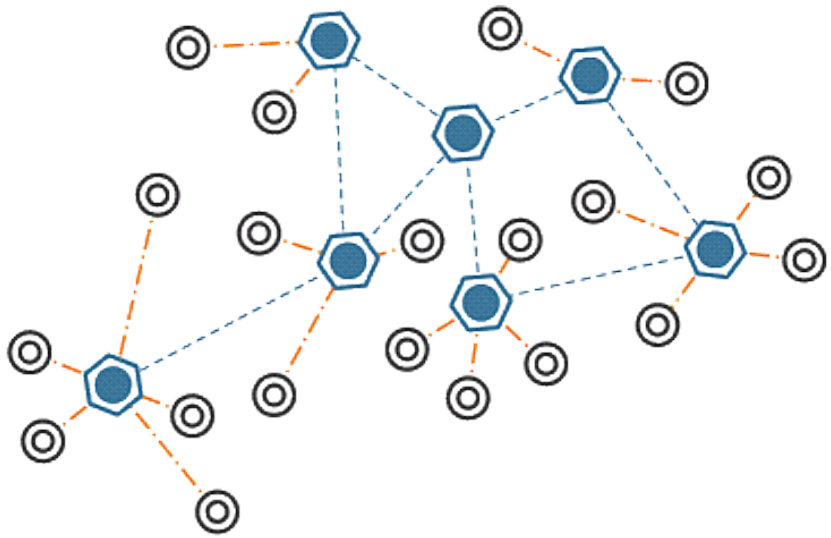
- IEEE802.15.4 one of the main standards of WSN.

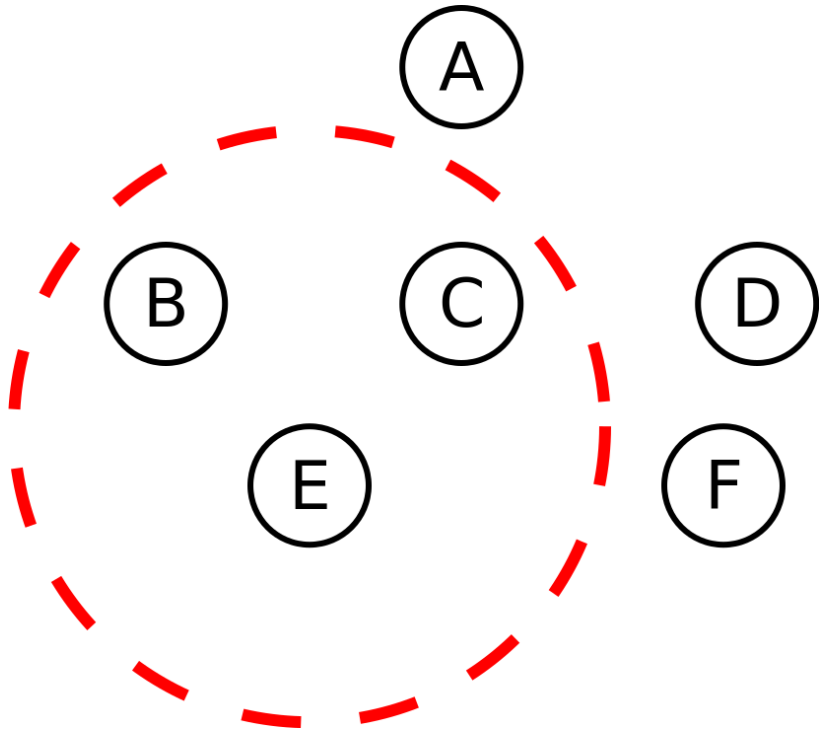


General intoduction

IEEE802.15.4

Converge Cast Structure

- Nodes radio ranges defines the neighborhood.



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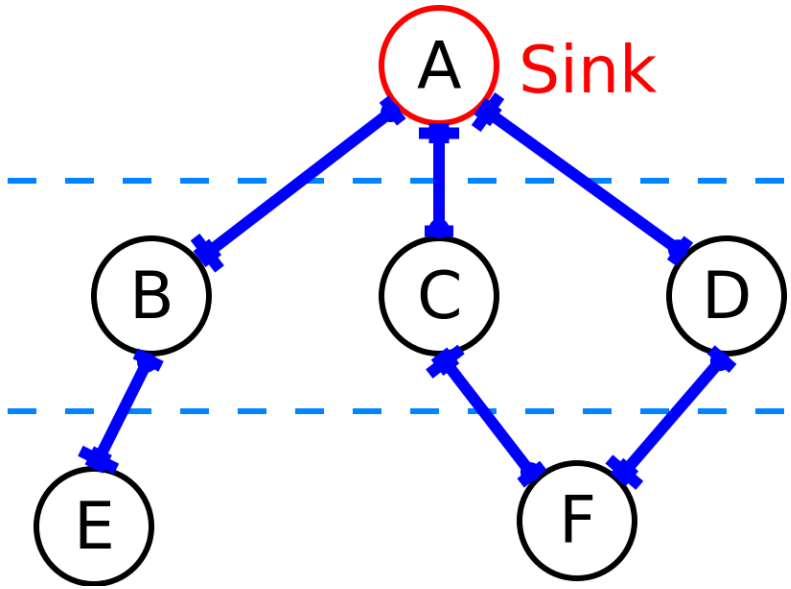

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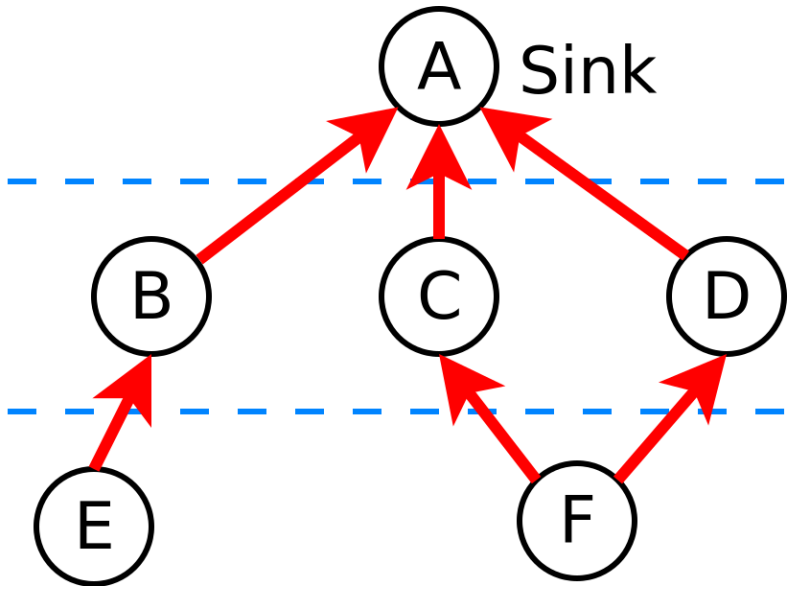

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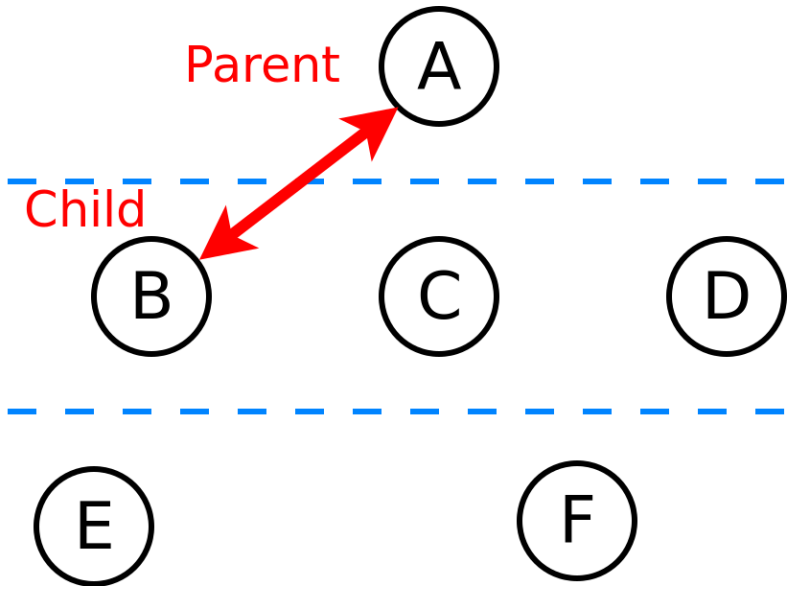
- Communication pairs.



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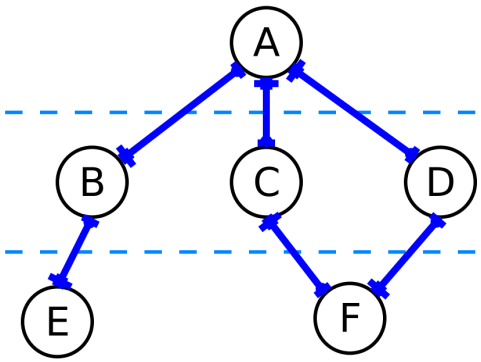
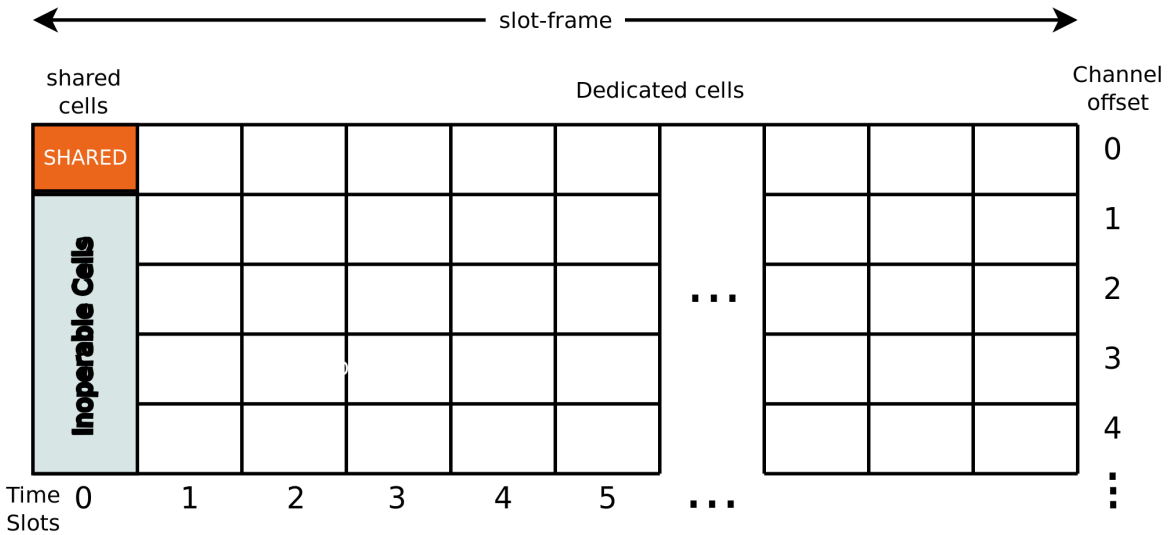
- TSCH is an extension of the MAC layer of IEEE802.15.4.





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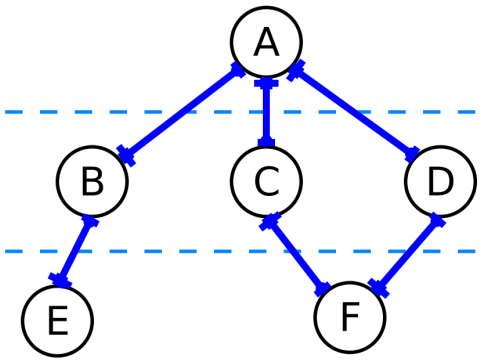

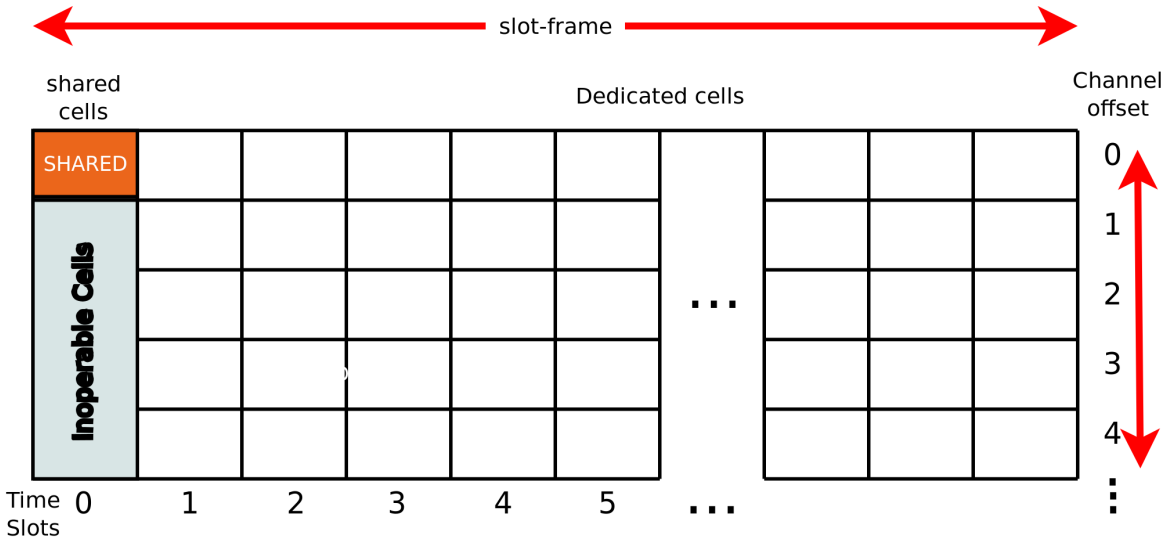

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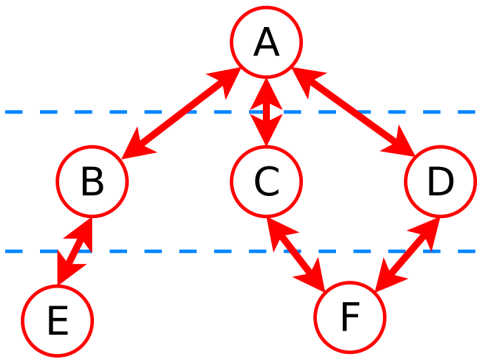

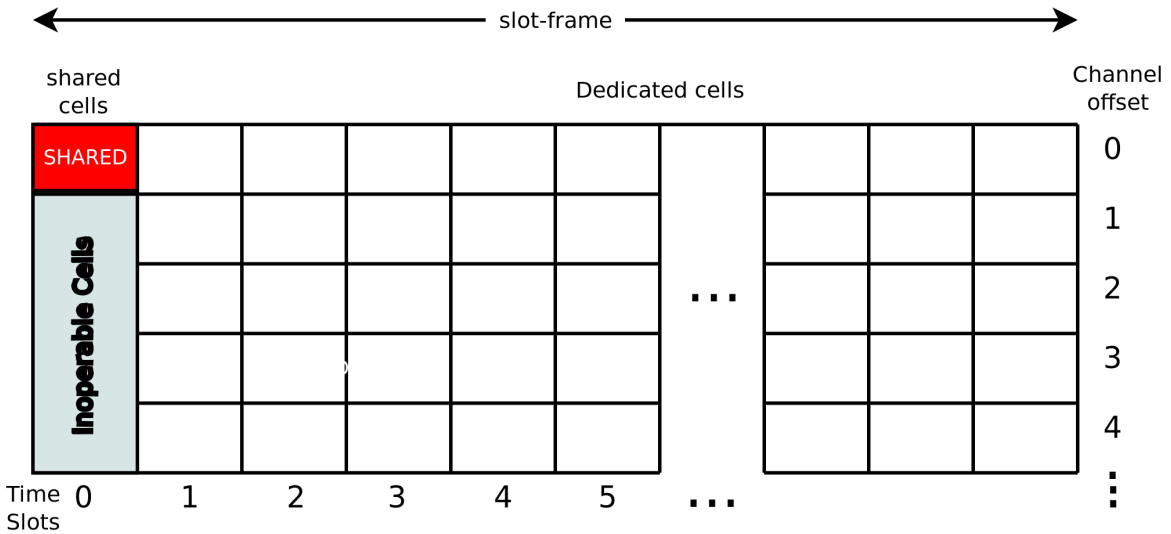

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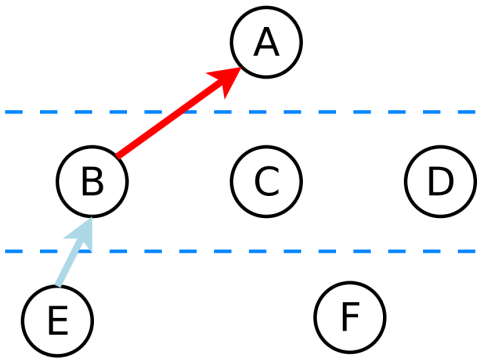

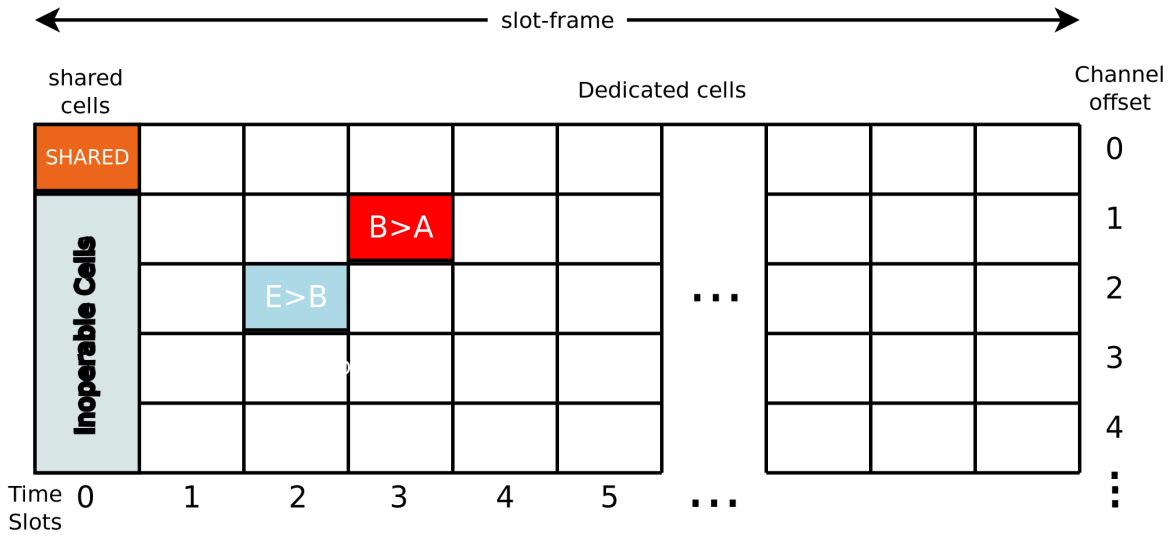

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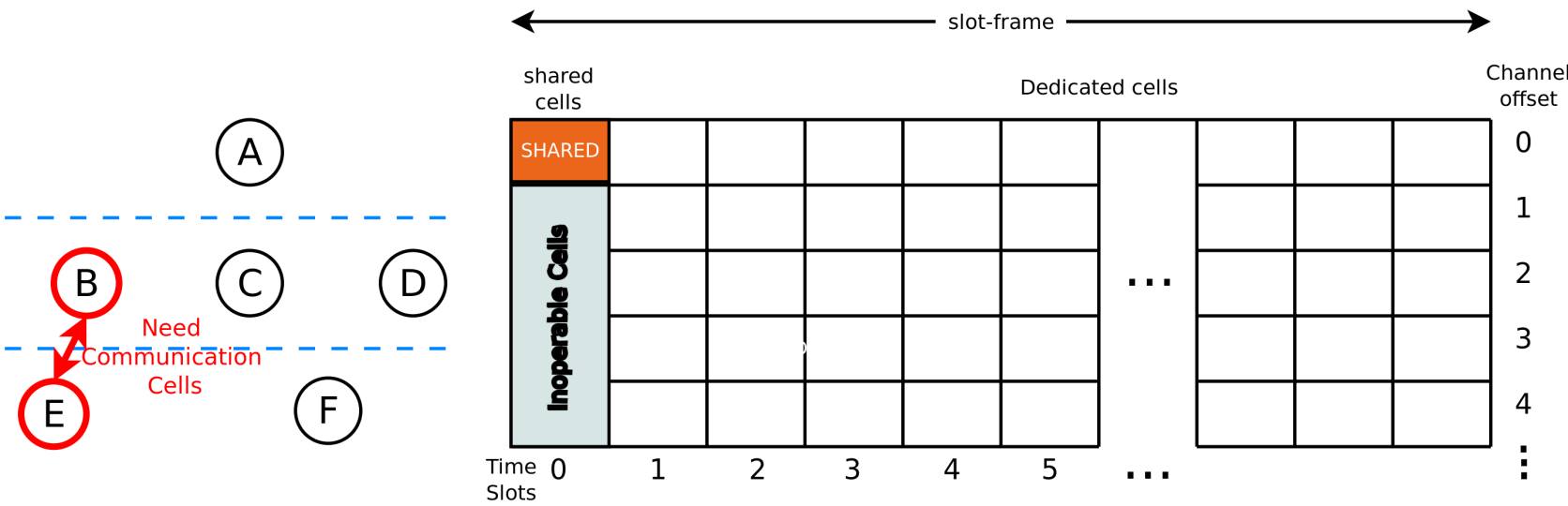
- 6TiSCH operation sublayer 6top will manage the TSCH.

IEEE802.15.4 Protocols

Cell Reservation Process

1. Scheduling function decides new cell should be assigned.



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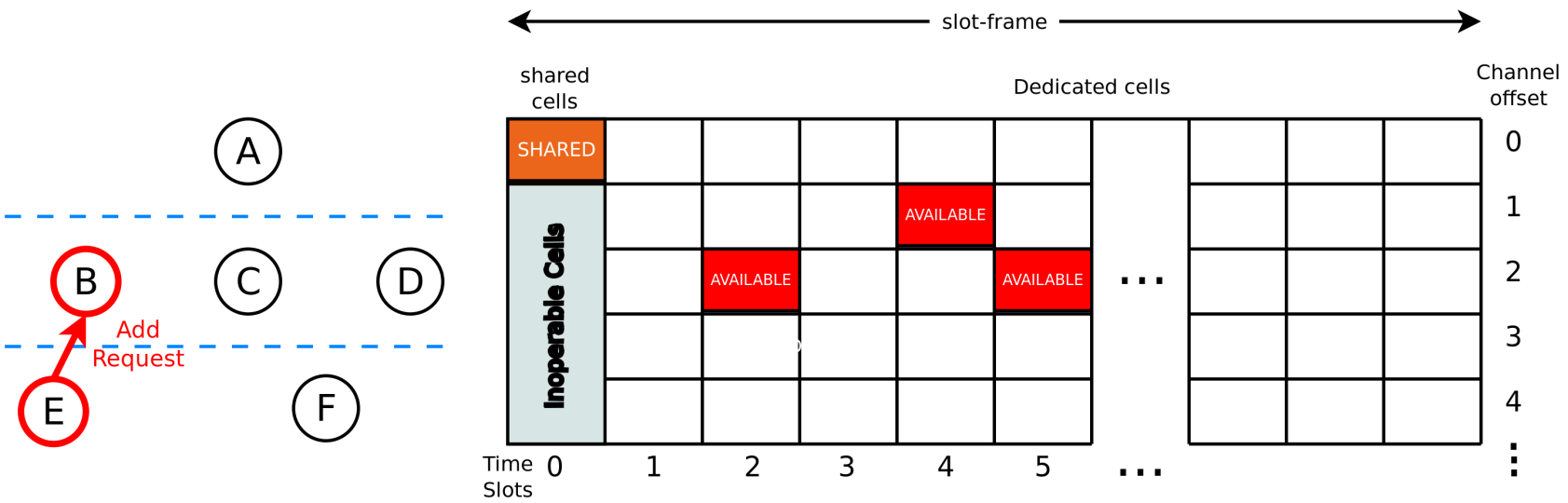

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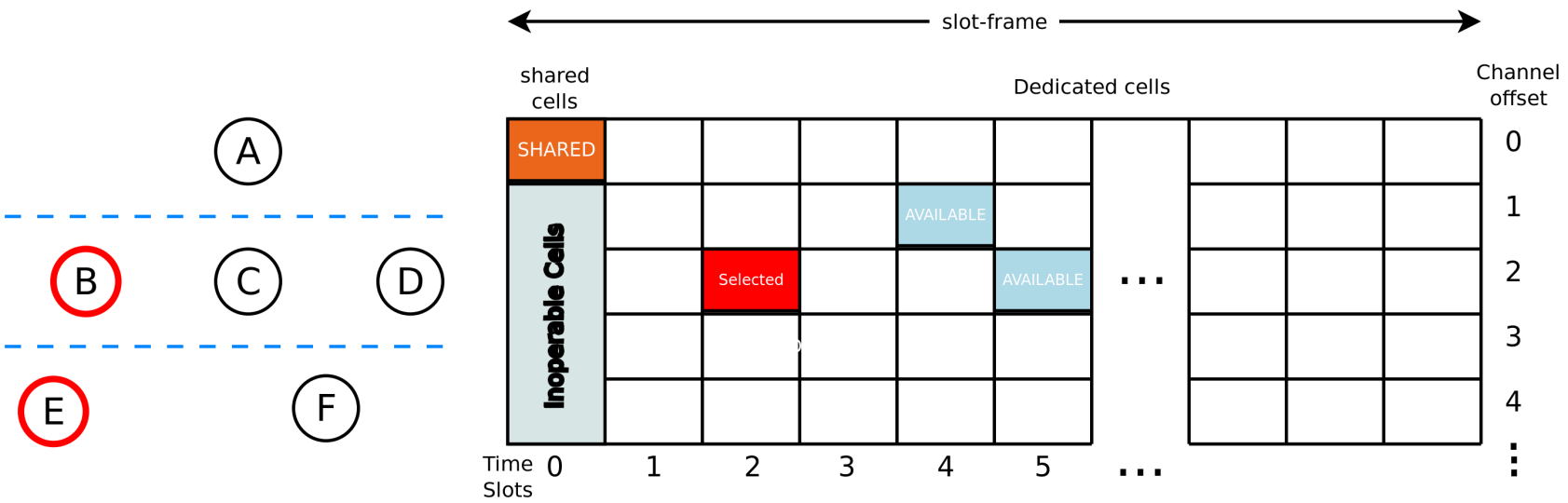

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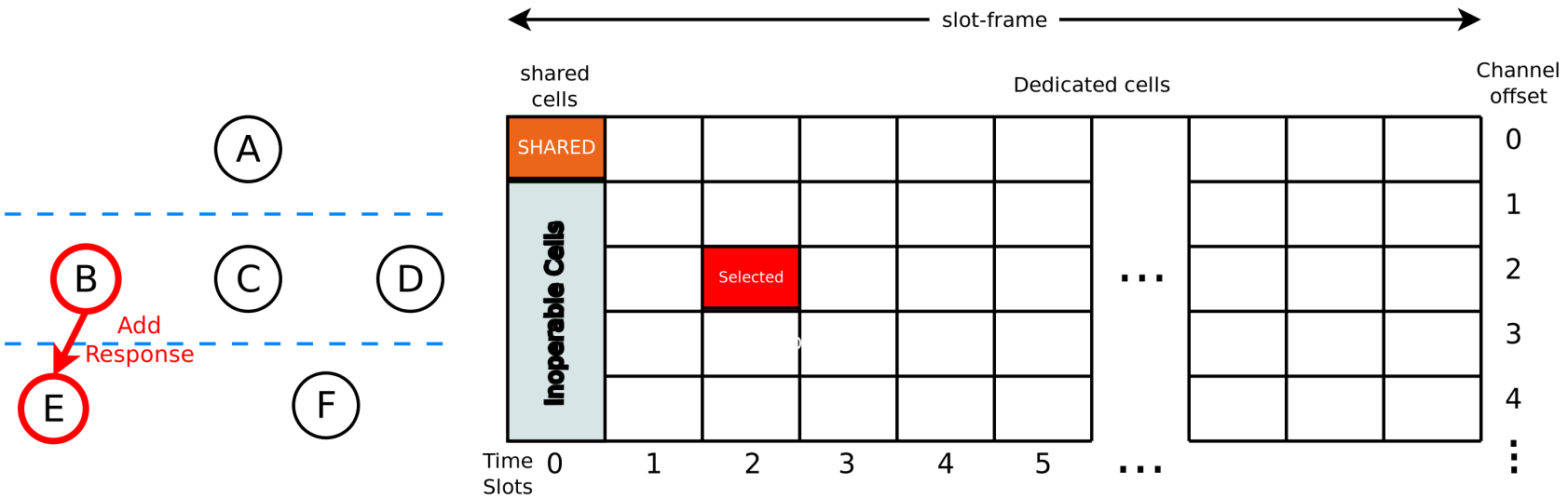

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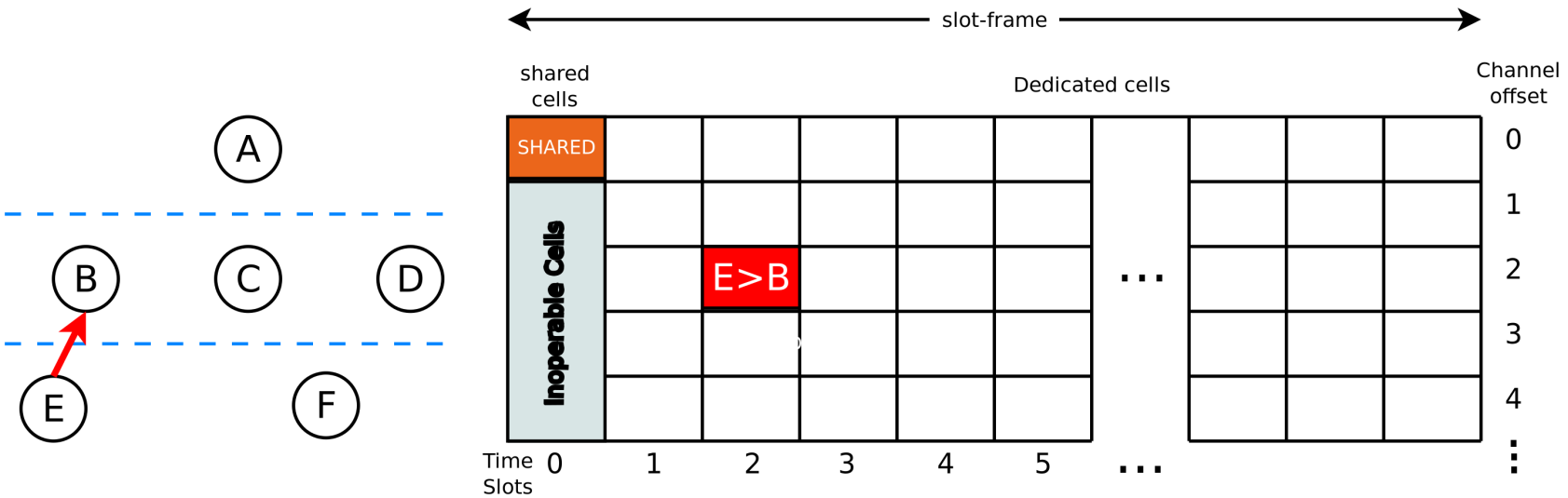
5. Cell is added and communication start.



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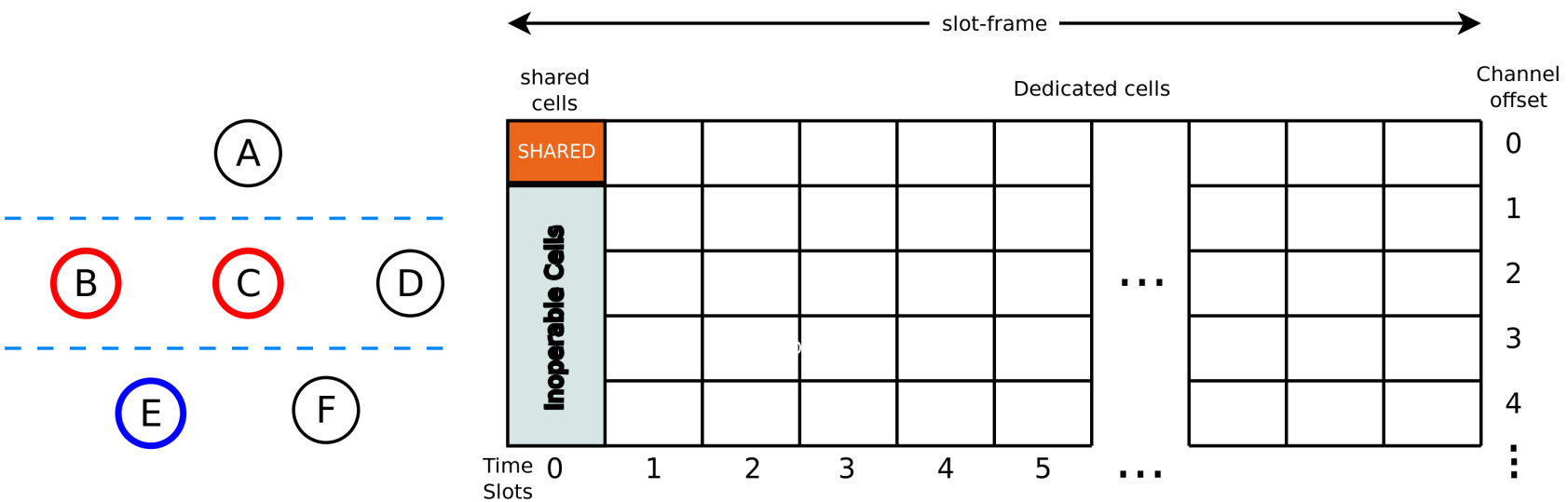
Collision in Dedicated Cells

- Collision free Dedicated Cells?
- Neighbor nodes can select the same communication cell.



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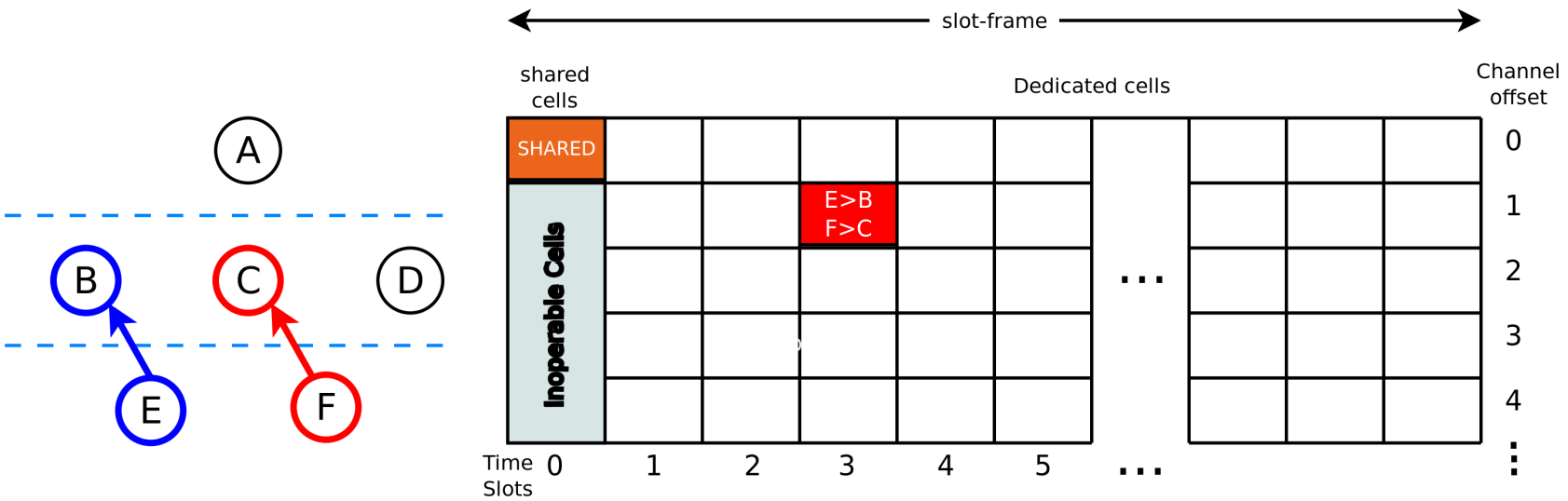

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Collision in Dedicated Cells

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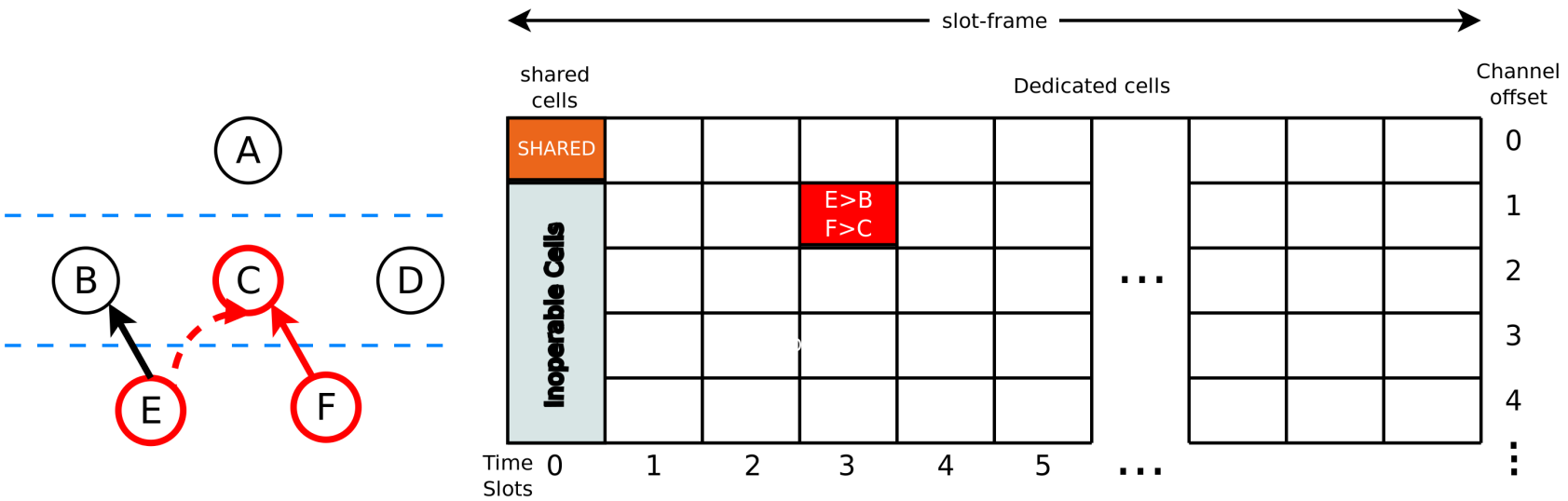
- Neighbor nodes can select the same communication cell.
- Collision at the reception Node.



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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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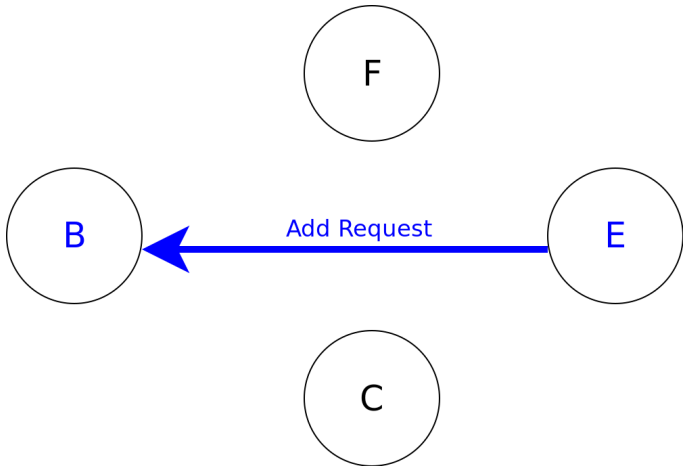
- Submitted in the shared slot.
- Contains the reserved cells.

How?

- The child node Sends an Add Request.



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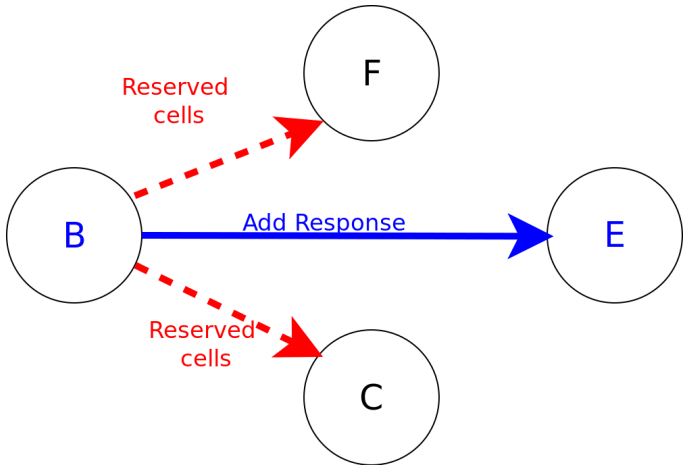

Using 6top Transaction

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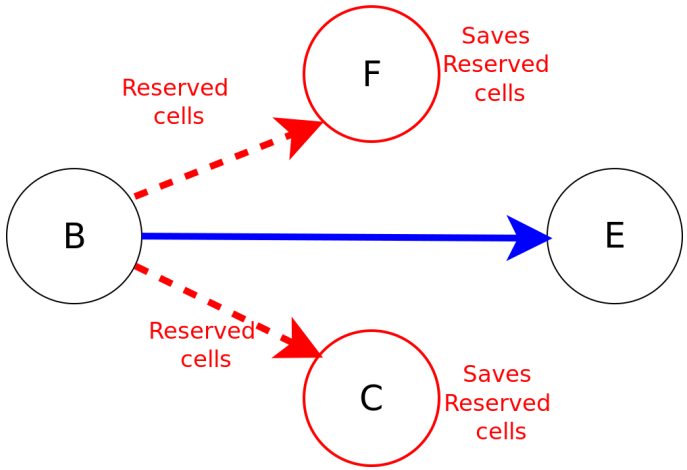
- The parent replies with the selected cells.
- The Neighbor nodes collects the reserved cells and save them.



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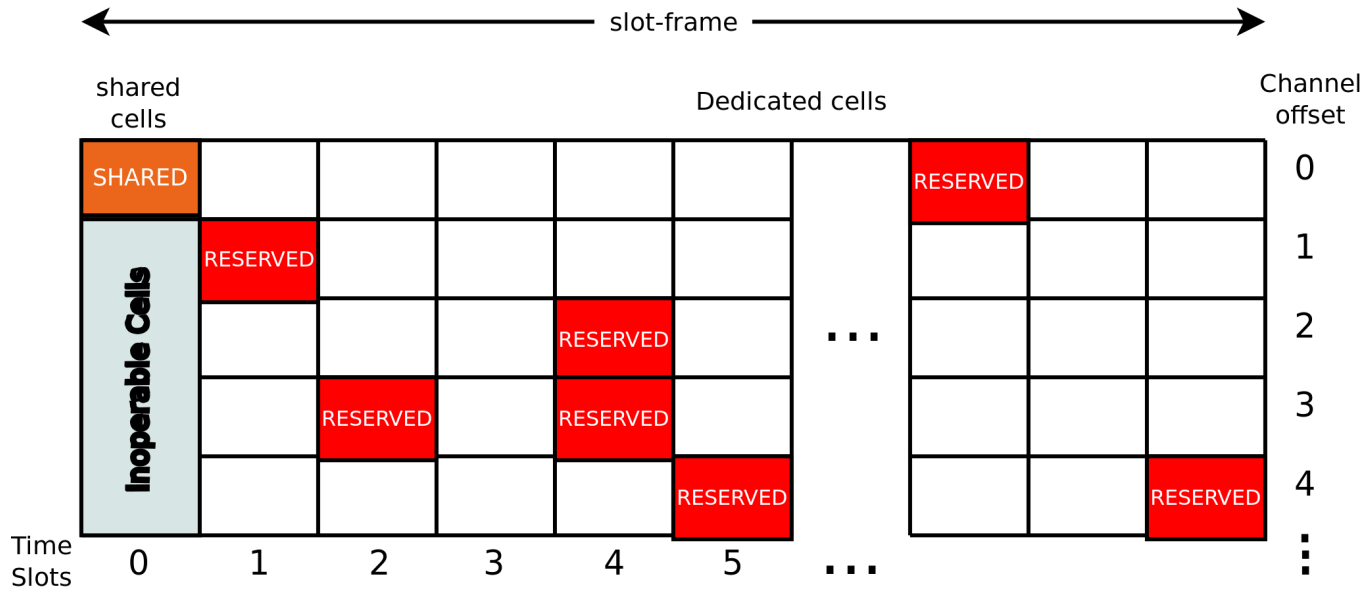
Avoid Table structure and functioning

Avoid Table

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



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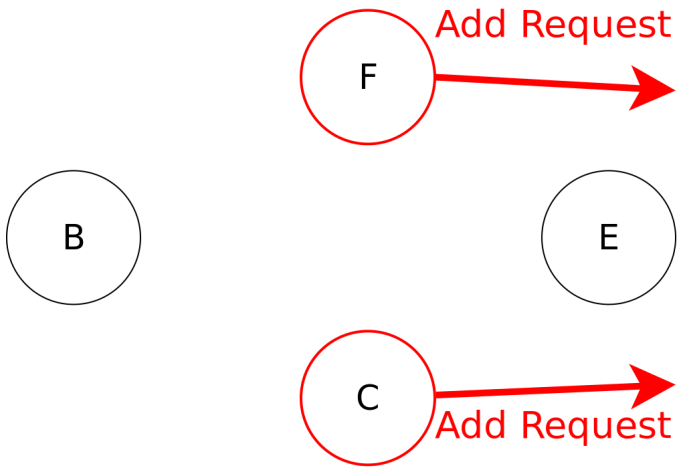

Avoid Table structure and functioning

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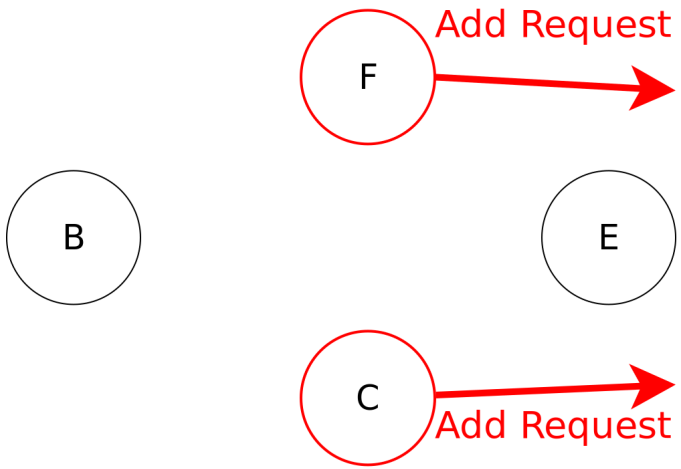
- 6top will manage this table.



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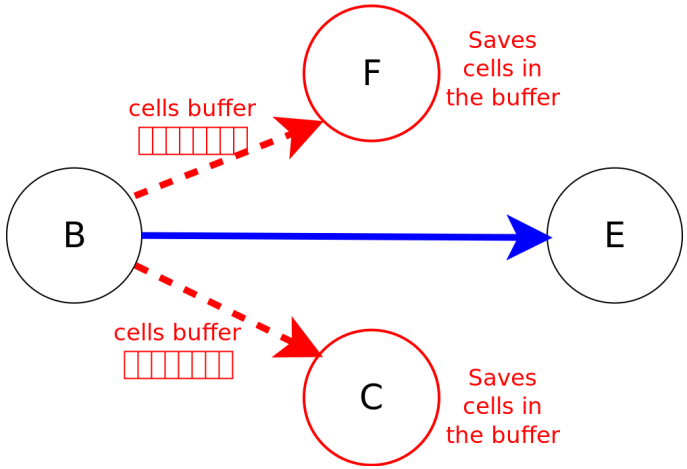
Cell Buffer

Why?

- Some of the 6top Transaction are lost.
- Number of the neighbors will not receive the reserved cells.

How?

- Creating a cell buffer that will contain k reserved cells for each node.



Cell Buffer

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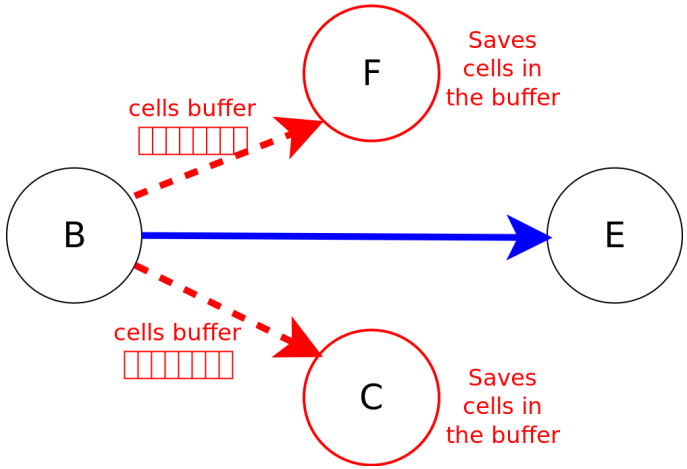
How?

- Creating a cell buffer that will contain k reserved cells for each node.
- Transmitting the cell buffer each time a cell is reserved.



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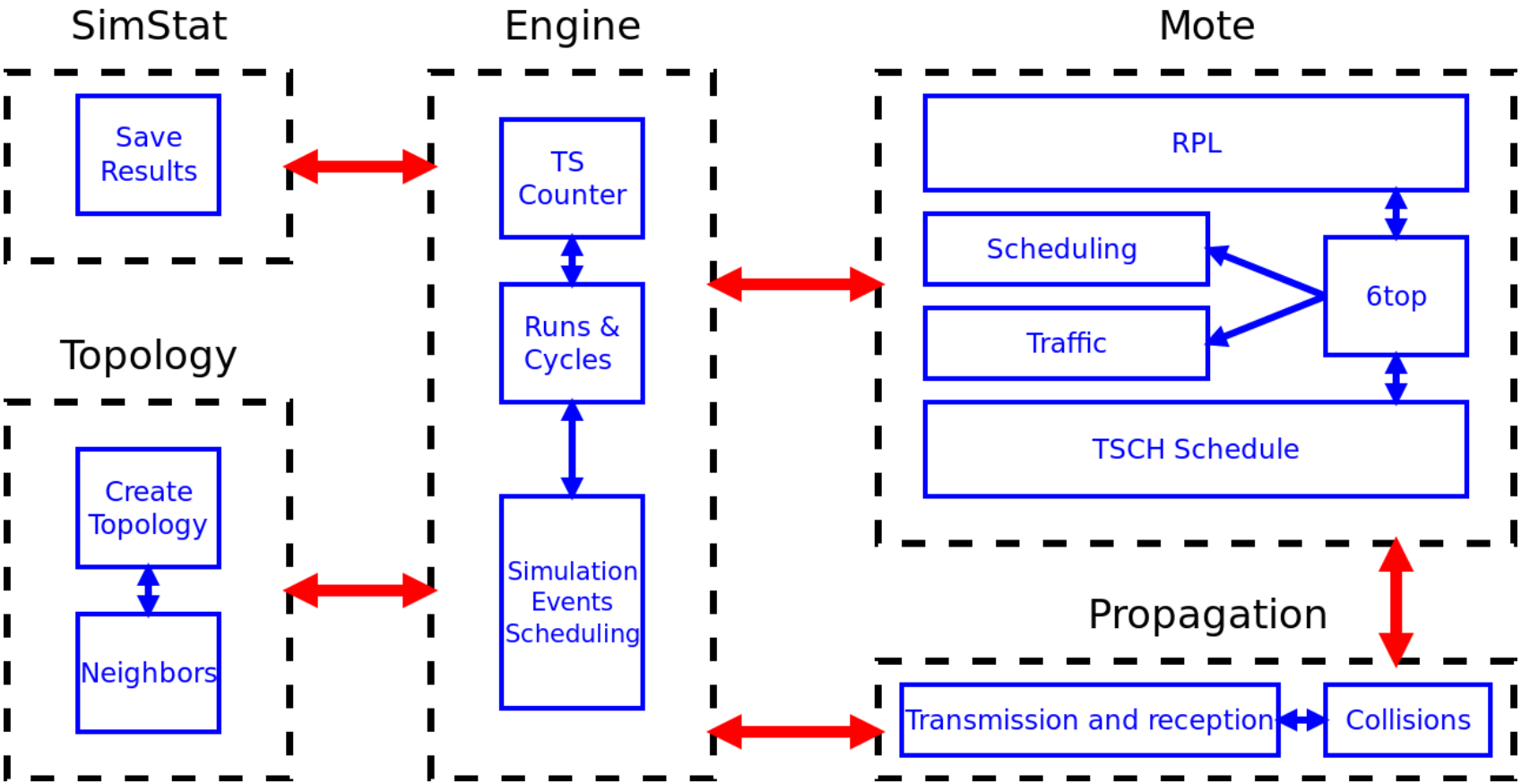
Simulator Architecture



Simulation Parameters

Parameter	Value
Number of Motes	100
Number of cycles per run	1000
Number of runs per simulation	1000
Timeslot duration	$10ms$
Slotframe length	101
Number of channels	16
Area	$1Km \times 1Km$
Topology constraint	$\geq$ 3 neighbors with PDR 50 %
Radio sensitivity	-97 dBm
Radio range	100m
Traffic	1 packet/node each 10 cycles

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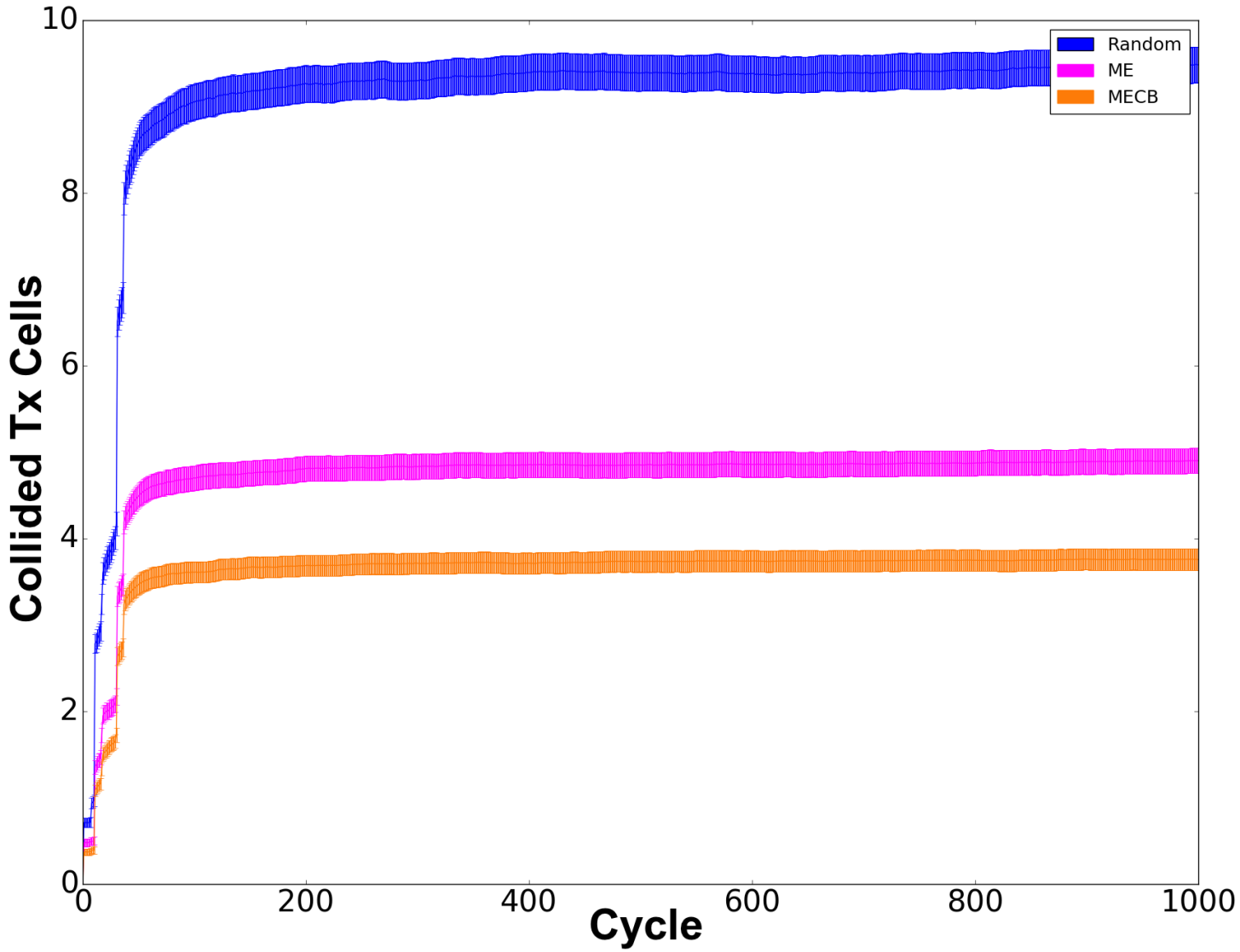
Random
ME
MECB
Collided Tx Cells
Cycle
0
2
4
6
8
10
0
200
400
600
800
1000

Results

Collision reasons

- The lost 6top transactions.

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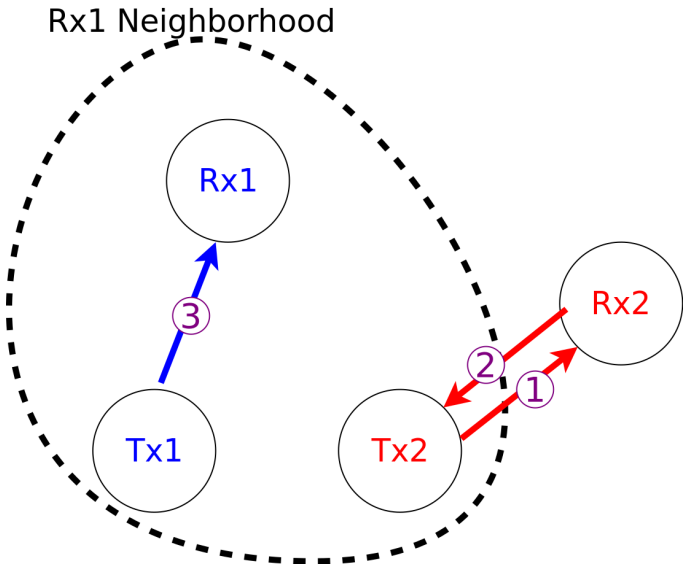
Collision reasons

- The lost 6top transactions.
- Special Case That Induce Collisions.



Project challenges & Objectives

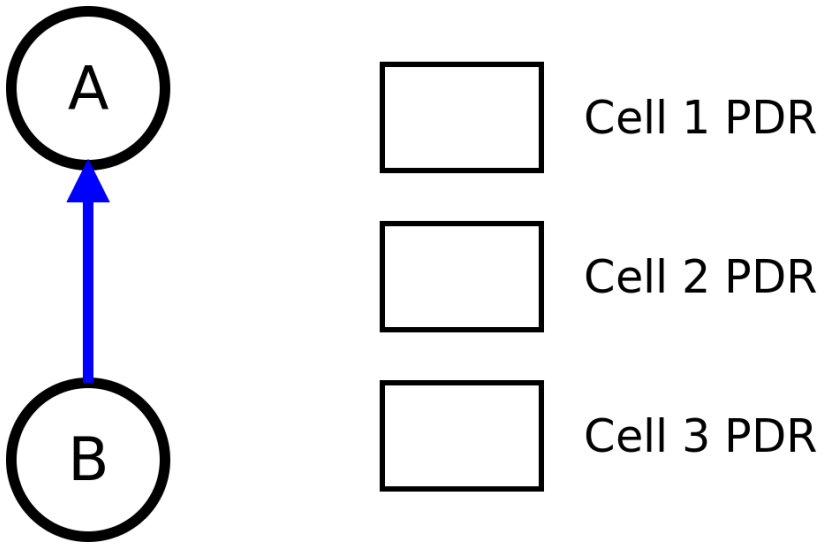
Collision in Dedicated Cells

- Housekeeping approach and cell relocation.

Project challenges & Objectives

Collision in Dedicated Cells

- Housekeeping approach and cell relocation.
- Tx housekeeping.



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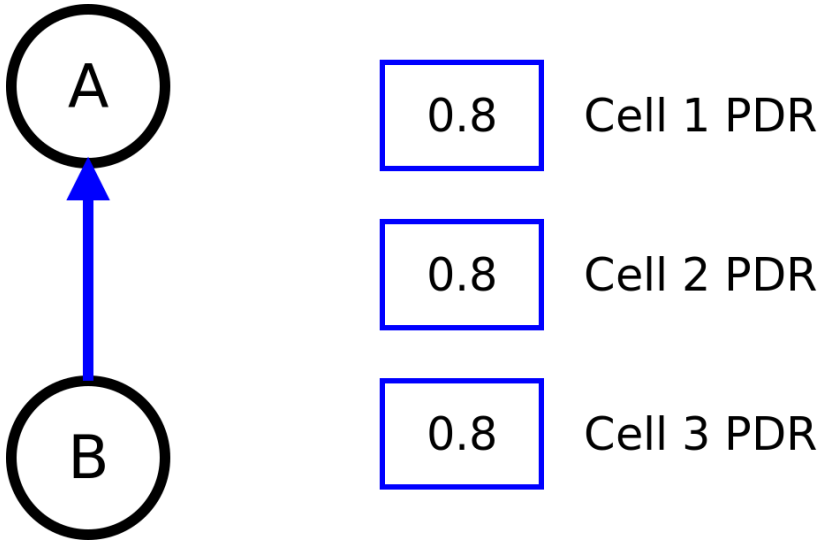

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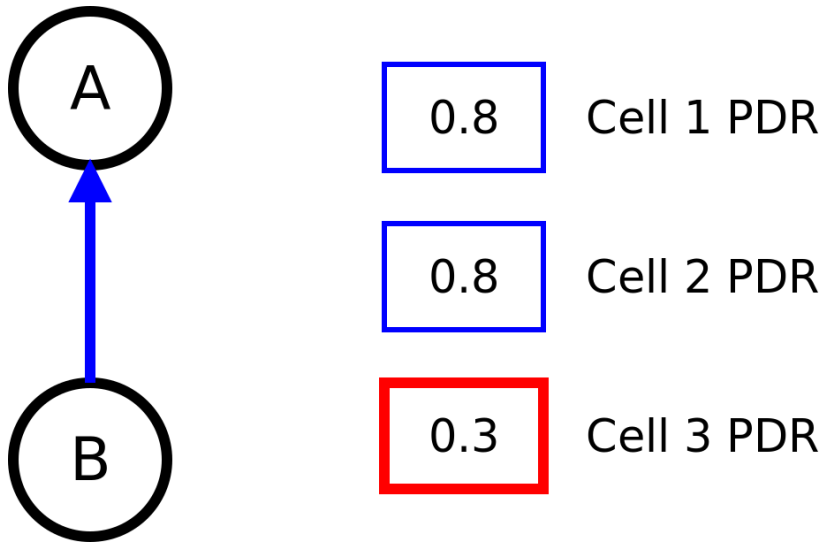

Project challenges & Objectives

Collision in Dedicated Cells

- Housekeeping approach and cell relocation.
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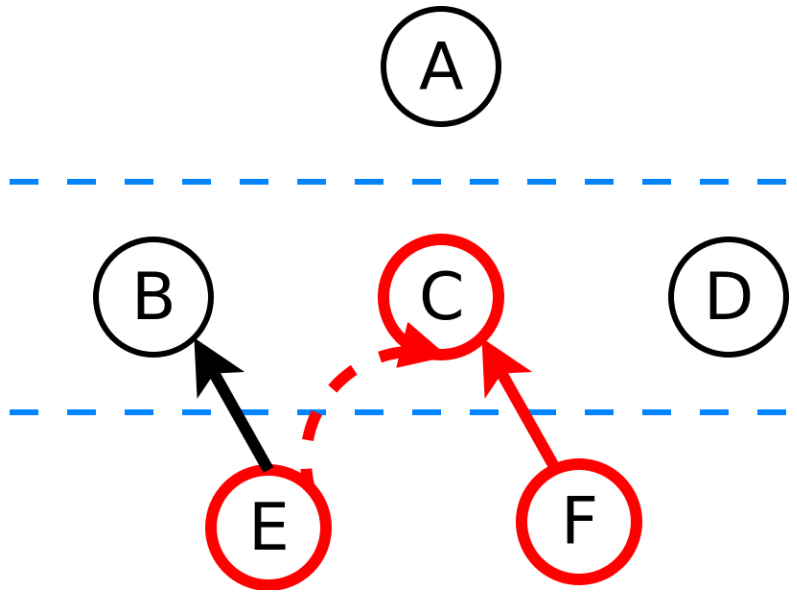
- Rx housekeeping.



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Collision in Dedicated Cells

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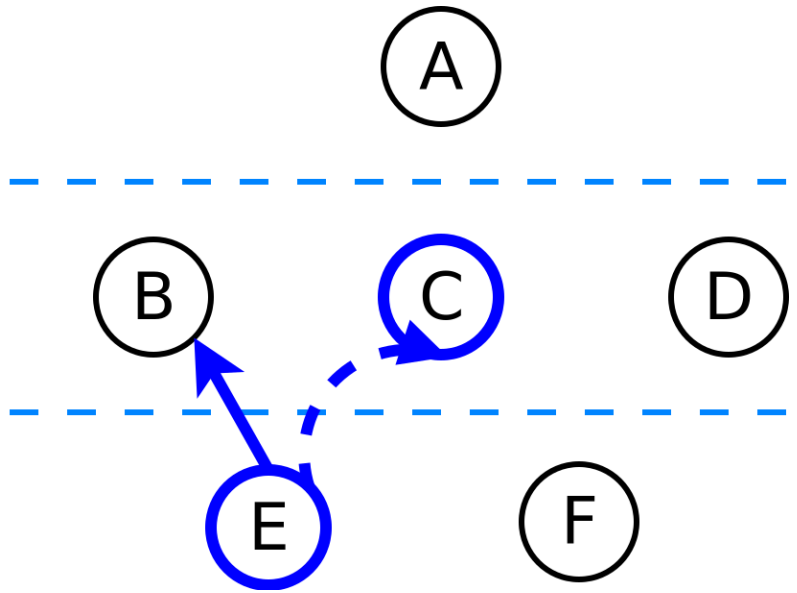
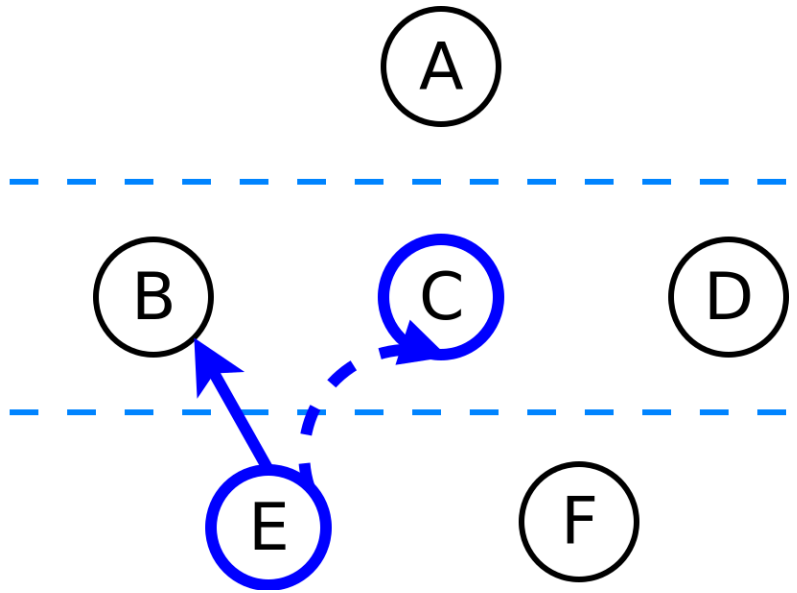


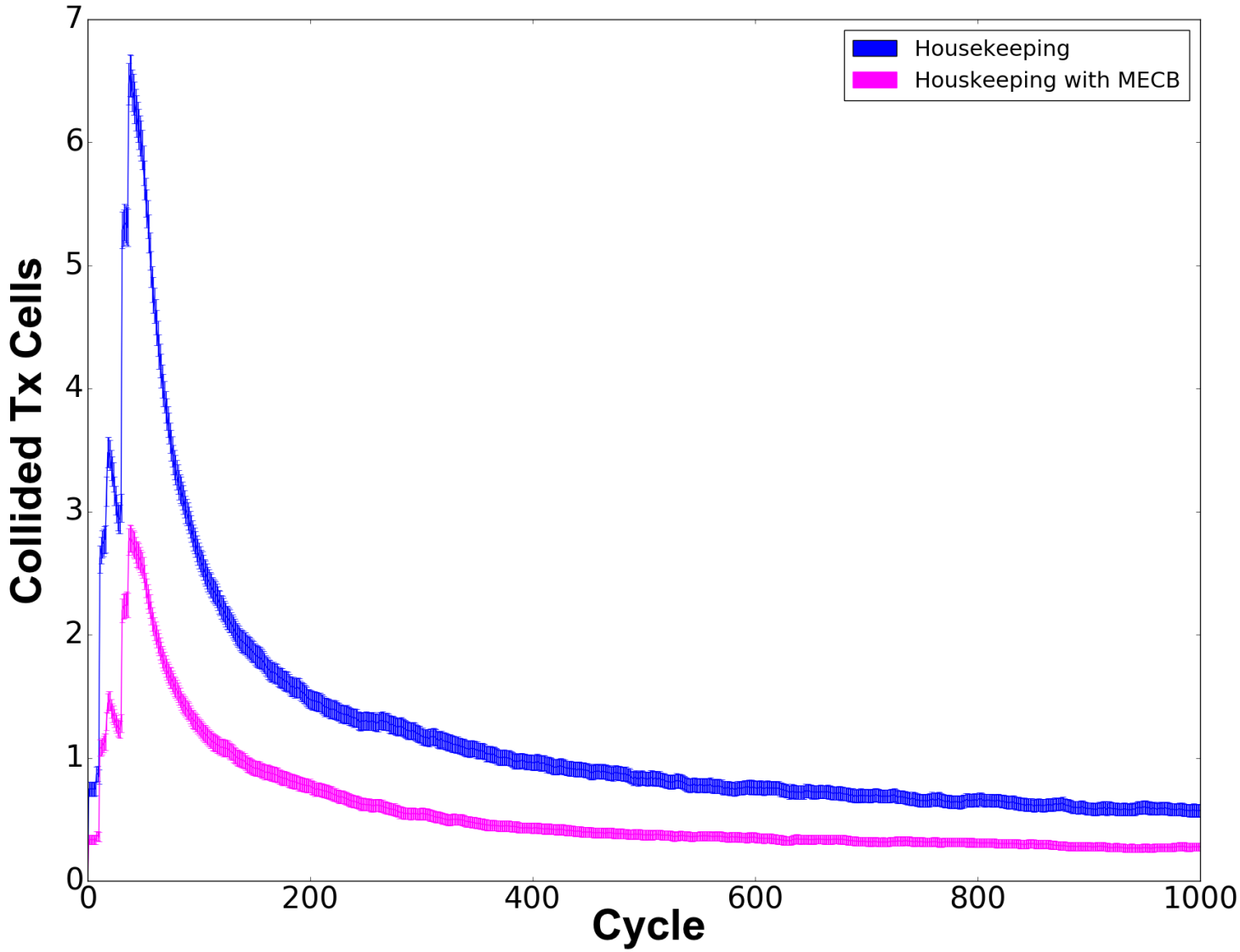
Project challenges & Objectives

Collision in Dedicated Cells

- Housekeeping approach and cell relocation.
- Tx housekeeping.
- Rx housekeeping.
- Dealing with collisions after they occur. Good idea ?



Comparison with Housekeeping



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.

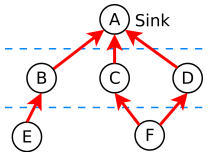
- Outlook
  - Our goal is to reach a place were we have collision free network, using more complex methods.
  - Our prespective in this project was work on 6top, but our next steps is to study the effects of traffic in the protocols performances.

General intoduction

IEEE802.15.4

Converge Cast Structure

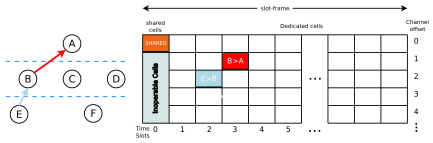
- Nodes radio ranges defines the neighborhood.
- Sink is selected.
- Packets are forwarded toward the sink.



IEEE802.15.4 Protocols

IEEE802.15.4e TSCH

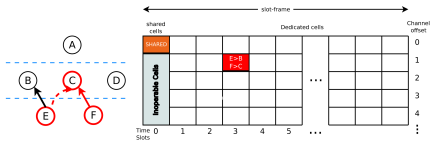
- IEEE802.15.4 defines the MAC and PHY layers.
- TSCH is an extension of the MAC layer of IEEE802.15.4.
- Time/Frequency multiplexing of the bandwidth.
- Shared cells.
- Dedicated cells.



Project challenges & Objectives

Collision in Dedicated Cells

- Collision free Dedicated Cells?
- No central entity in distributed approach.
- Neighbor nodes can select the same communication cell.
- Collision at the reception Node.
- Collision in terms of power, latency.



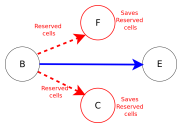
Using 6top Transaction

Why?

- Submitted in the shared slot.
- Contains the reserved cells.

How?

- The child node Sends an Add Request.
- The parent replies with the selected cells.
- The Neighbor nodes collects the reserved cells and save them.



Simulator Architecture

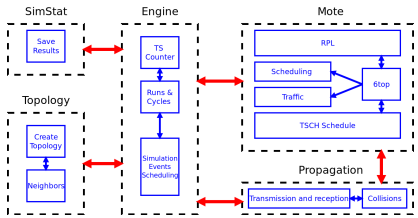


Figure: Simulator Architecture

Comparison with Housekeeping

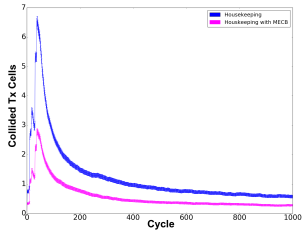


Figure: Simulation of the Number of Collided Tx Cells as Function of Cycle Number (Time) - comparison with the housekeeping approach

Thanks for your attention!
Questions?