

Collision Prevention in Distributed 6TiSCH Networks

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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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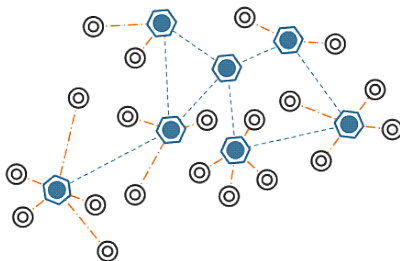
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Summary and Contributions

General Introduction

IoT & Wireless Sensor Networks

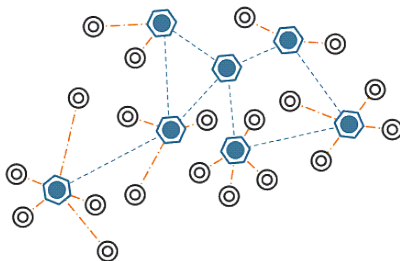
- ▶ Network technologies and IoT.



General Introduction

IoT & Wireless Sensor Networks

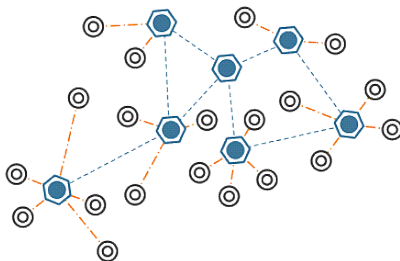
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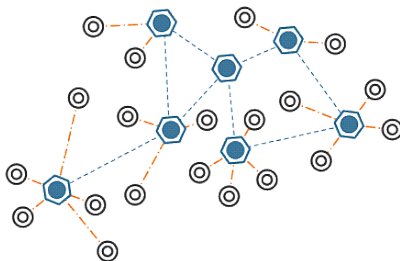
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- ▶ Low power consumption, low cost.



General Introduction

IoT & Wireless Sensor Networks

- ▶ Network technologies and IoT.
- ▶ WSN: standardization of IoT nodes communication.
- ▶ Low power consumption, low cost.
- ▶ IEEE802.15.4 one of the main standards of WSN.

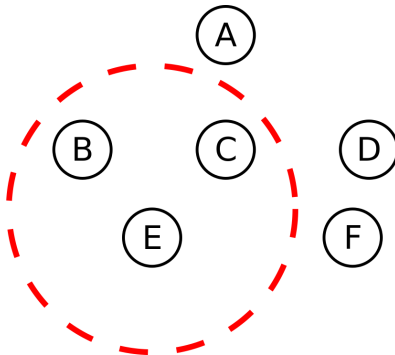


General introduction

IEEE802.15.4

Converge Cast Structure

- ▶ Nodes radio range defines the neighborhood.

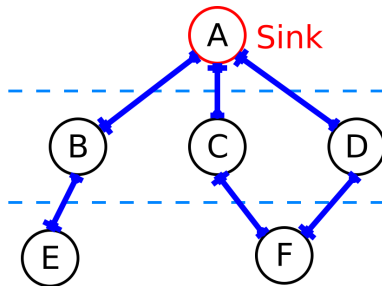


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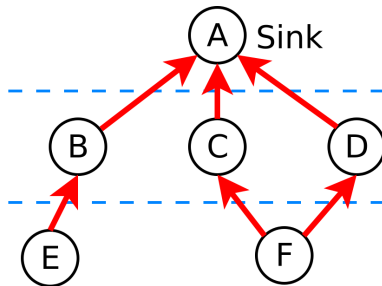


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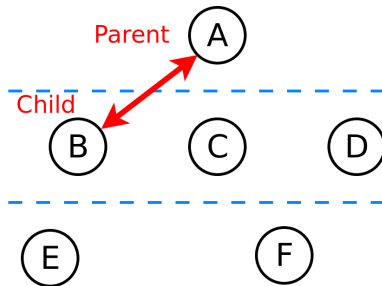


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Converge Cast Structure

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- ▶ Communication pairs.



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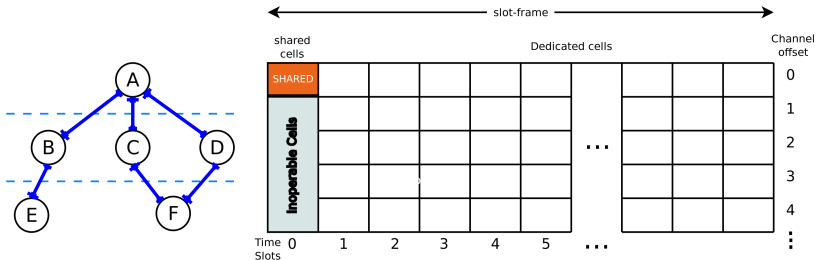
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Summary and Contributions

IEEE802.15.4 Protocols

IEEE802.15.4e TSCH

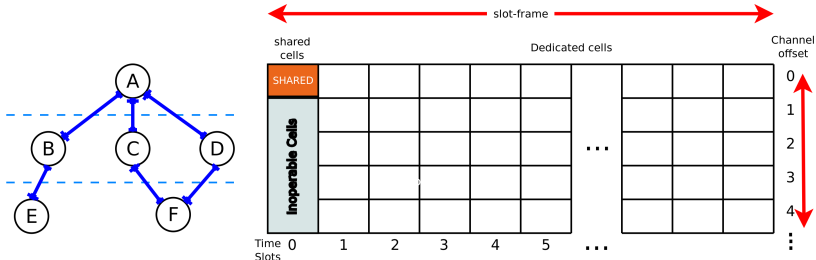
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IEEE802.15.4 Protocols

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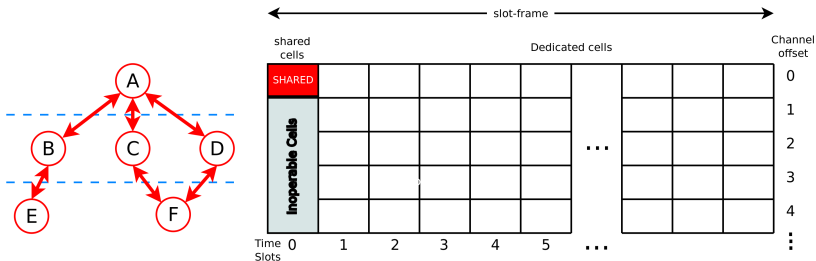
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IEEE802.15.4 Protocols

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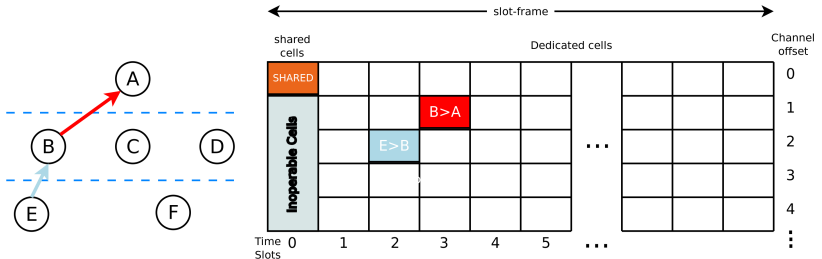
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- ▶ Shared cells/Dedicated cells..



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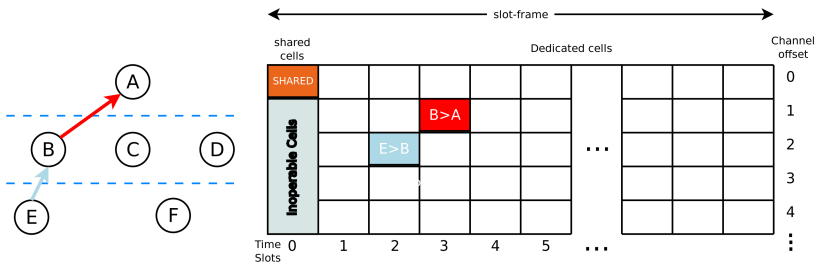
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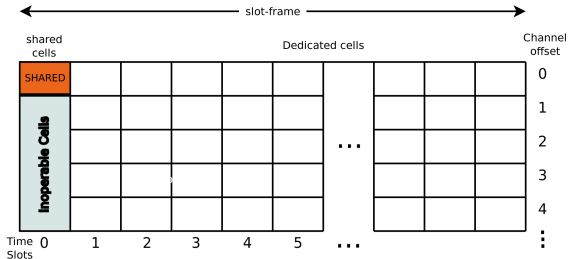
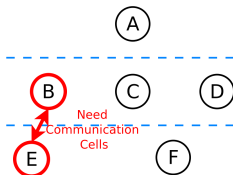
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- ▶ TSCH is an extension of the MAC layer of IEEE802.15.4.
- ▶ Time/Frequency multiplexing of the bandwidth.
- ▶ Shared cells/Dedicated cells..
- ▶ 6TiSCH operation sublayer 6top will manage the TSCH.



IEEE802.15.4 Protocols

Cell Reservation Process

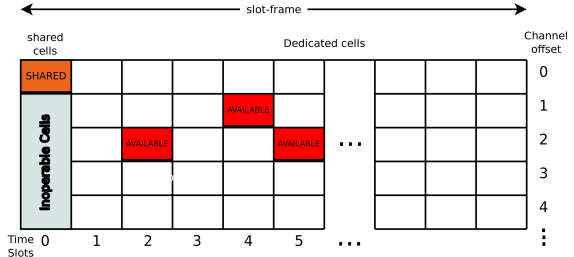
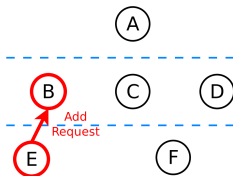
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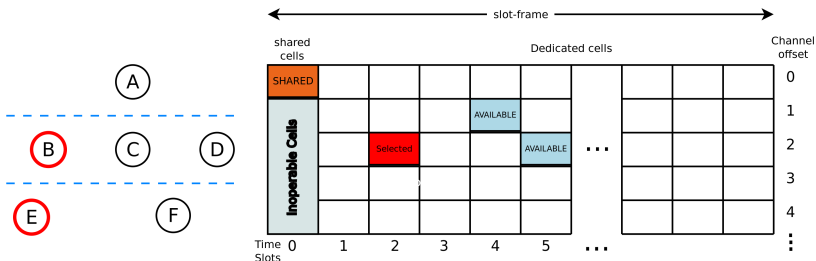
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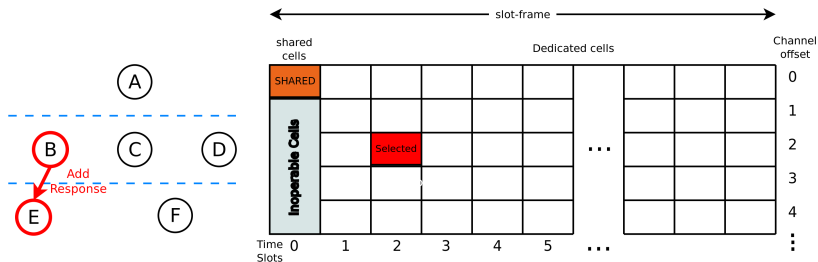
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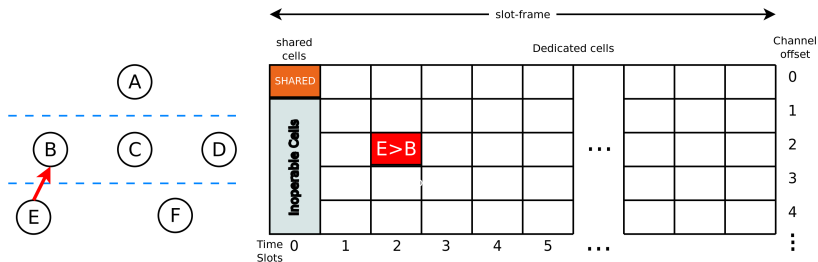
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Cell Reservation Process

1. Scheduling function decides new cell should be assigned.
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4. Parent node replies with an Add response.
5. Cell is added and communication start.



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Simulator

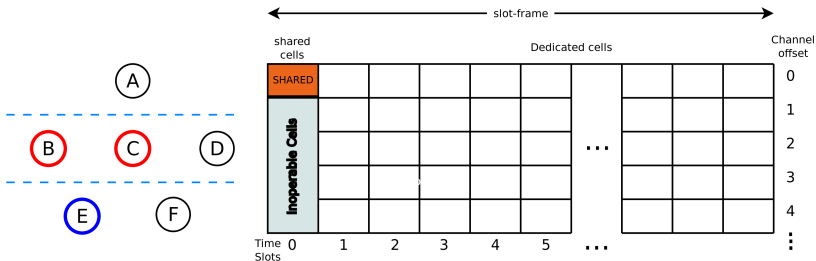
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Collision in Dedicated Cells

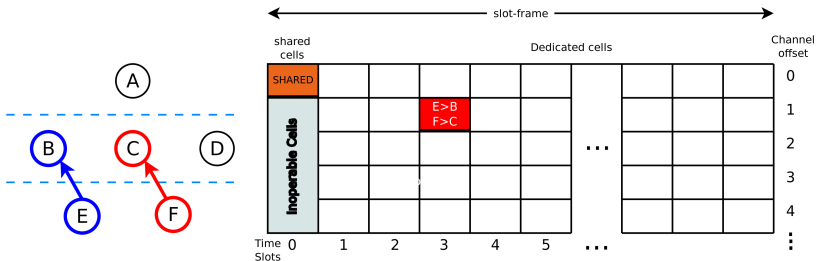
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- ▶ Neighbor nodes can select the same communication cell.



Project challenges & Objectives

Collision in Dedicated Cells

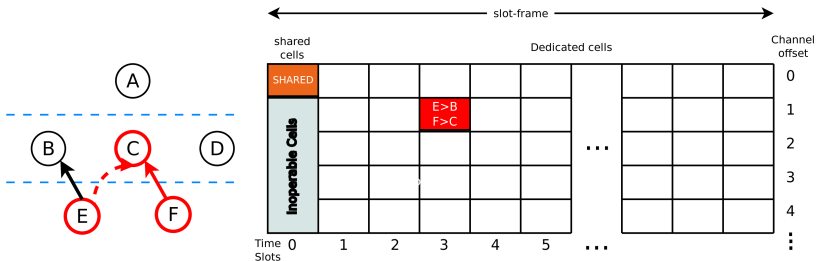
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Project challenges & Objectives

Collision in Dedicated Cells

- ▶ Collision free Dedicated Cells?
- ▶ Neighbor nodes can select the same communication cell.
- ▶ Collision at the reception Node.



Project Objectives

- ▶ Reducing the collisions in TSCH dedicated cells.

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- ▶ Modifying the Cell reserving process without introducing new overhead on the network

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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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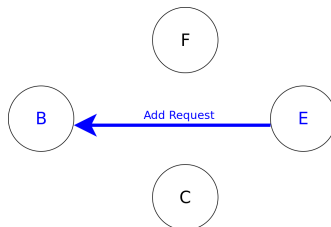
Using 6top Transaction

Why?

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

How?

- ▶ The child node Sends an Add Request.



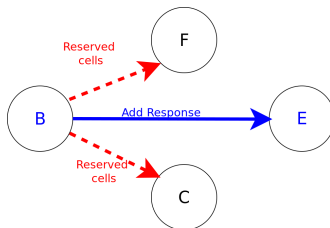
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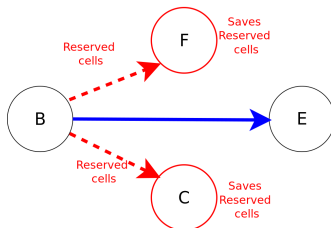
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Why?

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How?

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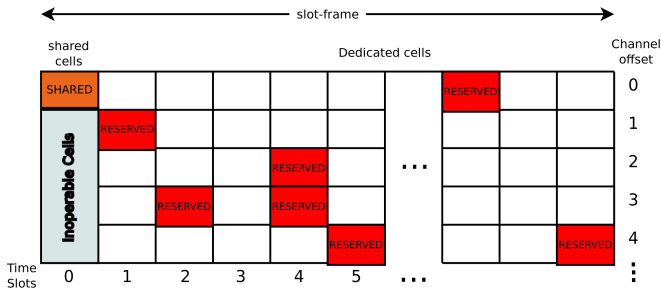
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Avoid Table structure and functioning

Avoid Table

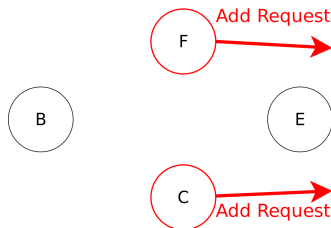
- ▶ The cells reserved by neighbors will be saved by a structure similar to TSCH table.



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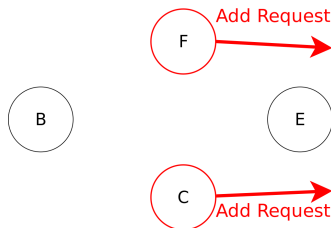
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- ▶ Scheduling function will avoid selecting cells found in this structure.



Avoid Table structure and functioning

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- ▶ The cells reserved by neighbors will be saved by a structure similar to TSCH table.
- ▶ Scheduling function will avoid selecting cells found in this structure.
- ▶ 6top will manage this table.



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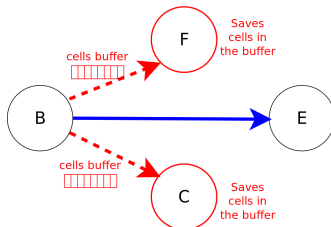
Cell Buffer

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.



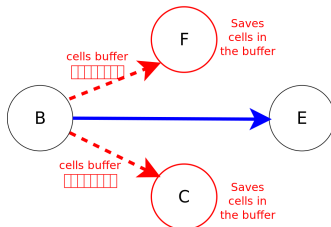
Cell Buffer

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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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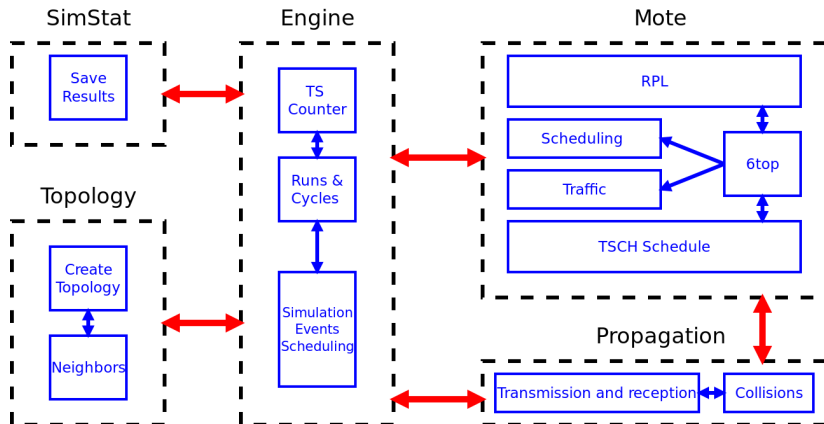
Simulator and Results

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Summary and Contributions

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 × 1Km
Topology constraint	≥ 3 neighbors with PDR 50 %
Radio sensitivity	−97 dBm
Radio range	100m
Traffic	1 packet/node each 10 cycles

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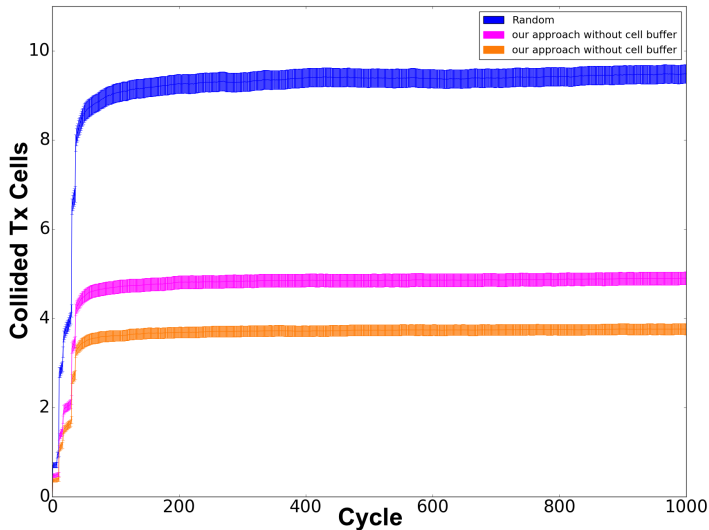
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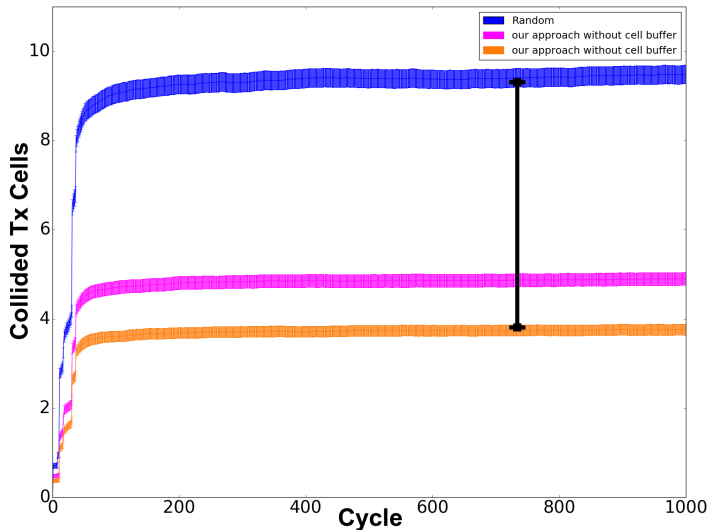
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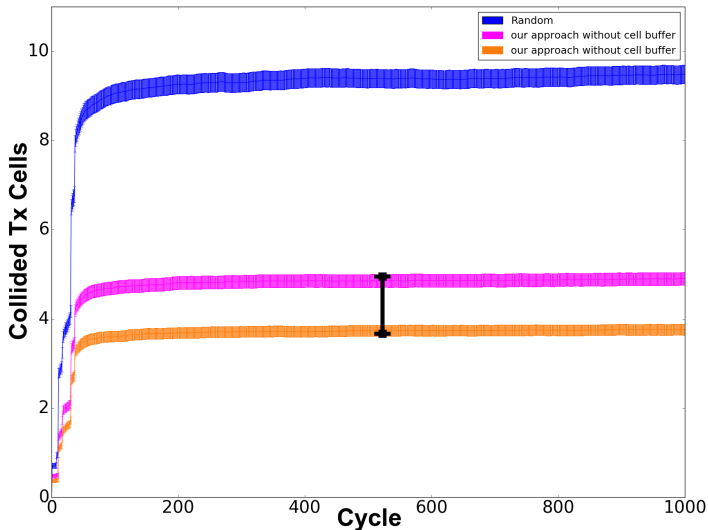
Comparison with random scheduling



Comparison with random scheduling



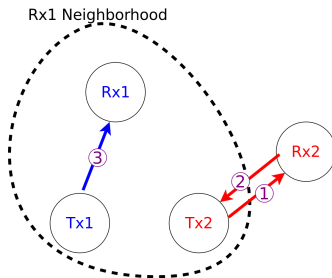
Comparison with random scheduling



Results

Collision reasons

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



Housekeeping Approach

Collision in Dedicated Cells

- ▶ Housekeeping approach and cell relocation.
- ▶ Tx housekeeping.



Cell 1 PDR



Cell 2 PDR

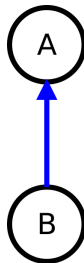


Cell 3 PDR

Housekeeping Approach

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0.8

Cell 1 PDR

0.8

Cell 2 PDR

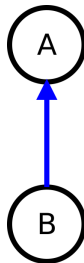
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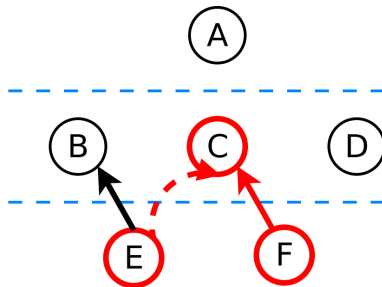
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Housekeeping Approach

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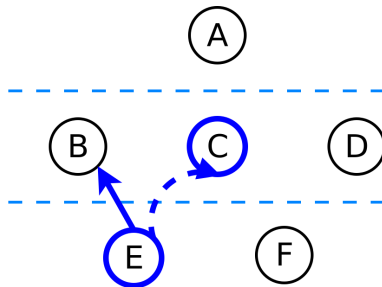
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Housekeeping Approach

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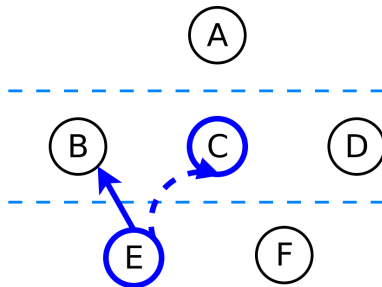
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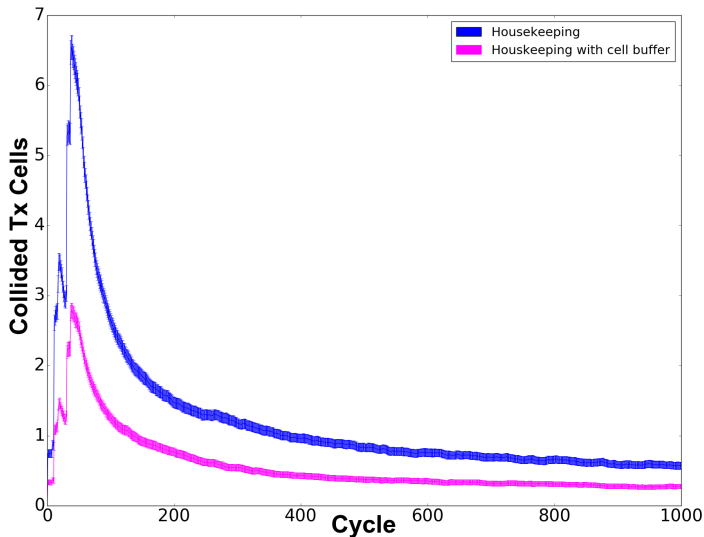
Housekeeping Approach

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.
- ▶ 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.

Contributions

- ▶ Understanding the simulator code.
- ▶ Optimizing, and implementing on top of this code.
- ▶ Designing the proposed mechanisms, and enhancing them.
- ▶ Publishing a poster in Computational sciences days in Grenoble, organized by LabEx PERSYVAL-Lab.
- ▶ Submitting a paper to Wimob 2017 conference.



General introduction

IEEE802.15.4

Converge Cast Structure

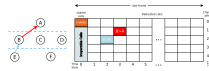
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IEEE802.15.4e TSCH

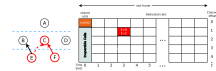
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- Time/Frequency multiplexing of the bandwidth.
- Shared cells.
- Dedicated cells.



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.
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How?

- The child node Sends an Add Request.
- The parent replies with the selected cells.
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Simulator Architecture

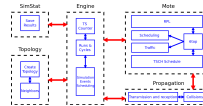


Figure: Simulator Architecture

Comparison with Housekeeping

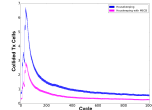


Figure: Simulation of the Number of Collided Tx Cells as Function of Cycle Number (Time) - comparison with the housekeeping approach

Thanks for your attention!
Questions?

IEEE802.15.4 Protocols

6TiSCH

- ▶ IEEE802.15.4 left the management of TSCH for other Protocols.

IEEE802.15.4 Protocols

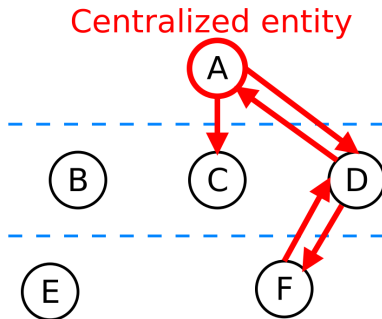
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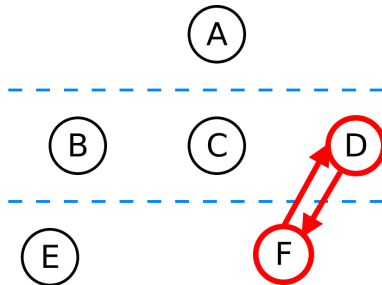
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 - ▶ Centralized algorithm.



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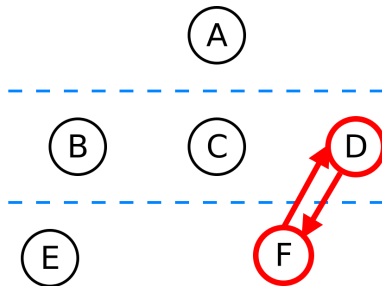
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 - ▶ Centralized algorithm.
 - ▶ Distributed algorithm.
- ▶ 6top contains:
 - ▶ 6top transactions.



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6TiSCH

- ▶ IEEE802.15.4 left the management of TSCH for other Protocols.
- ▶ 6TiSCH offered the integration of TSCH over IPv6.
- ▶ 6TiSCH operation sublayer (6top) offered the management of TSCH:
 - ▶ Centralized algorithm.
 - ▶ Distributed algorithm.
- ▶ 6top contains:
 - ▶ 6top transactions.
 - ▶ Scheduling function.

