

# 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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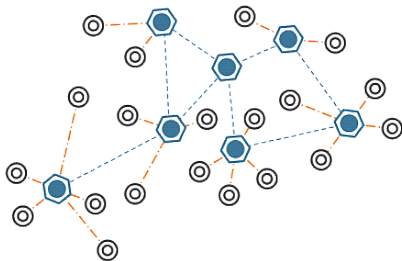
- Results

## Summary and Contributions

# General Introduction

## IoT & Wireless Sensor Networks

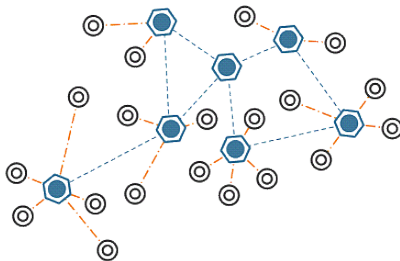
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# General Introduction

## IoT & Wireless Sensor Networks

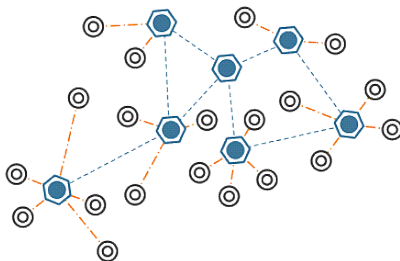
- ▶ Network technologies and IoT.
- ▶ WSN: standardization of IoT nodes communication.



# General Introduction

## IoT & Wireless Sensor Networks

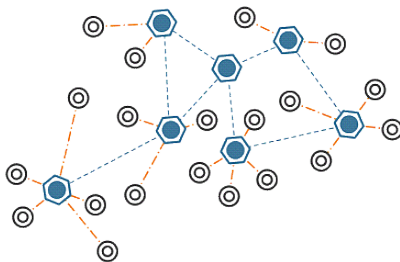
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# General Introduction

## 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.

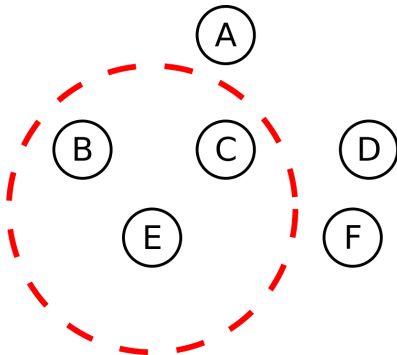


# General introduction

IEEE802.15.4

## Converge Cast Structure

- Nodes radio range defines the neighborhood.



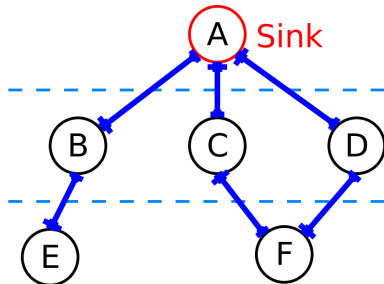


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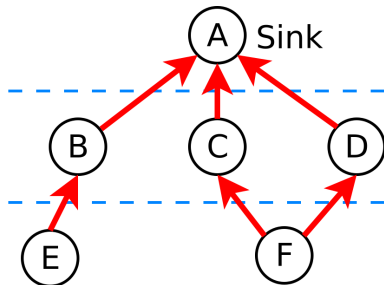


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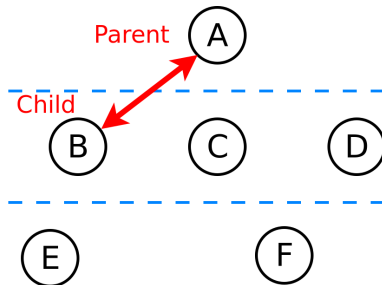


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- ▶ Packets are forwarded toward the sink.
- ▶ Communication pairs.



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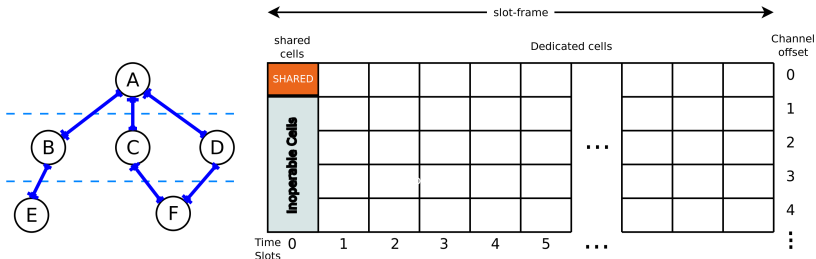
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## Summary and Contributions

# IEEE802.15.4 Protocols

## IEEE802.15.4e TSCH

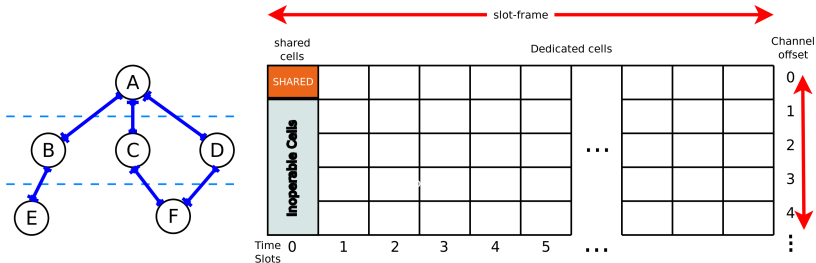
- ▶ IEEE802.15.4 defines the MAC and PHY layers.
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# IEEE802.15.4 Protocols

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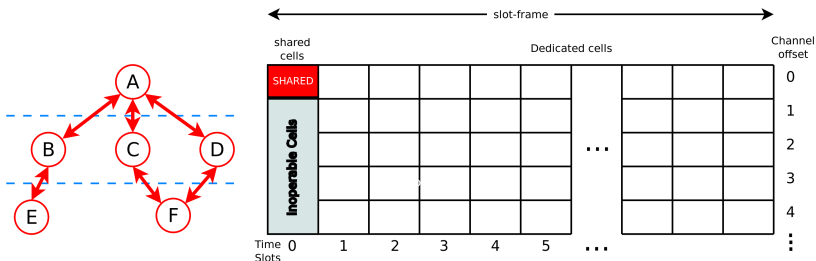
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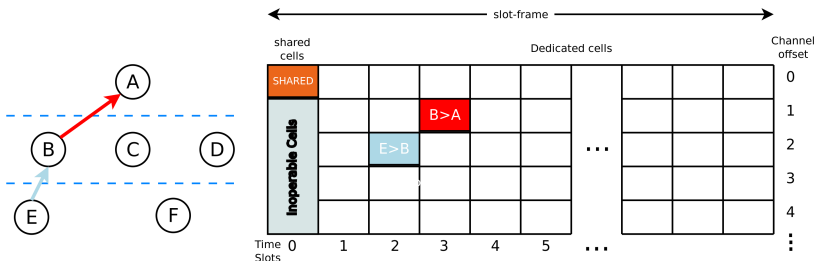
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- ▶ Shared cells/Dedicated cells..



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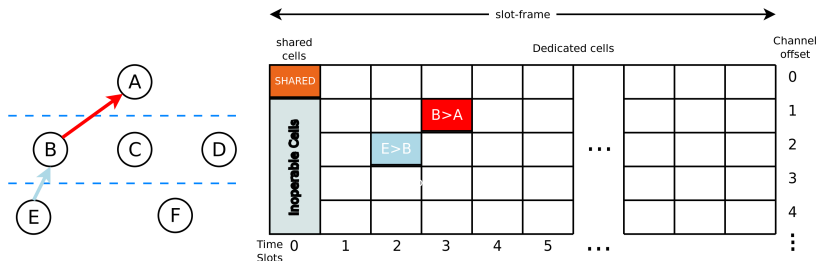




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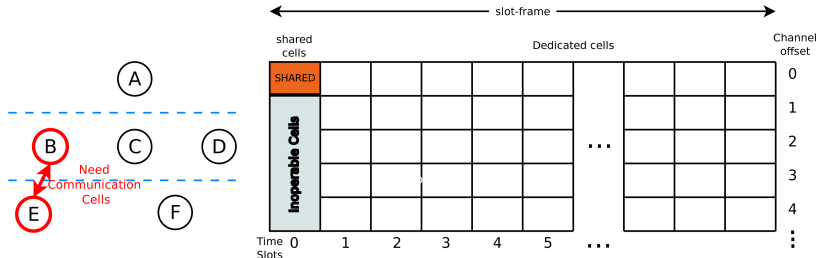
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- ▶ Shared cells/Dedicated cells..
- ▶ 6TiSCH operation sublayer 6top will manage the TSCH.



# IEEE802.15.4 Protocols

## Cell Reservation Process

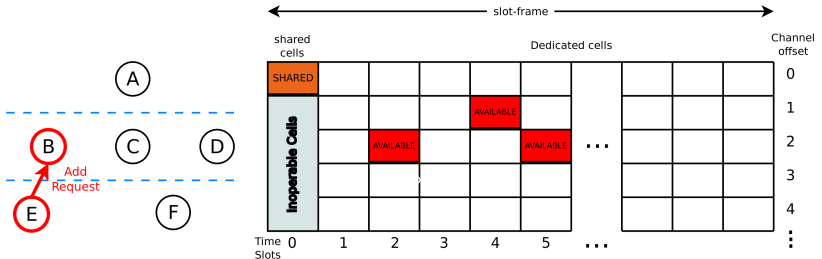
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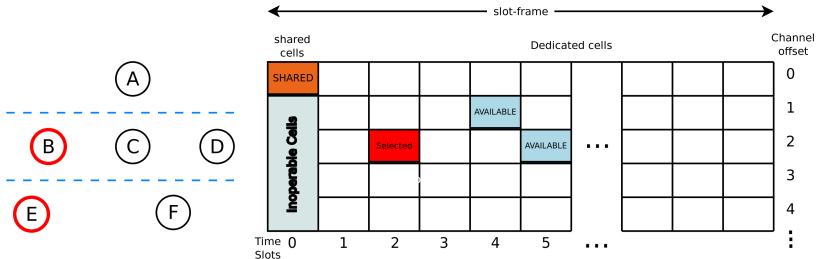
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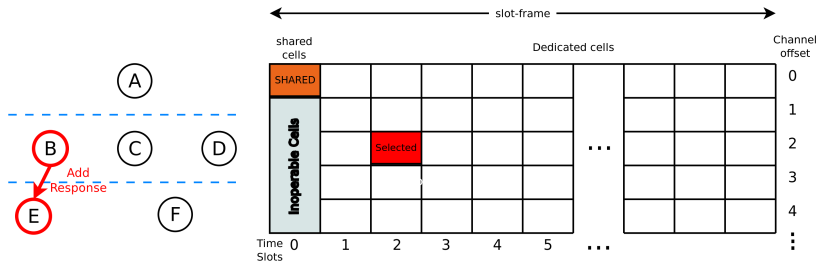
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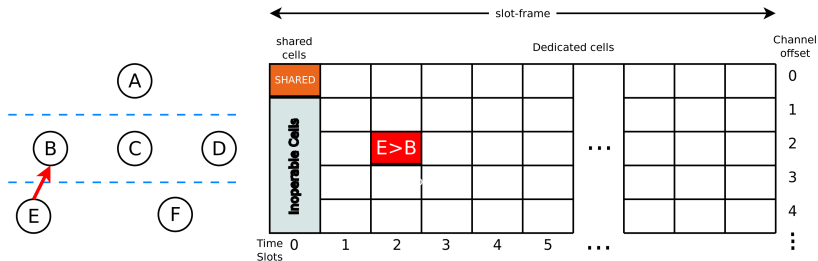
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2. Child node sends an Add request.
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4. Parent node replies with an Add response.
5. Cell is added and communication starts.



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- Project challenges & Objectives

## Proposed Mechanism

- Using 6top Transaction

- Avoid Table

- Cell Buffer

## Simulator and Results

- Simulator

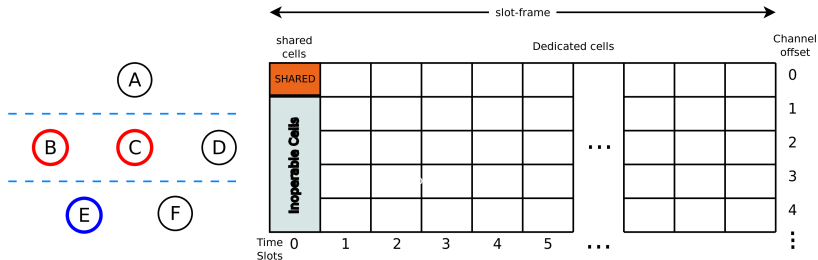
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# Project challenges & Objectives

## Collision in Dedicated Cells

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

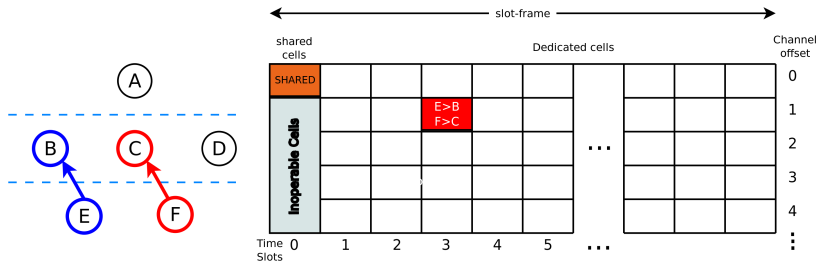




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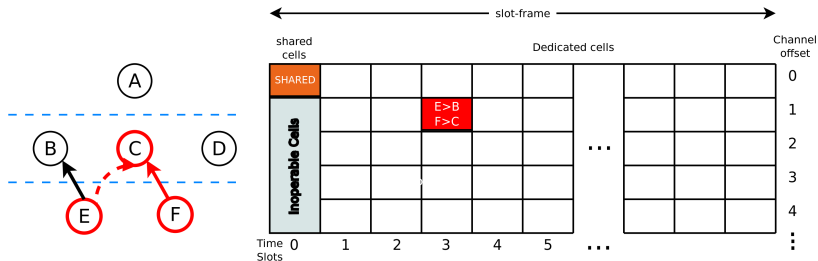
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# Project challenges & Objectives

## 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
- ▶ Creating a flexible mechanism, compatible with all scheduling functions

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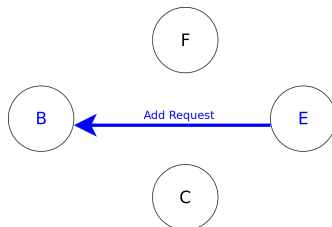
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## Why?

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

## How?

- ▶ The child node Sends an Add Request.



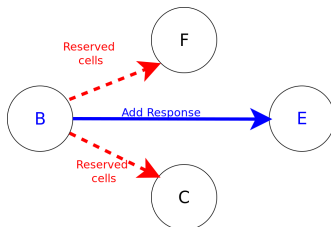
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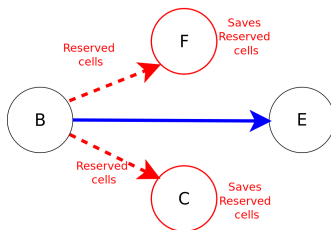
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- ▶ Submitted in the shared slot.
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## How?

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



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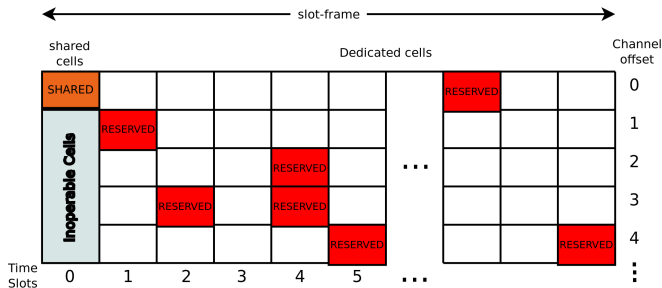
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# Avoid Table structure and functioning

## Avoid Table

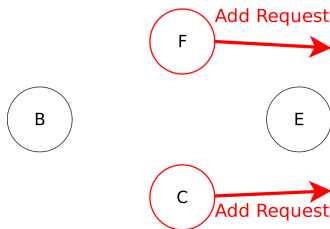
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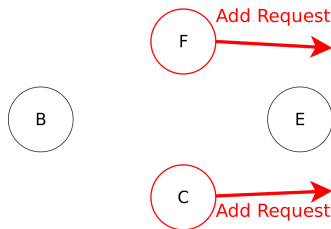
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- ▶ Scheduling function will avoid selecting cells found in this structure.



# Avoid Table structure and functioning

## Avoid Table

- ▶ 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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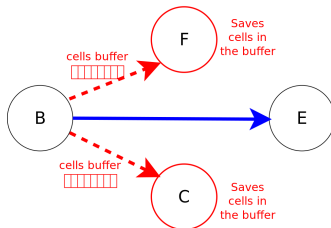
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## Why?

- ▶ 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



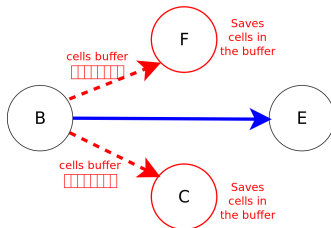
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## How?

- ▶ 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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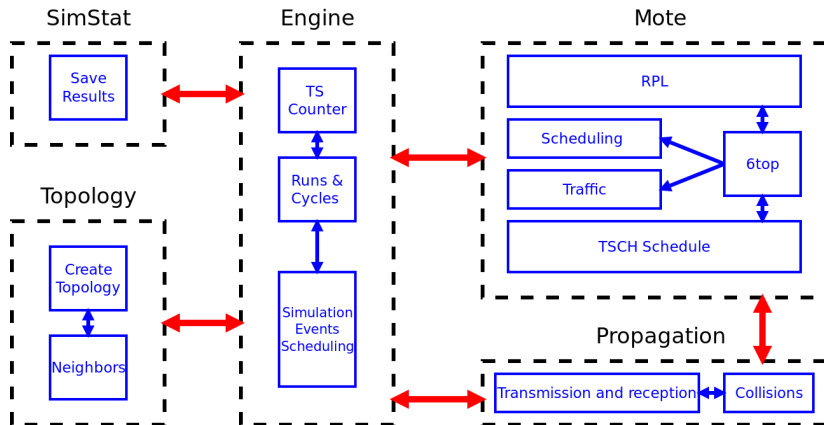
## Simulator and Results

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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 $\times$ 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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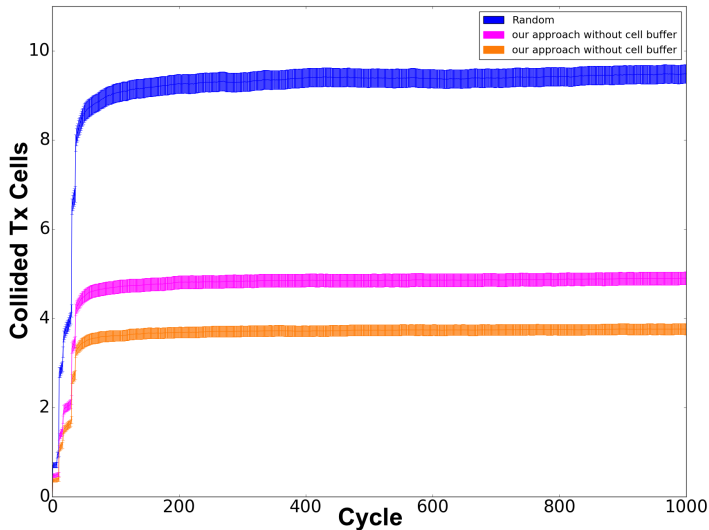
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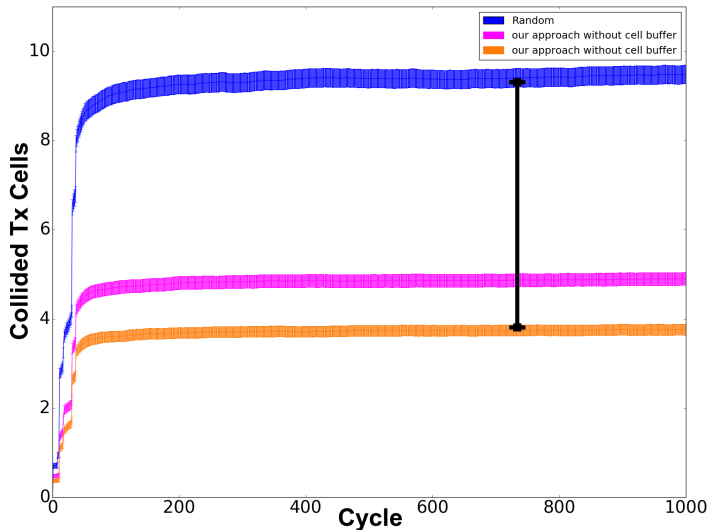
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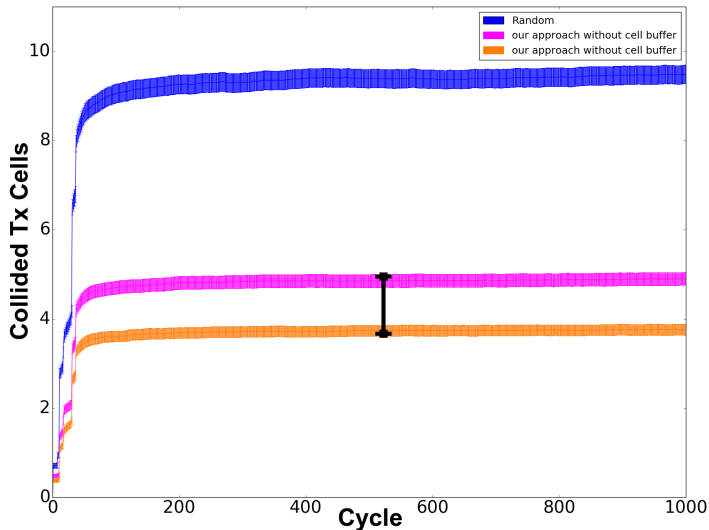
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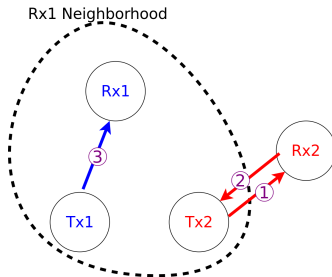
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# Results

## Collision reasons

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

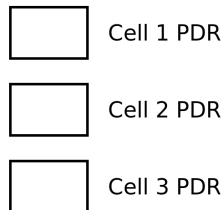
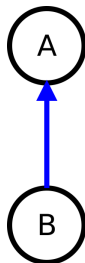




# Housekeeping Approach

## Collision in Dedicated Cells

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



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0.8

Cell 1 PDR

0.8

Cell 2 PDR

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Cell 3 PDR

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0.8

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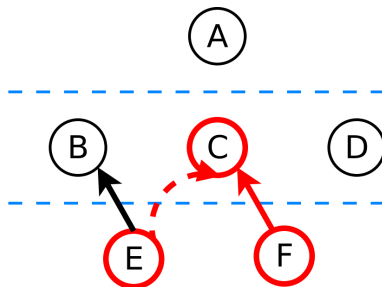
0.3

Cell 3 PDR

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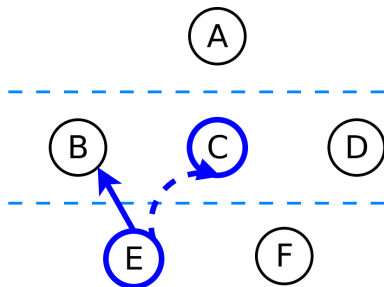
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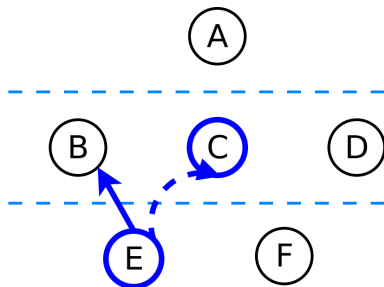
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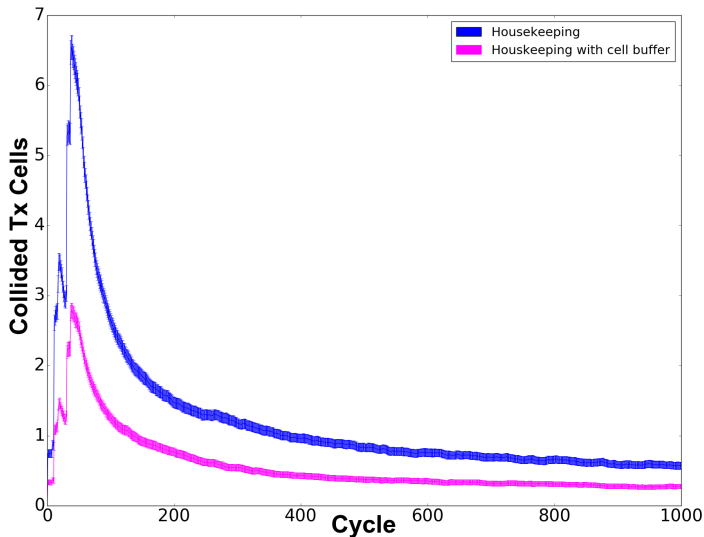
# Housekeeping Approach

## 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

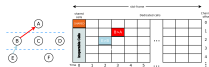
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- Time/Frequency multiplexing of the bandwidth.
- Shared cells/Dedicated cells.
- 6TiSCH operation sublayer 6top will manage the TSCH.



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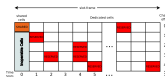
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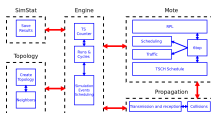
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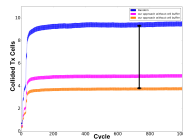
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## Simulator Architecture



## Comparison with random scheduling



Thanks for your attention!

Questions?

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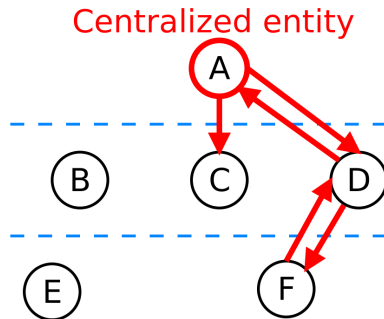
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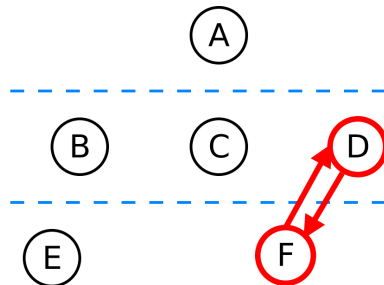
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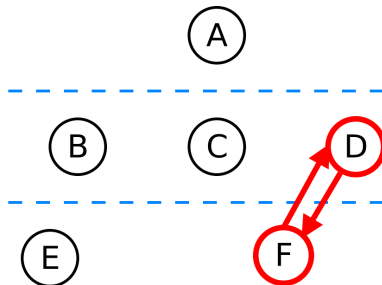
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  - ▶ Distributed algorithm.
- ▶ 6top contains:
  - ▶ 6top transactions.



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- ▶ 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.

