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NEW MONITORING STRATEGIES USING MASSIVE IOT

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SOMMAIRE

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1. CITER DES ARTICLE D UN POINT DE VUES DE PHRASES

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MONITORING SOLUTIONS : CONTEXT

One sensor approach

- **One precise sensor** with known characteristics, connected by **energy sources**

-One problem = one development
-Costly
-Not scalable over time

Few sensors approach

- **Battery powered sensors** with known location on wireless network

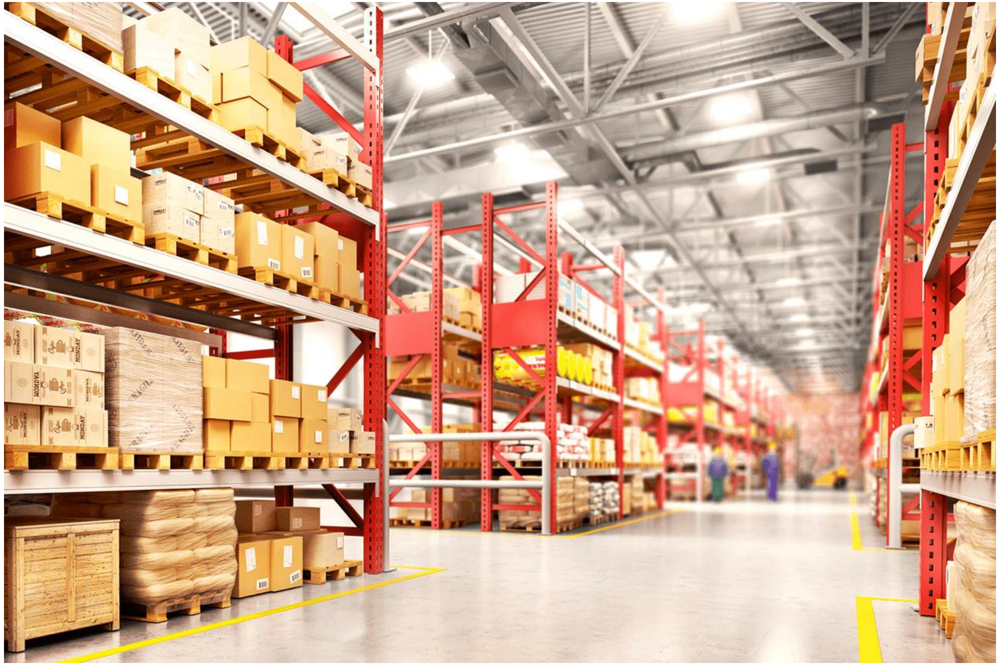
-Deployment cost
-Not scalable over time

Massive IoT approach

- Massive number of miniature **battery-powered** sensors transmitting **on a constraint network**

-Solution for many problem
-Low deployment cost
-versatile

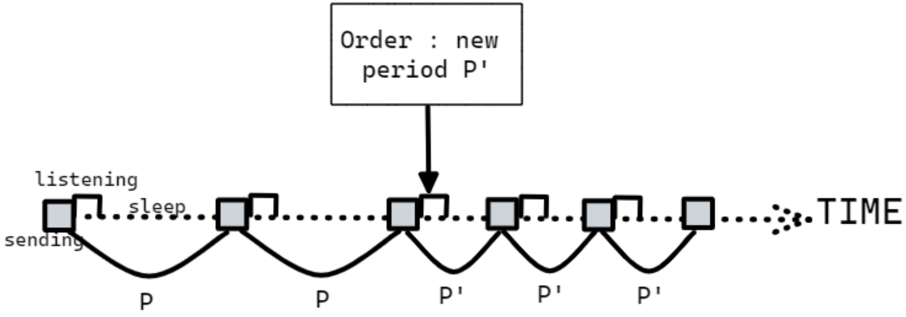
EXAMPLE



HYPOTHESES

Sensor and network assumptions

- The sensors emit **messages periodically**; in **sleep mode** most of the time; after each emission, opening of a **listening window to redefine the emission period**
- **Battery powered**, they consume energy over time, mainly during transmission.
- They **enter and leave the environment** without warning, and **we don’t know their position**



OBJECTIVES

Monitor an average physical quantity: temperature, humidity, CO2

- Tracking quality: various sensors send messages from the environment
- Efficiency in resource management: messages are sent by the group of sensors in an **optimal way**

- **Dynamic management** of sensor inputs and outputs
- robustness to the hazards of the **constrained network**

FRAMEWORK FOR THE FIRSTS SOLUTIONS

Monitoring solution = f **period update function** that redefines or does not the transmission period of a sensor that has just transmitted.

Metrics:

- Quality measure - **diversity** = number of pieces of **information from different sources**, weighted by their **relevance over time**.
  - Depletion function D(x)=e^(-x/T), x is the age of the data
- Energy efficiency
  - **Number of sensor emissions**
  - **Number of period change orders**

OVERALL IDEA ABOUT THE FIRST PROPOSED STRATEGIES

VERSATILITY - Want to keep the **diversity stable** when there is a change in the sensor field

→ No matter how many sensors are present, we want to keep a **constant amount of messages sent**.
We define τ the average time between two received messages, so that we receive $1/\tau$ messages per unit time no matter how many sensors are active.

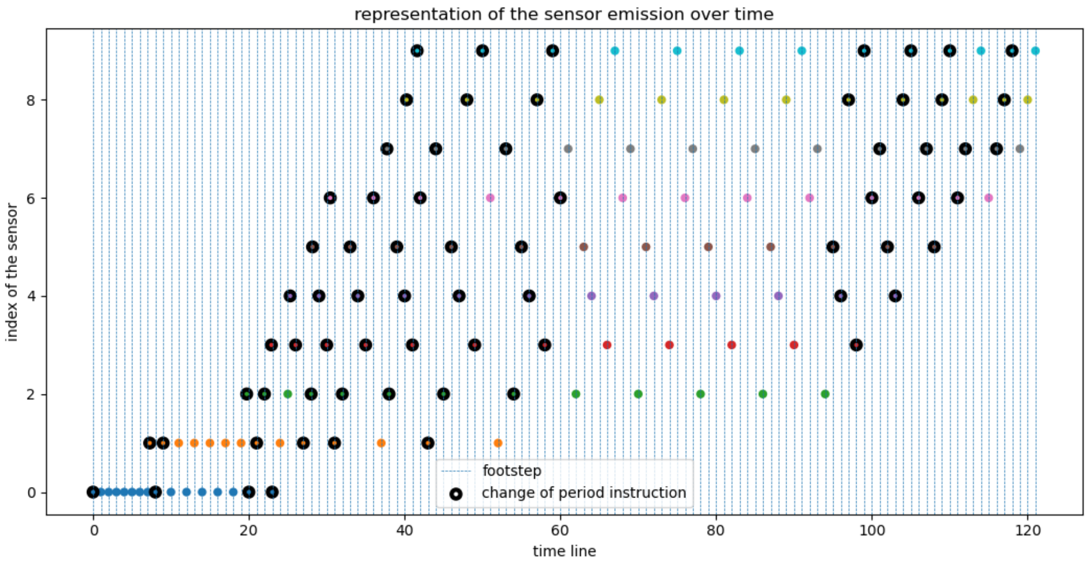
1ST APPROACH : PERIODIC ROUND-ROBIN

Additional constraint: receive messages at a **strictly regular rhythm**

Method: have all the sensors emit in turn, spaced by τ

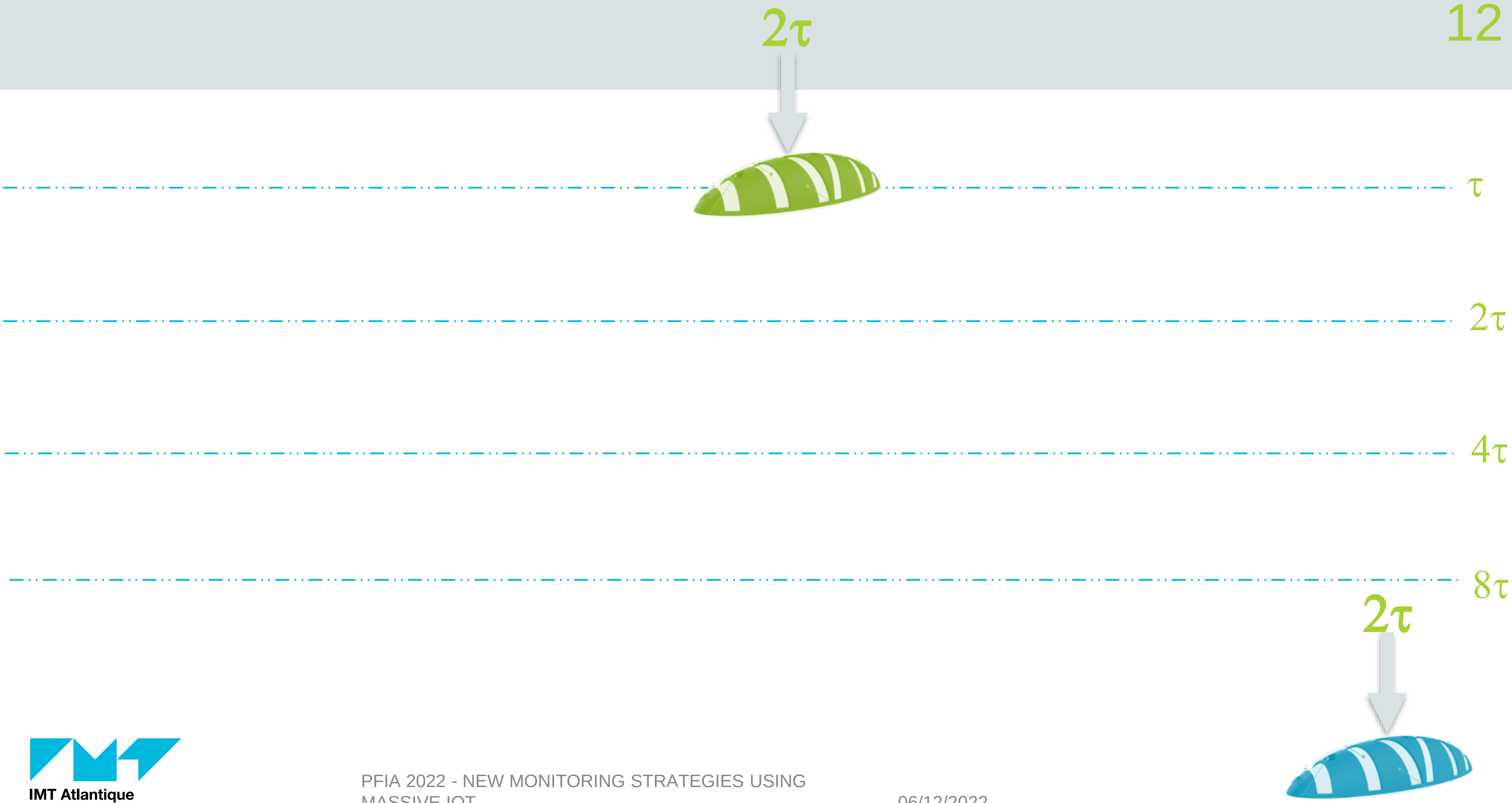
Définition 4. *We define the period update function, denoted $f_{1,\tau}$, by:*

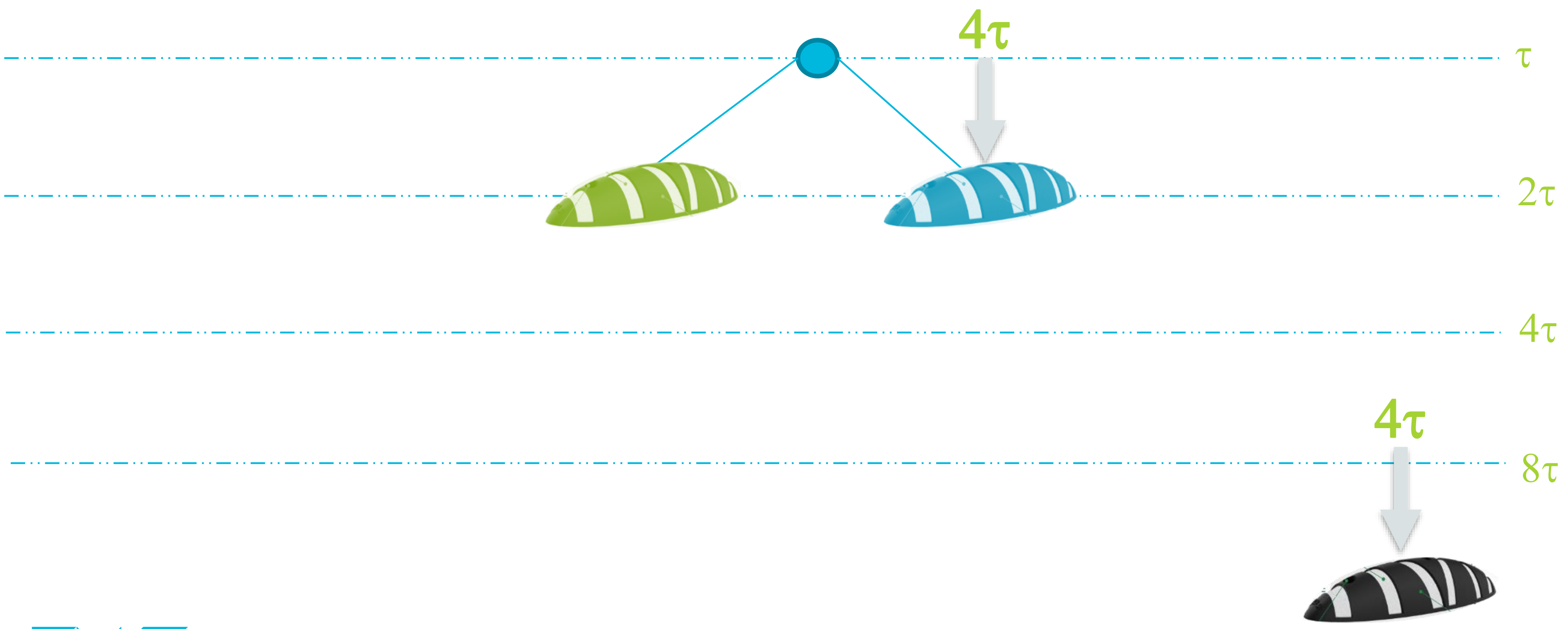
$$f_{1,\tau}(H_t) = \begin{cases} \tau|\Pi(t)| - (t - t_0)\%\tau & \text{if first message received from that sensor} \\ \tau|\Pi(t)| & \text{otherwise} \end{cases} \quad (8)$$



2ND APPROACH : 2-LEVEL ROUND-ROBIN

Method: The emissions are distributed among all the sensors, while reducing the number of period changes.


2τ
τ
2τ
4τ
8τ
2τ


4τ
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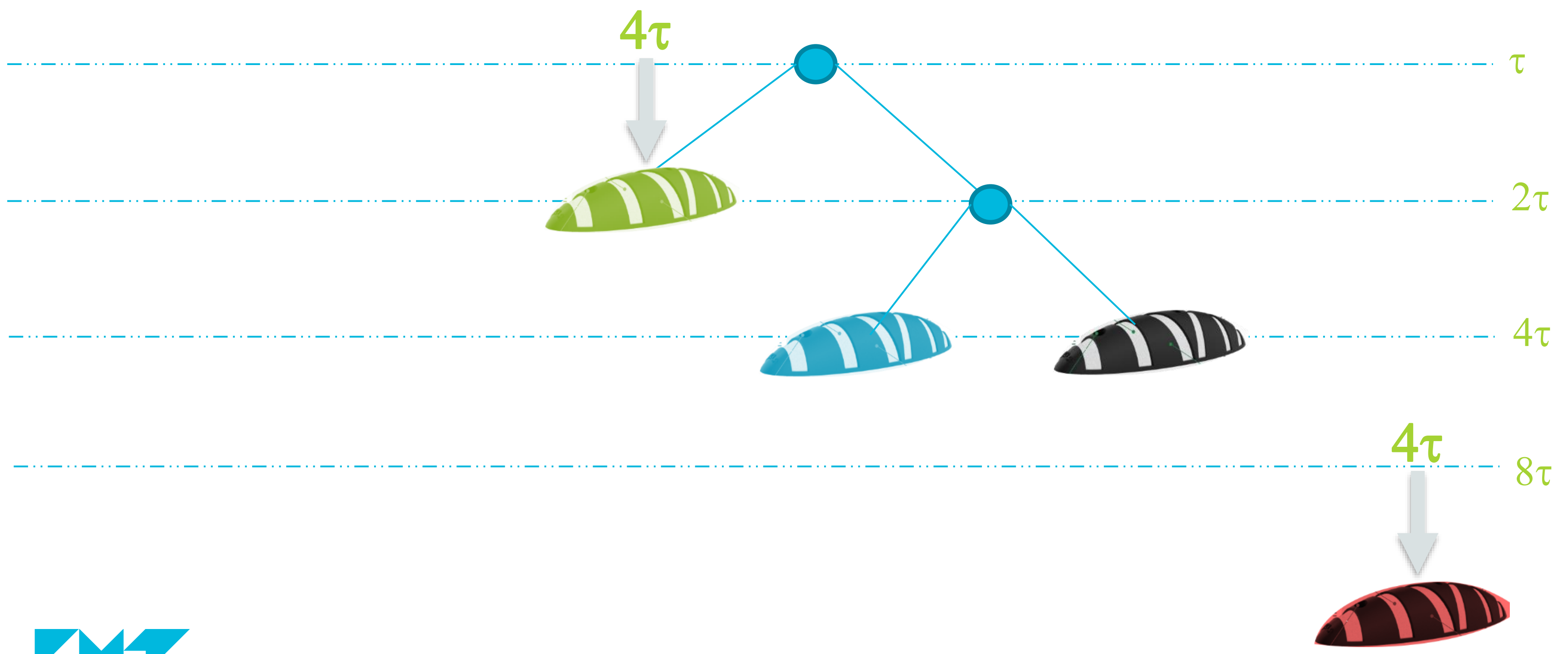
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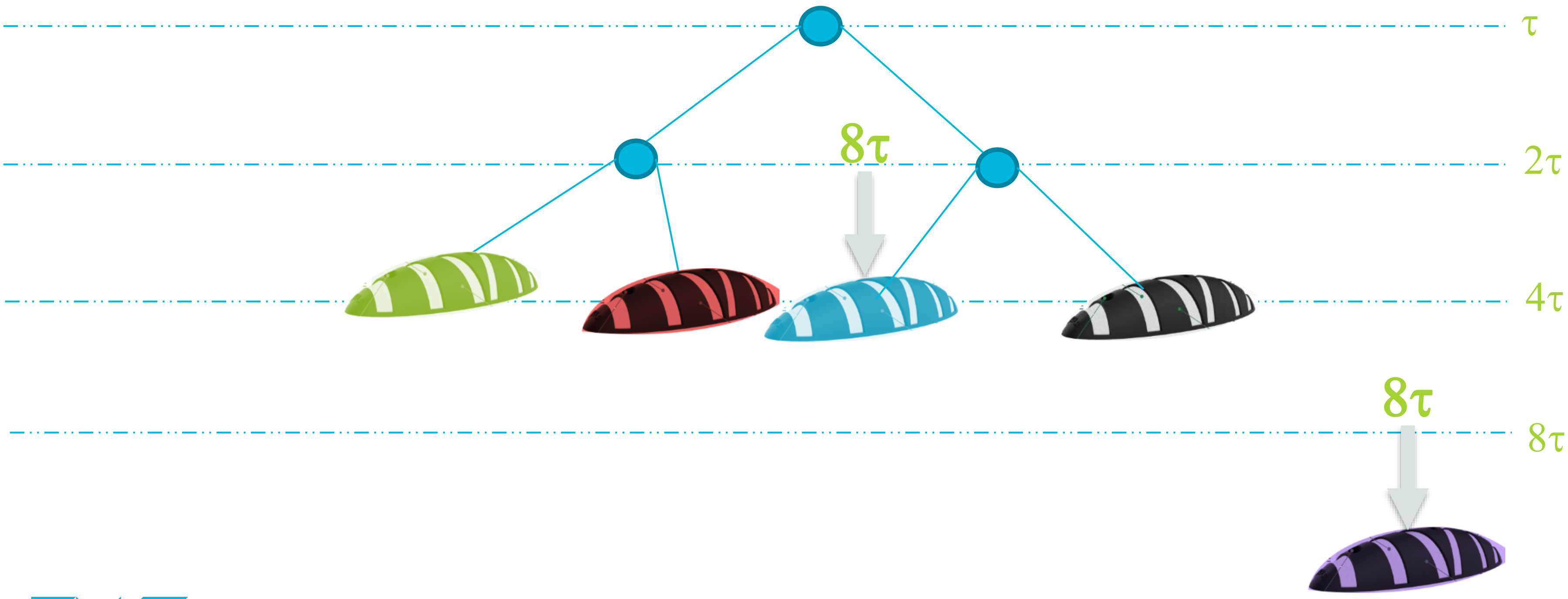
τ
2τ
4τ
8τ
8τ
8τ

2ND APPROACH : 2-LEVEL ROUND-ROBIN

Definition 2. *We define the period update function, denoted $f_{2,\tau}$, that for a sensor i represented at depth d_i in the binary tree is:*

$$f(H) = 2^{d_i}\tau \qquad (1)$$

Properties:

-The **time between two receptions is** on average τ

-Emissions are distributed among all the sensors

-The **management cost** when the sensor field is changed is **minimal** :

2 emission period definitions when a sensor enters

1 or 2 emission period definitions when a sensor leaves

EVALUATION OF THE STRATEGIES

- **Round-robin methods are better than "static" methods**, which do not adapt the emission period of the sensors when the field is modified.

- **2-level round-robin minimizes the number of sensor period changes** when the field is modified, while guaranteeing high message diversity

CURRENT WORK AND PERSPECTIVES

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CURRENT WORK

Sensors are deployed in an environment, looking at a **spatial physical quantity**.
We want to identify phenomena in the environment and follow them.

Objective: save energy by managing the emissions of the sensors

→ **Solution:** **detect similarity** in the sensor time series, cluster the sensors to **split the messages** within the group

Algorithm 1 Core algorithm

Require: new message, message history, saved clustering archetecture

sensor cluster = *clustering method*(new message, message history, saved clustering archetecture)
period = *period update function*(sensor cluster)
if period is not None **then**
    Send period to sensor
end if

CONCLUSION

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CONCLUSION

- **Proposal of an easy to develop monitoring method** allowing any user to build his own monitoring solution**. Less expensive, more versatile**

there are **still technological and conceptual barriers** to the development of these solutions → **need for more interoperability - standardisation**.

Open research questions

- How to know more about the sensors (ontology): precision, position
- How to integrate it into the monitoring policies ?