Demonstrating Pulse-Coupled Synchronization in Dynamic Meshes of Cooperating Agents

Diogo Almeida[1], Luis Pinto[2], Luis Oliveira[3], Pedro d'Orey[4,6], Luis Almeida[5,6*]

[1]Faculdade de Ciências, Universidade do Porto (FCUP), Portugal.
[2]Faculdade de Ciências, Universidade de Lisboa (FCUL), Portugal.
[3]Dep. of Computer Science, University of Pittsburgh, Pittsburgh, USA.
[4]Instituto Superior de Engenharia do Porto (ISEP), Portugal.
[5*]Faculdade de Engenharia, Universidade do Porto (FEUP), Portugal.
[6]Res. Center in Real-Time Emb. Comp. Systems (CISTER), Portugal.

*Corresponding author(s). E-mail(s): lda@fe.up.pt;

Abstract

This demonstration showcases the synchronization among a team of cooperating agents that establish dynamic links, aiming at supporting a TDMA framework for collision-free transmissions. The demonstration includes two approaches, both based on the principle of pulse coupling, namely RA-TDMA and DESYNC.

Keywords: Pulse-coupled synchronization, dynamic mesh, TDMA, cooperating agents.

1 Introduction

Cooperative agents, e.g., mobile robots, often use WiFi ad-hoc communication. However, WiFi uses a contention-based medium access control that leads to potential unpredictable delays with growing medium load. A TDMA overlay can solve this problem dividing time into slots assigned cyclically and exclusively to agents for their transmissions. Implementing TDMA requires synchronization but using global physical time can be challenging in dynamic meshes and GPS-denied environments. Alternatively, pulse-coupled synchronization allows synchronizing agents using relative delays, only. This demonstration showcases and compares two such approaches, namely the Reconfigurable and Adaptive TDMA (RA-TDMA) [1][2] and DESYNC [3].

2 Pulse-coupled synchronization demonstration

Pulse-coupled synchronization consists in the regular transmission of messages (pulses) by all agents, assessing the actual delays between pulses and setting transmission instants to make pulses take planned positions in a cycle. This simple mechanism allows all agents to converge to a common start (phase) of the pulses cycle and setup a TDMA frame. Fig. 1 shows the relative delays of agents pulses in their local views (growing upwards) in a network with a dynamically controlled topology.

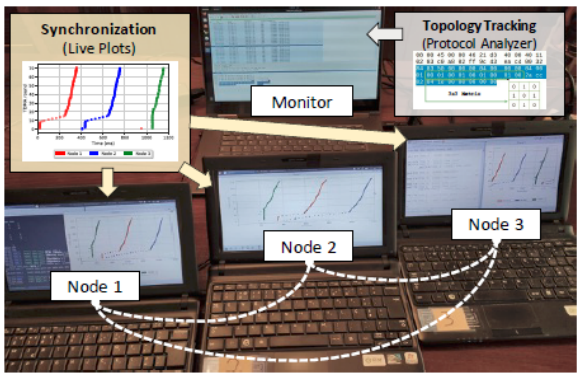

Fig. 1: Experimental setup with 3 nodes, showing the relative phases.

We use RA-TDMAs+ that combines topology tracking [1] with a synchronization that makes use of all transmitted packets per slot [2]. This method uses the maximum delay observed in the previous cycle to adjust the corresponding pulse position in the current cycle, thus phase compensations are always positive (TDMA phase only moves forward). Conversely, DESYNC [3] uses the delays of the previous and next pulses to position each agent pulse in the middle, thus phase compensations can be positive or negative (TDMA phase can move back). This demonstration is part of a thorough comparison between RA-TDMA and DESYNC.

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References

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