

# Efficient Distributed Communications for Multi-Robot Systems

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**Abstract.** Wireless communications are one of the technical problems that must be addressed by cooperative robot teams. The wireless medium often becomes heavily loaded and the robots may take too long to successfully transmit information, resulting in outdated shared data or failures in cooperative behaviors that require synchronization among teammates. This paper introduces a novel solution to enable the immediate transmission of synchronization data in a way designed to reduce and better tolerate packet loss. It does so by categorizing the communications in multi-robot systems in two classes, robot state diffusion and synchronization messages. For the former, an existing adaptive transmission method (RA-TDMA) is used, and for the latter a novel solution was developed. Experiments show an important delay reduction when sending synchronization messages over a loaded network.

## 1 Introduction

One of the challenges in developing multi-robot systems lies with the communications among them. Wireless networks used without special structure or restrictions provide adequate communication facilities. However, in the face of restrictions or high load, it is necessary to use the network carefully to better exploit its capabilities without overloading it.

An example scenario of multi-robot communication is a robot soccer game, where this work was applied. The *Robot World Cup (RoboCup)*[5] was proposed in 1997 as an attempt to foster AI and intelligent robotics research. The *RoboCup Middle Size League (MSL)* is a senior competition where two teams of five robots play a soccer game. The rules used are a subset of the official *FIFA* Laws with added constraints on the robots and environment[8]. During games, robots communicate using only *IEEE 802.11a* or *IEEE 802.11b* network modes. Unicast and multicast communication modes are allowed and broadcast is forbidden. The maximum transmission bit rate allowed per team is 20% of *IEEE 802.11b* (2.2 Mbps). However, the rules are mostly not enforced in practice and several problems occur frequently, degrading communications quality.

Efficient communications are a key factor for the success of teams during competitions but most teams simply schedule their robots to transmit information periodically, without any synchronization among robots. Thus, in the worst