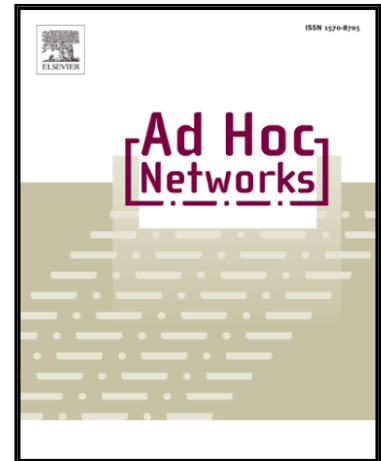


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# Fast network joining algorithms in Industrial IEEE 802.15.4 deployments

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## Abstract

Time Slotted Channel Hopping (TSCH) Medium Access Control (MAC) is a key feature of the IEEE 802.15.4 standard, aimed at accommodating the requirements of industrial Internet of Things systems. Time Division Multiple Access (TDMA) is a main pillar of TSCH, on top of which frequency hopping is added to increase the resilience of short range radio links. A tight synchronization among the network nodes is required in TSCH. Luckily, once a node joins the network, several lean techniques can be used to keep alive its synchronization. On contrary, the subtleties of the joining phase in TSCH still deserve investigations since they could hinder an effective usage of the TSCH MAC. To this end, the problem of acquiring the first synchronization in a TSCH network is investigated hereby, from several perspectives: (i) four novel mechanisms are proposed and implemented in real nodes to speed up joining operations; (ii) their average joining time is analytically modeled with closed form expressions as a function of node density, communication reliability, and beacon transmission frequency; (iii) their effectiveness and the agreement between experimental and theoretical outcomes are evaluated in several scenarios.

*Keywords:* Synchronization, IEEE 802.15.4, Time Slotted Channel Hopping, Industrial Internet of Things.

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## 1. Introduction

Nowadays the Internet of Things (IoT) is at the ground floor of many novel

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