Performance evaluation of a multi-radio, multi-hop ad-hoc radio communication network for Communications-Based Train Control (CBTC) - DTU Orbit (03/01/2019)

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Communications-Based Train Control (CBTC) is a modern signalling system that uses radio communication to transfer train control information between the train and the wayside. A vast majority of CBTC systems worldwide use IEEE 802.11 Wi-Fi as the radio technology mostly due to its cost-effectiveness. The trackside networks in these systems are mostly based on conventional infrastructure Wi-Fi. It means a train has to continuously associate (i.e. perform handshake) with the trackside Wi-Fi Access Points (AP) as it moves. This is a time-consuming process associated with a certain delay. Additionally, these APs are connected to the wayside infrastructure via optical fiber cables that incurs huge costs. This paper presents a novel design in which trackside nodes function in ad-hoc Wi-Fi mode, which means no association has to be performed with them prior to transmitting. A train simply broadcasts packets to any nodes in its range. A node upon receiving these packets forwards them to the next node and so on, forming a chain of nodes. Following this chain, packets arrive at the destination. To make the design resilient against interference, transmissions are separated on multiple frequencies. Furthermore, redundancy is introduced in the design as a node forwards packets to not only one but two of its neighbors. This paper investigates the performance of the new design from the perspective of resiliency, redundancy and scalability, and presents the results both from a field experiment carried out using prototype hardware and an extensive simulations study.
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