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Bluetooth Time Division Duplex - Exact Analysis as a Polling System

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Abstract. Bluetooth enables wireless communication via ad-hoc networks. The basic network topology (*piconet*) is a collection of slaves controlled by a master. A *scatternet* is a multihop network of piconets. Efficient piconet and scatternet communication requires design of intra and inter-piconet scheduling algorithms. Thus, numerous scheduling algorithms have been recently proposed. Analytical performance evaluation of such algorithms has great importance, since it may provide insight on their design and optimization. However, due to inherent complexities of the Bluetooth Medium Access Control (MAC), the performance of these scheduling algorithms has been analyzed mostly via simulation. Recently, Misic and Misic [18],[19],[20],[22],[23],[24],[25],[26] have claimed to provide exact analytic results regarding intra and inter-piconet scheduling algorithms which are based on the theory of M/G/1 queue with vacations. In this paper, we present alternative analytic results which are based on the theory of polling systems. Using these results we show that the results presented in [20] are *incorrect*, as they are based on unsatisfied assumptions leading to inaccurate probability generating functions. Thus, in some cases [20] *underestimates* the intra-piconet delay by more than 50% and in other cases it *overestimates* the delay by more than 50%. We also indicate that for similar reasons the results presented in [18],[19],[21],[22],[23],[24],[25], and [26] seem to be incorrect.

Keywords: Bluetooth, Scheduling, Polling, Queueing, Limited, Exhaustive, Personal Area Network (PAN), Piconet, Scatternet

1 Introduction

Bluetooth is a Personal Area Network (PAN) technology, which enables portable devices to connect and communicate wirelessly via short-range ad-hoc networks [4],[5]. The basic Bluetooth network topology (referred to as a *piconet*) is a collection of slave devices operating together with one master. A multihop ad-hoc network of piconets in which some of the devices are present in more than one piconet is referred to as a *scatternet* (see for example Figure 1). A device that is a member of more than one

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