A System Architecture Supporting Mobile Applications in Disconnected Sensor Networks

David Tacconi, Iacopo Carreras, Daniele Miorandi
CREATE-NET
Via Solteri 38, 38100 Trento, Italy
Email: name.surname@create-net.org

Antonio Casile, Francesco Chiti, Romano Fantacci
DET Department - Univ. of Florence
Via di Santa Marta 3, 50139 Florence, Italy
Email: name.surname@unifi.it

***Abstract*—This paper deals with the problem of supporting sink mobility in a wireless sensor network. It focuses on a specific scenario, where mobile nodes act themselves as both end-users, when querying the WSN for specific information, and as sinks, when gathering the queried data. Due to the mobility of users and to the topology of the network, sinks experience frequent disconnections from the WSN. A system architecture, and the related protocols, capable of supporting the envisioned application domain has been proposed. The performance of the proposed system architecture has been evaluated by means of simulative studies, together with addressing the impact of mobility, deployment geometry and routing parameters.**

***Index Terms*—Disconnected Wireless Sensor Networks, Intelligent Transportation Systems, Mobility Management**

I. INTRODUCTION

Due to the ever-increasing interest in remote monitoring, and thanks to advances in embedded and sensing technologies, the Wireless Sensor Networks (WSN) [1] research domain has experienced a great progress in recent years. Typically, a WSN is constituted by (i) a set of resource-constrained nodes, which are "immerse" into the spatial region to be observed and capable of performing user-defined data gathering tasks, (ii) a sink node, from which information of the WSN can be accessed by the end-user. Often, WSNs are deployed in remote hostile areas, and the sink is the only node through which the WSN is first queried and then accessed for data gathering operations. Hence, the sink is expected to be connected to the back-end through some form of long-range connection (i.e., satellite communication, Wi-Fi, Wi-MAX, etc.). This may result extremely inefficient in terms of infrastructure to be deployed, and management overhead necessary to guarantee the correct functioning of the network. However, when moving to an urban setting, the scenario differs significantly from the previous one. Indeed, let us assume the WSN to be deployed along a road, or in city area covered by a specific pervasive service. Let us further assume the end-user, while moving around the city, to be in direct contact with the WSN, thus acting both as end-user and sink at the same time. In this case, the mobile user can directly access services offered by the WSN, without the need to resort to a fixed sink node for querying and accessing the WSN. This is the case, for instance, of Intelligent Transportation Systems (ITS) [2], where deployed WSNs enable cars to obtain information on the conditions of the surrounding environment, and to use this information for taking appropriate decisions. For instance, the WSN could be used for detecting the formation of ice over the road, or monitoring the status of parking spots along the streets of the city center. This application domain, while intuitively clear, requires a general refinement of the standard WSN architecture and protocols. In particular, it entails the shift from a *partially* distributed network architecture, where nodes self-organize at bootstrap phase for the delivery of data to the sink node, to a *fully* distributed one, where no predetermined sink can be identified.

In this work, we refine the system architecture initially proposed in [3], and specifically tailored to the support of WSNs in urban settings. The considered scenario consists of a WSN deployed over an urban area. Multiple mobile sinks inject queries into the WSN, which answers, later on, with the requested information, if available. No particular requirement is imposed over the WSN deployment topology, and packets are routed within the network according to an adaptable geographical routing mechanism, where the position of the final destination (mobile sink) is related to the mobility pattern of the mobile user querying the network. This is achieved through a mobility management scheme, which takes into account speed variations, sudden direction changes, and similar factors, when forwarding packets. We evaluate the performance of the proposed system architecture, and related algorithms, by means of simulations, focusing in particular on how the sink mobility impacts the latency of data delivery, and the energy consumption of the network nodes.

The reminder of this paper is organized as follows. In Sec. II, the most significant work in the area of disconnected WSN and ITS is briefly reviewed. In Sec. III, the proposed system architecture is introduced, followed by the related protocols description given in Sec. IV. In Sec. V the performance of the proposed system is evaluated as a function of the nodes mobility pattern, and the network topology. Finally, Sec. VI concludes the paper by pointing out some promising research directions or future work.

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