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Review Article

Network-coding based event diffusion for wireless networks using semi-broadcasting ☆,☆☆

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ABSTRACT

Publish/subscribe is a well known and powerful distributed programming paradigm with many potential applications. Publish/subscribe content dissemination techniques based on opportunistic networking and network coding-based epidemic routing are key techniques for optimizing network resources, simplifying network architecture, and providing a platform for realizing innovative networking applications and service.

In this paper we consider the central problem of any pub/sub implementation, namely the problem of event dissemination, in the case of a wireless mesh network. We propose a new dissemination strategy based on the notion of *semi-broadcast*. In a semi-broadcast based protocol the actual content is disseminated in two phases. In the first phase only a fraction of the content is broadcasted (pushed) over the network and stored inside any node, whereas in the second phase the missed part is retried (pulled) on demand from other nodes. Thanks to network coding the partial content stored in each node at the end of the first phase is a set of random linear combinations over the *whole* content. This allows a very efficient recovery strategy as the missed part is found in nearby nodes with a high probability.The benefit of this approach is that only the interested subscribers, which can vary in number and position over time, can engage the pulling phase.

We propose several protocols based on non-trivial forwarding mechanisms that employ network coding as a central tool for supporting adaptive event dissemination while exploiting the broadcast nature of wireless transmissions and guided to the semi-broadcast principle. We show a considerable enhancement in term of total flooding costs and full decoding rates by a self parameter control deployment during the dissemination procedure.

Contents

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1. Introduction

This paper investigates the problem of event (message) diffusion among many mobile nodes over a Wireless Mesh Network (WMN) by leveraging a recent information dissemination technique called Linear Network Coding (LNC), and using a blind random dissemination algorithm that uses random LNC as a key forwarding mechanism. The WMN is a network of wireless routers connected to each other via multi-hop wireless links. A packet on a mesh network travels multiple wireless links before it reaches a gateway node, which is connected to the wired Internet. The major appeal of mesh networks is that because of their multi-hop nature, they can achieve the same coverage as single-hop access point based networks, either with much lower transmission power or significantly lower deployment costs. A WMN can be considered as two-tier architecture,[1]. The first tier is a wireless backbone composed of mesh routers capable of packet routing and optionally providing gateway functionality. The second tier is composed of mobile and/or portable wireless devices (e.g. WiFi-enabled smart phones, mobile TV devices, etc.) which can act as clients. A WMN is a self-organizing network with a certain degree of variability in terms of participants and topology. For example, clients can move, new clients can join a network, mesh routers can be occasionally switched off, or some clients can at times act as wireless routers. Having a suitable application level abstraction that can face with such changes is thus very appealing. In this regards, publish/subscribe (pub/sub) is a mature interaction paradigm that fits such requirements, since it allows for reference-decoupled and asynchronous interactions among the participants [8].

In pub/sub communication system publishers produce information in form of events and subscribers receive the subset of events that match their interests, expressed as a filter. Pub/sub systems have been widely studied in wired setting, e.g., SIENA [6],Gryphon [12], LeSubscribe [17]. However, while some papers have also focused on pub/sub systems running over networks exploiting wireless technology, e.g., [14], only a very few of them have considered WMNs, [11,22].

In addition, broadcasting protocols that exploit network coding for sending large information, e.g., XRBCast [18], could be in principle used but at the cost of sending information also to not-interested receivers.

We consider a WMN deployed over a Manhattan like city model, see [1], in which mesh routers can be considered as approximately placed at the intersection of two streets.

Since the streets are running east–west and north–south, mesh routers form a regular grid topology, Fig. 1. We assume that mesh routers are used as a dispatching structure to support event diffusion. This deployment model was borrowed from the proposal presented in [11]. We assume that each mesh client can communicate with only one mesh router (called its local mesh router), and mesh routers are equipped with additional software appliances that clients interact with.

Essentially, when the publisher needs to publish a new event, it contacts its local mesh router and then sends the event to it. The mesh router diffuses the newly event to all the other routers in the network, on behalf of the publisher. A subscriber periodically renews its subscription to its current local mesh router for a specific period of time, thus implementing a lease mechanism. This filtering procedure is done at the mesh router, and filters are not propagated into the network. A router notifies the client as soon as it receives an event matching the filter, given that the

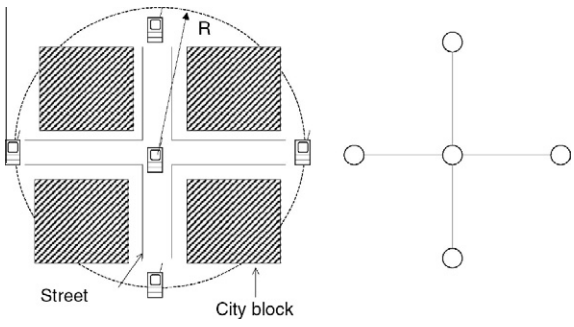

Fig. 1. The grid topology arising from a metropolitan deployment of a WMN.