Latency-Efficient Communication in Wireless Mesh Networks under Consideration of Large Interference Range

Qin Xin, Xiaolan Yao and Paal E. Engelstad

Abstract. Wireless Mesh Networking is an emerging communication paradigm to enable resilient, cost-efficient and reliable services for the future-generation wireless networks. We study here the minimum-latency communication primitive of gossiping (all-to-all communication) in multi-hop ad-hoc Wireless Mesh Networks (WMNs). Each mesh node in the WMN is initially given a message and the objective is to design a minimum-latency schedule such that each mesh node distributes its message to all other mesh nodes. Minimum-latency gossiping problem is well known to be NP-hard even for the scenario in which the topology of the WMN is known to all mesh nodes in advance. In this paper, we propose a new latency-efficient approximation scheme that can accomplish gossiping task in polynomial time units in any ad-hoc WMN under consideration of Large Interference Range (LIR), e.g., the interference range is much larger than the transmission range. To the best of our knowledge, it is first time to investigate such a scenario in ad-hoc WMNs under LIR, our algorithm allows the labels (e.g., identifiers) of the mesh nodes to be polynomially large in terms of the size of the WMN, which is the first time that the scenario of large labels has been considered in ad-hoc WMNs under LIR. Furthermore, our gossiping scheme can be considered as a framework which can be easily applied to the scenario under consideration of mobility-related issues since we assume that the mesh nodes have no knowledge on the network topology even for its neighboring mesh nodes.

Keywords: Ad-hoc networks; broadcasting; gossiping; minimum-latency communication; wireless mesh networks

INTRODUCTION

Wireless Mesh Networking (WMN) is a highly promising network architecture to converge the future-generation wireless networks. A WMN has the dynamic self-organization, self-configuration and self-healing characteristics, and additionally inherent flexibility, scalability and reliability advantages [1]. In a WMN, the mesh nodes can communicate with each other via multi-hop routing or forwarding. There are two types of WMN with respect to the mobility issues, i.e. static mesh networks and mobile mesh networks. The Wireless Local Area Networks (WirelessLAN) based on IEEE 802.11s standards is a kind of WMN with static nodes, where the Access Points (APs) can communicate with each other via multi-hop routing. Another example can be the WMN constructed by the mesh routers with static topology. On the other hand, if the mesh nodes are installed in the moving objects, e.g. bicycles, buses and trains, the network can be a kind of WMN with mobile nodes. In this paper, we focus on the WMN with static mesh nodes.

The two classical problems of information dissemination in the WMNs are broadcasting and gossiping. In the broadcasting problem, we want to distribute a message from a distinguished source mesh node to all other mesh nodes in the WMN. In the gossiping problem, each mesh node v in the network initially holds a message m_v, and we want to distribute all messages m_v to all mesh nodes in the WMN. For both problems, an important performance measure is the latency needed to complete the required communication task.

We consider the following model of a WMN. A WMN is a directed, strongly-connected graph G = (V,E), where V represents the set of mesh nodes of the network, and E contains an (ordered) pair of distinct mesh nodes (v,w) ∈ V × V if only if mesh node w is within the transmission range of mesh node v, e.g., v can directly send a message to w. If (v,w) ∈ E, then we say that w is a neighbor of v and v is an in-neighbor of w. The total number of in-neighbors of a mesh node w is its in-degree, and the maximum in-degree of a mesh node is called the max-in-degree of the WMN. The