Chapter 7

Topology-based Classification of Multicast Routing Protocols for Mobile Ad hoc Networks

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ABSTRACT

This chapter presents an exhaustive survey on the different categories of topology-based multicast routing protocols that have been proposed for mobile ad hoc networks (MANETs). Due to the inherent broadcast nature of the wireless medium, one-to-many multicast communications are characteristic of most of the MANET applications. MANET multicast routing protocols are primarily classified as tree-based and mesh-based protocols depending on the underlying topology used for communication. Tree-based protocols are further classified to source-tree based and shared-tree based depending on whether the tree is rooted at the multicast source or a common node. Further, there are several sub-categories of source-tree based and shared-tree based multicast routing protocols. The mesh-based multicast protocols are primarily categorized to source-initiated and receiver-initiated protocols depending on which entity (the source node or the receiver nodes) initiates the mesh formation. The book chapter explains in detail the working of eleven different multicast routing protocols, covering all of the sub-categories of tree-based and mesh-based routing protocols.

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INTRODUCTION

A mobile ad hoc network (MANET) comprises of wireless nodes that move independent of each other forming a dynamically changing distributed resource-constrained system. The wireless nodes are often limited in their transmission range and multi-hop routing is a common phenomenon that has been of significant interest. There are several application domains in which MANETs have been deployed. These include: disaster recovery, military operations in a battlefield, outdoor entertainment activities, crowd control, conferences, and etc. One-to-many multicast communication is a characteristic feature of all these applications. Several multicast routing protocols have been proposed in the literature to support these MANET applications.

Depending on the underlying topology used for communication, the multicast protocols are mainly classified as: tree-based and mesh-based protocols. In tree-based protocols, only one route exists between a source and a destination and hence these protocols are efficient in terms of the number of link transmissions. There are two major categories of tree-based protocols: source tree-based (the tree is rooted at the source) and shared tree-based (the tree is rooted at a core node and all communication from the source nodes to the receiver nodes is routed through this core node). Even though shared tree-based multicast protocols are more scalable with respect to the number of sources, these protocols suffer under a single point of failure, the core node. On the other hand, source tree-based protocols are more efficient in terms of traffic distribution. The source tree-based protocols are further classified into the following sub-categories: (i) Minimum hop-based, (ii) Minimum link-based, (iii) Stability-based, and (iv) Zone-based protocols. The shared tree-based multicast protocols are further classified into: (i) Cluster-based, (ii) Session-specific, and (iii) IP multicast session-based protocols.

In mesh-based multicast routing, multiple routes exist between the source node and each of the receivers of the multicast group. A receiver node receives several copies of the data packets, one copy through each of the multiple paths. Mesh-based multicast routing protocols provide robustness in the presence of node mobility; however, at the expense of a larger number of link transmissions leading to inefficient bandwidth usage. The mesh-based protocols are classified into source-initiated and receiver-initiated protocols depending on the entity (the source node or the receiver nodes) that initiates mesh formation.

The book chapter will review widely studied, characteristic, representative multicast routing protocols for each of the above sub-categories and explain the salient features of the particular sub-categories through these protocols. The book chapter will also discuss the pros and cons of each of these multicast routing protocols and the categories to which they belong. A classification tree of the different categories and their representative multicast routing protocols that would be discussed in the book chapter is given in Figure 1. As the routing protocols are often referred using their acronym, Table 1 provides the complete name of the multicast protocols listed in Figure 1.

The rest of the book chapter is organized as follows: The next section presents background information on MANETs, routing and multicast protocols. In the subsequent sections, the chapter discusses representative routing protocols for each of the 4 categories of source tree-based MANET multicast protocols, for each of the 3 categories of shared tree-based multicast protocols; followed by representative protocols for the source initiated and receiver-initiated categories of the mesh-based multicast protocols. The last two sections present the conclusions and future research directions. Throughout the chapter, the terms ‘node’ and ‘vertex’, ‘path’ and ‘route’, ‘edge’ and ‘link’, ‘message’ and ‘packet’ are used interchangeably. They mean the same.
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