Chapter 3.4
Mobile Multimedia Streaming Using Secure Multipath in Wireless Ad Hoc Networks

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ABSTRACT

Supporting reliable and secure multimedia streaming service is a challenging task in the environment of wireless Mobile Ad hoc Networks (MANETs) where radio signals are prone to security attacks and the quality of media streaming is degraded by signal strength loss and interference. The mobility of mobile devices makes streaming even more difficult as communication links are often broken when the devices move out of the transmission range of their neighbors. This paper proposes a stable multipath routing algorithm and an intelligent secure data distribution scheme for multimedia streaming in MANETs. The multipath Neighbor Stability Routing is able to find more stable and long-lasting paths than traditional ad hoc routing algorithms. The secure data distribution takes historical data-path distribution into consideration and maximally disperses new multimedia data to reduce the possibility of information leakage to unauthorized parties. The authors' simulation and analysis indicate that the combination of these two mechanisms can provide high quality paths to achieve secure multimedia streaming.

1. INTRODUCTION

Wireless networks have been deployed extensively in recent years. While conventional infrastructure-based wireless telecommunication systems may be effective in services such as cellular phone and local area data exchange, they can hardly support communication needs in situations where no fixed base stations or access points can be established. Mobile Ad hoc Networks (MANETs) are infrastructure-less wireless networks designed for such environments. In a MANET, each node is a mobile wireless device (e.g., notebook computer or 3G cell phone) which can communicate with its neighbors within its limited communication range. A pair of two communication end nodes far

DOI: 10.4018/978-1-61350-101-6.ch304

away from each other can utilize nodes between them to establish path(s) as data delivery channels. Thus, each node can act not only as a transmitter and a receiver, but also as a router which helps find path(s) and forward data for other nodes. MANETs are characterized by wireless connectivity through multi-hops and frequently changing network topology among wireless mobile devices. These characteristics require routing algorithms, methods finding the path(s) from source node to destination node, to be dynamic and adaptive to the constantly changing network structure. The ever changing topology, open signal transmission and low computation power of mobile devices make it very difficult for high data volume applications such as real-time video streaming.

The research, development, and deployment of MANETs play a crucial role in national security, transportation safety, and public welfare. However, several issues in MANETs need to be solved in order to support real-time video applications. The first issue to deal with is routing, or to find the path(s) from the source node to the destination node. In order to deliver the video smoothly, stable paths are preferred. Routing for multiple paths can be considered as an extension to routing for a single path. In Section 3, we first introduce the single path Neighbor Stability Routing (NSR), an ad hoc routing algorithm finding the most stable or long-lasting path between the source and the destination nodes. This single path routing algorithm is then extended to equip multi-path capability (Multi-path Neighbor Stability Routing or MNSR) and Quality of Service (QoS) features. In Section 4, we discuss how paths, selected from the above routing algorithm, can be evaluated according to the local neighborhood condition and previous data distribution. This evaluation contributes in making the decision on which path the current chunk of data should go through. Quantitative security analysis shows that the proposed distribution algorithm has advantages on both providing better security and more redundancy. We draw conclusions and propose future work in the last section, Section 5.

2. ROUTING IN MANETS

MANETs consist of mobile wireless devices communicating through relatively unreliable wireless connections. This unreliability is mainly caused by device mobility and signal interference, both can degrade networking performance significantly.

2.1 Single-Path Routing

In order to achieve better reliability in MANETs, (Ye, Krishnamurthy, & Tripathi, 2003) introduced a reliable routing framework in which some reliable R-nodes are manually inserted into the MANETs and play a role of supporting the network as backbones. This idea could be practical in some metropolitan areas where advanced network infrastructures are available, but it is not suitable for other improvisational situations such as disaster rescue.

Noticing that information exchange is important among neighbor nodes, in (Joe & Batsell, 2002) Joe and Batsell introduced MPR-based hybrid routing which makes use of the multipoint relaying based on the information exchange among neighbor nodes. Nevertheless, this routing algorithm does not involve any memory of the relationship among neighbor nodes. Thus all nodes are treated the same no matter they are stable in terms of mobility or not.

Some other researchers have suggested that routing can be done by collecting and aggregating relative information among neighbor nodes from the source to the destination. For example, ABR in (Toh, 1997; Toh, Delwar, & Allen, 2002) makes use of the Associativity Ticks among neighbor nodes. The Associativity Ticks show a mobile node's dormant time, in which the node is in a stable status. However, these Associativity Ticks