Mobile Ad Hoc Networks (MANETs) for Multimedia Transmission

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INTRODUCTION

Mobile Ad hoc Networks (MANETs) are becoming more essential to wireless communications due to growing popularity of mobile devices. A node in MANETs could act as a router while having also the possibility of being the sender or receiver of information. MANETs offer the freedom to use mobile devices and move independently of the location of base stations (and outside their coverage) with the help of other network devices. The ability of MANETs to be self-configured and form a mobile mesh network, by using wireless links, make them very suitable for a number of cases that other type of networks cannot operate. In addition, MANETs do not require vast technological investments.

An ideal application area for the utilization of MANET technology is for instance any disaster scenario in which the fixed infrastructure is incapacitated or non-existent. In this case it is important to ensure that a suitable communication solution is established within the very first critical hours of an incident, considering national or cross-border emergency incidents.

What is missing, however, from this type of networks is the so called a "killer application" that could boost its utilizations in the real world. Real time multimedia applications have the potential to turn MANETs into a very attractive solution in wireless networks taking into account its unique characteristics.

Our motivation for this article is to present the shortcomings and the current state of the art in MANETs in regards to the transmission of multimedia data, which is a promising application area.

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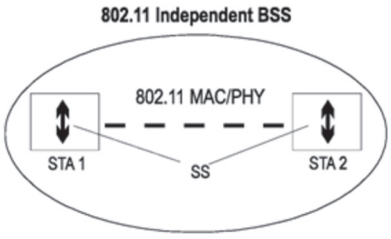
BACKGROUND

Wireless Local Area Networks (WLANs) are one of the most popular and ubiquitous forms of wireless connectivity between different types of equipment. WLAN interfaces are embedded in many common electronic devices: laptops, PDAs, smart phones etc. IEEE 802.11 (IEEE, 2007) is the dominant standard for WLANs. Networks can be deployed using available COTS (Commercial Off-The-Shelf) equipment supporting 802.11 for both home and enterprise scenarios. There is also a multitude of available hardware and software tools for many OS platforms, making them easy to administer. Furthermore, WLANs provide mobility, high-speed transmission, and distributed topologies.

The most common topology of IEEE 802.11 WLAN is infrastructure mode. Stations (STA) connect to an Access Point (AP) using a radio link. The AP is connected to the external network through a wired link (Ethernet being most common). This is a centralized approach, however, more robust topologies can be found in the 802.11 standard.

In ad-hoc mode presented in Figure 1, there is no central station (STA). All STA within range can communicate directly; otherwise a multi-hop packet-forwarding connection is used. This approach provides reliability and robustness to the connection. There is no single point of failure (provided there are multiple paths in the network) which makes them a feasible choice for ad-hoc networks deployments. For ad-hoc mode networks the IEEE 802.11 standard defines physical layer (PHY) and medium access layer (MAC) while network layer with routing protocols are defined mainly by the International Engineering Task Force (IETF).

Figure 1. IEEE 802.11 ad-hoc network



MANETs are based on ad-hoc technology. However, current MANETs built with IEEE 802.11 technology lack scalability and Quality of Service (QoS). Mobility is a unique feature but it results in a very dynamic topology in which routing can become a very complicated task. There is also a need for fast scanning and fast roaming to support real-time applications. The scanning process must consume as little energy as possible. Fast mobility must be supported to serve traffic in MANETs. During handoffs, except for QoS, security is of crucial importance. The routing protocols that have been designed for wireless ad-hoc networks directly affect the performance of the serving applications. Each protocol has its own routing strategy that is used in order to discover a routing path between two ends. The performance varies, depending on network conditions like the density of nodes in a specific area, their speed and direction. It is obvious that the selection of the proper routing protocol for a specific network topology plays a critical role.

On the other hand, multimedia applications and especially video streaming is characterized by three main attributes: a) high bandwidth requirements, b) delay-constraint applications with c) tolerance to small packet losses (usually less than 1%). A major key issue is therefore how to guarantee an acceptable level of QoS to the end users. Therefore, under these conditions there should be implemented additional mechanisms in order to support the utilization of multimedia applications in MANETs.

To this end, over the last few years, new protocols were designed and standardized in an effort to increase the transmission rates of the wireless medium. The IEEE 802.11e (IEEE, 2005) protocol with QoS enhancements is an international standard that is already implemented in MAC chipsets by a number of vendors. The efforts for the enhancements of the IEEE 802.11 protocol aim at creating a wireless environment in which, data transmission can be achieved at higher bit rates and longer distances while meeting the QoS criteria posed by applications with delay constrains, like multimedia transmission.

MAIN FOCUS OF THE ARTICLE

Routing in MANETs

Routing protocols for ad hoc networks can be classified into three main categories. In Proactive schemes, every node in the network has one or more routes to any possible destination in its routing table at any given time. Reactive routing protocols obtain a route to a destination on a demand fashion. When the upper transport layer has data to send, the protocol initiates a route discovery process, if such a route does not already exist, in order to find a path to the destination. In Hybrid routing protocols, every node acts reactively in the region close to its proximity and proactively outside of that region, or zone. Hybrid protocols take advantage of both reactive and proactive protocols, but may require additional hardware, such as GPS devices, separated or integrated into the communication device. Table 1 provides more details on existed routing schemes with associated protocols that are under research and development.

Various solutions have been presented for MANETs routing that rely on the three more dominant routing protocols, namely: Optimized Link State Routing Protocol (OLSR) (Clausen & Jacquet., 2003), Ad hoc On-Demand Distance Vector (AODV) (Perkins & Belding-Royer, 2003) and Dynamic Source Routing Protocol (DSR) (Johnson et al., 2003).

OLSR is a proactive protocol that is based on the link state algorithm. OLSR has been modified and optimized to efficiently operate MANET routing. The main concept of the protocol is to adapt the changes of the network without creating control messages overhead due to the protocol flooding nature. Thus, the designers of OSLR decided to have only a subset of nodes, named Multipoint Relays (MPRs), in the network responsible for broadcasting control messages and generating link state information. A second optimization is that every MPR may choose to broadcast link state information only between itself and the nodes that have selected it as an MPR.