Chapter 14
Security Management and Simulation of Mobile Ad Hoc Networks (MANET)

Ali H. Al-Bayatti
De Montfort University, UK

Hilal M. Al-Bayatti
Applied Science University, Bahrain

ABSTRACT
This chapter provides a detailed description of a framework for designing, analyzing, deploying, and enforcing high level security management for Mobile Ad Hoc Networks (MANETs). The framework, which can be used by researchers, academics, security administrators, network designers, and post-graduate students, is designed and simulated using the object oriented Network Simulator-2 (NS-2). In this chapter, the authors also provide a full illustration of how to design and implement a secure MANET, while maintaining the security essentials using NS-2. Then, they describe the characteristics, applications, design, coding style, advantages/disadvantages, and implementation of the NS-2 simulator. Finally, this chapter provides a description of the future trend NS-3, which is the "eventual replacement" of NS-2.

INTRODUCTION
Mobile Ad Hoc Networks (MANETs) have various defining characteristics that differentiate it from other wired and wireless networks, because MANET unique characteristics (i.e., infrastructureless, dynamic topology and constrained resources) nontrivial challenges will be raised, such as security, routing, scalability, availability, deployment considerations, media access and Quality of Service (QoS) (Murthy & Manjo, 2004). As a result, providing security management as defined in ITU-T M.3400 (International Telecommunication Union, 2000) is essential in order to overcome the security threats (e.g., Denial of Service (DoS), host impersonation and information disclosure) MANET might encounter.

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In order to evaluate the performance MANET and any other system; one of the available network simulators must be used. Many researchers have evaluated and simulated their work using various approaches and simulation tools. The most popular simulator is the Network Simulator version -2 (NS-2). As well known simulation tools in general and NS-2 in precise suffers from lack of credibility leading towards deceptive results from errors in simulation models or improper data analysis. As a result, to improve simulation credibility through open source simulation, Network Simulator version 3 (NS-3) was created targeting primarily researchers for academic purpose. NS-3 is intended to be the eventual replacement for NS-2; in this chapter we will highlight MANET characteristics, challenges and attacks, security requirements, security attacks, security management, NS-2 and NS-3 key elements and features showing the key difference with NS-2.

MOBILE AD HOC NETWORKS (MANETS)

A MANET is a group of large autonomous wireless nodes interconnecting each other on a peer-to-peer basis in a heterogeneous environment with no pre-define infrastructure. The field of communications networks continues to evolve, a need for wireless connectivity and mobile communication is rapidly emerging. To meet the need for fast and reliable information exchange, communication networks have become an integral part of our society. The success of any corporation largely depends upon its ability to communicate. Ad hoc wireless networks will enhance communication capability significantly by providing connectivity from anywhere at any time, referring to the relatively newly emerging technology pervasive (or ubiquitous) networks. The principle behind ad hoc networking is multi-hop (a scenario of multi-hop will be shown later) relaying, which traces its roots back to 500 B.C. Darius I (533-486 B.C.), the king of Persia, invented an innovative communication system that was used to send messages and news from his capital to the remote provinces of his empire by means of a line of shouting men positioned on tall structures or heights. This system was more than 23 times faster than normal messengers available at that time. The use of ad hoc voice communication was introduced in many ancient/tribal societies with a string of repeaters of drums, trumpets or horns.

In 1970, DARPA (Defence Advanced Research Project Agency) (Dugan, 2010) had a project known as Packet Radio, where several wireless terminals could communicate with one another on a battlefield. Packet radio extended the concept of packet switching (evolved from point-to-point communication networks) to the domain of broadcast radio networks.

During the 1970s, a group of researchers led by Norman Abramson (and others including N. Gaarder and N. Weldon) invented ALOHAnet (Abramson, 1985), which linked the universities of the Hawaiian Islands together by broadcast property to send/receive data packets in a single radio hop system. Even though ALOHAnet was established for fixed single-hop wireless networks, the ALOHA project led to the development of a multi-hop multiple-access packet radio network (PRNET) under the sponsorship of the Advanced Research Project Agency (ARPA) (Dugan, 2010). Unlike ALOHA, PRNET permits multi-hop communications over a wide geographical area, helping to establish the notion of ad hoc wireless networking in the same year (Mohapatra & Krishnamurth, 2004).

Characteristics of MANET

The study and development of infrastructureless wireless networks have been very popular in recent years. MANET belongs to the class of networks which does not require the support of wired access points or base stations for intercommunication. A mobile ad hoc network is unlike