HIGH SECURITY PERFORMANCE AND RELIABLE IN MOBILE AD HOC NETWORKS

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ABSTRACT

A **Mobile Ad-hoc NETwork** (**MANET**) is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. One of the main issues in such networks is performance- in a dynamically changing topology; the nodes are expected to be power-aware due to the bandwidth constrained network. Another issue in such networks is security - since every node participates in the operation of the network equally, malicious nodes are difficult to detect. There are several applications of mobile ad hoc networks such as disaster recovery operations, battle field communications, etc. To study these issues, a scenario based simulation analysis of a secure routing protocol is done and is compared with traditional non-secure routing protocols. The scenarios used for the experiments depict critical real-world applications such as battlefield and rescue operations, which tend to have contradicting needs. An analysis of the tradeoffs between performance and security is done to gain an insight into the applicability of the routing protocols under consideration.

INTRODUCTION

Over the past decade, there has been a growing interest in wireless networks, as the cost of mobile devices such as PDAs, laptops, cellular phones, etc have reduced drastically. The latest trend in wireless networks is towards *pervasive and ubiquitous computing* - catering to both nomadic and fixed users, anytime and anywhere. Several standards for wireless networks have emerged in order to address the needs of both industrial and individual

users. One of the most prevalent forms of wireless networks in use today is the Wireless Local Area Network (WLAN). In such a network, a set of mobile nodes are connected to a fixed wired backbone. WLANs have a short range and are usually deployed in places such universities, companies, cafeterias, etc. However, there is still a need for communication in several scenarios of deployment where it is not feasible to deploy fixed wireless access points due to physical constraints of the medium. For example, consider communication amongst soldiers in a battlefield, involving troops spread out over a large area. In this case, it is not only feasible to deploy a fixed wireless access point, but also risky since an enemy attack would bring down the whole network. This problem has led to a growing interest among the research community in *mobile ad hoc networks*, wireless networks comprised of mobile computing devices communicating without any fixed infrastructure. The rest of this chapter is organized as follows – initially a classification of wireless networks in use today is described followed by the background and origins of ad hoc wireless networks. The general issues in ad hoc wireless networks are then discussed, followed by a few interesting applications. The final section gives an outline of the chapters to follow.

Wireless LANs and PANs

A Wireless Local Area Network (WLAN) consists of a set of mobile users communicating via a fixed base station or an access point. The mobile node can be any device such as a palmtop, PDA, laptop etc.

as shown in Figure 1.

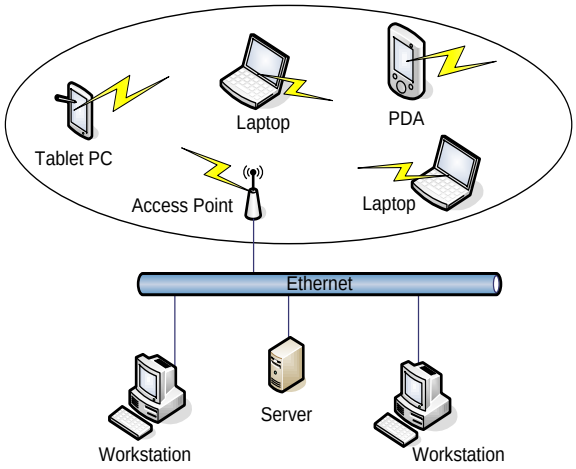

Figure 1 Wireless LAN

Such networks are usually deployed in offices, cafeterias, universities, etc. and are most prevalently used nowadays. There are three types of WLANs – Independent Basic Service Set (**IBSS**), Basic Service Set (**BSS**) and Extended Service Set (**ESS**). A detailed classification

ROUTING IN MANETs

Unlike wired networks, routing in MANETs poses unique challenges. Designers of routing protocols for MANETs need to address several issues. In this chapter these issues are identified and the routing protocols available for MANETs are classified. Then working principle of a few protocols such as DSDV, DSR, AODV, etc. are explained. Their pros and cons are also identified. This chapter concludes with a summary of routing in MANETs.

Route Maintenance:

The route maintenance phase is carried out whenever there is a broken link between two nodes. A failed link can be detected by a node by either passively monitoring in promiscuous mode or actively monitoring the link. As shown in Figure 2.8, when an intermediate node in the path moves away, causing a wireless link to break (6-7), a route error packet (RERR) is sent by the intermediate node back to the originating node. The source node re-initiates the route discovery procedure to find a new route to the destination. It also removes any route entries it may have in its cache to the destination node.

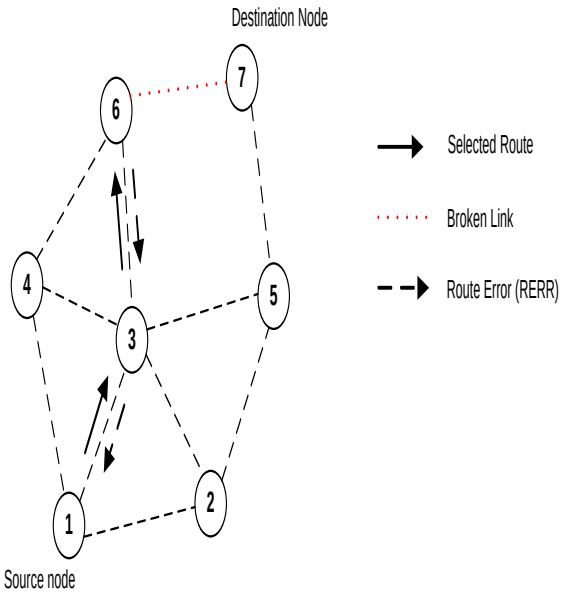

Figure 2: Route Maintenance in DSR

SECURITY IN MANETs

MANETs have certain unique characteristics that make them vulnerable to several types of attacks. Since they are deployed an open environment where all nodes co-operate in forwarding the packets in the network, malicious nodes are difficult to detect. Hence, it is quite difficult to design a secure protocol when compared to wired or infrastructure-based wireless networks. This section discusses some of the issues and challenges that a designer of secure protocols faces. These issues are analyzed with respect to the primary goals of a secure protocol – confidentiality, integrity and availability, authenticity and non-repudiation. The attacks and threats allowed by existing MANET routing protocols are then discussed. The working of a few secure routing protocols which address these threats such as SEAD, ARIADNE, ARAN and SRP is then described. The next section discusses another important issue in MANETs- certificate-based authentication. It surveys some mechanisms proposed and analyzes the requirements for effective certificate-based authentication in MANETs.

SIMULATION STUDY OF PERFORMANCE IN MANETs

Over the past few years there has been a growing interest in the research community for simulation study of performance in MANETs since there is a lack of necessary infrastructure for MANETs to be deployed

in a realistic scenario. A simulation study gives us an idea of how a protocol performs when it is practically employed. This approach is similar to the prototyping model in software engineering realm. However, the main challenge in the simulation study of MANETs is the dynamic nature of the network topology and the physical environment in which the nodes operate. In order to gain an insight of how a protocol performs when deployed in a realistic scenario, it is imperative that the simulation capture the exact nature of the physical environment and the movement of the nodes in the network, which might not be possible in all cases. For example consider a scenario where a set of nodes are deployed in a rescue operation. Even though the mobility of the nodes can be captured with certain realistic mobility models, the node doesn't capture the exact physical environment in which the nodes operate, such as uneven terrains, catastrophic failure of the nodes, etc.

This chapter discusses the simulation study of performance in MANETs using the network simulator ns-2 and certain realistic mobility models used to model the movement of the nodes. It is followed by a step-by-step tutorial for simulation study of MANET routing protocols using ns-2. A set of experiments conducted to study the performance of AODV in a battlefield scenario is then explained.

4.2 The ns-2 network simulator

Ns-2 is an open source discrete event simulator used by the research community for research in networking [30]. It has support for both wired and wireless networks and can simulate several network protocols such as TCP, UDP, multicast routing, etc. More recently, support has been added for simulation of large satellite and ad hoc wireless networks. The ns-2 simulation

software was developed at the University of Berkeley. It is constantly under development by an active community of researchers. The latest version at the time of writing this thesis is ns-2 2.28.

The standard ns-2 distribution runs on Linux. However, a package for running ns-2 on Cygwin (Linux Emulation for Windows) is available. In this mode, ns-2 runs in the Windows environment on top of Cygwin as shown in the figure 4.1. The simulations performed (discussed in following sections) have been run in this environment.

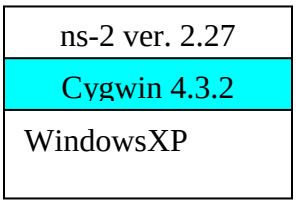

Figure.3: ns-2 over Cygwin

NS-2 provides a split-programming model; the simulation kernel is implemented using C++, while the Tcl scripting language is used to express the definition, configuration and the control of the simulation. This split-programming approach has proven benefits over conventional programming methods. Also, NS-2 can produce a detailed trace file and an animation file for each ad hoc network simulation that is very convenient for analyzing the routing behavior.

CONCLUSION

The two most important issues in mobile ad hoc networks – performance and security. Each mobile node in a MANET acts as a router by forwarding the packets in the network. Hence, one of the challenges in the design of routing protocols is that it must be tailored to suit the dynamic nature of the nodes. The second chapter discusses some of the other challenges faced by the designers of routing protocols for MANETs. A complete understanding of these issues will help in designing efficient and effective routing protocols. It also classifies the protocols and describes a few of them.

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