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Interference-based Topology Control Algorithm for Delay-constrained Mobile Ad hoc Networks

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Abstract: Conserving energy consumption is a major issue for ad hoc network deployment. Instead of using the maximum transmission power, nodes in a wireless ad hoc network collaboratively determine their transmission powers and hence the network topology is defined. In wireless communications, interference is a fundamental problem. The interference may result in collisions and consequently data retransmissions at the medium access layer. As a result, the network throughput degrades and the delay increases, due to packet retransmissions.

Keywords: Topology Control, Wireless Communication, ALOHANET.

INTRODUCTION

Since their appearance in 1970 in the form of ALOHANET, wireless packet radio networks have come a long way in terms of numbers, applications, and the feature set, among other things. The two largest attractions of wireless communication have been mobility and ease of deployment – laying cables is not only laborious and time consuming, but their maintenance is equally bothersome. Wireless communication today surrounds us in many colors and flavors, each with its unique frequency band, coverage, and range of applications. It has matured to a large extent, and standards have evolved for Personal Area Networks, Local Area Networks as well as Broadband Wireless Access.

Infrastructure-less Networks

In any but the most trivial networks (point-to-point links), some mechanism is required for routing the packets from the source to the final destinations. This includes discovery and maintenance of routes along with associated costs. In what is called an 'infrastructure-based' wireless network, the job of routing is assigned to dedicated nodes called access points (AP). Configurations of the APs are much less dynamic than their, possibly mobile, end-point nodes. APs are like base stations which keep track of nodes' associations/disassociations, authentication etc. and control the traffic flow between their clients as well as between fellow APs. The AP may also be connected to the Internet thereby providing Internet connectivity to its clients.

A very attractive and promising category of wireless networks that has emerged is based on an Ad Hoc topology; these networks are called Wireless Ad Hoc Networks. The term wireless network implies a computer network in which the communication links are wireless. The term Ad Hoc comes from the fact that there is no fixed infrastructure for forwarding/ routing the packets. Figure 1.1 [2] shows an infrastructure-based and an Ad Hoc wireless network.

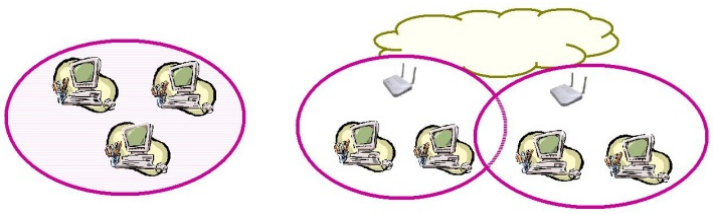

Figure 1.1: Ad Hoc and Infrastructure Network Topologies

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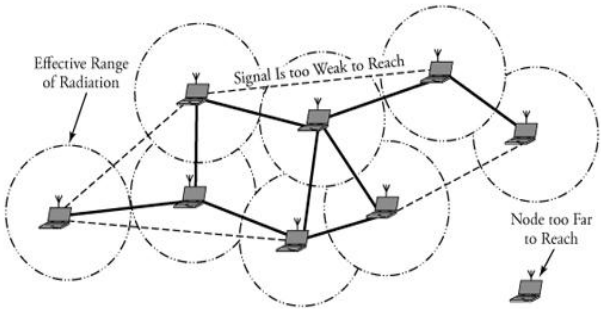

Figure 1.2: A Typical MANET

EXISTING SYSTEM

The devices in the wireless ad hoc network are modeled as a set of nodes in a planar graph. Given a set of nodes, V={v1, v2, …, vn}, in a two-dimensional area A, each node vi is located at a known coordinate (xi,yi) inside the area A and its maximum transmission range is ri. The network is modeled as a graph Gmax= (V, Emax). For any two nodes vi and vj in V, they are connected by an edge (vi, vj) if d(vi ,vj) < ri and d(vi ,vj) < rj, where d(vi, vj) denote the distance between nodes vi and vj. Hence, the edge (vi, vj) is in Emax. A node vk in the network Gmax is interfered by a communication edge (vi, vj) if node vk can receive messages transmitted by node vi or vj, but not intended for node vk. The interference load of a node vk is defined as the number of communication links, like (vi, vj), that will contribute interference to it.

PROPOSED SYSTEM

Delay requirement is one of the particularly useful QoS requirements for mobile ad hoc networks. Many QoS routing protocols which consider the end-to-end delay as a QoS measure have been proposed. An proposed algorithm to achieve guaranteed through put while satisfying QoS requirements and guaranteeing that all actual queue backlogs are deterministically upper-bounded. A queuing architecture to exploit the new degree of freedom of choosing service discipline for different arrival process. In MANETs, applications may have traffic to be sent at anytime, it is hard to know these information in prior.

METHODS

Routing in Ad Hoc Networks

The lack of a backbone infrastructure [37] coupled with the fact that mobile Ad Hoc networks change their topology frequently and without prior notice makes packet routing in ad-hoc networks a challenging task. The suggested approaches for routing can be divided into topology-based and position-based routing. Topology-based routing protocols use the information about the links that exist in the network to perform packet forwarding. They can be further divided into *proactive*, *reactive*, and *hybrid* approaches. Proactive algorithms employ classical routing strategies such as distance-vector routing (e.g., DSDV) or link-state routing (e.g., OLSR and TBRPF). They maintain routing information about the available paths in the network even if these paths are not currently used. The main drawback of these approaches is that the maintenance of unused paths may occupy a significant part of the available bandwidth if the topology of the network changes frequently. In response to this observation, reactive routing protocols were developed (e.g., DSR, TORA, and AODV). Reactive routing protocols maintain only the routes that are currently in use, thereby reducing the burden on the network when only a small subset of all available routes is in use at any time. However, they still have some inherent limitations. First, since routes are only maintained while in use, it is typically required to perform a route discovery before packets can be exchanged between communication peers. This leads to a delay for the first packet to be transmitted. Second, even though route maintenance for reactive algorithms is restricted to the routes currently in use, it may still generate a significant amount of network traffic when the topology of the network changes frequently. Finally, packets en route to the destination are likely to be lost if the route to the destination changes. Hybrid Ad Hoc routing protocols such as ZRP combine local proactive routing and global reactive routing in order to achieve a higher level of efficiency and scalability. However, even a combination of both strategies still needs to maintain at least those network paths that are currently in use, limiting the amount of topological changes that can be tolerated with in a given amount of time. Position-based routing algorithms eliminate some of the limitations of topology-based routing by using additional information. They require that information about the physical position of the participating nodes be available. Commonly, each node determines its own position through the use of GPS or some other type of positioning service. A *location service* is used by the sender of a packet to determine the position of the destination and to include it in the packet's destination address.

The routing decision at each node is then based on the destination's position contained in the packet and the position of the forwarding node's neighbors. Position-based routing thus does not require the establishment or maintenance of routes. The nodes have neither to store routing tables nor to transmit messages to keep routing tables up to date. As a further advantage, position-based routing supports the delivery of packets to all nodes in a given geographic region in a natural way. This type of service is called *geo casting.* Regardless of the approach to routing, a routing protocol should be able to automatically recover from any problem in a finite amount of time without human intervention. Conventional routing protocols are designed for nonmoving infrastructures and assume that routes are bidirectional, which is not always the case for ad-hoc networks. Identification of mobile terminals and correct routing of packets to and from each terminal while moving are certainly challenging.

CONCLUSION

Stamouli et al [10] have proposed architecture for Real-time Intrusion Detection for Ad Hoc Networks [RIDAN]. The detection process relies on a state-based misuse detection system. In this case, every node needs to run the IDS agent. There is no mention of a distributed architecture to detect attacks that require more than one-hop information. We show that our work has improved on many fronts. Our method has been shown to detect local as well as distributed attacks.

In their work, Stamouli et al conclude that AODV performs well at all mobility rates and movement speeds. Our conclusions are the same; however, we argue that their definition of mobility (pause time) does not truly represent the dynamic topology of MANETs. Our mobility factor is based on actual relative movement pattern. The only node speeds that Stamouli et al have shown are 5 meters/ second and 20 meters/ second which, in our opinion, do not cover the complete range. Our mobility factor has a speed range from 0 meters/ second (static scenario) up to 20 meters/ second, and we show how our protocol behaves in the complete range. According to the analysis that we performed, the most serious attacks are carried out by 'insiders' who carry out their attacks via an attached terminal, not via the network. Consequently, network-based IDS will fail to detect the most damaging attacks. Moreover, the most pervasive network-based IDSs are signature-based and are only able to detect known attacks. We presented new techniques that advance the field of intrusion detection in several areas. We have designed novel mechanisms to detect and mitigate aberrant behaviors encountered in Mobile Ad Hoc Networks (MANETs). Since MANETs are comprised of resource-constrained devices, we designed our intrusion detection mechanisms as protocols that monitor network state rather than system state. We also experimented with reactive protocols for MANETs, extending prior research to work with all mobile Ad Hoc routing protocols, not just AODV. We use a randomly selected set of 5 nodes out of 30 nodes and experimented with [10] and consider a sequence of five consecutive packets as constituting the attack signature. We found the accuracy of detection both in static and dynamic condition. It is not clear in RIDAN system, how an attack that requires more than one-hop information gets detected but in IDAODV, multihop information is considered which overcomes the limitation of RIDAN system. We have produced percentage of detection of attack using RIDAN system [10] for both static and dynamic node case, which was not present in the original work. We have also given a relative performance of IDAODV and RIDAN system. Our experiments and simulations have demonstrated that our protocol is functionally feasible given limited resources. An Intrusion Detection System aiming at securing the AODV protocol has been developed using specification-based technique. It is based on a previous work done by Stamouli et al [10]. The IDS performance in detecting misuse of the AODV protocol has been discussed. In all the cases, the attack was detected as a violation to one of the AODV protocol specifications. From the results obtained, it can be concluded that our IDS can effectively detect Sequence Number Attack, Packet Dropping Attack and Resource Depletion Attack with Incremental Deployment.The method has been shown to have low overheads and high detection rate. Our Intrusion Detection and Response Protocol for MANETs have been demonstrated to perform better than the ones proposed by Stamouli et al in terms of false positives and percentage of packets delivered. Since Stamouli et al do not report true positive i.e. the detection rate, we could not compare our results against that parameter with their method.

The implementation of the IDAODV protocol has shown its feasibility to work in real life scenarios; IDAODV performs real-time detection of attacks in MANETs running AODV routing protocol. The prototype has also given some insight into the problems that arise when trying to run real applications on an Ad Hoc network. Simulation results validate the ability of our protocol to successfully detect both local and distributed attacks against the AODV routing protocol, with a low number of false positives. The algorithm also imposes a very small overhead on the nodes, which is an important factor for the resource-constrained nodes.

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