ISSN (e): 2250 – 3005 || Volume, 07 || Issue, 10|| October – 2017 ||
International Journal of Computational Engineering Research (IJCER)

Wireless Ad Hoc Network: A Perspective on Issues and Challenges

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ABSTRACT
Wireless ad hoc networks consist of nodes that communicate over a typical wireless channel. Contrary to cellular networks, the nodes are not supported by any type of additional infrastructure, such as base stations, a wired backbone, a central network controller, etc. In this paper we surveyed the different types of ad hoc networks such as isolated ad hoc networks with large and small sizes and integrated ad hoc networks for the mobile access networks. We also have discussed some critical issues that must be overcome for this network paradigm to attain its full potential. In addition, this paper also introspect ad hoc networks challenges in terms of security and reviewed a certificate-based authentication scheme for wireless ad hoc network to deliver a robust and ubiquitous security support
Keywords: Cellular Topology; Issues, MANET, Nodes, Performance, Security, Wireless Ad Hoc

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Date of Submission: 24-10-2017 Date of acceptance: 04-11-2017

I. INTRODUCTION

Wireless Ad Hoc network is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration, in which individual nodes cooperate by forwarding packets to each other to allow nodes to communicate beyond direct wireless transmission range (As shown in Fig.1) [1].

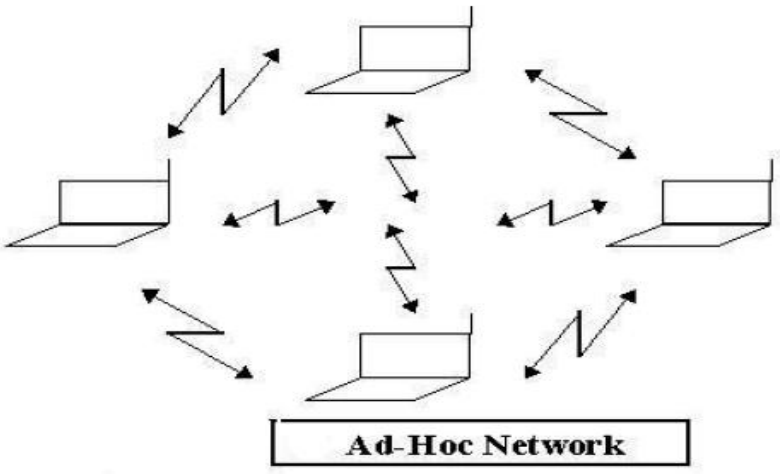

Figure 1 Wireless Ad Hoc Network

Wireless Ad Hoc Networks are mainly used for military applications, emergency search and rescue operations, deployment of sensors, conferences, exhibitions, virtual classrooms and operations in environments where construction of infrastructure is difficult or expensive. Due to lack of infrastructure and decentralized nature, they have become more popular within the computing industry. One obvious advantage of this kind of network is that they are fast to build. Contrary to cellular networks, where an extensive infrastructure must be installed, ideally, wireless ad hoc networks should be formed automatically whenever any number of nodes happen to be in the vicinity of each other [2][3][4].

II. DIFFERENT ARCHITECTURES OF AD HOC NETWORK

Wireless Ad Hoc Network is further categorized in the followings two ad hoc network [5].

A. Ad Hoc Network- Isolated

If all nodes communicate with each other within the same ad hoc network then it is called isolated ad hoc network. The isolated ad hoc network has no link with any infrastructure-based communication network, such as the global Internet (As shown in fig. 2).

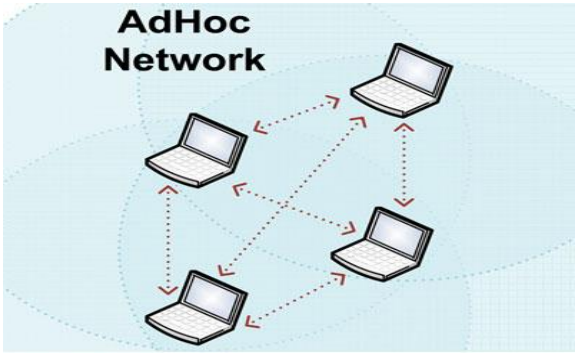

Figure 2 Ad hoc Network Isolated

The classification of the isolated ad hoc networks are: ¾ large scale isolated ad hoc networks ¾ small scale isolated ad hoc networks. A large scale isolated ad hoc network may consist of thousands of nodes. It is not suited to transmit huge quantity of data because these types of networks that causes higher security problems, high network architecture costs and very low level traffic performance. Small size ad hoc networks may have elevated commercial uses in smart home environments, business meeting places, hotspots, and also in some private areas. The promising wireless LAN technologies that enable the small size ad hoc networks are:

- IEEE 802.11
- HiperLAN2
- Bluetooth B

B. Ad Hoc Network – Integrated

In this kind of network, nodes may have link with any infrastructure-based communication network, such as the global Internet (As shown in fig. 3). Smart phone integration of ad hoc networks among different type of technologies are kept under such network.

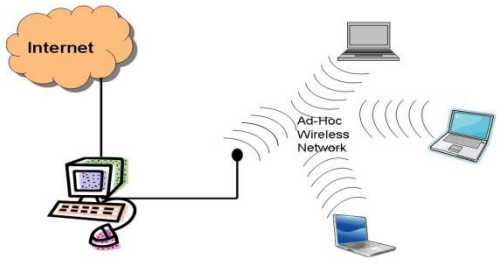

Figure 3 AD HOC NETWORK INTEGRATED

The wireless technologies are used by the network at three different layers as shown below in the table 1. The three layers are *device, physical,* and *application and service* (protocol) [6][7].

Table 1 Different Layers of Wireless Technologies

Layer	Technologies
Application and service	Wireless applications: WAP, i-mode, messaging, Voice over Wireless network, VoIP, location-based services
Physical	Wireless standards: 802.11a, 802.11b, 802.11g, AX.25, 3G, CDPD, CDMA, GSM, GPRS, radio, microwave, laser, Bluetooth, 802.15, 802.16, IrDA
Device	Mobile devices: PDAs, notebooks, cellular phones, pagers, handheld PCs, wearable computers

III. ISSUES AND CHALLENGES

Wireless Ad-hoc Networks are different from the well-known wired networks, it is an absolutely new architecture. Thus some challenges raise from the two key aspects: self-organization and wireless transport of information [10].

a. Mobility Prediction

Mobility prediction of a node is the estimation of its future locations. The definition of location depends on the type of wireless networks. In infrastructure networks location refers to the access points to which mobile terminal is connected. In infrastructure-less networks the location refers to geographical coordinates. Its main advantage is to predict the link expiration time to improve the node connectivity and routing performance. However, no studies discuss about the prediction of future locations considering realistic scenarios. This is one of the biggest challenges in MANETs.

b. Connectivity Efficiency and Cost Objective

So as to set up network in which requirement of nodes and deployment cost of static nodes must be taken into account. While placing the critical nodes in the network more concentration should be given on to maximize the connectivity and to have minimum cost of the route. But to achieve both cost objective and connectivity efficiency while spreading the critical node in the wireless network is considered a NP-complete problem. However, some researchers have attempted this part but no work has done to find the critical routes and critical nodes considering the both factor cost objective and connectivity efficiency. Since it is NP-complete problem, more optimized technique need to be followed in order to achieve this goal.

c. Energy Consumption issues

One of the key challenges is to save the limited energy and use it to prolong the network lifetime considering the network connectivity constraints. Since the energy is the most valuable resources in wireless network, its status should continuously be monitored after network deployment.

d. Bandwidth constrained

Bandwidth is also a big challenge for the researchers. As wireless links have significantly lower capacity than their hardwired counterparts. Also, due to multiple access, fading, noise, and interference conditions etc. the wireless links have low throughput [8].

e. Limited physical security

Wireless Ad hoc networks are usually a lot of vulnerable to physical security threats than fixed cable networks. There are more possibility of denial-of-service attacks, eavesdropping and spoofing in these networks. That's why it is always remain a major concern for the researchers [9].

Robust and Ubiquitous Security Support for Wireless Ad hoc Network

There are three main phases in Certificate-based authentication scheme [11]. The first phase is also known as "bootstrapping" phase, in which certificates are issued to the nodes through the certifying authority. The certificate is formed by the CA using the node's identity information, such as name, organization, IP address and its public key. The certificate additionally consists of the issuing time and the expiration time besides containing different information. During the second phase the certificate is "renewed" because of its expiration. The third phase involves revocation of the certificate by the CA, probably because of compromise of the private key of the certificate holder, or most likely as a result of the network believes that the user key binding is not any longer valid. Some of the proposed mechanisms are surveyed within the following sub-sections:

The certificate creation process is as follows: Initially all the nodes in the network need to be bootstrapped with their certificates from a trusted central management. When a new node wants to get its concern certificate, it is subject to sends a request to *k* neighboring nodes requesting for partial certificates. If the coalition thinks that the requesting node is a well-behaved node, they issue their partial certificates, which are then combined together by the target node to issue the new certificate using an interpolation function.

The certificate renewal process is performed by defining a renewal Time $T_{renew.}$ To renew a certificate, a network entity broadcasts its current valid certificate and a future expiration time $T <$ (current time + T_{renew}) to its k one-hop neighbors in the network. The neighboring nodes check the system public key and the Certificate Revocation List to determine whether to accept or deny the request.

The certificate revocation is performed by two ways as recommended by implicit or explicit mechanisms. In the implicit mechanism, the certificates are revoked if the expiration time (T_{expire}) is lesser than the time of issue plus the time of renewal (T_{renew}). On the other hand, during the explicit certificate revocation mechanism, every node in the wireless network contains a Certificate Revocation List having those certificates in it that haven't expired so far. The node once in a while consults its CRL for expired certificates and revokes them if it is found essential. The basic advantage of this method is that it does not require any centralized

certificate authority. Though, it depends on every node in the network which contains at least *k* one-hop neighbors for authentication. However, this may not be practical when k is large due to the dynamic nature of the nodes. Further, the certificates cannot be issued to nodes which are more than a hop away. It also requires a bootstrapping phase in order to distribute the system private key among *k* nodes initially.

IV. CONCLUSION

This paper presents various aspects of ad hoc networks and discusses the issues and challenges which encounter while creating the wireless ad hoc network. This network can also improve the performance of some existing networks and provide a wider range of services if integrated with existing networks. Thus this paper concludes that the ad hoc network surely provides a promising solution to fulfil the requirements of next generation wireless communication systems.

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International Journal of Computational Engineering Research (IJCER) is UGC approved Journal with Sl. No. 4627, Journal no. 47631.

Kavita Bhatnagar Wireless Ad Hoc Network: A Perspective on Issues and Challenges." IInternational Journal of Computational Engineering Research (IJCER), vol. 7, no. 10, 2017, pp. 53-56.