Chapter 81
A Study of Research Trends and Issues in Wireless Ad Hoc Networks

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ABSTRACT

Ad hoc networks enable network creation on the fly without support of any predefined infrastructure. The spontaneous erection of networks in anytime and anywhere fashion enables development of various novel applications based on ad hoc networks. However, ad hoc networks present several new challenges. Different research proposals have came forward to resolve these challenges. This chapter provides a survey of current issues, solutions, and research trends in wireless ad hoc networks. Even though various surveys are already available on the topic, rapid developments in recent years call for an updated account. The chapter has been organized as follows. In the first part of the chapter, various ad hoc network issues arising at different layers of TCP/IP protocol stack are presented. An overview of research proposals to address each of these issues is also provided. The second part of the chapter investigates various emerging models of ad hoc networks, discusses their distinctive properties, and highlights various research issues arising due to these properties. The authors specifically provide discussion on ad hoc grids, ad hoc clouds, wireless mesh networks, and cognitive radio ad hoc networks. The chapter ends with a presenting summary of the current research on ad hoc networks, ignored research areas and directions for further research.

INTRODUCTION

During last few years, extensive developments have been observed in the domain of wireless network. Different communication technologies i.e. general packet radio service (GPRS), en-hanced data rates for GSM evolution (EDGE) and worldwide interoperability for microwave access (WIMAX) etc. have evolved and newer form of computing devices i.e. personal digital assistant (PDA), tablets and smart phones are appearing in the market. The wireless computing has progressed

from 1G to 4G communication networks. During this progression, various modes of wireless networking have emerged. The simplest form of wireless networking is communication among two or more fixed hosts in open air. The conventional television system operates on this mode. Another approach is *wireless networking with access point*. There are different wireless hosts that are allowed to move while the basic infrastructure is supported by set of fixed nodes called base stations or access points. However, this approach doesn't provide the flexibility to be used in emergency situations requiring quick deployment or networking in adversarial surroundings. The evolution of technologies has lead to development a new mode of wireless networking where the nodes arrange themselves on the fly in the form of a network without any infrastructure support. Such networks are called ad hoc networks.

PROPERTIES OF AD HOC NETWORK

Formally, A*d hoc Network G(N,E)* is defined as a collection of nodes $N=\{n_1,n_2,n_3,\dots\}$ connected by edges (Islam & Shaikh, 2012). The nodes are usually mobile with limited capabilities, links are volatile and insecure, and there are no dedicated nodes for addressing, routing, key management and directory maintenance etc. The nodes are themselves responsible for various network operations i.e. routing, security, addressing and key management etc. It is obvious from these characteristics that network protocols and algorithm that are currently available for wired and infrastructure-less wireless networks are not suitable for ad hoc networks (Islam et al., 2010). For example, a conventional routing algorithm when employed for ad hoc network can suffer from loops, stale routes and other issues due to the very sharp changes in the network. Similarly, the current security solutions are based on availability of authentication servers, certification authority

and other security infrastructure, which are not generally available in ad hoc network. Therefore, new solutions are required for addressing various challenges of ad hoc network.

Different research efforts are underway to address various issues of ad hoc networks. In this chapter, we provide an adequate account of these efforts. There are already some surveys available that have summarized the previous researches on ad hoc networks. For example, Dow et al. (2005) and Singh et al. (2012) have provided a quantitative analysis of the number of research proposals appeared during last few years for addressing a particular issue of ad hoc network. Similarly, a summary of various research issues in ad hoc networks have been presented in (Chlamtac et al., 2003; Toh et al., 2005; Ghosekar et al., 2010; K.Al-Omari & Sumari, 2010). However, the focus of this chapter is on research pursued in ad hoc networks during recent years. The major contributions of this chapter are as follows:

- To provide a summary of various research issues in ad hoc networks and the recent approaches adopted to tackle these issues
- To investigate and report on various emerging models of ad hoc networking
- To present a comprehensive overview of issues and corresponding solutions for different ad hoc networking models i.e. ad hoc grids, ad hoc clouds, wireless mesh networks and cognitive radio ad hoc networks etc.
- To summarize the current state-of-the-art and avenues for further research

RESEARCH ISSUES IN AD HOC NETWORK

We start the discussion with an overview of major research issues in ad hoc networks. As discussed earlier, the issues arising in ad hoc network span across all layers of communication. In addition,

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