RESEARCH PAPER | Computer Science | Volume : 3 | Issue : 5 | May 2013 | ISSN - 2249-555X

A Survey on Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks

KEYWORDS: Routing protocol, ad-hoc wireless networks, resource constraints, error-prone channel state

U. Devee Prasan
Dept of CSE, Aditya Institute of Technology and Management, Tekkali, Srikakulam, Andhra Pradesh-532425

Dr. S. Murugappan
Dept of CSE, Annamalai University, Chennai, Tamilnadu

ABSTRACT *The major challenges that a routing protocol designed for ad hoc wireless networks faces are mobility of nodes, resource constraints, error-prone channel state, and hidden and exposed terminal problems. A detailed discussion on each of the following is given in the paper.*

I. INTRODUCTION

An ad hoc wireless network consists of a set of mobile nodes (hosts) that are connected by wireless links. The network topology (the physical connectivity of the communication network) in such a network may keep changing randomly. Routing protocols that find a path to be followed by data packets from a source node to a destination node used in traditional wired networks cannot be directly applied in ad hoc wireless networks due to their highly dynamic topology, absence of established infrastructure for centralized administration (e.g., base stations or access points), bandwidth-constrained wireless links, and resource (energy)-constrained nodes. A variety of routing protocols for ad hoc wireless networks has been proposed in the recent past. This paper presents the issues involved in designing a routing protocol for ad hoc wireless networks.

II. ISSUES IN DESIGNING A ROUTING PROTOCOL FOR AD HOC WIRELESS NETWORKS:

The major issues that a routing protocol designed for ad hoc wireless networks[6] faces are mobility of nodes, resource constraints, error-prone channel state, and hidden and exposed terminal problems.

1) Mobility:

The network topology in an ad hoc wireless network is highly dynamic due to the movement of nodes, hence an on-going session suffers frequent path breaks. Disruption occurs either due to the movement of the intermediate nodes in the path or due to the movement of end nodes. Such situations do not arise because of reliable links in wired networks where all the nodes are stationary. Even though the wired network protocols find alternate routes during path breaks, their convergence is very slow. Therefore, wired network routing protocols cannot be used in ad hoc wireless networks where the mobility of nodes results in frequently changing network topologies. Routing protocols for ad hoc wireless networks must be able to perform efficient and effective mobility management.

2) Bandwidth Constraint:

Abundant bandwidth is available in wired networks due to the advent of fiber optics and due to the exploitation of wavelength division multiplexing (WDM) technologies. But in a wireless network, the radio band is limited, and hence the data rates it can offer are much less than what a wired network can offer. This requires that the routing protocols use the bandwidth optimally by keeping the overhead as low as possible. The limited bandwidth availability also imposes a constraint on routing protocols in maintaining the topological information. Due to the frequent changes in topology, maintaining consistent topological information at all the nodes involves more control overhead which, in turn, results in more bandwidth wastage. As efficient routing protocols in wired networks require the complete topology information, they may not be suitable for routing in the ad hoc wireless networking environment.

3) Error-Prone Shared Broadcast Radio Channel:

The broadcast nature of the radio channel poses a unique challenge in ad hoc wireless networks. The wireless links have time-varying characteristics in terms of link capacity and link-error probability. This requires that the ad hoc wireless network routing protocol interacts with the MAC layer to find alternate routes through better-quality links. Also, transmissions in ad hoc wireless networks result in collisions of data and control packets. This is attributed to the hidden terminal problem [1]. Therefore, it is required that ad hoc wireless network routing protocols find paths with less congestion.

4) Hidden and Exposed Terminal Problems:

The hidden terminal problem refers to the collision of packets at a receiving node due to the simultaneous transmission of those nodes that are not within the direct transmission range of the sender, but are within the transmission range of the receiver. Collision occurs when both nodes transmit packets at the same time without knowing about the transmission of each other. For example, consider Figure 1. Here, if both node A and node C transmit to node B at the same time, their packets collide at node B. This is due to the fact that both nodes A and C are hidden from each other, as they are not within the direct transmission range of each other and hence do not know about the presence of each other. Solutions for this problem include medium access collision avoidance (MACA) [2], medium access collision avoidance for wireless (MACAW)[3], floor acquisition multiple access (FAMA) [4], and dual busy tone multiple access (DBTMA)[5]

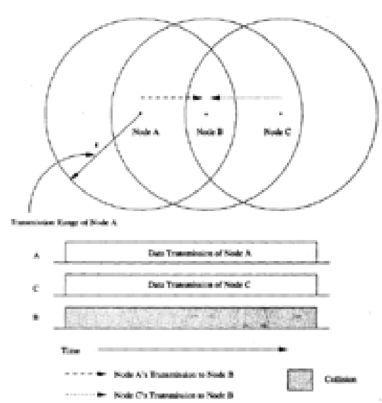

Fig :1 Hidden terminal problem.

Volume : 3 | Issue : 5 | May 2013 | ISSN - 2249-555X

MACA requires that a transmitting node first explicitly notifies all potential hidden nodes about the forthcoming transmission by means of a two-way handshake control protocol called the RTS-CTS protocol exchange. Note that this may not solve the problem completely, but it reduces the probability of collisions. To increase the efficiency an improved version of the MACA protocol known as MACAW[3] has been proposed. This protocol requires that the receiver acknowledges each successful reception of a data packet. Hence, successful transmission is a four-way exchange mechanism, namely, RTS-CTS-Data-ACK: Even in the absence of bit errors and mobility, the RTS-CTS control packet exchange cannot ensure collision-free data transmission that has no interference from hidden terminals. One very important assumption made is that every node in the capture area of the receiver (transmitter) receives the CTS (RTS) cleanly. Nodes that do not hear either of these clearly can disrupt the successful transmission of the Data or the ACK packet. One particularly troublesome situation occurs when node A, hidden from the transmitter T and within the capture area of the receiver R, does not hear the CTS properly because it is within the capture area of node B that is transmitting and that is hidden from both R and T as illustrated in Figure 2. In this case, node A did not successfully receive the CTS originated by node R and hence assumes that there is no on-going transmission in the neighborhood. Since node A is hidden from node T, any attempt to originate its own RTS would result in collision of the on-going transmission between nodes T and R.

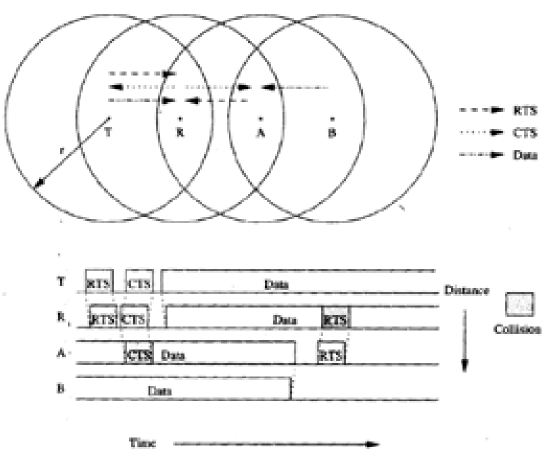

Fig :2 Hidden terminal problem with RTS-CTS-Data-ACK scheme.

The exposed terminal problem refers to the inability of a node which is blocked due to transmission by a nearby transmitting node to transmit to another node. Consider the example in Figure 3. Here, if a transmission 1rpm node B to another node A is already in progress, node C cannot transmit to node D, as it concludes that its neighbor, node B, is in transmitting mode and hence should not interfere with the on-going transmission.

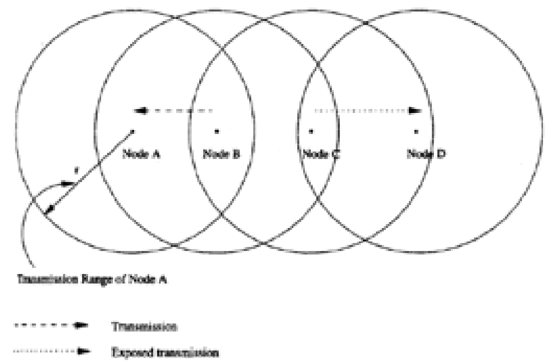

Fig: 3 Exposed terminal problem.

Thus, reusability of the radio spectrum is affected. For node C to transmit simultaneously when node B is transmitting, the transmitting frequency of node C must be different from its receiving frequency.

5) Resource Constraints:
Two essential and limited resources that form the major constraint for the nodes in an ad hoc wireless network are battery life and processing power. Devices used in ad hoc wireless networks in most cases require portability, and hence they also have size and weight constraints along with the restrictions on the power source. Increasing the battery power and processing ability makes the nodes bulky and less portable. Thus ad hoc wireless network routing protocols must optimally manage these resources.

REFERENCE

[1] C. L. Fullmer and J. J. Garcia-Luna-Aceves, "Solutions to Hidden Terminal Problems in Wireless Networks, " Proceedings of ACM SIGCOMM 1997, pp. 39-49, September 1997. | [2] P. Kiran, "MACA – Anew channel Access Method for Packet Radio," Proceedings of ARRL/CRRL Amateur Radio Computer Networking Conference 1990, pp. 134-140, September 1990. | [3] V. bharghavan, A. Demers, S. Shenker, and L. Zhang, "MACAW : A Media Access Protocol for Wireless LANs." Proceedings of ACM SIGCOMM 1994, pp. 212-225, August 1994. | [5] J. Deng and Z. Haas, "Dual Busy Tone Multiple Access (DBTMA): A New Medium Access Control for Packet Radio Networks," Proceedings of ICUPC 1998, Vol. 1, pp. 973-977, October 1998. | [6] A Text book Ad Hoc Wireless Networks-Architectures and Protocols by C. siva ram Murthy and B. S. Manoj