UDC 621.391

RESEARCH ON WIRELESS AD HOC NETWORK TECHNOLOGY

Y. WANG, P. ZENG, Z.J. WEI

Belarusian State University of Informatics and Radioelectronics, Republic of Belarus

Received February 20, 2022

Abstract. With the rapid development of communication technology and the improvement of people's requirements for communication, wireless AD hoc network has become an important research content of today's network. Wireless AD hoc network (WLAN) is a multi-hop, flexible, non-center network formed by several mobile wireless nodes self-organization. These characteristics provide a favorable guarantee for the military and civilian communication field. This paper first introduces the characteristics and applications of wireless AD hoc network. Secondly, the problems of existing routing protocols are studied. Finally, according to the problems of energy consumption, multipath and multicast in wireless AD hoc network, six methods are summarized to optimize the system and improve the transmission performance of wireless AD hoc network.

Keywords: wireless AD hoc network; routing protocol; rerformance optimization.

Introduction

Wireless AD hoc network is a multi hop, no center, temporary system. Each node in the network can be configured for fast networking, short networking time, and low system cost. It can work independently or with other networks in the form of subnets. The management of AD hoc network is relatively simple, without the control of the central base station, so it has good robustness and flexibility. In the military field, civil aviation technology has been widely used and has become a feasible or even the only feasible communication solution for temporary situations. Its characteristics are as follows:

1. No center: Without the support of base station and other control centers, each node in the network is equal.
2. Self-organization: After a node is powered on, it can automatically discover neighbor nodes for fast networking.
3. Multi-hop: When two communication nodes are not within the transmission range, the intermediate node can be forwarded.
4. Dynamic topology: Nodes can be moved randomly. Nodes in the network can join or leave at any time, resulting in changes in the topology structure.
5. Limited energy: AD hoc networks are often used in temporary situations. Most nodes are powered by batteries, playing the dual identity of terminal nodes and relay nodes. The exhaustion of energy will not only make a single node fail, but also may change the whole network topology.
6. Security: Without the help of a trusted third party, it is vulnerable to link layer attacks, eavesdropping and damage.

According to the above characteristics, it can be found that the wireless AD hoc network has great advantages compared with other networks, but there are some shortcomings in network security and energy saving. In order to make the wireless AD hoc network more reliable and bring greater benefits to our life, routing protocol is the core and lifeblood of the network and efficient and reliable routing protocol is the guarantee of the normal operation of the system.

Protocols for wireless AD hoc networks

According to the route discovery policy, routing protocols are divided into three types: table-driven routing protocols, on-demand routing protocols, and hybrid routing protocols, as shown in Figure 1.

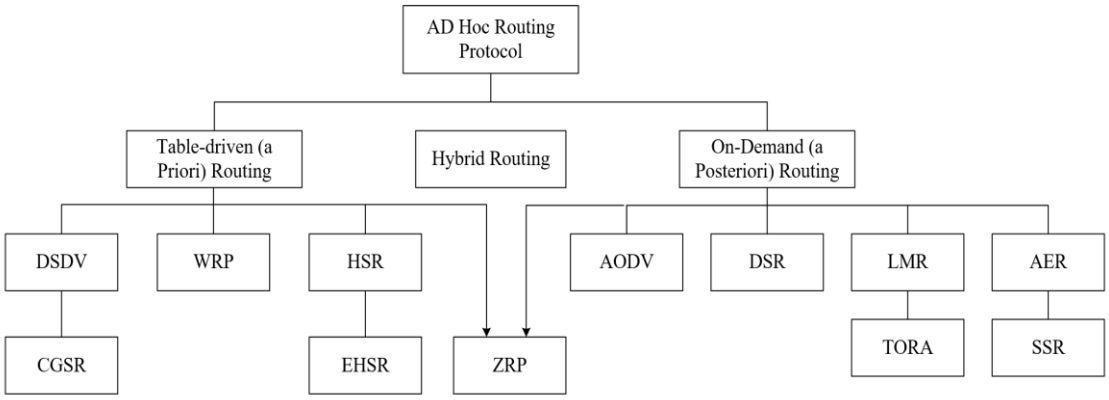

Figure 1. Common routing protocols for AD Hoc networks

On-demand Routing Protocol. This protocol includes route discovery and route maintenance. Nodes do not need to exchange information at any time, but maintain routing messages. When a node sends data packets, the route discovery function is enabled and the packets are forwarded in the form of flooding. Disadvantages: Latency of the initial route is a problem because the routing node looks up the route on demand without storing the route information beforehand. In some emergencies, the message delay may be delayed to the event because great influence. Advantages: Since there is no need to periodically broadcast, the network overhead is reduced.

Table Driven Routing. ProtocolEach node needs to maintain a routing table to transmit data according to the routing table, update the routing table in real time, and establish routes from the source node to the destination node. Each node in the network maintains a routing message table to the other nodes, so each node must have a high storage capacity. Disadvantages: Nodes need to master the topology of the whole network, so it is only suitable for small-scale networks. Nodes are always in working state, which will increase the network control cost and reduce the network life time. Advantages: The protocol always establishes routing links, and the delay between nodes is small. It can quickly adapt to network topology changes, and the packet loss rate to the system is small.

Hybrid Routing. Based on the analysis of the above performance and their respective advantages, a hybrid routing protocol is developed which is more excellent than each other. To improve the transmission efficiency of wireless AD hoc network system, the research results of literature [1] show that hybrid routing protocol (DSR+ FSR) has the characteristics of fast convergence, strong adaptability of network environment, stable and reliable routing information, and is more suitable for complex network environment.

Method of routing protocol optimization

Wireless AD hoc network is a mobile network. The topology changes constantly, which degrades the network performance. Therefore, it is crucial to select the appropriate routing protocol for different environments. The routing protocol is improved from the perspectives of service quality, energy saving, security, multipath, multicast, topology and so on. Aiming at these shortcomings in the system, six technologies are summarized to optimize wireless AD hoc networks, including packet aggregation technology, local repair, local spanning tree, network coding technology, cross-layer routing, and self-adaptation.

Packet aggregation technology, the technology is to reduce the number of nodes to send packets. Instead of immediately forwarding data every time, nodes wait for the maximum aggregation time. During the aggregation time, new data packets are added to the queue, waiting for the data to be sent. Especially in areas with dense nodes, this data transmission mode will reduce the probability of collision.

In addition, several data packets are aggregated into one UDP broadcast packet to reduce the transmission times of data. The new routing protocol BATMAN adv uses packet aggregation technology to reduce the system overhead and improve the system utilization.

In the local repair technology, when the link between nodes changes, it should inform other nodes of the change as soon as possible, readjust and calculate the shortest path. The faster the link status changes, the more overhead is incurred. The local repair technology can reduce the network delay. Local link repair technology pays more attention to route connectivity, reduces route cost and shorens route recovery time. Literature [2] proposes a new multi-metric wireless routing protocol based on AODV, which comprehensively considers four factors, including minimum hops, residual energy, and energy loss rate and network node density. Most importantly, a low-cost and efficient repair strategy is introduced to optimize AODV and improve the performance of routing protocols in network systems.

For broadcasting based on local spanning tree, routing protocols all adopt flooding technology to improve the efficiency of flooding and reduce the cost of flooding. The optimal method of flooding technology is minimum spanning tree for broadcasting, but minimum spanning tree must master the topology of the whole network, so it is not advisable before the establishment of routes. Therefore, it is possible to broadcast through local spanning tree, and broadcast in the form of packet, which can reduce the cost of the network and increase the service life of the network compared with the simple use of flooding. OLSR routing protocols flood broadcast link information using a local spanning tree approach.

Network coding technology, which can improve system throughput. Aiming at the broadcast characteristics of the physical layer of wireless AD hoc networking, scholars have proposed a network coding routing protocol [3-5]. The protocol changes the previous channel mode, fuses a large number of packets encoded by each target node, and then sends the packets to each target node, improving the throughput of the network. Peng Yongxiangzai [6] proposed a code-aware unicast routing protocol for multi-hop wireless networks. This protocol effectively describes network programming in a special way

The routing measures of code and unicast session characteristics, and the routing protocol is improved. In order to ensure that this routing metric can be effectively combined with widely used routing algorithms, a unique mapping procedure is used to ensure that common routes can obtain the path with the most coding opportunities. Simulation results show that the proposed routing protocol can improve network throughput. The application of network coding technology has greatly improved the performance of routing protocol.

The idea of cross-layer can realize the interaction parameters between various protocol layers of wireless Ad hoc network or integrate some network layers, to improve the overall performance of wireless AD hoc network. The cross – layer idea points out a new way for the research of network congestion control algorithm in the future. Xiao Ping's master's thesis [7] proposed an energy-efficient cross-layer energy-saving protocol, which was optimized based on MBCR protocol and considered the retransmission of data packets generated by node use of energy and power. The route consumption is taken as the measurement criterion for route selection, and the cross-layer method is adopted to collect the information such as residual energy and transmitting power of nodes at the physical layer. The transmission power is dynamically adjusted at the link layer according to the requirements of the network layer, and the route is selected according to the total energy consumption from the source node to the destination node at the network layer, thus reducing the consumption of routing protocols. The AODV routing algorithm is optimized. The improved algorithm (CLC-AODV) no longer uses periodic message sending for routing maintenance, but carries out periodic interaction through the grouping of RTS and RSP in the improved cross-layer MAC layer algorithm, obtains the topological relationship between the two hop ranges of nodes, and establishes local response routing. Moreover, efficient routing and fast repair mechanism are implemented to improve the performance of AODV.

Adaptive technology. For multi-hop mobile networks, topology changes degrade network performance. Adaptive technology can automatically select appropriate routing protocols and adjust routing parameters according to network changes to achieve the best results. Adaptive technology is described in this paper. For OLSR active routing protocol, an adaptive adjustment mechanism of protocol parameters and an adaptive multipath routing algorithm are proposed, and an adaptive multipath routing algorithm is proposed based on Linux platform. Moreover, the adaptive adjustment mechanism of OLSR protocol parameters, according to the local node link changes, to adjust the message sending interval. Wang Yanbin [8] studied the on-demand routing protocol AODV and proposed an adaptive routing protocol AODv-AOW combined with clustering algorithm. In the study

of MANET and DTN network architecture in [9], an adaptive routing protocol is proposed, which utilizes the characteristics of different network environments to achieve optimal routing performance. Based on adaptive technology, the routing protocol SEHR improves the transmission performance of wireless AD hoc networks.

Conclusion

Aiming at service quality, energy consumption, security and other problems, a variety of technologies are proposed to optimize the routing protocol, which greatly improves the transmission efficiency of routing protocol in the system. Finding out the way to solve the existing routing problems is a key problem that many scholars have been studying. In this paper, six main technologies are summarized to optimize the routing protocol of wireless AD hoc network. These technologies have significantly improved the performance of routing protocols. With the continuous improvement of people's requirements on network technology, more problems will appear. Therefore, it is necessary to continuously improve wireless AD hoc networks, especially to explore and study the changes of wireless AD hoc networks topology.

References

1. Yang P., Tian C., Zhang L. // Chinese Journal of Applied Sciences. 2006.
2. Sun Y. // Chengdu: Electronics University of Science and Technology. 2016.
3. S Katti., H Rahu.l, Wu H., [et al]. SIGCOMM Computer Communication Review. 2006. 243-254.
4. Zheng S., Hu S., Chen J., Li Z. // Multi-metric wireless based on AODV Research on Routing Algorithm. 2016.
5. S Katti., D Katabi., H Balakrishnan., [et al] // SIGCOMM Computer Communication Review. 2008. P. 401–412.
6. Peng Y. // Chengdu: University of Electronic Science and Technology of China. 2013.
7. Xiao P. // Jilin University. 2011.
8. Wang Y. // University of Electronic Science and Technology of China. 2015.
9. Dong M. // Xidian UniversityScience. 2009.