WMN Routing Scheme to Reduce the Traffic Overhead based on GPS-Addressing

S V Vambase* and Dr. S R Mangalwede**
*Asst. Professor, Dept. of M. Sc.(CS), BLDEA's S B Arts & K C P Science College, Vijayapur, KA, INDIA
santosh.vambase@gmail.com
**Professor, Dept. of Computer Science & Engineering, Gogte Institute of Technology, Belagavi, KA, INDIA.
srmangalwede@gmail.com

Abstract: The mesh topology in computer networks provides robustness and is suitable for applications that generate petite and significant data. The computer network has realized that it needs a multifaceted Wireless Mesh Network (WMN) for systems such as effective sharing of electricity. This paper extends the previous work and investigates the WMN architecture to propose a novel routing protocol (pro-active and reactive) for synchronized communication in Wireless Mesh Network. The authors broach an efficient utilization of network resources in mesh network thereby reducing the overhead in Layer-3, Layer-2 of TCP/IP protocol suite.

Keywords: Mesh Networks, Electrical Networks, Wireless ATM, Routing protocol.

Introduction

The multifaceted Wireless Mesh Network (WMN) provides better scalability and robustness in contrast with other networks. This paper focuses on the improvement in complexity and Network planning of WMN. Moreover, this paper investigates the WMN[1], the addressing scheme[2] and discusses the two aspects: routing protocol for Wireless Mesh Network and effective synchronization of communicating mesh nodes. The aim of proposed work is to form a Broadband-Hamnet suitable for routing the petite and crucial payload over the WMN, pointedly the payload structure[2] discussed by authors.
The literature survey [4-11] on Wireless Mesh Networks reveals that, the existing WMN protocol architecture incurs the considerable overhead in the network traffic. The control techniques - backpressure, shortest path routing, and Lyapunov optimization are suitable for WMN. The authors propose an optimized and effective routing protocol thereby reducing the overhead involved in traffic forwarding. The study on WMN reveals that the reduced overhead is necessary for multi-hop network. The various simulation tools [12] may be preferred for the implementation of proposed protocol.

Content structure

The remaining paper is organized as follows: Section II discusses the design and implementation covering different routing techniques of the proposed system. In section III, we discuss the aggregate overhead in network traffic. Finally, the Section IV focuses on conclusion and future work.

Design and Implementation

Address allocation module

The figure 1 depicts the communication between mesh node and various servers for address allocation. The mesh node when initialized, send request to Global Positioning System (GPS) server and obtains the GPS coordinates (4-byte latitude, 4-byte longitude). The mesh node forwards the GPS coordinates to Application- or Management-server. The Application- or Management-server processes and replies the 2-byte value representing index. The mesh node processes the 10-byte address and hive away in memory. The processed address acts as physical address in routing.

Routing table, Address format and Masking

The proposed addressing scheme enables each mesh node to have 10-byte address as unique physical address. The mesh node hives away the assigned address into EEPROM. The routing table for proposed addressing scheme consists of two components: (a) Index value and (b) Neighbor node address. The Index value provides the count of neighbor nodes. The Neighbor node address refers to the actual address of each neighbor node.

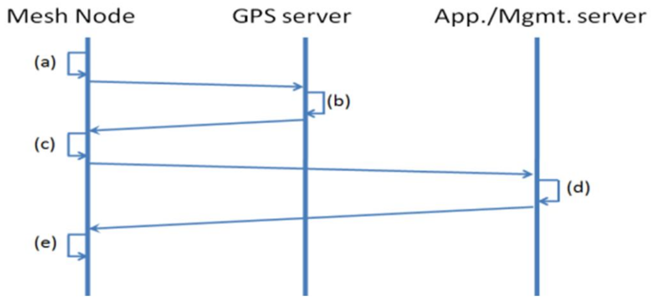

Figure 1. Address allocation in mesh node (Sequence diagram)

In IPv4/IPv6 network, the receiver node does masking of address by performing logical AND operation. However, in proposed network architecture the sender node (source/intermediate node) elects the appropriate neighbor node (next node) for routing the packets. Unlike IPv4/IPv6, the proposed address is in the form of 10-byte integer. The sender queries its neighbors for determining the difference between the neighbor node address and Destination node address. It then collects various differences and chooses the least thereby masking rest of the nodes. The sender now forwards the packet to the selected neighbor node. The neighbor node, when queried, computes the difference between itself and Destination node and hives the difference.

Reactive-routing module

The figure 2 depicts the sequence diagram for reactive routing protocol. The various operations are discussed below:

- (a) The source/sender node generates the node discovery request containing destination address and broadcasts the request to its neighbor nodes.
- (b) The neighbor/receiver node receives the request, determines the difference of destination address and itself. The computed difference acts as acknowledgement (ACK).
- (c) On receiving the ACK, the source/sender node selects neighbor node with least difference and forwards the packet.
- (d) On successful arrival of packet, the ACK will be dispatched.

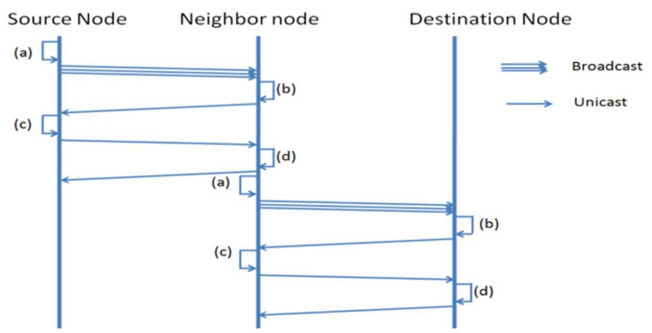

Figure 2.Reactive routing protocol for WMN (Sequence diagram)

The figure 3 depicts the flow of operations in proposed reactive routing protocol for WMN. The reactive routing approach is useful in networks having highly unreliable communication medium where the information about topology at each node gets obsolete in a wink.

Proactive-routing module

Unlike reactive routing protocol, the pro-active routing protocol uses routing table. The figure 4 depicts the sequence diagram. The various operations are as follows:

- (a) The source node forms the packet.
- (b) It then computes the difference of destination address and each entry in routing table. The entry with least difference is selected for routing the packet.
- (c) The neighbor node acknowledges the packet on receiving the each packet.
- (d) The neighbor node, will now act as source/sender node and continues the operation.
- (e) The destination node acknowledges the packet and processes the data.

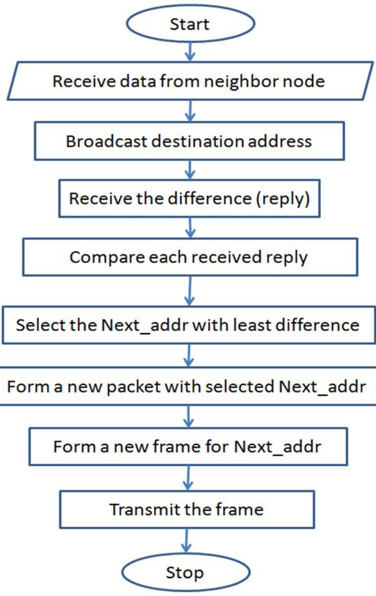

Figure 3.Reactive routing protocol for proposed system

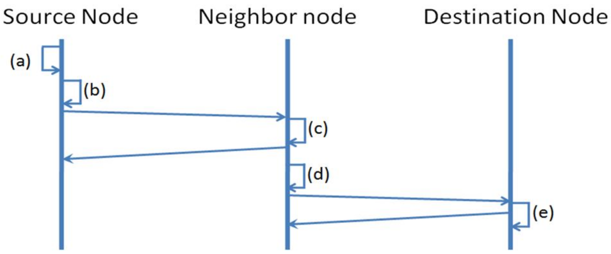

Figure 4. Proactive Routing Protocol in WMN (Sequence diagram)

The figure 5 shows the flow of operations for proactive routing protocol. In contrast to reactive routing approach, this approach avoids destination address broadcasting for each packet. However, it requires periodic updation of routing table through PING mechanism.

Proposed Packet format

The Table 1 lists the various fields and respective length in proposed packet format. The DESTINATION ADDRESS [2] and the SOURCE ADDRESS [2] are detailed by the authors. The TRAFFIC CLASS includes two values: differentiated services (6-bits) used to classify packets and management services (2-bits) used for Explicit Congestion Notification and priority values. The 2-byte FLOW LABEL is used to discriminate traffic flows and to detect the spoofed packets. It may be used by a source node to label sequences of packets for which it requests special handling by the mesh routers, such as non-default quality of service or "real-time" service. This aspect is still experimental and subject to change as the requirements for flow support in the WMN become clearer. Each node in proposed WMN supports the functions of the Flow Label when receiving or forwarding a packet The PAYLOAD LENGTH indicates the size (in octets) of the user/application data in the packet.

The HOP-LIMIT replaces the Time-To-Live (TTL) field of IPv4. The Hop-limit is reduced by one at each intermediate node visited by the packet. The packet is discarded if Hop-Limit is zero.

The PAYLOAD contains the actual data (0-1023 bytes) generated by user applications.

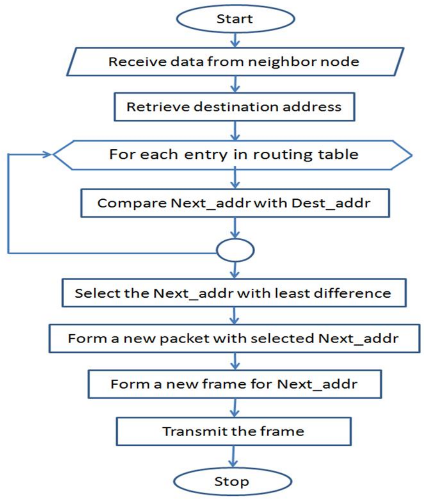

Figure 5. Pro-active routing protocol for proposed system

Table 1. Various fields in packet format for WMN

Field	Length
DESTINATION ADDRESS	10 bytes
SOURCE ADDRESS	10 bytes
TRAFFIC CLASS	1 bytes
FLOW LABEL	2 bytes
PAYLOAD LENGTH	10 bits
HOP-LIMIT	14 bits
PAYLOAD	0-1023 bytes

Proposed Frame format

The frame format of IEEE 802.11 is shown in figure 6 which includes the overhead of 34 bytes and network data of 0-2312 bytes. However, the proposed protocol reduces the frame overhead bits by 24 bytes. The figure 7 depicts the proposed frame format. The proposed frame format defines overhead of 10 bytes by eliminating Address 1, Address 2, Address 3 and Address 4. The 2 bytes of frame control in IEEE 802.11 remains unchanged in proposed frame structure.

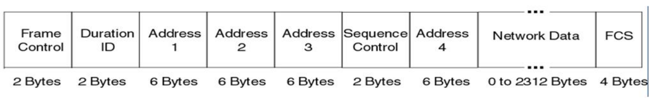

Figure 6. IEEE 802.11 frame format (src: www.google.co.in)

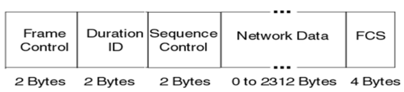

Figure 7. Frame format for proposed network

Aggregate Overhead Traffic in Network

This section discusses the significance of proposed multi-hop network in comparison with IPv4 network and IPv6 network. The figure 8 depicts the overhead in proposed network, IPv4 and IPv6 networks respectively.

IPv4 network

The IP datagram format for IPv4 network includes an overhead of 24 bytes. The frame format for WLAN includes overhead of 34 bytes. Collectively, the overhead associated with each data packet is 58 bytes. (src: www.google.co.in)

IPv6 network

The IP datagram format for IPv6 network includes an overhead of 40 bytes. However the frame format for WLAN depicts the overhead of 34 bytes. Conjointly, the overhead associated with each packet is 74 bytes. (src: www.google.co.in).

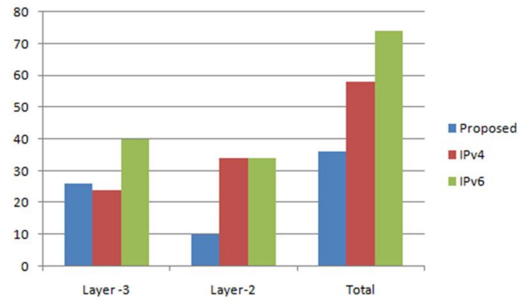

Figure 8. Respective Overhead in IPv4, IPv6 and proposed network.

Proposed multi-hop network

The IP datagram format for proposed network includes an overhead of 26-bytes. Withal, the proposed frame format depicts the reduced overhead of 10-bytes. Conjointly, the overhead associated with each packet is 36 bytes.

Conclusion

In this article, the routing issues associated with multifaceted WMN are discussed. The authors extend the previous work[1,2] and propose a novel routing protocol (pro-active and reactive). The proposed routing protocol ensures network traffic with reduced overhead. The revised packet format and frame format are also discussed in this article. The proposed protocol suite incorporates the features of IPv6. In contrast to overhead associated with IPv4 and IPv6 network, the proposed network incurs reduced overhead of 20.88% and 51.36% respectively.

The proposed routing protocol can be implemented using the NS2/NS3 network simulator or OMNET++ including INET module. The future implementation of proposed work focus on the latency associated with node synchronization, robustness of the architecture and multi-hop forwarding.

Acknowledgment

This work is partially funded by the BLDEA's S B Arts and K C P Science college, Vijayapur, KA, IN, for Education and Scientific Research project. The authors are thankful to the Principal for providing the resources and funds for the research work.

References

[1] S V Vambase, S R Mangalwede, "A novel cross layer wireless mesh network protocol for distributed generation in electrical networks", IEEE, ISBN: 978-1-4799-6629-5, 2014, Pg: 885-888.
[2] S V Vambase, S R Mangalwede, "ATM based WMN architecture for Distributed Generation systems in electrical networks", IEEE, ISBN: 978-1-4673-7910-6, 2016, Pg:119-123.
[3] K S Mathad, S R Mangalwede, "Scheduling Approaches and Routing Protocols in Wireless Mesh Networks-A Survey", IJARCCE, ISSN 2278-1021, 2015, Pg:307-310.
[4] Esmaeil Nik Maleki, Ghasem et.al., "Cross layer optimization framework for fault-tolerant topology control in wireless mesh networks", IEEE, ISBN: 978-1-4673-8789-7, 2016, Pg: 288 – 293.
[5] Karthika K.C, "Wireless mesh network: A survey", IEEE, ISBN: 978-1-4673-9338-6, 2016, Pg: 1966 – 1970.
[6] Sven Zehl, et.al., "LoWS: A complete Open Source solution for Wi-Fi beacon stuffing based Location-based Services", IEEE, ISBN: 978-1-4673-8746-0, 2016, Pg: 25 – 32.
[7] Raffaele Bruno, Marco Conti, et.al., "Mesh Networks: Commodity Multihop Ad Hoc Networks", IEEE Communications Magazine, 2005.
[8] Michael J. Neely , Rahul Urgaonkar, "Cross Layer Adaptive Control for Wireless Mesh Networks", ADHOC NETWORKS (ELSEVIER), Vol 5, 2007, Pg: 719-743.
[9] Steve Glass, Marius Portmann, and Vallipuram Muthukkumarasamy, "Securing Wireless Mesh Networks", IEEE INTERNET COMPUTING, 2008.
[10] Yang Yang W Konstantina Papagiannaki Song Ci Sherman Shen, "Wireless Mesh Networks: Applications, Architectures, and Protocols", IEEE Network, 2008.
[11] Ian F. Akyildiz, Xudong Wang, Weilin Wang, "Wireless mesh networks: a survey", Elsevier, Computer Networks, 2005, Pg: 445–487.
[12] Piotr Owczarek and Piotr Zwierzykowski, "Review of Simulators for Wireless Mesh Networks", JTIT, 2014, Pg: 82-89.