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Scalability Analysis using Auto-configuration process for coalescing of heterogeneous Wireless adhoc networks

Pradeep Kumar Gaur
Ph.D Research Scholar, Department of Electronics and Communication Engineering
Sant Longowal Institute of Engineering & Technology, Longowal, Distt.- Sangrur, India.

Corresponding Author

Dr. (Mrs.) Anupma Marwaha
Professor, Department of Electronics and Communication Engineering
Sant Longowal Institute of Engineering & Technology, Longowal, Distt.- Sangrur, India.

Abstract

Internet of Things is the buzz word these days for connecting the world wherein heterogeneous networks is an inevitable component for real life research and applications. Researchers of different working groups are working independently to maintain the utility of current infrastructure with the new generation evolving network standards. Wireless ad hoc networks (WANET) provides a substantial support in achieving the impossible notion of linking each and every node across the global horizons. This is fruitful only because of their infrastructure less, autonomous and multi-hopped features. This research work examines an approach of self-assigning of node addresses to nodes working in adhoc environment for transacting packets between themselves and other nodes of infrastructure based network and for maintaining efficient duplex communication. Multiple heterogeneous network of nodes have been made to work in cohesion for standard packet transmission. The nodes are evaluated using the two available addressing nodes using various performance parameters with respect to increasing no. of nodes. Further it was realized that nodes configured with IPv6 addresses behaved better than the IPv4 configured nodes while maintaining two way communication in between heterogeneous nodes.

Keywords: Duplex Communication, Infrastructure less, wide WANET, RREQ_I , RERR

INTRODUCTION

Wireless Adhoc Networks are categorized as autonomous networks characterized by infrastructure less, self-configured working with distributed operation, dynamic topology, multi-Hop routing and bandwidth constrained conditions. Various Research groups are working together to technically coalesce existing network infrastructure with the new advancements in upcoming next generation network standards. The user nodes of the network are expected to transact under a bandwidth limited environment having wireless links due to moving adhoc nodes and varying network topography over space and time. Further there is no fixed administrator to be demarcated in the WANET, so every working node has to do the operation for discovering topography and message delivery. [1]

A wide Wireless ad-hoc network (wide WANET) is formed and extended by deploying nodes of different network connected using wireless links; individual node act as an end system as well as a router on random basis for other nodes in the network. The wireless path formed between each pair of end systems may have multiple links and radio can be heterogeneous to organize the network in random fashion. Since the nodes are moving in nature so identification of nodes is required and which is considered to be a tedious task in wireless ad-hoc networks. Auto configuration algorithm is used to configure and manage the individuality of the nodes.

It is a well known fact that data is corrupted quite easily in Wireless domains resulting in huge packet loss and hindering the performance of transport layer. So acknowledgements be used to reduce packet loss due to collisions and medium issues as is done in solutions to hidden terminal problems by adopting similar to RTS-CTS exchange program.

The active challenge in designing and development of wireless sensor networks for a specific application is the support of the functional and non-functional requirements such as data latency and data integrity respectively while taking into account the computation, energy and communication constraints [3], besides integrating various network standards for transacting packets of different length of bytes while hoping through multiple mobile nodes, varying topology and changing access points or coordinators. Such challenges are taken care of and resoluted with the design and implementation dynamic routing protocols. In this paper impact of IPv6 addressing to nodes is improvised with the help of various parameters for the identified heterogeneous networks. The research paper follows with the related work done by the researchers in the field of integration of network standards forming wide wireless Adhoc networks. The subsequent section will illustrate the methodology adopted for discovering and address configuration of the active nodes of individual network standard and corresponding communication amongst themselves as per random and dynamic topology followed by discussion of results and conclusion.

RELATED WORK

Park et al provided a solution to enable global connectivity for adhoc mobile nodes by allocation of IPv6 protocol based addresses wherein an Internet gateway is used to link the connection. In this paper, the authors considered the hybrid MANET where the pure MANET is interconnected to the external Internet by some gateways. A modified new stateless address allocation protocol is presented for the global-scope address allocation in this hybrid MANET. The protocol devised and implemented the authors involves enhancement of duplicate address detection (DAD) mechanism of the address auto configuration protocol for reducing the latency of address allocation time. [2]

Ghassemian et al. analysed Gateway Discovery Algorithms for connecting internet with the Ad hoc Networks for different set of nodes. The authors evaluated the scalability methods applicable to interconnection of ad hoc networks to the Internet. The scalability comparison of these mechanisms is presented by means of analytical modeling with respect to different parameters such as number of mobile nodes, rate of link changes and rate of traffic sessions per each mobile node. Feedback Control Algorithm is proposed to optimize the overall overhead generated by the discovery protocols, which can adapt to period and transmission range of gateway advertisements. [4]

Khan et al examined the process of network migration for segregation while evaluating the performance of the IPv4 and Ipv6 protocols over bandwidth utilization and round trip time performance metrics. Authors acknowledged over all the performance of the router-to-router tunneling is superior then the host-to-host tunneling after performing various experiments and analyzing all results. This happens because of the fact that host-to-host tunneling generates more head then the router-to-router tunneling in the both the platforms but Linux performs better than the Windows platform. Both the IP protocols produced better results in linux environment as routers work on the layer3 of OSI N/W model. [5]

Morgan & Kunz worked on facilitation of a homogeneous seamless QoS interaction between both heterogeneous networks by employing a new framework at the gateway between the ad-hoc domain and the DiffServ access domain. The objective is to achieve a high level of performance and autonomy with a lightweight implementation, if any, on mobile nodes. The cross-domain QoS problem and use the aggregate resource reservation (ARSVP) for collective resource reservations, combined with a simple sponsorship mechanism has been solved with the new framework. The QoS policies has been enforced by the proposed gateway which uses admission control and re-marks all RT-packets based on the provided marking map. The proposed model further facilitated context control on per-aggregate bases as required by authenticated sponsor for all services. [6]

Li et al suggested that the study and analysis of prefix level characteristics of IPv6 networks is essential for enhancing performance management. In this paper the authors found from their observations that 48-bit width TCAM entry would be sufficient to catch the prefixes that relates to the skewed traffic distribution across the network, emancipating further that the number of vanishing and emerging prefixes are relatively stable whereby degenerating the need for swapping of prefixes in the cache. They proposed and validated a framework of MTE which may help in integrating monitored information for tuning of performance. [7]

Patel and Shah proved through the simulation results that the variations in the AODV implemented in the network provide better route discovery time and throughput if the malicious node is taken into account. Ad hoc network are prone to link attacks ranging from passive eavesdropping to active impersonation, message replay and message distortion due to the wireless nature of the deployed links. The routing protocols for Ad hoc networks including AODV can handle appreciatively the dynamically changing topology but are lesser equipped to defend malicious attackers. In this paper Authors have tried to study the impact of deployed malicious node which periodically drops packets and its impact on wireless LAN and AODV routing. Further the improved AODV detects and avoids link connection with such nodes while route is established in AODV. [8]

Wu et al. studied the heterogeneous wireless network to introduce a Multi-dimension self-organized model. The authors innovated a cross layer organizational model combining combined measurement report of link layer, route of network layer and the shift strategy in application layer. This paper focussed on enhancing Shifting frequency and organization efficiency of Wireless Mesh and P2P-base Heterogeneous wireless networks. They are distributed , adapting to all Heterogeneous wireless networks, but facing the problem of Shifting frequency and organization efficiency.

To improve efficiency of searching, the resources management, provide efficiency of shift in application layer and cut down communication cost, a modification in CAN for wireless self-organized network was introduced. Simulation Results taken by them showed lower network maintenance cost and better Connectivity. [9]

Llunch et al. addressed unstructured, decentralized federations based on opportunity contacts among federates by considering the characteristics demand of a network protocol capable of handling link disruption, heterogeneous link capacity and dynamic topologies. The paper is considered to be the first step exploring the network protocol techniques which could support the operation of Federated Satellite Systems (FSS). The latency in content delivery is reduced and the network state information is communicated effectively by conceptualizing FSS Communication network protocol along with OSLR-like proactive routing via 'hello' messages between nodes, predictive topology graphs and edge weights based upon link availability. Routing mechanism used in FSS network showed better performance than the shortest path routing without link availability or topology evolution considerations. The distributed scenarios can be simulated for different size of network using the object based network simulator described in this paper. [10]

METHODOLOGY

The given methodology entails the systematic steps/stages involved through which the proposed research work will approach for desired results.

a. Four networks have been designed in NS2 individually viz. UMTS, WIFI, ZigBee $ Satellite Network and then integrate them into a single wide WANET and connect it to the correspondent node of the wired network. The nodes are arbitrarily distributed in a WANET environment. Node 0 is a starting node and last node considered is the ending node. Between these two nodes, the system is free to choose any nodes of any network for communication. First the hypothetical internet communicates with the gateway of one of the wireless network and then the gateway acts like a bridge to enable communication with a mobile node. For the mixed scenario, few wired nodes are connected to the wireless nodes working in different domain consisting of n number of mobile nodes via base-station nodes, BS and Access Points (AP). One of the nodes as per his location from the other network or even the basic wired nodes, would act as a gateway for duplex transaction of packets within and out of the said network whereby TCP connection is established between host 0 node of the wired network working as the source of internet and last mobile node of any wireless network.

b. Hierarchical structure is implementing for transacting packets originating from the source node in wired domain, and moving through the other intermediate network architectures wherein destined for a wireless node in some other network domain while utilizing the modified AODV adhoc routing protocol to route the packet to its correct destination managing different no. of hopes

c. After setting up the communication, next step is to apply auto-configuration to automatically assign IP addresses to the nodes. First IPv4 auto-configuration algorithm is applied to the considered ad-hoc environment to allocate 32-bit IPv4 addresses to the nodes and then IPv6 auto-configuration algorithm is applied to allocate 128-bit addresses to the nodes. 64-bit prefix used is a non-mac and is a random number to avoid duplicity. NAT addresses (10.0.0.0/24) for IPv4 are used as private addresses and For IPv6, all range of addresses is available for deployment.

d. Auto-configuration is first implemented at local level for local communication in a network and then in whole WANET (intra- and inter-communication) to establish communication between different network standards. For global communication, the gateway assignment function is used in auto configuration process that helps in deciding the router for communication between two different networks. This function keeps on searching an appropriate node to act as a router with dual stack capability and as the router interface is found, the system demarcates the given node as the new default gateway for communication between two different networks.

e. In the Wireless domain, packets are routed to their destination with the help of modified AODV routing protocol [11] which routes the packets from start node to end node. Of course packets travel to various nodes and networks before reaching the final node. The gateway assignment function is used in auto configuration that helps in deciding the router for communication between two different networks.

f. *Reactive Gateway Discovery:* In this implementation, gateway is discovered using hop count metric. It means the node which is nearest to the base station will act as a gateway to communicate with far nodes that are not able to communicate with the base station directly. The moving node starts a discovery process to identify the gateway wherein the route to the gateway is updated as and when needed. The moving node transmits a RREQ with an 'I' flag (RREQ_I) to the WANET-Multicast Group address [12], i.e. the IP address group of gateways in a WANET, meaning thereby that the gateways are required to respond to this message and used for corresponding processing. Nodes lying within the rout just retransmit the message as they are not allowed to process it as per algorithm. The concerned gateway unicasts back a RREP_I on receiving the RREQ_I message while mentioning the IP address of itself. Reactive gateway discovery approach is beneficial in reducing the overhead since only the control message are shooted only when the nodes require information about the approachable gateways with in a wide WANET.

International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 14 (2017) pp. 4427-4432

RESULTS & DISCUSSION

The individually deployed network standards forming a wide WANET Network are made to communicate in a duplex mode with wired network considered to be the source of Internet using NS2 platform.

Table 4.1 Simulation Parameters for calculations w.r.t. number of nodes

Parameters	Values
No. of Nodes	25,50,75,100,125
IPv6 Simulation time	300 s
IPv4 Simulation time	300 s
Simulation area	1000m*1000m
Routing protocol	Modified AODV
MAC protocol	802.11, Sat, 802.15.4, UMTS
ifqType	Queue/ DropTail
ifqLen	100
antType	Omni directional Antenna
propInstance	2 Ray Ground propagation
phyType	Phy/ WirelessPhy
Channel	Wireless

The simulation parameters used for evaluating the performance of enacted scenario using the two addressing protocols are represented in Table 4.1.

The simulation time is fixed at 330s for checking the performance of the wide WANET for different sets of nodes commissioned.

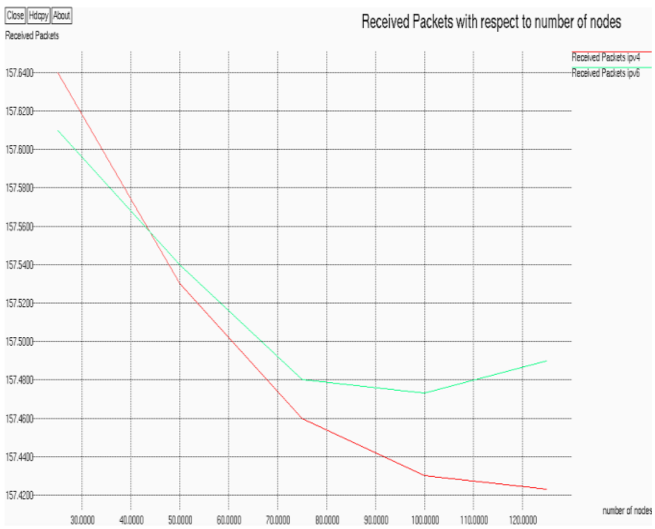

Figure 4.1: Packet receiving rate w.r.t number of nodes

Fig. 4.1 shows that nodes of wide WANET using IPv6 Addressing receives comparatively more packets than IPv4 based wide WANET since the processing of IPv6 router is better as it does not fragment data, so lesser congestion and receives more packets for given number of nodes, thus providing faster communication and better performance

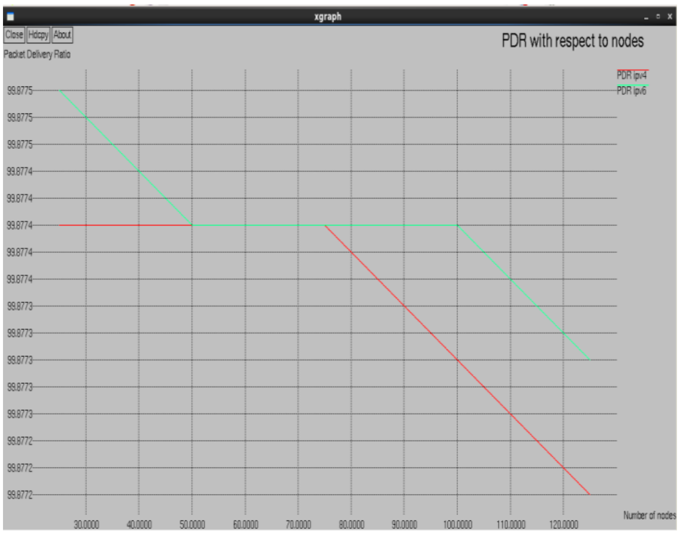

Figure 4.2: Packet Delivery Ratio w.r.t. number of nodes

Packets delivered to the end node is inversely proportional to link breaks which further relates to loss of data hence to reduce the same, more short and fresher routes to concerned gateways have to be identified by the nodes in periphery. Longer the routes can obviously may result in longer duration in receiving RERR message at the source resulting in lesser and delayed acknowledgement of dropped packets. In IPv6 processing is faster hence faster communication and higher Packet Delivery Ratio (PDR). As the number of nodes are increased as shown in Fig. 4.2, IPv6 addressed nodes shows better PDR than IPv4 addressed nodes.

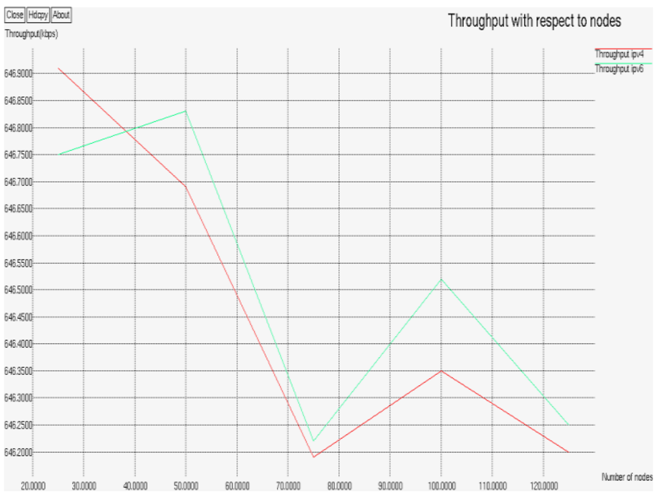

Figure 4.3: Throughput w.r.t. number of nodes

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Increasing number of nodes causes more congestion and lowers the throughput. IPv6 addressed nodes has better throughput as shown in Fig 4.3 for large number of nodes, thus IPv6 shows better scalability. This is because of lesser overhead at the routers in IPv6 that increases the throughput of the entire network.

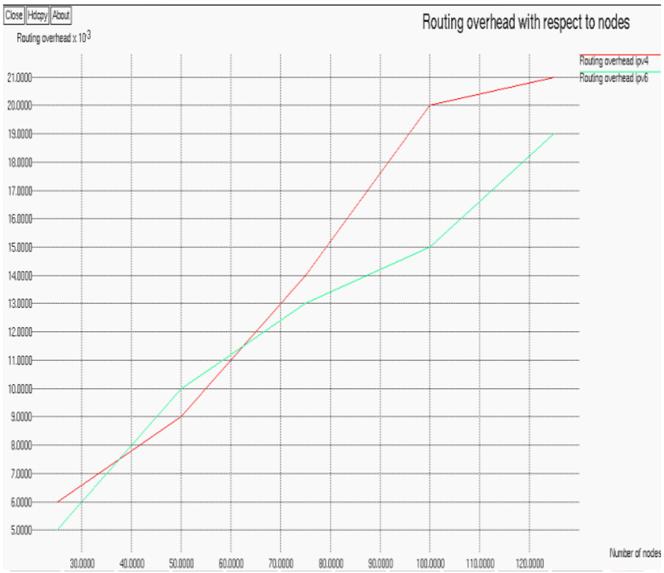

Figure 4.4: Routing Overhead w.r.t. no. of nodes

As the nodes increase numerically as depicted in Fig.4.4, IPv6 addressed nodes shows lesser routing overhead overall than IPv4 addressed nodes. There are two types of packets, information packets and routing packets. Routing packets are needed to forward the data packets properly. It carries control information, routing information etc. Smaller the no. of routing packets required to forward information packets, better is the protocol, therefore IPv6 addressed scenario shows better scalability in terms of routing overhead as well.

Figure 4.5: Average End to End Delay w.r.t number of nodes

Fig 4.5 shows that Average end to end delay tends to increase due to more congestion and queuing of packets for the wide WANET scenario using IPv4 addressing protocol than IPv6 protocol increasing number of nodes because IPv6 networks handles congestion and queuing of packets better.

CONCLUSION

A wide WANET is designed and simulated in the research paper using auto configuration addressing protocol clubbed with modified AODV routing protocol for evaluating the conceptual hierarchical structure for different sets of nodes. IPv6 addressed nodes in the simulated scenario showed better results maintain scalability for coalesced heterogeneous network standards.

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