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An IP Address Auto-reconfiguration and Optimal Duplicate IP Address Detection Scheme using AIPAC based Hunger Game-search Algorithm for Adhoc Networks

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Abstract

An ad hoc network is a kind of temporary Local Area Network (LAN) where multiple devices can be used at the same time, however, it reduces the performance of the network. Another issue faced by the users of ad-hoc is establishing configuration. Since the user devices are portable it changes the topology based on the location. There is no centralized framework and hence it is ineluctable to define the way of allotting IP addresses to the nodes. This is an arduous task due to the fact that the connections of nodes are dropped unexpectedly or by purpose. This minimizes the throughput of the network. To tackle those issues, we proposed a novel protocol in this article known as the AIPAC(Automatic IP Address Configuration)based Hunger Game-search (HGS) optimization model. This method is exploited to enrich the Optimized gradual merging index (O_{gmi}) and deletes the duplicate addresses in the network. This method is also utilized to manage the configuration, IP addresses, and so on. To analyze the performance we used the NS2 simulator which can be used to verify the efficacy of the applied protocol. This method also eliminates the overlapping and traffic issues in the dynamic ad-hoc network.

Keywords: *Hunger Game search, dynamic network, IP addresses, gradual merging index, traffic, and GPS*

Introduction

The use of an Adhoc network in a dynamic environment allows clients to interact with one another without being constrained by location, allowing them to move from one location to another [1, 2]. Usually, these clients utilize portable components with the inclusion of wireless interfaces in order to exploits the network resources. The multi-hop wireless network can be generated with the help of WLAN and it is named MANET (Mobile Ad hoc Network) [3]. The above said is generated without using any conditions or predefined infrastructures. These are

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mainly used in military applications, personal usage, indoor and outdoor applications, and for emergency applications such as during natural disasters, and so on [4].

The wireless channels rely on limited bandwidth and unreliable communications and hence the portable devices also possess bounded resources. To conduct communication a node should have its own IP address. The IP address is composed of class and subnet and depends on the position of the network nodes [5]. Whereas, the geographic addressing depends on the node's latitude and longitude positioning in the network and hence required GPS or any other location systems to perform this [6]. The GPS is expensive and installing a GPS receiver needs considerable space. For these reasons, GPS-based Adhoc is not commonly used in most ad-hoc scenarios. Besides, the estimation of location is also not precise and hence it cannot be applicable for the high density and mobility networks.

More often the network changes its topology and hence the IP address is used as unique identifiers (IDs) than the routing. Moreover, the configuration of the IP address must follow dynamic and distributed approaches. While some issues arise due to the overlapping of addresses due to the mobility of the nodes. These overlapping addresses also generate some errors in the ad-hoc networks. Hence, it is ineluctable to introduce a new mechanism to combine various nodes which maintain the unique identity. Hence we propose a novel method known as optimized AIPAC-HGS protocol to establish configuration between the nodes in a dynamic Adhoc network.

The contribution of our work is enlisted below

- The proposed AIPAC-HGS is used to overcome the shortcomings of proactive stages
- The proposed method enhances the Optimized gradual merging index (O_{gmi}) and thereby eliminates the duplicate addresses in the network.
- It also eliminates the overlapping issues and traffic while transmitting the information in the dynamic ad-hoc networks.

The rest of the work in this article is organized accordingly. In section 2 the relevant works of our proposed work are reviewed. Section 3 presents the description of the HGS optimization algorithm. In section 4 the proposed methodology is explained in detail. The experimental analyses and setup are explained in section 5. Finally, the article is summarized in section 6.

2. Related works:

For IPv6-Based MANET, Reshmi et al. [7] introduced a Hierarchical Autoconfiguration (HA) scheme. The unique addresses are ensured thereby minimizing address acquisition delay and overhead. The free addresses availability to novel entering nodes is ensured by utilizing an address reclamation model. Compared with an existing scheme, the HA scheme offered superior results and was implemented using NS-2. There are less packet losses, protocol overhead, and address acquisition delays. This method has higher computational complexity. According Rath et

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al. [8] suggested a security protocol with IDS (SP-IDS) framework. Due to moving versatile nodes, there is a dynamic change in its topology and not based on any settled infrastructure basic. The portable operator is used and this model is robust against different kinds of attacks. This method demonstrated a better network lifetime with less communication delay but the computational cost is higher.

Based on the NS2 simulator, Jiang et al. [9, 22] introduced the passive auto-configuration mobile network (PACMAN) model for IP address autoconfiguration. The major basis problem in MANET is address autoconfiguration protocols. The generic address assignment agent is incorporated in the NS platform, allowing for node address changes and dynamic generation understanding. Various studies are used to test the performance of the address autoconfiguration model. For large-scale MANETs, Rajula Angelin Samuel et al. [10, 23, 24] introduced a novel scalable autoconfiguration protocol (NSAP). The NSAP model consists of various amounts of CH nodes arranged in a hierarchical manner. The communication overhead between the nodes is minimized thereby exhibiting global connectivity. The experimental investigation with NSAP demonstrated less overhead with higher communication delay.

3. Background

3.1 Hunger Games Search (HGS):

This section describes the mathematical model with the working procedure of the Hunger Games Search (HGS) algorithm [13].

Food approach:

During foraging, the social animals often assist each other. A small number of people do not engage in the collaboration. For individual cooperative communication, the below equations express the game instruction of the HGS model.

$$\overrightarrow{Y(t+1)} = \begin{cases} G_1 : \overrightarrow{Y(t)} \cdot (1 + r(1)) & R_1 < L \\ G_2 : \overrightarrow{w_1} \cdot \overrightarrow{Y_a} + \vec{r_1} \cdot \overrightarrow{w_2} \cdot \left| \overrightarrow{Y_a} - \overrightarrow{Y(t)} \right|, & R_1 > L, R_2 > F \\ G_3 : \overrightarrow{w_1} \cdot \overrightarrow{Y_a} - \vec{r_1} \cdot \overrightarrow{w_2} \cdot \left| \overrightarrow{Y_a} - \overrightarrow{Y(t)} \right|, & R_1 > L, R_2 < F \end{cases} \quad (1)$$

The variable r tends to [-b, b] interval ranges. The two random numbers are R_1 and R_2 tend to 0 to 1 intervals. The current iteration is t in which the random number pleasing a normal distribution is $r(1)$.

$$F = S(|E(j) - AE|) \quad (2)$$

Equation (3) describes the formula of $\vec{r}$.

$$\vec{r} = 2 \times R - s_{hrink} \times s_{hrink} \quad (3)$$

$$s_{hrink} = 2 \times \left(1 - \frac{t}{T}\right) \quad (4)$$

The maximum number of iterations is *T*. Based on the source point's classification, the search directions are categorized into two classes.

Basis of $\vec{Y}$ search: The self-based one is simulated the initial game instructions that contains no teamwork strength [14].

Basis of $\vec{Y}_a$ search: The variables $\vec{r_1} \cdot \vec{w_1}$ and $\vec{w_1}$ corresponding to the second game instructions. The cooperation among many entities are simulated while they search for prey.

3.2 Role of hunger:

The HGS model simulates the starvation behavior of individuals. Equation (5) explains the $\vec{w_1}$.

$$w_1(j) = \begin{cases} H_{ungry}(j) \cdot \frac{M}{SH_{ungry}} \times R_4, & R_3 < L \\ 1, & R_3 > L \end{cases} \quad (5)$$

Equation (6) describes the formula of $\vec{w_2}$.

$$\overrightarrow{w_2(j)} = \left(1 - \exp\left(-\left| H_{ungry}(j) - SH_{ungry} \right|\right)\right) \times R_5 \times 2 \quad (6)$$

The number of individuals is *M* and the sum of hungry feelings is SH_{ungry}. Where, the interval ranges from 0 to 1 for R_3, R_4 and R_5. Equation (7) express the $H_{ungry}(j)$.

$$H_{ungry}(j) = \begin{cases} 0, & all \ \ fitness(j) === BF \\ H_{ungry}(j) + H, & all \ \ fitness(j) = BF \end{cases} \quad (7)$$

According to the current iteration, each individual fitness is $all \ \ fitness(j)$. The following equation explains the formula of *h* [15].

$$Th = \frac{E(j) - AE}{WE - AE} \times R_6 \times 2 \times (U_B - L_B) \quad (8)$$

$$h = \begin{cases} Lh \times (1 + R), & Th < Lh \\ Th, & Th \geq Lh \end{cases} \quad (9)$$

Each individual fitness is $E(j)$. Based on the current iteration, the best and worst fitness is AE and WE. The upper and lower bounds are U_B and L_B.

Selection of hunger: The upper and lower bounds limit of hunger range is controlled in order to obtain better performance. Simulate the activity of $\overrightarrow{W_1}$ and $\overrightarrow{W_2}$. The HGS algorithm performed well due to the prevalence of social animals. Based on the integration of living organisms, the mapping improves the HGS model performance.

4. Implementation of AIPAC strategy using the HGS algorithm

The AIPAC-HGS model is mainly designed based on the Ad-Hoc network characteristics to manage the IP addresses correctly. The main aim of this strategy is to minimize the resource consumption of mobile devices in terms of time and energy, minimize information loss, and also save the wireless channel bandwidth. The nodes that contain the crucial information in the network topology are often left undisturbed. Every node in the network knows its adjacent nodes inside their range of communication. This helps to limit the amount of information stored and processed in each node to be limited even if the size of the network grows. The bandwidth of the wireless channel is minimized by the HGS-AIPAC model.

The reactive Ad-Hoc On-Demand Distance Vector(AODV) routing protocol[16,17,22,23] minimizes the bandwidth of the wireless channel via the signaling packets to maintain the IP addresses. During the startup phase(initialization), each node is allocated a unique IP address but this doesn't solve the address duplication issue. Because the migration of nodes causes different Ad Hoc networks to overlap and it results in different nodes having the same address which causes problems during the routing process. To overcome this problem, we are designing an auto-configuration protocol that solves the problem of duplicated addresses in the Ad Hoc network.

In our proposed hunger games search optimizedAIPAC(HGS-AIPAC) model, every ad-hoc network is identified by its own network identifier(NID) and each node has an IP address and network Identifier pair(IP_address, NID) associated with it. The NID is a 4-byte number and in the Ad-hoc network, there is a probability that at least *k* individual Ad-hoc networks have the same NID and it is similar to the birthday problem[18] and depicted as follows:

$$A = 1 - \prod_{j=1}^{k-1} \left(\frac{m-j}{m} \right)^k \quad (10)$$

Here m represents that there are 2^{32} possible NIDS and from this, we can conclude that the NID of two or more Adhoc networks that integrate are always different. Since the reactive ADHOC routing protocol is used in this paper it is capable of identifying the duplicate IDs present in the network during the route discovery process and rectifying it. The IP address configuration and maintenance is divided into four stages:

Stage-1(Initialization): In this stage, each node is assigned its initial IP address before joining the network.

Stage-2: In this stage, the duplicated addresses are verified and corrected.

Stage-3(Network partitioning management): In this stage, the network that is divided is assigned the unique NID.

Stage-4(Gradual Merging): Even if the duplicate addresses problem is overcome in the Ad-hoc environment there lies a problem of overlapped networks which makes the data routing process more complicated.The hunger games search optimized AIPAC overcomes the heterogeneity of the communication system and corrects the duplicated address during data transmission.A detailed explanation of each stage is presented in this section:

Stage-1: The proposed HGS-AIPAC searches for a valid id using the initiator and requestor. The requestor is the node that wishes to join in the Ad hoc network and it randomly chooses a host ID(HID). Until a valid IP address is provided to the node, the node uses its HID. The requestor always searches for a configured node that can provide a valid address to it and it should be reached by the requestor in a single hop and it is called the initiator. The configuration requests are sent by the requestor via request packets until it receives a reply from its adjacent node. The reply can be provided by another requestor which sends notifies its presence via the hello packet. A new Ad hoc network can be created with the presence of two non-configured nodes and the node with the highest HID selects the parameters(NID, its own IP, and IP for other nodes). The requestor selects another node as its initiator from which it receives the hello message. The AODV protocol helps to select the best initiator among the adjacent nodes. Every requestor has to wait for *tconf* seconds until it receives the first response. In this way, the nodes entering the network have the same ID and the new ID is generated only when an isolated network is created.

An initiator's presence is identified using the *tini* timer which is constantly updated when the requestor receives a hello packet from the initiator. At the same time, every initiator can control different requestors. The requestor information is saved in the Requestor_table and each entry in this table comprises the requestor's HID, IP address that needs to be assigned, and the number of times the search has been made for the IP address. The initiator mainly selects the IP address IP_aat random and checks whether it is already present in the network by sending the search IP packet during the broadcast. Based on the two scenarios, the initiator identifies whether the selected $IP_{a\text{address}}$ can be used or not.

Scenario-1: Receiving the used_IP packet

In this case, it means that the address is already in use and a new address needs to be selected by restarting this schedule.

Scenario-2: Expiration of the tsearch timer

It indicates the time interval of other nodes to sent the used_IP reply has been passed and to prevent the information loss of the wireless channels, this request can be sent one more time. The autoconfiguration procedure is implemented by the HGS-AIPAC model using the following packets listed in Table-1.

Table-1: Autoconfiguration packets

Initialize	The packets generated by the intiator is passed via the network parameters to the requester
Requester	It is usually sent by a requester who wants to conquer a valid IP address
Hello	Aids the configured node in displaying its presence to neighboring nodes.
Search_IP	Packet sent by the initiator to verify if the IP sen by the requester is already used in this network
Used_IP	If the IP address is already in use, the node

	that receives the search IP packet informs the initiator that this ID is already in use in this network.

Stage-2: Stage-1 ensures that every node in the network has a different IP address.But in a scenario where differentMANETs are present, the mobility of nodes causes the different nodes to overlap. This scenario causes problems in the unique IP address validation and error in the data routing process. A novel strategy has been presented here to reduce the signaling traffic and improve the bandwidth of the network. Here the addresses for the node that has no node exchange between them are not checked. This is achieved by the reactive AODV protocol because the duplicate addresses are managed only when there is some data transfer that is held in the network.In this way, the signaling traffic and massive information storage for communication are reduced. The presence of any destination address for duplication is identified using the Route_discovery packets.

The routing path is identified via the Route_Request and Route_Reply packets. The source node sends the route_request packet and the destination node sends a Route_reply packet after receiving this information(Route_Reply). The destination node selects the optimal path from the list of available routes based on the one with the low transmission delay and the number of hops. Our proposed HGS-AIPAC model asks the destination node to add the details of the NID along with the Route_Reply and also filters the transmission and reception packets. The duplicate address management approach is presented in Figure-1and it is self-explanatory. To stop a routing protocol from sending the application data for a certain time interval, a tduplication timer is used. The HGS-AIPAC model checks the duplicated addresses before the timer expires and reactivates the routing protocol features. The change_IP process is activated when there are some nodes with duplicate IP addresses. Hence, m-1 nodes change their IP addresses using this stage.

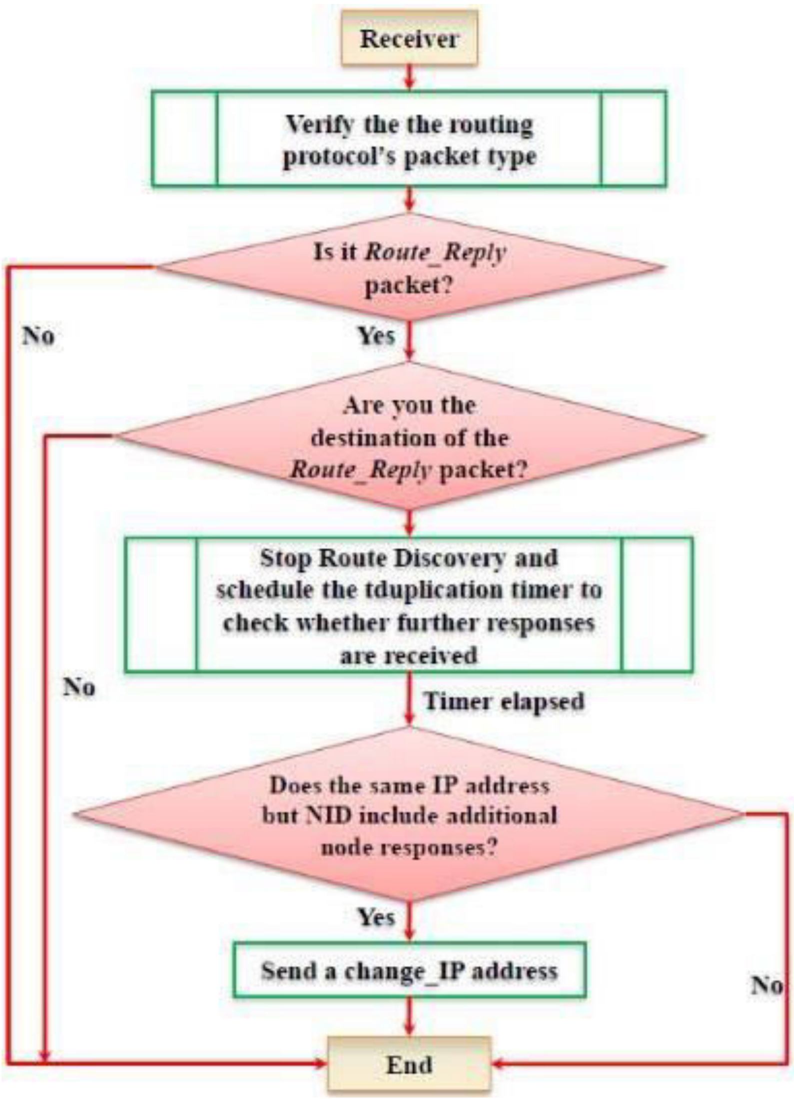

Figure-1: Flowchart for duplicate address management

Stage-3: Partitioning management

All ad hoc networks consist of various NetID in which the AIPAC controls to address the assumption. The network nodes are assigned different addresses that are guaranteed by the initial configuration process. Because of node mobility, modifying the network architecture has an impact on network partition into two or more sections or the merging of separate networks.

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Create a similar NID with the bunch of independent nodes whenever the network partitioning happens [11]. The duplicated address management model is described. Each node sends the hello packet regularly that obtains the information, which is saved in *Neighbor _Table*. From the network, the node is chosen to disconnect. The distribution node in the *Neighbor _Table* is verified thereby the goodbye packets.

An ad hoc network node's behavior is delineated in Fig 2. Many change *netid* messages travel at a certain time with varying values, in which several nodes of a similar subnet detect the partitioning [12]. The packets are received by the nodes prior to altering the configuration parameters. Schedule the *tdelay*while the node receives the *change_netid* packet. Permit the node to obtain the selected NID from another node in the network. The node obtains each possible*change_netid* message while the timer expires. In a short time, the correct *NID* is configured.

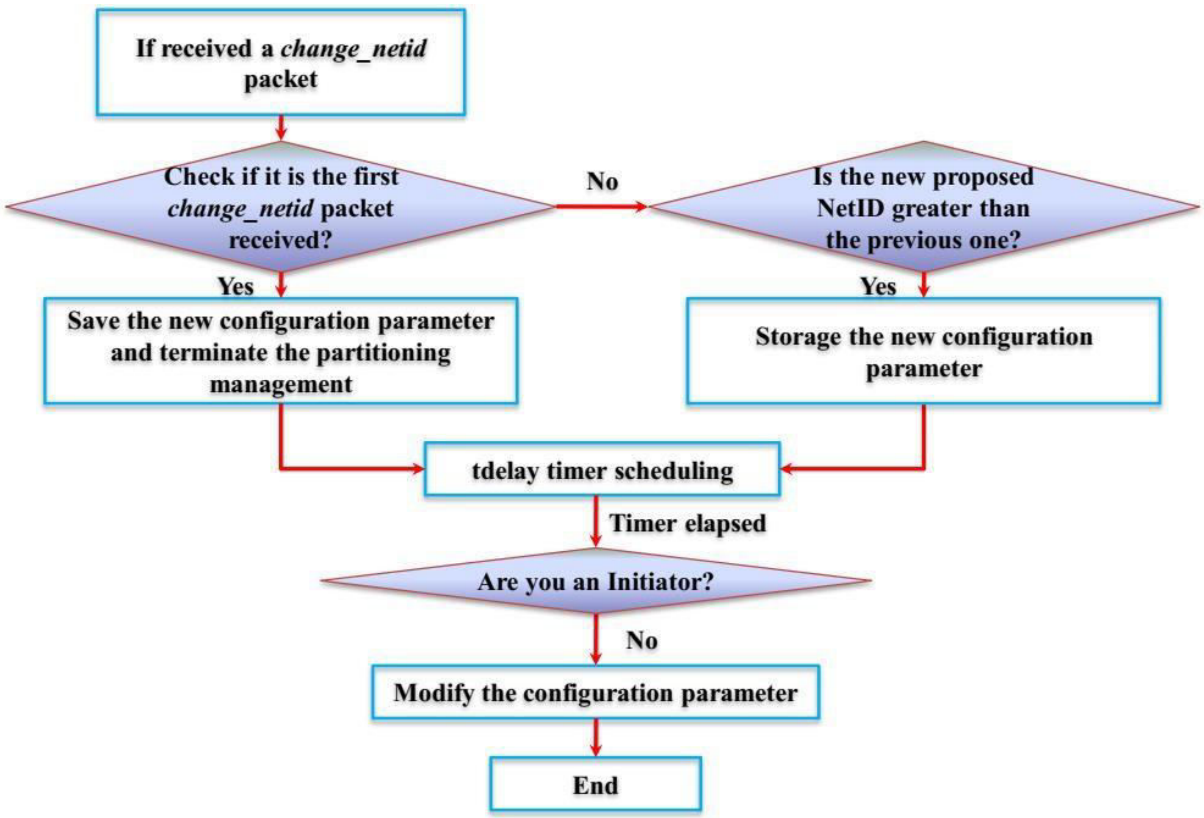

Fig 2: An ad hoc network nodes behavior

Stage-4: The main aim of this stage is to make the network homogenous where every node has unique IP addresses. The gradual merging phase is AIPAC is optimized using the HGS algorithm which prevents the reconfiguration of every node that comes in contact with others. Based on the network topology, the heterogeneity of the system is reduced. The HGS algorithm prevents the immediate node reconfiguration and the nodes are only reconfigured when it stays in the network for a longer period of time and it has the single network ID. In this way the HGS algorithm minimizes the network traffic for weak contact points and the gradual merging process is presented in Figure-3.

If a node finds that the number of nodes in another network is greater than its own network it may switch from one to another. For an instance, let's take *X* which belongs to NID1, m_mine is the number of nodes that are close to *X*, and m_other represents the number of nodes present in another network whose network ID is NID2. Node *X* computes the interval between its adjacent nodes present in between two networks($\Delta m = m\_other - m\_\min e$) every tmerg seconds. The total number of nodes present in the network is represented as $m_{total} = m\_other + m\_\min e$. Using the below equation, node X decides to move to another network.

$$\frac{\Delta m}{m_{total}} > O_{gmi} \qquad (11)$$

Where O_{gmi} is called the optimal gradual merging index(level of acceptable heterogeneity in the system) and it is set as the fitness value of the HGS algorithm to switch from one network to another. If the value of O_{gmi} is high then the nodes are less likely to switch to the other network and vice versa. If a node switches from one network(NID1) to another(NID2), then its entry from the neighbor table is deleted or else it is not capable of receiving the information from *X* or is subjected to partitioning. When a node exits from its old network it sends a goodbye packet to its neighboring nodes. The end condition of the HGS algorithm is reached when it experiences any one of the below:

- When a node is an initiator and the requestor which is based on it could no longer recognize it.
- The node cannot enter as a requester in the initialization of partitioning management.
- When the node is awaiting to change its configuration after receiving the change_netid packet and the tdelay to expire.

In the AIPAC-HGS model, the packets namely goodbye, hello, initialize, requester, used_IP, and search_IP.

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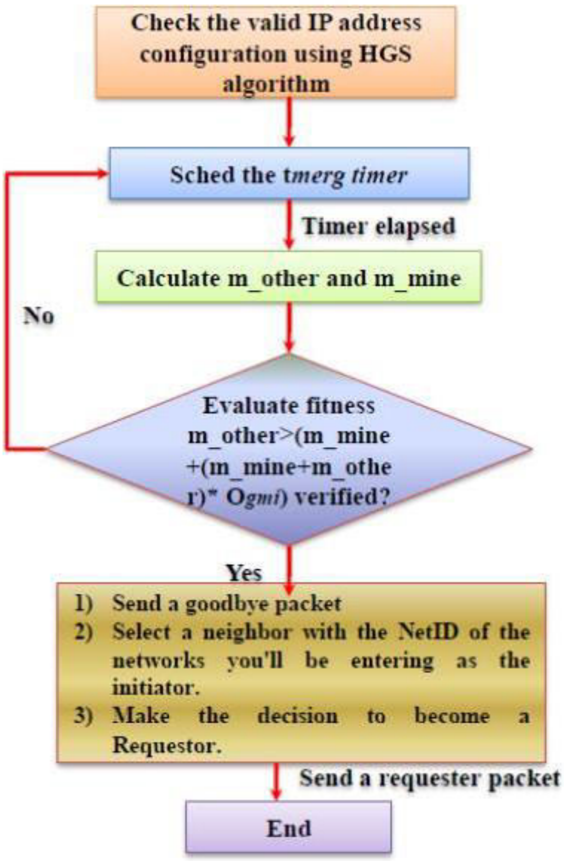


Figure-3: Gradual merging using the HGS optimizer

5. Experimental results

Our proposed (AIPAC-HGS) method is simulated by utilizing the NS2 simulator of version 2.26 and carried out in multi-hop wireless networks. It includes physical information and medium access control layers. The protocol used here is distributed coordination function (DCF) of IEEE 802.11. The information is transformed with the help of undivided carrier sense multiple access (CSMA) incorporated with collision avoidance (CSMA/CA). The trace of the simulation is viewed by using the graphical interface of the animation tool Nam. The trace file is nothing but it is composed of information about nodes, links, and traces of packet. After the generation of the trace file, the Nam tool can be used to animate it. Here we have considered the scenario with nodes 30 in an area of 1000×1000m. The packets used in our proposed AIPAC-HGS approach are illustrated in table 2.

Table 2: Packets used by AIPAC-HGS method

Configuring Initial Nodes	
Search-IP1	This is to check whether the IP selected is already used by others in the network

Requester1	The requester requests the valid IP address to configure
Used IP1	This is to send the requester to initiate
Initialize1	The initiator sends the parameters to the requester
Hello	Messages sent to the neighboring nodes by the initiator
O_{gmi}	
Goodbye	When the node is switching off then the node sends this message to other neighboring nodes to delete it
Hello	Used to upgrade the neighboring table that is utilized for the partitioning management
Requester2	Send by node 2 to have a configuration with the valid IP address
Search-IP2	This is to check whether the requested IP is in another use
Used-IP2	This is to initiate the process by the requester2
Initialize-2	Initialize to provide upgraded parameters to the requester2
Partitioning Management	
Hello	The configured nodes sent frequently this messages to the neighboring to confirm their existence
Check-partition	This is to check whether the partitioning takes place or not. This usually waits to receive the verify-partition packet
Change-netid	The netID of the subnetworks is changed while conducting the partitioning. This provides the exact NetID to the subnetworks

5.1 Analysis of variation of traffic based on gradual merging index

The performance analysis of varying traffic based on the gradual merging index is conducted by varying the parameter gradual merging index of our proposed AIAPC-HGS. Hence we focused to obtain the optimal value of the gradual merging index to reduce the traffics generated by the protocol. The graphical representation of Initialize1 based on the varying nodes with respect to the O_{gmi} is shown in figure 4. Here the overlapping of the nodes is also represented. This depicts that the initial configuration of the nodes is not based on the varying merging threshold.

The performance analysis with respect to increasing O_{gmi} and decreasing Initialize2 packets and their traffic are shown in figure 5. This is due to the fact that the nodes switch hardly from one network to the other with the optimal value of O_{gmi}. This implies a minimum number of initiators are included in stage 5. The bounded utilization of Change-netid packets helps the system to maintain stability. The traffic occurs due to the Change-netid packets based on the number of nodes and changing the O_{gmi} is depicted in figure 6.

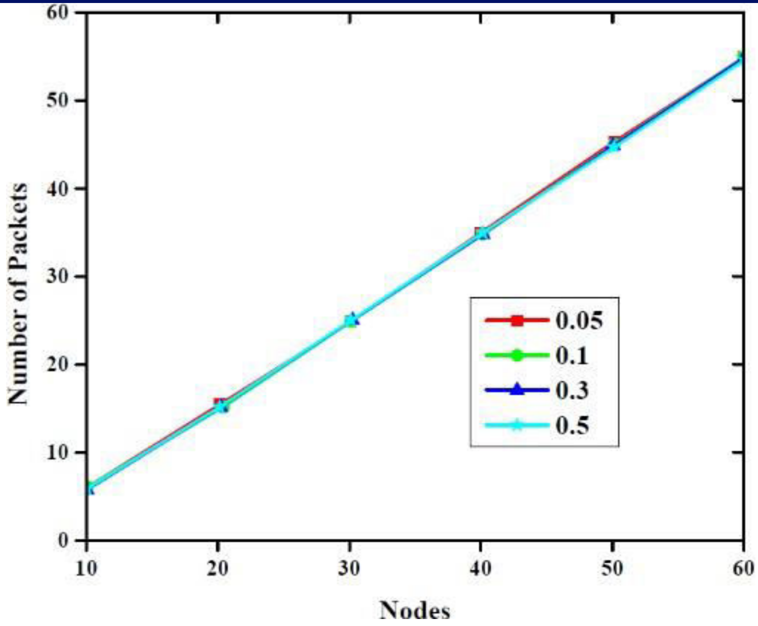


Fig 4: Number of Initialize1 packets transformed for varying O_{gmi}

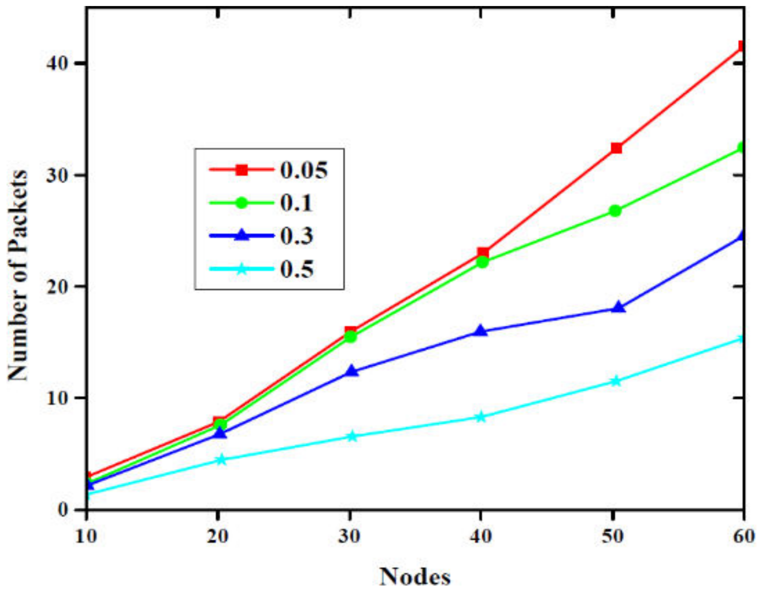


Fig 5: Number of Initialize2 packets transformed for varying O_{gmi}

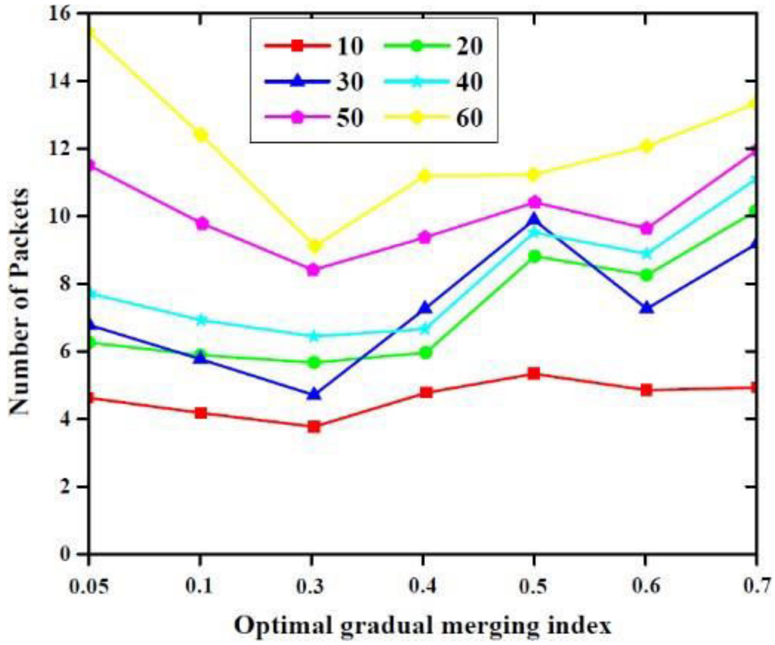
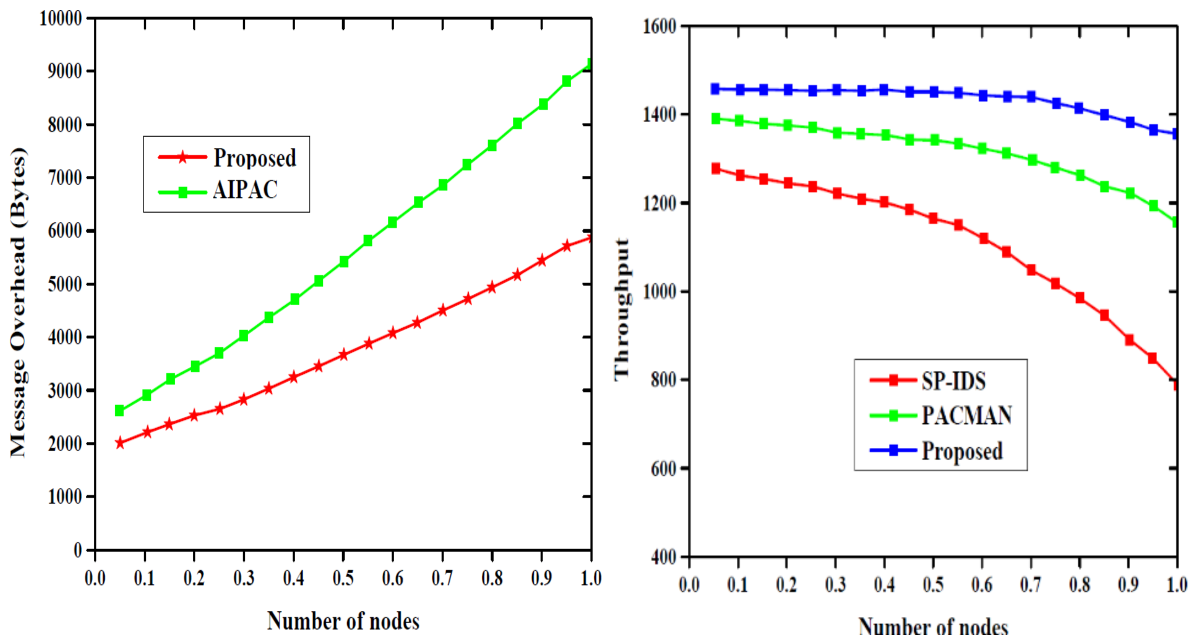


Fig 6: Number of Change-netid packets transformed for varying O_{gmi}

5.2 Performance evaluation of the proposed architecture

The IP acquisition time[21] is calculated as the time interval between the requestor sending the IP acquisition packet and the initiator retrieving its IP address packet from another requestor or a configured node in the network. The IP lifetime is the time interval for the requestor to obtain a valid IP address until the *tsearch* timer expires. The handoff latency is the time interval between the last packet retrieved from the old Ad hoc network to the first packet received in the new Ad hoc network. The data received at each second is represented using the throughput. The message overhead is measured using the total number of IP packets used and the number of packets sends to the initiator to identify if the IP address is already in use.

The message overhead, throughput, and handoff latency compared in terms of the number of nodes are presented in Figures 7(a), 7(b), and 7(e). The message overhead of our proposed scheme is higher when compared to the AIPAC model[19,20] because our proposed model uses the AODV routing protocol and HGS algorithm for optimization. In our proposed methodology, there is no need to send messages to the adjacent nodes when the nodes that enter another network are present for a minimum amount of time. The handoff latency of our proposed technique is very low when compared to the SP-IDS and PACMAN techniques. A low throughput indicates a higher packet loss rate and increased handoff delay. The packet loss rate derives the number of packets lost by the wireless channels towards the total number of packets. The proposed methodology has shown higher throughput when compared to the SP-IDS and PACMAN techniques.



(a) (b)

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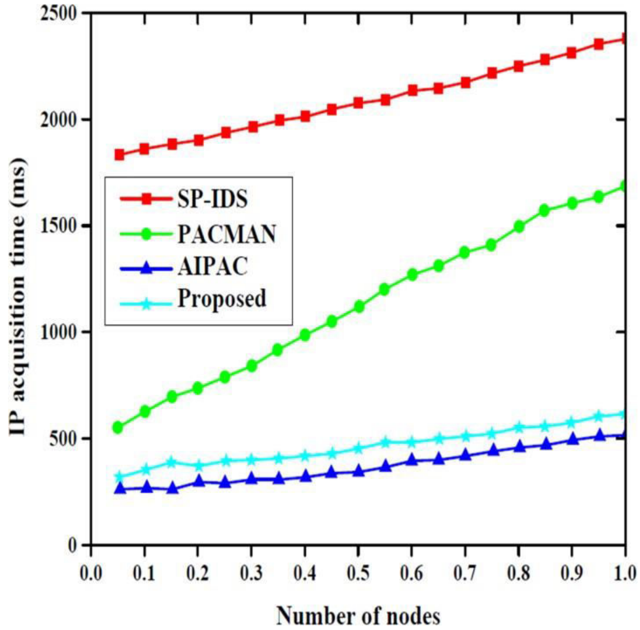
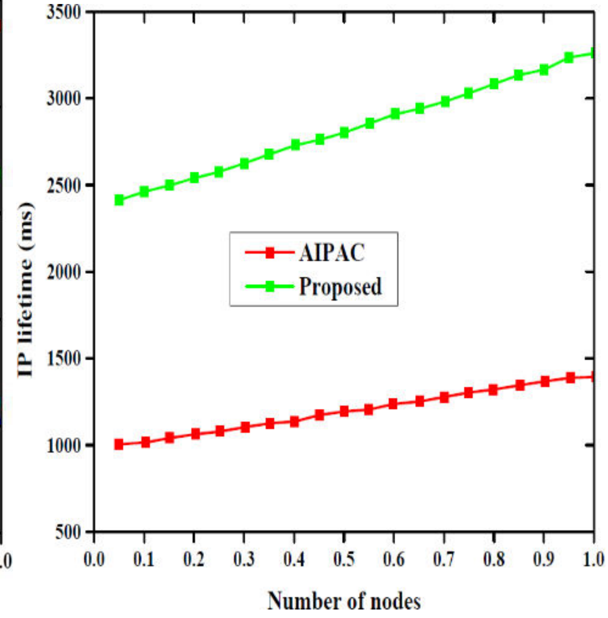
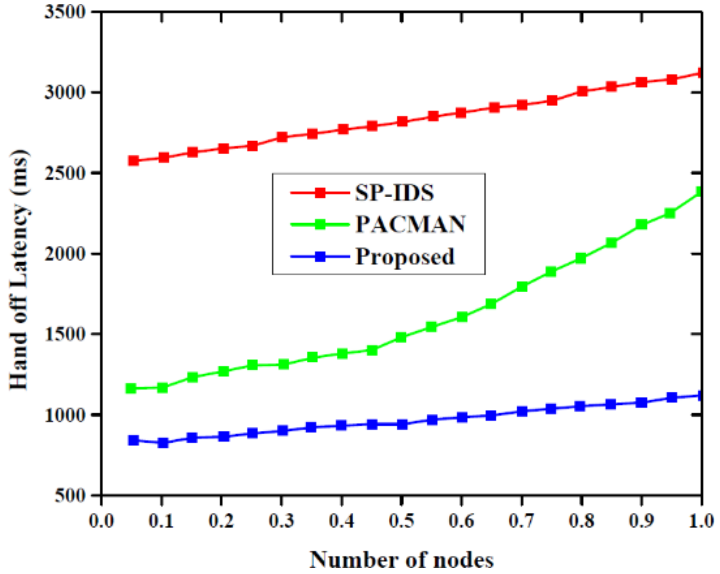


(c)



(d)



(e)

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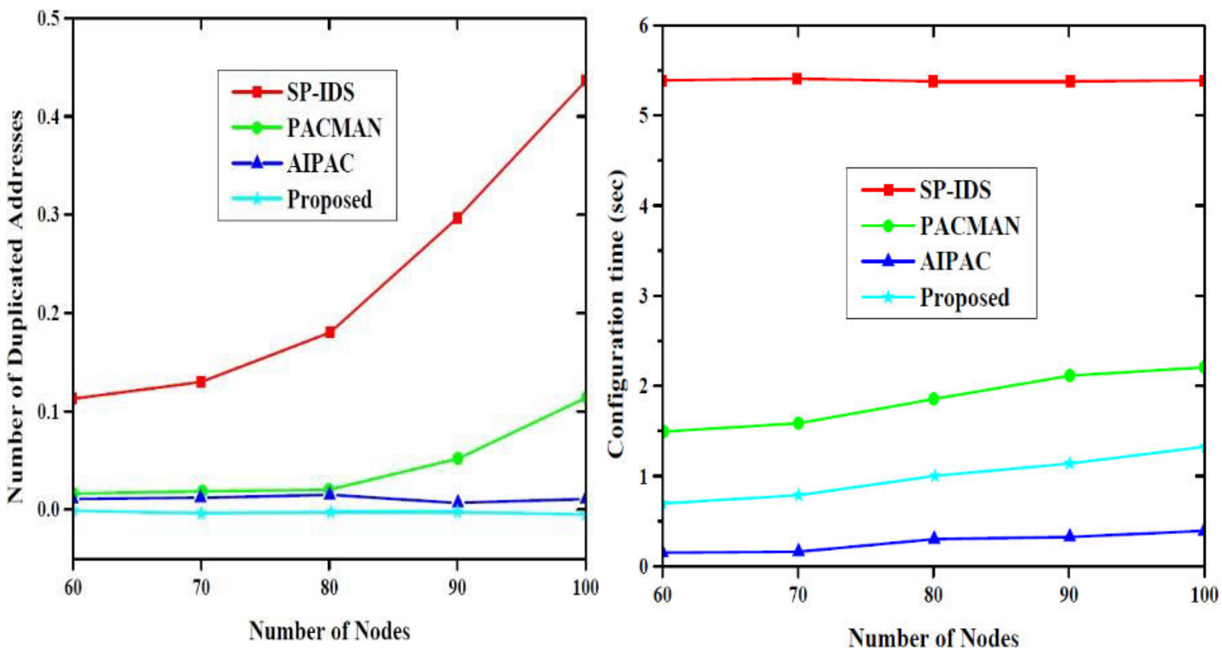
Figure-7: Performance evaluation using (a)Message overhead, (b) throughput, (c)IP acquisition time, (d)IP lifetime, and (e)Handoff latency



(a) (b)

Figure-8: Comparison of the uniqueness of allocated address and communication overhead. (a) Number of duplicated addresses and (b) Configuration time

The IP acquisition is compared with the number of nodes as shown in Figure-7(c). As the number of nodes increases the IP acquisition also increases because the increased vehicle density has higher contentions and collision associated with it. When compared to the SP-IDS, PACMAN, and AIPAC techniques, the IP acquisition of the proposed methodology is lowest. The lowest IP acquisition time and the handoff latency show the improved performance of our proposed technique. The IP lifetime is compared with the number of nodes as shown in Figure 7(d). As the number of nodes in the network increases, the IP lifetime also increases. The IP lifetime of our proposed methodology is higher when compared to the AIPAC technique. The HGS algorithm used reduces the number of false IPs in lesser time and improves the network lifetime when compared to the AIPAC technique.

The uniqueness of the allocated address in the address range of 256 is compared with the number of nodes as shown in Figure-8(a). This comparison helps to identify the routing protocols that show abnormal behavior due to the address conflicts. The comparison is held with the SP-IDS, PACMAN, and AIPAC techniques. The proposed approach achieves higher results in IP address uniqueness when compared to the IDS, PACMAN, and AIPAC techniques. The SP-IDS offers a high number of duplicated addresses because it has trouble maintaining consistency among other nodes. The communication overhead of the proposed technique is evaluated in terms of configuration time in seconds and the results obtained are shown in Figure-8(b). The proposed methodology shows low communication overhead because the new node communicates with the adjacent node only to obtain its address and not every time it enters a new network.

6. Conclusion

This paper presents an HGS-AIPAC model for IP address reconfiguration in Adhoc networks. The NS2 simulator is utilized as the implementation platform, and a variety of experiments are carried out. The proposed model addresses overlapping and traffic issues in a dynamic ad-hoc network. The HGS algorithm is used to optimize the gradual merging phase in AIPAC to achieve a homogeneous network with nodes with fewer duplicate IDs. The efficiency of the proposed methodology is evaluated using different performance metrics such as configuration time, message overhead, throughput, IP acquisition time, IP lifetime, and handoff latency,. When evaluated with the other state-of-art techniques such as AIPAC, PACMAN, and SP-IDS, the proposed methodology offers increased performance. In the future, we plan to conduct research in the security of the MANET architecture.

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