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AIF BASED RELAY NODE SELECTION APPROACH TO INCREASE THE SCALABILITY IN WIRELESS MESH NETWORK

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Abstract: The demand for wireless communication applications are increasing considerably; therefore many constrained features like computational capabilities, scalability, energy restoration, memory and presence of unreliable communication medium are the major challenges. The mesh network generally contain a huge amount of traffic, therefore it is essential to build some association policies that can tackle a different type of traffic by selecting appropriate RN. Considering a WMN environment, in this study we proposed the AIF based RN selection approach that is implemented using the centralized network model. This helps to manage the link selection in the mesh network through selecting suitable RN for the particular application. The scalability requirement generally depends upon the characteristics of data flow at wireless mesh network and suitability of RN that is used to serve signal to the user. Here, we are going to get suitable relay node among the A RNs composing the mesh wireless network and the wireless user can be associated with the selected RN that can provide scalability in data flow as per request of the new flow. In order to evaluate the network performance, our proposed model is compared with respect to state-of-art techniques.

Keywords: Wireless Mesh Networks (WMN’s), Relay Nodes (RN’s), Adaptive Informant Factor (AIF), Scalability.

I. INTRODUCTION

In the present era, we can observe the fast growth of wireless communication applications such as; vehicular ad-hoc networks (VANETs), wireless sensors networks (WSNs), Internet of Things (IoT) etc. These are the samples of some wireless networks, which attracted the interest of the scientific community and required promising interest of work due to the fast increasing market size [1]. WSN comes with many constrained features like computational capabilities, scalability, energy reserve and memory [2]. To handle these types of difficulty, several communication protocols have been developed for such network type; some research works are considered in the network and MAC layers and some substantial works are based on the MAC protocols is given in [3]. Some of the routing protocols work has been studied in [4] [5]; this proposed methodology allows enhancement of network performance. The MAC aims to avoid data collisions and the transceiver radio control in order to minimize energy consumption. However, the interference and fading are major challenges present in the wireless communication network. The signal fading can decrease the reliability and communication radio range at several types of wireless communication systems; the interference of signals restricts the reusability of spectral resources.

A recent observation has improved wireless communication system through using MIMO, which maximize the spectral efficiency at considered total transmit power. The MIMO system is an advanced technology, where antenna array communication requires multiple receive and transmit antennas; thus, the spatial diversity maximizes significant communication quality. The supportive network exploits particular antenna apparatus to obtain several advantages of the MIMO systems and therefore, a multi-user can use its antennas to make virtual MIMO system. The supportive networks used in communication systems, where the relay nodes are used to transfer the messages from user to the destination. Several cooperation approaches have been used as the relaying approaches decode-forward and amplify forward is used in [6].WMNs emerged as a major technology for up-coming generation of wireless networking, but there are several challenges that need to be overcome. In paper [7], they focus on designing and implementation of the routing protocol in order to improve the WMNs scalability, where the Directional Hierarchical-AODV routing approach has been proposed in order to decrease the load on the network bandwidth and also to detect routing breakage.

Several numbers of WMNs representatives have been deployed in many rural areas and cities across the worldwide [8] [9] [10], among these, the Athens wireless metropolitan network gain the considerable value from mesh network community [8]. Moreover, Frei funk, Wireless Leiden, Seattle Wireless is at the WMN forefront movement, which provides a maximum range of community dependent applications [8] [9]. Therefore, the unlicensed usage of spectrum and the nonappearance of the main management system, WMN is weak to interference and at huge traffic that can decrease the scalability and quality greatly. Most of the relay node approaches are used in WMN, but it has limited access to the MAC and physical layers. In certain, the quality selection approach has not explored in terms of sensitive provisioning applications. To clear this gap, relay node selection approach has been considered with capacity that provides adaptive quality services for streams under the unicast and assembled communication patterns. Also, we observed the challenges of quality assessment in WMN such as; the presence of unreliable communication medium, unpredictable channel access delay and varied quality requirements as per the users. A relay node selection schemes plays a necessary role to confirm the scalability at routing and in this view, routing metrics can be applied as routing protocols in order to judge the suitability of the offered paths. Routing protocols use several numbers of hops, interference, delay, bandwidth, and etc. for a variety of applications. This type of method usually considers the limited routing metrics for choosing the optimal path between destination and source, while there is extensive variety of relay nodes devices, which deployed at several routing metrics, which includes proposed approach such as IAR [11].

We have observed that the mesh network generally contain huge amount of traffic, therefore it is essential to build some association policies that can tackle different type of traffic through selecting appropriate RN. The priority wise selection is achieved via the centralized approach and it is effective to obtain the right assessment at entire network via consideration of latest developments in WSN environment. In this study we proposed the RN selection approach that implemented using centralized network model. That helps to manage the link selection of mesh network through selecting suitable RN for the particular application and this RN selection approach is depend upon novel RN selection algorithm, which calculates and assigns the objective metric to all RN, called an Adaptive Informant Factor (AIF). The available spectrum information is addressed by this approach as per the requirement of user applications. Therefore, to assign the most suitable RN, firstly we consider the scalability assessment to accomplish the wireless user connection in mesh network. The quality of connection and current network capacity are provided to every wireless users and then by taking this information, our proposed algorithm provide the suitable RN for required user request in mesh environment. In result analysis section, our proposed model is compared with respect to state-of-art technique in order to validate our model in terms of WMN capacity and scalability.

The remaining paper is organized as follows; section-II provides the comprehensive analysis of existing approach in context to our research work. Section-III we presented our proposed methodology, in that we discussed the AIF and RN selection approach. Section-IV we performed the simulation analysis to validate our proposed model and in section-V, we provided the conclusion remarks of this study.

II. LITERATURE SURVEY

There are many attractive features of the wireless mesh network; one of them is to scale up the large amount of data by just adding more wireless routers. This in terms increase the number of hops from source to destination, and thus it might affect the performance in terms of throughput and delay. There have been plenty of solutions for wireless mesh network. Among, a (HWMP) Hybrid Wireless mesh protocol combines functionalities of TBR (Tree Based Routing protocol) and RM-AODV (Radio Metric Ad-hoc on demand Distance Vector routing. In this particular, [12] proposed for evaluating the scalability of HWMP using the network simulator NS2 and for that, they have applied a grid wide network topology with the n*n stationary Mesh Point-routers.

In the paper [13], they proposed energy efficient multi-hop routing protocol for the WSNs (Wireless sensor networks).The nature of the sensor nodes with inefficient protocols and limited batteries are the prime factor for the sensor network lifetime. Here they aim to provide green routing protocol, so that it can be implemented in WSNs; proposed protocol has achieved the most significant achievement in the reduction of excessive overhead, which is typically seen in many routing protocols through reduction in the number of cluster head changes and by employing fixed clustering. In this, the performance analysis factor indicates that, the reduction of overhead significantly improves the lifetime and through an energy-efficient protocol the sensor nodes can be reduced. The transmission of collected cluster data is collected through inter cluster transmission is allowed by the implementation of the relay nodes.

The two different techniques for increasing the data rate as well as to overcome the fading in LTE advanced system are spatial diversity and spatial multiplexing respectively. Both can be accomplished through employing cooperative MIMO, it is an advanced technology in mobile communication. This method exploits the spatial domain of the fading channels and uses distributed antennas on different relay stations for obtaining the reliability, which is close to the MIMO. In paper [14] to group multiple relays into an array of virtual antenna for forming MIMO, is the underlying concept of this technology. So, for selecting the relay stations in forming a cooperative MIMO for transmitting the message from the base station to the mobile station, a new technique is being introduced. Through the comparison, selection is done by comparing performance of error rate in relaying a pilot tone by relay stations

Beyond 5g networks, UAVs (Unnamed Aerial Vehicles) which is also known as drones are considered to be the part, and it will help in the countless service such as civilians and the commercial domain [15]. Few Services which will be most benefited by drones includes: high efficiency in the response of the emergencies and disasters, Inspecting the critical infrastructures for agriculture, environment, logistics, flying camera for news media and filmmaking, gas pipeline and oil, wild life conservation, environmental conservations and many. Although the benefits of drone can be promising; the main challenging issue is providing the reliable communication through drone. Through paper [16], video surveillance application is considered; in this using the camera, which is mounted over the drone, the area is monitored and the data is sent to the Control Center (CC). Few relays are deployed on ground for ensuring the connectivity between the drone and CC. The network resulted will be the combination of the drone (moving component) and a static component. Here all these network devices are equipped with the IEEE 802,11s air interfaces. In this paper, their objective is to design and validate the routing protocol, which has to be appropriate for the scenario. Hybrid Wireless mesh routing protocol which combines the features of RM-AODV (Reactive Metric Ad-hoc On-demand Distance Vector) protocol and proactive (TBR) Tree Based Routing, for addressing the necessity for the faster and efficient path. For reliable connectivity, mixed optimized scheme was introduced called as Optimized –hybrid wireless mesh protocol, here both are used at the same time. In RM-AODV, the input given as per the tree based routing protocol, for minimizing the delays during the path discovery and the flooding of control packets.

In medical environment, communication is done through following the standards like Digital Imaging and Communications in Medicines [17]. This particular standard contains plenty of codes for the image data. In practice, a frame by frame coding is used through lossless JPEG [18]. Wavelet transform is primarily computed as weighted average of low-pass sub band. With ghosting artifacts signal displacement causes a blurry low-pass sub-band, this particular drawback is addressed by incorporating the feasible compensation methods direct into the transform. A signal contains the various displacements in various dimensions. A compensated wavelet transform in the direction, which is temporal in video coding, known as Motion-Compensated Temporal Filtering [19], and it is also called as Disparity Compensated [20] view of filtering through the view of multi-view sequence. Regardless of direction, data, transform and displacement, compensated wavelet is denoted by compensated wavelet lifting. Video sequence primarily contains translator motion. Consequently, for compensation in video sequence, block based methods are mainly used. However, for dynamic medical volumes, motion model of the translator movement of the object doesn't fit too well for the dynamic medical capacities [21]. Here the over time of the deforming displacement is primarily given by contraction and expansion of tissue. The methodology based on the mesh compensation has able to deform the displacement model very well [21]. Moreover, this mesh based approach has seen to be fine suited to deformation model within the dynamic medical size of applications such as; image registration [22]. Under the wavelet stimulating of video sequences, the mesh-based compensation has proved to be suitable option [23] and there are lots of efforts are put by the researchers for mesh-based compensation in order to improve the model. A methodology of efficient iterative refinement is proposed in [24] to allow the parallel processing and the hierarchic prediction permits the smoother estimation and faster convergence for larger displacements [25]. Regularizer is used to favor the similar movement of grid point's neighbors, therefore, the smooth motion-vector field [26] is required and this regularizer avoids the tiny local movements due to the presence of noise in mesh. Generally, the medical image contains a large amount of noise.

III. PROPOSED MODEL

In mesh wireless network, the selection of RN is the important factor; for that Adaptive Informant Factor (AIF) approach is proposed to get the scalability at bit-rate transmission. An approach of AIF is considered as an advanced objective metric, which can be achieved through RN-selection algorithm in order to enhance scalability; hence the scalability requirement generally depends upon the characteristics of data flow at wireless mesh network and suitability of RN that is used to serve signal to user.

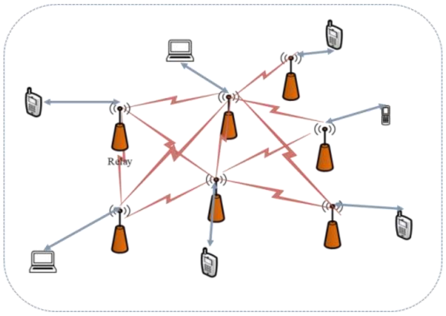

Fig 1: Mesh network diagram

Here, fig 1 shows the diagrams of mesh network by using several user equipments and relay node selection. In our WMN, B denotes the set of radio access frequencies used to provide the connection between stations and relay nodes applications. $D_{e,b}$ is the requested bit-rate at the temporal period of $\delta_{e,b}$, for the b^{th} request. Moreover, the compulsory available band is modeled as per the set of pools C and the c^{th} band pool is composed of some A_c band blocks, that having F_c bandwidth individually. The function of $D_{b,c}$ signifies the served bit-rate flow ($i.e.,$ b) in the relay node c. Maximal transmission of power in a band block is also accessible at each terminal, which involved in b^{th} Relay Node application.

In common, proposed AIF approach is improved via the $Softmax$ function ($G_{b,c}$), which provide the obtainable 'bit-rate' for b^{th} request from the RN c. The convenience function $G_{b,c}$ value based on Softmax [16] will upsurge with the serving 'bit-rate' flow b by RN c. Our main purpose is to get the best selection of RN via our proposed AIF approach by addressing the suitable RN for the data-rate flow with respect of offered 'bit-rate'.

The metric computation in AIF approach depends on the $G_{b,c}$ utility function, which generally used to signify the users b scalability on RN c. For each b flow and RN c, the computation metric of AIF can be given as:

$$H_{b,c} = \frac{1-e^{\frac{G_{b,c}\times D_{e,b}}{K\times D_{b,c}}}}{I} \quad (1)$$

Where, the normalization factor is I and $G_{b,c}$ denotes the utility function and represented by an equation (2)

$$G_{b,c} = \frac{\left[K.\left(\frac{D_{b,c}}{D_{e,b}}\right)\right]^J}{1+\left[K.\left(\frac{D_{b,c}}{D_{e,b}}\right)\right]^J} \quad (2)$$

The parameters J and K written in equation 1 and 2 shows the degrees of required bit-rate and the present 'bit-rate' in RN respectively. In brief, the parameters affect the performance of AIF slope that provides a proper RN for assured flow with the available bit-rate. In AIF approach, normalization factor is used to bind the value to one and, I can be written as;

$$I = 1 - e^{-\frac{1}{(J-1)^{\frac{1}{J}}+(J-1)^{\frac{(J-1)}{J}}}} \quad (3)$$

$D_{e,b}$ Can be compute through the essential quality assessment module and $D_{b,c}$ is calculated through the information of provided quality assessment. SINR [17] is denoted by $L_{b,c}$ that practiced through b flow and it is allied by c relay node. Equation 4 defines the calculated $L_{b,c}$ value that is necessary for user location with respect to flow b to RN c connection.

$$L_{b,c} = m_{b,c}.n_c / \sum_{r\in P'} \boldsymbol{m_{b,r}.n_r} + Q \quad (4)$$

Where $m_{b,c}$ signifies the c RN channel gain at flow b, the transmit power (TP) of c RN is n_c, $P' \subseteq P$ signify the interfacing set with RN c and Gaussian noise (Q). Therefore, SINR is getting affected and in accordance to IEEE 802.11 s/u standard, there is a presence of predefined bit rates that can range up to some Mbps by the RNs. Those bit-rates specify the capacity of link $\boldsymbol{s_b}$, between RN c and flow; also this computation can provide the quality assessment prototype via $L_{b,c}$ and $s_{b,c}$ can be definedas:

$$s_{b,c} = f\left(L_{b,c}, F_c\right) \quad (5)$$

The assigned bandwidth to each RN c (Hz) is represented by F_c and the computation $(\boldsymbol{s_c})$ is done via considered quality assessment. The result making value is generated through the $D_{e,b}$ via considering flows number U that are connected through c RN and maximal capacity (V_c) in bps are available at c RN. Therefore $D_{b,c}$ value can be calculated using function $\boldsymbol{g}$ with all considered parameters;

$$D_{b,c} = m\left(s_{b,c}, V_c, U\right) \quad (6)$$

The K value selection may affect the AIF approach behavior. In this paper, the K value is considered as $13e^{-1}$ and J value is 5.0 in order to provide smooth minimization of 'bit rate' (when the available bit rates at AIF flow steadily become much more to the essential bit-rate).

A. *Adaptive Informant Factor (AIF)*

However, the previously defined computation metric can help to find the appropriate RN in order to serve at each novel flow, this metric is not going to reflect the potential effect that associate between RN and a flow all over the network. In general, whenever the wireless user is relying with a RN, the whole capacity of network may be decrease due to serving of novel flow; may disturb some part of network performance. Therefore, the considered parameters are chosen for the AIF that depends on the function of standard deviation (W). In brief, the function of standard deviation defines the alteration in terms of average informant factor, which may result when a RN c initiate serving a (b) new flow.

At each RN c, the available 'bit-rate' functioned to all active flow is recalculated via equation (6) through considering the effect that happen because of new connection flow b. According to new selected value of bit rates, the AIF of active flows are updated by equation (1), afterwards the standard deviation can be computed as follows;

$$W_{b,C} = \sqrt{\frac{\sum_{r=1}^{R}\left(H_{r,C}-\overline{H}_C\right)^2}{R}} \quad (7)$$

Where, the function of $\overline{H_C}$ is defined as;

$$\overline{H}_C = \frac{1}{R}\sum_{r=1}^{R} H_{r,C} \quad (8)$$

Where, R signifies the active flows number in c relay node that also include the preceding active flows in relay node with their informant factor update and the b new flow.

Given A relay nodes, which are available for the selection in order to handle b new flow, The AIF is used to enhance the parameters like the informant metric of RN allowing the novel data flow and the factor of standard deviation that helps to maintain the overall network performance as much possible, to determine the most appropriate relay node. The function of $H_{b,c}$ is used to compute the $W_{b,c}$ standard deviation and the optimized relay node selection can be done by using equation (9);

$$Z_{f_b} = \arg max_{c\in\{1,\dots,P\}}\{\mathrm{H}_{b,c}\} \quad (9)$$

Where,

$$\mathrm{H}_{b,c} = H_{b,c}\{(1-W_{b,c})\} \quad (10)$$

Therefore, the computed Z_{f_b} can optimize each performance through better selection of relay nodes via the proposed AIF approach. In order to safeguard the whole network performance, the standard deviation function is used to minimize the impact on different active flows and for the relay node with no active flows is considered to be zero standard deviation value.

B. Relay Node Selection Approach

Here, we are going to get the suitable relay node among the A RNs composing the mesh wireless network, where the wireless user associated with the RN can provide scalability in data flow as per requested by new flow and RN association should able to safeguard the whole network performance. Each value of c RN stores the following sets such as; D_e^c includes the scalability requirements in terms of the bit-rates that corresponds to its 'active flows' and S^c with link capabilities in terms of active flow bit rates that is computed by equation (5). Algorithm 1 provides the detailed information of running sequence throughout the execution. Initially, to get the optimize RN in order to serve b new flow, the decision making model start by gathering the $(D_{e,b})$ required bit rate from the required scalability assessment. Afterwards, for each flow b RN collects data from provided scalability assessment, FA is set of function that related to selected relay node A and $(s_{c,b})$ link capacity in terms of bit rate that the RN can compute using equation (5) (i.e., 4th line in algorithm 1).

Algorithm 1 - RN Selection	
L-1:	acquire $D_{e,b}$ from required scalability assessment
L- 2:	FA ← ∅,
L- 3:	for c=1 to A do
L-4:	acquire $s_{c,b}$ from provided scalability assessment
L-5:	compute D^c for a=1 to $\lvert S_c\rvert$
L- 6:	if $s_{c,a} \le \{V_c/\lvert S_c\rvert\}$ then
L-7:	$D_{c,a} = s_{c,a}$
L- 8:	else
L-9:	$D_{c,a} = D'$
L-10:	end if
L-11:	$D^c \leftarrow D^c \cup \{D_{c,a}\}$, end for
L-12:	acquire D_e^c information
L-13:	$D_e^c \leftarrow D_e^c \cup (D_{e,b})$.
L-14:	FS ← ∅,
L-15:	for $r = 1$ to $\lvert D^c\rvert$ do
L-16:	calculate $H_{r,c}$ based on $D_{r,c} \in D^c$ and $D_{e,r} \in D_e^c$
L-17:	FS ← FS ∪ $\{H_{r,c}\}$,
L-18:	end for
L-19:	calculate $W_{b,c}$ based on the FS
L-20:	calculate $\mathrm{H}_{b,c}$ based on the $H_{b,c} \in$ FS and $W_{b,c}$
L-21:	FA ← FA ∪ $\{\mathrm{H}_{b,c}\}$,
L-22:	end for
L-23:	approve Z_{f_b}, based upon the values in FA
L-24:	update the selected RNs sets S and D_e

The decision making model then gets the D_e^c set of values and acquires the $D_{e,b}$ and D_e^c from line 12 and 13 in algorithm-1. Afterwards, the all AIF values are computed for all the flows that include flow b in c RN based on bit-rates at D_e^c and D^c respectively via equation (1) and these values are being stored in FS (from line 14 to 18 in algorithm-1). Therefore, decision making can use equation (7) in order to calculate the function of standard deviation $(W_{b,c})$ for c RN that based upon calculated set of FS (in line 19). Afterwards, the decision making model compute the $\mathrm{H}_{b,c}$ value for c relay node using equation (9) and keep the value in FA (lines 20 and 21 in algorithm-1). The complete computation of every $H_{b,c}$ is at $c \in \{1, 2, \dots, A\}$(in between lines 3 and 22), it also gives the most appropriate RN for b flow on Z_{f_b} in equation (9) (line 23 in algorithm-1). Lastly, the decision making model updates the sets of S and D_e corresponding to selected relay node that involves the link capacity and necessary bit rate for the b new flow (line 24 in algorithm-1).

IV. SIMULATION RESULTS AND PROPOSED MODEL

In this section, we are going to analyze the result simulation of our proposed model by using Matlab2015b, for that we use the system configuration of intel i5 processor, 2GB NVidia GC, 8GB RAM and 1 terabyte Hard Drive with the Windows 10 OS. Here, the proposed RN selection approach working at WMN environment that having area size of 400m×400m, where the nodes are having minimal distance of 20 meters. Moreover, we consider the path loss coefficient, path loss i.e., $e^2$and the transmit power of 25dBm. The simulation of code is conducted in order to get bit rate, error rate, station satisfaction and satisfied flows.

Evaluation of model can be complete through considering channel assignment technique with the radio frequency arrangement at WMN. Initially, the channel configuration should be initiated using channel assignment technique and then simulation is executed under dense wireless communication network. In that a novel downstream flow is making a connection in every 2 min and each novel flow provide a new wireless user 'or' it can be same existing user with different scalability requirements. Which is generated from some random location under consider network area. When the number of flows reaches to 1000, the evaluation has stopped for the selected approach. Moreover, the system model evaluation executes the RN selection approach at each period of time; whenever novel flow requests to make a communication to network. The selection of parameters shows the whole wireless communication network, which can address many cases infer to backbone mesh network.

Here, for displaying the results we are considering two scenarios such as scenario-A and scenario-B, in that two different number of RNs are considered. The bit rate can be represented in terms of bps (i.e., bits per second), the assigned RN serve to connected flows in a network. Specifically a new generated b flow is associated to RN c and then the performance of objective metric is calculated in terms of data rate at each active flow under the simulation network. The average satisfaction is obtained by the average percentage value with the connected flow in a network to provide more or equal bit rates with compared to existing bit rate. Additionally, the percentage updation is occurring in period of time, whenever a novel flow creates connection to a RN in WMN.

A. Scenario-A

In scenario-A, the considered number of relay nodes are 80, with distance of 20 meters between the RNs in a considered $400m \times 400m$ area. To compare our obtained result, here we considered the existing approach such as; QSOpt [27] and LBA [27].

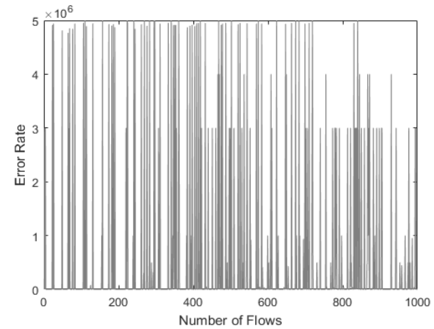

Fig 2: Error Rate w.r.t number of flows at AIF

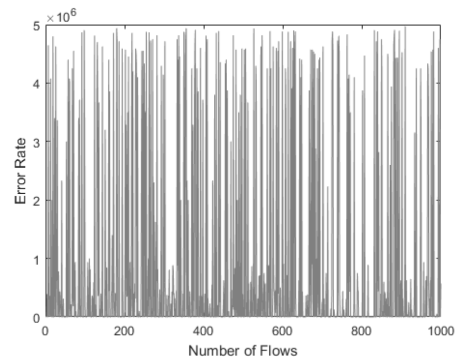

Fig 3: Error Rate w.r.t number of flows at QSOpt

Figure 2 shows the error rate in bps with respect to number of flows at AIF; figure 3 shows the error rate in bps with respect to number of flows at QSOpt. Figure 4 shows the error rate in bps with respect to number of flows at LBA, where we analyze that error rate occurrence per number of flow at fig 2 is less compared to the fig 3 and fig 4.

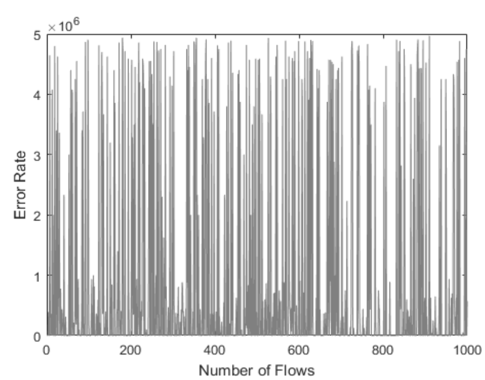

Fig 4: Error Rate w.r.t number of flows at LBA

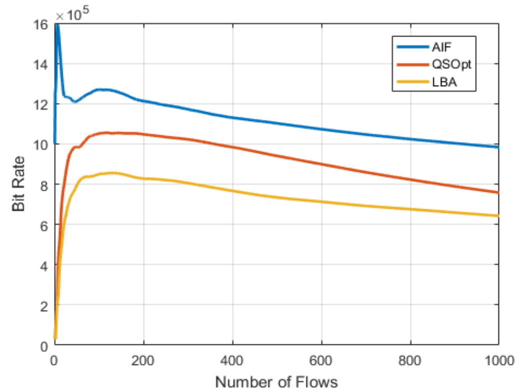

Fig 5: Bit rate w.r.t number of flows

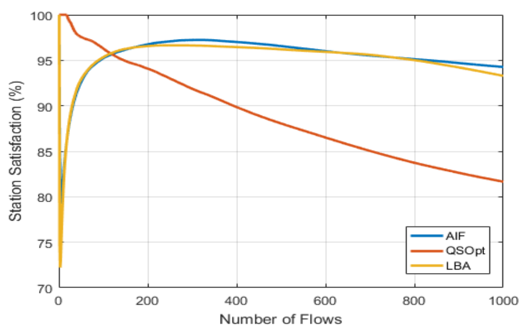

Fig 6: Station Satisfaction (%) w.r.t number of flows

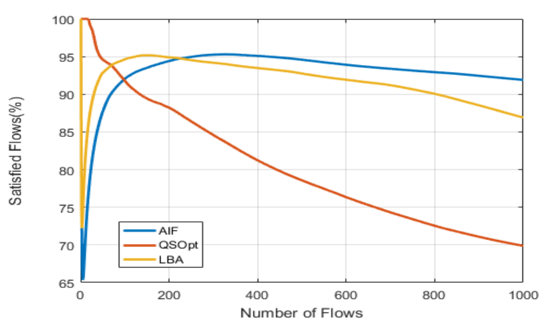

Fig 7: Satisfied Flows (%) w.r.t number of flows

Figure 5 shows the bit rate with respect to number of flows, where we can see our proposed approach is achieved considerably high bit rate (bps) from the starting number of flow and maintains the higher bit rate throughout the 1000 flows. The average achieved bit rate is 1.12Mbps of 1000 flows from our AIF based RN selection approach, 914Kbps is achieved from QSOpt approach and 732Kbps is achieved from LBA approach. Figure 6 shows the Station Satisfaction (%) with respect to the number of flows, where AIF based RN selection approach is achieved 95.49% station satisfaction, LBA approach has achieved 95.19% and QSOpt approach has achieved 88.85%. Which means our proposed model got 6.95% improved station satisfaction compare to QSOpt and 0.3%improved station satisfaction compare to LBA. Figure 7 shows the Satisfied Flows (%) with respect to the number of flows, where AIF based RN selection approach is achieved 92.94% station satisfaction, LBA approach has achieved 91.86% and QSOpt approach has achieved 80.27%. Which means our proposed model got 13.6% improved station satisfaction compared to QSOpt and 1.16%improved station satisfaction compared to LBA.

B. Scenario-B

In scenario-A, the considered number of relay nodes are 100, with distance of 20 meters between the RNs in a considered $400m \times 400m$ area. Similarly like scenario-A, here figure 8 shows the error rate in bps with respect to number of flows at AIF, figure 9 shows the error rate in bps with respect to number of flows at QSOpt and figure 10 shows the error rate in bps with respect to number of flows at LBA. Where, the error rate occurrence per number of flow at fig 8 is less compared to the fig 9 and fig 10.

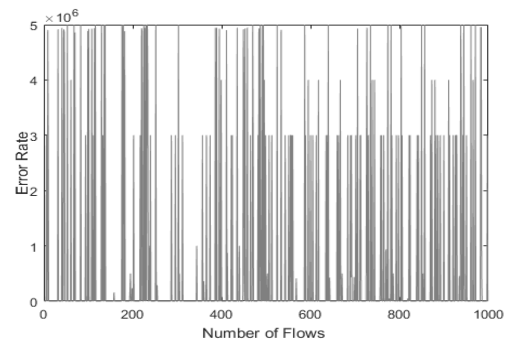

Fig 8: Error Rate w.r.t number of flows at AIF

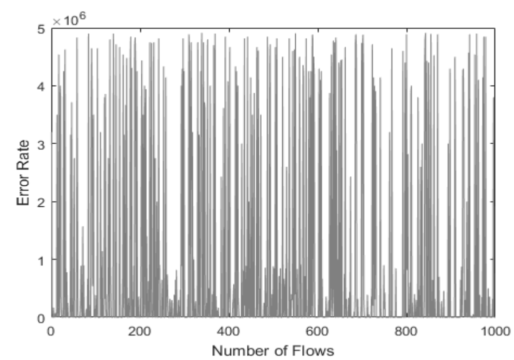

Fig 9: Error Rate w.r.t number of flows at QSOpt

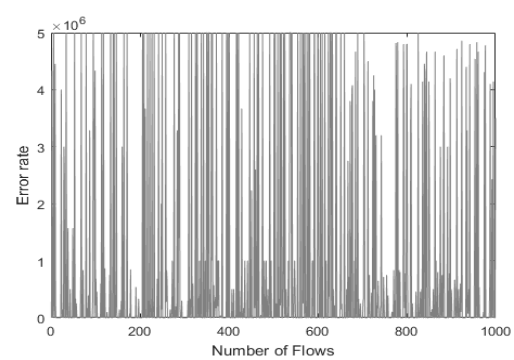

Fig 10: Error Rate w.r.t number of flows at LBA

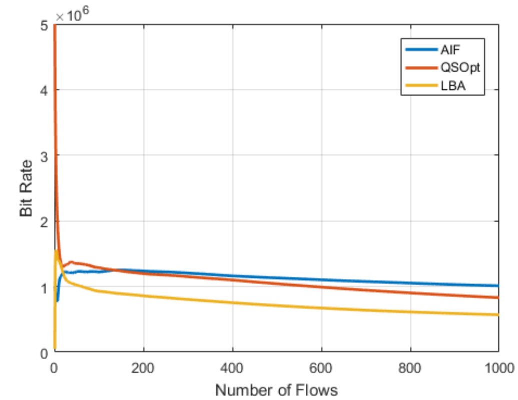

Fig 11: Bit rate w.r.t number of flows

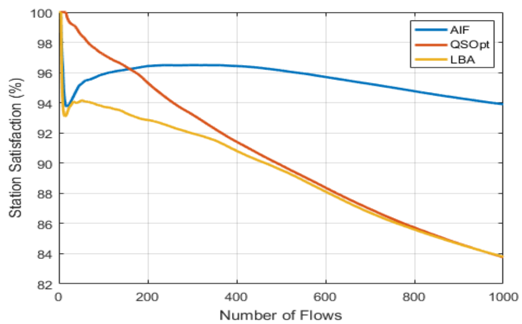

Fig 12: Bit rate w.r.t number of flows

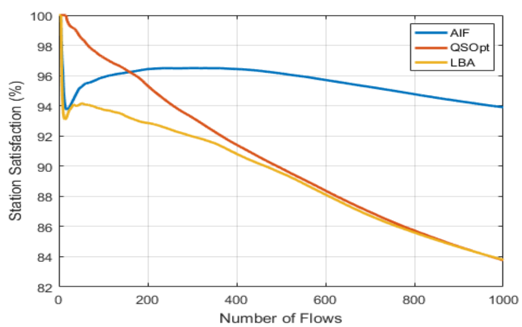

Fig 13: Station Satisfaction (%) w.r.t number of flows

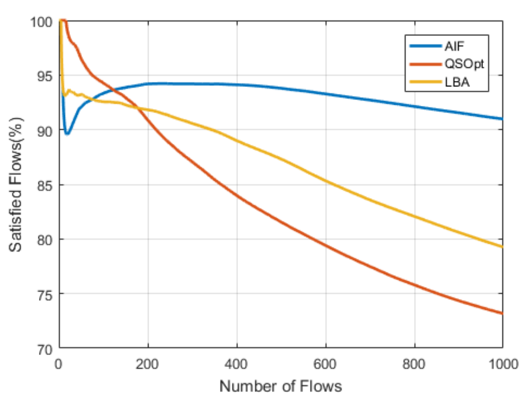

Fig 14: Satisfied Flows (%) w.r.t number of flows

TABLE 1: MEAN SUM RATE AT CONSIDERED NUMBER OF RNs

Number of Relay Node (RN)	QSOpt	LBA	AIF
RN=80	9.14E+05	7.32E+05	1.12E+06
RN=100	1.07E+06	7.45E+05	1.13E+06
RN=120	6.23E+05	8.98E+05	1.33E+06

Figure 11 shows the bit rate with respect to number of flows, where we can see our proposed approach is achieved considerably high bit rate (bps) compare to existing approach at 1000 flows. The average achieved bit rate is 1.13Mbps of 1000 flows from our AIF based RN selection approach, 1.07Mbps is achieved from QSOpt approach and 745Kbps is achieved from LBA approach. Figure 12 shows the Station Satisfaction (%) with respect to the number of flows, where AIF based RN selection approach is achieved 95.59% station satisfaction, LBA approach has achieved 89.33% and QSOpt approach has achieved 90.45%. Which means our proposed model got 5.37% improved station satisfaction compare to QSOpt and 6.54%improved station satisfaction compare to LBA. Figure 13 shows the Satisfied Flows (%) with respect to the number of flows, where AIF based RN selection approach is achieved 93.06% station satisfaction, LBA approach has achieved 86.97% and QSOpt approach has achieved 83.08%. Which means our proposed model got 10.72% improved station satisfaction compare to QSOpt and 6.5% improved station satisfaction compare to LBA. Table 1 shows the mean Sum Rate at considered number of RN, where we have shown for 80, 100, and 120 RNs. Our proposed model has achieved 18.07% more average bit rate compare to QSOpt at considered 80 RNs, and 34.44% more average bit rate compare to LBA approach at 80 RNs. Similarly at 100 RNs, our proposed model has achieved 5.28% more average bit rate compare to QSOpt and 34.1% more average bit rate compare to LBA approach. At 120 RNs, the average achieved bit rate is 1.33Mbps at our AIF based RN selection approach, 623Kbps is achieved from QSOpt approach and 898Kbps is achieved from LBA approach.

V. CONCLUSION

In this paper, an approach of AIF is considered as advanced objective metric, which can be achieved through RN-selection algorithm in order to get the scalability. However, the scalability requirement generally depends upon the characteristics of data flow at wireless mesh network. Using AIF, the objective metric and standard deviation parameters are enhanced; the informant metric of RN allowing the novel data flow and the factor of standard deviation that helps to maintain the overall network performance as much possible. The system model evaluation executes the RN selection approach at each period of time; whenever a novel flows request to make a communication to network. In considered scenarios, our model has performed very well in terms of achieved bit rate, station satisfaction and satisfied flows with respect to existing approach. At considered 120 RNs, our proposed model has achieved 53% more average bit rate compare to QSOpt approach and 32.4% more average bit rate compare to LBA approach. That shows the significance and scalability of our proposed model with increasing number of RNs in wireless mesh system.

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