ISSN 2047-3338

A Cross-Layer based Mobility Aware Transmission Optimization Technique for Wireless Mesh Network

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***Abstract*—Due to rapid growth of the wireless based application services is increasing the demand for wireless communication techniques that use bandwidth more efficiently. WMNs have been adopted as back haul to connect various networks such as Wi-Fi, WiMax etc to the Internet. Wireless mesh networks are multihop networks, self organized networks which can provide last mile connectivity, high transfer speed, and cover large area with low deployment cost. The existing systems proposed so far suffer in utilizing the channel efficiently and induce high collision due to mobility. To address this in this work, the author propose the cross layer based mobility aware transmission optimization technique by designing a routing strategy which considers the link quality parameters from various layers and use some of these parameters to reduce packet loss and throughput and to improve the QoS parameters of the network. The experimental result obtained shows that the proposed approach improves the throughput efficiency considering mobility to existing approaches.**

***Index Terms*—Wireless Network, TDMA, Network Layer, Radio Channel Measurement and Scheduling**

I. Introduction

IN current era wireless network gain much attention; research is ongoing day-by-day to improve more and more wireless technologies. WMN a part of this technologies growth. The IEEE 802.11s MAC is the standard for mesh communication in Wi-Fi network. WMN has a quality of dynamically self-organized and it can self-configure which make it more popular than other wireless network. Multi-hop transmission is one more characteristic of WMN. A wireless Mesh network is very attractive area for researchers in current time due to its flexibility. WMN has flexible infrastructure, it provide end to end communication between the nodes which is far away. WMN has improved from one hop to multi-hop connectivity between the communications ends. High service availability is provided by the WMN through multiple route, if one point or one route is dead or fail to communicate in that case other route is available. High demand of this WMN due to its flexible architecture to support this many mesh standards are given [1]-[3].

In upcoming wireless technologies mesh network play a very important role it has new generation of wireless architecture. Mesh client and mesh router is two important parts of Wireless mesh networks. User can interact with wireless mesh multistep Internet through mesh router, which is connected to the wired network. IEEE 802.11a/ b/g/n standard for wireless network mesh network can be based on any of the standard. Mesh network also has many restriction or issues in terms of number of user in specific location, movement or speed, transmission rate for a given QOS, data packet retransmission etc. using only above standard is some time seems like inefficient, and it require some alternative or some changes, for particular task [5]. Large community of user needs large bandwidth better QoS, wireless mesh networks (WMNs) are hope emerging technologies which give a hope to researcher to full feel the need of people. WMNs has capability to scale their capacity, WMNs has multi-channel, multi-radio capability. WMNs consist of three things stationary or mobile nodes, Mesh routers, Internet Gateway (IGW).

Using WMN IEEE 802.11S standard for wireless communications traffic has the following issue the need to be addressed as in [4], [23], [24] such as Distance: it is used for communications over short distances of several hundred meters. Together with this limitation there is a necessity in a large number of access points/roadside stations (remote control) to cover the entire route. Usually it transmits a plurality of control frames and messages for the association and/or network authentication before transmitting useful information. Handover is also difficult to implement due to the high speed of wireless mobile devices in network, where the handoff occurs very frequently between the remote control for the entire route. Difficulties in predicting the amount of traffic generated by nodes, hence the total system capacity. The wireless channel is stochastic and time-varying according to different parameters. Speed of mobile devices. Physical and transport levels of WMN developed for fixed stations, where high speed can lead to large and rapid changes in channel conditions, which in turn increases the probability of frame error (FER). This occurrence is due to the Rayleigh fading channel [12]. When designing a Mesh network appear the following difficulties such as it is difficult to predict the number of subscribers on the network at different intervals.

WMNs has dynamically self-configurable in nature, as per need WMNs changes their approach. Mesh router are connected through wireless link and it generally static in nature. Stationary or mobile node access internet through IGW, which is act as central point for these nodes in mesh network. Most of mobile or stationary node request of accessing internet is directed to the Gateway node which may lead to the congestion in network. Large number of user presence in WMNs increases the chances of network congestion. Providing QoS in transmission of multimedia in WMNs has an issue because high interference in radio in mesh network. To provide better QoS researchers are working on it for fine grain transmission in multimedia. Selection of path for transmission of data and rate adaption is very important for QoS.

Routing metric is a process of creation of routing table or routing decision by which transmission of data path is selected. Routing metrics create route table by capturing the network quality, it also takes the various parameter from network and MAC layer which helps to estimate a better path. Cross layer approach is used to exchange the parameter between various layers. Various cross layer approaches are purposed in literature such as Expected transmission time (ETT) [17], Expected Transmission count etc. Here author approach to overcome the drawback of these routing metric by considering the delay and using single interference. Network interference is used by cross-layer approach in MAC layer. At network layer delay and interference is computed. Rate of data transmission is plays a very important role in estimation of link quality in mesh network. So the author extends their work by choosing rate adaption parameter in routing metric. Packet loss or Signal to noise ratio (SNR) is generally used for computation of rate adaption.

Traditional WMNs support constant-bit-rate connections for simple voice service. Under these circumstances, fixed bandwidth or data rate allocation structures such as TDMA, CSMA/CD [21] and FDMA have been effectively used to multiplex multiple users' scenario while providing protection from multiuser interference however for future scenario these techniques should support a high throughput multimedia based application service. In [11] wireless mesh network high throughput need a TDMA based approach.TDMA support multichannel transmission, schedule dissemination and routing integration. TDMA based on routing metrics and stability of routing metrics. Experiment shows that it controls the network overhead and it not affected by external interference. It is not useful for large network. In [10] TDMA each frame is associated with some slot, and non –conflicting link is transmitted through these slots. Iterative procedure is used to find the nearest feasible schedule by exchanging the link information between nodes.

Author raise the following points like what is best routing path, traffic demands, placement of wireless node, network scheduling and capacity assignment for network which can reduce the delay of packet transmission in the network. To overcome or find the answer of these question we design a cross-layer optimization model, it involves MAC, network and physical layer. Our designed model is useful for capacity management, take routing decision and scheduling. Poisson process is used for packet arrival process in data transmission. TDMA system [6] is used for result of average packet delay, it allow the multiple slot assignment in a network which is useful to determine the delay in network. In this paper also considering the interference effect in wireless network for scheduling constraints into the model.

It is obvious that such static rate implementation will be unable to adapt to time varying wireless link conditions [7]. The proposed novel cross-layer adaptation MAC scheme is expected to take full advantage of network friendly optimized rate implementation, considering OFDMA to handle frequency selective fading and provide enhanced transmission performance considering mobility for WMNs.

The paper organization is as follows: The literature survey is presented in section two. The proposed models are presented in Section two. The results and the experimental study are presented in the section three. The concluding remark is discussed in the last section.

II. Literature Survey

There are several scheduling approaches that have adopted MAC basedslot selection for use with multi-hop networks, including WMNs and ad-hoc networks has been developed in recent times in order to reduce the collision and latency and provide QoS to its end user which are surveyed below.

MAC provides the actual benefit of mesh network. MAC layer protocol by default chooses the minimum available transmission rate and it does not protect from error. Mesh network based on CSMA/CA MAC protocol which has single hop transmission characteristics, cannot provide the quality of service for the application which is streaming in real time like skype based multimedia services, etc. CSMA/CA has some limitation due to which we need develop a new MAC protocol which gives better throughput, capacity and reduce delay. To achieve better QoS it is needed to use the Time division multiple access (TDMA) based approach in MAC layer. Total channel (frequency channel or single band) is split into time-frame slot in TDMA scheduling and assignment of transmitting slot to the node is done. Power drop, collision, data overhead is prevented by every time slot [13]. TDMA with distributed approach consist of two different methodologies. In first approach nearest feasible schedule is used to analyze the global feasible schedule and it inform the availability of a new schedule to the entire node. In second approach it based on Bellman ford algorithm [10], each node find a nearest feasible link, which are taken from two-hop routing information updated by neighbor node.

Number of MAC -layer multicast mechanism was proposed for WMN to overcome the inefficiency of the network. Hop-by-hop recovery on loss of packet is provided by researchers in various ways. Here [14] author gives the analysis of maximized output for a wireless mesh network over CSMA/CA in MAC layer protocol. Random access is not accounted in CSMA due to which collision overhead is increased. New development for optimal capacity analysis of network done in CSMA/CA with multi commodity flow

(MCF), author analyze throughput based on upper and lower bound of the network capacity over CSMA/CA. the drawback of CSMA/CA is that it is not suitable for real time data transfer like video calling. In [15] if physical rate is increases efficiency of the MAC layer is decreases. More efficient MAC layer protocol in terms of scalability still has issues. Proposed scheme by author is MAC protocol based on dual channel token called (DT – MAC). This protocol is suitable for large number of user in terms of scalability and efficiency. Token management is extra overhead for network and it is not suitable for upper layer.

It is understood that in the setting of WMNs, an arbitrary access based MAC convention, for example, CSMA/CA cannot give QoS to applications, for example, streaming of real-time multimedia content [16]. A TDMA -based methodology is important for low jitter and delay and to achieve good throughput.

In [11] wireless mesh network high throughput need a TDMA based approach. TDMA support multichannel transmission, schedule dissemination and routing integration. TDMA is based on routing metrics and stability of routing metrics. Experiment shows that it controls the network overhead and it not affected by external interference. It is not useful for large network. In [10] TDMA each frame is associated with some slot, and non –conflicting link is transmitted through these slots. Iterative procedure is used to find the nearest feasible schedule by exchanging the link information between nodes. Another part is work on wave based termination which is used to detect the scheduled nearest node and if any new node is scheduled which is activated. Spatial – TDMA [18] used for reduced the energy consumption and improve the throughput author formulate offline energy –throughput by the tradeoff curve. Physical interference involved where node used for controlling the power. Author work is based on single channel or single node; it is not feasible for multi-channel or multiple node scenarios.

Here [17] author works for high throughput and reliable mesh network in multi-hop transmission. Reduce network bandwidth in multicast tree. Author presents a distributed and centralized algorithm for tackle the problem of multicasting. Obtained result from expected multicast transmission count (EMTX) method, shows the effectiveness it reduces the number of hop-by-hop transmission per packet, but it not considerable for real life or realistic scenario.

In [11] here they presented an application of LiT – MAC that adopted a transmission based on multi-hop TDMA MAC by adopting Wi-Fi platforms. The conducted their evaluation by means of application level performance as well as micro benchmarks for both indoor and outdoor scenarios. They also presented an integration of their proposed work with numerous routing metrics and evaluated and compared with ROMA [19] and SLIQ [20]. There outcomes shows that the slot time of TDMA is as low as 2ms and has better time synchronization through varied hops thus reducing the control overhead of network. The conducted simulation sturdy for over several days and used 9 devices by considering the outdoor scenario and the result shows that their proposed approach is robust even in the occurrence of external interference but drawback of this approach is they did not consider special reuse due to this it underutilize to enhance the network capacity of WMNs.

In [10] proposed a pairwise synchronization methodology which is alike a LiT – MAC, and this methodology estimate the clock difference among corresponding device by considering propagation delay among the devices. It makes utilization of a guard band to represent handling delays experienced while data transmission, and keeps out estimations to exactly descant the estimation of the guard band. In view of the estimations completed on an indoor scenario, it reports synchronization exactness of the request of microseconds at three hops.

It is seen from literature that the existing mobility based MAC scheduling methodology for mesh network suffers from high collision due to mobility and improper utilization of channel slots. The proposed model is one effective technique that helps in utilizing the channel slot efficiently. To overcome the short coming here the author propose an efficient cross layer based sub-channel selection to improve the QoS of mobility aware WMNs by reducing collision thus improving the throughput efficiency.

III. List of Symbols Used

Table 1: Partial List of Symbol Used

Notation	Description
S	Group of the devices
m	Mesh Point
D	Collision devices
$\hat{J}(t)$	Decision Groups
$\hat{D}$	Decision for collision
$a_x(t)$	Transmitted data by device x
σ_a^2	Power of transmitted data symbols
$z_i(t)$	Channel Noise
$Y_{xs}(t)$	Rayleigh Distribution
$y_{im}(t)$	TDMA Channel Coefficient
$r_m(t)$	Transmitted signal by source device
U^{-1}	Pseudo inverse of channel coefficient
L_n	Mean packet
L_C	Collided Packet
L_l	Mean Likelihood

IV. Proposed Model

Here the author adopts a TDMA based channel for wireless mesh network where a group of devices i.e., $S = \{1,2, \dots, S\}$ and communicates with the mesh point (MP) i.e. $m$and $m \notin S$ and also considers that the devices operates with full duplex mode and are fortified with multi radio. The author also considers that it requires one slot time per data or packet transmission and all packet that are transmitted have same length. In order to get packet loss due to improper transmission here the author consider infinite buffer for each user.

To optimize the transmission strategy for packet collision avoidance here the author considers that at$t$ slotlet D devices collides. When the occurrence of packet collision arises the MP then predicts the collision in order to obtain the number of active devices and the collision order and through control channel it notifies its decisions to all its devices in the mesh network.

Now the author consider that let $\hat{J}(t)$ represent decision of group of active device $J(t)$ and Let $\widehat{D}$ represent the decision of collision order of D. The system enters the optimization transmission stage (OTS) in order to get the collided signal and the OTS length is obtained as $\widehat{D}$ -1 which are fixed.

Now let consider in a period of slot $t + d(1 \leq d \leq \widehat{D} - 1)$ one device arbitrarily chosen as a non- regenerative intermediate device and retransmit its collision period slot signal.The OTS is stopped or terminated after the slot $t + \widehat{D} - 1$. In the proposed scheme let consider the data transmitted by device x is represented as:

$$a_x(t) = \left[a_{x,0}(t), \ldots\ldots, a_x, H - 1(t)\right]$$

that has H number of signal queues and the obtained signal queues power is σ_a^2. Therefore the signal obtained by all the idle devices and by the destination devices is obtained by following equation

$$b_i(t) = \sum_{x \epsilon J(t)} y_{xi}(t) a_x(t) + z_i(t), \quad i \epsilon \{m\} \cup K(t), i \notin J(t) \tag{1}$$

Where $J(t) \cup K(t) = S$ and $y_{xi}(t)$ represent the $TDMA$ channel coefficient among x^{th} source devices and i^{th} receiving devices, $J(t)$ represent the collection of idle devices,$J(t) = \{x_1, \ldots., x_D\}$ represent the collection of source collides and$z_i(t)$ represent the communication channel noise.

Here the author consider a mobility based wireless mesh network, since these devices are wireless in nature they are prone to noisy nature of wireless medium which affects the data transmission and handover efficiency. To overcome this here the author adopt Rayleigh fast fading channel for communication among devices and it is represented by following equation

$$y_{xs}(t) = Y_{xs}(t) e\left(s \delta_{xs}(t)\right) \tag{2}$$

Where $Y_{xs}(t)$ is the Rayleigh distribution considering the variance $2\sigma_Y^2$, $\delta_{xs}(t)$ is evenly distributed in $(0,2\pi)$ and they are identical and uncorrelated considering the Gaussian variance and the signal strength received by the receiver devices in the period of slot $t + d$ is denoted by following equation

$$r_m(t + d) = y_{im}(t + d) l(t + d) b(t) + z_m(t + d), \quad i \in I(t) \tag{3}$$

Where $y_{im}(t)$ represent the $TDMA$ channel coefficient among i^{th} intermediate devices and the correspondent devices, $l(t + d)$ represent the signal scaling constant, $z_m(t + d)$ represent the noise parameter of channel and $I(t) = \{i_1, \ldots., i_{\widehat{D}-1}\}$ represent the collection of intermediate devices. If an intermediate device selected is other than the source i.e.if $i \notin J(t)$,

$$b(t) = b_i(t), \quad l(t + d) = \sqrt{\sigma_a^2 / D\sigma_y^2 + D\sigma_v^2} \tag{4}$$

If $i \in J(t)$ then

$$b(t) = b_i(t), \quad l(t + d) = 1 \tag{5}$$

Here considering the equation (4) and (5) the collection of active devices and collision order can be established. For the case let $\widehat{D} = D$ and$\widehat{J(t)} = J(t)$ represent the signal obtained by corresponding devices in overall slots which can be represented by following equation

$$R = [r_m^C(t), r_m^C(t + 1), \ldots., r_m^C(t + D - 1)]^C \tag{6}$$

Where $r_m(t) = b_m(t)$ which represent the signal transmitted by source devices which is obtained by following equation

$$A = \left[a_{x_1}^C(t), a_{x_2}^C(t), \ldots, a_{x_D}^C(t)\right]^C \tag{7}$$

The signal obtained by the corresponding node can be obtained by the following matrix

$$R = UA + Z \tag{8}$$

Where Z represents the matrix of noise, U represent the matrix of channel coefficient among source devices and corresponding device and the original packet are recovered by following matrix equation

$$\hat{A} = U^{-1} R \tag{9}$$

Where U^{-1} represent the pseudoinverse of U.

Here the authors consider throughput achieved per slot and packet loss likelihood as its performance metric. Now let evaluate the likelihood of packet loss considering a setup that each incorrect decision by MP will results in the loss of all packet that are involved in the OTS, Let $L_n$represent the mean packet that are lost, Likelihood of packet loss (LPL) is represented as follows:

$$LPL = \frac{L_n}{N} \tag{10}$$

The mean packet collided is represented as follows:

$$L_C = \sum_{D=0}^{S} DL(D) = S(1 - Le) \tag{11}$$

The mean number of packet loss likelihood is obtained by following equation by considering $L_M$is equal to 1 and L_F is equal to 0.

$L_{n,1} = \sum_{D=0}^{S} L(D)D[1 - L_{det}(D,0)] = S(1 - Le)\{1 - L_M[(1 - Le)L_M + Le(1 - L_F)]^{S-1}\}$ (12)

Now the author consider to evaluate the likelihood of throughput achieved per channel slot, let N represent the mean length of OTS, L represent the mean packets recovered positively therefore the throughput achieved (T) is evaluated as follows

$$T = \frac{L}{N} \quad (13)$$

So the sum of packet recovered is influenced by decision making by the MP, noise parameter and network transmission channel condition. Therefore it is an difficult task to predict sum of packet recovered, so here the author evaluate the likelihood of throughput at the collision slot to evaluate the network performance of OTS. Let considering L_l as the mean likelihood packet recoverable which is represented as follows

$$LT = \frac{L_l}{N} \quad (14)$$

Now the Le represent the likelihood of devices buffer is been vacant or null at the commencement of OTS. The likelihood of D devices collides at collision slot is evaluated by binomial expression which is shown below

$$L(D) = \binom{S}{D}(1 - Le)^D Le^{S-D}, \;\; \mathrm{D} = 0,1,2,\ldots,\mathrm{S} \quad (15)$$

The likelihood of negative prediction considering Rayleigh fading channel is represented as follows:

$$L_{F=} \int_C^{\infty} \frac{a}{\sigma_v^2} e(-a^2/2\sigma_v^2)dx = e(-C^2/\sigma_v^2) \quad (16)$$

Now to predict the likelihood of L_M is represented as follows:

$$L_M = \int_C^{\infty} \frac{a}{\sigma_v^2 + \sigma_v^2} e\left(-a^2/2\,(\sigma_v^2 + \sigma_v^2)\right) dx = e\left(-C^2/2\,(\sigma_v^2 + \sigma_v^2)\right) \quad (17)$$

The likelihood of $D - m$ source are lost in prediction and f idle devices have done negative prediction which is formulated by following equation:

$$L_{det}(m,f) = \binom{D}{m}(L_M)^m(1 - L_M)^{D-m}. \binom{S-D}{f}(L_F)^f(1 - L_F)^{S-D-f} \quad 0 \le m \le D; 0 \le f \le S - D \quad (18)$$

$m + f$ Is the congruently obtained collision order $\widehat{D}$. Therefor the OTS length is equated as follows:

$$K(D,m,f) = \begin{cases} m + f, 0 \le m \le D; 0 \le f \le S - D; m + f \ne 0 \\ 1, m = 0; f = 0 \end{cases} \quad (19)$$

The mean length of OTS when D source collides is represented as follows

$$K^{|}(D) = \sum_{m=0}^{D}\sum_{f=0}^{S-D} L_{det}(m,f)K(D,m,f) = DL_M + (S - D)L_F + (1 - L_M)^D(1 - L_F)^{S-D} \quad (20)$$

The mean OTS length is represented by following equation

$$K^{|} = \sum_{D=0}^{S} L(D)K^{|}(D) = SL_F + S(1 - Le)(L_M - L_F) + [(1 - Le)(1 - L_M) + Le(1 - L_F)]^S \quad (21)$$

To evaluate LT the author consider that likelihood of correct detection by MP. That is the exact prediction of active device $m = D$ and no idle device are negatively predicted $f = 0$, which is represented as follows

$$L_{det}(D,0) = L_M^D(1 - L_F)^{S-D} \quad (22)$$

Only D packets can be obtained precisely for a particular OTS. The mean likelihood recoverable packet is obtained by following equation

$\dot{L}_{l,1} = \sum_{D=0}^{S} L(D)DL_{det}(D,0) = S(1 - Le)L_M[(1 - Le)L_M + Le(1 - L_F)]^{S-1}$ (23)

The LP is evaluated considering when $L_M = 1$, $L_F = 0$, and $SNR = \infty$ (signal to noise ratio)

Therefore the $LP = S(1 - Le)/[S(1 - Le) + Le^D]$.

$$LP = \frac{\dot{L}_{l,1}}{N} \quad (24)$$

Based on the evaluation of equation (14) and (24) the likelihood of packet loss and throughput is estimated and based these transmission is optimized to retransmit the collided packet. In the next section the simulation outcome of proposed method is evaluated with existing methodology.

V. SIMULATION RESULT AND ANNALYSIS

The system environment used is windows 7 enterprises 64-bit operating system with 8GB of RAM. We have used MATLAB tool. We have conducted simulation study on throughput considering mobility speed and varied number of user and compared our proposed model with existing algorithm [22] which adopted $OFDMA$ channel width adaptation by adopting a greedy approach and conducted simulation study.

The simulation parameter for channel generation is shown in below Table 2.

Table 2: Simulation parameter for channel generation

Parameter	Value
Speed of nodes	1-5ms
Doppler frequency	2.4 GHz
Data rate	312500 bps
Total number of user	32
Packet length	80,000 bytes

The simulation parameter for throughput analysis is shown in below Table 3.

Table 3: Simulation parameter for throughput analysis

Parameter	Value
Number of sub-channel	4
Simulation slot	500
Number of user	10,20,30
Simulation range	10
Monte-Carlo iteration	1

In Fig. 2 the throughput performance is evaluated and computed for varied mobility speed of users for with control sub frames fixed to 20ms. As the mobility speed of user increases the throughput of proposed method decreases. In Fig. 3 we can see the average throughput achieved is high when mobility speed is 1ms and the through put achieved is low when mobility speed is 4ms.

In Fig. 4 the throughput performance for different sub channel is evaluated and computed for varied users with control sub frames fixed to 20ms. As the user increases the throughput of proposed method decreases for all sub channels except sub channel 4. In Fig. 5 we can see the average throughput achieved for varied user.

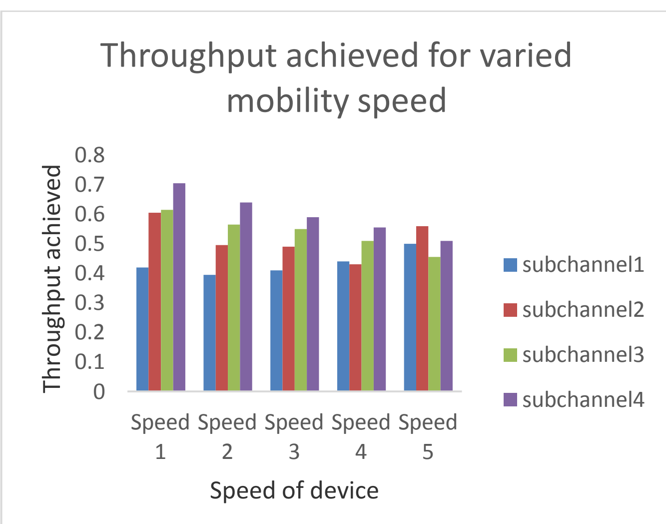

Fig. 2. Throughput achieved per channel considering varied mobility speed

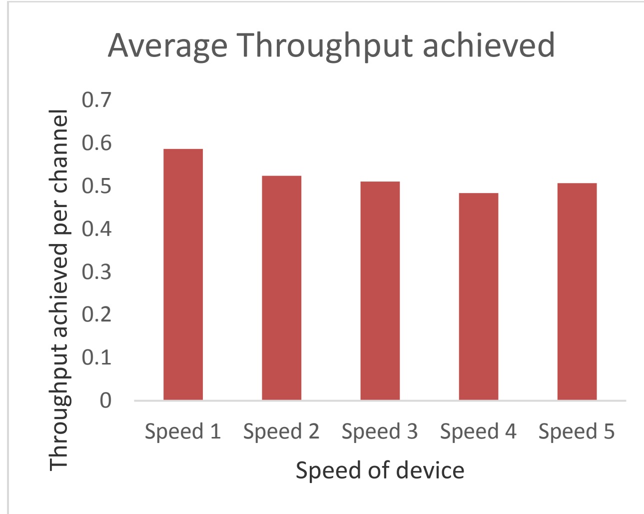

Fig. 3. Average Throughput achieved considering varied mobility speed

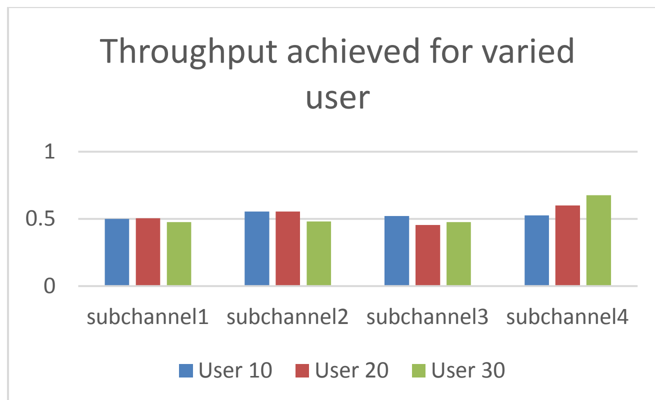

Fig. 4. Throughput achieved considering varied number of user

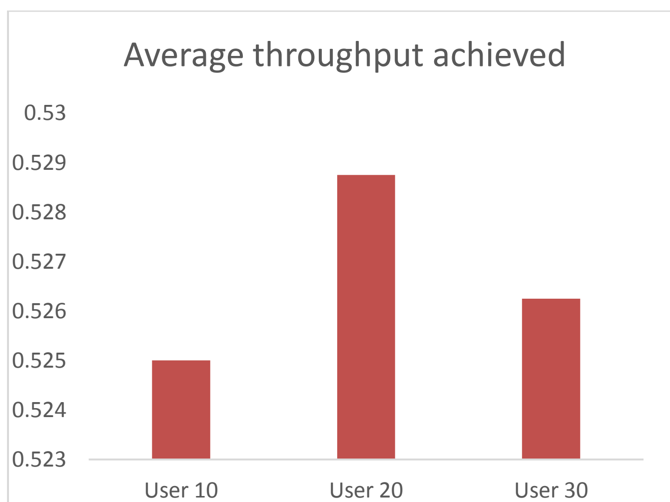

Fig. 5. Average Throughput achieved considering varied number of user

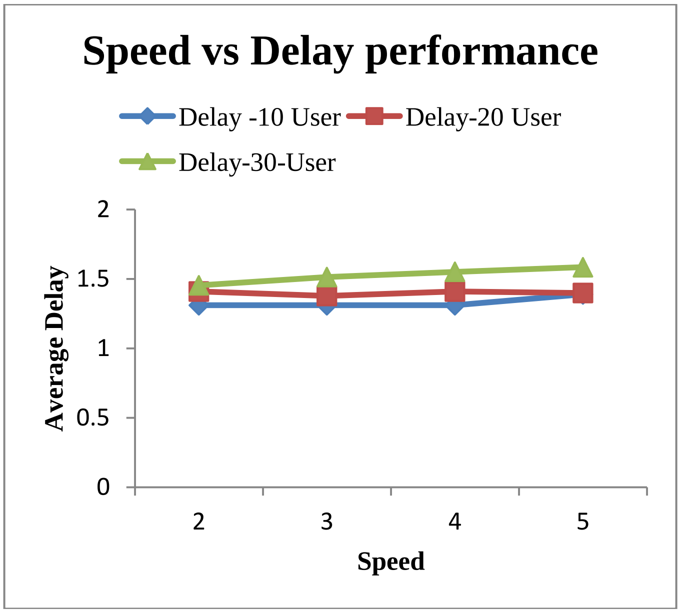

Fig. 6. Speed and delay performance for varied speed

Fig. 6 shows the performance of proposed model in terms of Average delay and speed. In this simulation study speed variation is considered as 2, 3, 4 and 5 and with respect to the speed variation average delay is computed for 10 users, 20 users and 30 users. This can be concluded from the figure that when speed and number of users increases, overall delay also increases.

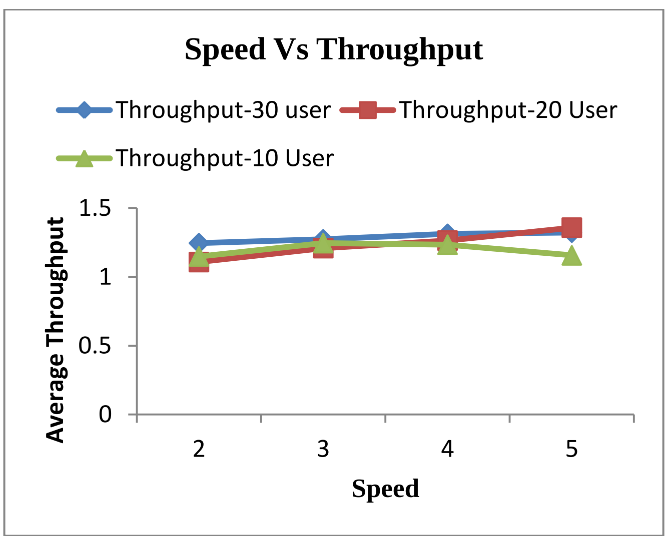

Fig. 7. Speed and throughput performance for varied speed

Similarly we perform the throughput computation by considering the same scenario of the user and speed. Results of this are depicted in Fig. 7. In this case the average throughput by considering 10 users, 20 users and 30 users is achieved 1.19, 1.23 and 1.28 respectively. It can be concluded from the above figure that when the number of users are increasing, throughput also increasing by using proposed approach.

VI. Conclusion

WMNs have been adopted as back haul to connect various networks such as $Wi-Fi, Wi-Max$ etc. to the internet. Wireless mesh networks ($WMNs$) are multihop systems which can develop the scope of remote systems, with the benefits of fast and easy deployment, high transfer speed, simple establishment and upkeep, low front expense. The existing systems presented so far suffer from high collision and delay in data transmission due to improper mobility awareness scheduling and suffer to cater QoS to its end user. The paper presents a model that help in the design of $WMNs$ that meets the QoS necessities of the end user. Here in this work we have presented a model that improves the throughput performance in $WMNs$ due to the adopted mobility based cross layer optimization technique which consider data load density and radio signal strength based on which bandwidth are estimated and relay selection is done. The experimental result shows the impact of proposed model on throughput efficiency when compared to existing greedy model. In future we would consider developing a threshold selection methodology for better usage of channel.

References

[1] IEEE Std 802.11s-2011, Amendment 10: Mesh Networking, IEEE Computer Society Std.

[2] IEEE Std 802.15.5-2009, Part 15.5: Mesh Topology Capability in Wireless Personal Area Networks (WPANs), IEEE Computer Society Std.

[3] IEEE Std 802.16j-2009, Amendment 1: Multihop Relay Specification, IEEE Computer Society and the IEEE Microwave Theory and Techniques Society Std.

[4] K. Bilstrup. A survey regarding wireless communication standarts intended for a high-speed mobile environment// Technical Report IDE, 2007.

[5] X. Wang and I.F. Akyildiz "A survey on wireless mesh networks". in Communications Magazine, IEEE, vol. 43, no. 9, pp.s23-s30, 2005.

[6] K.-T. Ko and B. R. Davis, "Delay analysis for a tdma channel with contiguous output and poisson message arrival," Communications, IEEE Transactions on, vol. 32, no. 6, pp. 707–709, 1984.

[7] B. J. Oh and C. W. Chen, "An Opportunistic Multi Rate MAC for Reliable H.264/AVC Video Streaming over Wireless Mesh Networks," In IEEE ISCAS, pp. 1241-1244, Taipei, Taiwan, May 2009.

[8] R. Lin, A. P. Petropulu, "Cooperative Transmission for Random Access Wireless Networks," IEEE ICASSP '05, Philadeplhia PA, 2005.

[9] R. Lin, A. P. Petropulu, "New Wireless Medium Access Protocol Based On Cooperation," IEEE Trans. Signal Process., vol. 53, no 12, pp. 4675-4684, 2005.

[10] Djukic, P.; Valaee, S., "Distributed Link Scheduling for TDMA Mesh Networks," in Communications, 2007. ICC '07. IEEE International Conference on, pp.3823-3828, 24-28 2007.

[11] Sevani, V.; Raman, B.; Joshi, P., "Implementation-Based Evaluation of a Full-Fledged Multihop TDMA-MAC for WiFi Mesh Networks," in Mobile Computing, IEEE Transactions on, vol.13, no.2, pp.392-406, 2014.

[12] Safronov, R.; Bakhtin, A.; Muravyev, I.; Muratchaev, S., "Designing roadside mesh network with TDMA," in Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT), pp. 131-135, 2014.

[13] Anusha, M.; Vemuru, S.; Gunasekhar, T., "TDMA-based MAC protocols for scheduling channel allocation in multi-channel wireless mesh networks using cognitive radio," in Circuit, Power and Computing Technologies (ICCPCT), International Conference on, pp.1-5, 2015.

[14] Yu Cheng; Hongkun Li; Peng-Jun Wan; Xinbing Wang, "Wireless Mesh Network Capacity Achievable Over the CSMA/CA MAC," in Vehicular Technology, IEEE Transactions on , vol. 61, no. 7, pp.3151-3165, 2012.

[15] Teymoori, Peyman; Yazdani, Nasser; Khonsari, Ahmad, "DT-MAC: An Efficient and Scalable Medium Access Control Protocol for Wireless Networks," in Wireless Communications, IEEE Transactions on, vol. 12, no. 3, pp.1268-1278, 2013.

[16] S. Xu and T. Saadawi, "Revealing the problems with 802.11 medium accesscontrol protocol in multi-hop wireless ad hoc networks," Computer Networks, vol. 38, no. 4, 2002.

[17] Xin Zhao; Jun Guo; Chun Tung Chou; Misra, A.; Jha, S.K., "High-Throughput Reliable Multicast in Multi-Hop Wireless Mesh Networks," in Mobile Computing, IEEE Transactions on , vol.14, no.4, pp.728-741, April 1 2015.

[18] Ouni, A.; Rivano, H.; Valois, F.; Rosenberg, C., "Energy and Throughput Optimization of Wireless Mesh Networks With Continuous Power Control," in Wireless Communications, IEEE Transactions on , vol.14, no.2, pp.1131-1142, 2015.

[19] A. Dhananjay, H. Zhang, J. Li, and L. Subramanian, "Practical, distributedchannel assignment and routing in dual-radio mesh networks," SIGCOMM, 2009.

[20] K. Chebrolu and A. Mishra, "Loss behavior analysis and its application in design of link quality metrics," in COMSNETS, 2011.

[21] D. Bertsekas and R. Gallager, Data Networks, 2nd Ed., Prentice Hall, 1992.

[22] Xudong Wang, Senior Member, IEEE, Pengfei Huang, Jiang Xie, Senior Member, IEEE, and Mian Li "OFDMA-Based Channel-Width Adaptation in Wireless Mesh Networks", 2 IEEE transaction 0n vehicular technology, vol. 63, no. 8, 2014.

[23] Hiertz, G.R.; Denteneer, D.; Max, S.; Taori, R.; Cardona, J.; Berlemann, L.; Walke, B., "IEEE 802.11s: The WLAN Mesh Standard," in Wireless Communications, IEEE , vol.17, no.1, pp.104-111, 2010.

[24] Lee, M.J.; Jianliang Zheng; Young-Bae Ko; Shrestha, D.M., "Emerging standards for wireless mesh technology," in Wireless Communications, IEEE , vol.13, no.2, pp.56-63, 2006.

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