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Cross Layer Design to Reduce the Latency for Effective Scheduling Technique for Mobile Ad hoc Networks

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ABSTRACT: Wireless Mesh Networking (WMN) technology provides a key revolutionary to the future backbone network access. WMN adopt a multihop based transmission to improve end to end data delivery. The 802.11s MAC (Medium Access Control) is designed using CSMA (Carrier Sense Medium Access) protocol which result in collision of slot due to failure in detecting hidden node in WMN. Various methodologies have been developed to optimize the MAC and hidden node and exposed node detection algorithm in recent time to utilize slot efficiently and reduce latency. Slot reutilization is an effective way in reducing latency but due to improper detection of hidden node of existing algorithm the latency is increased. To overcome this, our work propose an efficient device classification based MAC scheduler by adopting a cross layer design to reduce the latency. The experiment are conducted by varying network size and density and the outcome shows that the proposed approach perform better than existing CSMA/OCA in term of latency.

Keywords: *WMN, IEEE 802.11, Scheduling, Medium access control (MAC).*

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I. INTRODUCTION

In order to achieve a low cost application service the IEEE 802.11WLAN (wireless local area network) is a most sorted standard due to its unlicensed operating bands of 2.4 GHz and 5 GHz. Due to the regulatory enforcement limitation of transmission power result in limiting the transmission range of WLAN [1].Nevertheless the requirement of such large wireless network is in huge demand in various areas such as office, home, university, campuses etc… In order to address the issues of single hop communication the 802.11WLAN transmit the data through several hop and WMN are been used. The Task Group S [1] [2] has been working to standardize the IEEE 802.11 to achieve multi hop association by optimizing the routing capabilities and frame forwarding at medium access control layer. The 802.11s standardization bring a new cost effective and secure communication.

WMN establishes an ad-hoc infrastructure i.e. it is self-configured and self-organized, with the devices in the network can join and leave a network and still maintaining the mesh connectivity. The 802.11s mesh network are made of two forms of devices namely mesh clients and mesh routers. Like the 802.11 wireless device it also support routing proficiency for gateway tasks along with that the mesh router contain an added routing functionalities to provision mesh infrastructure. The WMN adopts a multi-hop transmission [2];which can achieve a better coverage by a mesh router with reduced power for transmission. To provide flexibility of WMN the wireless mesh router are fitted with multiple wireless interfaces built on various wireless access technologies.

Though the mesh network provides cost effective network coverage backhaul solutions it has numerous challenges [3], particularly when bandwidth per user is increased for multiple concurrent sessions among multi-hop wireless mesh devices in providing service as backhaul WLAN technologies. These challenges areas a result of 802.11's shared medium access restrains in achieving fairness in communication services considering the multi hop nature of mesh networks.

The provisioning of multimedia based communication services in multi-hop WMNs is an important service for the future perspective of Internet technology [4], but providing multimedia service poses new issues and challenges when deployed over a multi hop WMN such as packet losses and an increased delay due to interference in a multi hop network can significantly degrade the quality of end-to-end multimedia services. High traffic or load can leads to high medium contention which intern increases rate of packet loss as compared to single hop deployments [5].

The presence of hidden devices or failure to identify the presence of hidden devices will result further increase of packet loss rate and induces a high overhead in MAC (Medium access control) layer which result in low capacity for multimedia based services over internet over IEEE 802.11 based WMNs [5]. Various hidden node problem and MAC based scheduler problem are discussed in section 2.

Therefore, it is important to identify the hidden devices in the network for designing an effective MAC scheduler. This work proposes a cross layer based device classification based channel slot re-utilization for effective MAC scheduler.

Issues and challenges faced in IEEE 802.11swireless mesh network

When designing a Mesh network appear the following difficulties [2]:

Mesh Connectivity is an important factor in order to guarantee network self-organization, reliable connectivity, and topology control protocols are required. Topology conscious srouting and MAC protocols can efficiently enhance the performance of mesh networks.

Difficulties to predicting the number of subscribers on the network at different intervals. Difficulties in predicting the amount of load generated by mesh nodes, hence the total system capacity. The wireless channel is stochastic and time-varying according to different parameters.

Scalability is an important factor and necessities of Wireless mesh networks. The network performances will degrades badly without provision of scalability i.e. for varying network sizes and density. For instance, routing strategy may not be suitable or find difficulties in finding a cost effective routing path, loss of connectivity, and MAC protocols may see degradation in throughput performance. To ensure the scalability in Wireless mesh networks, all strategies from the medium access layer to the application layer need to be designed considering scalability.

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

II. LITERATURE SURVEY

Various methodologies have been proposed in recent timesfor performance enhancement of IEEE 802.11s wireless mesh networkthat adopt CSMA/CA MAC protocol [6][7] that include tuning the carrier-sense range [8] by adopting out of band control message [9] or local coordination [10] in order to improve the channel slot utilization.

The MAC protocols based on distributed scheduling [11],[13], [14] have been proposed to address the interference free [12] TDMA schedules. Yet these methodologies allocate equal slot access on time basis for each user request irrespective of traffic demand or load which affect the end to end performance.

Along with this there has been various cross layer design have been adopted to solve the routing, interference and MAC contention for better path selection [15] but they suffer in identifying alternative path and failed to address the interference due to hidden and exposed node problem.

Here [16] they considered link and bandwidth aware scheduling metric have been considered to address the problem of bandwidth wastage in TDMA based protocol. The hidden node problem are solved by giving time slot but the signalling message will cause channel overhead and the bandwidth are estimated based RSSI and improper measurement of RSSI will result in degraded throughput due to collision. To address the throughput degradation due to signalling overhead in [17] the author aim to block hidden devices to avoid data losses due to collision, and to allow transmissions to the exposed devices for effective utilization of available network capacity. They obtained better throughput than existing methodology [18], [19], [20] and [21]. As seen from [17] allowing the exposed to reuse the slots helps improving the throughput performance of the network.

It is seen from literature that the existing mac based mesh network suffers in handling the hidden and exposed node. To overcome the short coming of existing work this work propose an efficient cross layer based node classification based scheduling technique to improve the QoS of WMNs which is explained in section 3.

III. PROPOSED MODEL

Here the author proposes across layer based scheduling technique for efficient slot channel re-utilization optimization to improve the QoS (Quality of service) of wireless mesh networks. The slot re-utilization helps in reducing latency of data delivery but there is a chance of risk of collision to some other devices that may join late to the wireless mesh network. To address this paper adopts a node classification based slot re-utilization technique based on [22] to reduce latency and propose a scheduling is done based on this.Here the author classified the device pair based on the information of parenthood and neighborhood relationship. The classified device pair (x,y) is as follows and is represented in figure 1.

Connected inner relay node pair (CIRP): Here x and y are adjacent device that exist physically in the wireless mesh network, and either x and y are not adjacent device; or, either x or y has a child, but xand y have a conjoint adjacent device which is a child of either x or y.

DISTANT INNER RELAY NODE PAIR (DIRP): Here x and y are not adjacent devices physically but have a conjoint adjacent physical devices in common, although all these adjacent physical devices are neither x's nor y's children.

Connected leaf relay node pair (CLRP): Here x and y are adjacent devices that exist physically in the wireless mesh networks, but neither x nor y has any child.

Non-connected leaf node pair (NCLRP): Here x and y are not adjacent physical devices, neither do they have adjacent physical devices in common.

ISSN: 2454-4248
241 – 246

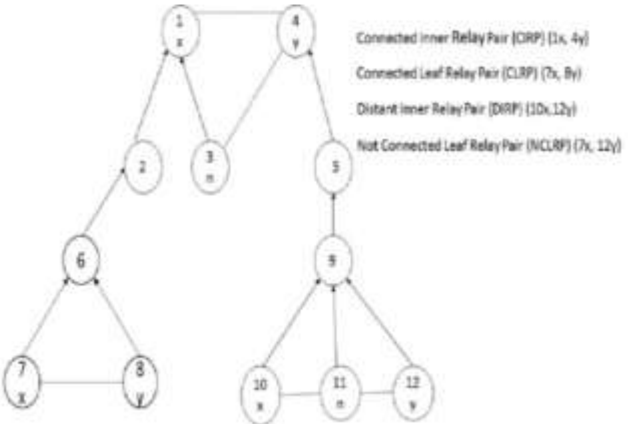

Fig. 1. Proposed device classification model

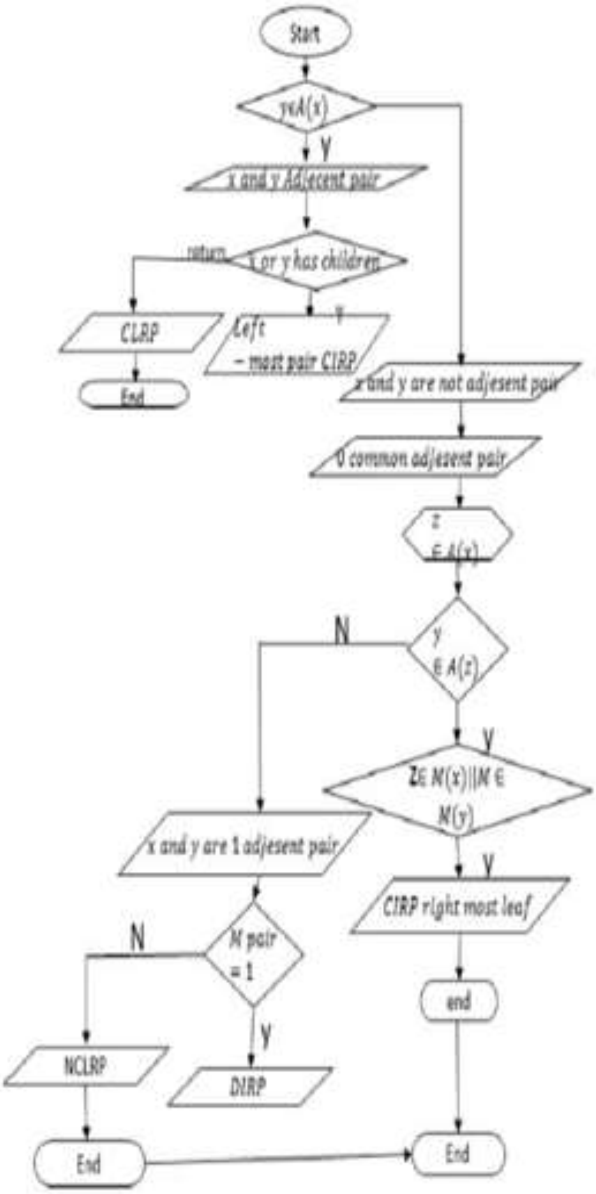

Fig. 2. Flow diagram for retPairClass(x,y).

The author in [22] proved that slot reutilization of CLRP is having higher probability of having risk in slot reutilization as compared with DIRP and slot reutilization of DIRP is having higher probability of having risk in slot reutilization as compared with NCLRP. The slot reutilization of CIRP is not considered in our work. The probability of having risk in slot reutilization is as follows $CLRP \geq DIRP \geq NCLRP$. The author propose channel slot reutilization by CLRP,DIRP and NCLRP when the probability of is risk is small.

Proposed Node Classification based Scheduling approach

The mesh router slot is set to zero initially for node join operation. When a device x needs to a join a wireless mesh network it primarily needs to search the node join operation of adjacent mesh router which are currently present in the wireless mesh tree. Let represent a collection of root contenders of wireless mesh router. The mesh router that cannot allow a leaf node is removed first by using .

The root selection strategy is then applied by node x to sort. In this case the x root device must be the adjacent wireless mesh router that hast the least depth parameter. In our strategy to break the ties, the adjacent mesh router is chosen that has highest number of slot and depth parameter. Once the ?is sorted, the device x choose a root device form ? by following strategy.

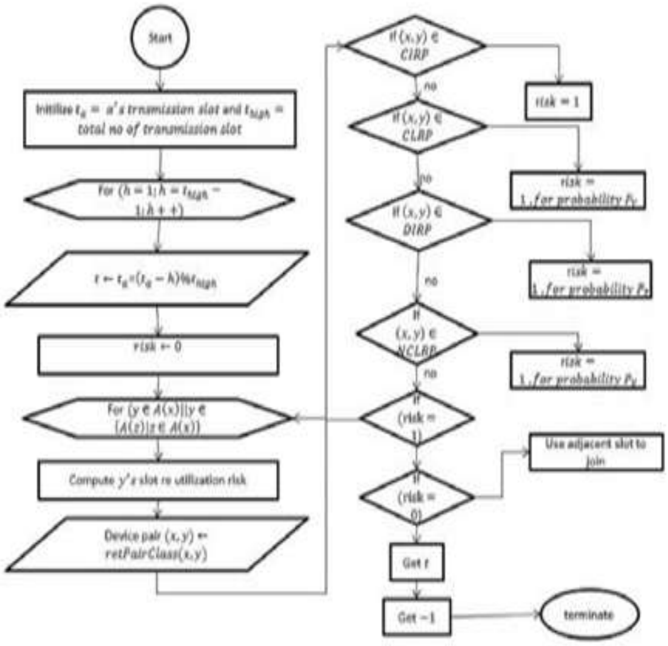

Fig. 3. Flow diagram for selectTranSlot(x)

Firstly, get the first of , compute weather x can join with as mesh router. If has lesser than the maximum number of leaf node of wireless mesh router or gateway amongst its leaf, and has a depth of maximum depth of tree -2 or lesser, and selectTranSlot (x) which gets a transmission slot t, then x joins with . If it fails to join the first t, it checks the next devices of till all the devices of is computed. To verify whether a device x can join as mesh router or as a mesh router end device the depth check is considered.

ISSN: 2454-4248
241 – 246

Secondly, the device x will join a mesh network as mesh router end device of 's first device if it fails to identify device in?. Below the flow diagram of the proposed node classification based slot reutilization based scheduling is shown were flow diagram 3 shows the slot selection selectTranSlot(,x)and flow diagram 2 represent device pair classification computation retPairClass(x,y)..

The simulation study of our proposed approach is evaluated in the below section of this paper.

IV. SIMULATION RESULT AND ANNALYSIS

The system environment used is windows 7 enterprises 64-bit operating system with i-5 class Intel processor and8GB of RAM. The author have used visual studio Dot net framework 4.0, 2010 and used VC++ programming language. This work has conducted simulation study for mean latency and means maximum latency for channel slot re-utilization by varying the network size and network density and is compared with the existing CSMA/OCA [18]. In our experimental studywe have varied the network size as 50, 100, 150, 200, 250 meter and network density from 100, 200, 300, 400 and 500 devices.

In Fig. 4,computes mean latency for varied network sizes and considers 1000 wireless mesh devices. The mean latency achieved for proposed approach when network size is 50mis reduced by 51.02%, for 100m it is 52.2%, for 150m is 53.06%, for 200m is 53.25%, and for 250m is 54.82%. From result

obtained we can see when network size is increased the latency also increases linearly for both proposed and existing approach. The average latency of proposed approach is reduced by 52.69% over existing CSMA/OCA considering varied network sizes.

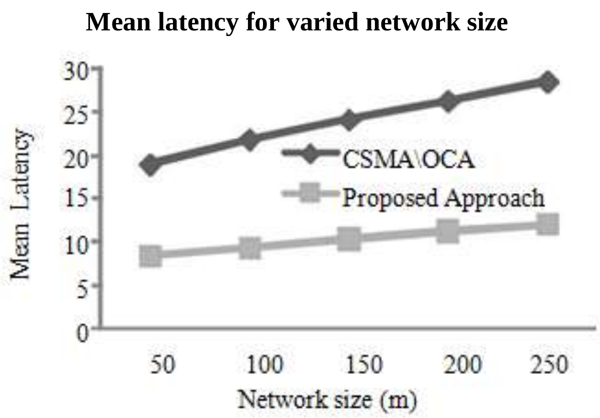

Fig. 4.Mean latency achieved for varied network size

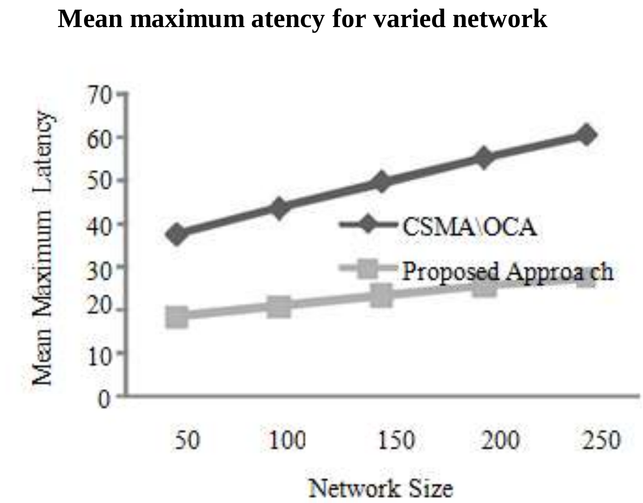

Fig. 5. Mean Maximum Latency for varied network size.

In Fig. 5, shows mean latency for varied network sizes considering 1000 wireless mesh devices. The mean maximum latency achieved for proposed approach when network size is 50m is reduced by 55.55%, for 100m it is 57.88%, for 150m is 57.08%, for 200m is 57.01%, and for 250m is 58.11%. From result obtained we can see when network size is increased the latency also increases linearly for both proposed and existing approach. The average latency of proposed approach is reduced by 57.09% over existing CSMA/OCA considering varied network sizes.

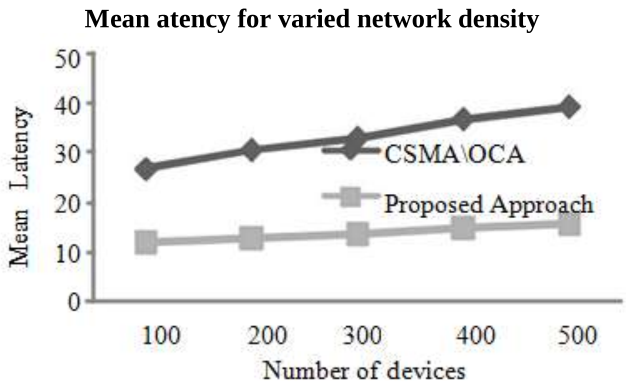

Fig.6. Mean Latency achieved for varied network density

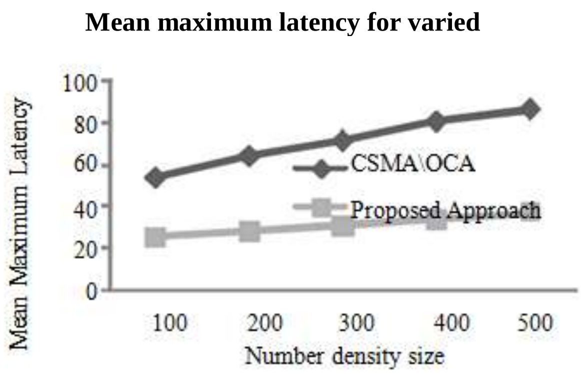

Fig. 7. Mean maximum latency achieved for varied network density

In Fig. 6, computes mean latency for varied network density and considers 500meter as the network size. The mean latency achieved for proposed approach when network density is 100 is reduced by 53.27%, for 200 it is 56.33%, for 300 is 57.28%, for 400 is 59.13%, and for 500 is 58.08%. From result obtained we can see when network density is increased the latency also increases linearly for both proposed and existing approach. The average latency of proposed approach is reduced by 57.02% over existing CSMA/OCA considering varied network density.

In Fig. 7, computes mean latency for varied network density and considers 500meter as the network size. The mean maximum latency achieved for proposed approach when network density is 100 is reduced by 55.2%, for 200 it is 58.11%, for 300 is 58.05%, for 400 is 59.07%, and for 500 is 60.08%. From result obtained we can see when network density is increased the latency also increases linearly for both proposed and existing approach. The average latency of proposed approach is reduced by 57.88% over existing CSMA/OCA considering varied network density.

V. CONCLUSION

This work presented a model that help in the designing a low latency wireless mesh network. Low latency wireless network is a crucial factor to meet QoS necessities of the end user. This work have presented efficient MAC scheduler based on node classification technique for slot reutilization to minimize the collision and thus helps in reducing latency for data transmission in wireless mesh network. The experimental result shows that the proposed model solves the hidden and exposed node problem in wireless mesh network. The proposed model is compared with existing MAC scheduler approach namely CSMA/CA and the outcome shows that proposed model reduce the mean latency of slot by 52.69% and mean maximum latency by 57.08% for varied network size scenario, and reduce mean latency by 57.02% and mean maximum latency by 57.88% for varied network density over CSMA/CA. In future we would conduct simulation sturdy for throughput analysis and also considering analyzing the proposed model by varying depth of tree and range of transmission to further evaluate robustness and scalability of the proposed model.

REFERENCES

[1] G. R. Hiertz, "IEEE 802.11s: The WLAN Mesh Standard," in IEEE Wireless Communications, vol. 17, no. 1, pp. 104-111, February 2010.

[2] F. Akyildiz and Xudong Wang, "A survey on wireless mesh networks," in IEEE Communications Magazine, vol. 43, no. 9, pp. S23-S30, Sept. 2005.

[3] Salitha Priyanka Undugodage and Nurul I Sarkar,"Achieving Transmission Fairness in DistributedMedium Access Wireless Mesh Networks: Design Challenges, Guidelines and Future Directions",IJWMN, Vol. 5, No. 3, June 2013.

[4] Kamal Kumar and Pooja Saini "Performance Evaluation of VOIP in MultiHop Wireless MeshNetwork",ICACCT, ISBN 81-87885-03-3, 2011.

[5] Bayer N, Castro M C, Dely P, Kesslar A"VoIP serviceperformance optimization in pre-IEEE802.11s Wireless mesh network", pp75-79, 2008.

[6] 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.

[7] IEEE 802 LAN/MAN Standards Committee, "Wireless LAN MediumAccess Control (MAC) and Physical Layer (PHY) Specifications, IEEE Standard 802.11," 1999.

[8] J. Deng, B. Liang, and P. K. Varshney, "Tuning the carrier sense rangeof IEEE 802.11 MAC," in Proceedings of IEEE Global Telecommunications Conference - Wireless Communications, Networks, and Systems (Globecom'04), 2004.

[9] P. Kyasanur, J. Padhye, and P. Bahl, "On the efficacy of separatingcontrol and data into different frequency bands," in Proceedings of 1stIEEE International Conference on Broadband Networks, 2005.

[10] A. Acharya, A. Misra, and S. Bansal, "Design and analysis of acooperative medium access scheme for high-performance wireless mesh networks," in Proceedings of 1st IEEE International Conference on Broadband Networks, 2004.

[11] L. Bao and J. J. Garcia-Luna-Aceves, "A new approach to channel access scheduling for ad hoc networks," in MobiCom '01: Proceedings of the 7th annual international conference on Mobile computing and networking, (New York, NY, USA), pp. 210-221, ACM Press, 2001.

[12] Chin-Ya Huang; Ramanathan, P., "Network Layer Support for Gigabit TCP Flows in Wireless Mesh Networks," in Mobile Computing, IEEE Transactions on , vol.14, no.10, pp.2073-2085, 2015.

[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 , vol., no., pp.1-5, 2015.

[14] Djukic, P.; Valaee, S., "Distributed Link Scheduling for TDMA Mesh Networks," in Communications, 2007. ICC '07. IEEE International Conference on , vol., no., pp.3823-3828, 24-28 2007.

[15] S. Zhao, Z. Wu, A. Acharya, and D. Raychaudhuri, "PARMA: APHY/ MAC aware routing metric for ad-hoc wireless networks with multi-rate radios," in Proceedings of IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM 2005),2005.

[16] Zhibin Wu and D. Raychaudhuri, "Integrated routing and MAC scheduling for single-channel wireless mesh networks," World of Wireless, Mobile and Multimedia Networks, 2008. WoWMoM 2008. 2008 International Symposium on a, Newport Beach, CA, 2008, pp. 1-8.

[17] S. Chakraborty, S. Nandi and S. Chattopadhyay, "Alleviating Hidden and Exposed Nodes in High-Throughput Wireless Mesh Networks," in IEEE

Transactions on Wireless Communications, vol. 15, no. 2, pp. 928-937, Feb. 2016.

[18] S. Chakraborty, S. Chattopadhyay, S. Chakraborty, and S. Nandi, "Defending concealedness in IEEE 802.11n," in proceedings of the 6thCOMSNETS, Jan 2014, pp. 1-8.

[19] K. Nishide, H. Kubo, R. Shinkuma, and T. Takahashi, "Detecting hidden and exposed terminal problems in densely deployed wireless networks," IEEE Transactions on Wireless Communications, vol. 11, no. 11, pp. 3841-3849, 2012.

[20] P. van de Ven, A. Janssen, and J. van Leeuwaarden, "Balancing exposedand hidden nodes in linear wireless networks," IEEE/ACM Transactions on Networking, vol. 22, pp. 1429 - 1443, October 2014.

[21] L. Deek, E. Garcia-Villegas, E. Belding, S. Lee, and K. Almeroth, "Intelligent channel bonding in 802.11n WLANs," IEEE Transactions on Mobile Computing, vol. 13, pp. 1536-1233, June 2014.