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Minimizing information asymmetry interference in multi-radio multi-channel wireless mesh networks

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Abstract

Multi-radio multi-channel wireless mesh networks (MRMC-WMNs) in recent years have become a preferred choice for end users, as they are reliable and extend the network connectivity on the last mile. MRMC-WMNs have already been deployed at various locations but still wireless mesh network faces link interference issues i.e. information asymmetry, near-hidden and far-hidden interference. Information asymmetry (IA) interference is one of the major problems that degrade the net capacity of multi-radio multi-channel wireless mesh network. Various studies have been done to minimize channel interference problems. In this paper a linear programming model called information asymmetry minimization (*IAMin*) is proposed to minimize the information asymmetry interference problem. The proposed channel assignment model optimally assigns IEEE 802.11b/g non-overlapping channels to various wireless links of multi-radio multi-channel wireless mesh network. The optimal channel assignment not only minimizes information asymmetry problem, but also maximizes the overall network capacity. A mathematical programming language (AMPL) tool has been used for solving the proposed *IAMin* model. The optimal channel assignment results taken from AMPL are further simulated in OPNET modeler. For extensive simulations, ten different MRMC-WMN scenarios have been considered. The proposed model is tested in both sparse and dense network scenarios where the number of mesh nodes is kept equal. Simulation results show that the proposed optimization model successfully minimizes information asymmetry interference and maximizes the capacity in sparse scenarios of multi-radio multi-channel wireless mesh networks up to 8%.

Keywords: Carrier-sensing range; channel assignment; information asymmetry (IA) interference; non-overlapping channels; wireless mesh network.

1. Introduction

Wireless mesh network (WMN) is a promising technology for providing reliable, scalable and affordable low-cost solutions for broadband wireless internet access in developing parts of the world. Multi-radio multi-channel wireless mesh networks (MRMC-WMNs) consist of wireless mesh routers, mesh clients and mesh gateways. In WMN the nodes (mesh routers) are static unlike the mobile adhoc networks. Si *et al.* (2009) have divided a WMN into three broad levels. The complete architecture of WMN is illustrated in Figure 1 showing all the three levels. First level of WMN consists of gateway nodes that connect a wireless mesh network to the outside world. On the second level, it has wireless mesh routers which works as backbone to relay traffic inside the WMNs on behalf of the mesh clients or end users. These mesh routers are also called mesh nodes, while the end users are the actual senders and consumers of data at the third level.

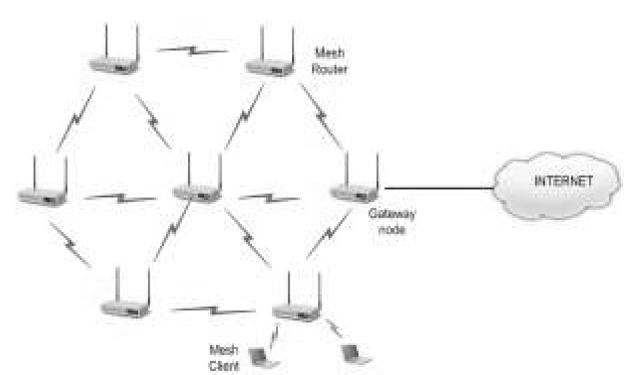

Fig. 1. Wireless mesh network

Mesh routers or nodes can only communicate, if they operate on same IEEE 802.11x frequency channel.

Depending upon the radio to channel configurational so called channel-radio mapping, mesh networks can be classified into i) single-radio single-channel (SRSC), ii) single-radio multi-channel (SRMC) and iii) multi-radiomulti-channel (MRMC) wireless mesh networks. In a SRSC-WMN, all mesh nodes in WMN are configured to use the same wireless frequency channel. This ensures network connectivity. However, all the nodes try to access the same frequency channel that affects network capacity due to limited number of available frequency channels. Bokhari (2011) says that such competition for frequency channel access cause channel collision and leads to interference that needs to be minimized.

In case of SRMC WMNs, mesh routers cannot utilize multiple channels efficiently. According to Si *et al.* (2009), the single radio need to be switched very frequently among frequency channels due to dynamic traffic demands. This switching causes considerable delays during data transmission. These delays can be in milliseconds and even leads to link disconnection. To overcome these limitations of SRSC and SRMC, multi-radio multi-channel architecture on the other hand is currently used. In multi-radio environments, each node is equipped with multiple radios and multiple frequency channels, which can be assigned to same node at the same time that leads to greater network capacity and throughput. Keeping the advantages of MRMC architecture in this paper, multi-radio multi-channel architecture is considered. Studies have shown that in case radio-channel mapping, various problems e.g. channel collision may arise. The main cause of channel collision or interference is the carrier-sensing range of a mesh node. In order to transmit data successfully, every mesh router has its own transmission and carrier-sensing range. Figure 2 shows transmission range (Tr) and carrier-sensing range (Cr) of a given node *S*.

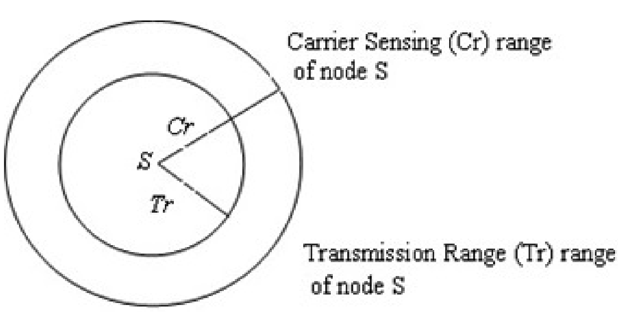

Fig. 2. Coordinated interference

Inside carrier-sensing range transmission activity on same channel is sensed, that can cause interfering situations. When interference occurs it causes transmission losses and also degrades WMN performance. The technology that we are using for channel assignment is IEEE 802.11x as most of the current deployments are IEEE 802.11x based. Among all the versions of IEEE 802.11x the most widely used is IEEE 802.11b/g ISM band. It has 11 frequency channels available for use out of 14 channels in ISM band (2.4GHz). Only three channels 1, 6 and 11 are called non-overlapping in IEEE 802.11b/g and for this research, all these three orthogonal channels are taken as channel set. Any two frequency channels separated by at least 22MHz frequency are termed as non-overlapping (also called orthogonal channels) and currently they are in use in mesh network deployments according to Fuxjager *et al.* (2007). Assigning these non-overlapping channels may cause co-channel interference as they are limited in number. In the next section some key interference conditions are explained, that have been categorized in the past.

Interference in wireless mesh network has been categorized as coordinated (CO) and non-coordinated (nCO) interference by Garetto *et al.* (2006). Two links are called coordinated (CO) interfering links if source nodes of these interfering links, are in each other's carrier-sensing range. Coordinated interference is not considered harmful, as the transmission capacity of frequency channel is shared successfully by the coordinated links. Similarly, in case of non-coordinated (nCO) interference, the source nodes of two links need not to be in carrier-sensing range of each other. Non-coordinated (nCO) interference is further divided into three types by Garetto *et al.* (2006) i.e. i) *Information asymmetry*, ii) *Near-hidden terminal* and iii) *Far-hidden terminal*. The authors also presented a probabilistic model to check the probability of occurrence of all these types of channel interference. However in this research a linear programming model is formulated that only minimizes information asymmetry interference while maximizing MRMC-WMN capacity. Figure 3 demonstrates coordinated (CO) and information asymmetry (IA) interference links.

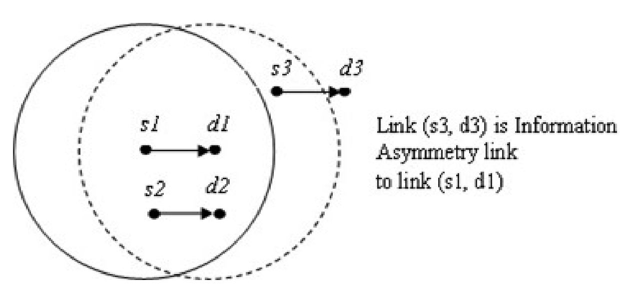

Fig. 3. Information asymmetry interference

Suppose in Figure 3 two links *e(s1, d1)* and *e(s3, d3)* where *s1* and *s3* are sending nodes while *d1* and *d3* are sink nodes. If both links are active on the same frequency channel, then for information asymmetry (IA) interference the following relationship must be true. If *d* represents the physical distance among mesh nodes the for IA interference;

- *d(s1, s3) > Cr*
- *d(d1, s3) < Cr*
- *d(s1, d3) > Cr*

Source nodes *s1* and *s3* are outside each other's carrier-sensing ranges (*Cr)* and same is the case with *s1* and *d3*. For *s3* and *d1* both these node are inside each other's carrier-sensing ranges. In such case, flow on link *e(s1, d1)* is dropped due to interference from link *e(s3, d3)*.

Studies have shown that channel assignment can perform a major role in minimizing IA interference. For optimal channel assignment and minimizing IA interference various channel assignment models and algorithms were proposed, which is discussed later in this paper. Therefore, an optimal channel assignment strategy can perform a significant role in maximizing WMN capacity by minimizing information asymmetry interference among WMN links.

The research contributions in this research paper are:

- A linear programming model called *IAMin* is proposed for optimal channel assignment strategy. Channel to radio binding is done according to the optimization model results.
- Second contribution is to analyze the performance of the *IAMin* channel assignment strategy on node density i.e. in sparse and dense MRMC-WMN topologies.
- In the end, the model results are verified through extensive simulations using OPNET modeler. Extensive simulation results also show that the channel assignment strategy given by the proposed optimization model performs better in minimizing information asymmetry interference.

In section 2 detailed survey of literature (related work) is given. Section 3 consists of the proposed problem formulation that represents the proposed linear programming model *IAMin*. Further in section 4, the results taken from the proposed model and simulation are discussed.

2. Related work

The problem of channel interference has been discussed in different studies already. Garetto *et al.* (2006) divided interfering links into two broad categories. One of them is coordinated (CO) and the second is non-coordinated (nCO) links. The author had further classified nCO interference as information asymmetric (IA), near-hidden (NH) and far-hidden (FH) interfering links. The author in his research has derived conditional packet loss probabilities of WMN links under each category and classification of interference. After comparison, the author has proved that non-coordinated link interference results in higher transmission losses, as compared to coordinated interference. In this research a linear programming model is proposed to check the impact of IA interference only. Raniwal *et al.* (2004) illustrated an iterative approach for solving the joint routing and channel assignment problem. Their proposed algorithm calculates both routing scheme as well as channel assignment scheme in MRMC-WMNs. This research work only focuses on channel assignment, not routing.

Naveed (2008) has presented the idea of dynamic channel assignment algorithm called LYCAS and presents a channel assignment optimization model for maximizing the network throughput. The model also minimizes the non-coordinated (nCO) interference and the author showed that *nCO* interference is more harmful than coordinated interference. However the author has taken two decision variables, which are difficult to solve. The work done by Naveed (2008) is extended in this paper using only one decision variable with the goal to maximize network capacity and minimize information asymmetry interference.

Bukkapatanam *et al.* (2009) presented joint channel assignment and flow allocation for MRMC-WMNs as a mixed integer linear program (MILP). They have done channel allocation statically and their objective was to enhance end-to-end throughput by utilizing both non-overlapping and partially overlapping channels. Further the channel assignment problem has been formulated by Alicherry *et al.* (2005) and Kodialam & Nandagopal (2005). They used linear programming (LP) for channel assignment with constraints on interference and fairness that is NP hard. Bokhari (2011)described an ant colony optimization (ACO) scheme in which smart ants called agents perform both routing and channel assignment in WMN to solve stochastically a dynamic network optimization problem. Shah *et al.* (2013) proposed an optimization model for minimizing non-coordinated interference. The proposed model in this paper does not consider partially overlapping channel, as we are looking forward to use them in future.

Larki *et al*. (2014) has given the idea of edge coloring that can be used in wireless network, where different non-overlapping channels can be represented by different colors. This coloring can help us easily assign IEEE 802.11b channels to various mesh nodes (edges). Paul *et al.* (2014) presented a novel interference based routing metric also called modified weighted cumulative consecutive expected transmission time (ModWCCETT), that select less interference path with more channel availability in wireless mesh network. They have applied mathematical equation for routing metrics called modified weighted cumulative consecutive expected transmission time (ModWCCETT). All the calculation and analysis show the path selection with respect to interference; the ModWCCETT metric is better than other metrics. Wang *et al*. (2015) has done research on utilizing partially overlapping channels improve network capacity. They have proposed a traffic-irrelevant channel assignment algorithm that assigns channels for all the mesh links in the network. A theoretical calculation approach is used to obtain the direct relationship between channel interference ranges and channel separations i.e. distance, which can be easily applied to wireless mesh networks. However their work was partially overlapping, while our research work is on orthogonal channel assignment in this paper.

Athota & Negi (2015) proposed a unique cluster-based channel assignment (CBCA) algorithm where topology preservation have been addressed. The proposed algorithm although retains network topology and minimizes network interference, but it does not specifically mention which type of interference it is minimizing. Qiao *et al*. (2015) have discussed the joint problem of cooperative routing and channel assignment in multi-radio wireless mesh network. Their proposed distributed algorithm reminder available transmission capacity (RATC) make flows pass through a mesh network in evenly manner. Still they did not mention the specific type of interference, whether co-channel or adjacent channel interference.

Wu *et al.* (2014) proposed a set of efficient multi-radio multi-channel (MRMC) assignment, scheduling and routing protocols. These protocols were based on Latin squares for WMNs with MRMC communication capabilities, called "*M*4". The main objective of *M*4 is to create cliques for inter-cluster and intra-cluster in a WMN. In this research an open network is taken for experimentation that do not consider cliques and clusters for channel assignment.

Zeeshan & Naveed (2016) have explored the MAC interaction of two-flow topologies to better understand the MAC behavior of nodes in multi-hop wireless mesh networks. They have observed that different transmission and carrier sensing ranges significantly affect the MAC behavior and throughput of flows. However in this research, we are assuming the same transmission and carrier sensing range.

3. Proposed optimization model

In this section the proposed model information asymmetry minimization (IAMin) is described in detail. The proposed model consists of one decision variable, a set of constraints and an objective function aiming to maximize MRMC-WMN capacity.

3.1 Problem formulation

Let's consider a directed graph $G = (V, E)$ consisting of V wireless mesh nodes and E mesh links or edges. Here K is the set of non-overlapping channels of IEEE 802.11b standard i.e. 1, 6 and 11. The transmission capacity of each frequency channel is represented by C_{ci}. Further the set of directional links incident on node v_j is denoted by $I(v_j)$. The number of interfaces or radios on each node v_j are $n(v_j)$, which is equal to three. $IA(e_j)$ represents the set of all information asymmetry (IA) interfering links of a link e_j while $co(e_j)$ is set of all coordinated interfering edges of a given edge e_j. Flow that is generated over each link of wireless mesh network is represented as $f(e_j)$. $x(e_i, c_j)$ is representing the binary decision variable that is equal to 1 if link e_i in active on channel c_j otherwise it is 0. Moreover, $\lambda(e_j)$ is the fraction of traffic flow on any edge e_j that is varying from 0 to 1 (0 to 100%). In case of data transmission, every mesh node has its transmission and carrier-sensing. Both these ranges are represented as Tr and Cr respectively.

One important parameter is $IA(e_i,Cr)$ that is the set of IA interference links of e_i(active on c_j) in carrier-sensing range Cr that is the maximum carrier-sensing range of each mesh node.

3.1.1. Decision variable

The decision variable is based on the channel assignment decision. This decision variable is binary, which means it has two states i.e. 1 or 0. If any directed link e_i is activated on any frequency channel c_j then it is equal to 1, otherwise 0. Mathematically the proposed binary decision variable is shown in Equation (1).

$$x(e_i, c_j) = \begin{cases} 1 & \text{if a directed link } e_i \text{ operates on channel } c_j \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

3.1.2. Constraint set

Constraints performs significant role in achieving the model results. Following is the set of channel assignment constraints of the *IAMin* model.

- *Single channel per link (SCL) constraint:*

SCL ensures that every edge or directed link in the set *E* edges of *G=(V,E)* must be assigned a single frequency channel from the IEEE 802.11b non-overlapping channels. This constraint in Equation (2) shows that if e_i is a link and these links are added over all the frequency channels then it is equal to 1.

$$\sum_{cj\in K} y(e_i, c_j) = 1 \qquad \forall e_i \in E, c_j \in K \qquad (2)$$

- *Coordinated interference constraint*:

Coordinated links are those links that do not create severe losses, because the frequency channel is shared among directed links. The network performance is not much affected, if multiple coordinated links are assigned the same frequency channel. The channel capacity *Ccj* is in fact distributed amongst all the coordinated interfering links. Here e_k is a link that belongs to the set *Nco*(*ei*). Set *Nco*(e_i) consists of the coordinated links of link e_i. All this means that e_i and set *Nco*(e_i) can be activated on same channel c_j. Flow generated on each source node is represented by *f(*e_k*)*. Equation (3) describes the coordinated constraint where is shows channel capacity is shared when multiple coordinated links are given same channel.

$$x(e_i, c_j).\lambda(e_i).f(e_i) + \sum_{e_k \in Nco(e_i)} x(e_k, c_j).\lambda(e_k).f(e_k) \le Cc_j$$

$$\forall e_i \in E, \forall c_j \in K \qquad (3)$$

- *Information asymmetry interference(IAI) Constraint:*

The *IAI* channel assignment constraint in Equation (4) ensures that those links that are information asymmetry to each other should not operate on common frequency channel. Here e_k belongs to set *IA(*e_i*,Cr)* where e_k is the information asymmetry interference link of link e_i. The *IAI* constraint ensures that e_i and e_k cannot operate on the same channel c_j on same time slot in carrier-sensing range *Cr*.

$$x(e_i, c_j) + \frac{\sum_{e_k \in IA(e_i, Cr)} x(e_k, c_j)}{1 + \sum_{e_k \in IA(e_i, Cr)} (1)} \le 1 \qquad \forall e_i \in E, \forall c_j \in K, e_k \in E \qquad (4)$$

- *Channel per node constraint:*

Channel per node constraint in Equation (5) represents that the total number of frequency channels active on incident links of a particular node v_i. Here c_j is the frequency channel belongs to set *K* while *I(vi)* is the set of incidents links on node *vi.* The variable *n(vi)* is the maximum number of radios on each node *vi*.

$$\sum_{cj\in K} \sum_{ei\in I(vi)} x(e_i, c_j) \le n(v_i) \qquad \forall v_i \in V, c_j \in K, e_i \in I(v_i) \quad (5)$$

3.1.3. Objective function

The objective of the proposed *IAMin* channel assignment model is to maximize the MRMC-WMN capacity. Getting the objective in Equation (3.6) all the constraints must be taken into consideration. Here all the link flows are added, fulfilled over all the links *E* and channel set *K*.

$$maximize \qquad \sum_{ei\in E} \sum_{cj\in K} x(e_i, c_j).\lambda(e_i).f(e_i) \qquad (6)$$

3.2 Proposed model assumptions

For implementing the *IAMin* model, the following assumptions are considered:

- The transmission capacity of all frequency channels is equal i.e. 11 Mbps.
- Each node is equipped with three radios for taking advantage of multiple-radio multi-channels technology.
- All the mesh nodes are static and all the paths in network are taken as single link paths.
- Only single flow at unit time is passing from each link (a links is not shared by multiple flows).

4. Results and discussion

In this section, a detailed description of results taken from proposed channel assignment model is given. For model implementation and simulation, ten different MRMC-WMN sparse and dense topologies are taken. Here sparse MRMC-WMN topology refers to a network topology, where the mesh nodes are far from each other considering their physical distance. For experimental purposes, five sparse and five dense WMN topologies are generated in MATLAB. These topologies are depicted in Figure 4(a, b). Results are divided into two phases.

In the first phase the *IAMin* model is solved in a mathematical programming language (AMPL). AMPL tool is widely used for solving linear and non-linear programming model. Model execution gives the optimal channel results based on IEEE 802.11b non-overlapping channels. To verify the channel assignment results further simulation is done in OPNET simulator. In the next section the AMPL results are discussed.

4.1. AMPL results

We have used MATLAB for WMN topology construction. In MATLAB ten different MRMC-WMN topologies are drawn, where five are sparse and five are dense WMN networks. Each WMN topology consists of 30 nodes. Maximum transmission range *Tr* of each node is kept 30 meters, while carrier-sensing range *Cr* is 78 meters that is 2.6 times of transmission range *Tr*. During AMPL implementation, all the coordinated and information asymmetry links have been generated through MATLAB. Figure 4(a) and 4(b) shows the MATLAB generated dense and sparse WMN topologies respectively.

In dense scenario, the mesh nodes are kept closer to each other while in case of sparse the nodes have larger distance. The solid line circle show the transmission range, while the dotted and dashed line circles represent the carrier-sensing ranges of source and sink node of a considered link respectively. The solid lines between two nodes are links or edges, where flow is transmitted from source to sink node. The terrain is kept 100 by 100 meters and all the nodes are deployed randomly.

The carrier-sensing range of the mesh nodes depends on the power of the node.

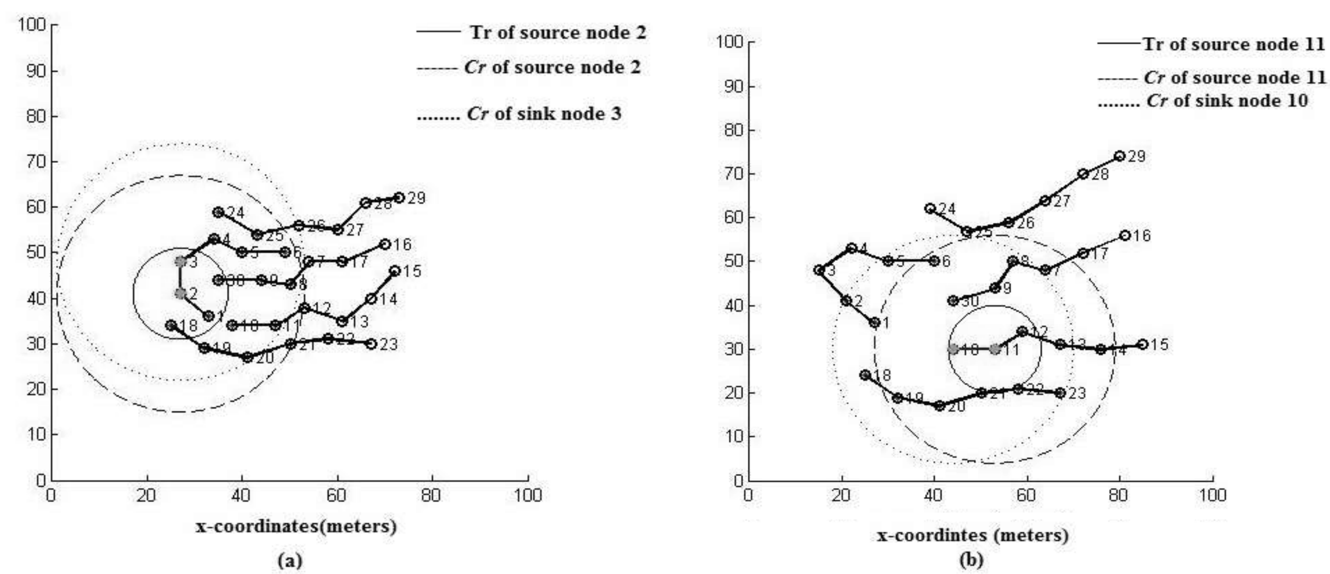

Fig. 4. MATLAB generated 25 node WMN topology

The source flow on each source node is varied from 50 to 500 packets/sec. The *IAMin* model after execution gives the channel-radio binding which are near optimal channel results. Table 1 gives the optimal channel assignment result taken for the WMN topology given in Figure 4 (a). For all the remaining nine topologies same kind of channel assignment results are derived and based on those channel assignment results Table 2 is derived. The three non-overlapping channels 1, 6 and 11 have been assigned to various links according to proposed model constraints. Same kinds of results have been obtained for all the reaming scenarios. In Table 2 the average network capacities for both the sparse and dense WMN topologies taken for varying flow demands (packets per second).

The average network capacity results given in Table 3 are also represented through line charts in Figure 5.

Table 1. AMPL: Channel assignment results in Sparse and Dense WMN topologies

AMPL Channel Assignment Results			
WMN link	Assigned Channel	WMN link	Assigned Channel
(1,2)	1	(19,20)	6
(2,3)	6	(20,21)	1
(3,4)	1	(21,22)	1
(4,5)	6	(22,23)	11
(5,6)	11	(24,25)	1
(30,9)	1	(25,26)	6
(9,8)	11	(26,27)	11
(7,17)	6	(27,28)	11
(17,16)	1	(28,29)	1
(18,19)	11	(15,14)	1
(14,13)	6	(12,11)	11
(13,12)	11	(11,10)	6

Table 2. AMPL: Network Capacity Comparison in Sparse and Dense WMN topologies

Flow Demand (Packets/sec)	Sparse Network Average Capacity (packets/sec)	Dense Network Average Capacity (packets/sec)
50	1395	1320
100	2210	1830
150	2290.5	1797.5
200	2425	1817.5
250	2590	1750
300	2700.5	1819.5
350	2715	1805
400	2870.5	1850
450	2910	1855
500	2968	1897

In the next section the result taken from AMPL are verified in OPNET modeler.

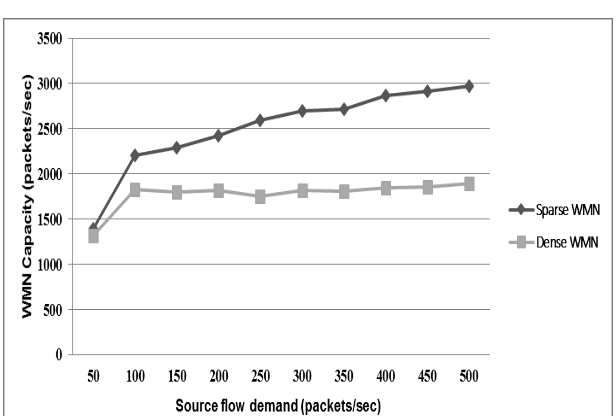

Fig. 5. AMPL: Network Capacity improvement of sparse over dense WMN

4.2. OPNET Results

For OPNET simulations the optimized channel assignment strategy given by the *IAMin* optimization model is used. This research considers only one parameter that is overall network capacity. The terrain area is kept 100m by 100m for all the ten WMN topologies.

All the simulation parameters used during simulation are given in Table 3. Total simulation time is taken as four minutes for simulating both sparse and dense networks. The transmission range *Tr* is taken as 30 meters. The reason is, all the mesh routers just like WiFi routers have same range for transmitting data. The carrier-sensing range is taken as 2.6 times of transmission range because we have tested them in OPNET. Just like the AMPL results the flow demand is varied from 50 to 500 packets/sec.

Although we have taken 30 nodes in each network, only 25 nodes are sending data. For example in Figure 4 (a) if each mesh node sends 50 packet/sec then the total 25 source nodes flow becomes 1250 packets/sec. Table 4 contains the achieved average network capacities for both sparse and dense networks.

The average network capacities are increasing with increase in flow demand from 50 packets/sec to 500 packets/sec on source links.

Table 3. Simulation Parameters

Parameter	Value
Radio Technology	IEEE 802.11b
Number of Nodes	30
Radios per Node	3
Transmission Capacity	11Mbps
Transmission Range	30 meters
Carrier-sensing Range	2.60*30 meters
Number of channels	03
Packet size	4096 bits
Terrain Area	100m x 100m
Transmission Power	0.1w
Packet Reception Power	-50dB
Simulation Time	4 minutes

Among these 30 nodes 5 nodes (i.e.29, 6, 16, 10, 23) are kept as destination nodes in Figure 4(a).The destination nodes are those which do not send any data. In case of sparse WMN in Figure 4 (b) results are taken in the same pattern as for Figure 4(a).

The average network capacities in Table 4 are also represented through line chart in Figure 6. For each traffic load varying from 50 to 500 packets/sec the percentage improvement of sparse over dense topology has been calculated that is 8%. In case of sparse scenarios as the physical distance among mesh nodes increases, the number of information asymmetry links also increase. The proposed *IAMin* model is designed for the sole purpose of minimizing the IA interference. This means that the proposed model performs much better in sparser network topologies.

Table 4. OPNET: Network capacity comparison in sparse and dense WMN topologies

Flow Demand (Packets/sec)	Sparse Network Average Capacity (packets/sec)	Dense Network Average Capacity (packets/sec)
50	1397	1327.5
100	2392.03	2111
150	2758.63	2352.23
200	2994.7	2484.88
250	3392.45	2720.57
300	3458.63	2752.23
350	3697	2815.24
400	4006.63	2937.27
450	4020	3110
500	4092.45	3120.57

5. Conclusion and future work

In this paper the problem of information asymmetry interference is discussed in detail. For minimizing the IA interference a linear programming model called *IAMin* is proposed that maximizes network capacity and minimizes IA interference in MRMC-WMNs. The proposed model optimally

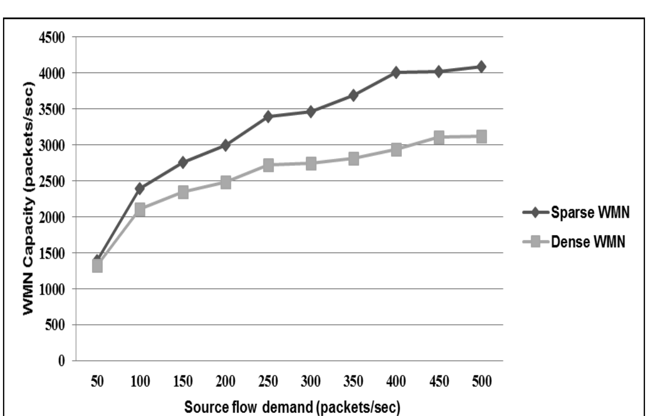

Fig. 6. OPNET: Network Capacity improvement of sparse over dense

Assigns IEEE 802.11b non-overlapping frequency channel to various links of WMN network. The model gives better results for sparse environments where the information asymmetry (IA) interference is high. For testing model results the flow demands on source link is varied to check the performance of model in high data rate.

After getting optimal channel assignment results, they are verified through extensive simulations. The simulation results show that proposed optimization model performs 8% better in sparse MRMC-WMN topologies. In future, we are looking forward to extend the proposed optimization model for partially overlapping channel assignment. In case of partially overlapping channels, the challenge is to handle the adjacent channel interference. The proposed *IAMin* model has the potential to be applied for partially overlapping channel assignment.

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الحد من تداخل التباين المعلوماتي في الشبكات اللاسلكية المتداخلة متعددة القنوات ومتعددة الراديوية

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ملخص

في السنوات الأخيرة، أصبحت الشبكات اللاسلكية المتداخلة متعددة القنوات ومتعددة الراديوية (MRMC-WMNs) خياراً مفضلاً للمستخدمين النهائيين، حيث أنها موثوقة وتُعزز اتصال الشبكة إلى الميل الأخير. وقد تم بالفعل نشر هذه الشبكات MRMC-WMNs في مواقع مختلفة، غير أن الشبكة المتداخلة اللاسلكية لا تزال تواجه مشاكل تداخل الارتباط، أي التباين المعلوماتي، والتداخل شبه الخفي والتداخل الخفي. ويعتبر تداخل التباين المعلوماتي (IA) أحد المشاكل الرئيسية التي تؤدي إلى تدهور صافي قدرة الشبكة اللاسلكية متعددة القنوات الراديوية. وقد أُجريت العديد من الدراسات للحد من مشاكل تداخل القنوات. وفي هذا البحث نعرض نموذج برمجة خطية يسمى الحد من التباين المعلوماتي (IAMin) للحد من مشكلة تداخل التباين المعلوماتي. ويعين نموذج تخصيص القناة المقترح قنوات IEEE 802.11b/g غير متداخلة لوصلات لاسلكية متعددة من شبكات التداخل اللاسلكية متعددة القنوات ومتعددة الراديوية على النحو الأمثل. ولم يؤدي التخصيص الأمثل للقناة إلى الحد من مشكلة التباين المعلوماتي فحسب، بل عمل كذلك على زيادة السعة الإجمالية للشبكة. وقد تم استخدام أداة لغة برمجة رياضية (AMPL) لحل نموذج التباين المعلوماتي المُقترح. من ناحية أخرى تمت محاكاة نتائج التخصيص الأمثل للقناة المأخوذة من لغة البرمجة الرياضية (AMPL) في صانع نماذج OPNET. ولمحاكاة أوسع، تم الوضع في الاعتبار عشرة سيناريوهات مختلفة من MRMC-WMN. وتم اختبار النموذج المقترح في كل من سيناريوهات الشبكة المتناثرة والكثيفة عند الاحتفاظ بعدد عقد الشبكة متساوٍ. وتُبين نتائج المحاكاة أن نموذج الحل الأمثل يحد من تداخل التباين المعلوماتي بنجاح ويزيد القدرة في سيناريوهات الشبكة المتناثرة للشبكات اللاسلكية متعددة القنوات ومتعددة الراديوية حتى 8%.