

# VOIP: Effect of Various VOIP CODECS and Channel Strategies over WMNs

Shweta

Dept. of Computer Science and Engg.,  
Swami Devi Dyal Group of Professional Institutions  
Barwala, Haryana, India

Kamal Tanwar

Dept. of Computer Science and Engg.,  
Swami Devi Dyal Group of Professional Institutions  
Barwala, Haryana, India

## Abstract-

*In the recent past, there has been a tremendous proliferation of VoIP services in both residential homes and corporate offices. The cost savings achieved by VoIP by using existing data infrastructures along with easy deployment benefits are the main reasons driving the steady growth of VoIP. Providing VoIP users with true mobile phone services having the freedom of roaming requires wide area wireless coverage, and multihop wireless mesh networks have been considered a practical solution for wide area coverage. One fundamental problem of WMNs with a limited number of radio interfaces and orthogonal channels is that the performance degrades significantly as the network size grows. This results from increased interference between nodes and diminished spatial reuse over the network. A WMN node needs to share a common channel with each of its neighbours in the communication range, requiring it to set up a virtual link. Moreover, to reduce network interference, a node should minimize the number of neighbours that it shares a common channel with. The objective of a channel assignment strategy is to ensure efficient utilization of the available channels (e.g., by minimizing interference) while maximizing connectivity in the network.*

*Index Terms-WMN, VOIP, CCA.*

## I. INTRODUCTION

One of the most promising and discussed technology in the last decade is the wireless technology which allows users to utilize devices that enable the access to information at any time any place. These needs make wireless networks the best solution for interconnecting devices and people. Wireless networks are comprised of devices that communicate through media such as radio signals and infra-red, and they are generally classified into two categories: Infrastructure-based and ad-hoc wireless networks.

Infrastructure-based wireless network consists of base stations localized in convenient places, which provide wireless connectivity to devices within their coverage area. Examples of this category are Wireless Local Area Networks (WLANs) [5] and cellular networks. A WLAN is a flexible data communication system implemented as an extension to a wired LAN within a building or campus.

On the other hand, ad hoc wireless networks do not have a pre-established infrastructure. Moreover, nodes connect to each other through automatic configuration when they are in transmission range and willing to forward data for other nodes. In this way, an ad hoc wireless network is formed which is both flexible and powerful. Therefore, these capabilities make wireless ad hoc networks suitable for many applications where one central node may not be convenient and where minimal configuration and quick deployment is required in emergency.

Wireless ad hoc networks can be further classified by their application:

- Mobile Ad-Hoc Networks (MANET)
- Wireless Sensor Networks (WSN)
- Wireless Mesh Networks (WMN)

### 1.1. WIRELESS MESH NETWORKS

Wireless Mesh Network (WMN) [1] is a highly promising technology and it plays an important role in the next generation wireless mobile network. WMNs have emerged as important architectures for the future wireless communications. WMNs consist of mesh routers and mesh clients, and could be independently implemented or integrated with other communication systems such as the conventional cellular systems. In addition, WMN are dynamic, self-organized, self-healed, self-configured, and enable quick deployment, easy maintenance, low cost, high scalability and reliable service [2].

Some of the benefits and characteristics of wireless mesh networks are highlighted as follows:

- **Increased Reliability**

In WMNs, the wireless mesh routers provide redundant paths between the sender and the receiver of the wireless connection. This eliminates single point failures and potential bottleneck links, resulting in significantly increased communications reliability [6]. Network robustness against potential problems, e.g., node failures, and path failures due to RF interferences or obstacles, can also be ensured by the existence of multiple possible alternative routes.

Therefore, by utilizing WMN technology, the network can operate reliably over an extended period of time, even in the presence of a network element failure or network congestion.

- **Low Installation Costs**

Recently, the main effort to provide wireless connection to the end-users is through the deployment of 802.11 based Wi-Fi Access Points (APs). To assure almost full coverage in a metro scale area, it is required to deploy a large number of access points because of the limited transmission range of the APs. The drawback of this solution is highly expensive infrastructure costs, since an expensive cabled connection to the wired Internet backbone is necessary for each AP. On the other hand, constructing a wireless mesh network decreases the infrastructure costs, since the mesh network requires only a few points of connection to the wired network. Hence, WMNs can enable rapid implementation and possible modifications of the network at a reasonable cost, which is extremely important in today's competitive market place.

- **Large Coverage Area**

Currently, the data rates of wireless local area networks (WLANs) have been increased by utilizing spectrally efficient modulation schemes. Although the data rates of WLANs are increasing, for a specific transmission power, the coverage and connectivity of WLANs decreases as the end-user becomes further from the access point. On the other hand, multi-hop and multi-channel communications among mesh routers and long transmission range of WiMAX towers deployed in WMNs can enable long distance communication without any significant performance degradation.

- **Automatic Network Connectivity**

Wireless mesh networks are dynamically self-organized and self-configured. In other words, the mesh clients and routers automatically establish and maintain network connectivity, which enables seamless multi-hop interconnection service. For example, when new nodes are added into the network, these nodes utilize their meshing functionalities to automatically discover all possible routers and determine the optimal paths to the wired Internet [6]. Furthermore, the existing mesh routers reorganize the network considering the newly available routes and hence, the network can be easily expanded.

## 1.2. DESIGN ISSUES FOR WMNS

There are still open research issues that should be addressed in order to build high-performance and robust WMNs. Here, we outline some of these design challenges:

- **Topology Control Under the Physical SINR Model**

Most of the studies on topology control are inherently based on the graph model that characterizes graph-theoretic properties of wireless networks, while ignoring important physical aspects of communications. Moscibroda et.al studied the problem of topology control under an information theoretic SINR model [11]. They derived the time complexity of a scheduling algorithm that assigns transmit power levels to all the nodes and schedules all links of an arbitrary network topology. They proved that if the signals are transmitted with correctly assigned transmission power levels, the number of time slots required to successfully schedule all links is proportional to the squared logarithm of the network size. They also devised a centralized algorithm for approaching the theoretical upper bound. In spite of its theoretical importance, the centralized scheduling algorithm cannot, however, be practically implemented. Devising localized topology control algorithms under the physical SINR model remains as a research challenge.

- **Channel Assignment and Routing in Multi-radio, Multi-channel Environments**

A traditional channel assignment problem is what channel should be assigned to a transmission pair in order to enable transmission, mitigate inter-/intra-interference, and improve network capacity. This problem is augmented with another dimension in multi-radio and multi-channel environments: what channel should be associated with each of the radio interfaces a node possesses? Although there have been some preliminary work [1,2], a rigorous treatment of this problem has been lacking. This problem is further complicated, when it is considered in conjunction with routing. Several research efforts have been made to address the joint problem of channel assignment and routing, and various heuristics have been proposed under certain interference models. The challenge, however, remains to consider the problem in an analytic framework under a realistic interference model. Tuning All the PHY/MAC Control Knobs for Spatial Reuse, there are several PHY/MAC attributes that can be used to improve spatial reuse, mitigate interference and maximize network capacity:

- a) the transmit power each node uses for communications,
- b) the carrier sense threshold each node uses to determine if the shared medium is idle,
- c) the channel on which the node transmits, and
- d) the time intervals in which each node gain access to the channel.

On top of all these, routing also plays an important role in mitigating interference and improving end-to-end throughput. Most existing work has only focused on tuning one or two attributes, in spite of the fact that these attributes actually

intertwined with each other. The challenge remains to establish an optimization framework of maximizing the network capacity by adjusting PHY/MAC parameters in all possible dimensions in the design space. Several routing metrics have been proposed based on the link transmission time that Leverage PHY/MAC Attributes.

- **Overheads Incurred in Cross-Layer Design and Optimization**

Most of the theoretical results that demonstrate the advantage of cross-layer design and optimization in WMNs do not adequately consider the computing and communications overhead thus incurred, i.e., the overhead incurred in collecting information needed for inferring the interference, calculating the route metrics, switching the channels, or scheduling frame transmission. It is thus not clear whether or not the performance gain in engaging multiple protocol entities in the protocol stack or across the network outweighs the overhead thus incurred. An in-depth empirical study on a large WMN is needed to better quantify the overhead.

- **Considering Mesh Client Characteristics in WMNs**

In WMNs, there are roughly two entities: mesh routers and mesh clients. The former is usually stationary and not energy-constrained, while the latter is battery-powered and may move arbitrarily. Most of the existing studies have focused on MAC and routing on mesh routers, without considering the characteristics of mesh clients. Incorporating the end-to-end performance requirements and constraints of mesh clients into WMN design will be an interesting and challenging research issue.

## II. VOICE OVER IP

Voice codecs are the algorithms that enable the system to carry analog voice over digital lines. There are several codecs, varying in complexity, bandwidth needed and voice quality. The more bandwidth a codec requires, normally the better voice quality is. One problem that arises in the delivery of high-quality speech is network efficiency. Albeit it is feasible to provide high-quality speech, this comes at the expense of low network efficiency. Most domestic PSTN operate with voice sampled at 8 kHz and an 8-bit non-linear quantization scheme according to ITU-T G.711, which encodes at 64 kb/s. Nonetheless, a much lower bitrate is desirable for a number of applications on account of the limited capacity or in order to maximize the amount of traffic that can be carried over the network.

There exist several codecs that compress voice to as low as 2.15 kb/s, quality is well below that of G.711 though [12].

### Narrowband codecs

- **G.711**

G.711 is a Pulse Code Modulation (PCM) scheme that produces one 8-bit value every 125  $\mu$ s, resulting in a 64 kb/s bitstream. Each audio data is encoded as eight bits after logarithmic scaling [4,5]. This standard has two forms, I-Law (used in North America and Japan) and A-Law (used in Europe and the rest of the world). An A-Law G.711 PCM encoder converts 13 bit long linear PCM samples into 8 bit compressed PCM (logarithmic form) samples, and the decoder does the conversion vice versa, whilst an I-Law G.711 PCM encoder converts 14 bit linear PCM samples into 8 bit compressed PCM samples. The G.711 is the standard codec used in H.323 and the Integrated Services Digital Network (ISDN) network.

- **G.723.1**

G.723.1 is a dual rate speech codec standard from ITU-T, originally developed for videophones that deliver video and speech over regular phone lines (PSTN). It was designed for the ITU-T H.323 and H.324 audio and videoconferencing/telephony standards for compressing the toll quality speech. G.723.1 was standardized in 1996 as a part of the overall H.324 family of standards and can operate at two bit rates:

- 6.3 kb/s (using 24 byte chunks) using a Multi Pulse-Maximum Likelihood Quantization (MPC-MLQ) algorithm.
- 5.3 kb/s (using 20 byte chunks) using an Algebraic Code Excited Linear Prediction (ACELP) algorithm.

The implementation of G.723.1 Annex A also includes silence compression techniques to reduce the transmitted bitrate during the silent intervals of speech. The additional advantages that accrue from the use of Voice Activity Detection (VAD) consist in using lower processing loads and bandwidth during silence intervals.

- **G.726**

ITU-T G.726 superseded ITU-T G.723. It works at four bitrates, i.e., 16, 24, 32 and 40 kb/s. Specifically, this codec is recommended for the conversion of a single 64 kb/s A-law or I-law PCM channel encoded at 8 kHz to a 16, 24, 32 or 40 kb/s channel. It works based on the principle of ADPCM. Nonetheless, the 16 and 24 kb/s encoding rates do not provide toll quality speech. Therefore, ITU-T G.726 recommends that the 16 and 24 kb/s rates should be alternated with higher data rate encoding to provide an average sample size of between 3.5 and 3.7 bits per sample.

- **G.729/G.729 Annex A**

The G.729 codec allows for stuffing more calls in limited bandwidth in order to utilize IP voice in more cost-effective ways [5]. The basic algorithm of G.729 runs at 8 kb/s and is optimized to represent speech with high quality. It uses the conjugate structure algebraic code excited linear prediction (CS-ACELP) algorithm with 10 ms frames. However, the complexity of this algorithm is rather high. To this end, ITU-T came up with the G.729 Annex A (G.729A) codec, which is a medium complexity variant of G.729 with slightly lower voice quality. The G.729 and G.729A codecs are inter-

operable, i.e., speech coded with G.729 can be decoded by G.729A decoder and vice versa. G.729A is a very robust speech codec that works at bitrate of 8 kb/s with very good speech quality comparable to 32 kb/s ADPCM. Like G.729, G.729A is also based on the principle of CSACELP. The Annex B of G.729 adds functionality to the G.729 family of codecs. In essence, it comprises a VAD module, a DTX (Discontinuous Transmission) module which decides on updating the background noise parameters during silence periods, as well as a CNG (Comfort Noise Generation) module[4].

- **G.729 Annex D**

Annex D of the G.729 recommendation was approved in September 1998. This annex describes a lower bitrate codec that operates at 6.4 kb/s. This codec can be employed during periods of congestion, so that operation can continue at 6.4 kb/s with minimal degradation of speech quality, or when more bits are needed by the forward error correction scheme to compensate for channel impairments[4].

- **G.729 Annex E**

Annex E of the G.729 recommendation was also approved in September 1998. This annex delineates a higher bitrate codec that can be used when bandwidth is available in order to improve performance in the presence of background noise and music. G.729E describes a codec operating at 11.8 kb/s that encodes each frame in two different ways and then selects the method that appears to provide the greatest fidelity. The difference between the two methods lies in the algorithm used for the compression. One is based on CS-ACELP, whereas the other features a backward-adaptive Linear Predictive Coding (LPC) synthesis filter[12].

- **GSM-FR**

The ETSI GSM 06.10 Full Rate (FR) codec was the first digital speech coding standard used in GSM (Global System for Mobile Communications) digital mobile phone systems, working on an average bitrate of 13 kb/s. Introduced in 1987, this codec uses the principle of Regular Pulse Excitation- Long Term Prediction-Linear Predictive (RPE-LTP) coding. The speech encoder takes its input as a 13 bit uniform PCM signal either from the audio part of the mobile station or, on the network side, from the PSTN via an 8 bit/A-law to 13 bit uniform PCM conversion. The quality of the encoded speech is quite poor in modern standards, but at the time of its development it was a good compromise between computational complexity and quality. The codec is still widely used in networks around the world[4].

- **GSM-HR**

The GSM 06.20 GSM half rate (HR) codec was introduced in 1994 for use in GSM. It uses the VSELP (Vector- Sum Excited Linear Prediction) algorithm, which translates into a greater need for processing power. GSM-HR's average bitrate is 5.6 kb/s. Since the codec, operating at 5.6 kb/s, requires half the bandwidth of the full rate codec, network capacity for voice traffic is doubled, at the expense of lower audio quality[4].

- **GSM-AMR**

The Adaptive Multi-Rate (AMR) speech codec standard was introduced by the 3rd Generation Partnership Project (3GPP) for compressing toll quality speech (8 kHz). This speech codec was designed with the volatility of the wireless medium in mind for speech compression in the 3rd generation (3G) mobile telephony. This codec operates at eight basic bitrates, 12.2, 10.2, 7.95, 7.40, 6.70, 5.90, 5.15 and 4.75 kb/s, allowing the on-the-fly switch between different rates. It uses the principle of ACELP for all bitrates. Besides, there are two types of VAD and CNG algorithms. Moreover, it was specifically designed to improve link robustness. AMR supports dynamic adaptation to network conditions, using lower bitrates during network congestion, while preserving audio quality at an acceptable level. By trading off the speech bitrate to channel coding, AMR maximizes the likelihood of receiving the signal at the far end. AMR can be considered to be the most widely deployed codec in the world today[12].

### **III. RELATED WORK**

Wireless mesh network (WMNs), with multiple hops and mesh topology, has been emerged as a key including broadband home networking, community networking, business organization networking, and metropolitan area network [1]. Traditional WMNs operate in single-radio single-channel (SR-SC) architecture where each mesh router has only one NIC card and all the mesh routers share one common radio channel. In such a networking, the network suffers from low performance and capacity due to frequent packet collisions and back offs, especially for real-time applications such as VoIP transmission across multi hop WMNs [2].

According to [4], The SR-MC architecture can help to reduce the interference and increase network performance. A required function of the SR-MC solutions is there for each router to dynamically switch between channels along with dynamic network traffic, while coordinating between neighboring nodes to ensure communication on a common channel for some period. However, this type of coordination is usually based on tight time synchronization between nodes, which is difficult to realize in a multi hop WMN. It is noted that the latency in switching the channels with the use of commodity hardware 802.11 NICs can be up to 100 ms.

According to [5], IEEE 802.11a band assign 3 and 12 non-overlapping frequency channels, respectively. Though still there exist significant interference between these standard non-overlapping channels in the current IEEE 802.11 hardware, this problem can be handled by providing better frequency filters in hardware for multi-channel use. So, the use of single-radio multiple-channels (SR-MC) has been proposed to enhance the performance of WMNs.

According to [19], In such architecture, every mesh router is equipped with multiple NICs and each NIC can operate on multiple frequency channels. In MR-MC architecture, multiple transmissions/receptions can occur concurrently, and neighboring links allocated to different channels can carry traffic free from interference. However, MR-MC architecture

use poses some new issues. In general, these issues include topology control, power control, channel allocation, link scheduling, and routing

According to [8], the number of available channels is limited to 3 or 12 in IEEE 802.11 frequency bands. This implies that some logical links may be assigned to the same channel. In such case, interference occurs if these logical links are closer to each other, and so these interfering links cannot be active on same time. Furthermore, the number of available NICs are also limited, and hence some logical links within a router require to share a NIC to transmit and receive the data packets. Furthermore, the physical topology of the routers and other constraints in MR-MC WMNs, four important issues that needs attention are summarized in i.e., logical topology formation, interface assignment, channel allocations, and routing decisions.

According to [9], the authors considers the issues with the MR-MC architecture, existing communication protocols, ranging from routing, MAC, and physical layers, need to be revised and enhanced. In physical layer, techniques mainly focus on three research areas: enhance transmission rate, enhancing error resilience capacity, and increasing re configurability and software controllability of radios. In order to improve the capacity of wireless networks, many high-speed physical techniques, such as OFDM, UWB, and MIMO, have been discovered.

### CHANNEL ASSIGNMENT SCHEMES FOR WMNS

Channel Assignment (CA) in a multi-radio WMN environment consists of assigning channels to the radios in order to achieve efficient channel utilization (i.e. minimize interference) and, at the same time, to guarantee an adequate level of connectivity. The problem of optimally assigning channels in an arbitrary mesh topology has been proven to be NP-hard based on its mapping to a graph-coloring problem [10]. Therefore, channel assignment schemes predominantly employ heuristic techniques to assign channels to radios belonging to WMN nodes.

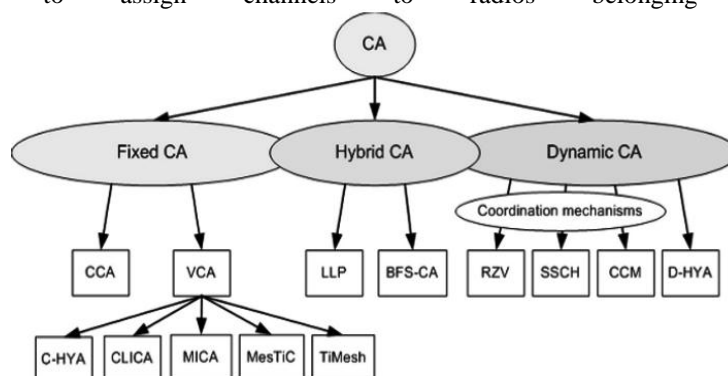


Fig.1: Taxonomy of channel assignment schemes in wireless mesh networks.

#### Fixed Channel Assignment Schemes

Fixed assignment schemes assign channels to radios either permanently, or for time intervals that are long with respect to the radio switching time. Such schemes can be further subdivided into common channel assignment and varying channel assignment.

#### Common Channel Assignment (CCA)

This is the simplest scheme. In CCA [5], the radios of each node are all assigned the same set of channels. For example, if each node has two radios, then the same two channels are used at every node as shown in Figure 2.

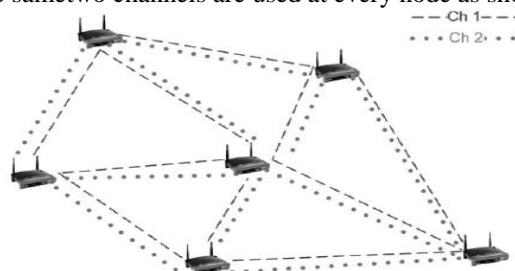


Fig.2: Common Channel Assignment.

#### Varying Channel Assignment (VCA)

In the VCA scheme, radios of different nodes may be assigned different sets of channels [9, 10]. However, the assignment of channels may lead to network partitions and/or topology changes, which may increase the length of routes between mesh nodes. Therefore, in this scheme, channel assignment needs to be carried out carefully. Below we discuss the VCA approach in more details by presenting five algorithms that belong to this sub-category.

- **Centralized Channel Assignment(C-HYA)**

Based on Hyacinth, a multi-channel wireless mesh network architecture, a centralized channel assignment algorithm for WMNs was proposed in [18], where traffic is mainly directed toward gateway nodes, i.e. the traffic is directed

to/from the Internet. Assuming that the offered traffic load is known, this algorithm assigns channels thus ensuring network connectivity and satisfying the bandwidth limitations of each link. It first estimates the total expected load on each virtual link by summing the load due to each offered traffic flow. Then, the channel assignment algorithm visits each virtual link in decreasing order of expected traffic load and greedily assigns it a channel. The algorithm starts with an initial estimation of the expected traffic load and iterates over channel assignment and routing until the bandwidth allocated to each virtual link matches its expected load. Although this scheme presents a method for channel allocation that incorporates connectivity and traffic patterns, the assignment of channels on links may cause a ripple effect whereby already assigned links have to be revisited, thus increasing the time complexity of the scheme. An example of node revisiting is illustrated in Fig. 3. In this case, node a is assigned channels 1 and 4, and node b channels 3 and 8. Because a and b have no common channel, a channel re-assignment is required. Specifically, link (a,b) needs to be assigned one of the channels from [1, 3, 4, 8]. Based on the channel expected loads, link (a,b) is assigned channel 1, and channel 8 assigned already to link (b,d) is changed to channel 1. The results in [18] showed that by deploying only two radios per node, it is possible to achieve a factor of up to 8 in the improvement of the overall network goodput when compared to the case of a single-radio inherently limited to a single channel.

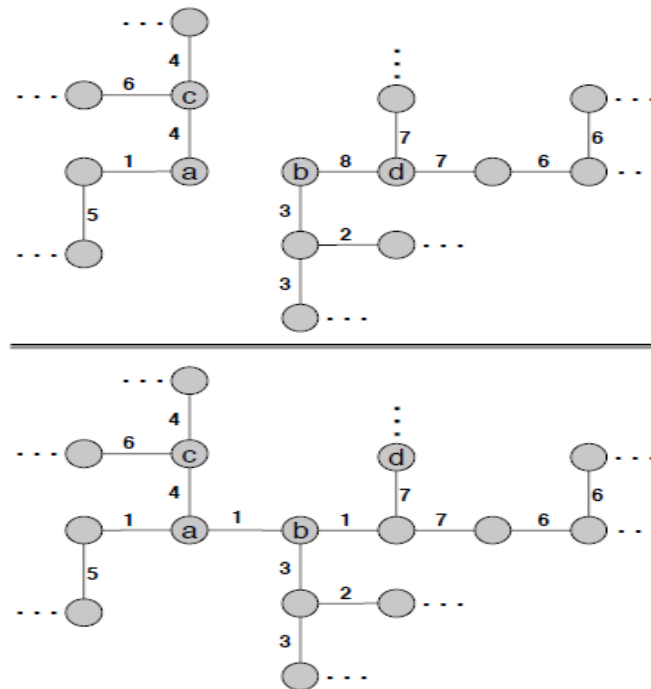


Fig.3: Centralized Channel Assignment.

- **Connected Low Interference Channel Assignment (CLICA)**

A polynomial time greedy heuristic, called Connected Low Interference Channel Assignment (CLICA), was presented in [5] to enable an efficient and flexible topology formation, ease of coordination, and to exploit the static nature of mesh routers to update the channel assignment on large timescales. CLICA is a traffic independent channel assignment scheme which computes the priority for each mesh node and assigns channels based on the connectivity graph and on the conflict graph. However, the algorithm can override the priority of a node to account for the lack of flexibility in terms of channel assignment and to ensure network connectivity. Although this scheme avoids link revisits, it does not incorporate the role of traffic patterns in channel assignment for WMNs.

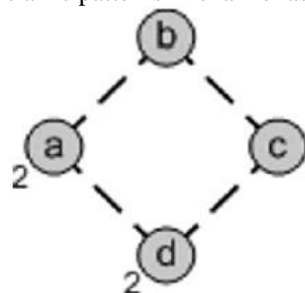


Fig.4: Connected Low Interference Channel Assignment.

- **Minimum-Interference Channel Assignment (MICA)**

In [7] the authors extended [5] and developed two new algorithms. The first is based on a popular heuristic search technique called Tabu search, which was originally designed for graph coloring problems. The second is a greedy

heuristic inspired by the greedy approximation algorithm for Max K-cut problem in graphs. The Tabu-search based method starts with a random assignment. A neighbourhood search is then run for a better solution by flipping the assignment of some nodes. At the same time, the method remembers the best solution seen so far and stops when the maximum number of iterations allowed is reached without a better solution being found. This solution is the best without taking into account the interface constraint, i.e. the total number of available channels at any network node is less than or equal to the number of radios on that node. Therefore, the last step in the algorithm is to start from the node with the maximum violations of the interface constraint, and combine any assignments of radios that share the same channel and share an edge between them in such a way as to minimize the increase in conflicts.

- **Traffic and Interference Aware Channel Assignment Scheme (MesTiC)**

MesTiC stands for Mesh based Traffic and interference aware Channel assignment. It is a fixed, rank-based, polynomial time greedy algorithm for centralized CA, which visits nodes once in the decreasing order of their rank. The rank of each node  $R$  is computed on the basis of its link traffic characteristics, topological properties and number of radios on a node according to the following ratio:

$$R(\text{node}) = \text{Aggregate traffic}(\text{node}) / \text{min hops from gateway}(\text{node}) * \text{number of radios}$$

Clearly, the aggregate traffic flowing through a mesh node has an impact on the channel assignment strategy. The rationale is that if a node relays more traffic, assigning it a channel of least interference will increase the network throughput. Thus, aggregate traffic in the numerator increases the rank of a node with its traffic. In addition, due to the hierarchical nature of a mesh topology, the nodes nearest to the gateway should have a higher preference (rank) in channel assignment, as they are more likely to carry more traffic. At the same time, the number of radios on a node gives flexibility in channel assignments and should inversely affect its priority (i.e. the lower the number of radios, the higher the priority in channel assignment).

- **Topology Design and Channel Assignment (TiMesh)**

In [5], the authors presented a decentralized channel assignment strategy that considers topology control and channel allocation as two separate but related problems. The former takes care of channel dependency and the latter deals interference. The logical topology formation and radio assignment are formulated as a joint optimization problem based on a Multi-channel WMN (MC-WMN) architecture called TiMesh. The model of the proposed solution takes into account: the number of radios on each mesh router, the channel dependency among the nodes that share a common channel, the degree of a node, and the expected traffic load between the various source and destination nodes. The goals are: (1) to guarantee network connectivity, by supporting both internal traffic (among the wireless routers) and external traffic ;(2) to prevent ripple effects among the logical links sharing the same channel. The MC-WMN is modelled by a physical topology graph  $G(N,E)$ . Where  $N$  is the set of mesh routers (each equipped with  $I$  radios) and  $E$  is the set of links between the mesh routers. The first constraint to the problem is that logical links are assumed to be bidirectional. The second constraint is channel dependency. To restrict this dependency an upper bound on the number of additional logical links that may share a radio with a particular link is set. The larger this value is, the smaller the proportion of time that each logical link can access the shared radio. The third constraint is the ripple effect. The approach is to assign an exclusive radio to one end of each logical link. This means that if node  $x$  is responsible for the channel allocation on logical link  $(x,y)$ , then the radio that is assigned by node  $y$  to attach to link  $(x,y)$  should not be used by any other logical link. For capacity planning, a statistical model of the network traffic is used and flow conservation is applied at each node. This guarantees that there is at least one path available between each source and destination pair  $(s,d)$ . Thus, the obtained topology is always connected. The fourth constraint is the hop count, which states that for each source and destination pair  $(s,d)$ , there exists at least one path where the hop count is less than or equal to the shortest path + a tunable parameter  $\Gamma$  (a positive integer). It is assumed that a power control algorithm maintains a constant data rate in the presence of fading and other channel imperfections. This implies that there is a fixed nominal capacity associated with the logical links. However, the actual capacity depends on the number of additional logical links that are sharing the same channel. The utilization of the logical link is then defined as the total traffic load between source and destination (which is assumed to be known) divided by the effective link capacity.

#### IV. CONCLUSION AND FUTURE WORK

In this paper, we have identified the key challenges associated with VOIP against assigning channels to radio interfaces in a multi-radio multi-channel wireless mesh networks. After presenting the design issues for WMNs, we have provided a taxonomy of existing VOIP codecs and WMN channel assignment schemes and summarized this survey with a comparison of the different schemes.

#### REFERENCES

- [1] I. Akyildiz, X. Wang and W.Wang (2005) "Wireless Mesh Networks: A Survey," Computer Networks and ISDN, vol 47, issue 4, pp 445-487.
- [2] J Li, C Blake, DS De Couto, HI Lee, R Morris (2001) "Capacity of ad hoc wireless networks" Proceedings of the 7th annual international conference on mobile computing and networking (Italy, Rome, 2001), pp. pp. 61-69
- [3] A Raniwala, T-C Chiueh (2005) "Architecture and algorithms for an iee 802.11-based multi-channel wireless mesh network" INFOCOM'05, vol. 3, pp. 2223-2234.

- [4] Steve, Portmann, and Valipuram (2008) “Securing Wireless Mesh Networks,” IEEE Internet Computing, vol 12, no 4, pp 30-36.
- [5] A. Raniwala, K. Gopalan, and T. Chiueh (2004) “Centralized channel assignment and routing algorithms for multi-channel wireless mesh networks,” ACM Mobile Computing and Communications Review (MC2R).
- [6] D. S. J. De Couto, D. Aguayo, J. C. Bicket, and R. Morris (2003) “A high-throughput path metric for multi-hop wireless routing,” in Proc. of ACM MobiCom.
- [7] P Bahl, A Adya, J Padhye, A Wolman (2004) “Reconsidering wireless systems with multiple radios” ACM Comput. Commun. Rev 34, pp. 39–46.
- [8] AHM Rad, VWS Wong (2007) “Joint logical topology design, interface assignment, channel allocation and routing for multichannel wireless mesh networks” IEEE Trans. Wirel. Commun 6(12), pp. 4432–4440.
- [9] S Seth, A Gankotiya, A Jindal (2011) “Current state of art research issues and challenges in wireless mesh networks” IEEE Second International Conference on Computer Engineering and Applications, pp. pp. 199–203.
- [10] KN Ramachandran, EM Belding, KC Almeroth, MM Buddhikot (2006) “Interference aware channel assignment in multi-radio wireless mesh networks” in Proc. ed. by . of INFOCOM’06 (Barcelona, Spain), pp. 1–12.
- [11] PH Pathak, R Dutta (2011) “A survey of network design problems and joint design approaches in wireless mesh networks” IEEE Commun. Surv. Tutor 13(3), pp. 396–428.
- [12] Stylianos Karapantazis, Fotini-Niovi Pavlidou, (2009) “VoIP: A comprehensive survey on a promising technology” conference on computer network, Science direct, pp. 2050-2090.