# Traffic Profiling and Dynamic weight computing using dWRR for Average packet delay versus traffic load

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**Abstract:-** The capacity of the conventional wireless mesh network (WMN) with single channel single radio is limited due to co-channel interference. To resolve this capacity limitation problem, multi-channel multi-radio (MCMR) protocols have been proposed. Wireless mesh networks has attractive significant attention towards promising technology. It is becoming a trend for the fourth generation of wireless mobility. Communication in large-scale wireless networks can create bottlenecks for scalable implementations of computationally intensive applications. Classes of crucially important communication patterns that have already received considerable attention in this regard are group communication operations, since these inevitably place a high demand on network bandwidth and have a consequent impact on algorithm execution times. Multicast communication has been among the most primitive group capabilities of any message passing networks. Existing solutions offered for providing multicast communications in WMN have severe restriction in terms of almost all performance characteristics. Consequently, there is a need for the design and analysis of new efficient multicast communication schemes for this promising network technology. An IEEE 802.11s standard draft has been lately designed to define the WMNs framework and architecture. Multi-channel multi-radio wireless mesh networks (MCMR WMNs) have been introduced to improve system performance. However, interfaces and channels management in MCMR WMNs becomes essential to achieve the network performances rise. In this paper, we propose a solution that defines a MAC layer module named Interface Management Module (IMM) under a hybrid channel assignment. The IMM manage the multi-channel radio interface based on scheduling algorithms. A dynamic scheduling algorithm has been proposed. The algorithm is based on traffic profiling and dynamic weights computing for channels scheduling.

**Keywords-** multicast; Wireless Mesh Network; Interface Management Module; Traffic Profiling

## I. INTRODUCTION

Currently accessing the internet, working on internet all over the world has been increased, especially in the developed and developing countries. Wireless Mesh Networks (WMNs) have emerged as a advanced technology as a backbone for a wide range of applications. Their main feature is autonomy. They can be formed without the need of any infrastructure suitable for using in scenarios such as communication in natural disaster (infrastructure damage), home networking, etc.

Now a days, the demand for group communication technology has significantly increased. More and more people prefer to watch football matches and TV drama from the internet rather than from traditional TV. As a technology of group communication, the aim of multicast is to send information from the source sender to multiple receivers. Therefore, multicast is used by the service provider to deliver service to multiple subscribers.

On the other side, the popularity of wireless local area networks (WLANs) based on IEEE 802.11 has been significantly increased [1]. Consequently, the interest over networks based on this topology has also been raised. Thus, IEEE 802.11-based WMNs are being actively explored. Thus, an IEEE 802.11 task group, i.e. 802.11s, was formed. Its aim and essential motivation is to specify a flexible and extensible standard for WMNs based on IEEE 802.11 and to provide solutions by which the WMN backbone could be built without the need of any centralized administration and with minimal configuration difficulties. The last released draft defines the MAC and PHY layer specifications of the 802.11 based wireless mesh networks [2]. It presents WMN framework architecture. A WMN is composed of wireless mesh nodes, commonly known as Mesh Points (MPs) which form a self-contained network with wireless backbone access: Mesh Basic Service Set (MBSS). Mesh stations communicate with each other through single-hop or multi-hop paths in a peer-to-peer fashion. They are either stationary or with low mobility and have ample energy supply. A MP may be collocated with one or more other entities. It is a Mesh Portal (MPP) while it is configured as a gateway allowing access to external networks such as wired LANs. MP can also handle access point functionalities, i.e. Mesh Access Points (MAP), while associated with wireless network interface card. Besides, WMNs can be deployed in a multi-channel multi-radio fashion; commonly known as multi-channel multi-radio wireless mesh networks (MCMR WMNs). MCMR WMNs support MCMR mesh nodes where MPs are equipped with multiple radio interfaces, interfaces can be tuned on a different frequency channel. A Unified Channel Graph (UCG) is a set of MPs that have links via a common wireless medium communication. According to [2], a multi-channel mesh network is composed of several UCGs and a single channel MBSS has only one UCG. Moreover, a multi-radio mesh node belongs to different UCGs because the same device is composed of multiple radio interfaces, each one is tuned on a specific UCG. A mesh node may change its operating channel and switch from one UCG to another, using the Channel Switch Protocol (CSP) [2]. Channel switching causes are numerous (e.g. high level of interferences, etc).

Description about multi-channel, multi-radio multicast requirement this paper. Section II examines the proposed solutions for interfaces and channels managements in a MCMR WMN; followed by section III which describes implementation of proposed method. Section IV presents simulation results while implementing our solution. Finally, the last section concludes this paper.

## II. RELATED WORKS

Some methods have been proposed to resolve the interfaces and channels management problem in MCMR WMNs (i.e. which interface(s) and channel(s) to use for traffic exchanging with neighboring nodes). Most methods require having as many interfaces as the number of channels for each node which prove to be expensive in the real system implementation. Few methods propose solutions for nodes with interfaces fewer than channels.

The challenges posed by the continuously growing need for delivering efficient multicast communication over wmn .this study presents a new load balancing aware multicast algorithm with the aim of enhancing the QOS in the multicast communication over WMN's . In this paper a Gateway-cluster based Load Balancing Multicast algorithm(GLBM) investigate the load balancing problem of multicast in the WMNs is proposed. The multicast applications such as multicast conference & multicast TV require instant real time communication & large packet size. Due to these concerns priority metrics are end to end delay and throughput. Algorithm focuses on high throughput and low end to end delay multicast session through achieving load balancing[1].

In this paper[2] ,introduction of new voice call capacity model of hybrid multi-channel protocol(HMCP) on Multi-Channel Multi-Radio(MCMR) WMNs .Both experimental and simulation results demonstrate that the proposed call capacity model accurately estimates the voice call capacity for G.711 & G.729 codes. Propose 2 QoS routing algorithm for finding feasible routes to meet QoS constraints as well as to improve the call capacity of network by utilizing the proposed call capacity model. Proposed QOS routing algorithms effectively protect voice calls and increase the call capacity[2].

In this paper [3], we propose a solution that defines a MAC layer module named Interface Management Module (IMM) under a hybrid channel assignment. The IMM manage the multi-channel radio interface based on scheduling algorithms. A dynamic scheduling algorithm has been proposed. The algorithm is based on traffic profiling and dynamic weights computing for channels scheduling.

## III IMPLEMENTATION

In this section, we address the interfaces and channels management dilemma in a MCMR environment.

using a hybrid channel assignment strategy where the first interface is a fixed interface with a static channel assignment; while the second interface is a switchable interface which uses the dynamic channel assignment strategy [9]. Thanks to this interfaces‘ assignment approach full duplex mode can be achieved. In fact, the MCMR mesh node fixed interface is primarily used for receiving data from neighbors while its dynamic interface is dedicated to transmit data to its neighboring nodes. The switchable interface is tuned on a channel which may be changed at any time. Thus, if two mesh nodes need to communicate for exchanging data, the switchable interface of the sender node and the fixed interface of the receiver node must be tuned on the same channel. If it‘s not, the sender node switchable interface switches on the channel on which the receiver node fixed interface is tuned. Radio interfaces coordination for channel switching is handled by CSP. This work focuses on defining channels management module for the switchable interface for decision coordination of which and when the interface has to be tuned on that channel.

Switching the radio interface from one channel to another incurs a non-negligible delay. Consequently, too frequent channel-switching may significantly degrade network performances. According to [10], the channel-switching delay varies from 200 µs to 20 ms. Therefore, when an interface is not tuned on the correct channel, packets have to be buffered in

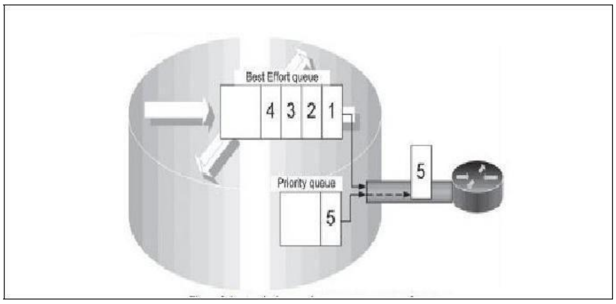


Fig1.Priority and profile mapping

a channel queue until the interface switches on the corresponding channel. Thus, there is a need to use a queuing algorithm to buffer packets, as well as a scheduling algorithm to transmit these buffered packets. The scheduling algorithm decides on which channel does the switchable interface has to be tuned on and for how long. It must also reduce the frequent switching and ensure that the queuing delay is not very large. Therefore, due to the non-negligible channel switching delay, introduces the *T*min parameter. *T*min is the minimum channel scheduling time[3]. The aim of the traffic profiling is to profile the traffic received and buffered in the channels‘ queues. The profile characterizes the packet priority. Three traffic profiles are considered: Voice, Video and Best Effort (BE) profiles. Traffic priority information is carried in the packet header. In fact, the frame format includes _*QoS Control Field*‘ which contains TID sub-field that specifies the packet priority [1]. The TID sub-field is set to a value between 0 and 7(table 1).

TID sub-field value is used then to profile traffics. A mapping between profile and packet priority is done . BE

*A. System Model*

Fig2.Module Management for interface

The _Scheduler‘ computes the service time *TS* of each channel and selects the channel queue to service when the *TS* of the current channel ends. The network card of the switchable interface switches then on the selected channel and transmits its corresponding packets during its *TS* . The _Scheduler‘ uses a scheduling algorithm to select the channel to serve. In this paper, we study two well -known and basic scheduling algorithms: round robin (RR) and weighted RR (WRR), here named as static WRR.

## *B. Scheduling algorithms*

During the implementation of the interface module, there is one queue for every channel. Each queue buffers the packets that have to be sent on the corresponding channel. channel scheduling methods used are.

### ***Static Weighted Round Robin***

The Round Robin (RR) is a scheduling algorithm that assigns to active channels equal portions of service time in circular order without handling the queued packets priority. An active channel is a channel which has packets in its buffering queue. Thus, RR algorithm allows every active channel to take turn in transferring packets on the shared switchable interface in a periodically repeated order. If one channel queue is out of packets, the next channel queue takes its place. The RR algorithm provides fairness among all channels‘ queues, i.e. all channels have equal weights, so equal service times *TS* . The *TS* value is assigned by the _Scheduler‘ and must be at least $T_{min}$ .

With Static Weighted Round Robin (sWRR) scheduling algorithm, different static weights are affected to each active. They are inflexible with traffic load variation and insensitive to queued packets priority. The channel service times are computed for each channel using its static weight and (1) and (2). Switchable interface tunes then on every channel during its *TS* . First, the _Scheduler‘ stores $W_{min}$ :

$$W_{min} = \min_{1<i<N} \{Wi\} \qquad (1)$$

where $W_{min}$ is the the channels‘ smallest weight, *Wi* is the weight of the channel i and *N* is the number of buffering queues. Then, it computes the service time of all the channels:

$$TS_i = \frac{T_{min}}{W_{min}} * W_i \qquad (2)$$

where *TSi* is the service time of the channel i, $T_{min}$ is the minimum service time allocated to the channels.

With the sWRR scheduling algorithm, channels haven‘t got equal weights nor service times. Moreover, *TS* values are static and don‘t consider the traffic flows variation. Therefore, they may be not adapted to the channels load in some traffic load configuration which causes network performances degradation.

### ***Dynamic Weighted Round Robin***

Dynamic Weighted Round Robin (dWRR) & EDCA scheduling algorithm jointly considers EDCA features for QoS-based services differentiation and channels weights dynamicity.

*Weights Computing:*

After profiling the traffics, the channels‘ weights are computed. To this end, coefficients are assigned to each traffic profile. These coefficients are then used to compute the dynamic channels weights by applying an additive metric. Higher priority profiles have got bigger coefficient ( a < þ < ç ), see Table I. Dynamic channel weights are then computed using (3) and (4):

$$Coef_i = \sum_{j=1}^{Ki} Coef_{ij} \qquad (3)$$

where *Coefi* is the coefficient of the channel i, *Coefij* is the coefficient of the flow j in the channel i and *Ki* is the number of traffic flows buffered in queue i. The dynamic weights are then computed using this formula:

$$W_i = \frac{Coef_i}{\sum_{j=1}^{N} Coef_j} \qquad (4)$$

where *Wi* is the dynamic weight of the channel i,coefficient of the channel i and *N* is the number of buffering queues. After computing the channels‘ dynamic weights, channels‘ service times are computed using (1) and (2). With traffic profiling and dynamic weights computing, channels‘ weights become adapted to buffered packets priority. Moreover, channels weights are dynamically updated while traffic load and priorities vary to achieve adaptability with incoming flows.[3]

The _Scheduler‘ sub-module uses one of the three aforementioned scheduling methods to select the next channel on which the dynamic interface will be tuned on. The dynamic interface serves channels for an amount of time that equals their corresponding service times. It uses then EDCA mechanism to attempt to access to the wireless shared medium.[3]

## IV. SIMULATION RESULTS

### *A. Network Topology*

To compare the performance of the aforementioned scheduling algorithms, the network topology depicted in Fig. 2 is used. The MBSS is composed of 4 static mesh nodes. It is a simple topology that is designed to avoid routing problems and bad links troubles which are caused by a large network topology. A mesh node has two radio interfaces configured to use EDCA medium access mechanism. The radio band is 2.4 GHz. Thus, there are 3 orthogonal frequency channels. According to [13], in real case, the number orthogonal channels dependents on the hardware chosen and the distance between radios. Consequently, in the simulations, we place mesh nodes far enough distant that inter-channel interferences are neglected.

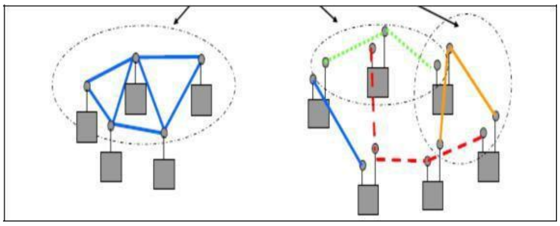

Figure 3. Network Topology

Every node is equipped with two radio interfaces using a hybrid assignment strategy. The static interface, dedicated to traffic reception, is configured to one of three available orthogonal frequency channels while the dynamic interface, may switch and tune on any of these orthogonal channels.

Flows‘ source node is Node A (c.f. Fig. 4). For sack of simplicity, all flows are CBR traffics with different priority. Node A sends Voice (AC_VO) and Video (AC_VI), Voice and BE, Voice and BK traffics to Node B, C and D respectively. IMM is implemented in all nodes but simulation results are collected from node A as the MCMR interfaces management appears only in this node using this configuration.

### *B. Simulations Results*

With sWRR scheduling algorithm, channels‘ weights are invariable with traffic load variation. Thus, channels‘ weights

might be maladjusted to queues load due to an unlucky weights assignment or, could be adapted in some other cases. To show the consequence of an unlucky weights choice maladjusted to the channels‘ traffic priority and load, two simulation scenarios are examined. The first scenario is an

dWRR reduces VoIP latency in comparison with the remaining scheduling algorithms because channels carrying high priority traffics have higher time services during the scheduling decision than those with low priority traffics.

Unlucky Weights Choice

(UWC) of sWRR channels‘ weights where weights are not adapted to the traffic priorities of buffered packets. The second scenario is a Lucky Weights Choice (LWC), i.e. channels‘ weights and packets priorities are proportional. These scenarios point out adequate channels‘ weights importance.

The dWRR channel scheduling algorithm adapts channels‘ weights to its channels‘ traffic priorities and load, see Fig. 6.

Fig4.Traffic Generation Graph for sRR

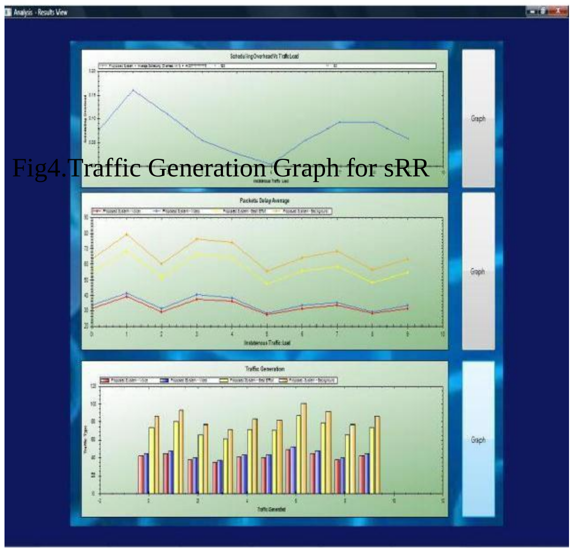

Fig 5.Traffic Generation Graph for dWRR

Moreover, while applying dWRR channel scheduling algorithm, the delay average of voice traffic is kept almost constant. In fact, when traffic load increases, dWRR adapts channels‘ weights to the traffic buffered in its queues. As a consequence, channels that handle delay sensitive traffics have priority to access to the shared resource. Therefore end to end delays decreases considerably while comparing to other scheduling scenarios. Besides, in sWRR and RR channel scheduling scenarios, delay average increases significantly as the network load rises and it exceeds 150ms (the voice delay constraint) which causes quality of service degradation. Delays increase is caused by constant weights that are kept invariant which may generate channels‘ time services maladjusted to traffic load and priority carried in channels‘ queues.

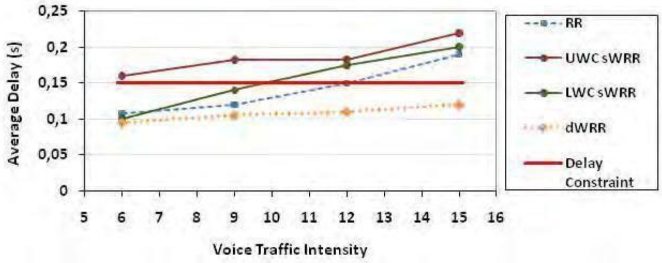


Fig6. Delay Average Vs Traffic Load

## V. CONCULSION

In this paper, we have presented an interfaces and channels management method for multi-channel multi-radio wireless mesh networks. This method introduces an Interface Management Module (IMM) that uses scheduling algorithms to serve channels. Three scheduling algorithms have been studied. dWRR algorithm assigns dynamic channels‘ weights which are adapted to the traffic priorities and channels‘ load.

Simulations have shown that a bad weights choice affects considerably the network performances while using sWRR scheduling algorithm. dWRR presents the best simulation results because it affects adequate weights to the channels. As future works, dWRR can be further performed by affecting dynamic coefficients to traffic profiles.

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