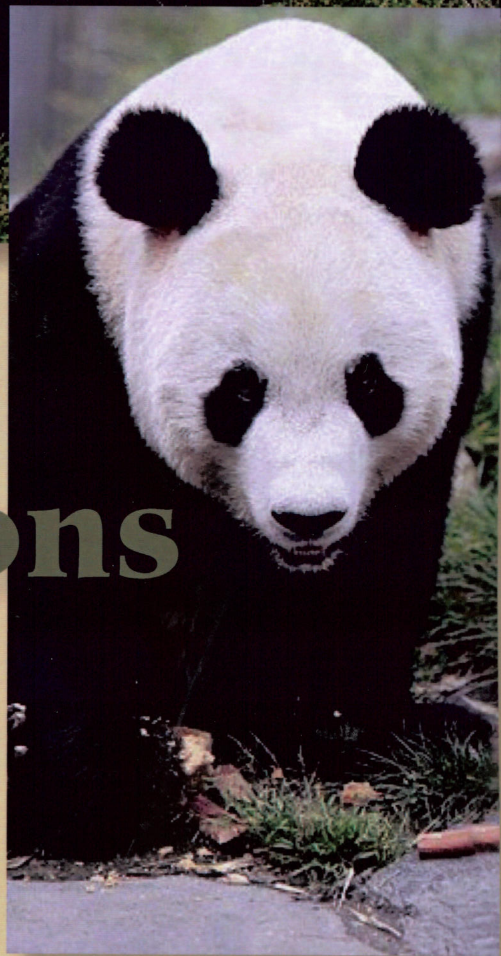
2009 Pacific-Asia Conference on

Circuits, Communications and Systems



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2009 Pacific-Asia Conference on Circuits,Communications and System

PACCS 2009

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Message from the PACCS 2009 Conference Chairs

The 2009 Pacific-Asia Conference on Circuits, Communications and System will be held on May 16-17, 2009 in Chengdu, China. We are delighted to invite you to participate in 2009 Pacific-Asia Conference on Circuits, Communications and System (PACCS 2009) in Chengdu, China, May 16-17, 2009. PACCS 2009 provides an inter-disciplinary forum for scientific researchers, academicians, engineers, university faculties, staffs and students working in the areas of communication theory, networks and devices, signal processing, computational intelligence, and the theory, design and implementation of circuits and systems, to discuss state-of-the-art technologies, progress in industry R&D and standards, services as well as their applications in telecommunication and information systems.

Welcome to PACCS 2009 Conference. Welcome to Chengdu, China, May, 2009. 2009 Pacific-Asia Conference on Circuits, Communications and System is co-sponsored by Intelligent Information Technology Application Research Association, Hong Kong, Wuhan Institute of Technology, China and International Journal of Intelligent Information Technology Application. Much work went into preparing a program of high quality. We received about 620 submissions. Every paper was reviewed by 3 program committee members, about 195 were selected as regular papers for PACCS 2009, representing a 31% acceptance rate for regular papers.

The purpose of PACCS 2009 is to bring together researchers and practitioners from academia, industry, and government to exchange their research ideas and results and to discuss the state of the art in the areas of the conference. In addition, the participants of the conference will have a chance to hear from renowned keynote speakers Prof. Hoi-Jun Yoo, an IEEE Fellow, Department of Electrical Engineering & Computer Science, Korea Advanced Institute of Science and Technology.

We thank Ms. Silvia Ceballos, the production supervisor of IEEE Computer Society Press, USA, who enthusiastically support our Conference. Thanks also go to Mr. Bob Werner for his wonderful editorial service to this proceeding. We would also like to thank the program chairs, organization staff, and the members of the program committees for their hard work. Special thanks go to IEEE Computer Society.

We hope that PACCS 2009 will be successful and enjoyable to all participants. We look forward to seeing all of you next year at the PACCS 2010.

Qi Luo, Wuhan Institute of Technology, China

PACCS 2009

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An Efficient Variable Channel Allocation Technique for Wireless Local Area Network (WLAN) IEEE802.11 Standard

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***Abstract*- The limitation of existing fixed channel allocation caused the degradation on overall throughput of the Wireless Local Area Network (WLAN). This paper proposes a variable channel allocation technique based on the bandwidth requirement and Quality of Service (QoS) of the network. According to this paper's proposal, the distributed system (DS) of WLAN distributes the available frequency band to access points (APs) or the access points will get required channel bandwidth, in such a manner that the maximum possible bandwidth efficiency will be achieved. The numerical results of the proposed technique are shown in this paper and compared with the existing fixed channel allocation.**

Keywords- Frequency Distribution; Channel Allocation; WLAN; Bandwidth Efficiency; QoS

I. INTRODUCTION

On demand of wireless connectivity, IEEE 802.11 working group has developed a list of different standard for wireless LAN in different frequency band with the basic standard's extension, which contains a various versions with different data speed and number of communication channels. Due to the simplicity and cost effectiveness, wireless local area network has been deployed widely [4].

Now the maximum data rate 54 Mbps has been achieved in 802.11a standard with 64-QAM modulation technique. But, because of user's mobility and frequent change of demand with fixed channel allocation, the maximum possible throughput cannot be achieved and the maintenance of Quality of Service (QoS) requirement becomes difficult. Several research studies have shown the unfairness resulting from this equal access capability of Distributed Coordination Function (DCF) [1].

Many studies refer that users' service demands have an absolutely dynamic nature [2]. This study stated a comprehensive survey of different load balancing mechanisms in 802.11 WLANs.

A study in [3] proposed dynamic change of access points' coverage areas. Dynamic channel assignment technique was proposed for IEEE 802.11 wireless networking [4]. The author's algorithm assigns channels dynamically in a way that minimizes the channel interference generated by neighboring Access Points (APs) on a reference access point, resulting in higher throughput. Still because of allocated channels usability, the ultimate possible achievement of bandwidth is not acquired with the continued growth of WLANs.

After considering all aspects and complicacy of above proposed methods, this paper is to propose a variable channel allocation where first we will measure the requirement of bandwidth and then we can distribute the bandwidth so that the maximum throughput can be achieved.

The remainder of this paper is organized as follows: Existing WLAN's channel allocation technique is presented in Section II. In Section III, possibilities, considerations and variable channel of the proposed method are presented. Required bandwidth analysis and calculation are presented in Section IV, and section V, channel bandwidth allocation techniques in section VI, numerical results are presented in Section VII, and finally Section VIII concludes the paper.

II. CHENNEL ALLOCATION OF IEEE 802.11

For different version of IEEE 802.11, there is different frequency ranges allocated. Here, we consider 5 GHz band for IEEE 802.11a.

TABLE I

Regulatory domain	Band (GHz)	Operating channel numbers	Channel center frequencies (MHz
United States	U-NII lower band (5.15–5.25)	36 40 44 48	5180 5200 5220 5240
United States	U-NII middle band (5.25–5.35)	52 56 60 64	5260 5280 5300 5320
United States	U-NII upper band (5.725–5.825)	149 153 157 161	5745 5765 5785 5805

Valid operating channel numbers by regulatory domain and band

Table 1 shows the three different U-NNI bands, operating channel number frequency band, and channel center frequency [7].

The particular channelization used for this standard depends on such allocation, as well as the associated regulations for the use of the allocations. In United States, the FCC is the agency that is responsible for the allocation of the 5 GHz U-NII bands.

Channel center frequencies are defined at every integral multiple of 5 MHz higher than 5 GHz. The association between center frequency and channel number is given by the following equation:

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Channel center frequency = 5000 + 5 $\times n_{ch}$ (MHz)

Where n_{ch} = 0,1,...200.

This explanation provides a unique numbering system for all channels with 5 MHz spacing from 5 GHz to 6 GHz, where all channels' width is the same for a layer. The lower and middle U-NII sub-bands accommodate eight channels in a total bandwidth of 200 MHz; the upper U-NII band accommodates four channels in a 100 MHz bandwidth. The centers of the outermost channels shall be at a distance of 30 MHz from the band's edges for the lower and middle U-NII bands, and 20 MHz for the upper U-NII band [7]. The width for lower, middle and upper layer bands' are different but for a single layer those are the same and per channel width are fixed.

In a multiple cell network topology, overlapping and/or adjacent cells using different channels can operate simultaneously [7]. This shows the standard's efficiency but still the different requirement of bandwidth is not fulfilled with a well-organized frequency distribution.

III. POSSIBILITIES, CONSIDERATION AND VARIABLE CHANNEL

To measure the effect of different bandwidth requirement on throughput we can look through on Shannon's capacity measuring theorem. If we consider all possible multi-level and multi-phase encoding techniques, the Shannon–Hartley theorem states that the channel capacity *C*, meaning the theoretical tightest upper bound on the rate of clean (or arbitrarily low bit error rate) data that can be sent with a given average signal power *S* through an analog communication channel subject to additive white Gaussian noise of power *N*, is:

$$C = B\log_2\left(1+\frac{S}{N}\right) \qquad (1)$$

where

C is the channel capacity;
B is the bandwidth;
S is the total signal power over the bandwidth;
N is the total noise power over the bandwidth; and
S/N is the signal-to-noise ratio (SNR) or the carrier-to-noise ratio (CNR) of the communication signal to the Gaussian noise interference expressed as a linear power ratio

According to Shannon's formula (1) if we increase the bandwidth, the capacity will increase rapidly.

However if we consider the best effort of Signal to Noise Ratio (SNR), in terms of equal distribution of bandwidth, the maximum possible throughput achievement is impossible. Because, the requirement of bandwidth is different for each access points (APs). Let consider the upper U-NNI band, in the figure 1 we can see the possibility of Variable frequency spacing like here 30 MHz, 10 MHz, 20 MHz, 15 MHz and 25 MHz instead of the traditional fixed carrier spacing that is 20 MHz for all. If we use different carrier spacing with different frequency range, according to Shannon's formula, the capacity will be different for the different requirement of data rate, and different bandwidth requirement can be fulfilled.

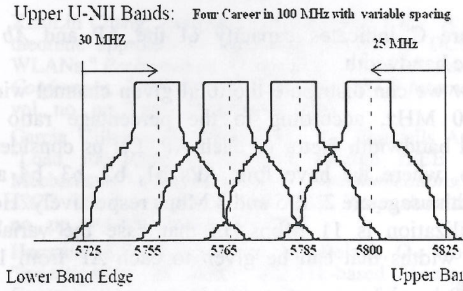

Fig. 1. Variable Frequency Spacing for upper U-NII Band.

IV. BANDWIDTH REQUIREMENT CALCULATION

There are different bandwidth measurement techniques [10]. We can find out the required bandwidth for each AP easily by using different method like available bandwidth measurement, link measurement. Let us consider a simple way. Instantaneous bandwidth (BWSi) can be computed by

$$BWSi = tdsi/SIi \qquad (2)$$

Where *SIi* is sampling interval and *tdsi* is total transmitted data. Available Bandwidth is *BWSi.*

Multiple sampling intervals may share common starting times. A bandwidth calculation is performed whenever a feedback message is received by the sender. The receive time of the feedback message (*fbi*) is used as the sampling interval end point. Therefore, the duration of the sampling interval is computed by

$$SIi = fbi - sti \qquad (3)$$

where *sti* is the sampling interval's starting time. In the example above, *sti = t0* for *i* = 0, 1, 2, and *sti = t2* for *i* = 3, 4 [8][9].

V. REQUIREMENT ANALYSIS

We can distribute available frequency in two different ways: 'fixed presumed' and 'intelligent variable'. In 'fixed presumed', after presume the requirements and considering the network, we can decide the distribution and fix the channel width. And in 'intelligent variable' allocation, the required bandwidth will be calculated every after a certain time, and every time it will reallocate the frequency. Then, the maximum possible throughput can be achieved. For the 'fixed presumed' we can assign the channel width according to QoS of each node but for 'intelligent variable' allocation we need requirement analysis.

With different methods like [6], after getting the available bandwidth or throughput usability of each node we can calculate and analyze the bandwidth requirement of each node. Required bandwidth factor Rf is,

$$Rf=((C-Ab)/C)*100 \qquad (4)$$

where C indicates capacity of the AP and Ab is available bandwidth.

Now we can distribute the total given channel width like 100 MHz, according to the percentage ratio of required bandwidth factor of each AP. Let us consider a scenario, where we have four APs b1, b2, b3, b4 and bandwidth usage are 2, 1, 5 and 3 Mbps respectively. Here total utilization is 11 Mbps. In that case the variable channel widths that can be given to each AP from 100 MHz are:

For b1= (2/11)*100 MHz.
For b2= (1/11)*100 MHz.
For b3= (5/11)*100 MHz.
For b4= (3/11)*100 MHz.

VI. BANDWIDTH ALLOCATION

The proposed variable bandwidth allocation can be done in two different manners: centralized and independent.

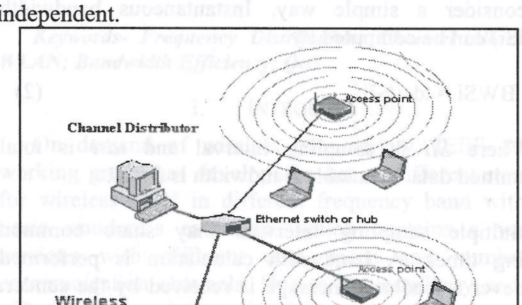

Fig. 2. Centralized approach of channel distribution.

In centralized approach (Figure 2), one channel distributor will collect all the connected APs' required bandwidth and then based on the requirement and available channel width it will recommend channel width for those.

For independent approach (Figure 3), channel distributor is not required. Neighbor APs will exchange their channel usability. And then they will negotiate and change the width based on requirement.

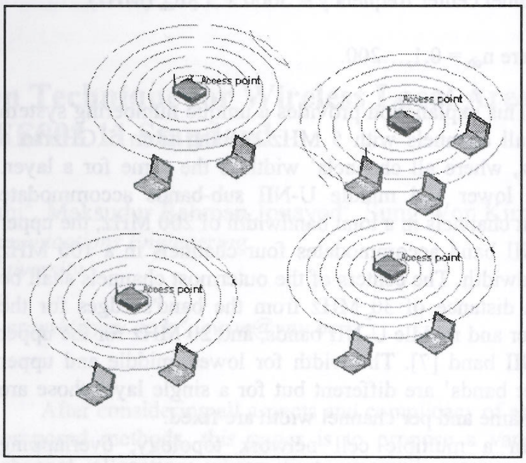

Fig. 3. Independent Approach of Channel distribution.

VII. NUMERICAL RESULTS

For numerical analysis of the proposed system, we consider IEEE 802.11a and four upper channels of U-NNI band with four neighbor APs, in both scenarios: fixed 20 MHz width and variable width. We consider a usual condition of a network where first two APs require the maximum 5 Mbps data rate and the second require the minimum 10 Mbps and the maximum 15 Mbps. But with the present fixed allocation, the channel width is same for each AP. We considered each AP's maximum possible data rate is 10 Mbps. And in such case, our simulation results shows how the throughput degrades for over-required allocation and under-required allocation of frequency range, and the variable width channel's improvement.

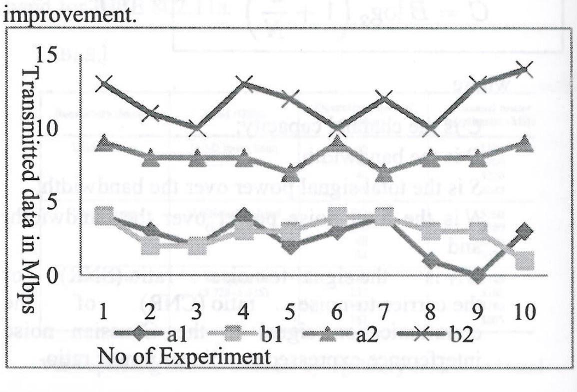

Fig. 4. Data rate of fixed and variable channel allocation for different experiments.

In figure 4, we can see the difference of transmitted data unit through two APs with fixed allocation and variable allocation. Here, a1 and a2 are the APs of fixed 20 MHz allocated channel and b1, b2 are variable channels having width of 10 MHz and 30 MHz respectively. In 10 different experiments we can see for a1 and b1, data rates are the same which is less than 5 Mbps, as their maximum requirement is 5 Mbps, but for a2 and b2, data rates are 8 and 13 Mbps respectively. In existing channel allocation system, even though the requirement for different access point is different, they have the same channel width.

In Figure 5, we can see per channel's total throughput and total throughput of the system for both, existing and proposed system, where A is the throughput of existing system and B is the throughput of proposed system. Here for the first two channels' (t1 and t2) throughputs are almost same as their requirements of bandwidth are the same. But the difference comes out from the next two channels where the requirements are different. As a result, we can see that total throughput increase more than 30% in the proposed system compared with the existing system.

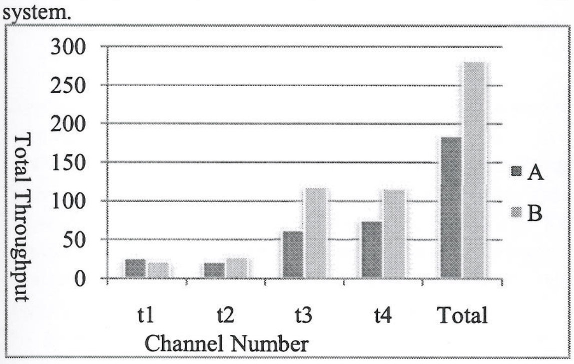

Fig. 5. Total and per channel throughput increase according to total transmitted packet for fixed (A) and variable channel(B) allocation.

VIII. Conclusion

In this paper, we proposed a different variable channel allocation technique for IEEE 802.11. We have shown the possibilities, consideration, benefit and implementation technique, which can be established in two different ways where one is 'Centralized' allocation and another one is 'Independent' allocation, in which frequency range of channel will varies time to time in need. Numerical results show that the overall throughput and bandwidth efficiency have been increased up to 30% without affecting the individual's requirement of data transmission.

Future work includes examining variable single and multi-channel allocation considering MIMO technology's antenna diversity used in IEEE802.11n.

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