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# Partial overlapping channels are not damaging

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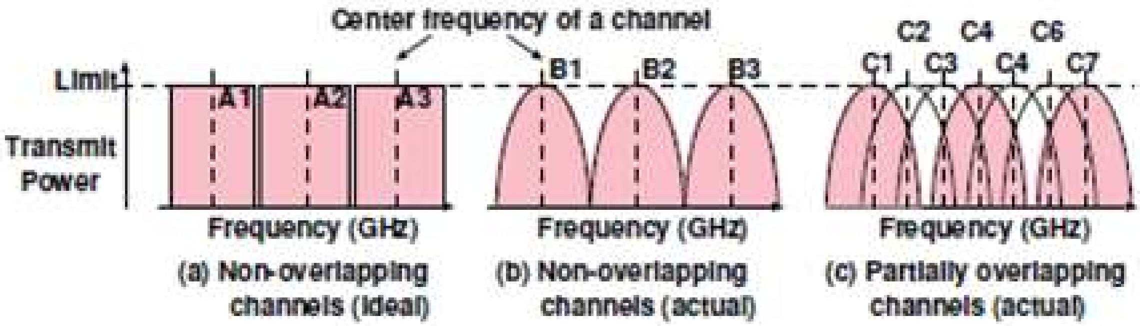
***ABSTRACT***
We know that in many different technologies, many wireless channels will be partially overlapped. However, due to the interference effects in such partial overlapping channels, they are often avoided using them simultaneously. In this paper, we propose to use the method of the system for the first time to try to simulate some overlap between channels. Through this model, we show that the use of partially overlapping channels is not always harmful. In fact, if careful use of some of the overlapping channels often leads to significant improvements in spectrum utilization and application performance. We demonstrate this view through analysis, as well as through detailed application layer and MAC layer measurements. In addition, we illustrate the benefits of the model we developed by using it to directly enhance the performance of two previously proposed channel allocation algorithms - in wireless LANs and other in multi-hop wireless mesh networks. Through a detailed simulation, we show that in these two cases, the use of partially overlapping channels can improve the application throughput factor of the terminal to the terminal between 1.6 and 2.7, depending on the wireless node density. Finally, we observe that some of the overlapping concepts can be flexibly designed to design efficient channel access mechanisms in emerging software radio platforms.

***KEYWORDS:*** IEEE 802.11, Channel allocation, partially overlapping channels

## 1. Introduction



(a) Non-overlapping channels (ideal)

(b) Non-overlapping channels (actual)

(c) Partially overlapping channels (actual)

Figure 1. Partially overlapping and non-overlapping channels

In order to correctly solve the transmission of the transmitter on wireless media, many wireless technologies adopt a dual approach. First, the split spectrum band is a sub-range called 'channel and each transmitter (and its corresponding receiver) occupies one of these channels. Obviously, when the number of transmitters does not match the number of channels, there will be contention problems. Different technologies use different mechanisms, such as time division multiple access (TDMA), code division multiple access (CDMA) or random access mechanisms.

This article lists an example of a wireless communication technology based on 802.11 (a / b / g), where 802.11b operates at a 2.4 GHz spectral band and is divided into 11 channels. The bandwidth of each channel is 44 MHz. When operating in 802.11 DCF mode, the channels assigned to the wireless transmitter use a random access contention mechanism, such as an RTS-CTS handshake. The wireless signal itself uses FM frequency hopping (FHSS) or direct sequence spread spectrum (DSSS) technology, allowing it to potentially coexist with other wireless technology for transmission and ambient noise.

Interference range: The transmission of a given channel and any other transmission in the same channel interference within a certain range. The transmission interference range depends on the transmission power. So the choice of transmission power determines the same channel space reuse. Two simultaneous transmissions in the same channel coexist require physical separation. In order to improve the spatial re-use of the channel, each wireless technology reinforces its specific limits on the allowable transmission power on the channel.

Channel demarcation: First, the relationship between the energy of the transmitted signal and the information capacity of the wireless channel is studied.

Shannon formula is as follows:

$$C = B\log_2(1 + SNR)$$

Each wireless technology defines the exact limits of the transmitter's output power in the channel's frequency range. In order to maximize the capacity of a given channel within the constraint of the transmit power, the transmitter should transmit all the frequencies of the channel with the maximum allowable power.

For example, Figure 1 (a) shows. The transmitter limits the output power at a different frequency as an ideal bandpass filter. According to such a structure, the adjacent channels (A1, A2 and A3) logically have no overlap, that is, two adjacent channels do not share any frequency. And the structure of the channel is effective in terms of capacity. But the reality is not as shown in Figure (a) the ideal band-pass filter. But as shown in Figure (b), which means that the capacity of such channels is lower than the ideal ones in Figure 1 (a).

The 802.11 standard adjacent channels are constructed in two different ways. The construction of the 802.11a standard channel is similar to that shown in Fig. 1 (b) and there is no overlap between adjacent channels. Thus, the channels B1 and B2 can be simultaneously used for transmission in the vicinity of the same object.

802.11b standard, the channel is constructed similar to Figure 1 (c), where adjacent channels (e.g., C1 and C2) are partially overlapped in the frequency domain. The meaning of this structure is that the physical transmission of channels C1 and C2 at the same time will cause interference. We call this channel part of the overlapping channel. Thus, in many cases, such partially overlapping channels cannot be used at the same time. In the present embodiment, it can be seen that only channels C1, C4 and C7 do not overlap the frequency domain, we call them non-overlapping channels. When two remote transmitters operate on the same channel, they interfere with each other. This interference is known as co-channel interference. When the two transmitters operate in the overlapped portion of the adjacent channel, it causes a lesser degree of interference, which is called adjacent channel interference. Finally, the two transmitters do not interfere with each other in non-overlapping channel operations.

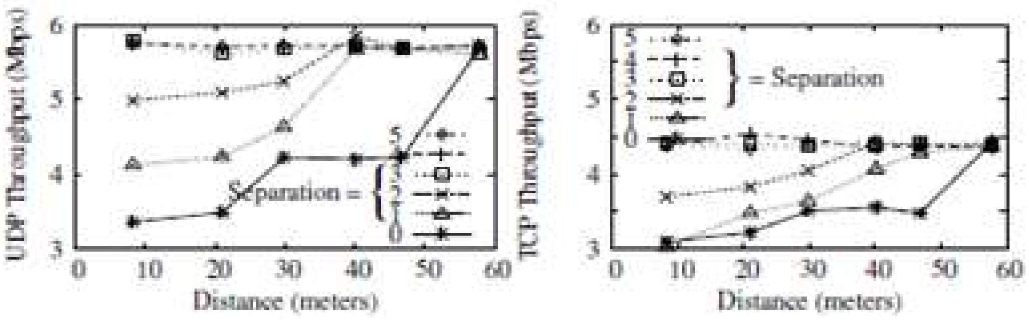
Can some of the overlapping channels be used?

Assigning a channel to a node that performs wireless communication is an important issue. For example, 802.11b defines 11 channels, where only three channels do not overlap, ie, 1, 6, and 11. Most users and wireless LAN administrators configure their wireless interfaces to typically use one of these three non-overlapping channels. This results in two more adjacent nodes allocating the same channel in the most typical scenario in a more intensive scenario. This method is accepted for the following reasons:

In the same channel, that is, the interference with the channel interference can be detected directly and can be handled explicitly by the contention resolution mechanism, for example, in the RTS-CTS handshake in the 802.11 network. In contrast, adjacent channel interference tends to contribute to background noise and cannot be handled in a clear way through channel-based techniques. Therefore, the systematic approach to handling adjacent channel interference is often considered difficult. Due to the adverse effects of adjacent channel interference, all previous wireless channel allocation methods also use non-overlapping channels separately in different wireless protocols (e.g., cellular networks, 802.11 wireless local area networks, etc.).

The focus of this paper is to study the systematic approach to the efficient use of partial overlapping channels to improve spectral efficiency. Specifically, we first describe a model that captures the effects of partial overlapping channel interference and then explains how such a model can be effectively utilized in improving the design of the channel allocation algorithm and ultimately conduct a detailed evaluation study to demonstrate such a model And how the algorithm approach leads to an increase in the utilization of the wireless spectrum. Our example is to draw two scenarios - the channel needs to be allocated over a wireless local area network (WLAN) and a multi-hop wireless Mesh network.

Related to the physical layer of the coding technique: at first glance it may seem that the better physical layer modulation technology can take advantage of the entire range of the spectrum while also allowing 'coexistence' for different transmissions. For example, in the frequency hopping spread spectrum method, a single transmission is encoded at different frequencies and different times. The selection of the frequency sequence of the transmission is prior to the 'frequency hopping' mode. Thus, nodes with different frequency hopping patterns can coexist in the same frequency domain. However, the capacity of all nodes sharing the wireless medium using the same physical layer modulation technique is determined by modulation.



(a) UDP throughput at 11Mbps data rate

(b) TCP throughput at 11Mbps data rate

Figure 2: TCP / UDP throughput and physical distance.

The focus of this paper is to manage the simultaneous transmission at the same time in the frequency domain to improve the spectrum utilization - which is complementary to the physical layer mechanism.

Major contributions: The following are the main contributions of this work:

A detailed system of partially overlapping channel models is common in wireless communications and is suitable for a wide range of communication technologies. The model motivates through detailed experiments.

We use the model to modify the existing two channels to allocate and manage the algorithms in different wireless scenarios. And show how the new model significantly improves the utilization of the wireless spectrum.

## 2. The measurement part of the overlap

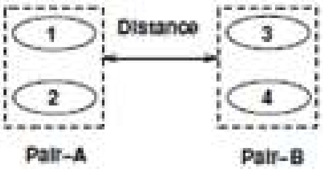


Figure 3. The measurement setup.

Set: two pairs of wireless communication and communication nodes to establish 802.11 hardware placement as shown in Figure 3. In each pair, two communication nodes are placed in the vicinity of each other. The lower nodes in each pair send traffic to the upper nodes. In order to communicate, in all of the experiments, each pair of two nodes is configured to use the same wireless channel. The physical isolation and channel separation between two pairs of nodes are variable. In [18] experiment, using 1 and 2 Mbps data rates at the physical layer it uses binary phase shift keying (BPSK) modulation. We report the results using the complement keying (CCK) modulation, the 802.11 b specified standard, which provides a data rate of 11 Mbps. Figure 2 shows these results for TCP and UDP traffic at application layer. We note that the following are the following points:

(I) As can be seen from the results of Fig. 2, the physical separation increases, the interference decreases, and leads to increased throughput.

(II) However, the same level of throughput in small physical separations can be achieved by increasing the separation between two pairs of nodes. For example, the physical separation of the three channels separated (as in channels 1 and 4) as shown in Figure 2 is about 10 meters sufficient to maximize the throughput of the two nodes. However, the operation on the same channel requires about 60 meters of physical separation before the two link operations are not disturbed.

Therefore, if careful use of partial overlapping channels can provide greater space reuse.

## 3. Partially overlapping models

The wireless signal concentrates most of the energy at a certain limited bandwidth within its defined frequency range. When a transmitting node transmits a radio signal in a particular radio channel. It uses an emission spectrum mask. The transmit spectrum mask at the specified frequency upper limit is allowed for all frequencies of the transmitted signal. Figure 4 shows that the transmit spectrum mask uses DSSS modulation under the IEEE 802.11 standard standard. The channel bandwidth is 44 MHz. The center frequency fc, the mask's limited output power is 0 - the output power is equal to the input power and the signal transmission is not affected. Frequency at Fc + 11 MHz and Fc-11 MHz.

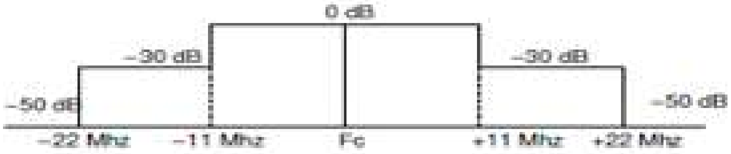
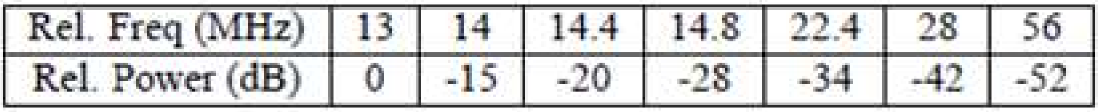


**Figure 4: The Transmit Spectrum Mask for IEEE 802.11 DSSS modulation.**



| Rel. Freq (MHz) | 13 | 14 | 14.4 | 14.8 | 22.4 | 28 | 56 |
|---|---|---|---|---|---|---|---|
| Rel. Power (dB) | 0 | -15 | -20 | -28 | -34 | -42 | -52 |

Table 1: Emission Spectrum Mask Used for the 28 MHz channel at the physical layer of the IEEE 802.16 standard wireless metropolitan area network

The power attenuation is reduced by -30 dB and further to -50 dB at Fc ± 22 MHz, where the center frequency of channel c is Fc. Similarly, Table 1 lists the emission spectrum mask under the IEEE 802.16 standard (WiMAX) with a similar structure.

Note, that the emission spectrum mask is ideal and there are only some continuous approximations in reality.

In order to receive a given signal, a receiver uses a different bandpass filter to selectively receive a certain frequency band. The bandpass filter 'allows' to allow a certain frequency band near the center frequency and eliminates all other frequencies through the radio circuit at the receiving end. The power of the received signal depends on the amount of overlap between the band-pass filter of the receiver and the signal distribution of the transmitter (usually defined by the transmit spectrum mask) in the frequency domain.

Based on these observations, the concept of partial overlap between two wireless channels can be quantified. As shown in Figure 5, the output power of a transmitter is distributed over a specific channel with a center frequency of Fc. If FC = 2.437 GHz, corresponds to channel 6 under the IEEE 802.11b standard. The signal occupies the center frequency of about 44 MHz bandwidth. An ideal bandpass filter receiver is positioned at Fc + 10 MHz. Since the 802.11b channel has a 5MHz separation, the receiver is tuned to channel 8. The signal transmitted on channel 6 is received at channel 8 with a low received power, and this power is indicated by the energy in the shaded area. In addition, if the filter of the receiver is continuously switched to correct, the received power will be reduced in a corresponding continuous manner.

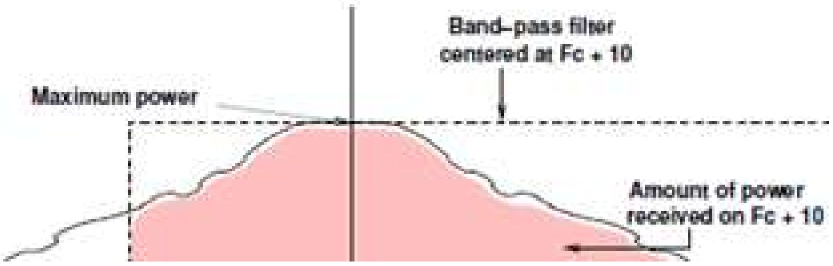


Figure 5: Power reduction due to overlap between receiver and transmitter channel reduction.

The development model: the first step to the development mechanism to take part in the overlap of the advantages of establishing a model to capture in a quantitative way overlap. The concept of the interference factor (I-factor abbreviation) we introduce is to capture the amount of overlap between a certain frequency FT and a particular received frequency FR. The overlap amount is quantitatively captured by calculating the signal spectrum between the bandpass filter and the receiver's bandpass filter. ST (f) represents the power distribution of the signal over the entire spectrum, and BR (f) represents the frequency response of the bandpass filter, respectively. IF (t) is the received power.

$$IF_{(T,R)}(\tau) = \int_{-\infty}^{+\infty} S_T(F) B_R(F-\tau)\, df$$

Specifically for IEEE802.11-based transmission, we define the idealized discrete model I-factor representation for Itheory (i, j) as the overlap between i and j channels. T = 5 | i - j |

$$B_R(f) = S_T(f) = \begin{cases} -50dB & \text{if } |f - F_c| > 22\text{MHz} \\ -30dB & \text{if } 11\text{MHz} < |f - F_c| \leq 22\text{MHz} \\ 0dB & \text{otherwise} \end{cases}$$

The discrete I-factor can also be measured by experience as follows:

Pi represents the received power of a particular signal at a given position in channel i, and Pj represents the same signal at the same position as the received power at channel j.

Then Imeasured (i, j) is calculated by Pi / Pj. This actually gives a small amount of power on channel j to be received by channel i and will be empirically obtained by measuring any given wireless technology.

The graph in Figure 6 shows that the theoretical and measured I factor values match the two interfering 802.11b wireless channels quite well. We can also see the theoretical factor I in the 2.4 GHz 802.11 signal from the 802.16 transmission from Figure 7.

## 4. Infer interference effects

The signal strength of the wireless signal from the transmitter to the receiver will be attenuated if the transmitter and receiver are tuned to the same channel, which is the only form where the attenuation of the signal is visible at the receiver. If the receiver and transmitter can be tuned to different channels (with different center frequencies) the signal attenuation is considered to be attached to the receiver at the given I factor. Therefore, both the physical distance and the spectral distance between the transmitter and the receiver should be responsible for the attenuation of the signal. Thus, the interference effect of a signal takes into account these two factors.

The received power is as follows:

$$P_r = \frac{P_t C_t I(i,j)}{d^k}$$

If N is the ambient noise of the receiver and then the signal is correctly received if the signal noise ratio (SNR) exceeds the carrier detection threshold th, in this case R is considered to be within the transmission range of T if the SNR is below At this threshold, the signal is not correctly decoded at the receiver. Rather than receiving the power to increase the noise at the receiver. In this case, we consider R to be within the interference range of T but not within its transmission range.

Now consider the two transmitters T and T0, trying to communicate with the two receivers R and R0, respectively. Assume that both receivers are within the transmit range of the transmitter. In this case, the two transmissions cannot occur simultaneously (due to interference) and thus reduce the parallelism. However, since both transmitters are within the receiver range, they can be used for content transmission and can be solved using standard's standard MAC layer mechanisms such as RTS-CTS.

This competitive solution is not possible when the receiver R is within the interference range of the transmitter T rather than within its transmission range. This is because the MAC-level mechanism, such as RTS-CTS, relies on R to correctly receive frames from T. In particular, transmission from T will increase the noise at R, thereby receiving data when it reduces its signal to noise ratio from other transmitters T0. If the resulting signal-to-noise ratio is below the carrier detection threshold, such data is not correctly received.

We study these two cases, in turn.

The influence of partially overlapping channels in the transmission range. When R is within the transmission range of T, the conditions under the two radiographic propagation modes are:

$$Th < \frac{P_r}{N} = \frac{P_t C_t I(i,j)}{N.d^k} \text{ i.e.,} \qquad (3)$$

$$d < \sqrt[k]{\frac{P_t C_t I(i,j)}{N.Th}} \qquad (4)$$

Please take note, this equation means that even if the transmission on any channel is likely to be properly tuned to receive an incoming receiver to an adjacent partially overlapping channel.

If i = j; the transmitter and receiver operate on the same channel, then I (i, j) = 1, the transmission range is

$d_{ii} = \sqrt[k]{\frac{P_t C_t}{NTh}}$, if the transmitter is in channel i, the receiver is in channel j, then the transmission range is

$d_{ij} = \sqrt[k]{\frac{(P_t C_t I(i,j)}{N_a}}$, it follows the:

$$d_{ij} = I(i,j)^{1/k} d_{ii} \text{ where, } d_{ii} = \sqrt[k]{\frac{P_t C_t}{NTh}} \qquad (5)$$

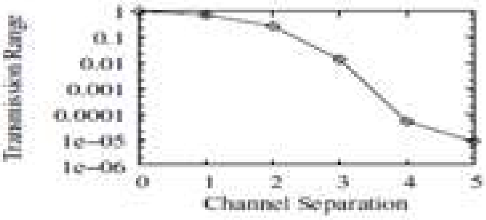


**Figure 8: Transmission range (normalized) and channel separation for 802.11 networks.**

Similar models can introduce other radio propagation models. In Figure 8, we show how the transmission range and channel separation are two-line planar propagation models. We can observe the attenuation of the interference range is quite fast.

Part of the overlapping channel in the noise and the impact of the error, if a signal below the carrier detection threshold is R received at the receiving end cannot be correctly decoded and instead increase the noise. If R tries to receive a signal from another transmitter, if transmitted from T below his signal to noise ratio may increase the loss.

$P_{ii} = \frac{P_t C_t}{d^k}$ Indicates that the received power on channel i is transmitted on the same channel.

$P_{ij} = I(i,j)\frac{P_t C_t}{d^k}$ Represents the power received on channel j. Considering the transmission noise, we realize that partial overlap will reduce the signal strength by I (i, j), 1 / I (i, j) such a concurrent transmission in the partial overlapping channel to make noise at the same layer as a simple transmission on the same channel.

Consider the case when the receiver has a bandwidth of 2.4 GHz at channel 4 and the transmitter on channel 6, in order to match the interference of a single transmitter on channel 4, we will need 1 / I (4,6) = 10-1.147 = 14 Transmitter channel 6. This is even rare in a more intensive wireless environment. This is because 14 emitters can be transmitted simultaneously on the same channel (channel 6) if and only if they are not in the range of each other. Since the receiver R is within the range of all 14 transmitters, it is difficult to find a configuration in which these transmitters are in the common range.

Bit error rate: In order to simulate the impact of the interference transmitter on the bit error rate, we need to use some of the models used in the modulation scheme. The modulation scheme used in 802.11 environments is based on the DSSS Binary Phase Shift Keying (BPSK). For such a modulation scheme, the bit error rate of the channel is .

$$p_b = erfc(2 * E_b/N_o)$$

Let T be the transmitter in the R interference range, and when T` becomes the transmitter in the transmission range of R. R receives the received power from the interference transmission from T by the two-line plane model discussed in the previous section. We assume that T and T have the same transmit power Pt and the same radio characteristics are represented by constant Ct. Calculate the bit error rate at R, tuned channel j. For the following cases, T 'transfers data to channel J on channel j. A transmission from channel T on channel i causes interference. Based on the bidirectional plane propagation model, the error model for BPSK, and the definition of I (I, J) is given by:

$$p_b = erfc\left(\frac{2 * P_t C_t}{d^k_{T'R}\left(N_o + I(i,j) * \frac{P_t C_t}{d^k_{TR}}\right)}\right)$$

Where dT`R and dTR have the distance between T 'and T and R, respectively.

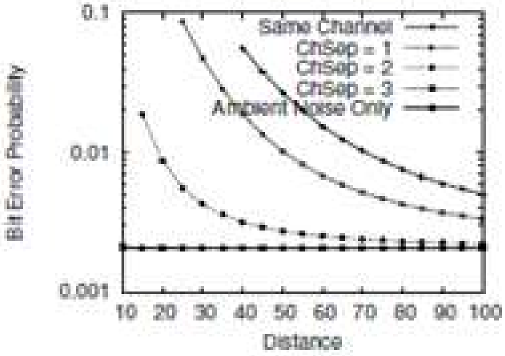


Figure 9. Effect of partial overlap on the bit error rate.

Figure 9 shows the error probability Pb for various configurations, when K = 2. Note that each of the graphics lines is cut off at the transmission of T by the correct reception distance of R (ie, R is within the transmission range of T). 'The same channel' shows the effect of bit error rate when T, R operates on the same channel. In the case of 'only ambient noise', the bit error rate is given because any interference of ambient noise in any channel is not present. It is easy to observe that the bit error rate drops rapidly in increasing the distance of the channel interval.

## 5. Capacity upgrade

The focus is on the overall capacity of the partially overlapping channel in terms of the total capacity of the wireless environment. The obtained capacity is compared only if the non-overlapping channel is used. Let us consider a total of M channels in a given spectral band, where N is not overlapping. In 802.11b, M = 11, N = 3.

We first study the non-overlapping channel, and now we consider a wireless environment, a group of nodes V in a certain area to share a group of N non-overlapping channels. We define a link between any node u, v (belonging to V), which communicate with each other through basic wireless transmission, we represent this link by a directed edge e = (U, V), as shown in Fig 10.

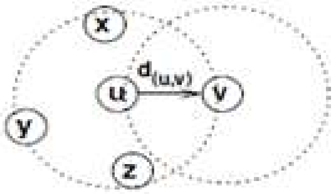


Figure 10. The interference region for node u transmitting to node v.

For simplicity, let us assume that each node has a similar radio characteristic, if d (u, v) □ R, which means that node u can be transmitted to node v. Figure 10 shows the transmission of node u and node v on channel i. We want the u node to get about 1 / n of the capacity of the wireless medium, and use the standard method to solve the contention at the link layer. One way to reduce this contention is to divide a group of contention nodes with N nodes in N non-overlapping channels, assuming that the nodes are randomly distributed within a specific area, representing the unit density, which is given by the number of nodes the expected number:

$$\lambda(N) = R^2 \frac{\phi}{N} = \lambda(N)$$

Using these M-channel and I-factor concepts, we can compute the expected number of nodes (M) with node u, given by:

$$\lambda(M) = \sum_{j\in\{1\ldots M\}} (R(I(i,j))^{1/2})^2 \frac{\phi}{M}$$

We evaluated the (N) and α (M) values of the existing 2.4 and 5 GHz band channel structures with a channel spacing of 5 GHz, a channel bandwidth of 20 GHz, and N non-overlapping channels would have M = 5N-4 overlapping channels. Estimated ratio $\frac{\lambda(M)}{\lambda(N)}$ n

$$\frac{\lambda(M)}{\lambda(N)} = \frac{N}{M} \sum_{j\in\{1\ldots M\}} I(i,j) = \frac{1.2N}{5N-4}$$

We now use a partially overlapped channel to reduce the number of contention nodes, and we hope

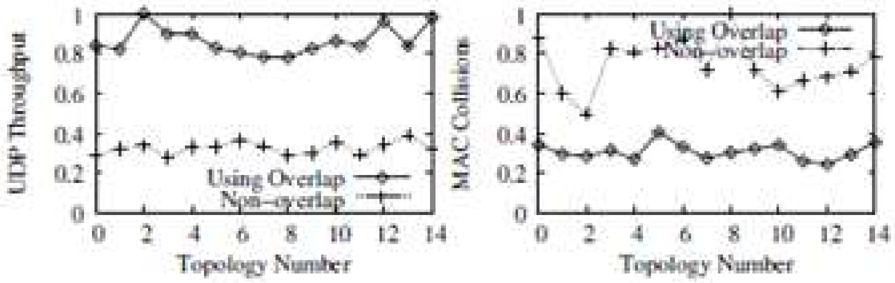
$\lambda(M) < \lambda(N)$, is $\frac{1.2N}{5N-4} < 1$ or $N > \frac{4}{3.8}$; , is , that is indeed present in some of the overlapping channels (when N □ 2), for example, there are three non-overlapping channels in the 2.4 GHz bandwidth, 3. This is a link-level contention reduction of 3.05 times.

## 6. Application

Discuss how to propose a partially overlapping channel model can improve spectrum utilization. In two different situations: (a) Wireless local area network (b) Multi-hop wireless Mesh network

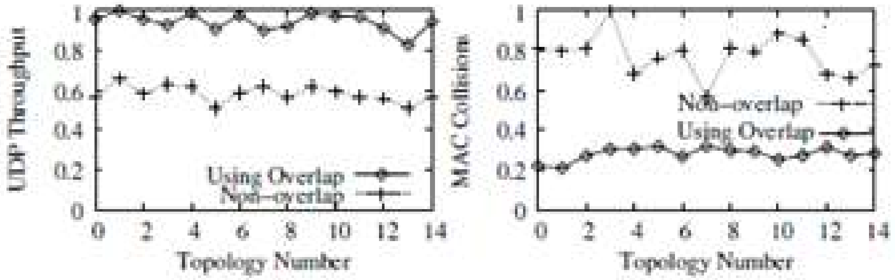
Figure 11. A WLAN example.

Channel allocation in the wireless LAN: The problem of channel allocation in the WLAN is assigned to allocate channels for APs, thus maximizing performance by eliminating interference between adjacent BSSs. In general, wireless LANs either use static channel assignments or APs using simple heuristics. With careful allocation of channels, APs can improve performance through heuristics, and customer load balancing available APs are important for achieving significant growth. Increasing the density of the access points on a given neighborhood averages, and careful balancing of the client and load of the assigned channel has become an important issue.



(a) UDP throughput (b) MAC Collisions

Figure 12.Results for high interference topologies



(a) UDP throughput (b) MAC Collisions

Based on partial overlap enhancements: We briefly discuss our enhancements which include the concept of partial overlapping channels. All enhancements are limited to the cfc function, as previously described. Client c experienced total interference. Random compression algorithm, the use of this objective function does not need to be modified.

Simulation results: We made modifications to the NS-2 simulator to improve the behavior of the wireless link into the real channel model. Our modifications include the existence of NS-2 in a fixed binary interference model, an implementation of the bit error rate model, and partial overlapping channels based on the implementation of the I-factor model.

We observed that 11 partial overlap channels resulted in improved TCP / UDP throughput by a factor of between 1.6 and 3.0 depending on customer density. If the 11 channels were non-overlapping, we expected one of the best improvements to be 11/3 = 3.67 (more than 3 non-overlapping channels). We use 11 overlapping channels with a throughput increase of 3 channels that do not overlap at 2.4GZH bandwidth. We also observed that the throughput of some overlapping channels of the client is 70% of the maximum possible value compared to 11 non-overlapping channels. This gap is about 30% due to partial overlap in the channel.

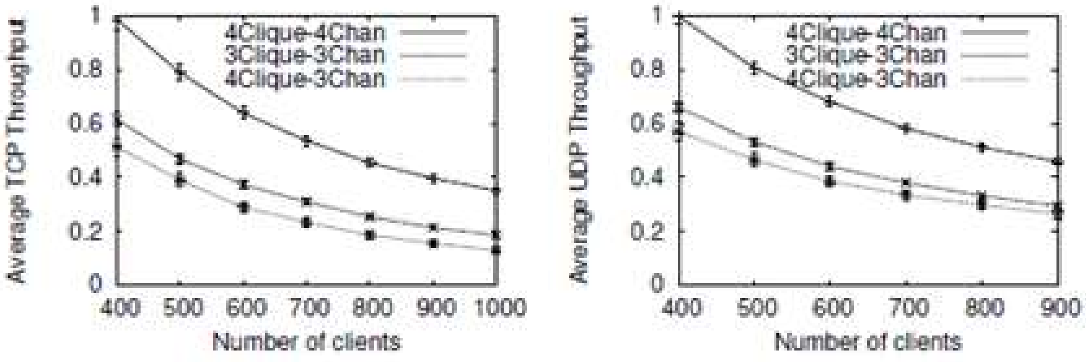
Improved throughput: Two graphs show that some overlapping channels will perform better. For example, in Figure 12 (a), if the number of topologies is 0, the throughput of each client is 0.3 UDP using non-overlapping channels, and the partial overlap throughput is 0.82 and the factor has an improvement of 2.73.

As shown in Figs. 12 (b) and 13 (b), when the number of collisions is partially overlapped, an average factor of 2 is reduced. This reduction shows how some of the overlapping channels reduce this competition and thus improve the application-aware metrics.

Impact of client density: Increasing client density to mimic the so-called network deployment, that is, in the form of hotspots or unmanaged networks, the throughput of UDP / TCP in Figure 14.15 is alone by increasing the density of clients / APs. The use of partial overlapping channels has improved with increasing density.

Our improved results of the existing channel management approach show that the I-factor model has a wide applicability in capturing partial overlap between channels in a quantitative manner. These results indicate significant results that can be considered by the presence of space and the possibility of spectral re-use in a combined manner.

Increase the capacity of wireless LANs: We show the basic experiment of TCP and UDP in Figure 17. In the experiment the client is placed uniformly in the square area, and the APs are arranged as above. Different experimental clients are varying from 500 to 1000 range. The throughput of the four partially overlapping channels is increased by 50% to 80%. There is an increase in the number of overlapping channels in the same spectrum bandwidth from 4 to 11.



(a) UDP throughput (b) TCP throughput

Figure 17. Greater Spatial re-use with overlapped channels in WLANs.

## 7. Mesh network channel allocation

In this paper, we discuss the advantages of partial channel overlap by means of mathematical representation, and briefly discuss the problem of solving the problem of scheduling the interference link by our enhanced linear programming model. First, we briefly discuss the following changes to the link traffic scheduling problem. Later, we used our full set of enhanced experimental mesh topology, showing the average performance improvement factor of factor 1.6.

Link Traffic Scheduling: The mesh network is modeled as a directed graph G by setting the wireless router as the vertex of the V. The directed boundary includes the set E that the backbone link is in the mesh network. Link scheduling problem refers to how a series of link interference can be scheduled transmission, transmission interference or collision frequency will be reduced. This is done by dividing the time into time slots.

The necessary conditions for link flow scheduling: for any time slot t (1 □ t □ T) any interference free edge communication scheduling S must be satisfied on channel i:

$$X_{e,i,\tau} + \sum_{e' \in I(e)} X_{e',i,\tau} \leq q$$

In the above equation, q represents an upper bound on the number of concurrent transmissions belonging to the ISET (e) edge range and gives the edge e not being transmitted at time slot t, that is, the value of Xe, i, t = 0.q depends on e The geometric properties of the interference region of the edge.

We modify this limit to include all the metric variables Xe`, j, t. The edge of the channel j will interfere with the e edge of channel i.

$$X_{e,i,\tau} + \sum_{e' \in I(e)} \sum_{j \in \{1 \ldots M\}} POV(e,e',i,j) * X_{e',j,\tau} \leq 1$$

| Number of Channels ($N$, $M$) | $N$ Channels No-overlap | $M$ Channels Partial Overlap | $M$ Channels No-overlap |
|---|---|---|---|
| 3, 11 | 0.27 | 0.42 | 0.88 |
| 4, 16 | 0.36 | 0.63 | 1 |
| 5, 21 | 0.45 | 0.81 | 1 |

Table 2.Aggregate throughput acihieved (normaliazation  to best case scenario within these set of experiments.

Table 2 shows that obtaining a standardized throughput by using N = 3.4.5 for non-overlapping channels. With the use of M = 5N-4 the performance of the overlapping channel. This can be compared to the case of M = 5N-4 non-overlapping channels. This as an 'upper limit' can be improved by using the M part of the overlapping channel. From the table we can observe that the partial overlap channel improves the throughput of each client by an average of 1.6. We also note that as the number of N increases, the gap between the 'upper limit' and the use of some of the overlapping channel implementations is reduced. It is also important to realize that the two sets of channels (partially overlapping and non-overlapping) use exactly the same frequency space. As a result, we achieve performance gains that do not cost any additional spectrum.

## 8. Summary

Channel allocation and management is an important issue. In all wireless environments, most of the existing channel allocation method limits the solution only to non-overlapping channels. This limitation is inefficient, which leads to poor spectrum utilization, and rational use of spectrum resources requires the use of partial channel overlap. In order to achieve this, it is necessary for the appropriate model to interfere with the interference of some overlapping channels. The system is then designed to apply the model, or in some cases to enhance the channel allocation algorithm.

In this paper, we define the corresponding partial overlap channel model, suitable for a variety of different wireless technologies. Subsequently, we used this model to improve the first two proposed allocation algorithms (WLAN and other wireless mesh networks) and to quantify their benefits.

## References

1. mobile broadband coverage, the Chinese information industry official website [EB / OL]. Http://www.cnii.com.cn/.
2. wireless local area network, Baidu encyclopedia definition [EB / OL]. Http://baike.baidu.com/.
3. WLAN application status, China Economic Net [EB / OL]. Http://www.ce.cn/.
4. WiFi, Baidu Encyclopedia of business cards [EB / OL]. Http://baike.baidu.com/view/43867.htm.
5. EEE 802.11, Wikipedia [EB / OL]. Http://zh.wikipedia.org/wiki/IEEE_802.11
6. list of WLAN channels, Wikipedia [EB / OL]. Http://en.wikipedia.org/wiki/WLAN
7. Research on Overlapping Channel Allocation in Wireless Access Networks WANG Dongsheng