ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2015

A Review on Minimization of BER and Power of Ad hoc Network

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ABSTRACT: Over the last decade, a large number of pioneering works have provided foundations for both theory and applications of Wireless Ad hoc Networks (WLAN). As ad hoc technology is becoming the demand of present and future trends that needs for a reliable communication link having minimum BER and power. This review work presents the impact of mobility, and energy efficiency and clustering on optimization of Bit Error Rate (BER) and power as well as on throughput. An analysis review is made on Network coding scheme to optimize BER and throughput. And finally how these factors vary in WLAN is discussed in conclusion.

KEYWORDS: Bit Error rate, Energy Efficiency, Wireless Ad hoc networks, Signal to Noise Ratio, Power, Through-put.

I. INTRODUCTION

The ad hoc wireless arena has been experiencing exponential growth in the past decade. Also great advances in network infrastructures growing availability of wireless applications and the emergence of Omni-directional wireless devices such as portable and handheld computers and mobile phones, all these are getting powerful in their capabilities. Some examples, mobile users can check their e-mail, browse the internet, travelers with portable computer can surf the internet from public locations like airport, railway stations, cafes, tourists can use GPS terminals, installed inside these mobile nodes to check their location, files or other information can be exchange by connecting these portable active mobile nodes via wireless LANs while attending conferences; at home a family can synchronize data or transfer files between portable devices and desktops.

II. HISTORY TO PRESENT AD HOC NETWORK

The life cycle of mobile ad hoc networks is characterized into first, second, third generation [1]. First generation of ad hoc network can be traced back to the Defence Advanced Research Projects Agency (DARPA) in 1970s [2]. In 1970s these are called by the name Packet Radio Network (PRNET). DARPA initialize the research by using packet switch radio communication to bring reliable dissemination between computers and urbanized PRNET. Basically PRNET follows the Areal Location of Hazardous Atmosphere (ALOHA) and Carrier Sense Multiple Access (CSMA) for multiple access [3]. In early 1980s the PRNET is then emerge into the Survivable Adaptive Radio Network (SURAN). It provides assets by improving the radio performance in terms of creating them smaller, economical and power thrifty. This is fundamentally motivated by the efficacy of the packet switching high tech for instance the stored or forward routing and the bandwidth allocation, its possible application in the mobile ad hoc environment well in the packet radio networking equipment at that time. At the same time the advance of microelectronics technology and it was made possible to integrate all the nodes so the network called into single unit ad hoc networks.

United State Department of Defence (DOD) continued financing for programs such as Globe Mobile Information System (GloMo) [4] Near Term Digital Radio (NTDR) [5] is work by US Army. This is the only real ad hoc network in use. Due to keen interest of the communication engineers various other great developments takes place in 1990s and then advance in flexibility also mobility and decentralized infrastructure at that time they play an important role in military application and related research efforts, for e.g. GLoMo program, NTDR program and also has been the increase in the police, commercial sector and rescue operation in use of such networks under disorganized manner. In the middle of 1990s with advice of commercial radio technology and the wireless become aware of the great benefit of ad hoc networks outside the military battle field domain, and then become so active research on WLAN start in 1995 in

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2015

the conference session of Internet Engineers Task Force (IETF) [6] in 1996 this group had emerge into mobile ad hoc networks. Most of the currently available solutions are not designed to scale to more than a few hundred nodes.

Ad hoc communication systems are characterized by absence of infrastructure. This property makes them resourceful and capable of re-establishing communication among many nodes either utilizing single hop or multi hop fashion or in order to communicate the information between nodes. WLAN is a type of infrastructure-less ad hoc network. These are self configuring network of autonomous nodes connected by wireless links without central access. Accordingly ad hoc network can be employed in many situations like rescue operations, environmental monitoring, battle fields or any other application that rescinds from an infrastructure less communication system [7].

III. WHY BER RELATING TO POWER IN AD HOC WIRELESS NETWORKS

A related and very important issue is to the behavior of BER in ad hoc networks when they become dense and very far apart from each other. In such cases the communicating nodes i. e. transmitting and receiving can be located either very close or far apart to each other. Consequently the channel propagation model should take care to describe more accurately the realistic case. Model that include received power as a function of distance between the nodes must account for the situation of dense network in order to avoid the received power not be greater than the transmitted power due to law of conservation of energy.

On the other hand the BER is quality to measure the data transmission in a communication link. This link may be wired, wireless or ad hoc infrastructure less network between transmitter and receiver. In ad hoc networks due to multi hopping, the BER accumulates along the path from source to destination and its impact on the network parameters like delay, through put, power. It is important to conveniently to check this measure. An important factor that can be involved in the degradation of quality of service is BER. The average BER in wireless environment has an order of magnitude 10^{-3} against 10^{-9} in a wired network [8]. However this criterion is seldom direct use for evaluating the routes between nodes. Contrary to more immediate matrices such as delay or number of hops, nevertheless routes with high BER can lead to a high packet loss and delay. Since the MAC layer tries to send packets several times when errors have been detected this case is especially met when large size of packet is transmitted [9].

By taking into account different incoming load, [10] network size, hidden terminal problem, the effect of transmission error at the same time and the effect of these factors on IEEE 802.11 DCF MAC protocol a model is designed using Finite State Markov (FSM) Chain. In channel the operation of IEEE DCF MAC protocol is modeled by an embedded Markov chain, with the help of these two Markov chains the average throughput of the IEEE 802.11 MAC protocol is calculated very accurately. For this π/4 DQPSK modulation with coherent detection was used. The minimum BER and minimum steady state probability in 4 state channels are $2.464\text{x}10^{-10}$ and 9.823 $\text{x}10^{-1}$ at 15 dB and 10 dB respectively. And for the minimum BER and minimum steady state probability in seven state channels are $2\text{x}10^{-12}$ and 7.93 $\text{x}10^{-1}$ at 15 dB and 10 dB respectively. This shows when BER increases throughput always degrades. The throughput in single hop ad hoc network is highly dependent on the number of active nodes and incoming traffic load. When the incoming traffic load is light the throughput increases when the network size grows. When the network operate in heavy or (saturated) load condition the throughput decreases when the network size grows. This fact is predominant because the collision becomes larger with increase of network size. So one another fact is coming out that there are increasing BER always result in throughput decreases regardless the incoming traffic load and the size of network. The IEEE 802.11 DCF MAC protocol has better performance in single hop ad hoc network than in multi hop ad hoc networks this is due the absence of hidden terminal problem it conclude that the BER also has negative impact on the performance of IEEE 802.11 MAC DCF protocol in multi hop ad hoc network. So to increase the throughput BER should be decrease in multi hop ad hoc network for this hidden terminal problem should be avoided.

A close form expression [11] for the Average Bit Error Rate (ABEP) of binary modulation scheme in a wireless network with aggregate interference that is modeled as an α stable random variable derived in terms of Fox's H function and is valid for any arbitrary real value of characteristic exponent α which depends on the path loss coefficient in the propagation environment υ as $\alpha=2/\upsilon$. It is observed form the model result ABEP decreases as SNR increases path loss exponent of 2.5 which is beneficial for ad hoc system this is achieved at 0dB interference to the noise power ratio. But when but when interference to the noise power ratio increases for various density of interferers (10^{-2}, 10^{-3}, 10^{-4}) with path loss exponent $\upsilon=3$ at fix SNR of 20 dB ABEP increases. The impact of interference to the noise power

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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depends on interferes density and it is severe for high values of interferes density. So to minimize the BER interferes density should be low in high interference environment. From [10] and [12] the authors Xialong and Panupat work is good than the Aalo and Peppas in terms of BER minimization in high interference.

Table1. Impact of Minimum BER and Power On Throughput

Protocol/model	Minimum BER and SNR	Analysis
IEEE 802.11 FSM chain [10]	10^{-12} at 15 dB	BER increase throughput decrease for single hop. BER increase throughput increase for multi-hop.
α stable interference[11]	10^{-4} at 30 dB	SNR increase BER decrease this only at path loss exponent 2.5
ALOHA MAC [15]	10^{-15} at 1 mw by Friis model and 10^{-20} by Friis and adapted	BER improved optimizes power saving so through put improved at 10^{-1} nodes/m^2.
MPR selection algorithm [18]	10^{-7} at 20 dB up to 50 nodes from base MPR selection	BER decrease packet delivery ratio increase this improves the through put.
K V transform technique [19]	10^{-7} at less than 10 dB	Such a low BER throughput increase power saving increases.

A generalized model of opportunistic Network Coding (NC) that allow obtaining a close form expression of the average end to end BER to regenerate multi hoc communication system showing [12] the effect of different factors on BER when transmitted signal is modulated by BPSK/QPSK message bits from a flat Rayleigh fading channel with balance link condition. The probability found in the network encoded packet at the constant intermediate node. When the size of network encoded packet increases more error propagate in the encoded packet. On the other hand when the size of encoded packet is constant the errors in the packets for the encoding process increasing. So when encoded packet size increases BER also increases. The BER found for decoding packets process is even higher than the encoding packets; clearly the reason is noise corruption and channel fading in the encoded packets when intermediate node transmits the packet to the destinations and also the errors from the possible corrupted listened packet in the decoding process. The effect of increasing the number of encoded packets together also increases the average end to end BER. It is also found that the average end to end BER not only varies with the number of hops of the packet encoded together from source to intermediate node but also with number of hops the listened packet that have traveled from source to sink node. So conclusion is BER optimize by Markov chain process in [10] is more worth full than the opportunistic NC because in that case minimum BER optimize is 10^{-12} and by NC is 10^{-3} even when different actions like two hops, three hops, increasing the number of encoded and decoded packets has performed. So this work emphasize the need and the existing challenges for the designers to find strategies to solve the end to end BER while trading off with the existing limited sources such as energy or available frequency band to maintain both the higher throughput benefit from the opportunistic NC with substantially low BER.

Some other authors have use the same technique i.e. NC to optimize BER of ad hoc network. [13] Uses two approaches to reduce the complexity for the problem. One as all the channels statistically independent and have unit capacity. The network is directed, acyclic and delay free. Code symbols are binary. And second is the coding scheme is linear and deterministic. It means coding approach has been set and remains unchanged during the transmission process. The NC scheme is applied if no channel error the sinks will correctly reproduce information bits. It is observed that the optimized coding scheme has bit error probabilities (BEPs) are very close with other scheme. This is because all channels have identical BEPs and all schemes have the same flow. If the channels BEPs are different, then the optimized result can be much better than other schemes for high SNR. This can work as the bridge of cross network and physical layer design. Since the optimization in the network layer can have a great impact in the essential physical layer issue. Thus specified channel transmission parameters (modulation, channel code and rate etc.) can consider during NC optimization. In future this work can be implemented on nonlinear or non binary coding symbol to investigate the BER with the same technique. Cooperative diversity [14] has been proposed as an implementation for

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 3, Issue 2, February 2015

WLAN where terminals are restricted to using physical arrays, this technique can implements space diversity by creating virtual antennas array with cooperating nodes in order to combat multi path fading by the use of NC over some scenarios in relay networks in order to mitigate the propagation errors in WLAN that maximizes throughput. Adaptive scheme performs better than a simple and Amplify Forward (AF) scheme because the relay does not transmit unreliable packets. The use of relay diversity but still this is not as good as the transmit diversity bound. If compare the work of [10], [13] and [14] then optimized BER to reduce the transmit power achieved from [14] which is better than other two because optimize BER is less as compared in [10] and in [13].

Table1. Effect of NC Technique on Minimum BER and Power

Modulation Technique	Minimum BER and SNR	Analysis
M-PSK, M=2,4 [12]	10^{-3} at 16 dB SNR	Encoded packets have less BER than without encoded. The BER decrease power saving increase.
BPSK [13]	10^{-6} at 11 dB SNR	Improves BER in noisy channel increase more power saving can be use in cross network and physical layer design.
BPSK, QPSK [14]	10^{-7} at 30 dB with transmitter diversity and from AF scheme 10^{-5} at 30 dB	Less improve BER than AF scheme reduce power saving as in work of [13].

Multi-hop wireless ALOHA ad hoc networks evaluating the BER with an alteration of the Friis propagation model [15] that permits its application to any node density with random network topology and obey the law conservation of energy. BER diminishes with the increase of node density until a point at which total interference is greater than the utile received power. For high node density the evaluation [16] acts as an upper limit for the route BER since it aggrandize the received power on nodes on the route have neighbors located at distance smaller than minimum distance (1-meter). If comparison made between adaptive mode and previously used models route BER begins to abate as a function of node density well before previous model so previously used model have the wrong impression that the route BER has good performance for any node densities. Friis model and adaptive Friis model for the two values of transmission power 1 mW and 1μW. it is observed that for densities less than 10^{-1} node /m^{2,} to transmit with high power diminishes the route BER and if the node density greater than 10^{-1} node /m^2, increasing the transmission power doesn't increase the BER performance. So for high densities the increase in power causes interference to be dominant. This is much important fact for the power efficiency like in sensor networks [17] the deviation between the Friis and adaptive Friis model is emphasize for the transmission power at 1mW of node densities from 10^{-4} to 10^{-1} node/m^2 the BER value difference is 5 times by reason is the increase of the retrograde the approximation in the Friis model as a result of the effect of overestimated interference power educed by the node located at a distance less than minimum distance from the receiver impel to domineer the SNIR.

The rate increased by augmenting the transmission band of the communication channel. This indicate that increasing the transmission band not always improve the BER performance because more of more background noise is captured by the receiving nodes which reduces the SNIR however if both transmission band and power are increased than a better performance can be achieved reduction in BER even for high node densities since with elevated transmission rate the time required to send a packet is reduce the collisions in the shared communication medium. The adapted model BER and power optimization is more meaningful than the work done in [10]. In this minimization route BER is 10^{-15} at 1 mW on 10 nodes /m^2 and 10^{-20} route BER from Friis model at transmitted power of 1 μW for 10 nodes /m^2.

To enhance the optimum link state routing quality of service authors approach heavily relies on BER matrix and allows to increase Packet Delivery Ratio (PDR) [18]. Selecting good links during the MPR selection is not enough as the routing protocol does not provide any guarantee to use good links. To compute the shortest path Dijsktra algorithm was used in terms of BER not in terms of number of hops. For this the element of optimum link state routing should be changed, one is Multi Point Relay algorithm (MPR) selection and second is the route computation. From the simulation work it is observed that PDR increases according to number of nodes. Up to 40 nodes, the PDR evaluated when using BER based MPR is better than the original MPR selection. Means selecting MPR using Quality criteria normally

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2015

allows the routing protocol to choose better route. But this is only when active nodes are 40 or 50. BER based MPR have higher Normalized Oversize Load (NOL) than the original OLSR because packet received are increased so number of additional neighbors selected as MPR increases. But percentage of additional MPR compared to original OLSR does not increase more than 8%. A significant improvement in delivery rate of packets with a lower routing load compared to standard OLSR. This approach can provide several benefits. First, it can be used to test in mobile environment. Second, different strategies can be used to have a better deal with the compromise between the number of selected MPR and a good coverage of second neighbor in terms of BER.

Based on block code technique a novel idea of Koay Vaman (KV) transform is discussed in [19] to provide ability to detect errors and correct errors and identifies the remaining errors in block in each of the transmitted packet. By exploiting this property will allow design of BW efficient ad hoc and sensor networks to support provision of multiservice applications. KV transform technique permits recovery of end user information at low SNR which is typically seen in heavy multi path fading environment. This is applicable for both indoor and outdoor applications. It addresses the challenges of mobile network that needs BW and power efficiency, Quality of service provisioning of multi service and scalability. This technique is based on discrete sample orthogonal and invertible transform using time frequency variation analysis on comparing the result of KV/32 ary PAM system with single retransmission and interleaving and "32 ary PAM systems". The KV/32 ary PAM system with single retransmission and interleaving achieve BER less than 10^{-7} at less than 10 dB of SNR. This is achieved for both the systems transmitting JPEG picture for different conditions this technique can also be use on different modulation technique to achieve low BER at low SNR in ad hoc wireless system. This work optimizes BER less than 10 dB this is more beneficial than discussed work in [11], [15].

A precise numerical technique to optimize BER and Inter-Carrier Interference (ICI) caused by carrier frequency offset occur in Orthogonal Frequency Division Multiplexing (OFDM) presented in [20]. For the 10^{-1} randomly generated OFDM frame to obtain the error rate. Gaussian approximation field optimistic result, this is acceptable for the BPSK case, since the difference in SNR between approximation and simulation is less than 0.4 db. This difference is more in QPSK modulation. Here this optimize BER is at less than 16 dB. This difference attributes due to the reduction of the minimum Euclidian distance between any two signal constellation points in QPSK. Gaussian approximation is valid for small values of CFO even. It is deviating from simulation results for increasing CFO. Gaussian approximation is acceptable when noise dominates in ICI in the system. For 16 QAM OFDM simulation is more precise but Gaussian approximation is less this technique can be use to solve the problem of error correct codes to suppress the ICI caused by CFO. This work is less meaning full than [19] optimizes BER 10^{-7} less than 10 dB of SNR but in this work minimum BER 10^{-3} is at 16 dB of SNR from Gaussian and BPSK modulation.

BER obtained from [21] Space Time Transmit Diversity (STTD) the desired user's BER performance improves as fading of interfering signals decreases. Nakagami-m fading is becoming more prevalent in performance analysis and other studies like mobile radio communications. BER is determined for identically independently distributed (i.i.d) Nakagami-m fading channels with BPSK, QPSK, M-QAM. For higher value of m-SNR requirement is low. BPSK requires 3dB less value of SNR than QPSK to achieve the same BER. This is valid only when BER in term of SNR per carrier is considered in terms of SNR per bit the BER is same for both QPSK and BPSK. In case of 16-QAM and 64-QAM at m=0.5 to 5.5 and 1-2.2 dB showing that for higher value of m result in decrease the probability of error. The required SNR is low indicating the favorable result of the system. The minimum average BER optimize is 10^{-6} at 20-25 dB of SNR for m=2.3, 5.5 Nakagami parameter. So this transmitter diversity technique is suitable to enhance the capacity of ad hoc radio system. Error analysis of the non identical Nakagami-m relay fading channel can also be evaluated.

A frame-work [22] on the exact computation of the Average Symbol Error Probability (ASEP) of multi-hop transmission over generalized fading channels when an arbitrary number of AF relay is used. The approach relies on Moment Generating Function (MGF) framework to have an exact single integral expression computed from Gaussian Chebyshev Quadrature (GCQ) rule. It is observed that increasing the number of hops greater than one ASEP decrease but not that the large diversity gain occurs with double hop transmission. The minimum BER obtained from different modulation techniques M-PSK, M-QAM with Nakagami-m and various Nakagami figures just optimized the minimum BER to 10^{-4} at minimum SNR of 20 dB. So to increase the efficiency of multi hop transmission the diversity techniques

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

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should be applied at least on double hop channels possible in the multi hop transmission between source and destination.

One or 2-Dimentional WLAN with distributed (static) nodes which can move according to the Random Way Point (RWP) model is considered. The inter-distance distributions between any two nodes within these networks are obtained. The connectivity is considered and minimum transmission range is derived. The BER performance is then analytically evaluate in [23] the connected regions of the network taking into account the effect of path loss Nakagami-m or Rician fading. The observations found first is for transmission range and hence fixed link nodes, as the number of nodes increases the probability of connectivity is increases and so the minimum transmission range decreases. Second is mobility improves the connectivity of ad hoc network this is because for a constant transmission range the probability of setting up a link between two nodes with in a network with RWP mobility model is higher than that within a network with uniformly distributed nodes as the number of nodes increases the difference between the probability of connectivity of a network with RWP mobility model and a network with uniform placement of nodes become smaller. This implies that the minimum transmission range in a network with RWP mobility model is less than that in a network with uniform distributed nodes. third, the average received SNR increased by increasing the transmission range in turn improves the BER over each link thus for a given number of users the BER has minimum value at minimum transmission range and monotonically decreases with increasing the transmission range to its lowest value. Fourth, by increasing the number of users the minimum transmission range decreases. This implies the minimum transmission power can be reduced or for a constant transmitter power, the average received SNR will increase and so BER over each link decreases. The BER of WLAN with N users for a given transmission ranges the BER decrease by increasing the number of users.

End to end ABER in multi hop Decode and Forward (DAF) routes within the WLAN by considering the Nakagami-m fading channels with various modulation schemes like binary differential phase shift keying (DBPSK), 4-QAM ascribed in [24]. These are associated to a differentially coherent instead of the ideally coherent detection of 4-QAM in single and multi hop. Result corroborates the linear increase of end to end ABER and the linear decrease of end to end SNR with increasing number of hops. A wide range of multi path fading channels through different values of Nakagami fading parameter m. thus the fading effect when there is no direct line of sight (LOS) path is accurately modeled by the Rayleigh distribution fading environment less severe than those of Rayleigh fading are also considered by Nakagami m distribution. When m>1approximating other such as the rice fading (used to model the effect of one strong direct LOS components). Accordingly the Nakagami-m distribution is in interest because it can represent the best fit to land mobile and multi path propagation, scintillation, ionosphere radio link, satellite to indoor and satellite to outdoor radio wave propagation [25] the end to ABER as a function of single hop average SNR per bit for two hop with BDPDK , two hop 4-QAM, and 100 hop 4-QAM using both AAF and DAF relaying, for two hop, the DAF relaying barely out performs AAF for low SNR with both modulation. The difference is less marked with the coherent 4-QAM receiver then with the non-coherent DBPSK receiver. However regardless the modulation technique both the DAF and AAF performance tends to equalize as SNR increases, so in single route non-cooperative communication MHWN with Rayleigh fading channels, DAF relaying provides higher performance than AAF relaying. The end to end ABER as a function of the SNR per bit for two hop with 4-QAM modulation, using both DAF and AAF relaying over Nakagami-m channels with m belongs to (2, 3, 4) analogous to the Rayleigh channel case, in Nakagami-m propagation channels the DAF relaying barely outperforms AAF for low SNR values, however index m increases for a fixed value of SNR, the difference in end to and ABER between the DAF and AAF strategies increases.

The multi hop communication system was analyzed with regenerative relays in terms of average symbol error probability (ASEP) in [26] M-QAM an exact analytical close form expression for the ASEP in time domain AWGN channel as well as generic expression for slow frequency flat fading channels examine numerically identical Nakagami-m fading on all hops. An increase in the number of hops generally result in a loss of spectral efficiency since always only one may transmit at a time. This loss might be compensated by increasing the modulation order, for example it is better to employ high order modulation schemes with multiple hops or to transmit diversity from the source to destination with a one robust modulation scheme. The impact of the relay position on the ASEP is in Rayleigh fading m=1 ASEP marginally degrade as compared to direct examine and only if the relay is located in the middle between source and destination otherwise the performance getting worse. In less severe fading (m > 1) the ranges of possible values for which the reduction in error rate in case of dual hop examine become more significant. This is due to less severe fading the relative difference between the ASEP on the first and second hop become more pronounced on

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2015

overall SER is more and more governed by the ASEP of the weaker hop which may smaller than the ASEP of the direction transmission through a higher order modulation scheme is use to reduce the path loss. So it is observed 16-QAM generally have a higher complexity and requires amplitude information of the received signal where as in QPSK phase information is sufficient. Relayed information may be useful for combating shadowing effects due to shielding obstacles.

A design criterion for optimizing the ABER [27] for arbitrary constellation and beam forming codebooks in correlated fading channels approach generalized the original spectral modulation scheme by not selecting a single transmit antenna element depend on the bits to be transmitted, rather a certain beam forming vector from a give codebook. In result it is observed that in presence of spatial correlation is either at the transmitter or the receiver side the performance degrades considerably compared to the totally uncorrelated case, resulting in effective SNR loss of more than 6.5 dB in the SNR region. Conventional spatial modulation with QPSK compared to an Alamouti scheme with 8-PSK, so that spectral efficiency 3bits/Hz-sec in both case for totally uncorrelated spatial modulation have smaller BER than the Alamouti scheme in low SNR. With increasing the SNR scheme have advantage from its higher diversity order, therefore generally leading to a better performance. In case of transmitter correlation, the Alamouti scheme has lower BER than conventional spatial modulation yielding a gain of 4 dB at 10^{-3} BER value.

Two Input Multi Output (TIMO) systems represent an important case of Multiple Input Multiple Output (MIMO) and occur in practical scenarios where there are limitations on cost and/or space to install more antennas [28]. The proposed power allocation scheme offers 0.5, 1.2, 0.6 dB gain at BER of 10^{-3} over (Zero Forcing) ZF, Successive Interference Cancellation (SIC), Ordered Successive Interference Cancellation (OSIC) respectively. Both SIC and OSIC with power allocation outperforms proceeding schemes at 10^{-3}, OSIC with power allocation offers 0.9 and 1.9 dB SNR gain over Zero Forcing-Minimum Bit Error Rate (ZF-MBER) and Minimum Mean Square Error (MMSE) precoding/decoding respectively. It is also observed that QPSK beam forming offers superior performance to all other simulated scheme except maximum likelihood ML-MD [29] precoding BER at 10^{-3} with SNR gain over OSIC with power allocation 3.3 dB. This is more efficient in a way to exploit partial channel state information at transmitter.

Work on mobile WLANs has primarily focused on studying the impact of node mobility [30] on the performance of various routing schemes and the development of mobility models to present node mobility. The main reason for degrading performance as a result of node mobility is due to the traffic control overhead required for maintaining accurate routing tables for table-driven protocols and maintaining routes in the case of on-demand protocols. Geographic routing in the presence of mobility is receiving considerable attention in both ad hoc and sensor networks [31].

Table3. Impact of Mobility on BER and Power

Model/Protocol	Minimum BER and SNR	Analysis
RWP mobility model [23]	10^{-3} at 20 dB	For constant transmission range connectivity increase, SNR increases BER improves power saving increase.
RBS [29]	10^{-3} at 3.3 dB	Improved BER efficient to exploit partial channel state information at transmitter for power saving.
RES & GO MAC [30]	10^{-6} at less than 10 dB	BER is effective against interference with 10^{-6} node/m^2 at 2Mbps data rate
ALOHA MAC [31]	10^{-7} at less than 12 dB	Effective with INI at less than 10^{-2} node/m^2.

It is found that the call duration depends on both message length and data rate [32]. It is also possible to fix the message length and vary the data rate instead, decrease in data-rate would, of course, degrade BER because the message duration will be longer. However, it is not clear whether BER performance will improve if the data-rate increases. And on another side, increasing data-rate decreases the message duration and hence BER is affected less by mobility. Also, increasing data-rate decreases the SNR; therefore, the BER degrades in this case. It remains to be seen which of these two effects is dominant. However, it is clear that one cannot arbitrarily increase data rate in WLAN as this would, beyond a critical value, decrease the transport capacity [33]-[35]. For a fixed data-rate and a given target end-to-end BER on an average multi-hop route, an increase in the message length, call duration time, or maximum

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

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node velocity determines the ability of a network to support communication at a specified node spatial density. Thus, the relationship between end-to-end BER of an average multi-hop route, node spatial density, message length, maximum node velocity, and internodes interference (clearly depends on the MAC protocol used) one can determine whether a given application (such as voice, video, email, etc.) requiring a specific target application BER can be supported by a WLAN. To combat the deleterious effects of mobility (or increase in message length for a given mobility) on the BER, use of coding or reducing packet length could be considered.

The BER at the end of a multi-hop route with the mobility characteristics performance [36] of the nodes and the routing strategy, are derived. Two node mobility models are considered: Direction-Persistent (DP) and Direction-Non-persistent (DNP). In particular, two network switching scenarios namely: (i) Opportunistic Non-Reservation-Based Switching (ONRBS), where a message flows from source to destination by opportunistically choosing the available shortest consecutive links; and (ii) Reservation-Based Switching (RBS), where, after the creation of a multi-hop route from source to destination, the message is "forced" to flow over the reserved links, regardless of their actual lengths are analyzed. The network performance is evaluated in ideal (without inter-node interference, INI) and realistic (with INI) cases. It is observed the use of ONRBS allows supporting, at the cost of heavier control traffic, a higher mobility level than the use of RBS. The larger the traffic load (and, consequently, the INI, the lower is the impact of the routing strategy (i.e., RBS versus ONRBS) on the network performance. RBS-based WLANs, a DNP mobility model leads to a better performance, since frequent changes of directions average out, forcing the nodes to move around their original positions in a route, rather than moving far away and, therefore, disrupting connectivity. The same switching scenarios and node mobility models [37] are consider improving the robustness of BER against mobility from ONRBS, wrt RBS, is evaluated. It is shown that DP mobility causes a much more profound reduction in the end-to-end route BER than DNP mobility. The conclusion is more pronounced in WLAN employing RBS. Overall, the results show that if the MAC protocol is not efficient in canceling or mitigating the interference, then the role of the switching/ routing strategy in network performance is quite minor. In RBS-based WLANs, DNP mobility supports a better performance than DP mobility, since frequent changes of directions average out, forcing the nodes to move around their original positions, rather than moving far away and, therefore, affecting connectivity. Switching and, therefore, routing plays a vital role in WLANs only if the MAC protocol is effective against the interference. If communications in the network are affected by significant interference, then the selection of the switching scheme does not significantly improve the performance.

A technique is established via clustered Multi-Carrier Code Division Multiple Access (MC-CDMA) system. The available bandwidth is divided into the clusters of carriers, their MC-CDMA is applied within each cluster and Frequency Division Multiple Access (FDMA) is applied across clusters. A master node allocates carrier clusters and their associated power to the nodes in order to minimize the interference temperature, with constraints on BER and transmission data rates for different services. Sub-optimum algorithm used for optimization of the problem and their impact on interference temperature in multi-service wireless networks is investigated in [38]. Data is transmitted over those sets of subcarriers that provide favorable channel gain during a particular transmission period [39].

Enhances the BER performance of a network when compared with conventional MC-CDMA technique [40] subcarrier allocation has been presented as an optimization problem in [41], which aims to maximize the throughput capacity of the system. Non-contiguous partitioning based algorithm performs better than contiguous partitioning as it preserves the frequency diversity gain. Lower cluster size of 4, leads to higher interference temperature the reason is lower cluster sizes do not optimally exploit the available frequency diversity gains. However, higher cluster sizes are limited in resource allocation flexibility: all nodes using a cluster should transmit with the same power. Increasing the cluster size has two contrastive effects on the interference temperature. The first is increasing number of carrier increases the total power. The second is due to the diversity gain; increasing number of carrier reduces the BER for the same SNR or reduces the SNR for the same BER. Consequently, the first effect increases, while the second one reduces the interference temperature. In case NCP, increasing number of carrier decreases the separation between two successive subcarriers within the same cluster because the total number of subcarriers is finite. In fact, decreasing the separation beyond carrier frequency deviation/ decreases the frequency deviation diversity gain per carrier and the rate of impact of frequency diversity. It is clear that increasing cluster size from 4 to 8 has higher impact on BER compared to increasing it from 8 to 16. That leads to the lowest temperature interference.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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The concept of uniformly clustered WLANs, and a simple parameterize analytical model [42] can provide significant insights. In particular a single inter-cluster (long) hop damages the BER performance over a multi-hop route. Successive inter-cluster hops have increasing the further transmitted power limited impact. In long hops (with respect to the transmitted power considered for short hops) could be a simple power control strategy to improve the performance. However, this might cause problems in a realistic communication scenario with INI.

BER and power is minimized using Genetic Algorithm (GA) [43] from M-PSK and QAM technique for WLAN. The minimum BER 10^{-7} achieved from GA at 15 dB of SNR and 8-QAM minimum BER 10^{-7} achieved from GA at 19 dB of SNR. So 8-PSK is better than 8-QAM which optimizes more power BER for the cross and physical layer design [43]. Protocol on transmission power control and error correction coding to achieve high energy efficiency discussed in [44]. This is useful in extending battery lifetime and consequently the lifetime of nodes and the network. Based on the quality of the communication channel (minimum BER and BW) and characteristics of the packet to be transmitted adaptively choose the most energy efficient transmission power level and error correction coding. The impact of ECC and transmission power, respectively, on transmission energy and packet loss rate. Adaptive method is able to reduce the total transmission energy for 1000 messages by more than 20%, the total number of retransmitted packets is reduced by about 40%, and the packet loss rate is reduced almost by half. The radio transmission range as a system parameter affects the energy consumption economy of WLAN. A large transmission range increases the expected progress of a data packet toward its final destination at the expense of higher energy consumption per transmission. On the other side, a short transmission range consumes less per transmission energy, but requires an increase in number of hops for a data packet to reach its destination in terms of minimum BER. [45]. Minimizing the number of intermediate hops results in better BER when operating in poor wireless channel settings. When wireless channel conditions ameliorate, however, better BER is achieved by maximizing the number of intermediate hops. Another interesting result is that, in several scenarios, the overlay scheme outperforms the single multi-hop path scheme under the same total energy budget constraint [46].

IV. CONCLUSION

Ad hoc technology is present of wireless technology in which minimum power and BER play an important role for the reliability and connectivity of digital communication system. This work performs an analysis review from the history to present ad hoc wireless technology. The impact of mobility, energy efficiency, and clustering on BER, power and throughput of WALN is analyzed. So it is concluded that

When the incoming traffic load is light the throughput increases when the network size grows. When the network operate in heavy or (saturated) load condition the throughput decreases when the network size grows. This fact is predominant because the collision becomes larger with increase of network size. So one another fact is coming out that there are increasing BER always result in throughput decreases regardless the incoming traffic load and the size of network. So to increase the throughput BER should be decrease in multi hop ad hoc network for this hidden terminal problem should be avoided.

As the number of nodes increases the probability of connectivity is increases and so the minimum transmission range decreases. Second is mobility improves the connectivity of ad hoc network. the average received SNR increased by increasing the transmission range in turn improves the BER over each link thus for a given number of users the BER has minimum value at minimum transmission range and monotonically decreases with increasing the transmission range to its lowest value. Fourth, by increasing the number of users the minimum transmission range decreases. This implies the minimum transmission power can be reduced or for a constant transmitter power, the average received SNR will increase and so BER over each link decreases. The BER of WLAN with N users for a given transmission ranges the BER decrease by increasing the number of users. If per bit energy efficiency improves BER performance improves so increases the transmission power saving and hence improves throughput of the ad hoc network.

Successive inter-cluster hops increases the further transmitted power have limited impact. Long hops could be a simple power control strategy to improve the performance. However, this might cause problems in a realistic communication scenario with INI. Increasing the cluster size has two contrastive effects on the interference temperature. The first is increasing number of carrier increases the total power. The second is due to the diversity gain;

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2015

increasing number of carrier reduces the BER for the same SNR or reduces the SNR for the same BER. Consequently, the first effect increases, while the second one reduces the interference temperature.

When the size of network encoded packet increases more error propagate in the encoded packet. On the other hand when the size of encoded packet is constant the errors in the packets for the encoding process increasing. So when encoded packet size increases BER also increases. The BER found for decoding packets process is even higher than the encoding packets; clearly the reason is noise corruption and channel fading in the encoded packets when intermediate node transmits the packet to the destinations and also the errors from the possible corrupted listened packet in the decoding process.

Increasing the transmission power doesn't increase the BER performance. So for high densities the increase in power causes interference to be dominant. This is much important fact for the power efficiency. Increasing the number of hops greater than one ASEP decrease but not that the large diversity gain occurs with double hop transmission. So to increase the efficiency of multi hop transmission the diversity techniques should be applied at least on double hop channels possible in the multi hop transmission between source and destination.

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