Statistical Multipath Signal Detection in CDMA for Ad hoc Network.

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Abstract:
Mobile ad hoc networks (MANETs) represent complex distributed systems that comprise wireless mobile nodes that can freely and dynamically self-organize into arbitrary and temporary, ‘‘ad-hoc’’ network topologies, allowing people and devices to seamlessly internetwork in areas with no pre-existing communication infrastructure, e.g., disaster recovery environments. Ad hoc networking concept is not a new one, having been around in various forms for over 20years.Ad Hoc networks are multi-hop wireless networks where nodes may be mobile. These types of networks are used in situations where temporary network connectivity is needed. Ad hoc networks are formed on a dynamic basis, i.e. a number of users may wish to exchange information and services between each other on an ad hoc basis, in order to do this they will need to form an Ad Hoc network. Multipath signal detection is done using BPSK for CDMA Extended for OFDM and calculated the BER and that signal is analyzed in Ad hoc Network.

Keywords: Ad hoc, BER, BPSK, CDMA, MANETs, OFDM, SNR.

I Introduction

It is important to evaluate the performance of wireless devices by considering the transmission characteristics, wireless channel parameters and device structure. The performance of data transmission over wireless channels is well captured by observing their BER, which is a function of SNR [1] at the receiver. In wireless channels, several models have been proposed and investigated to calculate SNR. All the models are a function of the distance between the sender and the receiver, the path loss exponent and the channel gain. Several probability distributed functions are available to model a time-variant parameter i.e. channel gain. The term ad hoc often means improvised or for the needs o the moment for a specific purpose. In Computer networking, we
Think of ad hoc network as a wireless network. Without any infrastructure, e.g. wireless base
Stations. More thoroughly described, an ad hoc network consists of a number of nodes with wireless communication capabilities that potentially move around and cause the network topology to change frequently.

Characters and Fundamental Challenges of Wireless Ad-hoc Networks

Since Wireless Ad-hoc Networks are inherently different from the well-known wired networks, it is an absolutely new architecture. Thus some challenges raise from the two key aspects: *self-organization* and *wireless* transport of information [2], [3]. First of all, since the nodes in a Wireless Ad-hoc Network are free to move arbitrarily at any time. So the networks topology of MANET may change randomly and rapidly at unpredictable times. This makes routing difficult because the topology is constantly changing and nodes cannot be assumed to have persistent data storage. In the worst case, we do not even know whether the node will still remain next minute, because the node will leave the network at any minute. Bandwidth constrained is also a big challenge. Wireless links have significantly lower capacity than their hardwired counterparts. Also, due to multiple access, fading, noise, and interference conditions etc. the wireless links have low throughput. Energy constrained operation. Some or all of the nodes in a MANET may rely on batteries. In this scenario, the most important system design criteria for optimization may be energy conservation. Limited physical security: Mobile networks are generally more prone to physical security threats than are fixed cable networks. MANETs are internetworks formed by mobile wireless routers, with each router having one or more associated host devices (e.g., computers and sensors). A MANET’s router implements routing protocols that—unlike conventional routing techniques—tolerate rapid changes in connectivity among nodes. The paper is organized as follows. Section II explains Rayleigh fading, CDMA, and OFDM. Section III deals with the implementation. Section IV deals with results and discussions. The paper is concluded in Section

II Rayleigh Fading, Cdma, and Ofdm

The Rayleigh fading is primarily caused by multipath reception [4]. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal. It is a reasonable model for troposphere and ionospheres signal propagation as well as the effect of heavily built-up urban environments on radio signals. Rayleigh fading [5] is most applicable when there is no line of sight between the transmitter and receiver.
Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal, such as that used by wireless devices. Rayleigh fading models assume that the magnitude of a signal that has passed through such

a transmission medium (also called a communications channel) will vary randomly, or fade, according to a Rayleigh distribution the radial component of the sum of two uncorrelated Gaussian random variables. Rayleigh fading model: The Rayleigh fading is primarily caused by multipath reception. Rayleigh fading is a statistical model for the effect of a propagation environment on a radio signal. It is a reasonable model for troposphere and ionosphere signal propagation as well as the effect of heavily built-up urban environments on radio signals. Rayleigh fading is most applicable when there is no line of sight between the transmitter and receiver.

Rayleigh fading is a reasonable model when there are many objects in the environment that scatter the radio signal before it arrives at the receiver. The central limit theorem holds that, if there is sufficiently much scatter, the channel impulse response will be well-modeled as a Gaussian process irrespective of the distribution of the individual components. If there is no dominant component to the scatter, then such a process will have zero mean and phase evenly distributed between 0 and 2π radians. The envelope of the channel response will therefore be Rayleigh distributed.
In CDMA there is no restriction on time and frequency. In this scheme all the users can transmit at all times and at all frequencies, as shown in Fig 1. Because users are isolated by code, they can share the same carrier frequency, eliminating the frequency reuse problem encountered in other
Technologies.

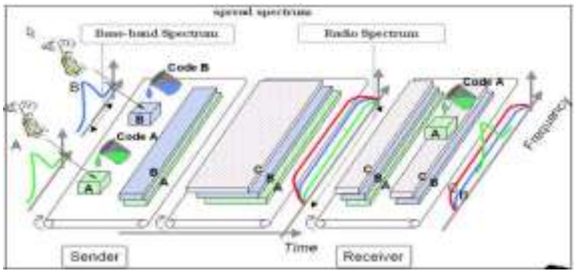

Fig1. Code Division Multiple Access

Problems in Cdma Detection

There are two problems encountered in CDMA Detection

1. Multipath Fading:

In a mobile environment, a mobile station will receive one direct signal from the base station and multiple signals which are reflected from obstructions like buildings and towers as shown in Fig 4. Each signal would have traveled a different length and would be displaced in time. Due to this, when they are combined at the mobile handset, it will cause interference resulting in poor signal quality. This is known as *fading*. This problem is handled in a very good way in CDMA. Here, the phase of the multiple signals is modified such that only positive interference (addition) takes place and the overall signal strength. A receiver that implements the above principle is known as RAKE receiver.

2. Near Far Problem:

The problem is best described by taking and considering a receiver and two transmitters (one close to the receiver; the other far away). If both transmitters transmit simultaneously and at equal powers, then due to the inverse square, the receiver will receive more power from the nearer transmitter. This makes the farther transmitter voice more difficult to understand. Since one transmission's signal than the farther transmitter, then the SNR for the farther transmitter may be below detect ability and the farther transmitter may just as well not transmit. This effectively jams the communication channel.

OFDM

Recently, a worldwide convergence has occurred for the use of *Orthogonal Frequency Division multiplexing* (OFDM) as an emerging technology for high data rates. In particular, many wireless standards (Wi-max, IEEE802.11a, LTE, and DVB) have adopted the OFDM technology as a mean to increase dramatically future wireless communications. OFDM is a particular form of Multi-carrier transmission and is suited for frequency selective channels and high data rates. This technique transforms a frequency-selective wide-band channel into a group of non-selective narrowband channels, which makes it robust against large delay spreads by preserving orthogonality in the frequency domain. Moreover, the ingenious introduction of cyclic redundancy at the transmitter reduces the complexity.

Multicarrier modulation splits the broadband channel into a large number of (narrowband) sub channels. The total bit stream is divided over these sub channels. These bits are modulated per sub channel onto a subcarrier with standard narrowband modulation techniques like PSK or QAM. The sum of all the modulated subcarriers forms the composite multicarrier signal that is sent over the channel. When the subcarriers are orthogonal, the sub channels may overlap without interfering each other, resulting in a high spectral efficiency (compared to e.g. frequency division multiplexing, where all the sub channels are separated by guard bands to prevent interference). The generation of these subcarriers is done in the digital domain, so that only one global local oscillator is needed instead of one for each subcarrier. Normally the Fourier Transform is used.

A. *Theoretical BER*

The BER, or quality of the digital link, is calculated from the number of bits received in error divided by the number of bits *transmitted.*

BER= (Bits in Error) / (Total bits received).

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The BER is the number of bit errors divided by the total number of transferred bits during a particular time interval. BER is a unit less

Performance measure, often expressed as a percentage [7].

The theoretical BER for BPSK modulation scheme over Rayleigh fading channel (with AWGN noise) is given by

$$P_b = \frac{1}{2}\left(1 - \sqrt{\frac{E_b/N_0}{1+E_b/N_0}}\right)$$

The theoretical BER for BPSK modulation scheme over an AWGN channel is given here for comparison

$$P_b = \frac{1}{2} er\, fc\left(\sqrt{E_b/N_0}\right)$$

E_b / N_0	BER in AWGN	BER in Rayleigh
-5 : 0	0.1064	0.1033
0: 5	0. 0952	0.0944
5: 10	0. 0578	0.0608
10: 15	0. 0235	0.0275
15: 20	0. 0078	0.01
20 : 25	0. 0025	0.0029

Table 1. BER in AWGN and Rayleigh fading channel

The following model is used for the simulation of BPSK over Rayleigh Fading channel and its comparison with AWGN channel

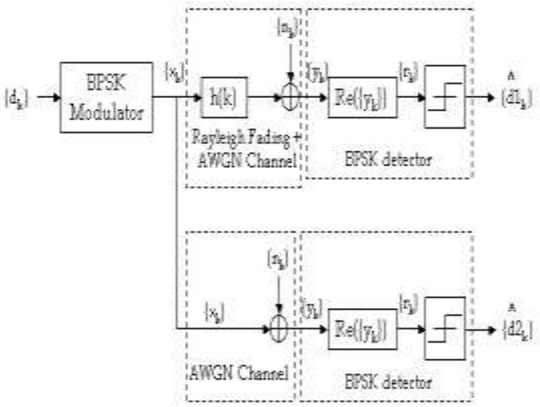

Figure2: BPSK Modulation over Rayleigh and AWGN channel

Figure2 refers to modulation and BPSK detection over Rayleigh and AWGN channel. Using BPSK modulation, randomly varying Rayleigh fading channel, Walsh spreading code, number of sub carriers 4, number of users 15 and other parameters same as [6,8].

B. Simulation Results

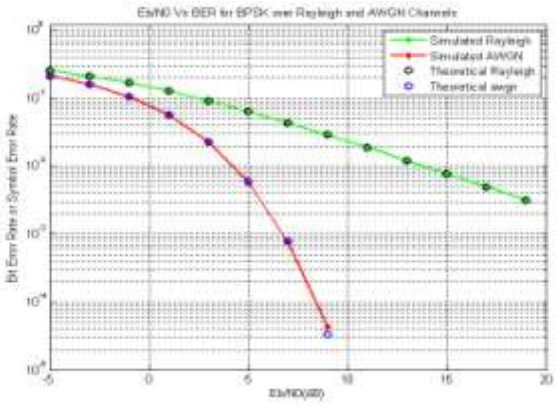

Figure 3.Eb/N0Vs BER

The Simulated and theoretical performance curves (Eb/N0 Vs BER) for BPSK modulation over Rayleigh Fading channel and the AWGN is shown in table and in figure2.

III Implementation

Figure4. shows the generated signal from modulator is transmitted in multipath via Rayleigh fading[9,10] channel and at the receiver side having highest received power signal is compared with threshold value and reordered in descending order using statistical algorithm. The signal having highest receiving power is selected for BER calculation. The implementation here is considered for five channels. In this paper, one of the important topic in wireless communications that is the concept of fading[11-13] is demonstrated by the approach available in MATLAB. Simulink is a graphical extension to MATLAB for the modeling and simulation of systems. In Simulink, systems are drawn on screen as block diagrams. Many elements of block diagrams are available (such as transfer functions, summing junctions, etc.), as well as virtual input devices and output devices. Simulink is integrated with MATLAB and data can be easily transferred between the programs.

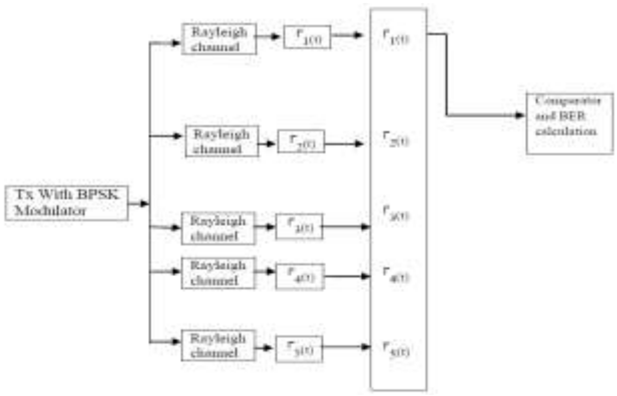

Figure 4. Five channel with BPSK Modulation

IV Results and Discussions

The reverse and forward Link interoperations comprise of convolution encoding and repetition, block interleaving, long PN sequence, data scrambling, Walsh coding and Quadrature modulation shown in figure 5 and 6and figure7shows BER for five channels. The signal which is having highest receiving power and better BER that signal is considered (output signal from figure 4) and used to transmit the signal over ad hoc Network and shortest path algorithm is used to transmit the signal from source to destination.

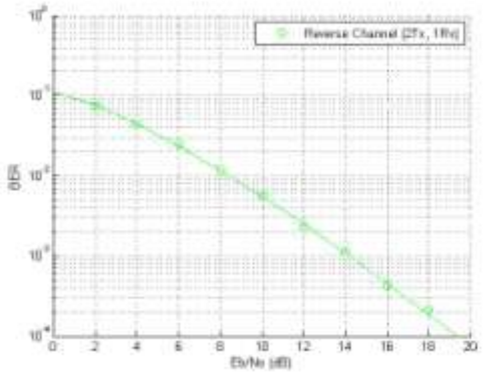

Figure 5. Reverse channel.

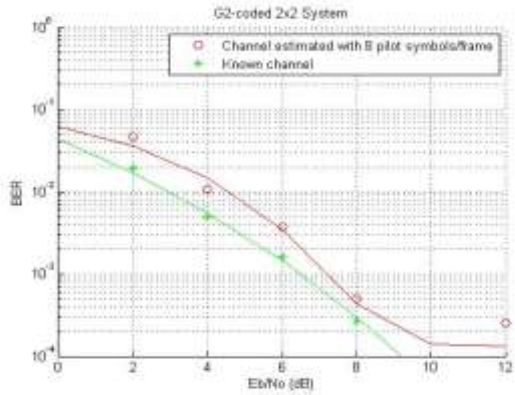

Figure 6 Forward channel.

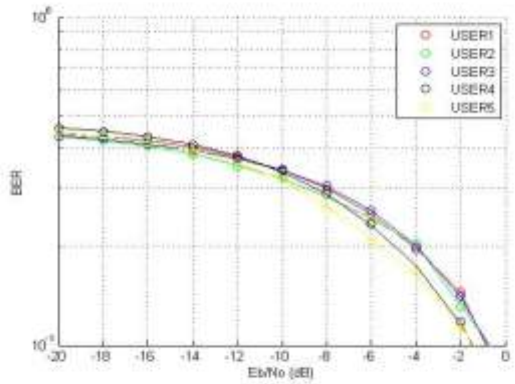

Figure 7. BER for five channel

Figure 8.Adhoc network

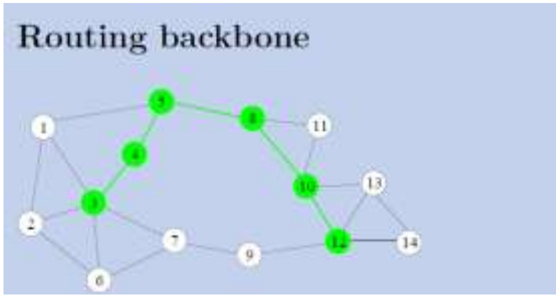

Figure 9.Adhoc network routing

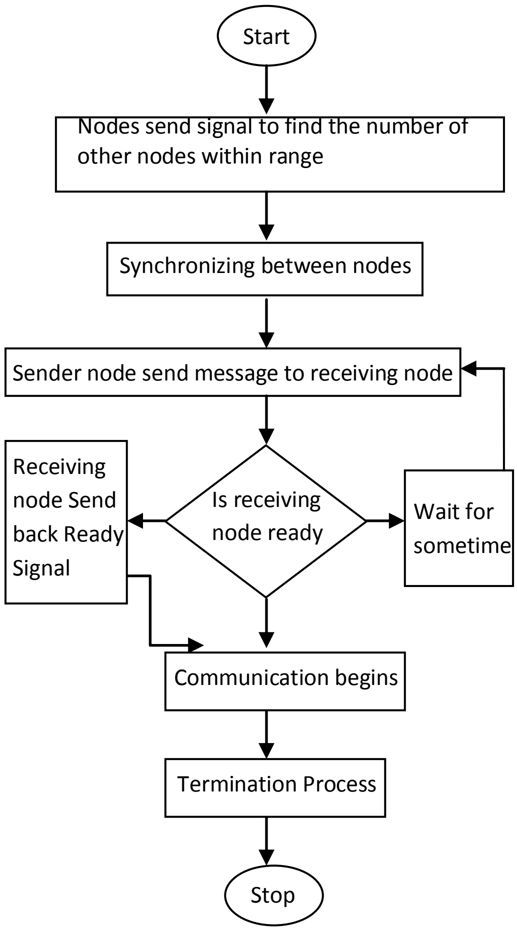

Figure 10.Adhoc network working

V Conclusion

In this paper, the simulation of statistical multipath signal passing through five different channels is presented. The signal having the highest SNR is considered at the receiver and the BER for that particular signal is calculated, and obtained signal is again used in wireless communication application ie in Ad hoc network to transmit the information from source to destination which uses the shortest path algorithm.

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