IOSR Journal of Engineering (IOSRJEN)
ISSN: 2250-3021 Volume 2, Issue 8 (August 2012), PP 59-67
www.iosrjen.org

Amplify-Forward & Distributed Space Time-Coded Cooperation to Exploiting CD Based Robust MAC Protocol in Ad-hoc Network

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Abstract: - *Cooperative Diversity MAC, it exploits the cooperative communication promising of the physical layer to get enhanced strength in wireless ad hoc networks. In CD-MAC every terminal is aggressively selects a relay for partnership and lets it transmit at the same time so that this mitigates intrusion from near terminals and thus improves the network routine. The incremental relaying protocol is observed in space-time coded cooperation below the amplify-and-forward & distributed space time-coded cooperation model. We build up and examine space–time coded cooperative diversity protocols for terminal's multi path elimination across multiple protocol layers in a wireless network. The protocols use spatial diversity accessible among a set of dispersed terminals that relay messages for one another in such a way that the target terminal can average the loss.*

In interference-rich and loud surroundings, wireless communication is often vulnerable by undependable communication links. These protocols achieve complete spatial diversity in cooperating terminals, not just number of decoding relays, and can be used successfully for higher haunted efficiencies than recurrence based schemes. We discuss problem related to space–time code design for MAC protocols, emphasizing codes that eagerly allow for appealing spreader versions. The proposed scheme can achieve an outstanding coding increase in similarity to direct transmission.

I. INTRODUCTION

In wireless ad hoc networks, signal loss, that is due to full of communication surroundings and intrusion, that is due to other terminals are two major obstacles in realizing their complete impendence in delivering signals. Cooperation among the terminals is considered critically important in addressing these problems. Conventional routing layer solutions support the cooperative delivery of information by selecting middle forwarding terminal for a source to destination. It may be complicated to make most of the routine if nodes are synchronized to cooperate at lower levels. This is because the network capability is often determined by the essential MAC and physical layer protocols. For example, consider a carrier sense based MAC protocol such as Distributed synchronized Function. A node is regarded as a starving challenger to other nodes in its closeness as they try to win with each other to take the shared medium, it jumble about each other's communication, and origin's collisions. At the physical layer, a node's data transfer not only provides intrusion to other nodes sparing their chance of using the medium but also energy consumption by understanding them to overhear. Recently, there has been active assessment in developing cooperative MAC algorithms such as MAC-layer packet relaying. Every transmitter sends its signal in cooperation with its correlated in a cooperative way to improve the communication steadiness. Effect of network traffic in term of unbalanced number of communication sessions as well as varying packet rate has been calculated to understand the scalability of CD-MAC.

Signal loss arising from multi path transmission is a mainly severe form of intrusion that can be mitigated through the use of diversity—transmission of not needed signals over basically independent channel realizations in consensus with suitable receiver combining to average he channel effects. Space-time coding (STC) has received a vast attention in way to increase capability and/or reduce the transmitted power to accomplish a target bit error rate (BER) using multiple antenna. Cooperative diversity techniques have been introduced to get better the obscure and power efficiency of the wireless networks. Cooperative diversity allows a collection of radios to relay signals for each other and effectively create a virtual antenna array selection for resist multipath loss in wireless channels. The feature of these techniques is that each node is ready with only one antenna. This asset makes them impressive for deployment in ad-hoc mobile networks as well as in cellular mobile devices, which have problem with exploiting multiple-antenna due to the size restraint of the mobile terminals. We use the immediate signal to noise ratio (SNR) to enable discovery of decoding errors at the target.

If the source-destination SNR is not sufficiently high for errorless direct transmission, the feedback requests that the relays amplify-and-forward what they received from the source with space-time coded cooperation.

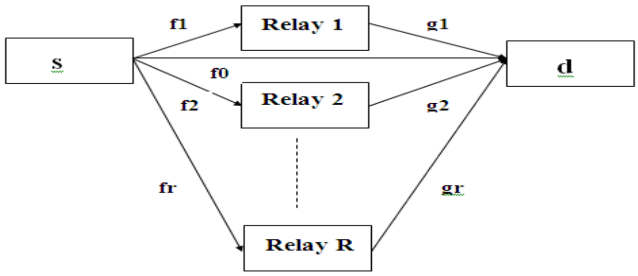


Fig.1. Wireless relay network consisting of a source s, a destination d, and R relays.

The bit error rate of amplify-and-forward based space-time cooperation and incremental relaying side are derived, when the source destination link is considered in both phases.

II. BACKGROUND & SYSTEM MODEL

The system model that we develop is extensions of the repetition-based algorithms as well as the space–time-coded cooperative diversity algorithms. Differences between the model employed here and the one employed in include a bigger number of terminals and dissimilar medium-access control protocols for space–time-coded and repetition-based CD. Narrow-band transmissions endure the effects of frequency non selective loss. Receivers can accurately measure the realized loss coefficients in their acknowledged signals, but the transmitters either do not exploit knowledge of the realized loss information. We focus on the case of slow loss and gauge routine by outage prospect to isolate the benefits of space diversity. We utilize a discrete-time channel model, baseband-equivalent for the continuous-time channel. CD-MAC is an efficient MAC scheme that makes use of physical layer cooperation for dependable communication.

1. Cooperative Diversity

A new category of diversity techniques called cooperative diversity has been planned, in which distributed radios act together to jointly transmit information exploiting diversity existing by multiple users. Diversity techniques such as co-located antenna array can mitigate the intrusion problem by transmitting unnecessary signals over basically self-governing channels. Relays amplify or fully decode their received signals and replicate information to the projected receiver; hence, they are called repetition-based cooperative diversity algorithms [1]. This profit comes at a price of falling bandwidth effectiveness because each relay requires its own channel for repetition. Code and transmitted through multiple antennas at the same time.

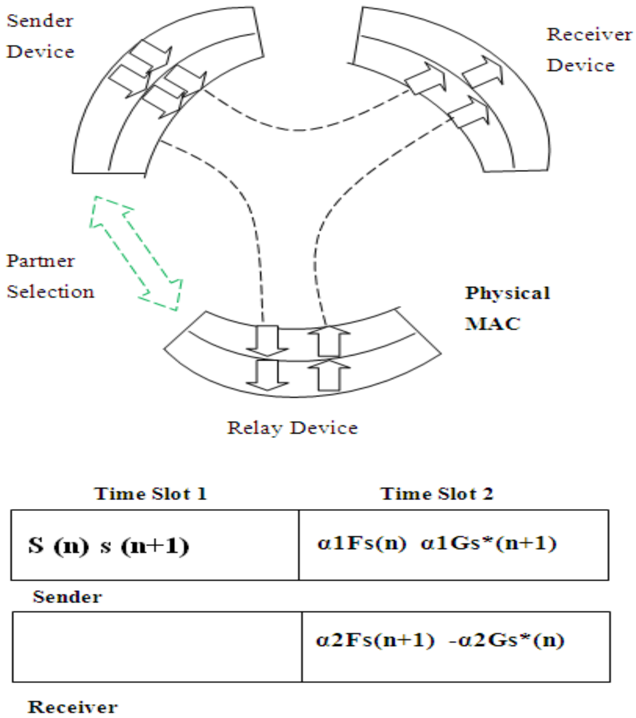


Fig.2. Cooperative communication using distributed space-time coding scheme based on Single channel model. (* denotes conjugation and two real coefficientsα1 and α2 are related to each other by α21 + α22 = 1.)

In time slot 1, the sender device send two symbol blocks, s(n) and s(n+1), to the relay. The sender and its relay cooperatively send the two blocks in time slot 2. By virtue of the orthogonally of the two matrices, it is unable for both the sender and the relay to transmit concurrently on the same channel but also improves the consistency of the communication [1].

2. Medium-Access Control

For medium-access control, nodes transmit on basically channels as in many current wireless networks. As a base line for evaluation, Fig. 3 shows example of channel allocations for non cooperative transmission, in non cooperative transmission each transmitting terminal utilizes a portion 1/N of the total degrees of freedom in the channel. Note that these are the same basic limitations on MAC protocols described. Now we describe how the medium-access control protocol differs under space–time-coded and repetition-based cooperative diversity. Fig. 4 describe example of channel and sub channel allocations for repetition-based cooperative diversity, in repetition-based cooperative diversity relays amplify what they receive or fully decode and repeat the source signal [3]. In order for the destination to join these signals and attain diversity gains, the replication must occur on effectively orthogonal sub channels.

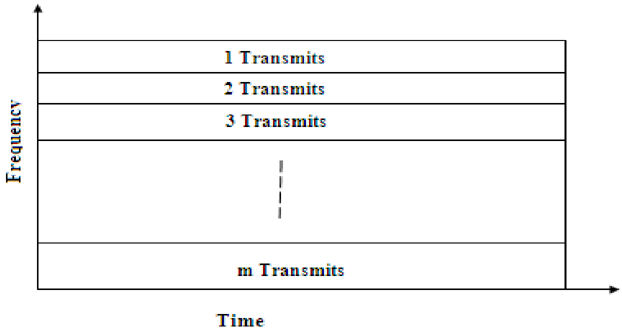


Fig.3. Non cooperative medium-access control. Example source allocations among m transmitting terminals across orthogonal frequency channels.

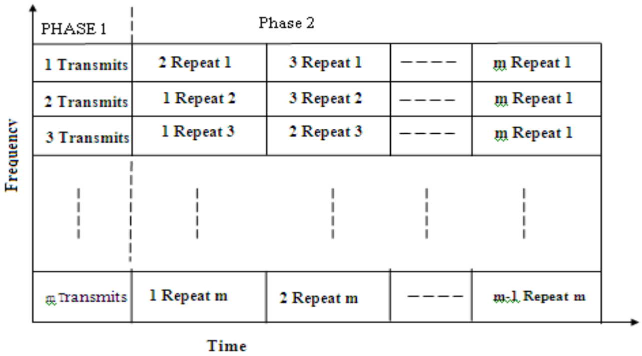


Fig. 4. Repetition-based medium-access control. Example source channel allocations across frequency and relay subchannel allocations across time for repetition-based cooperative diversity among N terminals.

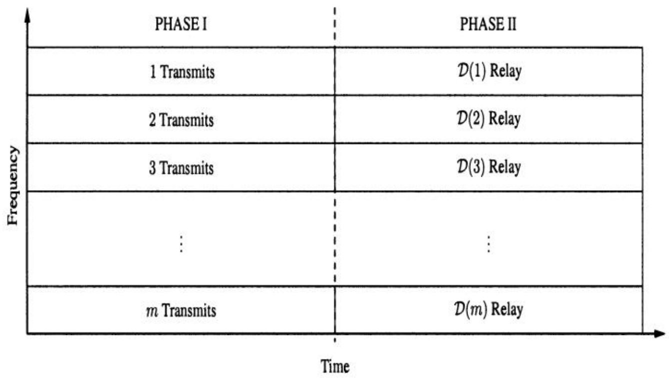


Fig. 5. Space–time-coded medium-access control.Example channel allocations across frequency and time for N transmitting terminals.

For source s, D(s) denotes the set of decoding relays participating in a space–time code during the second phase.As in non cooperative transmission, transmission sandwiched between source and destination d{s} utilizes a portion 1/N of the total degrees of freedom in the channel. Similarly each cooperating terminal transmits in a portion 1/N of the total degrees of freedom. Fig. 5 shows example channel and sub channel allocations for space–time-coded cooperative diversity, in which relays use a suitable space–time code in the second phase and therefore can transmit concurrently on the same sub channel. Again, transmission between source S and destination d{s} utilizes 1/N of the total degrees of freedom in the channel. In difference to non cooperative transmission and duplication- based cooperative diversity transmission, each node applying space–time-coded cooperative diversity transmits in ½ the total degrees of freedom in the channel. It is important to keep track on ratios when normalizing power and bandwidth in the continuation [3].

3. Cooperative Diversity in Wireless Ad hoc Networks

Dependability of a communication link is very vital in wireless ad hoc networks, because they are often deployed as a momentary network in noisy and unbalanced environments. MAC layer maintain that is necessary to make use of the cooperative diversity. As we studied distributed automatic repeat request mechanism, where a source and distributed repeater nodes concurrently transmit the same data frame constantly until the source properly receives an acknowledgement from the destination. Each node contributes to get hold of the diversity gain by encoding the frequent data based on DSTC. This method improves the communication dependability at the cost of more power rakishness, more routing transparency, and more network traffic, and accordingly results in the fall of network throughput [1].

In C-MAC, four control frames such as relaying start, relay acknowledgement, relay broadcasting and transmission start are defined in addition to conventional request-to-send, clear-to-send, and ACK. While DATA frame is transmitted using cooperative diversity, all control frames as mentioned above are transmitted through the straight single-input-single- output (SISO) link. This results in undependable delivery of control frames, which may limit the applicability of this protocol. A SISO path between a source and a destination is exposed using an accessible routing protocol such as Dynamic Source Routing (DSR) and Ad-hoc On-demand Distance Vector (AODV) or multiple relays are selected by exchanging intermittent one-hop hello packets [1].

4. Signal Propagation and Reception Model

Radio circulation within a mobile channel is described by three effects: reduction due to distance between the sender and the receiver, investigation due to the lack of visibility between the two nodes, and loss due to multi path circulation. To effectively receive a transmission, the following two conditions have to be satisfied. First, the receiver must be within transmission range of sender. In other words, the received signal power must be equivalent or larger than the receive threshold. Second, received signal power must be sufficient strong to overcome power of the noise and interference. This condition is described by following signal-interference-noise ratio (SINR) model. $SINR = Pr \div \{(N + \Sigma i\_=rPi)\} \geq Z0$

Where Pi denotes the received power of other signals arrived at the receiver, Pr is the received signal power, Z0 is the minimum required SINR, N is the effective noise at the receiver, commonly called capture threshold. In the abovementioned reception model, N and Z0 are two important parameters that affect the communication dependability. Signal reception in real-life surroundings is not deterministic. A smaller SINR increases bit error rate and thus a communication could fail with a elevated possibility. The success or failure of a communication is determined probabilistically based on SINR [1].

5. DCF (IEEE 802.11 MAC)

According to the SINR model as we seen in the prior sub section, intrusion from other signals is also a significant factor. The routine of a MAC protocol is greatly affected by collisions because a frame transmission to a busy receiver is not queued but incurs transmission failures at both frames. For example, a simple algorithm such as ALOHA allows many data transfers to arise concurrently but its throughput is seriously limited because of the lack of collision evading mechanism. On the other hand, carrier sense (CS)- based MAC algorithms such as DCF improve the interference problem by mandating a node to hold up awaiting transmission requests when it observes a carrier signal above a convinced value, called CS threshold. A lower CS threshold will result in less intrusion by interpretation nodes in a wider range to defer. This is known as four way handshaking. During the process, every neighboring node of the two communicating nodes recognizes their communication by overhearing the control frames and refrains from initiating its own transmission. However, the RTS/CTS exchange does not suggest benefits in practice as observed in. On the other hand, the RTS/CTS exchange has been used for other purposes that are for reserving a time interval. In a recent study, differentiate transmission failure due to collision from that due to channel error. The transmission failure of an RTS is measured due to collisions because RTS frame is very short, particularly when it is transmitted at the lowest data rate. The transmission failure of a data after a successful RTS/CTS swapping is considered due to channel error because collisions are already barred based on the RTS/CTS method [1].

III. CD MAC

In a wireless network, many nodes are spread over a network area. These all nodes communicate with each other using multi hop routed instead of direct communication. A link failure at one hop of a multi hop route, caused by the unpredictable communication situation, it would bring a lot of overhead:

(i) Data transmission up to that intermediary node becomes useless.
(ii) A new alternative route must be discovered. and
(iii) The middle node experiencing the link failure needs to report this event to the original source of the data packets.

This is not preventable if the cause of the problem is node mobility. If it is due to the changeable communication situation or channel error, it would be much better that the in-between node tries again with the help from its neighbors. This section proposes a new MAC protocol called cooperative diversity MAC (CD-MAC) for single-channel wireless ad hoc networks. It exploits cooperative diversity via DSTC to conquer the link failure problem due to undependable, unpredictable communication surroundings. In CDMAC, each node pro actively selects one relay device for its cooperative communication. Two-node cooperation is beneficial compared to multi-node cooperation because orthogonal code design is not possible with more than two cooperating nodes without declining the data rate. Moreover, the two-node cooperation is easier to organize than multi-node cooperation and the relay selection is simpler.

1. A Simple Cooperation Scheme

The proposed CD-MAC is based on DCF. If a major link forced by the upper layer routing protocol is dependable enough to effectively transmit frames, the conservative MAC is used and no cooperative transmission is enabled. If it fails, the sender retransmits the frame but cooperatively with its relay. Fig. 6 shows the cooperative transmission of a data stream along a path between a source (s) and a destination (d). Each middle node including s and d is matching with its relay, both of which sooner share the same communication background. For example, node i transmits its frame to the next hop node j over the primary link. If it fails, node i and its relay ri retransmit the frame cooperatively. Note that, during the retransmission, the relay ri overhears the blocks from the sender i in time slot 1, encodes it using DSTC, and cooperatively transmits it in time slot. Likewise, the node *j* transmits its frame (*e.g.*, ACK) to node *i* cooperatively with its relay *rj* .

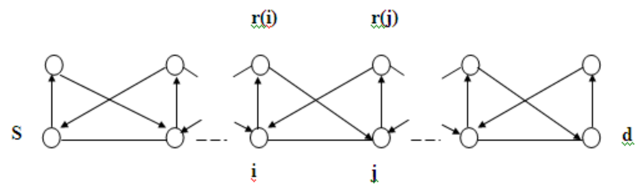
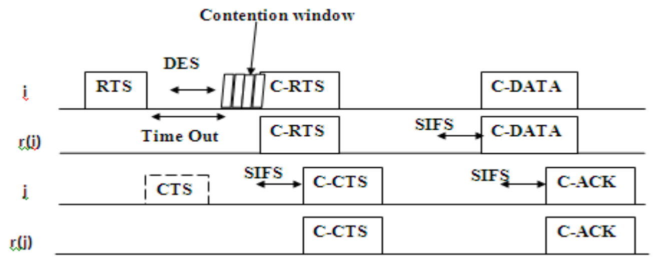
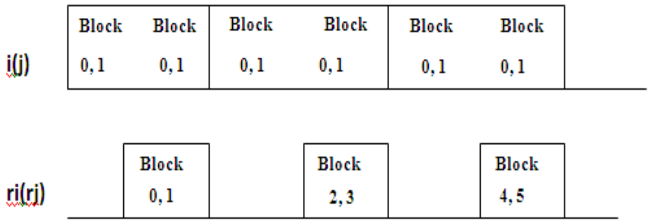


Fig. 6. Cooperative transmission with routing path and relays.

That is, if node i receives a CTS frame effectively from receiver j after transmitting an RTS frame, it transmits a data frame without cooperation according to the DCF principle. If i does not receive a CTS from j, then the cooperative transmission with its relay, ri, is attempted as shown in Fig. 7(a). That is, i and ri cooperatively transmit cooperative RTS (C-RTS) and j and rj cooperatively transmit cooperative CTS (C-CTS). After receiving C-CTS, i and ri cooperatively transmit data frame to j. After receiving the data frame, j and rj cooperatively transmit cooperative ACK to node i.



(a) Four-Way handshaking



(b) Transmission blocks of C-DATA (C-RTS, C-CTS, or C-ACK)

Fig. 7. Cooperative transmission

However, the simple cooperation scheme has a many of troubles: First, each cooperative transmission follows the same transmission standard as drawn in Fig. 7(a) in Fig. 7(b); namely, two symbol blocks from the sender to the relay in time slot 1 and then from both the sender and the relay to the receiver in time slot 2, that is i/ri to j for C-RTS and CDATA, and j/rj to i for C-CTS and C-ACK. This means that the transmission time becomes double longer than that without cooperation because we guess to use off-the-shelf radios with half-duplex antenna that operates on a single channel.

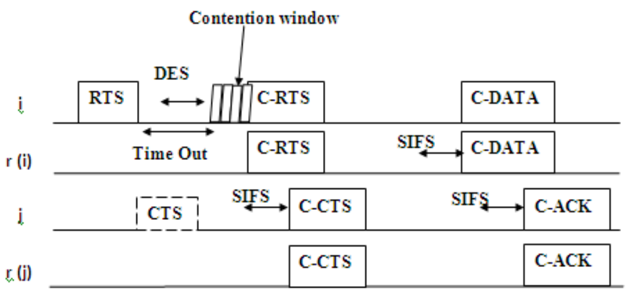
2. REPETITION-BASED COOPERATIVE DIVERSITY

We examine routine of a repetition decode- and-forward cooperative diversity algorithm for more than two nodes. Such protocols consist of the source broadcasting its transmission to its destination and possible relays. Probable relays that can decode the transmission become decoding relays and contribute in the second stage of the protocol by repeating the source message on orthogonal subchannels. Even though the set of decoding relays is a arbitrary set, we will see that protocols of this form offer full spatial diversity in the number of cooperating nodes, not just the number of decoding relays participating in the second phase. Fascinatingly, possible relays that cannot decode contribute as much to the routine of the protocol as the decoding relays, just as in the choosing decode- and-forward algorithm developed for two terminals.

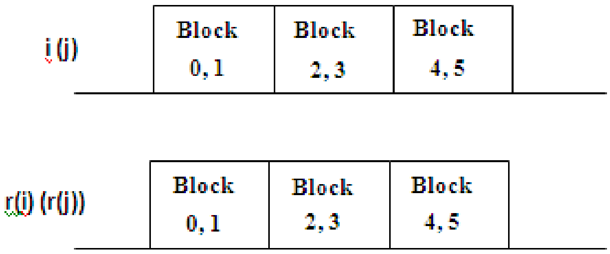
3. Cooperative Diversity MAC (CD-MAC)

To preparation the abovementioned problems, the following operation principles have to employ in the proposed CD-MAC:

- The RTS/CTS exchange is normally disabled.
- On the other hand, the RTS/CTS exchange is used only when a sender (i) experiences transmission failures at least once with a particular neighbor (j) in the current past. This is called as RTS probing, commonly used in multi rate variation protocols. Fig. 8(a) shows the four-way handshaking in the CD-MAC protocol.
- No cooperative communication is used for RTS and CTS control frames as in Fig. 8(a) because transmission failure of those short control frames are typically due to collisions. This should be contrasted with the simple scheme in Fig.8 (a), where the cooperative communication is useful to every frame including RTS and CTS.
- Cooperative communication is used for DATA and ACK frames when the data transmission unsuccessful but, consequently, the RTS/CTS exchange was successful.
- Transmission of symbol blocks in CD-MAC is drawn in Fig. 8 (b). Comparing to the transmission circumstances, time slot 1 for the symbol blocks of C-DATA is skipped and thus, the frame transmission time is not bigger than the original DATA [1]. This is possible because the relay node (ri) already overheard the original DATA frame from node i. Node i doesn't have to repeat the original symbol. The first two symbol blocks can optionally be transmitted for the organization purpose among i and ri. Concerning the ACK frame, rj as well as j receives C-DATA and thus rj can make C-ACK as fine.



(a) Four-Way handshaking



(b) Transmission bocks of C-DATA

Fig. 8. CD-MAC with relays *ri* and *rj* on a weak link (*i*, *j*).(RTS is normally not used in CD-MAC but it is employed in

Fig. (a) Because the preceding communication failed. The DATA frame in this figure consists of 6 blocks.)

Failure may be a good signal of a easily broken link. If a link is undependable and the problem persists for a wide era of time, it would be more suitable to find out a new routing path consisting of strong links. Fig. 8(a), 8(b) shows the state Transmission bocks of cooperative DATA, the receiver and the relay, respectively. In Fig. 8(a), if n is smaller than nth, the RTS/CTS exchange is skipped because the prior communication is successful and the communication environment is free from channel errors. No cooperative communication of DATA will be initiated. Otherwise, the RTS/CTS exchange will precede the data communication and DATA is transmitted cooperatively with its relay.

IV. PERFORMANCE EVALUATION

The routine of the projected CD-MAC protocol is evaluated in evaluation to the conventional IEEE 802.11 DCF using ns-2.

1. Signal Reception in NS-2

The signal response model implemented in ns-2 is based on three fixed physical parameters, i.e., carrier logic threshold (CS), receive threshold (Rx) and capture threshold (CP). When a frame is received, each node compares the received signal power beside CS Thresh and Rx Thresh. The modified ns-2 network simulator to take bit error rate (BER) into deliberation when shaping the success or failure of a received signal. It is based on the following 3-step process:

(i) Compute SINR,

(ii) look up the BER-SINR curve to obtain BER, and

(iii) Calculate frame error rate (FER) and determine whether to receive or drop the frame.

According to the equation, the efficient noise N is one of key parameters that determine SINR. First compute the thermal noise level within the channel bandwidth of 22 MHz's According to the well known noise density of - 174 dBm/ Hz, it is -101 dBm. Assuming a system noise figure of 6 dB, the effectual noise at the receiver is -95 dBm. It is assumed that the surroundings noise is fixed to be -83 or -90 dBm and that loss is contained in the noise. Hence, BER is a function of SINR and modulation method as well as the cooperative diversity. It should be calculated separately for the three parts of a frame [1].

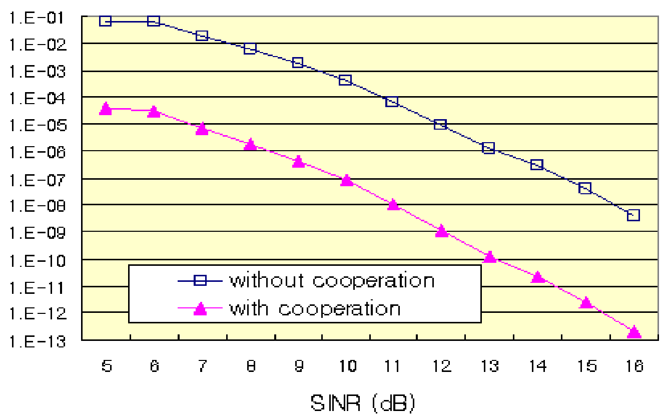


Fig. 9. (a) BER versus SINR

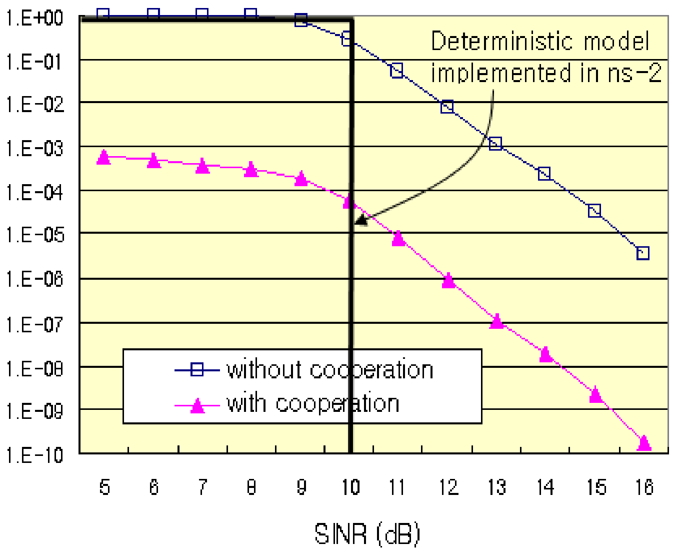


Fig. 9. (b) FER versus SINR

Once BER is obtained, FER can be calculated, which determines the percentage that a frame is received correctly. For comparison, Fig. 9(b) also shows the FER curve used in original ns-2, if SINR is larger than CP Thresh, the frame succeeds (FER = 0.0). Otherwise, it fails (FER = 1.0). The outline is FER is not deterministically but probably determined based on SINR in our simulation study makes evaluation more realistic and meaningful.

2. Amplify & Forward Signal in CD-MAC

The number of relays supposed to be R = 4. The BER routine of the incremental relaying protocol is compared with the permanent AF protocol and direct transmission. Since the IAF curve is in parallel with the non-cooperative curve in high SNR conditions, the IAF protocol could not accomplish full diversity as the permanent AF protocol. Fig. 10 illustrates the spectral efficiency curves as functions of the average SNR per symbol for different protocols [2]. It is understandable that haunted efficiency of AF space-time codes is half of the direct transmission duo to its two-phased transmission nature.

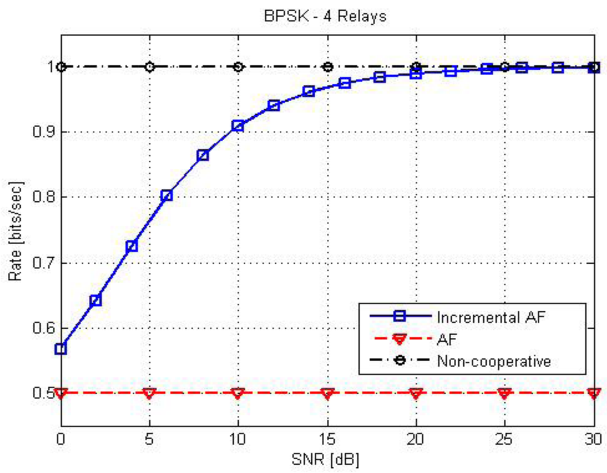


Fig. 10. The average normalized rate of a distributed space-time coded cooperation system with the employment of different protocols.

Comparing two cooperative protocol curves, one observes that incremental AF protocol can significantly get better the spectral efficiency of the system. It can be seen that Protocol I outperforms from the other protocols in low SNR regime. All of the employing protocols have the same routine in high SNR due to occurrence of the direct source-destination link in high SNRs [2]. By raising the SNR threshold for choosing among non-cooperative transmission and cooperative transmission, the privileged diversity gain will be achieved, while the spectral efficiency of the system is condensed. Finally, Fig. 10 compares the performance of protocols.

V. CONCLUSION

This paper recommend cooperative diversity MAC (CD-MAC) and discusses design issues and presentation settlement in wireless ad hoc networks. When a communication link is undependable, a sender transmits its signal jointly with its relay delivering the signal more dependably. In order to select a relay, each node inspects its neighbors with respect to link quality by receiving periodic hello packets and overhearing continuing communications. We developed a sensible reception model based on BER and FER, which are resulting from Inters radio hardware arrangement. We proposed incremental relaying protocol in AF based space-time cooperation. Immediate signal to noise ratio (SNR) utilized to conclusion between direct transmission and two-phase cooperative transmission using accessible relays. From another viewpoint, cooperative diversity corresponds to a particular form of network coding that unambiguously models the multipath loss, noise, and intrusion effects of the wireless channel. Existing insights and code designs can be leveraged and modified to the distributed environment of the cooperative problem. We consider several areas of future investigate on cooperative diversity will be productive. Some progress toward this objective has occurred in. Algorithms and protocols for creating cooperating groups of terminals will be necessary.

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