Rate less forward error correction using ldpc For manets

R.Rathi
Assistant Professor (O.G),Saveetha School Of Engineering,
Thandalam,Chennai

Abstract

The Topology-transparent scheduling for mobile wireless ad hoc networks has been treated as a theoretical curiosity. This makes two contributions towards its practical deployment. One is cover-free family and another one is rateless forward error correction. As a result from cover free family, a much wider number and variety of constructions for schedules exist to match network conditions. In simulation, I closely match the theoretical bound on expected throughput by using rateless forward error correction (RFEC). Since the wireless medium is inherently unreliable, RFEC also offers some measure of automatic adaptation to channel load. These contributions renew interest in topology-transparent scheduling when delay is a principal objective.

Keywords*-Mobile ad hoc Networks, rateless forward error correction, Topology-transparent scheduling*

Introduction

Mobile ad hoc Networks is a collection of mobile nodes that are dynamically communicating without centralized supervision. It is self-creating, self-organizing and self-administrating network. Absence of the base station from the network necessitates the functionality of the network nodes to include routing as well. This task becomes more complex as the network nodes change randomly their positions. An efficient routing protocol that minimizes the access delay and power consumption while maximizing utilization of resources remains a challenge for the ad-hoc network design.

For these reasons we have considered efficient routing protocols and we have evaluated their performances on a different MAC layers.

The main objective of this paper is to reduce delay and maximum throughput for mobile nodes. Part 2, defines a cover-free family and examines time division multiplexing and as I also derive the bound on expected throughput. Part 3, discusses acknowledgment schemes including RFEC for this purpose and overviews the LDPC process. In part 4, the simulation environment is explained and in part 5, the conclusion is stated.

Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequent. The medium access protocol attempts to order to minimum delay and maximum throughput on a per hop basis on each nodes

A Vehicular Ad-Hoc Network, or VANET, is a form of Mobile ad-hoc network, to provide communications among nearby vehicles and between vehicles and nearby fixed equipment, usually described as roadside equipment

Intelligent vehicular ad hoc networks (InVANETs) are a kind of artificial intelligence that helps vehicles to behave in intelligent manners during vehicle-to-vehicle collisions, accidents, drunken driving etc.

Scheduled approaches to channel access provide deterministic rather than probabilistic delay guarantees. This is important for applications sensitive to maximum delay. Furthermore, the control overhead and carrier sensing associated with contention MAC protocols can be considerable in terms of time and energy [1].

Two approaches have emerged in response to topology changes. Topology-dependent protocols alternate between a contention phase in which neighbor information is collected, and a scheduled phase in which nodes follow a schedule constructed using the neighbor information [2],[3]. Topology-transparent protocols are to design schedules that are independent of the detailed network topology. The schedules do not depend on the identity of a node's neighbors, but rather on how many of them are transmitting. Even if a node's neighbors change its schedule does not change. The schedule is still succeeds when the number of neighbors does not exceed the designed bound.

RELATED WORK

The extensive work related to this paper can be categorized into cover-free family and rateless forward error correction

Cover Free Family

In designing a topology-transparent transmission schedule with parameters N and D we are interested in the following combinatorial property. For each node, we must guarantee that if a node υ_i has at most D neighbors its schedule S_i guarantees a collision-free transmission to each neighbor.

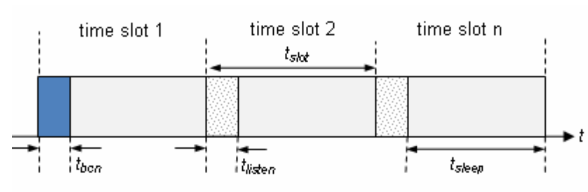
This is precisely a D cover-free family. These are equivalent to D disjoint matrices and to superimposed codes of order. As a result, there is also equivalence between the no-tation used for cover-free families, disjunct matrices, and superimposed codes. Such combinatorial designs arise in many other applications in networking.
As we showed existing constructions for topology-transparent schedules correspond to, time division multiple access giving cover-free families. Since this is essential to the provision of topology-transparent schemes of sufficient variety and number for practical applications, we outline this connection in more detail.
TDMA-based MAC protocol developed for low rate and reliable data transportation with the view of prolonging the network lifetime,

Adapted from LMAC protocol. Compared to conventional -based protocols, which depend on central node manager to allocate the time slot for nodes within the cluster, our protocol uses distributed technique where node selects its own time slot by collecting its neighborhood information. The protocol uses the supplied energy efficiently by applying a scheduled power down mode when there is no data transmission activity.
The protocol is structured into several frames, where each frame consists of several time slots. As shown in each node transmits a message at the beginning of its time slot, which is used for two purposes; as synchronization signal and neighbor information exchanges.
By using this message, the controlled node informs which of its neighboring nodes will be participating in the next data session. The intended nodes need to stay in listening mode in order to be able to receive the intended packet, while other nodes turn to power down mode until the end of the current time. TDMA calculates collision frequency for each nodes and automatically send packets from the source to destination. By allocating time we can easily find collision and thus it reduces time and the throughput increases.
Next Destination-Sequenced Distance-Vector (DSDV) and Wireless Routing Protocol (WRP) that are distance vector table driven protocols. Table-driven protocols periodically exchange routing table information in an attempt to maintain an up-to-date route from each node to every other node in the network at all times.

ACKNOWLEDGMENT SCHEMES

To approach the theoretical bound for expected throughput of topology-transparent scheduling in practice an acknowledgment scheme is required. Without an acknowledgment, a node must transmit the same packet in each of its assigned slots to guarantee reception to a specific neighbor. This is because while the schedule guarantees a collision-free slot to each neighbor by the end of the frame, it is not known which of its slots is successful to a specific neighbor; this depends on the schedules of the nodes currently in its neighborhood.

The operation of time slot assignment in A-MAC is divided into four states; initial, wait, discover, and active. As illustrated in the Fig. 4 below, a new node that enters a network starts its operation in initial state where node listens to the channel for its neighbor's beacon message in order to synchronize with the network. Node starts synchronization when it receives a beacon message from one of its neighbors and adjusts its timer by subtracting the beacon received time with beacon transmission time.
Node remains in this state for a Listen frames in order to find the strongest beacon signal. This is important as to continuously receive the signal from the synchronized node.
Else, a potential synchronization problem with the rest of neighboring nodes might arise due to the resulted drift problem caused by imprecision of microcontroller's timer. analyze the effects of MAC protocols, four ad hoc routing protocols are selected for study. First, the Dynamic Source Routing (DSR) and Ad hoc On-Demand Distance Vector Routing protocol are included as examples of on demand protocols. On-demand protocols only establish routes when they are needed by a source node, and only maintain these routes as long as the source node requires them.



Structure of A-MAC frame

With forward error correction (FEC), the source includes enough redundancy in the encoded packets to allow the destination to decode the message. Most FEC schemes require knowledge of the loss rate on the channel. Determining a suitable rate for the code in practice is not easy. If the rate is chosen conservatively to account both for collisions and for communication errors, as well as allowing for the maximum number of permitted active neighbors, many additional packets are sent containing redundant information. Too low a rate decreases throughput, while too high a rate fails to deliver enough information to decode. Worse yet, adapting to a more suitable rate requires an agreement between transmitter and receiver to change the encoding in use.

With *backward error correction*, the destination explicitly returns feedback to the source. These techniques may require the source to wait an entire frame for receipt of the feedback, even if both transmitter and receiver have at most D neighbors. In the pathological case that the transmitter is densely surrounded by neighbors while receiver is not, acknowledgment can cause collisions at the transmitter and result in total loss; this may result in stalling for many frames. Further, these techniques require window buffer, and timer management, not to mention that packets suffering collision need retransmission

Rateless Forward Error Correction

Rateless FEC overcomes numerous concerns with acknowledgment in topology-transparent schemes.

Among the rateless FEC codes currently available I use LDPC code. The LDPC process is capable of generating a potentially infinite number of equally useful symbols from a given input, giving the codes immunity to tolerate arbitrary losses in the channel. This makes LDPC codes an effective coding technique for wireless channels. for a symmetric memory-less channel. The noise threshold defines an upper bound for the channel noise up to which the probability of lost information can be made as small as desired. Using iterative belief propagation techniques, LDPC codes can be decoded in time linear to their block length.

Low-density parity-check (LDPC) code

LDPC (Low Density Parity Check) codes are a class of linear bock code. The term "Low Density" refers to the characteristic of the parity check matrix which contains only few '1's in comparison to '0's.We can define *N* bit long LDPC code in terms of *M* number of parity check equations and describing those parity check equations with H is represented by a bipartite graph.
There is an edge from v to c if and only if

$$H(v,c) \neq 0$$

A codeword is an assignment of v's s.t.:

$$\sum_{v|c} x_v = 0 \forall c$$

A linear code C (over a finite field) can be defined in terms of either a generator matrix or parity-check matrix.
Generator matrix G (k×n)
C={mG}
Parity-check matrix H (n-k×n)
C={c:cH'=0}

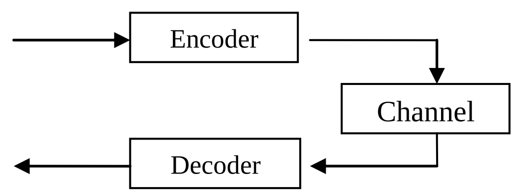
LDPC Codes -- linear codes defined in terms of H.
H has a small average number of non-zero elements per row

$$H = \begin{matrix} 0 & 1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 1 \end{matrix}$$

a*M* x *N* parity check matrix H. Encoder chooses the mthcodeword in codebook C and transmits it across the channel

Decoder observes the channel output y and generates m' based on the knowledge of the codebook C and the channel statistics.Representations for LDPC codes Basically there are two different possibilities to represent LDPC codes.Like all linear block codes they can be described via matrices. The second possibility is a graphical representation

A low-density parity-check (LDPC) code is a linearerror correcting code, a method of transmitting a message over a noisy transmission channel, and is constructed using a sparse bipartite graph. LDPC codes are capacity-approaching codes, which means that practical constructions exist that allow the noise threshold to be set very close to the theoretical maximum for a symmetric memory-less channel. The noise threshold defines an upper bound for the channel noise up to which the probability of lost information can be made as small as desired. Using iterative belief propagation techniques, LDPC codes can be decoded in time linear to their block length.



Message Passing (or Belief Propagation) decoding is a low-complexity algorithm which approximately answers the question "what is the most likely *x* given *y*?"

MP recursively defines messages $m_{v,c}^{(i)}$ and $m_{c,v}^{(i)}$ from each node variable node *v* to each adjacent check node *c*, for iteration i=0,1,...

Liklihood Ratio

$$\lambda_{x,y} = \frac{p(y|x=1)}{p(y|x=0)}$$

For y1,...yn independent conditionally on x:

$$\lambda_{x,y_1^n} = \prod_i \lambda_{x,y_i}$$

Probability Difference

$$\mu_{x,y} = p(x=1|y) - p(x=0|y)$$

For $x_1,\ldots x_n$ independent

$$\mu_{\sum_i x_i, y} = \prod_i \mu_{x_i,y}$$

Definition:

$$B(x) = \frac{1-x}{1+x}$$

$$B(B(x)) = x$$

$$B(\lambda_{x,y}) = \mu_{x,y}$$

$$B(\mu_{x,y}) = \lambda_{x,y}$$

$$B(\lambda_{x,y}) = B\left(\frac{p(y|x=1)}{p(y|x=0)}\right)$$

$$= \frac{p(y|x=0) - p(y|x=1)}{p(y|x=0) + p(y|x=1)}$$

$$= \frac{p(y|x=0) - p(y|x=1)}{2p(y)}$$

$$= \frac{2p(x=0|y)p(y) - 2p(x=1|y)p(y)}{2p(y)}$$

$$= p(x=0|y) - p(x=1|y)$$

$$= \mu_{x,y}$$

SIMULATION

This work is implemented using the Network Simulator Ns-2.33The simulation environment is chosen with the following parameters:

1. Number of nodes : 100
2. Antenna Directional : Omni
3. Network Area : 1500 * 1500 m
4. MAC Layer : IEEE 802.11 CSMA/CD
5. Routing Protocol : DSR protocol
6. Node Max Speed : 5 m/s
7. Mobility Model : Random Waypoint
8. Data rate : LDPC rate
9. Wireless interface : 11 MBPS

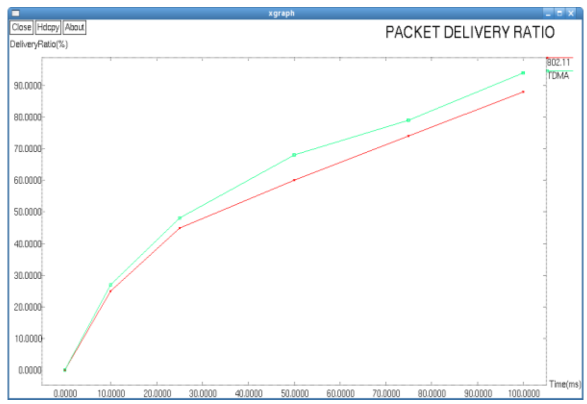
END-TO-END-DELAY

When compared to 802.11,the TDMA has minimum delay. Because the data transfer in 802.11 consumes more time.

- In Density Evolution we keep track of message *densities*, rather than the densities themselves.
- At each iteration, we average over all of the edges which are connected by a permutation.
- We assume that the all-zeros codeword was transmitted (which requires that the channel be *symmetric*).

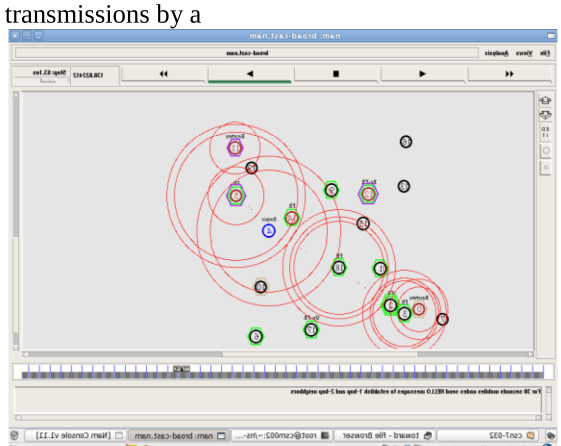
Regular update Rule:

- Every variable node has degree λ, every check node has degree ρ.
- Best rate 1/2 code is (3,6), with threshold 1.0



PACKET DELIVERY RATIO

Packet received.The performance of topology-transparent scheduling using schedules generated from an TDMA is measured by two metrics, throughput and delay. *I* define *throughput*as the average number of successful transmissions by a



node in a frame. In the best case a node can have as many as successes. If the degree of the node is at most , at least one success is guaranteed. The *delay* incurred at the MAC layer is defined as the amount of time taken on average for a packet to reach its next-hop destination; this includes queuing delay

Screenshot Description:

The scenario is implemented using networksimulator NS2 version 2.3.0. Nodes were distributed over a simulation area they move at a constant speed such a way when the nodes are within their transmission range, data transfer occurs.

The OMN and cover free family were implemented using network simulator NS2 version 2.33. A total of nades were distributed over a 300 1500m simulation area connected to their peers via a shared 11 mbps wireless interface. Nodes waschoosen to be 289, since the schedules were designed from a frame length of various; this can support at most 289 nodes. A rectangular simulation area was selected in order to force a longer network diameter. The steady state was initialized random way point mobility model was used in initialization the topology and controlling the movement patterns of the nodes; this ensures higher confidence in results. Simulations were run for various numbers of source-destination pairs, for static and mobile scenarios. Different values of were chosen to illustrate the relation amoung the number of neighbours, throughput, delay and frame length.

While transferring the packet from one node to another node, it will sent a message to neighbor nodes using orthogonal array. At that time of transferring , each node calculates the collision free slot.

Conclusion

The combinational characterization leads not only to more general construction schemes but also to analysis results suggesting that topology-transparent schemes retain strong throughput and delay performance even when in an environment with neighborhoods larger than anticipated.The fundamental problem, from the beginning, has been to develop a realistic acknowledgment model that realizes the performance indicated by a theory based on omniscient acknowledgment (OMN) and in which collision is the only cause of erasures. Rate less forward error correction (RFEC) has been proposed here as a solution, and a practical implementation using LT codes described. We emphasize that LT codes is just one of a number of schemes that could be used.The simulation results examine the case of unicast traffic when every packet follow a single router. The technique opens the door for a true multicast and reliable broadcast and in this cases RFEC appears to be not just the best, but perhaps the only currently viable acknowledgement scheme. To validate this solution, experiments have been conducted using topology-transparent schedules based on orthogonal arrays, to compare OMN and RFEC, and to explore the analytical model developed earlier.

REFERENCES

1. Rate less Forward Error Correction for Topology-Transparent SchedulingViolet R. Strontium, Member, IEEE, Charles J. Coburn, and South Yellamraju

2. J.-H. Ju and V. O. K. Li, “An optimal topology-transparent scheduling method in multihop packet radio networks,” IEEE/ACM Trans. Networking, vol. 6, no. 3, pp. 298–306, Jun. 1998.

3. C. J. Colbourn, A. C. H. Ling, and V. R. Syrotiuk, “Cover-free families and topology-transparent scheduling for MANETs,” Designs, Codes, and Cryptography, vol. 32, no. 1–3, pp. 35–65, May 2004.

4. V. R. Syrotiuk, C. J. Colbourn, and A. C. H. Ling, “Topology-transparent scheduling for MANETs using orthogonal arrays,” in Proc. DIAL-M/POMC JointWorkshop on Foundations of Mobile Computing, Sep. 2003, pp. 43–49.

5. D. R. Stinson, R. Wei, and L. Zhu, “Some new bounds for cover-free families,” J. Combinatorial Theory, ser. A, vol. 90, pp. 224–234, 2000.

6. M. Ruszinkó, “On the upper bound of the size of the ?-cover-free families,” J. Combinatorial Theory, ser.A, vol. 66, pp. 302–310, 1994.

7. D.-Z. Du and F. K. Hwang, Combinatorial Group Testing and Its Applications,
ser. Series on Applied Mathematics, 2nd ed. Singapore:World Scientific, 2000, vol. 12.

8. A. D’yachkov, V. Rykov, and A. M. Rashad, “Superimposed distance
codes,” Problems Control and Information Theory, vol. 18, pp.
237–250, 1989.

9.C. J. Colbourn, J. H. Dinitz, and D. R. Stinson, “Applications of combinatorial designs to communications, cryptography, and networking,” in Surveys in Combinatorics, ser. Lecture Note Series 267, J. D. Lamb
and D. A. Preece, Eds. London, U.K.: London Mathematical Society,
1999, pp. 37–10