

RELIABLE DATA COMMUNICATION OVER MOBILE ADHOC NETWORK USING WEAC PROTOCOL WITH ARQ TECHNIQUE

A. Kamatchi*, Dr. Annasaro Vijendran#

*Ph.D(Part time) Scholar, Department of Computer Science, Karpagam University, Coimbatore, India.

#Director, MCA Department, SNR & Sons College, Coimbatore, India.

Abstract: Error control techniques are very hot research topics in mobile adhoc networks. This paper deals with Performance of ARQ (Automatic Repeat reQuest) mechanism in mobile adhoc network using WEAC (Warning Energy Awareness Clusterhead) Protocol. Error control techniques are very popular in all types of networks. In Wireless network many types of Error control techniques are used. Automatic Repeat reQuest is one of the major error control techniques in wireless network. In this technique the erroneous packet will be retransmitted. Hence Loss of data is eliminated and it provides opportunity for reliable data delivery. This paper analyzes the famous three ARQ protocols and their performance in many circumstances and the advantages of various types in ARQ. The results of this paper shows that the amount of loss of data is eliminated using ARQ and it leads reliable data communication over noisy channels.

Keywords: ARQ Technique, WEAC Protocol, Mobile adhoc network.

I. Introduction

A Mobile adhoc network contains mobile hosts prepared with wireless communication devices. The data transmission of a single mobile node is received by all nodes within its transmission range.[9][10] If two mobile nodes are out of their transmission ranges in the ad hoc networks, other mobile nodes placed between them can forward their messages, which effectively builds connected networks among the mobile nodes in the deployed area. Due to the mobility of wireless hosts, each host needs to be equipped with the capability of an autonomous system, or a routing function without any statically established infrastructure or centralized administration. The mobile hosts can move arbitrarily and can be turned on or off without notifying other hosts. The mobility and autonomy introduces a dynamic topology of the networks not only because end-hosts are transient but also because intermediate hosts on a communication path are transient.[2][4]



Fig. 1: Architecture of Mobile adhoc Network

II. WEAC Protocol

The Warning Energy Awareness Clusterhead (WEAC)/Virtual Base Station On-demand (VBS-O) routing protocol is proposed in this work. A mobile node is selected from a set of nominees to act as a temporary base station for a period of time within its zone. In each cluster, a token is used to assign the channel among contending Mobile Terminals. A clusterhead supports multiple classes of services and also manages to minimize collisions. Here the

characteristics and performance of the WEAC protocol are studied and evaluated by simulation. It is shown that both it scales well to large networks of mobile stations and is proved to perform well for non-real time traffic[7].

III. ARQ Technique

Error control techniques are used to provide reliable communications over noisy channels[5][8]. The commonly used techniques are Forward Error Correction (FEC), Automatic Repeat reQuest (ARQ) or a combination of them called hybrid-ARQ. In ARQ, data is protected by error detecting codes. If the receiver detects errors, the corresponding frame will be retransmitted[6].

- i) Stop-and-Wait (SW) – Stop and wait for acknowledgement.
- ii) Go-Back-N(GBN) - Go next without acknowledgement
- iii) Selective Repeat (SR). - Go next without acknowledgement

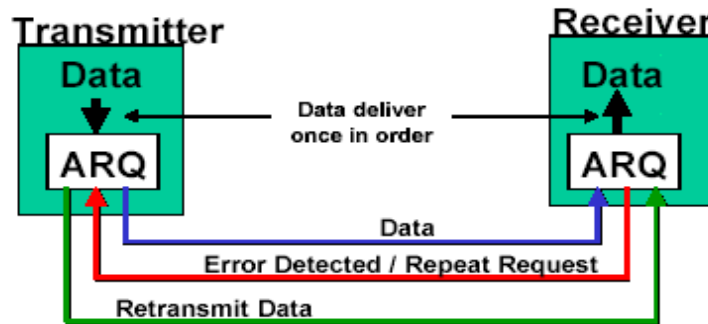


Fig. 2: ARQ Architecture

In **SW**, after sending a frame, the transmitter waits for feedback. A new frame is transmitted only when a positive acknowledgment (ACK) for the current frame is received. In contrast to SW, both GBN and SR protocols transmit frames continuously without waiting for acknowledgment messages. So GBN and SR are collectively called continuous ARQ protocols.

GBN is designed to operate without a re-ordering buffer at the receiver. Whenever a frame is missing or erroneous, the receiver simply discards all subsequent frames and sends no feedback for these discarded frames. So the transmitter has to retransmit all frames, starting with the erroneous one. If the error rate is high, the GBN protocol is inefficient.

In **SR**, only lost frames are retransmitted. Subsequent frames, which are correctly received, are stored in the receiver buffer so that the frames are sent to higher layer in the correct order. Because only lost frames are retransmitted, SR protocol is more efficient, resulting in higher throughput. Therefore there is a trade-off between bandwidth and buffer space. Depending on the availability of these resources, GBN or SR protocol will be used[1][3].

IV. Go Back N Protocol

This paper analyzes Go Back N protocol which is used to overcome the inefficiency of Stop-and-Wait ARQ . In this technique sender continues sending enough frames to keep channel busy while waiting for ACKs a window of W_s outstanding frames is allowed m -bit sequence numbers are used for both – frames and ACKs, and $W_s = 2m-1$.

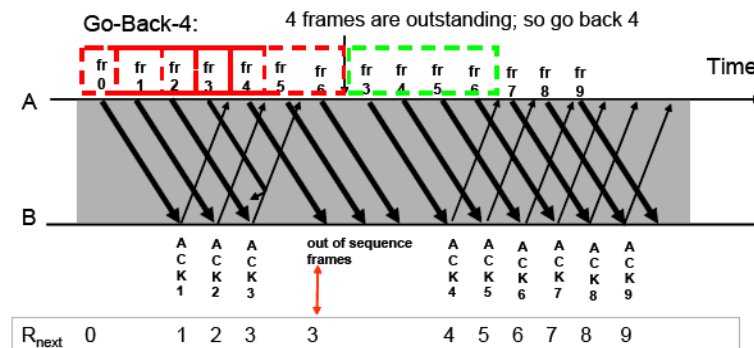


Fig. 3: Go Back N Protocol

Assume: $W_s = 4$

- 1) **Sender** sends frames one by one
- 2) Frame 3 undergoes transmission error – **receiver** ignores frame 3 and all subsequent frames
- 3) **Sender** eventually reaches max number of outstanding frames, and takes following action:
Go Back $N = W_s$ frames and retransmit all frames from 3 onwards.

V. ARQ Feedback Types

- i) cumulative
- ii) cumulative+selective
- iii) cumulative+sequence

i) If there are positive acknowledgements in the beginning of the ARQ transmission window, construct the cumulative part. If there are no negative acknowledgements, then a single cumulative feedback message is created.

ii) If there are remaining negative acknowledgements (optionally followed by positive and other negative acknowledgements), which we cannot send by using the cumulative part, then we have to choose a map type. To make a decision, we construct the sequence maps and calculate whether the selective maps can acknowledge more blocks. The maximum number of blocks to acknowledge selectively is 64 and it should be a multiple of 16. As for the sequence part, there is a limit for a sequence length and the number of sequences we can send in one message. As a choice is made, we "attach" map(s) to the cumulative part constructed at the previous stage. Eventually, we will have either the cumulative+ sequence or cumulative+selective feedback type.

iii). Note that we can reach this stage in two cases. The first one is when there are no positive acknowledgements in the beginning of the ARQ transmission window and there is no way to create cumulative, cumulative+ selective, or cumulative+sequence types. The second case to reach this stage is when neither cumulative+ selective nor cumulative+sequence feedback types encode all the blocks[11][12].

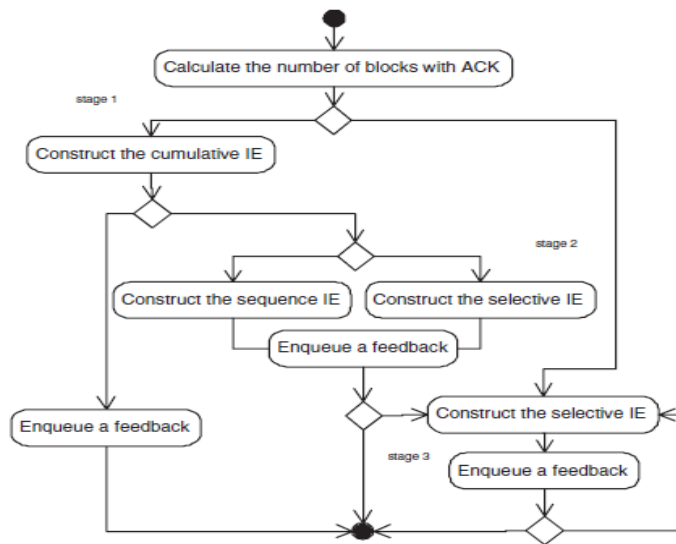
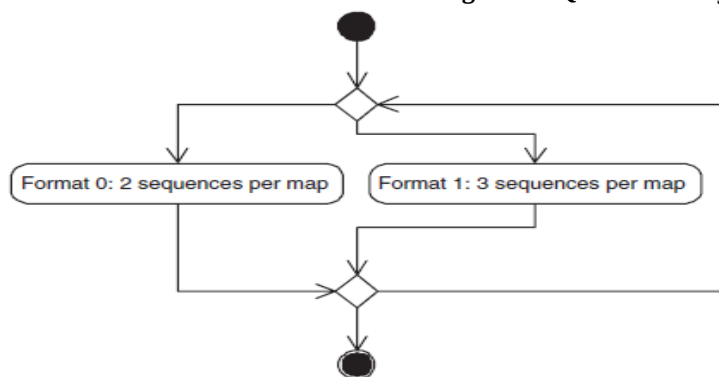


Fig. 4: ARQ Feedback Types



$$\text{Format} = \begin{matrix} 0, & (S_i > 15) \text{ OR } (S_i + 1 > 15), \\ 1 \end{matrix}$$

Fig. 5: Constructing sequence maps

GO BACK N(cumulative+sequence feedback type)

- Sender keeps copy of up to W_s outstanding packets .
 - k-bit sequence number, SN in packet header.
- When the receiver notices a missing/erroneous frame.
 - It discards all frames with greater SNs and sends no ACK.
- Sender timeout(i):
 - Retransmit all the frames in its sending window(packet I and all frames after that with higher SNs)
- Cumulative ACK
 - ACK(i): ACK all packets up to, including SN #i

Efficiency of Go Back N with transmission errors - Approximate analysis

Assume: $N = \left\{ \frac{S}{D_{TP}} \right\}$ $TO = N * D_{TP}$

- When an error occurs the entire window of N packets must be retransmitted. Let X = the number of packets sent per successful transmission

$$E[X] = 1*(1-P) + (X+N)*P$$

$$= 1 + N*P/(1-P)$$

$$\text{Efficiency} = 1/E[X]$$

Simulation Results

- Data rate - 25 kbps
- Carrier frequency - 20 kHz
- Source-Destination distance - 1 km
- Source power level - 94 dB
- Sound speed - 1500 m/s
- Packet size - 500 bits
- Fragmentation/packing- ON
- PDU size - as large as possible
- CRC/ARQ - ON
- ARQ feedback - standalone
- ARQ feedback types - Cumulative+sequence
- ARQ block size - 16 B
- ARQ window - 1024
- ARQ block rearrangement- ON
- ARQ deliver in order - ON

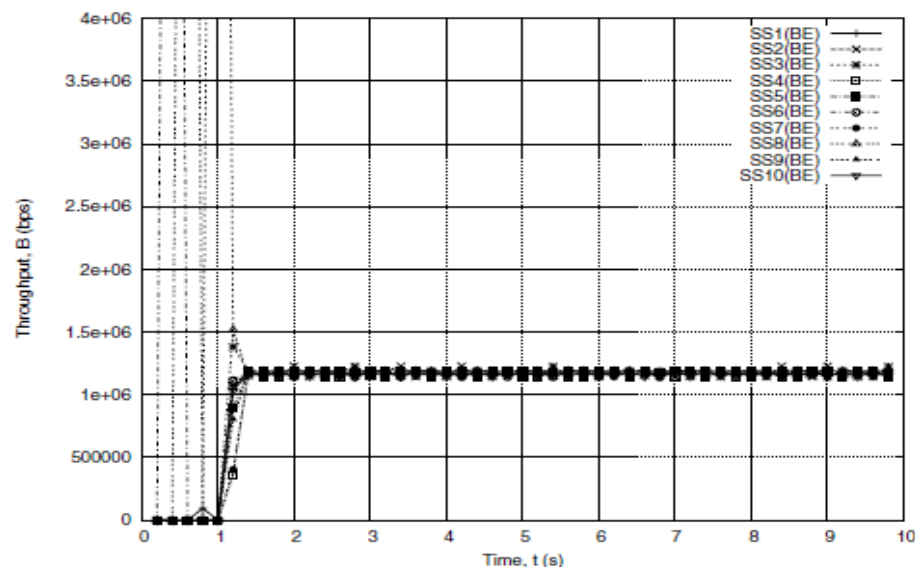


Fig. 6: Uplink throughput (no errors, no ARQ).

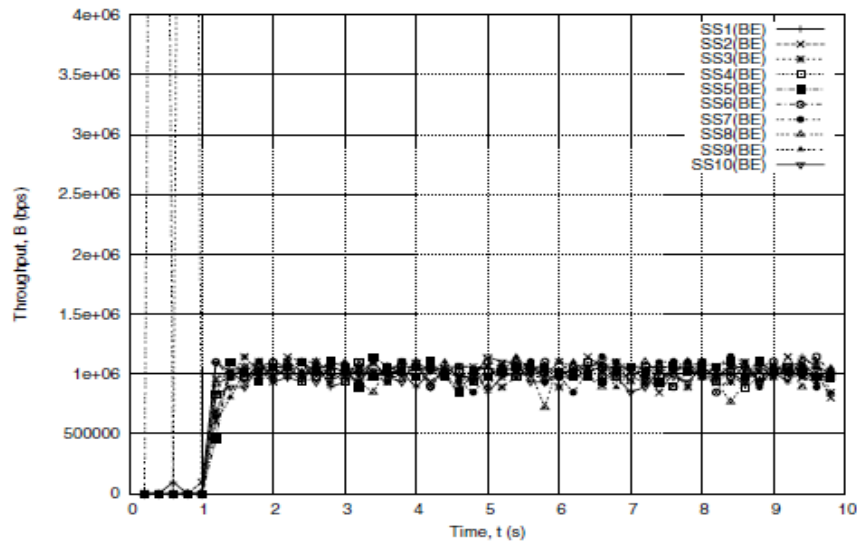


Fig. 7: Uplink throughput (errors, ARQ).

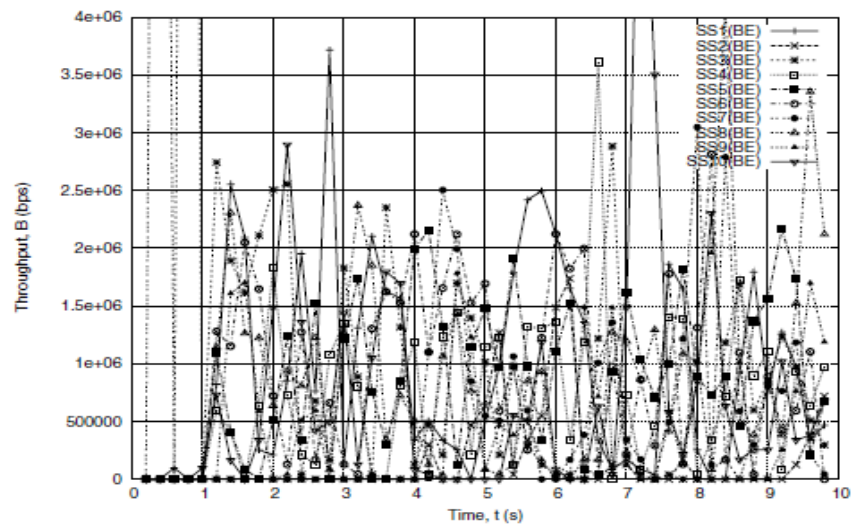


Fig. 8: Uplink throughput (errors, no ARQ).

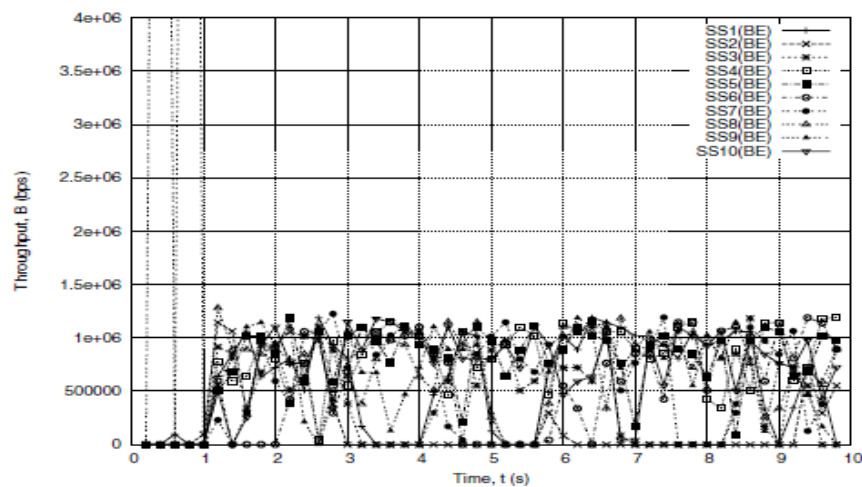


Fig. 9: Uplink throughput (no ARQ block rearrangement, large PDU).

VI. Conclusion

This paper proposes ARQ Technique in wireless network to improve the performance of data transmissions in mobile adhoc network. Network simulation results shows that under mobile adhoc network scenario using WEAC Protocol takes advantage of ARQ technique to reduce the number of dropped packets at relaying nodes, thus can improve the throughput of the network.

The proposed solution is based on how to prioritize normal PDUs, ARQ feedbacks, and retransmissions. The simulation results have also revealed the importance of the ARQ block rearrangement functionality. This paper also deals with Go Back N algorithm and its performance over mobile adhoc network. The efficiency of Go Back N algorithm over wireless network also analyzed.

This paper also demonstrates that a connection must choose sufficiently large ARQ transmission window size to utilize the allocated resources. While large ARQ blocks can utilize resources even with a small ARQ window, small ARQ blocks, such as those of 16 and 32 bytes, require much larger ARQ window. The proposed lightweight, yet efficient, algorithms are used to select the ARQ feedback type and to build block sequences for the cumulative+sequence feedback type. The analysis of the simulation results for the ARQ feedback types has revealed an importance of the feedback type.

The future research works will aim to study the optimal parameters of the ARQ mechanism, which is especially the case for the ARQ-enabled QoS connections. It is also important to compare the results provided by the ARQ mechanism and the HARQ mechanism.

References

- [1] A. G. i Fabregas and G. Caire, "Coded modulation in the block-fading channel: coding theorems and code construction," *IEEE Trans. Inf. Theory*, vol. 52, no. 1, pp. 91–114, Jan. 2006.
- [2] A. Stefanov and E. Erkip, "Cooperative coding for wireless networks", *IEEE Trans. Commun.*, vol. 52, no. 9, pp. 1470-1476, Sep. 2004.
- [3] D. Daley and D. Vere-Jones, *An Introduction to the Theory of Point Processes*. Springer, 2003.
- [4] D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*. New York: Cambridge University Press, 2005.
- [5] J. Li, C. Blake, D. De Couto, H. Lee, and R. Morris, "Capacity of adhoc wireless networks", In *ACM MobiCom '01*, July 2001.
- [6] M. Dianati, X. Ling, K. Naik, and X. Shen, "A node-cooperative ARQ scheme for wireless ad hoc networks," *IEEE Transactions on Vehicular Technology*, vol. 46, pp. 1032–1044, May 2006.
- [7] M. Haenggi and D. Puccinelli, "Routing in ad hoc networks: a case for long hops," *IEEE Commun. Mag.*, vol. 43, no. 10, pp. 93 – 101, oct. 2005.
- [8] M. Haenggi, "On distances in uniformly random networks," *IEEE Trans. Inf. Theory*, vol. 51, no. 10, pp. 3584–3586, Oct. 2005.
- [9] M. Janani, A. Hedayat, T. E. Hunter and A. Nostratinia, "Coded cooperation in wireless communications: space-time transmission and iterative decoding," *IEEE Trans. Signal Processing*, vol. 52, no. 2, pp. 362-371, Feb. 2004.
- [10] M. Sikora, J. Laneman, M. Haenggi, D. Costello, and T. Fuja, "Bandwidth- and power-efficient routing in linear wireless networks," *IEEE Trans. Inf. Theory*, vol. 52, no. 6, pp. 2624 –2633, june 2006.
- [11] P. Gupta and P. R. Kumar, "The capacity of wireless networks", *IEEE Transactions on Information Theory*, IT-46(2):388–404, March 2000.
- [12] R. J. Lavery, "Throughput optimization for wireless data transmission," *M. S. Thesis*, Polytechnic University, June 2001.