American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)

ISSN (Print) 2313-4410, ISSN (Online) 2313-4402

http://asrjetsjournal.org/

Performance Model of Reliable Hybrid Multicast Protocol (RHMP)

Okonkwo Obikwelu Raphael[a], Achuenu Chukwuemeka Anthony[b*], Epetimehin Olaitan Ibukun[c]

[a]Department of Computer Science, Nnamdi Azikwe University, Awka, Anambra State, Nigeria

[b,c]Department of Computer Science, Auchi Polytechnic, Auchi, Edo State, Nigeria

[a]Email: atcbusiness2009@gmail.com

[b]Email: tonynayou2003@yahoo.com

Abstract

The Pragmatic General multicast (PGM) and Elastic Reliable Multicast (ERM) are reliable multicast protocols. The difference between reliable and unreliable multicast protocol is that they make sure that the multicast data packets gets to its destinations. Both the PGM and ERM sends flood messages to the Rendezvous Point source (RPS) from the source node towards the stub nodes which then forward it to leaf nodes, leaf nodes that are not interested sends a prune message while any leaf node that misses a packet sends a message to the RPS through the stub node requesting for the multicast packet. A repair multicast packet is then forwarded to all leaf nodes that requested for it. In the reliable hybrid multicast protocol (RHMP) being proposed the stub nodes originates the flood message to the leaf and uninterested leaf sends prune message, any stub that has one or more interested leaf sends a join message to the RPS. If a leaf node in the multicast distribution misses a multicast packet it requests a repair packet from its stub node and the stub node sends the repair data. A simulation model was developed to mimic the behaviour of PGM, ERM and RHMP in different network size using hierarchical network and the control bandwidth overhead (CBO) for each of the multicast protocols was calculated, the CBO was use as the cost metric. The result shows that the RHMP uses less CBO than PGM and ERM in a sparsely and densely populated network. For state storage it was discovered that the RHMP uses more resources at the stub nodes than at the source / RPS or leaf node when compared with PGM and ERM, but since the stub nodes are present in a distributed way it does not necessarily affect the multicast process.

Keywords: PGM; ERM; reliable multicast; Hybrid multicast; join; flood and prune.

----

* Corresponding author.

1. Introduction

The main advantage of reliable multicast protocols is that it makes sure the multicast packets gets to their destinations but generally the control bandwidth overhead (CBO) for a reliable multicast protocol is higher than that of an unreliable multicast protocol because in unreliable multicast protocol no CBO messages are sent if a leaf or stub misses a packet. In PGM the Negative Acknowledgement (NAK) that is sent by a leaf if it misses a packet is send upwards to the RPS or the source which then sends the repair data down to all affected leafs, PGM has some method of preventing congestion such as once a NAK is received from a stub it suppressed subsequent NAK request for the same missed packet from other leaf nodes within that stub node, but this does not guarantee that the multicast protocols CBO will not be much, because as the number of nodes increases, the total number of CBO messages sent also increases, hence the need to use the proposed model where the stub nodes (a node before the leaf nodes) act as temporary RPS and this stub nodes generates flood/prune message towards leafs connected to them and a join/ prune message towards the RPS /source node if any of the stub's leaf is interested in receiving a multicast stream, it also sends repair packets (FEC) to leaf nodes that misses a multicast packet without necessarily requesting it from the source node or RPS.

This paper is organized into five parts: Sections 1, Introduces the research, section 2, discuss the justification for this research, related work is described in section 3 and the methodology use in section 4. While section 5, focus on the performance analysis of the proposed multicast protocol, against the existing PGM and ERM protocol.

1.2. Justification of this research

The workload by the source or RPS can become much as the number of multicast users (leaf nodes) increase in a reliable multicast scenario, this is evident by the amount of CBO message that is exchanged between the RPS and the leaf node, especially in a network where they are frequent failures along the multicast distribution path. Some methods were proposed to help reduce the workload on the RPS or source such as [1,2,3] some of the problems with these existing models is that CBO is use in trying to locate the closest leaf node that has a copy of the FEC. Secondly the repair data (FEC) usually sent is gotten out of order and the requesting leaf now needs a method of re-sorting the repair data. The above problem are eliminated if the stub node is the initial source or RPS for that leaf, as less CBO will be use and the FEC packets will arrive in the correct order as is being proposed in the reliable hybrid multicast protocol (RHMP) which uses a decentralized system of propagating multicast packets thereby further reducing the control bandwidth overload and workload of the RPS or source node.

1.3 Related Work

The author [4] evaluated the performance of protocol independent multicast sparse mode (PIM SM) against multi-protocol label switching (MPLS0 and ended up merging this two protocols to get a multicast protocol that has scalability and a reduce control bandwidth overhead than the individual multicast protocols. A researched on a new approach to multicast routing protocols in MANETs based CASE based reasoning method the new approach was based on an existing on-Demand multicast routing protocol (OMRP) but nodes with CBR based

OMRP becomes autonomous, by keeping track of previous route discovery experience to reuse as a solution. This reduced control bandwidth overhead and also improve scalability [5].

Reference [5] proposed an Ant Based Adaptive Multicast Routing Protocol (AAMRP) for Mobile Ad Hoc Networks that exploits group members desire to simplify multicast routing and invoke broadcast operations in appropriate localized region, results from the authors simulation shows that there is an increase in packet delivery fraction with a little reduction in control bandwidth overhead and routing load. Elastic traffic or protocol can adjust, over wide ranges, to changes in delay and throughput across an internet and still meet the needs of its applications [7], reference [8] discuss the structure and behaviour of Elastic Multicast Protocol. The need to reduce the control bandwidth overhead when setting up, maintaining and tearing down a multicast distribution tree necessitated [9], to propose an Optimized Flooding Protocol (OFP), based on a variation of The Covering Problem, which is encountered in geometry, to minimize the unnecessary transmissions drastically and still be able to cover the whole region. They concluded that OFP does not need hello messages and hence OFP saves a significant amount of wireless bandwidth and incurs lesser overhead.

The author in [10], proposed an efficient hybrid multicast routing protocol suitable for high mobility applications and it addresses the scalability issue of ODMRP protocol by separating data forwarding path from join query forwarding path, they incorporated a low overhead local clustering technique to classify all nodes into core and normal categories. When multicast routes to destination nodes are unavailable, join-query messages are sent to all nodes in the network and data packets are forwarded by the core nodes to the destination nodes using Differential Destination Multicast by [11]. The author in [12] gave a general overview on multicast protocols in Ad Hoc Networks, describing how they work, showing the reasons for developing these protocols and comparing the protocols to explain the advantages and limitations. Flooding and prune is one technique use to set up, maintain and tear down the multicast tree, in a multicast network, but it is discovered to have some draw backs such as contention, because neighboring nodes tend to retransmit flood message, redundant retransmission can also occur where node re-broadcast a flood message to other nodes that have already received it especially in flooding a wireless network based CSMA/CA as illustrated by [13].

1.4 Materials and Methods

A video stream from source to RPS was created using Microsoft encoder to IIS stream server, stub nodes were also created from which leafs (users) can connect to the RPS, as illustrated in Figure 1

The stub nodes originates the flood message to the leaf nodes and if any leaf node under a stub indicates an interest the stub node sends a join message to the RPS or source but once the multicast process is started and any of the leafs misses some multicast packet it sends an NAK to the stub which in turn send a repair data FEC to the leafs that requires them therefore the stub nodes stores a version of the multicast packets for a particular amount of time from which it can send a repair data if there is need for it.

The overall total number of CBO was calculated for each of the multicast protocols for a three tier, four ties, five tier and six tier hierarchical network in a controlled environment and the test data use for each of the instances of the multicast protocol being analysis is show in Table 1.

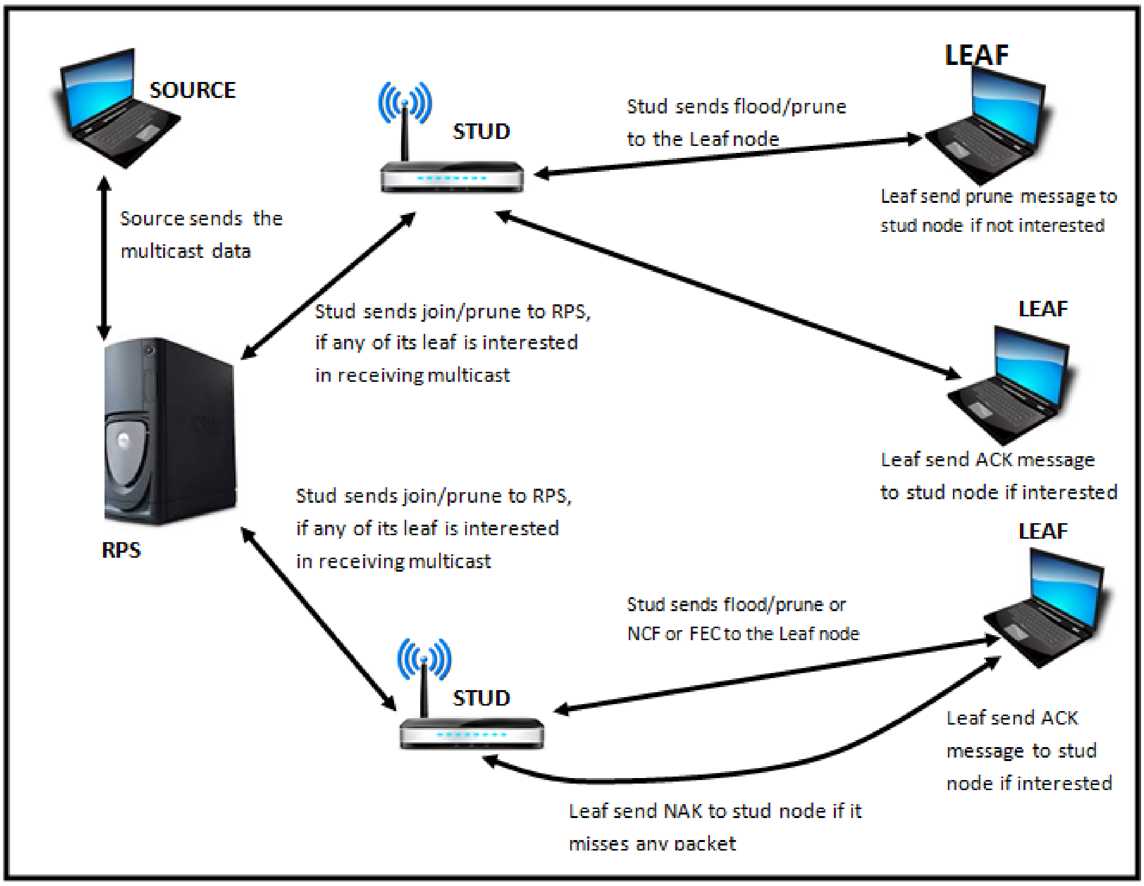

Figure 1: Model/Architecture of the proposed Reliable Hybrid Multicast Protocol (RHMP)

Table 1: Test Data for the Multicast protocols

RANGE OF CONNECTED LEAFS	STUD1	STUD2	STUD3	STUD4	STUD5
1 – 5	1 leaf	2 leafs	3 leafs	1 leaf	4 leafs
6 – 10	6 leafs	7 leafs	8 leafs	7 leafs	9 leafs
11 – 15	11 leafs	13 leafs	14 leafs	13 leafs	12 leafs
16 – 20	16 leafs	17 leafs	18 leafs	17 leafs	19 leafs
21 – 25	21 leafs	22 leafs	23 leafs	22 leafs	24 leafs
26 – 30	26 leafs	27 leafs	28 leafs	27 leafs	29 leafs
31 – 35	31 leafs	32 leafs	33 leafs	32 leafs	34 leafs
36 – 40	36 leafs	37 leafs	38 leafs	37 leafs	39 leafs
40 – 45	41 leafs	42 leafs	43 leafs	41 leafs	44 leafs
46 – 50	46 leafs	47 leafs	48 leafs	46 leafs	49 leafs
> 51	51 leafs	70 leafs	83 leafs	52 leafs	110 leafs

1.5 Result

From the above description the overall CBO used by PGM, ERM and RHMP multicast protocols for a three tier hierarchical network is presented in table 2

Table 2: Comparison between PGM, ERM and RHMP for a three level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERM CBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	44	36	20
2	6 – 10	603	550	270
3	11 – 15	1666	1400	742
4	16 – 20	3249	2774	1482
5	21 – 25	5568	4536	2472
6	26 – 30	8610	8370	3596
7	31 – 35	10710	8877	4488
8	36 – 40	10812	9520	4620
9	40 – 45	13962	12558	7462
10	46 – 50	18941	18000	10944
11	> 51	19799	19100	11010

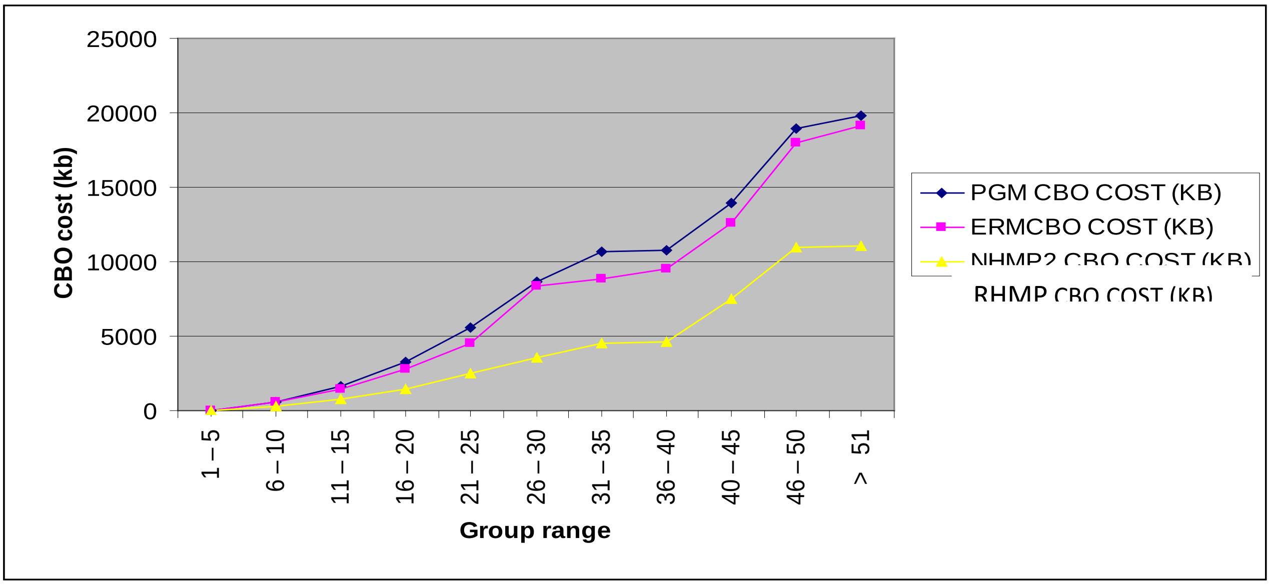

Figure 2: A graph showing the comparison between PGM, ERM and RHMP for a three level hierarchical condition where source is outside the network

Figure 2 and table 2 shows that the RHMP uses less control bandwidth that PGM and ERM in a three level hierarchical network so it is preferable to implement the RHMP in a three level hierarchical network for reliable multicast data transport. When the number of leafs is small or large the difference in CBO overhead is much therefore RHMP is suitable for both sparsely and densely populated scenarios.

Table3: Comparison between PGM, ERM and RHMP for a four level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERM CBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	140	52	28
2	6 – 10	1224	640	550
3	11 – 15	2856	2436	1350
4	16 – 20	6480	4769	2280
5	21 – 25	9246	7130	3792
6	26 – 30	14224	11060	6240
7	31 – 35	21590	16626	7990
8	36 – 40	27495	21723	10257
9	40 – 45	39192	28776	12264
10	46 – 50	48246	42135	20193
11	> 51	58520	51562	25810

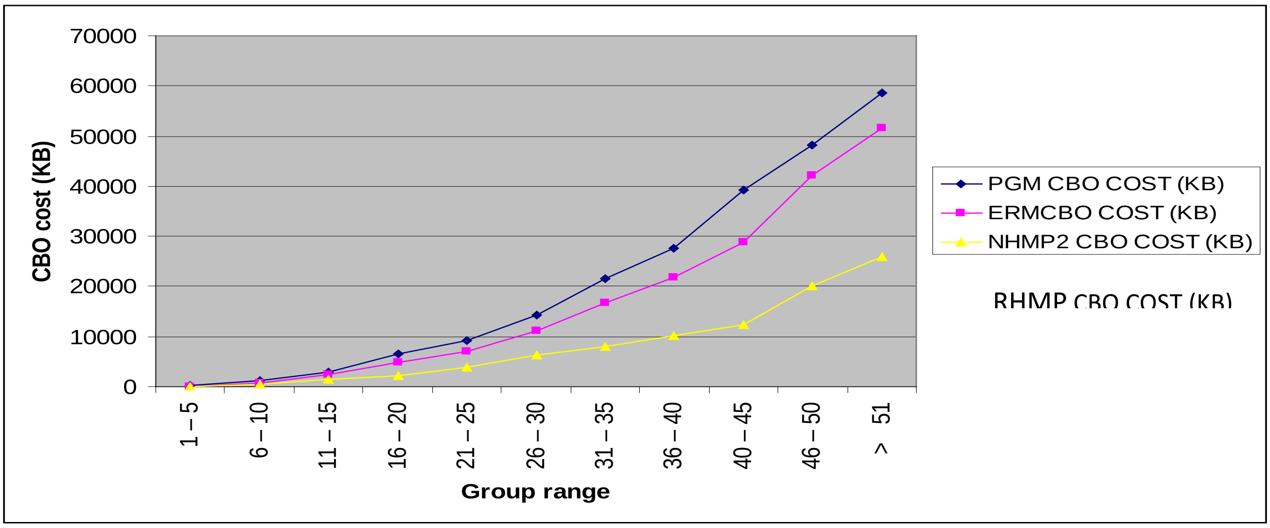

Figure 3: A graph showing the comparison between PGM, ERM and RHMP for a four level hierarchical condition where source is outside the network

Figure 3 and table 3 shows that the RHMP uses less control bandwidth than PGM and ERM in a four level hierarchical network so it is preferable to implement the RHMP in a four level hierarchical network for reliable multicast data transport.

Table 4: Comparison between PGM, ERM and HMP2 for a five level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERM CBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	56	36	20
2	6 – 10	1804	940	368
3	11 – 15	3038	2450	1232
4	16 – 20	6365	5073	2546
5	21 – 25	9792	7824	3960
6	26 – 30	15254	10611	5346
7	31 – 35	22746	16192	8096
8	36 – 40	30856	22903	11396
9	40 – 45	41151	30828	15246
10	46 – 50	52896	39903	19646
11	> 51	66038	50284	23562

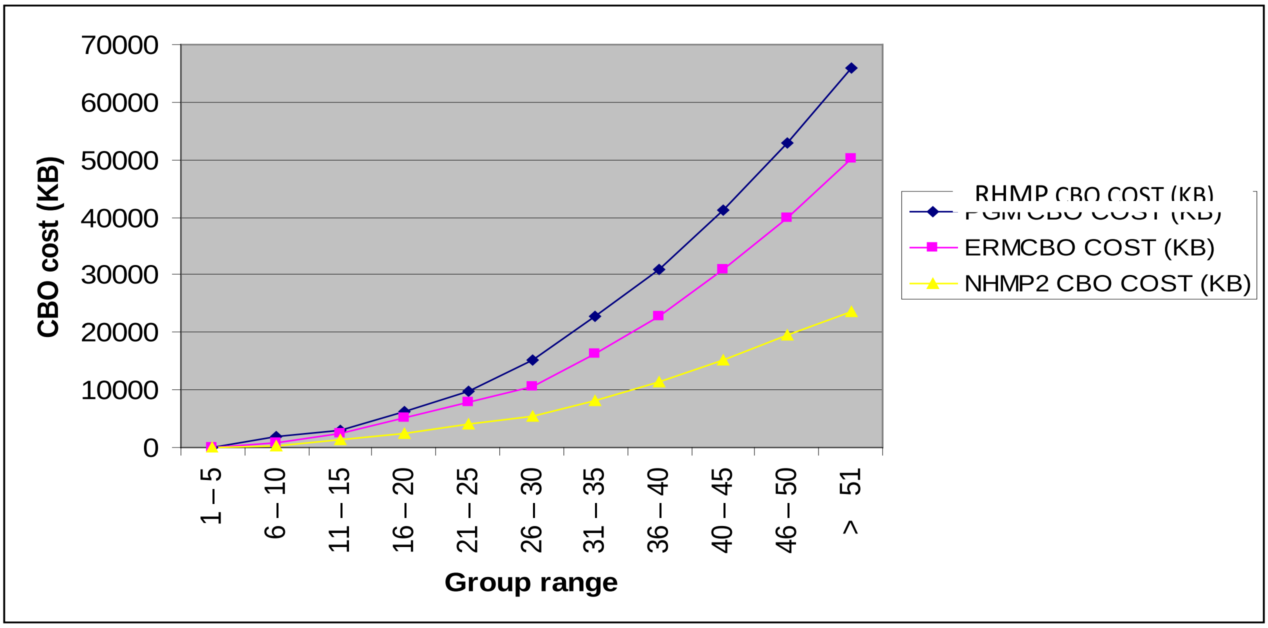

Figure 4: A graph showing the comparison between PGM, ERM and HMP2 for a five level hierarchical condition where source is outside the network

Figure 4 and table 4 shows that the RHMP uses less control bandwidth that PGM and ERM in a real life network so it is preferable to implement the RHMP in a five level hierarchical network for reliable multicast data transport.

1.6 Conclusion

The stress level at the RPS is much for PGM and ERM than the RHMP because of the overall CBO consume / generated. The stress level at the leaf for PGM and ERM is also more than that of RHMP, but the stress level at the stub node is much for RHMP than PGM or ERM because of the CBO consumed at the stub node. The hybrid multicast protocol is better since it is a decentralized form of RPS multicasting thereby managing bandwidth resource in the network infrastructure.

References

[1] Sabari A. and Duraiswamy K (2009) "Ant Based Adaptive Multicast Routing Protocol (AAMRP) for Mobile Ad Hoc Networks" (IJCSIS) International Journal of Computer Science and Information Security, Vol.6, No. 2

[2] J. William Atwood , Octavian Catrina , John Fenton and W. Timothy Strayer, (1998) "Reliable Multicasting in the Xpress Transport Protocol" https://www.researchgate.net/publication/2395758

[3] Jim Gemmell (1997), "Scalable Reliable Multicast Using Erasure-Correcting Re-sends" Microsoft Research Advanced Technology Division, Microsoft Corporation, One Microsoft Way,Redmond, WA 98052

[4] Rose Ann Cyril(2013), "Performance Evaluation of Multicast Transmission on MPLS Network Using PIM SM", International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 6,

[5] Fentie S.G and Sreenivasarao V. (2013), "A NEW APPROACH OF MULTICAST ROUTING PROTOCOLS IN MANETS BASED ON CASE-BASED REASONING METHOD" Information Systems, Development Informatics & Business Management Vol. 4 No. 2

[6] Sabari A. and Duraiswamy K (2009) "Ant Based Adaptive Multicast Routing Protocol (AAMRP) for Mobile Ad Hoc Networks", (IJCSIS) International Journal of Computer Science and Information Security, Vol.6, No. 2, 2009

[7] "INTERNETWORK OPERATION" Faculty of Engineering Computer Engineering Department Islamic University of Gaza (2012)

[8] Brian Adamson, Claudiu Danilov and Joe Macker, (2013) "Elastic Multicast" draft adamson elasticmcast-00, IETF 88 Vancouver

[9] Vamsi K Paruchuri, Arjan Durresi and Raj Jain (2003), "Optimized Flooding Protocol for Ad hoc Networks", https://arxiv.org/ftp/cs/papers/0311/0311013.pdf

[10] Jayanta Biswas, Mukti Barai and S. K. Nandy (2004), "Efficient hybrid multicast routing protocol for ad-hoc wireless networks", Proceedings of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04) 0742-1303/04

[11] L. Ji, and M.S. Corson, "Differential Destination Multicast - A MANET Multicast Routing Protocol for Small Groups", In Proceedings IEEE/INFOCOM'01, Apr, 2001..

[12] Mohammed R. BAKER, M. Ali AKCAYOL, (2011), "A Survey of Multicast Routing Protocols in Ad-Hoc Networks", Gazi University Journal of Science GU J Sci 24(3):451-462 (2011) www.gujs.org pp. 2-3

[13] Youssef Saadi, Bouchaib Nassereddine, Soufiane Jounaidi and Abdelkrim Haqiq (2015), "Wireless Mesh Networks Capacity Improvement Using CBF", International Journal of Wireless & Mobile Networks (IJWMN) Vol. 7, No. 3, Jun 2015 pp.1-2