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Qualitative Analysis of an Unreliable Hybrid Multicast Protocol (UHMP)

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Abstract

Protocol Independent multicast Sparse mode (PIM SM) and Protocol independent multicast Dense Mode (PIM DM) uses a best effort method of propagating data along a multicast distribution tree, but the difference between them is that in PIM SM, leafs interested sends join message to the stud which in turn sends to the Rendezvous Point source (RPS) or source and the distribution tree is created, while in PIM DM the RPS or source sends a flood message to the stub nodes which then forward it to leaf nodes and leaf nodes that are not interested sends a prune message. In the hybrid multicast protocol (UHMP) 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. A simulation model was developed to mimic the behaviour of PIM SM, PIM DM and UHMP 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 UHMP uses less CBO than PIM DM both in a sparsely and densely populated network. While the differences in CBO usage between UHMP and PIM SM was not noticeable in sparse mode, UHMP however uses less CBO then PIM in a dense mode scenario.

Keywords: PIM SM; PIM DM; Unreliable multicast; Hybrid multicast; join; flood and prune.

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1. Introduction

Flooding or Network wide broadcasting is the process in which one node sends a packet to all other nodes in the network. Many applications as well as various unicast routing protocols such as Dynamic Source Routing (DSR), Ad Hoc On Demand Distance Vector (AODV), Zone Routing Protocol (ZRP), and Location Aided Routing (LAR) use broadcasting or a derivation of it. The principal use of flooding in these protocols is for Location Discovery and for establishing routes [1].

The main advantage of unreliable multicast protocols is that it uses less control bandwidth overhead (CBO) since it does not guarantees that a receiver in the group either receives all data packets transmitted, 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 a 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 Main RPS /source if any of the stub's leaf is interested in receiving a multicast stream.

This paper is organized into four parts: Sections 2, describes related work in view to reducing the control bandwidth overhead cost. Sections 3, discuss the methodology use . While Section 4, focuses on the performance analysis of the propose multicast protocol against the existing PIM SM and PIM DM protocol.

1.1. Related Work

The need to reduce the control bandwidth overhead when setting up, maintaining and tearing down a multicast distribution tree necessitated [1], 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 [2], 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 [3].

The author [4], 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 [5].

1.2. 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

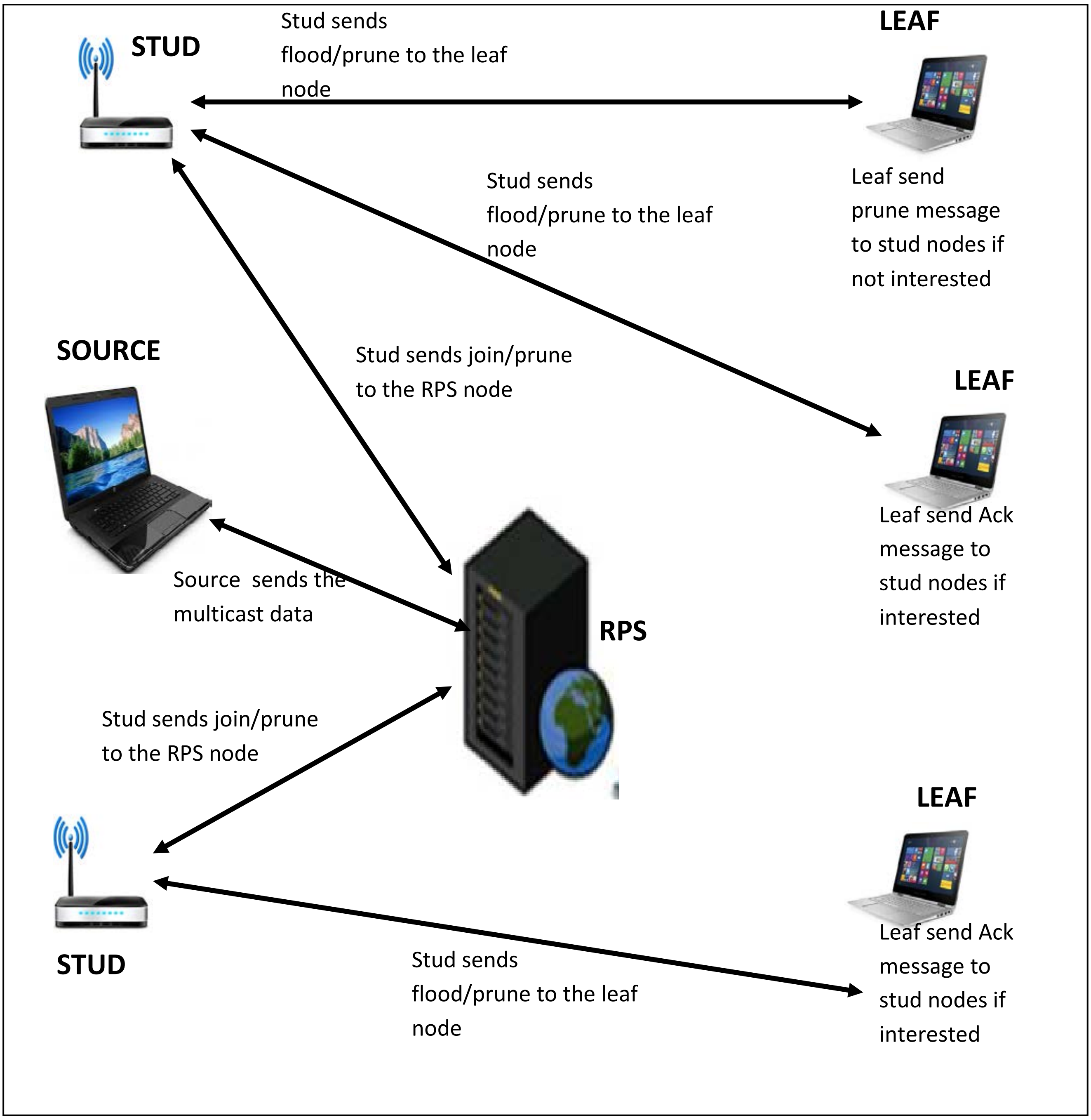

Figure 1: Model / Architecture of the proposed unreliable Hybrid Multicast Protocol (UHMP)

When the leafs initiate the multicast process it behaves as a PIM SM and when the source /RPS initiate the multicast process it acts as a PIM DM but when the stubs initiate the multicast process using a hybrid of flood/prune of the PIM DM and Join/prune of the PIM SM it acts as an unreliable Hybrid Multicast Protocol (UHMP).

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.

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

1.3. Result

From the above description the overall CBO used by PIM SM, PIM DM and UHMP multicast protocols for a three tier hierarchical network is presented in table 2.

Analyzing figure 2 and table 2 it shows that UHMP uses less control bandwidth that PIM SM and PIM DM in a three level hierarchical network for unreliable multicast data transport.

When the number of leafs is small the difference in CBO overhead is not much but as the number of leafs increase there is a noticeable difference between the PIM SM, PIM DM and UHMP

Analyzing figure 3 and table 3 it shows that the UHMP uses less control bandwidth overhead than PIM SM and PIM DM in a four level hierarchical network for unreliable multicast data transport.

Table 2: CBO cost for Unreliable data transport (PIM SM, PIM DM and UHMP) for a three level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PIM SM CBO COST (KB)	PIM DM CBO COST (KB)	HMP1 CBO COST (KB)
1	1 – 5	16	24	12
2	6 – 10	216	270	162
3	11 – 15	616	770	462
4	16 – 20	1216	1501	912
5	21 – 25	1840	2544	1650
6	26 – 30	3016	3770	2262
7	31 – 35	4216	5705	3162
8	36 – 40	5616	7520	4212
9	40 – 45	8272	9495	7644
10	46 – 50	11016	12393	8754
11	> 51	15100	16300	5200

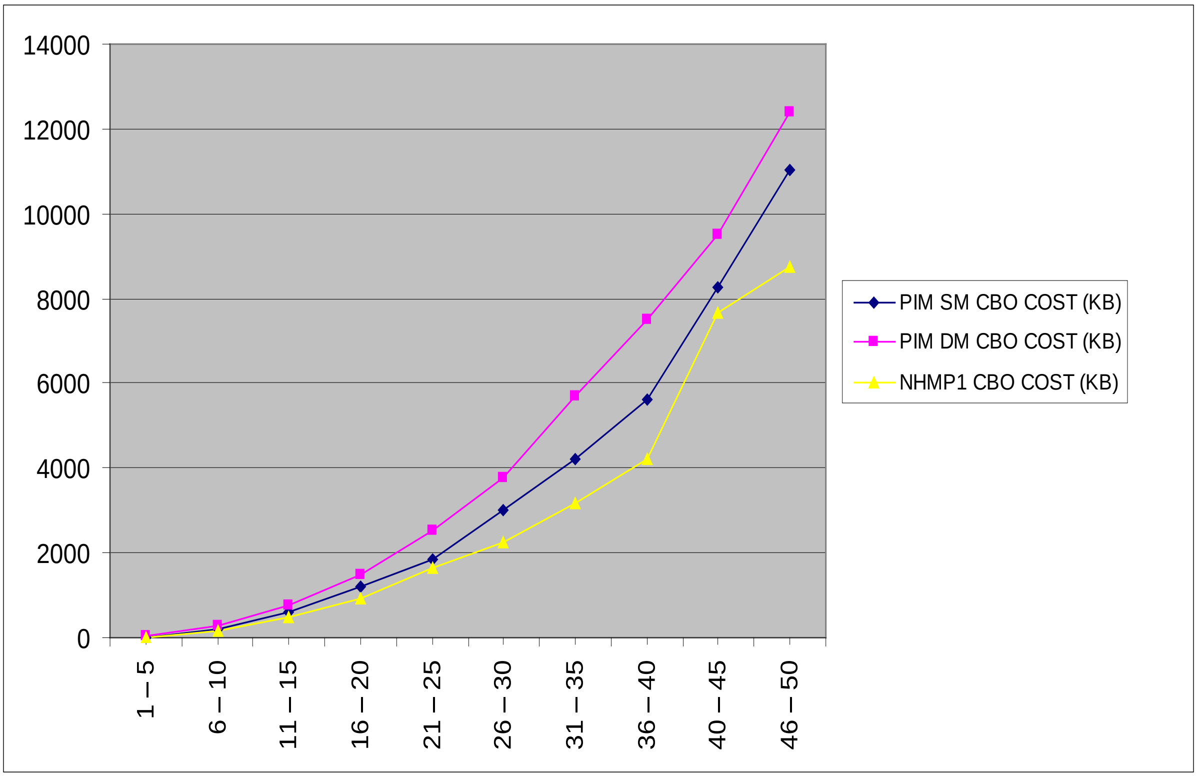

Figure 2: A graph showing the comparison between PIM SM, PIM DM and HMP1 CBO cost for a three level hierarchical condition where source is outside the network

Table 3: Comparison between CBO cost for PIM SM, PIM DM and UHMP for a four level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PIM SM CBO COST (KB)	PIM DM CBO COST (KB)	HMP1 CBO COST (KB)
1	1 – 5	24	28	20
2	6 – 10	324	520	207
3	11 – 15	924	1190	616
4	16 – 20	1824	3366	1216
5	21 – 25	3024	3960	2016
6	26 – 30	4524	5916	2800
7	31 – 35	5568	7582	4216
8	36 – 40	9266	11080	5616
9	40 – 45	11703	12716	5984
10	46 – 50	12900	15651	6840
11	> 51	13936	16748	7808

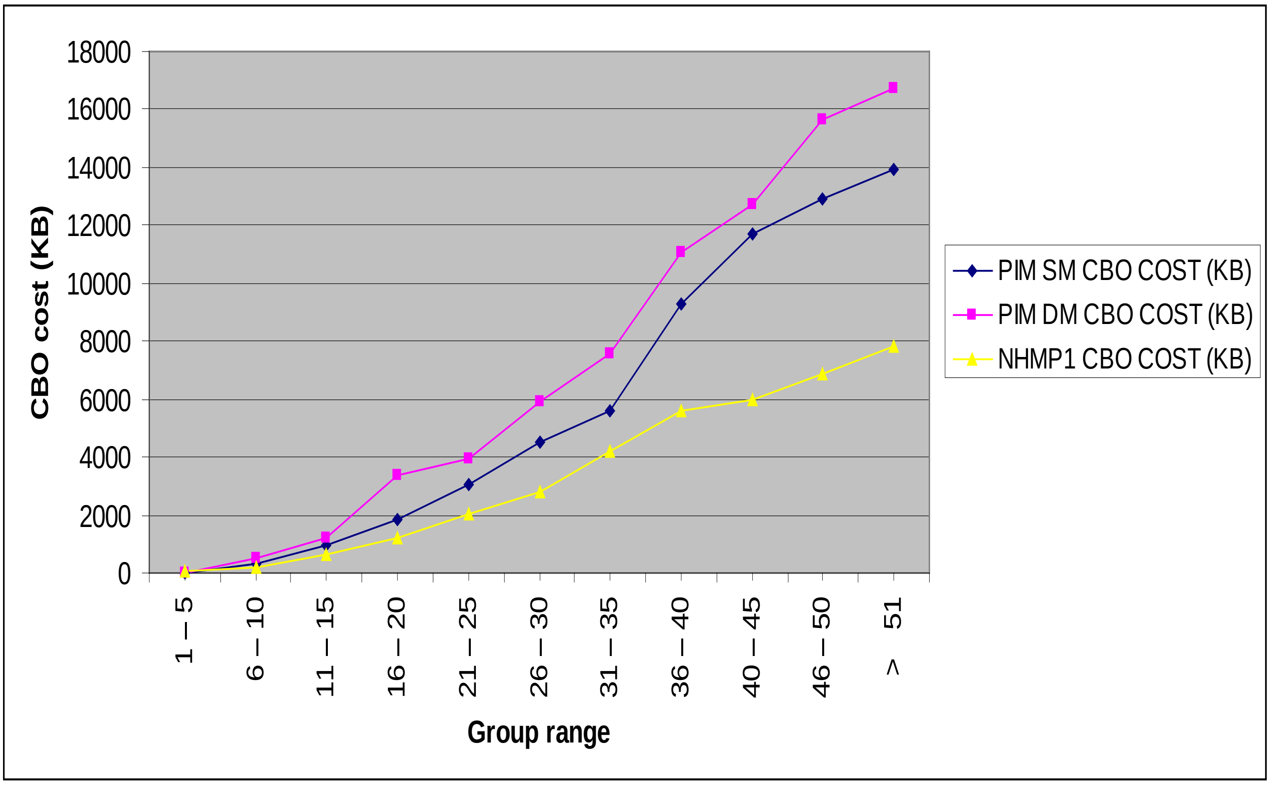

Figure 3A: graph showing the comparison between PIM SM, PIM DM and UHMP for a four level hierarchical condition where source is outside the network

Table 4: Comparison between CBO cost for PIM SM, PIM DM and UHMP for a five level hierarchical condition where source is outside the network

SN	RANGE OF CONNECTED LEAF	PIM SM CBO COST (KB)	PIM DM CBO COST (KB)	HMP1 CBO COST (KB)
1	1 – 5	16	20	12
2	6 – 10	342	432	225
3	11 – 15	896	1148	602
4	16 – 20	1900	2489	1254
5	21 – 25	3360	4416	2184
6	26 – 30	5220	6873	3364
7	31 – 35	7480	9860	4794
8	36 – 40	10140	13494	6474
9	40 – 45	13200	17292	8404
10	46 – 50	16660	22001	9856
11	> 51	20520	27108	11661

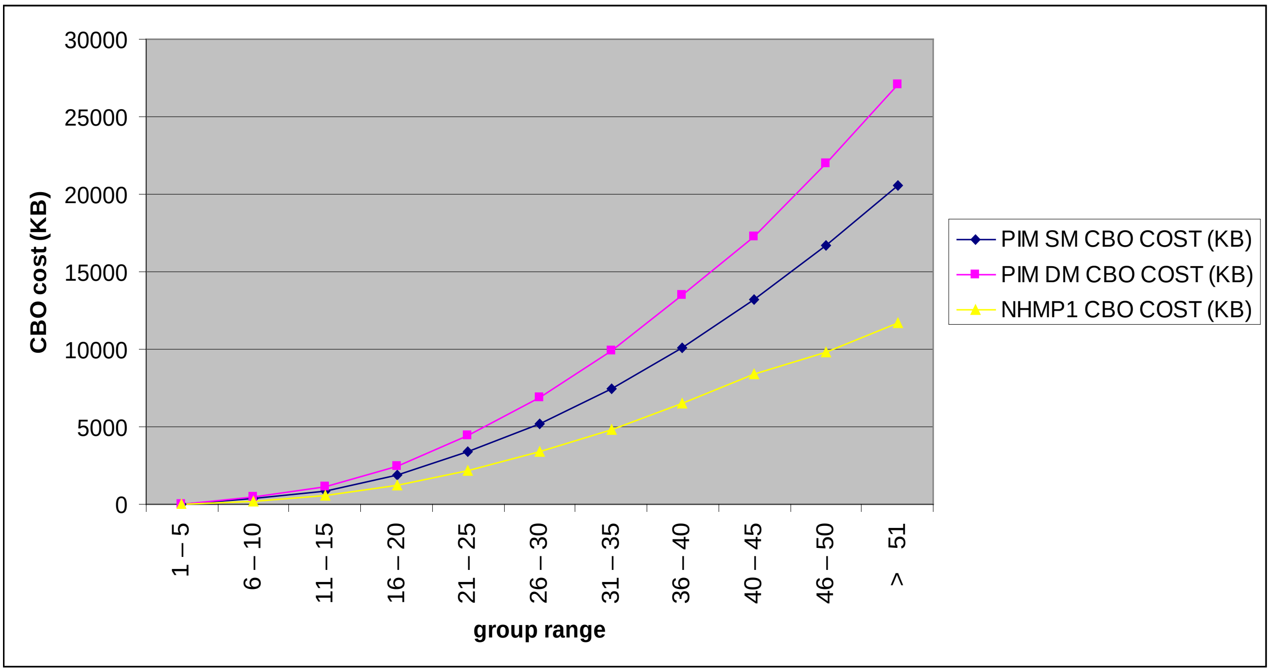

Figure 4: A graph showing the comparison between PIM SM, PIM DM and UHMP for a five level hierarchical condition where source is outside the network

Analyzing figure 4 and table 4 it shows that the UHMP uses less control bandwidth overhead than PIM SM and PIM DM in a five level hierarchical network for unreliable multicast data transport.

1.4. Conclusion

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

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