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A Distributed Rendezvous Point Source (RPS) For Congestion Control in A Reliable Hybrid Multicast Protocol (RHMP)

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Abstract : *Multicast protocols can be classified as either reliable or unreliable both uses a best effort method of setting up, maintaining and tearing down the multicast distribution tree. Pragmatic General Multicast (PGM), Reliable Hybrid Multicast Protocol (RHMP) and Elastic Reliable Multicast (ERM) are examples of reliable multicast protocols. 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 missed multicast packet. A repair multicast packet is then forwarded to all leaf nodes that requested for it. For a large distribution tree congestion might occur in the RPS if there is much failure and the leaf node keeps requesting for repair data. In a distributed RPS such as the reliable hybrid multicast protocol (RHMP) 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 its 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 at the source node, stud node and leaf nodes, 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 at the source and leaf nodes but more CBO is used at the stub nodes but since more than one stub nodes act as the RPS to the leafs connected to it, RHMP was found out to be better than the PGM or ERM.*

Keywords: *PGM; ERM; reliable multicast; Hybrid multicast; join; RPS; flood and prune,*

I. Introduction

Reliable multicast makes sure that the multicast packets get to its destination and in the right order. Pragmatic General Multicast (PGM) and Elastic Reliable Multicast (ERM) places more emphasis on the Rendezvous Point source (RPS) or the source node which co-ordinates the multicast process, this can become stressful for the RPS if they are much failure rate within the distribution tree with leaf node requesting for repair data. A lot of mechanism such as Control NAK (Unterbrunner et al, 2011), resending the multicast packets (Unterbrunner et al, 2011) getting repair data for nodes closest to the requesting node (Kaur and Sachdeva, 2012). These methods reduce the control bandwidth overhead (CBO) but the distributed RPS method eliminates most of the problem inherent in the existing method for congestion control in a multicast process.

This paper is organized into five parts: Sections 1, introduces the concept of reliable multicast and the cost of CBO associated with reliable multicast protocols, section 2, discusses the justification for this research, related works is described in section 3. Object oriented analysis and design (OOAD) methodology was used in section 4. While section 5, analyzed the control bandwidth overhead (CBO), at the source, sub and leaf node for RHMP, PGM and ERM protocol.

II. Justification of this Research

This research shows the amount of CBO used by the source, stub and leaf node by different types of reliable multicast protocol. Error is randomly generated at some point during the multicast process and the amount of CBO use by the source or RPS, stub and leaf node is recorded. In a reliable multicast process if the packet failure rate is high the RPS will use more CBO message to ensure that multicast packet gets to their destinations, thereby overloading the RPS, but a situation where every stub node act as an RPS in a decentralized manner makes the workload on the source /RPS less and all the source / RPS has to do is to ensure load balancing among the connected stubs.

III. Related Works

Karim et al. (2004) presented a framework for systematic testing of multicast congestion control protocols. It was based on the systematic testing of robustness by evaluation of synthesized scenarios (STRESS) applied to multicast routing, modeling of sequence, numbers, traffic, and congestion window. It was also characterized by a high degree of interleaving between events and long-term effects of individual events. An automated search engine to generate all possible error scenarios was created and finally a valuable tool to expedite the development and standardization of multicast protocols was developed.

Read (2006) carried out a Multicast Performance Evaluation between PGM and Multicast Dissemination Protocol with Congestion Control (MDP-CC) under varying network conditions and he concluded that PGM was superior in performance to MDP-CC though MDP-CC is not an equal match to PGM

Mir et al (2014) evaluated the fault tolerance on Protocol independent multicast (PIM) and Core base tree (CBT) both of which are unreliable multicast protocols, some of their performance evaluation parameter include the end – to – end delay, network source usage and the overhead bandwidth cost, their result showed that PIM out performed CBT as the network size increase.

Emad et al (2011) focused on user-centric mobileTV service considering the users' consumption style, the cost reduction of network resources and the enhancement of End-Users Quality of Experience (QoE). A scenario where each user is able to access his mobile TV content AnyTime, AnyWhere and from Any Device (ATAWAD), considering the eMBMS (Evolved Multimedia Broadcast Multicast Service) diffusion. In multicast TV delivery, clients join/leave the multicast TV source of channels according to their requests. However, during Nomadic Access (NA), the multicast tree has to be reconstructed according to the new demands. optimizing the investment cost of multicast sources (streaming points) opens the way to an enhancement of the Quality of Experience (QoE) of End-User.

Jayanta et al (2004), 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 (Ji, and Corson, 2001).

BAKER et al, 2011, 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 (Youssef et al, 2015).

IV. Methodology

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

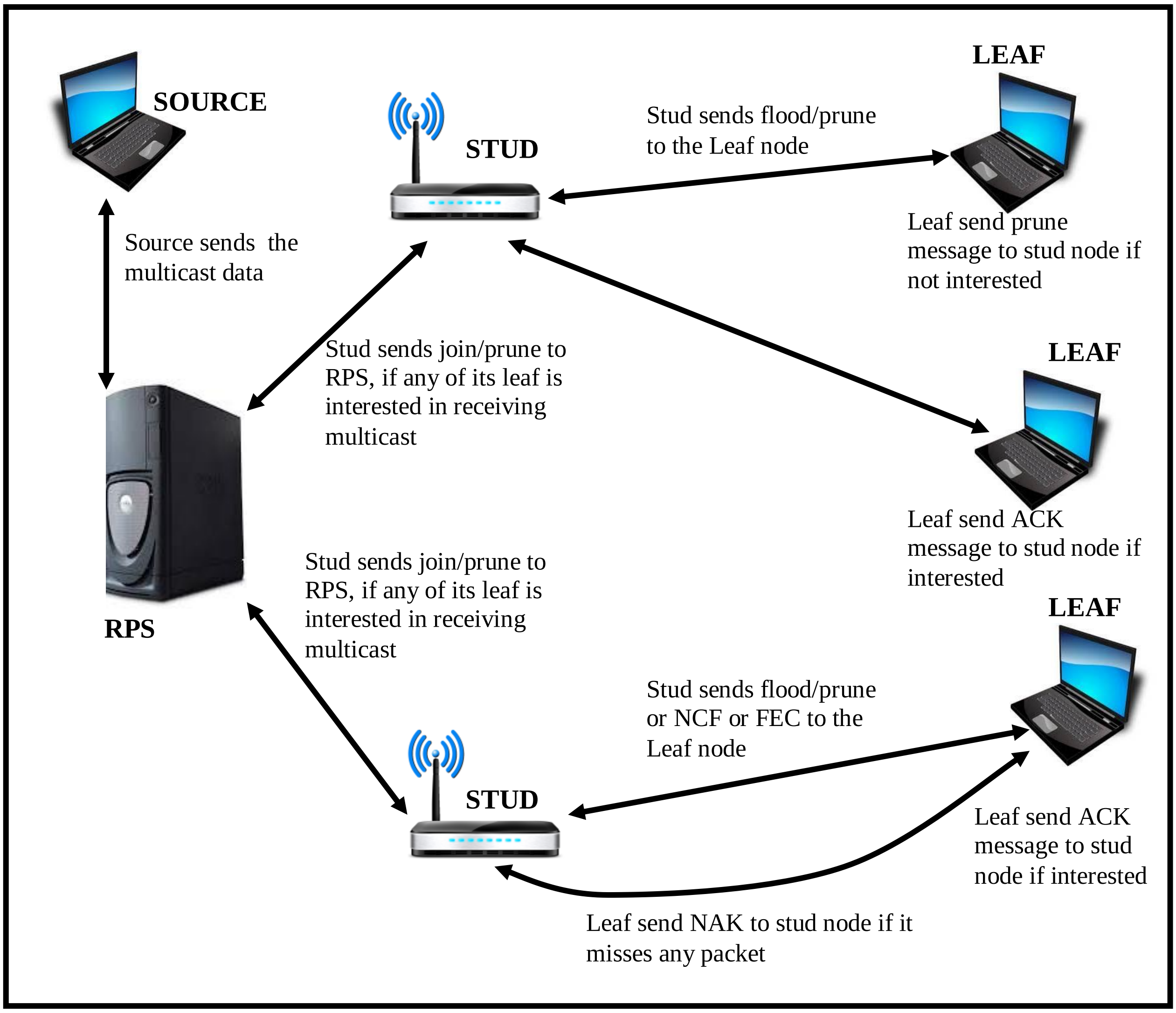

Figure 1 : Model/Architecture of the proposed Reliable Hybrid Multicast Protocol (RHMP)

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 a 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.

Table 1: Test Data for the Multicast Protocols

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

V.Result

From the above description the overall CBO used 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 the total amount of CBO message by the leaf node in a Real life network

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERM CBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	13	11	7
2	6 – 10	155	94	44
3	11 – 15	201	157	80
4	16 – 20	307	239	121
5	21 – 25	373	291	147
6	26 – 30	479	351	177
7	31 – 35	609	451	227
8	36 – 40	738	551	277
9	40 – 45	868	651	327
10	46 – 50	998	751	377
11	> 51	1128	854	417

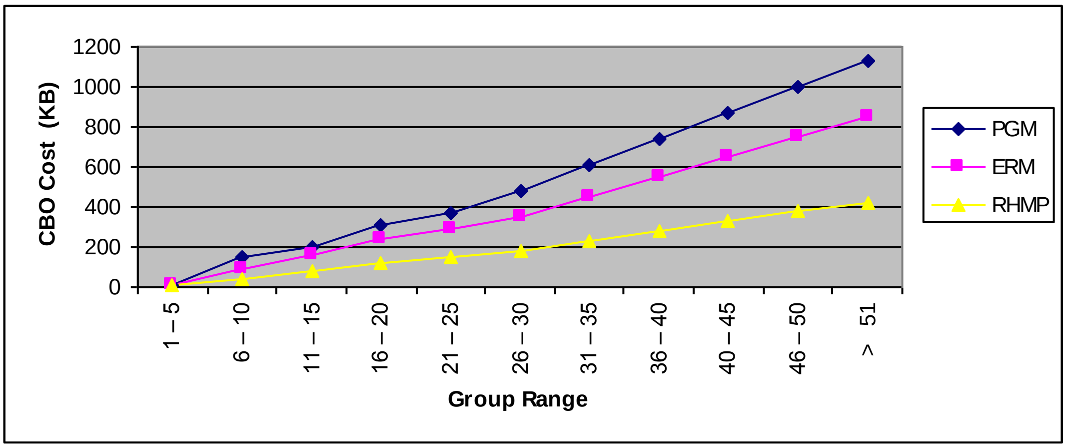

Figure 2: A graph showing the comparison between PGM, ERM and RHMP for the total amount of CBO message by the leaf node

Analyzing Figure 2 and Table 2 they show that RHMP uses less control bandwidth that PGM and ERM in a reliable 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 CBO consume at the leaf node between PGM, ERM and RHMP.

Table 3 Comparison between PGM, ERM and RHMP for the total amount of CBO message by the stud node in a three level hierarchical

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERMCBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	23	19	9
2	6 – 10	191	112	60
3	11 – 15	286	229	105
4	16 – 20	434	330	144
5	21 – 25	544	413	189
6	26 – 30	685	584	240
7	31 – 35	847	649	267
8	36 – 40	902	735	306
9	40 – 45	1078	816	348
10	46 – 50	1233	980	462
11	> 51	1915	1266	852

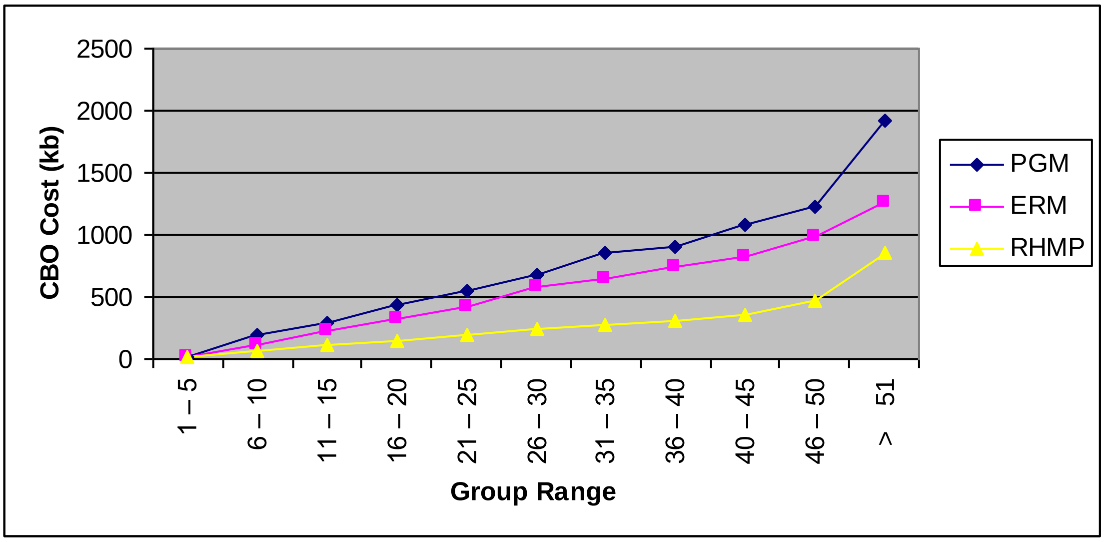

Figure 3: A graph showing the comparison between PGM, ERM and RHMP for the total amount of CBO message by the stud node in a three level hierarchical network

Analyzing Figure 3 and Table 3 they show that the RHMP uses more control bandwidth overhead than PGM and ERM at the stud nodes. RHMP uses less CBO at the stub nodes because the CBO is distributed across the stub nodes in RHMP reliable multicast data transport.

Table 4 Comparison between PGM, ERM and RHMP for the total amount of CBO message by the server/ source in a Real life network

SN	RANGE OF CONNECTED LEAF	PGM CBO COST (KB)	ERMCBO COST (KB)	RHMP CBO COST (KB)
1	1 – 5	14	9	5
2	6 – 10	164	94	46
3	11 – 15	217	175	88
4	16 – 20	335	267	134
5	21 – 25	408	326	165
6	26 – 30	526	393	198
7	31 – 35	669	506	253
8	36 – 40	812	619	308
9	40 – 45	957	734	363
10	46 – 50	1102	849	418
11	> 51	1246	967	462

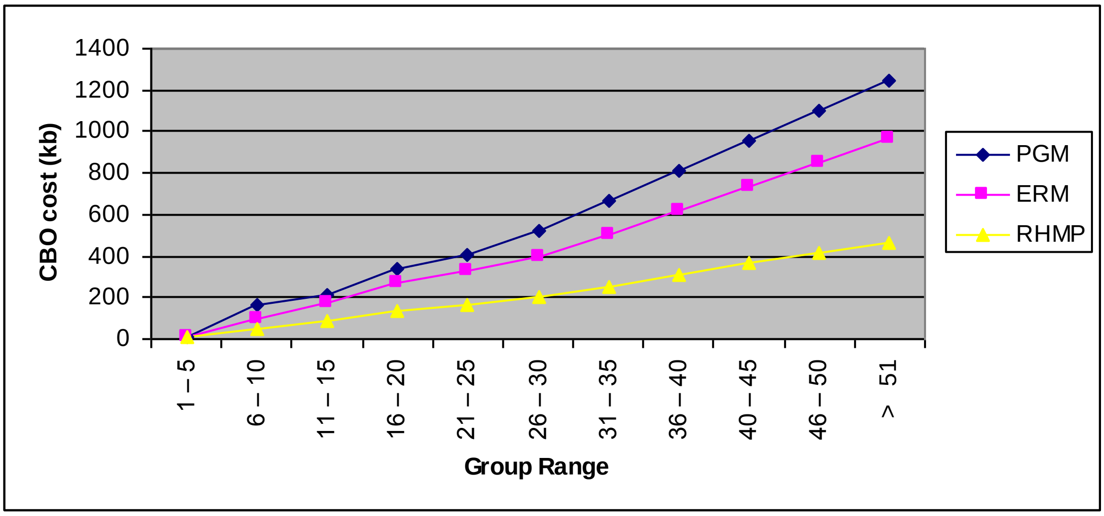

Figure 4: A graph showing the comparison between PGM, ERM and RHMP for the total amount of CBO message by the server/ source

Analyzing figure 4 and table 4 it shows that the RHMP uses less control bandwidth overhead than PGM and ERM in reliable multicast data transport.

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 and ERM because of the CBO consumed at the stub node. The Reliable hybrid multicast protocol (RHMP) is better since it is a decentralized form of RPS multicasting thereby managing bandwidth resource in the network infrastructure.

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