International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 6, Issue 10 (Oct. 2017), PP.01-07

Recent Developments in QOS Heterogeneous Multicast Wireless Network

Dr U.Vidya Sagar,
Associate Professor, St John's College of Engineering & Technology,
Yerrakota, Yemmiganur

ABSTRACT: Multicasting allows IP traffic to be sent from many sources and transmitted to multiple destinations. In multicasting, a single data packet is directed to a multicast group identified by a single IP destination group address instead of sending individual packets to each destination. For the multicast sessions to be efficient, the network must transmit data in these sessions using minimal network resources. Multicasting optimizes the performance of the network, as only one multicast data stream is transmitted preserving bandwidth and eliminating traffic redundancy. Multicasting also provides enhanced efficiency by controlling the traffic on the network and reducing load on network devices.
Index Terms: Multicast, IP traffic,bandwith,redudancy

Date of Submission: 30-09-2017 Date of acceptance: 12-10-2017

I. INTRODUCTION

The convergence of wireless and wired devices in multicast communication has provided new research challenges in the directions of facilitating better Quality of Services (QoS). Maintaining QoS in Mobile Ad-hoc Networks (MANET) is challenging due to the high mobility of the nodes leading to the link loss. The new route discovery increases the control packet overheads using the available sparse bandwidth. These factors decrease the overall QoS of the network though wired nodes that do not face these problems. The importance of maintaining uniform QoS becomes very important for providing a reliable multicast system capable of handling wired and wireless devices.

Most quality metrics including delay and cost being additive in nature, spanning trees and routing problems solved in the literature are either

NP-Hard or NP-Complete problems. The traditional methods used in multicasting cannot solve the QoS problem. Researchers are working extensively in the areas of the heuristic algorithms to provide solutions which improve the QoS. Heuristic algorithms provide near optimal solutions within a polynomial time crucial for the real time networks. The literature survey reveals that constant QoS is achievable in wired networks whereas wireless networks suffer from delay and jitter which affects the overall QoS of the network. It is also seen from literature survey that traditional wired network based multicast protocols like Protocol Independent Multicast–Sparse Mode (PIM-SM), Core Based Tree (CBT) do not work well in a MANET due to the frequent tree organization. In this thesis, heuristic techniques are investigated to achieve overall QoS. The detailed objectives of this paper are listed as follows.

Investigate the performance of multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) under different number of senders and receivers.

Investigate PIM-SM on wired side of the network and Multicast Ad-hoc On-Demand Distance Vector Routing Protocol (MAODV) on wireless side i.e., MANET side of the heterogeneous network using a gateway for interconnection.

Propose an improved multicast forwarding technique PIM-HMC (Heterogeneous Multicast Connectivity) on wireless side to decrease the end to end delay and jitter.

Propose a Protocol Independent Multicast Quality of Service Improvement in Heterogeneous Network using Genetic Optimization.

Multicasting in Heterogeneous environment is emerging as an exciting research area due to the QoS challenges especially in live streaming and video conferencing. This challenge increases multifold with different physical media for data transmission comprising wired and wireless devices. The wireless devices can either be one hop devices connecting to an access point or MANET using multihop routes to reach the wired / wireless gateway or multicast communication between nodes in the wireless media itself.

This work critically examines the performance degradation of multicast networks in a heterogeneous environment. The parameters examined include Packet Delivery Ratio (PDR), End to End Delay and Jitter. Based on the conclusion drawn from the initial investigation a novel multicast protocol PIM-HMC is proposed to improve the performance of the wireless side of the heterogeneous network.

Since wireless networks are mainly affected by mobility and link quality, the route discovery mechanism techniques based on shortest path does not guarantee as the optimal route for required QoS. Route discovery based on QoS being an NP Complete problem, it is proposed to use optimization technique using Genetic Algorithm for identifying ideal routes based on the derived fitness function.

This work focuses on providing uniform QoS across a heterogeneous multicast network. The work studies the multicast packet transmission across wired and wireless nodes and provides methods to decrease the end to end delay and jitter.

II. OVERVIEW OF MULTICASTING

A communication pattern where a source host can send a message to a number of target hosts is known as Multicast (point-to-multipoint) as shown in Figure 2.1. Though this can be sent by different unicast (point-to-point) messages, multicasting capability is much desired for a lot of reasons. Decrease in the network load is the basic advantage of multicasting. Viewing from the point of developers, multicast is very interesting, as all the complications are removed from the end-host and moved to the network. Multicast has an efficient delivery system of information, as it sends only once the message over each link in the network. Only when the destination link is split, copies of the message are created. Since the routers create an optimal distribution path, it is more complex. To get the packets to the destination, a spanning tree is constructed. In many applications e.g. stock ticker application, it is required to send packets to hundreds of stations. A group of links are shared on their paths, by the packets to their destinations.

IP networks originally introduced Multicast. Many applications, for example, Internet gaming, IP teleconferencing, and Internet television need data to be sent from one or several senders to several receivers. Multicast applications involve multipoint communication/multicast whereby data is delivered from one or several sender nodes to several designated nodes. The 2 types of addresses on the Internet are unicast and multicast. Normally on the internet a host/node has only one unicast address and it can be a member in multiple multicast groups.

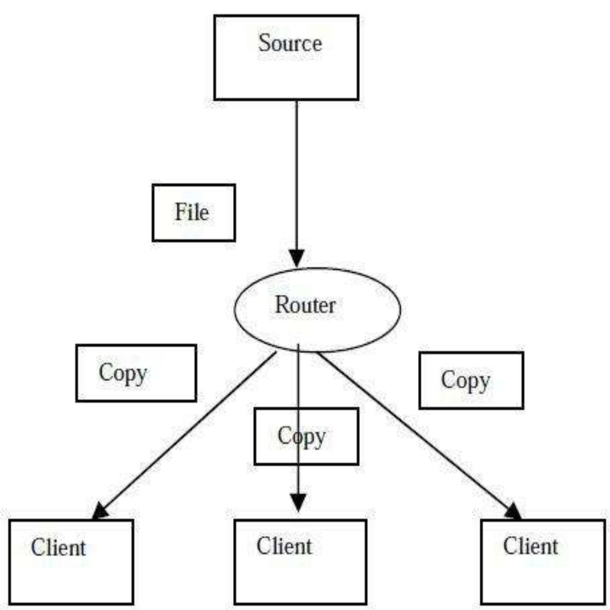

Figure 2.1 Basic multicast networks

In the native multicast, IP multicast equips multicast service in the IP routing level such that individual packet data are transferred from the source and duplicated at the routers. Then they are simultaneously delivered at several receivers.

A virtual/logical network where endpoints are addressable and provide messaging, connectivity, and routing between endpoints is an application layer. When a new network has to be deployed or to provide a routing topology which is not available in the underlying physical network, an overlay network is used frequently as a substrate. Many peer-to-peer systems that run on top of the Internet are overlay networks. At the overlay network layer, multicast service is implemented by the overlay multicast. Overlay network is formed in a multicast session by participating hosts and they utilize unicasts for data dissemination among pairs of hosts. The overlay multicast hosts handle exclusively routing, tree construction, and group management without any help from Internet routers and are known commonly as Application Layer Multicast (ALM) or End System Multicast (ESM).

III. LITERATURE SURVEY

INTRODUCTION

This section deals with the review of various aspects of multicasting. The papers reviewed are sectioned as follows:

- **A)** Multicasting in Wired Network
- **B)** Multicasting in Wireless Network
- **C)** Multicasting in Heterogeneous Network
- **D)** Multicasting Routing Algorithm
- **E)** Multicast Routing Qos

A. MULTICASTING IN WIRED NETWORK:

A scheme meant for wired networks, Distance Vector Multicast Routing Protocol (DVMRP) was developed by Deering et al (1990) can also be used by wireless networks like MANETs. DVMRP uses data packets source flooding to discover group members. Non-member nodes prune themselves form neighbours, thereby creating a shortest path between source and multicast group members based on Reverse Shortest Path Forwarding mechanism (RPF). When set up, data is forwarded by nodes to the tree. As DVMRP is a soft state protocol, regular flooding/pruning is normal to locate new members. New members also join the tree through forwarding o graft message. Though widely used in Internet multicast routing, DVMRP does not suit MANETs due to potentially high data flooding.

PIM-DM (Deering 1994) has been designed for networks that are densely populated with members of a multicast group. PIM-DM builds the multicast tree using “flood-and-prune” RPF, as in DVMRP. Periodic flooding is carried out in the dense-mode networks by the multicast sources with multicast traffic and then prune messages inactivate routers without clients. The prune messages are generated by the routers that do not have any interested multicast receiver for that multicast group under its subnet.

The primary difference between DVMRP and PIM-DM is that PIM-DM is independent of the unicast routing protocol; it simply requires that a unicast routing protocol exists to construct the unicast routing tables; PIM-DM uses the unicast routing tables to build the multicast tree. The PIM-DM assumes that the unicast routes are symmetric. The packet forwarding on outgoing interfaces is also slightly different between PIM-DM and DVMRP. PIM-DM accepts additional overhead to simplify the RPF check. Else, the two protocols are very similar, and the arguments for and against DVMRP apply to PIM-DM also. PIM-SIM, sparse-mode protocols, set up distribution trees through the use of explicit messages. Such trees are set up on only on distribution tree routers with data packets being sent to LANs which have hosts joining the groups. So Sparse-mode protocols suit big internet works in which dense-mode protocols are likely to waste bandwidth through packet flooding in the entire internetwork prior to pruning unwanted connections. Sparse-mode protocols construct both shared trees or source trees or both types of trees. Sparse-mode protocols might suit a magazine subscription as a distribution tree is built only if a receiver joins the group.

Both algorithms generated minimum delay trees that intrinsically balanced short latency with a small degree, and thus avoided an external trial-and-error type of balancing between the two as the study solutions do not impose a maximum degree on the multicast trees.

The heuristic scheme achieved an optimal solution for grid graphs, and provided performance bounds for multicasting in the grid and tree topologies. A simulation study evaluated the average performance of the said algorithms. The results showed that the study was scalable for a large group sizes, and produced results that were very close to optimal.

The works incorporated in the literature are ideal for wired nodes where frequent tree reorganization is not required. The traditional routing protocols can cause significant overheads which may not be acceptable in the wireless side of the network where bandwidth constraint is common.

B. MULTICASTING IN WIRELESS NETWORK

Multicasting involves datagram transmission to a group of zero or more hosts identified through a single destination address. It is meant for group oriented computing. A multicast datagram is delivered to the destination host group members through "best effort" reliability similar to regular unicast IP datagrams. In other words, there is no guarantee that this datagram will arrive intact at group member's destinations or in an order similar to other datagrams (Deering 1989). Wired networks multicast protocols cannot be ported to MANETs as they will be unable to handle frequent link breaks and route changes or two networks deferring characteristics Chiang et al designed mechanisms to make wired multicast protocols compatible to MANETs (Chiang et al 1997).

MANET Multicasting is more complex and challenging than in wired networks. Multicast group members movement precludes fixed infrastructure multicast topology use as wireless channel characteristics do vary with time in addition to there being restrictions on node energy/capacity (Chiang 1998). Multicast in MANETs reduces communication cost, improves wireless channel efficiency when forwarding multiple data copies using wireless transmission's broadcasting properties., Multicasting minimizes channel capacity consumption instead of sending data through multiple unicasts, lowers sender/router processing, energy consumption, and delivery delay, important MANET factors. Multicasting is also a simple yet robust communication method through which receiver's individual address is not known to the transmitter or transparently changeable by it (Paul 1998; Stojmenovic 2002).

ODMRP (Lee et al 1999), is an on-demand mesh based, besides it is a multicast routing protocol, which also uses unicast technique to send multicast data packet from the sender nodes toward the receivers in the multicast group. To start sending multicast data packets, ODMRP uses two kinds of control messages: join-query and join-replay, if there are nodes which want to join to the multicast group, it uses join-query. Using of join-reply will be activated when the receiver node accept to receive the multicast data packet. In ODMRP protocol, each source floods a join request (i.e Join-Req.) message periodically in the multicast group. A node receives the Join –req message uses store the greatest node ID in a Routing Table, then it will rebroadcasts the massage. The process continues until reaching the multicast receiver node. Once the receiver node received the Join-Req. message, it will declare its joining by broadcasting Join-Reply message to the multicasting group.

Tseng and Chen (2001) introduced a distributed candidate's selection protocol, named DSDMR, which is self-adapting based on group density. An adaptive two-direction join mechanism technique which addresses the problem of poor scalability resulting from high control overhead is proposed by the author. The mechanism performed well both in densely populated and sparsely populated networks. Extensive simulation results show that DSDMR can create low cost tree close to optimal greedy strategy with very low control overhead and join latency

ADMR (Jorjeta et al 2001) is an on-demand source-based protocol. By using the shortest-delay path from the sender node to the receivers, ADMR uses packet forwarding techniques by using a sequence number to uniquely identify the packets and is generated as a count of all flooded ADMR packets.

Bettahar and Bouabdallah (2002) incorporated a new approach for delay-constrained routing which captured the trade-off between cost minimization and the risk level regarding to the delay constraint. The work incorporated a protocol called Parameterized Delay-Constrained Routing (PDCR) protocol that implemented a simple and efficient parameterized selection function. Simulations revealed that the protocols produced paths and trees which were stable, less risky and suitable for various network conditions.

C. MULTICASTING IN HETEROGENEOUS NETWORK

The recent past saw the Internet evolving from wired infrastructure to a hybrid of wired/wireless domains ensuring microwave access (WiMAX), Wi-Fi, and cellular networks interoperability globally ensuring an increasing need to facilitate reliable content delivery over heterogeneous networks. But, Application Layer Multicast (ALM) is a promising approach to stream media content from a server to many interested nodes. ALM nodes construct a multicast tree through which they deliver the data stream.

Xiaohua Jia et al presented (2001) i) a delay analysis model for admission control of real-time multicast ATM network connections; ii) a distributed multicast routing algorithm generating suboptimal routing trees in real-time constraints; and iii) a connection setup procedure integrating multicast routing and admission control. Simulation revealed that group size was always made up of less than 30% of the total nodes, because multicast applications running in a wide area network usually involved only minimum network nodes.

A load sensitive routing (LSR) algorithm attempting to route packet through an alternate route due to link congestion was tried out by Shaoo (2002). Increase in real-time applications like Voice over IP, audio and video streaming in the internet ensured QoS based routing. The study believed that a better way of implementing QoS routing was to localize the QoS routing changes in the region where QoS had deteriorated, instead of flooding the entire network. LSR routing was contained locally. Only neighboring nodes of a congested node performed LSR routing and so it had much less overhead than other QoS routing protocols reported.

The LSR algorithm was designed to avoid any looping. Simulation results of LSR algorithm showed that its average performance was better than OSPF algorithm with regard to delay and jitter. Most techniques in the literature were able to improve the QOS in the heterogeneous network; however they do not address the NP-Hard problem faced by protocols used to improve QOS. Further work needs to be done to address the QOS issues.

D.MULTICAST ROUTING ALOGRITHM

Sun et al (1998) proposed a distributed delay constrained dynamic multicast routing algorithm DCDMR. The proposed algorithm DCDMR scales well as the source of the multicast tree needed only limited computation or might not even be involved in the route computation. Many new distributed multimedia applications involved dynamic multiple participants have stringent end-to-end delay requirements and consume large amount of network resources. When group membership changed, the existing multicast tree was perturbed as little as possible and the average resulting tree cost was very satisfactory. DCDMR had very good cost performance. Simulation results showed that DCDMR in the fast mode was at least better than NAIVE and DCDMR in the slow mode was at least better than DCDMR in the FAST mode. When DCDMR worked in the FAST mode the route computation was very fast and when it works in the slow mode very low cost trees could be computed.

Karaman et al (2007) analyzed the problem of constrained cost minimization and proposed a new Solution, SPAN. The proposed model executed on multiple metrics for constrained multipoint communication, and spanned the entire range of solutions in its search. Constrained cost minimization in Qos routing for multipoint communication groups was the problem of path construction to achieve efficiency. Generally, the source-or-core-based approaches are used soley searched a sub-domain of the solution space.

The study's analysis of the space solution for this range of problems indicated the need for a broader range which was not explored by existing models. But SPAN met this need through a distributed asymmetric framework for constrained, multi-source, multipoint communication groups searching for solutions in an extended space for improved cost-efficiency. Simulation results demonstrated the significance of the findings indicating the potential contribution of the range of models processing in the extended space. SPAN operated on local distance-vector information on the routers, and its functionality was not restricted due to the characteristics of autonomous systems. Its core-based architecture could be extended further for inter-domain groups with participants cutting across routing domains through the construction and management of intra-domain routes coordinated by core placed in the domain.

Alrabiah et al (2001) focused on developing low-cost, delay-bounded multicast trees to support the QoS requirements of multimedia applications. The study was necessitated by the fact that support for multimedia applications was a major objective of future high speed networks. Multimedia applications were usually resource intensive, with stringent QoS requirements, and in many cases involved large multicast groups. Multicasting enabled these applications to scale to a large number of users without overloading network and server resources. The approach taken in development of multicast trees was to decouple cost optimization from bounding the delay by first building a low-cost tree and then handling any delay violations that might occur in the tree. Three new heuristics were proposed.

The first two delay-constrained low-cost inexpensive multicasting (SLIM) and SLIM+, used the least-cost path between the multicast nodes to incrementally build a multicast tree that satisfied delay requirements of multicast nodes. Their complexity was O(n3), where n was the number of network nodes.

The third heuristic, K-SLIM, built a set of k shortest paths and used them to further reduce the cost of the multicast tree without violating delay requirements of multicast nodes. Its time complexity was O (kn3 log(n)), where k, a user-defined parameter, denoted the number of shortest paths under consideration. Simulation results showed that K-SLIM on average outperformed well-known heuristics. The results proved that SLIM+ produced low-cost, delay-bounded trees with an average cost close to the average cost of trees produced by K-SLIM but with reduced processing overhead.

IV CONCLUSION

Though internet services have tremendous growth, many growing demands are yet to be satisfied. Traffic Engineering (TE) is the emerging Internet Network Provider mechanism which is vital to optimize network performance and traffic delivery. A message is sent from one sender to many active receivers instead of all receivers as in broadcast communication; in multicast communication for which traffic is a major issue as it is used by various multimedia applications.

Multicast communication can greatly help multimedia application deployment. When paths to many destinations overlap, only a single data packet copy is sent on a network link on that path. Packets are duplicated in the router and sent out to appropriate links, when paths divert. When necessary every packet stream in the network is replicated. Multicast usage has twofold benefits. It reduces server load, as the latter forwards only one packet per link, and not multiple packets to different receivers. It also, additionally, reduces, total network load, as only one data packet copy is transmitted thereby bandwidth consumption dramatically.

Specifically, tree-based protocols such as PIM-SM and PIM-DM use membership information to create optimized delivery trees within a relatively stable network such as a backbone, typically deployed in a wired environment. On the other hand, MANET protocols have to deal with unstable networks where the overhead of creating and maintaining dissemination trees makes membership-based protocols can be more expensive than simply delivering multicast packets to every node, and therefore, use an optimized broadcast dissemination where packets reach all nodes in the network, with minimal overhead, regardless of the individual membership of each node.

Traditional wireline multicast protocols like Protocol Independent Multicast – Sparse Mode (PIM-SM), Core Based Tree (CBT) do not work well in a MANET. In a wireless environment, since the nodes are mobile, the frequent tree reorganization from these traditional multicast protocols can cause significant signalling overhead and frequent loss of datagrams. In this thesis, a PIM based protocol is implemented to maintain the quality of service of the heterogeneous network. The aim of this work was to find techniques to improve the performance of multicast routing protocols for multimedia traffic and improve QoS.

Multicasting in a heterogeneous network using Protocol Independent Multicasting Sparse Mode (PIM-SM) was implemented and evaluated under different number of senders and receivers are studied. All the experiments were conducted using OPNET simulation tool. Network contains both wired and wireless nodes. The Wireless nodes are one hop away from the Access point of the infrastructure based network. Simulations are conducted using varying number of senders and are varied from 1, 5, 10, 20, 30, 40 and 50 senders. Number of receivers is 30 to 60 nodes and consists of a combination of both wired and wireless nodes. The performance of the heterogeneous network is studied in terms of Packet Delivery Ratio (PDR), End to End delay and Jitter.

It is observed from simulations that heterogeneous network performs better when all the nodes are wired and there is negligible degradation in the performance of the network when the number of wireless nodes increases. It is seen that performance of real time streaming is not affected by nodes using a wireless network in the last mile. Further work needs to be done to measure the QOS in networks consisting of MANET connected to Legacy wired system using gateway with PIM-SM on the wired network side and MAODV on the MANET side.

A current challenge in interconnecting MANETs with backbone legacy networks is the lack of compatibility between different multicast routing protocols when using multiple gateways, due to differences in both forwarding semantics and implementations of the different protocols. Simple deployments may use static membership configuration of multicast gateways, or manually select one gateway that will forward based on dynamic membership.

SMF can be directly interconnected with both PIM-SM and PIM-DM protocols in a multi-gateway, dynamic membership environment. A new algorithm PIM-HMC was implemented in a heterogeneous network made of Mobile Ad hoc NETwork (MANET) and wired network connected via gateway. Two sets of protocols are investigated for this heterogeneous network.

PIM-HMC tries to improve the connectivity of the network which is highly dynamic. It uses the best feature of PIM-SM which is the selection of Rendezvous point (RP) so that multiple senders can use the shared tree. This improves the scalability of the network. A unique feature of the proposed protocol is the formation of the tree using group members where possible and switching to a non-group member only when a tree could not be formed.

V.FUTURE WORKS

Future investigations can be conducted on the working of a reliable MAC layer that scales with the number of nodes. Though, link constraints (e.g., bandwidth) and path constraints were considered in this research, further investigation on improving the probability of the successful joining, minimizing the joining time and cost of joining can be investigated. Investigate the performance of the proposed PIM-GAHMC with larger networks.

REFERENCES

[1]. Abdullah M.S., Alkahtani, A.M.S., Wood Ward, M.E. and Al-Begain, K. "An Overview of Quality of Service (QoS) and QoS Routing in Communication Networks", 4th PGNET2003 Symposium, Liverpool, UK, pp. 236-242, 2003, 2003.

[2]. Adams, A.J., Nicholas and Siadak, W. "Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification (Revised)," RFC 3973 (Experimental), Jan. 2005. (Online).Available: http://www.ietf.org/rfc/ rfc3973 .txt

[3]. Adjih, C., Jacquet, P. and Viennot, L. "Computing Connected Dominating Sets with Multipoint Relays", Ad Hoc and Sensor Wireless Networks, 2005.

[4]. Albrecht, M., Koster, M., Martini, P., & Frank, M. "End-to-end QoS management for delay-sensitive scalable multimedia streams over DiffServ". In Local Computer Networks, 2000. LCN 2000. Proceedings. 25th Annual IEEE Conference on pp. 314-323, 2000.

[5]. Alfawaer, Z.M., Gui Wei Hua and Noraziah Ahmed, A. "Novel Multicast Routing Protocol for Mobile Ad Hoc Networks", American Journal of Applied Sciences, Vol. 4, pp.333-338, 2007.

[6]. Al-Hunaity, M.F., Salam Najim, A. and Ibrahiem El-Emary, M. "A Comparative Study between Various Protocols of MANET Networks", American Journal of Applied Sciences, Vol. 4, pp.663-665, 2007.

[7]. Allam Maalla, Chen Wei and Haitham Taha, J. "Optimal Power Multicast Problem in Wireless Mesh Networks by Using a Hybrid Particle Swarm Optimization", American Journal of Applied Sciences, Vol. 6, pp.1758-1762, 2009.

[8]. Alrabiah, T. and Znati, T. "Delay-constrained, low-cost multicast routing in multimedia networks". Journal of Parallel and Distributed Computing, 61(9), 1307-1336, 2001.

[9]. Al-Talib, S.A., Ali, B.M. and Khatun, S. "An Approach to Improve the State Scalability of Source Specific Multicast", American Journal of Applied Sciences, Vol. 6, pp. 1347-1351, 2009.

[10]. Aurrecoechea, C., Campbell, A.T. and Hauw, L. "A survey of QoS architectures", Multimedia systems, Vol. 6, No. 3, pp.138-151, 1998.

[11]. Badarneh, O. S. and Kadoch, M. "Multicast routing protocols in mobile ad hoc networks: a comparative survey and taxonomy", EURASIP Journal on Wireless Communications and Networking, Vol. 26, 2009.

[12]. Ballardie, A. "Core Based Trees (CBT) Multicast Routing Architecture", RFC 2201, Internet Engineering Task Force, 1997.

[13]. Ballardie, A., Francis T.P. and Crowcroft, J. "Core based trees (CBT): An architecture for scalable inter-domain multicast routing", In Proceedings of ACM SIGCOMM, 1993.

[14]. Banik, S. M., Radhakrishnan, S. and Sekharan, C. N. "Multicast routing with delay and delay variation constraints for multimedia applications", In High Speed Networks and Multimedia Communications, pp. 399-411, 2004.

[15]. Bettahar, Bouabdallah, Bettahar, H. and Bouabdallah, A. "A new approach for delay-constrained routing", Computer Communications, Vol. 25, No. 18, pp.1751-1764, 2002.

[16]. Fenner, B.M., Handley, H., Holbrook, and Kouvelas, I. "Protocol IndependentMulticast - Sparse Mode (PIM-SM): Protocol Specification (Revised)", Internet Draft, draft-ietf-pim-sm-v2-new-05.ps, 2002.

[17]. Fragouli, C. and Soljanin, E. "Information flow decomposition for .network coding", in IEEE Transactions on Information Theory, Vol. 52, pp. 829-848, 2006.

[18]. Fenner,B., Handley, M., Holbrook, H. and Kouvelas, I. "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)",RFC4601(Informational),2006.(Online).Available:http://www.ietf.org/rfc/rfc4601.txt.

[19]. Thaler, D. "Border gateway multicast protocol (BGMP)": Protocol specification, 2004.

[20]. Tropea, M. and Santamaria, A. F. " Multicast Heuristic Approaches on Multi-layer Wireless Network". International Journal of Information and Computer Science, Vol. 2, No. 3, 2013.

[21]. Tseng, C.J. and Chyou Hwa Chen "The performance of QoS-aware IP multicast routing protocols", Information Networking, 2001. Proceedings, 15th International Conference , pp.181-188, 2001.

[22]. Wang, B. and Hou, J.C. "Multicast routing and its QoS extension: problems, algorithms, and protocols", IEEE Network, Vol. 14, No. 1, 22-36, 2000.

[23]. Wen Liu and Wang L.P. , "Solving the delay constrained multicast routing problem using the transiently chaotic neural network", ISNN 2007, Lecture Notes in Computer Science, LNCS 4492, pp.57-62, June, 2007.

[24]. Wen Liu, Wang L.P. and Haixing Shi, "Noisy chaotic neural networks for delay constrained multicast routing " IEEE Symposium on Computational Intelligence in Scheduling (CI-Sched 2007), a part of the IEEE Symposium Series on Computational Intelligence (IEEE SSCI 2007), pp. 267-270, April, 2007.

[25]. Wu, C.W., Tay, Y.C. and Toh, C.K. "Ad hoc Multicast Routing protocol utilizing Increasing id-numbers (AMRIS)" draftietf-