iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** III **Month of publication:** March 2019

DOI: http://doi.org/10.22214/ijraset.2019.3172

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 7 Issue III, Mar 2019- Available at www.ijraset.com

Competent Wireless Multimedia Multicast in Multi-Rate Multi-Channel Mesh Networks

Kokila. S[1], Dr. S. Chandrasekaran[2]
[1]PG Student, [2]Assistant Professor, Department of Computer Science and Engineering, P.S.V. College of Engineering & Technology, Krishnagiri

Abstract: Devices in wireless mesh networks can operate onmultiple channels and automatically adjust their transmissionrates for the occupied channels. This paper shows how to improveperformance-guaranteed multicasting transmission coverage for wireless multi-hop mesh networks by exploring the transmission opportunity offered by multiple rates (MR) and multiple channels (MC). Based on the characteristics of transmissions with different rates, we propose and analyze parallel low-rate transmissions (PLT) and alternative rate transmissions (ART) to explore the advantages of MRMC in improving the performance and coverage tradeoff under the constraint of limited channel resources. We then apply these new transmission schemes to improving the WMN multicast experience.The above interference becomes more intensive when multicasting multimedia data because of the high transmission rates and the long communication durations.

I. INTRODUCTION

Multicast in wireless mesh networks (WMN) is promising in efficiently utilizing wireless resources to provide flexible and reliable wireless connections to a group of multimedia receivers (e.g., video conferencing users). However, as illustrated in Fig. 1, wireless multicasting leads to complicated interference patterns for the following reasons. 1) Consecutive transmissions on the same multi-hop WMN paths. In Fig. 1 (a), on the multicasting path $n0 \rightarrow n1 \rightarrow n2$, because of the streaming transmission of multimedia data, while $n0$ sends the multicasting traffic to $n1$, $n1$ is forwarding multicast data (received from $n0$) to $n2$. Due to the nature of wireless broadcast, as highlighted in the circle of Fig. 1 (a), the transmission $n1 \rightarrow n2$ competes with the transmission $n0 \rightarrow n1$ to occupy the same channel. This conflict degrades the multicast performance from $n0$ to $n1$ as well as from $n1$ to $n2$;

2) Parallel delivery of multicast data on paths that haveat least one interfering hop. In Fig. 1 (b), suppose $n1$ and $n3$ are within each other's interfering range. While multicasting transmissions are on the path $n0 \rightarrow n1 \rightarrow n2$, multicasting transmissions $n3 \rightarrow n4$ take place in parallel. The parallel transmissions on these paths cause interference (shown in the circle of Fig. 1 (b)) which further degrades the performance of multimedia traffic entering $n1$ and $n3$.

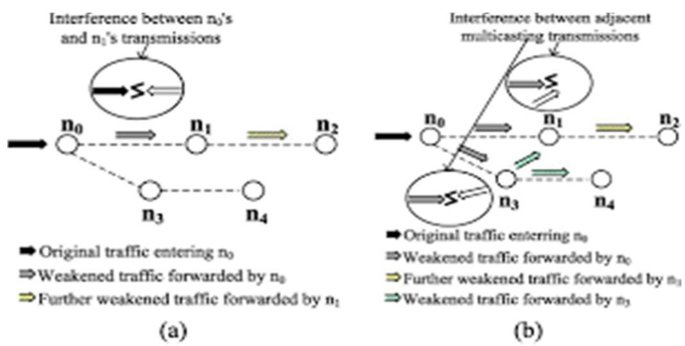


Fig.1. Parallel Transmissions

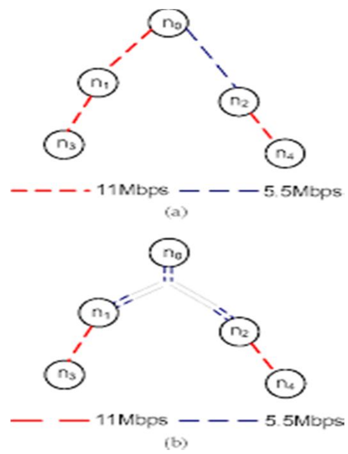
II. RELATED WORK

Multi-channel multi-radio multicast. Research on multiple channels has consistently focused on channel assignment with diverse static and dynamic solutions being proposed. O. Karimi et al. studied high-throughput WMN multicast by exploring the advantages of channel diversity and multiple mesh gateways. By forming WMN multicast as a mathematical problem, an iterative primal-dual optimization framework is proposed to iteratively switch between solving primal subproblems for channel allocation and routing. S. Lim et al. improved multicast connectivity in a multi-channel WMN. The proposed protocol builds multicasting paths while inviting multicast members. The channel assignment guarantees that neighbouring members will have common channels. N.

III. PARALLEL LOW-RATE TRANSMISSION (PLT)

A. Throughput-Coverage Trade Off

It has been established in the literature that a tradeoff exists between improving network throughput and extending transmission coverage. Generally, for a channel transmitting at a higher rate, a higher communication throughput is delivered to a smaller area. This tradeoff becomes severe in a multicast communication as shown by the following example. We consider a simple IEEE 802.11b wireless multicast. Suppose n1 is located in the 11Mbps transmissionrange of n0 and n2 is located out of the 11Mbps transmissionrange but within the 5.5Mbps transmission range of n0. In theliterature, it is not unusual for n0 to transmit at 5.5Mbps forthe sake of connectivity. However, this limits the throughputand prolongs the delays that n1 can potentially achieve sincen0 is capable of transmitting at 11Mbps. Moreover, when n1forwards the received packets to n3, the already degradedthroughput or delays at n1 may cause unacceptable performance at n3 if n3 requires at least 5.5Mbps throughput. Thisshrinks multicast coverage when n3 cannot be admitted intothe multicast.



B. Parallel Low-Rate Transmissions (PLT)

In order to efficiently utilize MRMC to extend performance-guaranteed multicasting coverage via simple and low-overhead operations, we propose the idea of parallel low-rate transmissions (PLT). Instead of hiring multiple channels working at different rates to transmit a multimedia stream multiple times to guarantee the maximum available throughput for different receivers, PLT employs multiple channels to transmit a multimedia stream together and at the same rate, this being less than the maximum available rate. In other words, through multiple low-rate channels, PLT provides an aggregate high throughput to users across a larger area. We use a simple example in Fig. 2 (b) to illustrate PLT. As a PLT node,n0 employs two 5.5Mbps orthogonal channels in parallel to transmit half of the traffic via each channel. As a result, both n1 and n2 receive the same high network throughput without requiring n0 to transmit the same traffic more than once. Like DF, in this multicast, PLT uses 3 orthogonal channels.

C. Analysis of PLT

We now theoretically evaluate the two transmission schemes(PLT and DF), considering an interference model concerning transmissions on the same channel with receivers of one transmission within the interference range of another transmission.

IV. ALTERNATIVE RATE TRANSMISSION

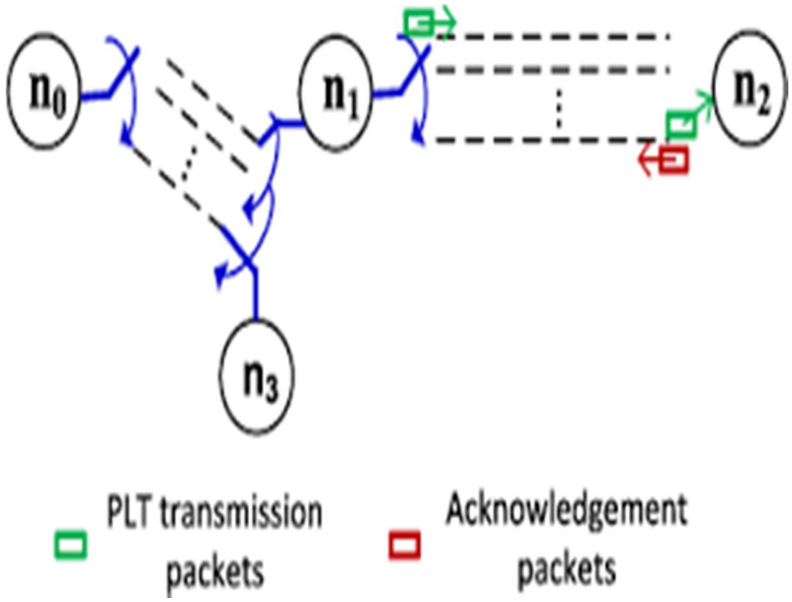
Although PLT requires a simple process to effectively improve transmission ranges with high throughput, its significantbenefit relies on the availability of orthogonal channels. Withlimited channel diversity in practice, we propose alternativerate transmission (ART). ART classifies WMN multicast nodesas regular nodes and PLT nodes. To limit usage of orthogonalchannels (so that there are enough for PLT), regular nodes usesingle channels to transmit at the benchmark rate (R). PLTnodes employ PLT transmissions to multicast packets at thePLT rate ($\check{R}$).

A. Alternative Rate Transmission

As analyzed in Fig. 1, WMN multicasting experiences complicated interference (caused by consecutive transmissions and parallel delivery) which negatively affects performance guaranteed wireless multicasting coverage. ART controls interference caused by consecutive transmissions with the minimum number of orthogonal channels by assigning regular and PLT roles to mulitcasting nodes in the way.

B. Benchmark Rate and PLT Rate

Bearing the motivation of improving both performance and coverage in mind, by referring to our observations in [18] wireless transmissions may achieve high throughput across wide areas by using multiple hops, ART regular transmissions should use such a rate (i.e., the benchmark rate R) so as to provide the best balance between coverage and performance over multiple hops. More specifically, the benchmark rate R helps to deliver multimedia data to the greatest coverage with guaranteed delays and throughput. We now analyze how to achieve R among n available rates.



C. Analysis of PLT

We now theoretically evaluate the two transmission schemes(PLT and DF), considering an interference model concerning transmissions on the same channel with receivers of one transmission within the interference range of another transmission. Suppose there are n (n > 0) different rates,denoted as {r0, r1, ..., rn−1}, required by DF. Based on thestudies in [18-20], due to MAC overheads, the throughputprovided by a transmission rate is reduced from the nominaltransmission rate. For example, a 11Mbps transmission mayonlyprovide 4.55Mbps throughput to its next-hop receiver(s)[18-19]. Without loss of generality, we denote the throughputreduction factor of rate ri (i∈ [0, n − 1]) as βi. Meanwhile,we use dito represent the radius of transmission range of rateri and µito represent the radius of interference range of rateri. For PLT, if its transmission rate is r (rmin ≤ r ≤ rmax),denote the throughput reduction factor of r as β and theradiuses of transmission range and interference range of rater as d and µ, where rmax = max{ri, i∈ [0, n − 1]} andrmin = min{ri, i∈ [0, n − 1]}.

V. ALTERNATIVE RATE TRANSMISSION

Although PLT requires a simple process to effectively improve transmission ranges with high throughput, its significant benefit relies on the availability of orthogonal channels. With limited channel diversity in practice, we propose alternative rate transmission (ART). ART classifies WMN multicast nodes as regular nodes and PLT nodes. To limit usage of orthogonal channels (so that there are enough for PLT), regular nodes use single channels to transmit at the benchmark rate (R).

A. Alternative Rate Transmission As analyzed in Fig. 1, WMN multicasting experiences complicated interference (caused by consecutive transmissions and parallel delivery) which negatively affects performance guaranteed wireless multicasting coverage. ART controls interference caused by consecutive transmissions with the minimum number of orthogonal channels by assigning regular and PLT roles to mulitcasting nodes.

B. Benchmark Rate and PLT Rate Bearing the motivation of improving both performance and coverage in mind, by referring to our observations in [18] - wireless transmissions may achieve high throughput across wide areas by using multiple hops, ART regular transmissions should use such a rate (i.e., the benchmark rate R) so as to provide the best balance between coverage and performance over multiple hops. More specifically, the benchmark rate R helps to deliver multimedia data to the greatest coverage with guaranteed delays and throughput.

VI. LINK-CONTROLLED MULTI-RATE MULTI-CHANNEL MULTICASTING TREE (LC-MRMC)

This section designs the link-controlled multi-rate multichannel multicast (LC-MRMC) algorithm to extend performance-guaranteed multicast coverage by using ART and controlling interference analyzed in Fig. 1. Unlike our study on single-group multicast [18], this paper focuses on multi-group multicasting communications, a more general case in practical systems.

A. The LC-MRMC Weight With our ART-based multicast [18], each group needs to run an individual multicast tree. Then, in a WMN with multiple multicast groups, a node (e.g., a forwarding WMN router) may play different roles (i.e., PLT or regular) in different groups, causing complicated multicasting communications as well as increased interference. Hence, new developments are required to support multi-group MRMC multicast. We propose to develop multicast in the backbone of a WMN system that can be shared by different multicasting groups. More specifically, the new LC-MRMC algorithm constructs a multicast tree rooted at multiple mesh gateways (MGs), allowing multicast senders to load data to the multicast tree via their closest MGs and hence benefitting real-time multicast communications. The following metrics are employed to construct the LC- MRMC tree for multi-group multicasting.

B. The LC-MRMC Algorithm We assume the existence of a group manager (GM)8 in our multicast system. The GM of LC-MRMC maintains information about group senders/receivers and system topology, as well as implementing ART analysis based on Theorems 2& 3. Multicast senders and receivers contact the GM to get information regarding the group ID, the benchmark rate, and the PLT rate. Note that, for the sake of reliable multicast, it may be necessary for multiple GMs to coexist. The construction of an LC-MRMC tree is triggered by the registration procedure of receivers of multicast groups. In detail, a receiver broadcasts to its multicast sender(s) a REGISTRATION packet which mainly includes the fields of Group ID (identifying the multicast group(s) that the receiver belongs to), Hop Count (the number of hops from a mesh node to its closest root/MG), and Forwarders List (recording the IP address, node type9, and link loss rate of a mesh node that forwards this REGISTRATION message). Hop Count is initially set to 0 by a receiver but increases by 1 at each intermediate node forwarding this REGISTRATION.

1) *Algorithm 1* The Link-Controlled Multi-rate Multi-channel Multicasting Tree Input: Multicast senders and multicast receivers;
2) *Output:* The constructed LC-MRMC tree;

VII. SIMULATION EVALUATION

In this section, we use the discrete event network simulator NS2.33 to conduct an extensive simulation-based evaluation for ART and LC-MRMC.

Table I lists the simulation parameters. The video transmission rate range in the table is generated by varying the frame rates of the MPEG-4 file StarWarsIV.dat. Performance curves in the figures of this section are plotted based on the average value of 20 simulation runs. The simulations mainly observe the following performance metrics.

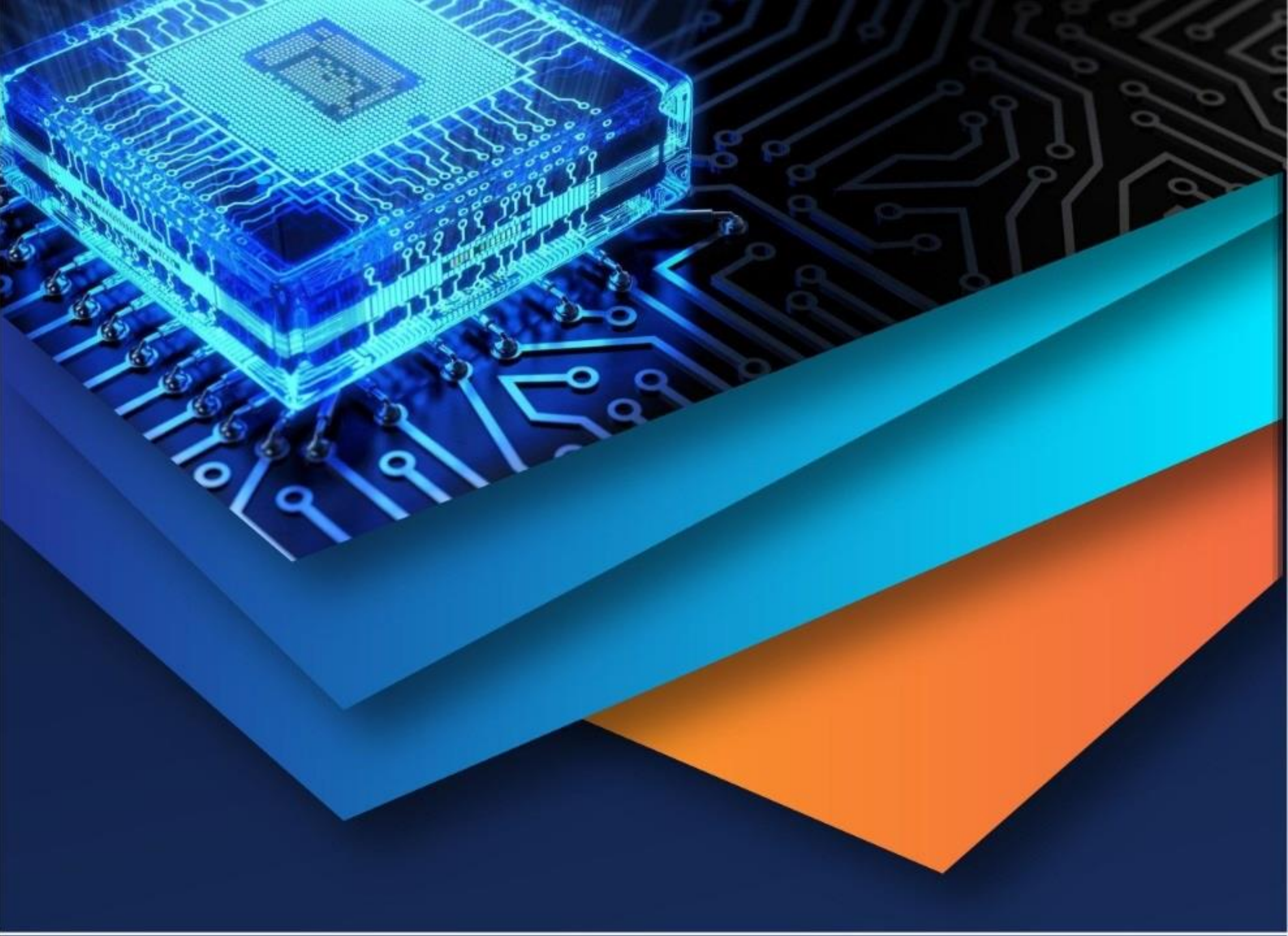
A. ART Evaluation The first group of simulations looks into the ART generated by Theorems 2 & 3 - whether ART provides the best balance between throughput and coverage among all channel and rate allocation plans. Our simulations employ the mesh topology in Fig. 7 (a). The blue dotted lines in the topology illustrate the 10-hop path that we will use to evaluate ART transmissions.We first simulate one-hop transmissions (using the first hop on the 10-hop path) with the four different rates (11Mbps, 5.5Mbps, 2Mbps, and 1Mbps) and demonstrate the results in Table II. We then examine Theorem 2 by applying PLT transmissions at different hops to observe the achievable throughput ratios. The benchmark rate is 11Mbps and the PLT rate is 5.5Mbps. Based on Theorem 2, ART should implement PLT transmissions at every 3rd hop.

B. Performance Evaluation in a Random WMN For evaluating LC-MRMC, we compare the average multicast throughput, the average multicast delay and the multicast coverage of the following five different wireless multicast schemes in a wireless network with 100 mesh nodes: DF [11], MCM which uses Breadth First Search to find the minimum number of relay nodes [16], MCM-MC which is a MCM tree with channel allocation [16], LC-MR which is our multicast tree without channel allocation, and our LC-MRMC. The locations (i.e., coordinates) of mesh nodes are randomly set by the simulations so as to achieve a distribution density such that there is on average 3.82 nodes within the range of 11Mbps transmissions. Among the 100 mesh nodes, 15 nodes are selected as group receivers. All other simulation settings are the same as the ones used for previous simulations.

C. Performance Evaluation in Multi-group Multicasting In this group of simulations, we observe the performance of the five multicast schemes in multi-group WMN multicasting. The WMN system is formed by 100 backbone nodes (i.e., mesh routers or mesh gateways) and 3 coexisting multicasting groups. Similar to the formation of the topology in the last section, the locations of the 100 backbone nodes are randomly set by the simulations so as to achieve a distribution density such that there are on average 3 nodes within the range of 11Mbps transmissions. For the 3 multicast groups, they are formed by mesh users who directly connect to the backbone via a mesh router or mesh gateways. Each group has 15 users. All other simulation settings are the same as those used for previous simulations.

VIII. CONCLUSION

This paper showed how to exploit multiple channels and multiple transmission rates with simple procedures and light overheads to improve performance-guaranteed multicast transmission coverage. The transmission opportunity afforded by MRMC was investigated by proposing PLT. PLT enables a mesh node to employ multiple channels transmitting at a lower rate (than the maximum available rate) in parallel to share the delivery of a full multimedia flow with an aggregated throughput across greater distances. We then designed ART which alternately uses regular transmissions and PLT transmissions to make the best of limited available channel and rate resources while promoting communication coverage with high throughput and short delay performance. ART became a key strategy in developing our LC-MRMC algorithm to multicast multimedia traffic across much larger areas wirelessly. LCMRMC also controls multicast interference well and hence benefits high-throughput multicast. The results of our NS2 simulations proved that LC-MRMC distributes multiple groups of video flows to receivers with better performance across an area which is at least 80%.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY