International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:268
Vol.3, No.1, January 2014 DOI:10.15693/ijaist/2014.v3i1.15-20

A Competent Concurrent Multi-flow Wireless Multimedia Transmissions

SANGEETHA.P
M.E. Applied Electronics
P.S.R.Engineering College
Sivakasi

MARICHAMY.P
Professor & Head / ECE, Dean (Academic),
P.S.R.Engineering College
Sivakasi

GURUPRAKASH.B
Assistant Professor(Sr.Gr.) / /IT
P.S.R.Engineering College
Sivakasi

***Abstract* - Wireless multimedia services are major applications of next generation wireless networks In wireless network, an efficient utilization of network resources are necessary for its increasing performance. The major goal of the efficient utilization of network resources is to increase the number of performance guaranteed concurrent multimedia flows. The concurrent multimedia flows are attained by two theoretical policies: Flow scheduling policy and Channel aggregation policy. A novel algorithm is designed to attain maximum concurrent multi-flow transmissions (MCMT) which applies to the above two theoretical studies in order to improve multicasting network's ability to admit performance guaranteed concurrent multimedia communications**.

Index terms - Multimedia multicasting, resource awareness, flow scheduling, flow splitting, multiple flows, wireless networks.

I. INTRODUCTION

Advances in technology enable portable computers to be equipped with wireless interfaces, allowing networked communication even while on the move. Whereas today's notebook computers and personal digital assistants (PDAs) are self contained (introvert) tomorrow's networked mobile computers are part of a greater computing infrastructure (extrovert). Key problems are that these portable wireless network devices need to handle multimedia traffic in a dynamic and heterogeneous wireless environment, and the need to operate with limited energy resources.

Wireless communication is much more difficult to achieve than wired communication because the surrounding environment interacts with the signal, blocking signal paths and introducing noise and echoes. As a result wireless connections have a lower quality than wired connections: lower bandwidth, less connection stability, higher error rates, and, moreover, a highly varying quality. They need to be able to operate in environments that may change drastically – in short term as well as in long term – in available resources and available services. These factors can in turn increase communication latency due to retransmissions, can give largely varying throughput, and incur a high energy consumption.

Wireless networking is a broad area, and has many applications ranging from voice communication (cellular phones) to high performance multimedia networking. In this paper we are somewhat based towards multimedia traffic, as it is expected that the new generation of wireless networks will carry diverse types of multimedia traffic.

As various wireless networks evolve into the next generation to provide better services, a key technology, wireless mesh networks (WMNs), has emerged recently. In WMNs, nodes are comprised of mesh routers and mesh clients. Each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations.

A WMN is dynamically self-organized and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad hoc network). This feature brings many ad- vantages to WMNs such as low up-front cost, easy network maintenance, robustness, and reliable service coverage. Conventional nodes (e.g., desktops, laptops, PDAs, PocketPCs, phones, etc.) equipped with wireless network interface cards (NICs) can connect directly to wireless mesh routers. Customers without wireless NICs can ac- cess WMNs by connecting to wireless mesh routers through, for example, Ethernet. Thus, WMNs will greatly help the users to be always-on-line anywhere anytime. Moreover, the gateway/bridge functionalities in mesh routers enable the integration of WMNs with various existing wireless networks such as cellular, wireless sensor, wireless-fidelity (Wi-Fi), worldwide inter-operability for microwave access (WiMAX), WiMedia networks.

WMNs can be deployed incrementally, one node at a time, as needed. As more nodes are installed, the reliability and connectivity for the users increase accordingly. Deploying a WMN is not too difficult, because all the required components are already available in the form of ad hoc network routing protocols, IEEE 802.11 MAC protocol, wired equivalent privacy (WEP) security, etc.

II. RELATED WORK

M. Kodialam et al. [1] presented a network characterization that captures the constraints associated with multi-channel multi-radio (MC- MR) multi-hop wireless mesh networks. We showed that our model is extensible and can cover a wide variety of cases that react a range of practical constraints. We then presented an algorithm(link channel assignment and

International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:268
Vol.3, No.1, January 2014 DOI:10.15693/ijaist/2014.v3i1.15-20

scheduling algorithms) that computes the optimal routes for a given objective of meeting a set of demands in the network using a set of necessary conditions as constraints and also able to characterize network capacity and achieve a performance that is close to optimal.

P.Wan et a l . [2] provided the full characterization of their NP hardness and approximation hardness and also developed polynomial algorithms with better approximation bounds. In particular, developed a unified framework for both the design and the analysis of polynomial approximation algorithms.

R.L Cruz et.al. [3] developed an integrated routing, link scheduling and power allocation policy for a general multihop network that minimizes the total average power consumption to support minimum average rate requirements per link. The power allocation policy can support higher throughputs than with conventional approaches to radio resource allocation, at the expense of decreased energy efficiency. The policy requires time synchronization between transmitters, and requires that channel conditions remain constant over several time slots. The optimal link schedule time-shares a small number of optimal subsets of links in order to achieve the required data rates.

T.El-batt et.al. [4] presented a cross-layer design framework for the multiple access problem in contention-based wireless ad hoc networks. This focused on next neighbour transmissions where nodes are to send packets to their respective receivers while, at the same time, satisfy a set of SNR constraints. The main contribution is to solve the multiple access problem via two alternating phases until an admissible set of users, along with their transmission powers, is reached. This, in turn, reduces the computational overhead significantly and simplifies the structure of the power control problem. In the first phase, a simple scheduling algorithm coordinates independent users' transmissions to eliminate strong levels of interference that cannot be overcome by power control. In the second phase, a distributed power control algorithm determines the set of powers that could be used by the scheduled users to satisfy their transmissions, if one exists.

III MOTIVATION PROBLEM FORMULATION

As introduced, the major goal of our study is to propose schemes/algorithms that can increase the number of performance guaranteed concurrent multimedia flows by efficiently utilizing the capacity of each wireless channel. It is common throughout that a wireless node will no longer admit more flows when its allocated capacity of output channels is saturated because of transmitting the existing flows. The motivation of this paper is to investigate appropriate schemes that fully utilize a wireless node's allocated channel capacity to extend the ability of a network to admit performance guaranteed concurrent multimedia flows. In this proposed work tackled this problem by exploring the advantages of the performance gap which is defined as the difference between the acceptable performance bounds and the performance achieved when a channel is saturated. We present two novel flow management policies. The flow scheduling policy increases a wireless node's ability to admit more flows by intelligently scheduling flows to transmit in turn. The channel aggregation policy accumulates the residual capacities of multiple channels of a wireless node for transmitting a flow via multiple channels in parallel, when the residual capacity of no channel can accommodate such a full multimedia flows.

IV PROPOSED WORK

As we will present in the following sections, these studies are studied based on flow profiles, users' experience, and current network conditions to make full of the performance gap for admitting more flow traffic.

A. Flow Scheduling Policy

An effective approach to utilize the transmission opportunity provided by the performance gap through scheduling the transmissions of concurrent flows. This finding raises an interesting problem to develop an appropriate flow scheduling policy that can be generally used to increase the number of performance guaranteed multimedia flows. Therefore, our first objective is to study a sound flow scheduling policy that should

1) Correctly judge whether a channel is able to admit a new multimedia flow *f* without degrading the performance of current flow transmissions

2) Schedule multiple concurrent multimedia flows with guaranteed performance.

Process of Flow Scheduling Policy

It can be developed for multi-hop wireless transmissions because the flow scheduling operations are run by individual wireless nodes based on the allocated capacities of their own channels and the profiles of transmission flows. To make this improvement, the delay bound should be guaranteed after multiple hops instead of a single hop. That is, the delay bound and the rate-distortion bound at each sender/forwarder. This process helps to balance the utilization of network capacity and therefore promotes balanced traffic load in networks. Another issue that should be considered when developing an appropriate multi-hop flow scheduling policy is the de synchronization of time slots scheduled to transmit a flow at different hops. The lines label the starting time for N0 to N2, thus transmit 'f' within a scheduling period.

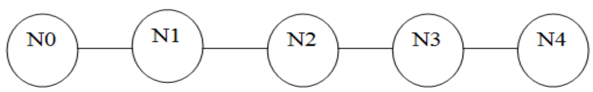


Figure 1. Multi-hop Wireless Transmissions

Flow Scheduling Policy Architecture

The data flow between the nodes through flow scheduling policy. Initially a request is been sent from N0 to N4 and receiver N4 sends the acknowledge to N0. Through clear observation it is been analyzed that the request and acknowledgment are different in size for the signal interference. Thus when packets are sent from sender to receiver sender some packet are lost and some get distorted. Now the packets are sent between two adjust nodes and the throughput values are analyzed.

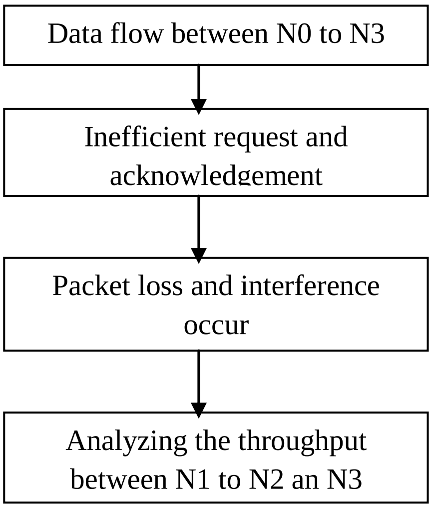


Figure 2. Flow Scheduling Policy Architecture

B. Channel Aggregation Policy

On the other hand, performance gaps are not always large enough for a wireless channel to admit a full multimedia flow. Instead of wasting the residual capacities created by small performance gaps, efficient resource utilization schemes may take the method of capacity(channel capacity) aggregation into account, given that multiple channels/interfaces are popular for nodes in modern wireless networks. This encourages our second objective which is to investigate an appropriate channel aggregation policy that can be generally used to transmit a flow with guaranteed performance via multiple channels in parallel. A sound channel aggregation policy should

1) Correctly judge whether the aggregated residual capacity of channels at a wireless node is enough for transmitting a flow *f*

2) Provide an appropriate method to transmit *f* over multiple channels without affecting other existing transmissions.

Wireless channel aggregation is relatively straight forward. The channel aggregation is an analysis solution capable of receiving data from multiple channels simultaneously, and enough wireless adapters to cover each of the channels to be analyzed. The data is then captured into a single analysis session and all the data from all the channels and can perform any level of detailed analysis that's required. The channel aggregation policy is applicable for a wireless node with multiple channels. The idea is to accumulate the residual capacity of channels of a wireless node for useful flow transmission. To improve the channel aggregation policy for flow splitting transmission via a multi-hop path, similar to the multi-hop flow scheduling policy, the sender and forwarders share equally. Also similar to scheduling flows in multi hop networks, due to different hops have different traffic load, the time slots arranged for splitting transmission based on channel's residual capacity may not be synchronized at different hops. Then introduce the practical implementation of the channel aggregation policy. In general, this proposes to use the minimum number of channels for the splitting transmission. If the sender has enough accumulated residual capacity for transmitting 'f', its output channels in decreasing order of channels residual capacity and then continuously selects a channel from the head of this list until the total accumulated capacity is enough for 'f'. After these operations, sender splits the data input within a period into sub flows and transmits these sub flows via multiple channels in parallel. Instead of randomly picking channels, the proposed approach reduces overheads (generated for identifying sub flows) and process delays (caused by flow splitting and packet encapsulation/de-encapsulation) through using the minimum number of channels.

C. Maximum Concurrent Multi-Flow Transmission

This section proposes an maximum concurrent multi-flow transmissions (MCMT) algorithm that uses the two studied policies to multicast concurrent multimedia communications in wireless networks.

The proposed MCMT consists of 4 main modules which are illustrated as steps below

User Experience

In multimedia multicasting, there is usually a group of receivers who may require different performance from the communications. We employ user experience as a criterion to design our multicast algorithm to support QoE-aware services. With our motivation in this thesis work which is to save network resources for useful data transmission, this criterion is designed as follows.

Multicast transmissions only need to guarantee the performance required by individual receivers. However, for a sender/forwarder whose child nodes (i.e., all downstream nodes) have different-level performance requirements, the transmission of this sender/forwarder should guarantee the highest-level performance.

Path Selection

Referring to our previous works, the path selection criterion include the following
metrics.

Hop distance: A path with shorter hop distance is preferred which benefits multicast by providing shorter delays and less transmission contention.

Nodes with rich connectivity: A node that has more neighbors as multicast forwarders/receivers is preferred to be a forwarding node. This metric helps to control the number of forwarders and therefore avoiding interference/conflict caused by parallel transmissions in multicasting.

Reliability: A reliable path has the priority to be a multicast path because wireless links are lost frequently which affects the continuity of multimedia presentation. We employ the *path weight* to combine the above metrics. The *path weight* of path *i* that connects a sender and a receiver is

$$\omega_i = \frac{1}{h_i} \times \sum_{j=1}^{h_i} \frac{D_{i,j}}{N_{i,j}} \times \prod_{j=1}^{h_i} (1 - l_{i,j}) \qquad (1)$$

From the equation (1), where *hi* is the number of hops on this path, *Di,j* and *Ni,j* are the total number of child nodes and neighboring nodes at the *j*th hop on this path, *li,j* is the loss rate at the *j*th hop on this path.

International Journal of Advanced Information Science and Technology (IJAIST) ISSN: 2319:268
Vol.3, No.1, January 2014 DOI:10.15693/ijaist/2014.v3i1.15-20

With the above criteria, we design the MCMT algorithm that employs the flow scheduling policy and the channel aggregation policy for performance guaranteed multi-flow multicasting. Since the implementation of both policies requires wireless nodes to know about flow profiles, the algorithm requires a flow sender to broadcasts a light-weight PROFILE packet in the multicasting network. A PROFILE packet includes the fields listed in Table I.

Table I: Fields of Profile Packets

Field	Function
MESSAGE ID	Distinguish between different PROFILE packets sent by the same sender
FLOW PROFILE	Record a flow’s profile such as the average transmission rate, the burstiness, etc.

Note that the value of MESSAGE ID is increased by 1 whenever the sender issues a PROFILE packet for a new flow. Once a receiver receives a PROFILE message, it replies a REPORT packet (by broadcasting) which includes the fields listed in Table II. Note that QUALITY LEVEL is used to represent the user experience criterion, which allows the MCMT algorithm to deal with individual users’ performance requirements. PATH INF and LINK LOSS are introduced for achieving path weights. With PATH INF, the sender knows the hop distance (h) of a path and the number of neighbours who are also child nodes (D/N) on this path; with LINK LOSS, the sender achieves the reliability of a path. CHANNEL PROFILE is set for using the two policies to admit concurrent multimedia flows. In order to save control overheads, we require each wireless node to calculate its availability to admit a new flow after receiving PROFILE by the two policies. Hence, the information recorded in CHANNEL PROFILE includes the longest scheduling period and the bound of average transmission rate of each node on a path that the REPORT travels. This process also reduces the calculation burden of the flow senders. We now present the detailed operations of the MCMT algorithm.

Table II: Fields of Report Packets

Field	Function
NODE ID	Identify the receiver who issues this REPORT
QUALITY LEVEL	Inform the sender of the quality level required by this receivers
PATH INF	Record nodes on a path that this REPORT Travels
LINK LOSS	Record the loss rates of channels of nodes on a path that this REPORT travels
CHANNEL PROFILE	Record the state of each node on a path that this REPORT travel

Algorithm 1 Maximum Concurrent Multi-Flow Transmissions (MCMT)

Input: A new multimedia flow *f* input by a wireless node *s*.
Output: Multicast *f* to meet the expected performance of individual users.
1. *s* broadcasts a PROFILE packet;
2. After receiving PROFILE, each node checks whether it can admit *f* with and without the two policies;
3. Each receiver replies a REPORT packet by broadcasting;
4. After receiving a REPORT packet, each forwarder fills the fields of PATH INF, LINK LOSS, and CHANNEL PROFILE with the information stated in Table II;
5. After receiving the REPORT packets of all receivers, *s* selects all of the paths that can deliver *f* to receivers with their required performance;
6. *s* filters the selected paths to form the MCMT tree by using the *path weights*;
7. *f* is multicasted to receivers via the MCMT tree in as follows: *s* or a forwarder implements the transmission by scheduling /splitting *f* (based on the two policies) using the highest performance requirements of all the downstream receivers as bounds.

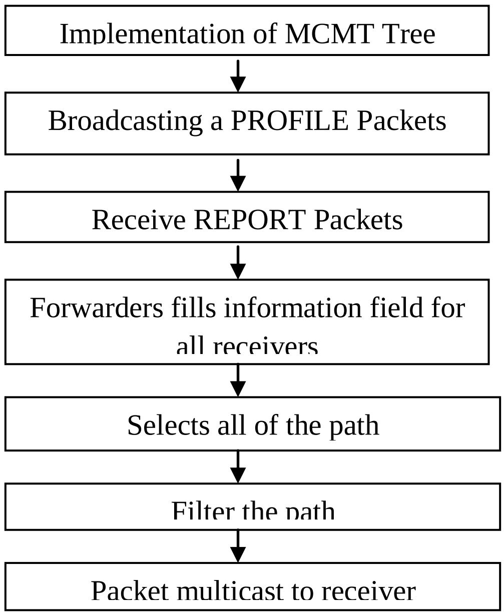


Figure 3. MCMT Architecture

Figure 4.1.3 clearly shown that, In the MCMT algorithm, both PROFILE and REPORT packets are broadcasted in the network. If the average out degree of nodes in the network is η (η > 1), the broadcast of PROFILE/REPORT makes each node to forward the same PROFILE/REPORT packets η times. That is, the overheads issued to the network are η times of a PROFILE/REPORT packet size, where *n* is the number of nodes in the network. In order to control the overheads (for saving network resources), in our algorithm, the PROFILE/REPORT packets of the same multimedia flows (which can be identified by the same MESSAGE IDs) are only transmitted once by the same wireless node. Hence, the overheads generated by PROFILE/ REPORT packets are reduced to at most *n* times of the PROFILE/REPORT packet size.

V. SIMULATION EVALUATIONS

In this section, we demonstrate that the derived results above are consistent with simulation results. We use NS2 to conduct a performance study to compare the performance of MCMT with that of existing scheme, and investigate the feasibility of MCMT. The simulation parameters are listed in Table III.

Table III: Simulation Parameters

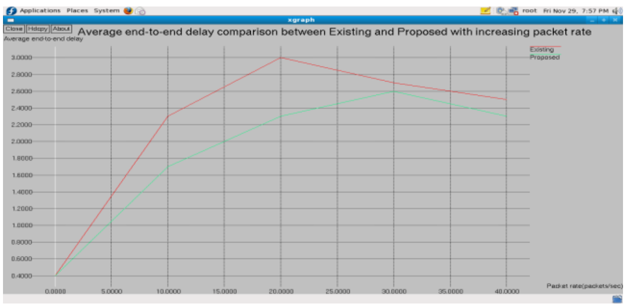
Simulation Parameter	Value
Ns2 Simulator	Ns2.3
Protocol	AODV
Number of output channel at the sender or forwarders	4
Bandwidth of output channels	100Mbps
Delay	100ms
Scheduling time	Low
Concurrent flow transmission	High

In this section, we conduct an extensive simulation-based evaluation. There are 3 groups of simulations implemented to study the flow scheduling policy (FC), the channel aggregation policy (CA), and the MCMT algorithm separately by using the discrete event network simulator NS2.3. The evaluation of FC and CA is conducted in both single-hop and multi-hop wireless networks that use AODV as the routing protocol. The evaluation of MCMT is carried out in wireless multicast networks with single channel and multiple channels respectively and compared with three other multicast schemes Link – controlled routing tree (LCRT), Channel diversity transmission (CDT), and Network – flow interaction chart with multi flows (NFIC-MF) respectively. The simulations mainly observe the average delays and the average data loss rates of multimedia transmissions. Average delays are defined as

$$AD=\sum_{i=1}^{n} di/n \qquad (2)$$

From the equation (2), Where n is the number of receivers, and di is the average delay of all packets received by the ith receiver. Delays exceeding the bound cause lag which adversely affects the ability of users to communicate in real time. ADs demonstrate how well a network transmission scheme can guarantee real-time communications to different receivers.

A. Comparison for End To End Delay

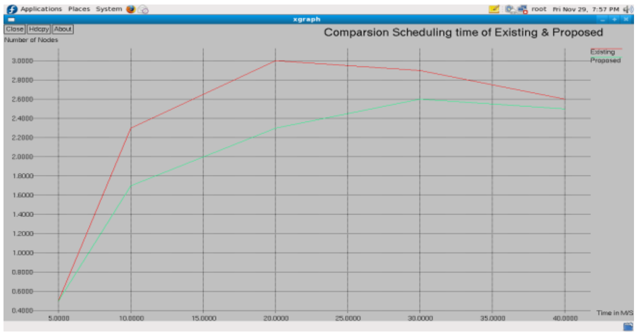


Time (ms) Vs Delay (ms)

Figure 1. Shows the End-To End Delay Comparison Graph between the Existing Scheme (LCRT, CDT & NFIC-MF) and Proposed Scheme (MCMT)

Figure 1, it is clearly shown that the proposed MCMT algorithm (coloured as green) didn't produce so much delay even the number of nodes increased. It is better the other scheme such as LCRT, CDT and NFIC-MF (coloured as red) respectively.

B. Comparison for Scheduling Time

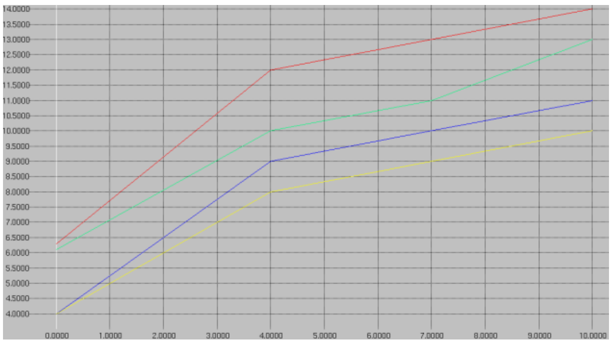


Time (ms) Vs Number of Flows

Figure 2. Comparison of scheduling time between Existing Scheme (LCRT, CDT & NFIC-MF) and Proposed Scheme (MCMT)

From the figure 5.2, it is clearly shown that when number of nodes and packet increases the scheduling time is minimized in MCMT (coloured as green) when compared to the existing scheme such as LCRT, CDT, NFIC-MF (coloured as red) respectively.

C. Comparison for Concurrent Flow Transmission



Number of Nodes Vs Number of Flows

Figure 3. Comparison of Concurrent flow Transmission between Existing Scheme (LCRT, CDT & NFIC-MF) and Proposed Scheme (MCMT)

From the figure 5.2, it is clearly shown that when number of nodes and packet increases the concurrent flow transmission is maximized in MCMT (coloured as red) when compared to the existing scheme such as LCRT (coloured as green), CDT (coloured as blue), NFIC-MF (coloured as yellow) respectively.

VI. PERFORMANCE OF LCRT, CDT, NFIC – MF AND MCMT

We have also conducted a suite of simulations to evaluate the performance of our proposed algorithms in wireless multimedia transmissions. In this section, we present the simulation results and compare them with other three existing schemes (LCRT, CDT & NFIC-MF) respectively. For clarity, we list the comparisons between the existing work and our proposed MCMT approach in Table I.

Table I: Comparison between Existing Schemes & Proposed Schemes

PARAMETERS	LCRT	CDT	NFIC - MF	MCMT
Delay	High	High	Average	Low
Throughput	Medium	Average	Low	High
Scheduling Time	Average	High	High	Low
Policy	NIL	NIL	Flow Scheduling Policy	Flow Scheduling Policy & Channel Aggregation Policy
Transmission	Single Hop	Multi - Hop	Multi – Hop with Multi - Flow	Multi – Hop with Concurrent Flows

VII. CONCLUSIONS AND FUTURE WORK

In this paper, we studied the issue of improving a wireless network ability to admit more numbers of performance guaranteed concurrent multimedia flows. We are among the first to tackle this issue by investigating the transmission opportunity provided by the performance gap. The flow scheduling policy and the channel aggregation policy were theoretically analyzed and presented as a way to strategically utilize network resources for concurrent multimedia flow transmission. A set of theoretical results regarding the scheduling condition, the aggregation condition, and the appropriate methods to schedule and split flows were contributed to increase the number of concurrent multimedia flows that can be admitted by a wireless channel. We then introduced how to apply these theoretical results to practical multimedia multicasting by proposing a novel maximum concurrent multi-flow transmissions algorithm. We used ns2 simulations to evaluate the two flow management policies and the MCMT algorithm. The simulation results demonstrated that the MCMT algorithm achieved at least 80% improvement in increasing the number of admitted flows as compared to some related work. In addition, we discussed the potential to use the two policies and the algorithm to support QoE-aware multimedia services. With the further development of QoE schemes on relating user experience to QoS, our study will be useful for QoE applications. Moreover, the practical implementation of the two proposed policies can be easily integrated into other existing wireless routing protocols without further hardware or network architecture deployment.

REFERENCES

[1] K. Jain, J. Padhye, V.N. Padmanabhan, and L. Qiu. Impact of interference on multi-hop wireless network performance. ACM/Springer Wireless Networks 11:471487, 2005.

[2] M. Kodialam, and T. Nandagopal. Characterizing achievable rates in multi-hop wireless networks: the joint routing and scheduling problem. Proc. ACM MobiCom 2003.

[3] M. Kodialam and T. Nandagopal. Characterizing the capacity region in multi-radio multi-channel wireless mesh networks. Proc. ACM Mobi- Com 2005.

[4] P. Wan. Multiflows in Multihop Wireless Networks. Proc. ACM MOBIHOC 2009.

[5] R. Cruz, and A. Santhanam. Optimal routing, link scheduling and power control in multi-hop wireless networks. Proc. IEEE Infocom 2003.

[6] T. El-Batt and A. Ephremides. Joint scheduling and power control for wireless ad hoc networks. IEEE Trans. Wireless Commun., vol. 3, January 2004.

[7] G. B. Middleton, B. Aazhang, and J. Lilleberg. A flexible framework for polynomial time resource allocation in multiflow wireless networks. Proc. the 47th Allerton Conference on Communication, Control and Computing, September 2009.

[8] G. B. Middleton, B. Aazhang, and J. Lilleberg. Efficient Resource Allocation and Interference Management for Streaming Multiflow Wireless Networks. Proc. IEEE ICC, May 2010.

[9] R. Cruz. A Calculus for Network Delay, Part I: Network Elements in Isolation. IEEE Trans. Information Theory, vol. 37, no. 1, pp. 114-131, January 1991.

[10] Guokai Zeng, Bo Wang, Yong Ding, Li Xiao, and Matt Mutka. Multicast algorithms for multi-channel wireless mesh networks. Proc. of 15th IEEE International Conference on Network Protocols (ICNP 2007), Beijing, China, October 16-19, 2007.

[11] W. Tu, C. Sreenan, C. Chou, A. Misra, and S. Jha. Resource-aware video multicasting via access gateways in wireless mesh networks. Proc. 2008 IEEE International Conference on Network Protocols (ICNP'08), Florida, USA, October, 2008.

[12] M. Garetto, T. Salonidis, and E. Knightly. Modeling per-flow throughput and capturing starvation in CSMA multi-hop wireless networks. Proc. the 2006 IEEE Infocom, Barcelona, Catalunya, Spain, April 2006.

[13] M. Baghaie, D. S. Hochbaum, B. Krishnamachari. On hardness of multiflow transmission in delay constrained cooperative wireless networks. In Proc. the 2011 IEEE Globecom, Houston, Texas, USA, 5-9 December 2011.

Authors Profile

P.Sangeetha received the **B.E.** degree in electronics and communication engineering from the Sardar College of Engineering, Tirunelveli, Anna University, Chennai, India. Currently doing **M.E.** in electronics and communication engineering (Applied Electronics) in P.S.R Engineering College, Sivakasi, India. Her research interest includes wireless networks, Mobile Ad hoc networks, Sensor Networks, and Embedded Systems.