International Journal of Computer Applications (0975 – 8887)
Volume 30– No.9, September 2011

A Well-organized Dynamic Bandwidth Allocation Algorithm for MANET

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ABSTRACT: The anxiety made by users are mounting as the 'mobile ad hoc networks' became an essential part of this stage and call for the use of significant applications such as multimedia and videoconferencing. In this paper we introduce a new examine model with a dynamic stipulating architecture that provides bandwidth allocation dynamically based on its utility. Initially allocate the required bandwidth with respect to the user`s subscription & monitors the broadcast to reshuffle the bandwidth allocation if any congestion occurs. In addition, the network periodically individuates unused bandwidth and suggests immediate convention where extra-bandwidth is allocated and guaranteed entirely to users who can utilize it to transmit at a higher rate than their subscribed rate. We exhibit through simulation in a network scenario that the proposed dynamic bandwidth provisioning model is greater than the static bandwidth provisioning algorithm with respect to the utilization of bandwidth and user`s support.

Keywords

Mobile adhoc networks; Bandwidth allocation; Dynamic provisioning architecture; Lingering bandwidth estimation; Quality of Service

1. INTRODUCTION

A mobile ad hoc network is a self-configuring network of mobile devices connected by wireless links. Nodes in mobile ad hoc network are free to move and organize themselves in an arbitrary fashion. The Quality of Service (QoS) refers to the ability of a network to provide better services for the selected network traffic. The main goal of QoS in MANET is to attain a more reliable network behavior so that the information carried out by the network can be delivered with better utilization of network resources. A well-organized dynamic resource providing algorithms are essential for the development of QoS networks. The main objective of these algorithms is to offer services to satisfy the requirements of QoS to the individual users in terms of utilization of network resources. In cellular networks, resource allocation is carried out in a static way, taking place on the order of hours or months. Conversely, static allocation of network resources can turn out to be an inefficient or considerably not fully utilized if drastically the traffic statistics changes [1].

Thus, a main challenge for the expenditure of QoS is the growth of solutions that can dynamically follow traffic statistics and allocate network resources efficiently. While satisfying the QoS requirements of users, concentrate on maximizing, all together, resource utilization and network profits. The key resource in MANET, the bandwidth is not adequate than that of wireline networks. In the past few years, the number of mobile users has increased massively for the reason that easy access to wireless networks. In the meantime, new wireless applications in particular bandwidth-exhaustive multimedia applications are upcoming which influenced the bandwidth demand in wireless networks. Recently, dynamic bandwidth allocation has paying attention in research interest and many algorithms have been projected in the papers [1, 2]. These approaches and related works are discussed in Section 2. In this paper we propose a new service model that provides the bandwidth guarantees based on the amount of traffic and subscription of transmission rate by users. In addition, the network individuates the unused bandwidth periodically and suggests immediate indenture where additional bandwidth is to be allocated and guaranteed the users who can make use of it for high transmit rate than their subscribed rate. To implement this service model we propose a scattered provisioning architecture intended with core and access routers.

The core routers are responsible for monitoring the traffic and if importunate congestion is detected, it immediately report to access routers. Based on communication from core routers, access routers allocate bandwidth dynamically and efficiently using our proposed algorithm. Moreover, the access routers are periodically estimating the lingering bandwidth and taking into consideration of user`s profile and willingness to get hold of extra-bandwidth based on their utility function for reallocation of bandwidth.

We assess the performance of our proposed bandwidth allocation algorithm by simulation in realistic network circumstances. Simulation results show that our architecture allows to attaining better performance than statically allocated bandwidth in networks in terms of accepted traffic and network profits. In brief, this paper provides the definition of a new service model and the scheme of a stipulating architecture that achieves a dynamic bandwidth allocation to maximize the user's utility and network profits. The paper is structured as follows: Section 2 discusses related work. Section 3 presents our proposed service model and stipulating architecture. Section 4 converses the technique for estimating lingering bandwidth in the path and its performance altitude. Section 5 describes the proposed dynamic bandwidth allocation algorithm. Section 6 discusses simulation results that show the efficiency of our dynamic resource allocation algorithm compared to a static allocation technique. Finally, Section 6 concludes this work.

2. RELATED WORK

The problem of bandwidth allocation in wireless networks has been deal with in many recent works. Even if the progress is being made for high-speed wireless communications, such as the introduction of 3G and WLAN, bandwidth is still the major bottleneck in wireless networks due to the physical limitation of wireless media.

Dynamic bandwidth provisioning in QoS networks has recently attracted a lot of research attention due to its prospective to attain efficient resource utilization to network users. In [1], the authors proposed a dynamic core provisioning architecture for distinguished services IP networks. The core provisioning architecture consists of a set of lively node and algorithms for interior nodes and core nodes. The provisioning algorithm assume a self-adaptive mechanism to adjust service weights of weighted fair queuing schedulers at core routers and it reduces the boundary bandwidth while receiving a congestion signal from a node provisioning module and affords periodic bandwidth rearrangement. This rearrangement of bandwidth allocation has similar objectives to our dynamic bandwidth allocation algorithm. Conversely, their service model differs from our proposed model and they are not taken into account the traffic statistics in the allocation procedure. Moreover, the architecture they followed only a centralized scheme not the distributed architecture as we proposed. The authors T. Ahmed, R. Boutaba, and A. Mehaoua.in [6], proposed a policy-based architecture with a measurement-based approach for dynamic QoS version in DiffServ networks. The proposed architecture is a collection of one Policy Decision Point (PDP) and a set of Policy Enforcement Points (PEP). All these points are mounted in access routers and bandwidth monitors applied in core routers. While any considerable changes in available bandwidth the monitors will inform the PDP which changes dynamically the policies on in-profile and out-of-profile input traffics based on the current state of the network estimated using the information collected by the monitors. But the authors does not take into account the users utility function and their ultimate compliance to be charged for transmitting out of profile traffic, consequently it increase the network revenue. In [3], a standard pricing structure is presented to differentiate the pricing schemes currently used in the Internet. A congestion-sensitive pricing algorithm is introduced to provide an incentive for multimedia applications to adapt their sending rates according to network conditions. As per the suggestion presented in [3], we make an allowance for user`s bandwidth utility functions to implement our proposed allocation algorithm for achieve the maximum network revenue. The authors in [4], proposed an active resource management approach (ARM) for differentiated services environment. The basic concept of ARM is that by effectively knowing when a client is sending packets and how much of its allocated bandwidth is being used at any given time, to reallocate the unused bandwidth without loss of service. This concept is in turn with our proposed bandwidth allocation algorithm. However, ARM does not guarantee to the user a minimum subscribed bandwidth throughout the convention period, since unused bandwidth is sent to a pool of available bandwidth and it can be used for new connections in the network, regardless of those already admitted. The authors of [9] suggested for bandwidth reservation for maximum utilization of resource. It may either static or dynamic. Static approach reserves a fixed percentage of bandwidth in the network. The advantage of static reservation is that no communications between nodes are needed thus it is very trouble-free in practical implementation. Dynamic bandwidth reservation can change the amount of reserved bandwidth according to the traffic on the network. Compared to static reservation, it usually achieves better performance in reducing dropping probability. However, dynamic reservation often involves high implementation complexity and message overhead since it needs the calculation of traffic and the frequent message exchanges between nodes. In [7] a max-min fair allocation algorithm is proposed to allocate bandwidth equally among all connections bottlenecked at the same link. In our work we extend the max-min fair allocation algorithm with new service model to perform a periodical allocation of unused bandwidth to users who expect more than their subscribed rate.

3. SERVICE MODEL AND DYNAMIC STIPULATING ARCHITECTURE

We offer a service model that provides a quantitative bandwidth assurance to users and then reallocate the unused bandwidth observed periodically in the network. In this process, different weights are assigned to network users to allocate extra bandwidth with different precedence. Such weights can be set based on the application proposed by the user, or can be modified based on the user bandwidth utility function.

Thus our proposed service model has the following characteristics:

- A quantitative bandwidth guarantee, expressed through the requirement of user's subscribed rate
- Short-term assurance for additional bandwidth by periodical monitoring of the network
- A weight that expresses the user's priority in the assignment of extra bandwidth
- A bandwidth utility function, $U(x)$ that shows the user's preference for an allocation of x bandwidth units. As in the paper [8] we consider the utility function as part of the service model.

To apply our service model we assume a stipulating architecture composed by core and access routers, as shown in Fig. 1.

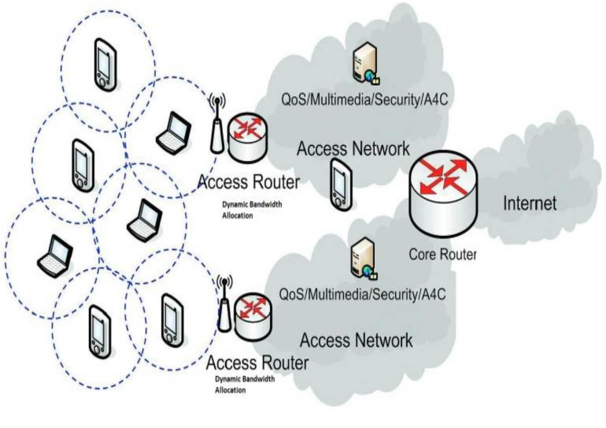

Figure 1. Distributed Architecture

Traffic monitors are installed on access and core routers to perform online measurements on the incoming traffic flows. Core routers send messages with access routers to report the congestion situation. Our proposed dynamic bandwidth allocation algorithm is deployed in all access routers. Each access router collects the measurements performed by traffic monitors and periodically reallocates the bandwidth by implementing our algorithm and exchange update messages with all other access routers to report the current incoming traffic statistics. In addition, it takes into account the congestion information reported by core routers to allocate network resources dynamically and efficiently.

4. LINGERING BANDWIDTH ESTIMATION

Mobile ad hoc networks are not disposing any consistent mechanism for quality of service. Therefore, nowadays research in this field has received much attention. Though, estimating the lingering bandwidth still represents one of the main difficulties to address when designing a QoS solution. In this section, we proposed an improved estimation mechanism to calculate the lingering bandwidth in MANET.

The lingering bandwidth estimation techniques can be divided in two categories[8],

Proactive Approach: This method is based on end-to-end probe packets to estimate the lingering bandwidth along a path.

Passive Approach: This method uses local information on the used bandwidth and that may finally exchange via local broadcasts. Usually these local broadcasts are performed using Hello messages that are used in many routing protocols to discover local topology. Local passive measurements combined to control packets and locally broadcasted appears a reasonable overhead, in particular considering that most routing protocols already use Hello packets to determine local topology. So we propose that resources evaluation information may be piggybacked in such packets at a very less cost. In our technique, neighboring nodes exchange their available bandwidth computed locally via Hello messages. Let us consider an arbitrary node s in the network during an observation interval of Δ seconds. Every Δ seconds, each node locally estimates its medium possession and includes this information in such a Hello packet. The accuracy of the bandwidth evaluation performed audibly depends on the value of Δ, which represents the period between two consecutive measurements. When the larger Δ, the measurements are more stable. On the other hand, Δ should be small enough to acquire fast result when load variation and mobility of nodes. For this study, we have randomly chosen $\Delta = 1$ second, i.e. two times faster than the Hello messages period. In the lead reception of a Hello message from a node S, a node R estimates the lingering bandwidth of the link (S,R) using the following equation.

$$AB(s,r) = (1 - K) \cdot (1 - p_m) \cdot B(s,r)$$

Where, p_m is the collision probability for packets of m bits. B(s,r) is the estimated available bandwidth on the link(s, r). K is the proportion of bandwidth lost due to the backoff scheme.

One drawback of passive techniques is the overhead they generate. Preferably, the Hello packets sending frequency should be personalized to the nodes mobility. In the results section, we compare the accuracy of our approach with existing approach by simulation, using network simulator 2.

5. DYNAMIC BANDWIDTH ALLOCATION ALGORITHM

We propose a dynamic bandwidth provisioning algorithm that allocates bandwidth efficiently based on traffic statistics measured by traffic monitor. Bandwidth allocation is performed by access routers periodically and is enforced using traffic conditioners as well as the utilization of previous transmission. We signify the interval between two consecutive allocations performed by the algorithm as the revise interval, whose duration is *Tu* seconds. In addition, core routers monitor the flow of the traffic and if congestion detected on some links, it immediately notify to access routers. The access routers solve this situation by implementing dynamic bandwidth allocation. Initially bandwidth is allocated to all active connections by considering their subscribed rate and traffic requirements that are expected based on information collected by access routers. The dynamic bandwidth allocation algorithm is performs in two steps. In first step, lingering bandwidth by idle and active connections is estimated on each link by implementing the method we discussed in the previous section. In step two, such available extra-bandwidth is allocated with guarantee during the current update interval exclusively to connections that can take advantage of it since they are already fully exploiting their subscribed rate.

To demonstrate the allocation algorithm, let us model the network as a directed graph $G = (N,L)$ where nodes represent routers and directed arcs represent links. Each link l €L has allied the weight w1. A set of K connections are existing to the network. Each connection is represented by the notation (s_k, d_k, sr_k), for $k = 1, . . .,K$, where s_k, d_k and sr_k represent the links source node, destination node and the subscribed rate, respectively.

At the beginning of the n^{th} update interval, each access router computes the transmission rate, $t_k^{n-1}$for all connections $k \in K$ that access the network through it. The access router send this information to all other access router via control messages as discussed in the section []. Now all access routers having the information about the n-1th transmission rate. The amount of bandwidth allocated to each source k during the n^{th} update, is performed in two-steps approach described as follows :

: First step: Connections having the transmission rate t_k^{n-1} < r-mink considered as inactive where r-mink is the initial subscription of bandwidth. All other active connections are further classified as insatiable if they used a fraction greater than of their subscribed rate s_{rk} otherwise they are classified as moderate. Let us denote by K_i, Kis and K_{md} the sets of inactive, insatiable and moderate connections, respectively.

: Second Step: Implement the bandwidth allocation algorithm. The dynamic bandwidth allocation algorithm is described in Table.1

Table 1. Dynamic bandwidth allocation algorithm

Step 1: Identify the types of connection from each node i.e. If bandwidth allocated in the past measurement is not fully utilized is referred as Inactive, More bandwidth is used then the node named as insatiable otherwise referred as moderate where the bandwidth is utilized as per the subscription.

Step 2: Allocate bandwidth for inactive & moderate connections based on past traffic measurements i.e. $A_k^n = \min(U(x), s_{rk})$.

Step 3: Find out the lingering bandwidth from Inactive and moderate connections.

Step 4: Allocate the bandwidth for insatiable connections using the expression: max $(2*U(x), s_{rk})$.

6. SIMULATION RESULTS

The dynamic bandwidth allocation algorithm offered above has been implemented and evaluated using the NS-2 network simulator, version 2.33. During a simulation, we assign the bandwidth based on the requirement by the nodes. We then compute the remaining bandwidth on the link by measuring the length of idle periods and bandwidth usage by the node. In such estimation, the logs of the emitter and receiver are synchronized. The allocation algorithm is implemented in core and access routers. After periodical evaluation the algorithm will execute and allocated the bandwidth based on the constraints we already presented.

In this section, we compare the accuracy of our proposed algorithm and static allocation algorithm. In our scenario we measure the effectiveness of the proposed dynamic bandwidth allocation algorithm with the network that consists of 2 core nodes, 6 access nodes, 40 end nodes (20 source-destination pairs). The buffer size of each link can contain 50 packets.

The parameters used for both the scenarios are presented on Table.2

Table 2: General Parameters for Simulations

Parameter	Values
HELLO interval	1 s
Packets size	1000 bytes
Medium capacity	11 Mbps
Communication range	250m
Carrier sensing range	550m
Grid size	900×900m
Core & Access Routers	2 & 23

Simulation results illustrate that our allocation algorithm allows increasing both resource utilization and network revenue with respect to static provisioning algorithms. The figure shows that the bandwidth utilization, packet delivery ratio is more optimum than the existing static bandwidth allocation. At the initial stage the static provisioning technique attains the performance equally with our proposed dynamic provisioning approach. This is because of the static provisioning is sufficient to handle incoming traffic initially. Conversely, our proposed model monitors the network flow for some time and starts its reallocation by implementing dynamic provisioning algorithm periodically to obtain better performance than the existing model.

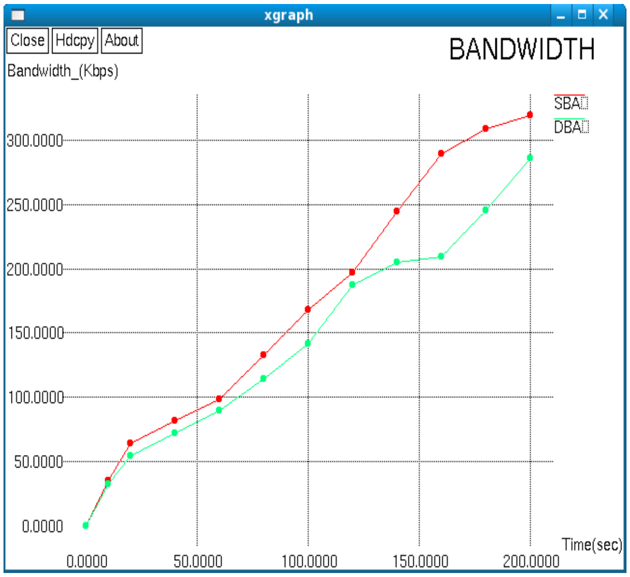

Figure 2. Bandwidth utilization

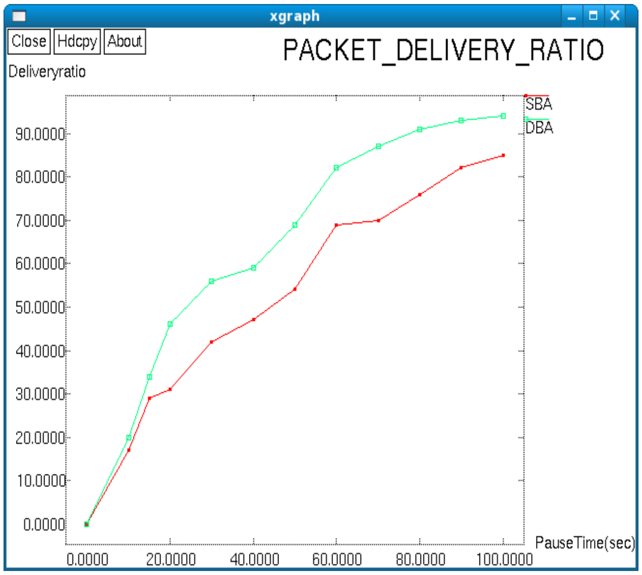

Figure 3. Packet delivery ratio

7. CONCLUSION

The optimized bandwidth allocation in mobile ad hoc networks has been addressed in this paper. To implement the proposed algorithm we suggests a new service model where users can subscribe for certain bandwidth, and the network periodically individuates lingering bandwidth that is re-allocated and guaranteed for users who can better make use of it. Also we implemented a well-organized bandwidth allocation algorithm that takes traffic statistics into account to increase the packet delivery and optimum bandwidth utilization. Simulation results conscious in network scenarios and show that our proposed allocation algorithm allows to increase both resource utilization and network revenue with respect to static provisioning techniques.

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