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Convolution Analysis and Algorithm for Advance Bandwidth Preparation in Devoted Networks

Aswathi G.A[1],P.Durga[2], S.Arunmozhivarman[3], B.Devandar Rao[3]
[*1,2]U.G Student, [3]Assistant Professor,
Department of Computer Science and Engineering
Alpha College of Engineering, Chennai, India.
[1]*aswathinair18@gmail.com*

Abstract: An increasing number of high-performance networks provision dedicated channels through circuit switching or MPLS/GMPLS techniques to support large data transfer. The link bandwidths in such networks are typically shared by multiple users through advance reservation, resulting in varying bandwidth availability in future time. Developing efficient scheduling algorithms for advance bandwidth reservation has become a critical task to improve the utilization of network resources and meet the transport requirements of application users. We consider an exhaustive combination of different path and bandwidth constraints and formulate four types of advance bandwidth scheduling problems, with the same objective to minimize the data transfer end time for a given transfer request with a prespecified data size: 1) fixed path with fixed bandwidth (FPFB); 2) fixed path with variable bandwidth (FPVB); 3) variable path with fixed bandwidth (VPFB); and 4) variable path with variable bandwidth (VPVB). For VPFB and VPVB, we further consider two subcases where the path switching delay is negligible or nonnegligible. We propose an optimal algorithm for each of these scheduling problems except for FPVB and VPVB with nonnegligible path switching delay, which are proven to be NP-complete and nonapproximable, and then tackled by heuristics. The per-formance superiority of these heuristics is verified by extensive experimental results in a large set of simulated networks in comparison to optimal and greedy strategies.

Index Terms: *Bandwidth scheduling, dedicated networks, nonapproximable.*

1. INTRODUCTION

To improve the bandwidth utilization while maintaining the same QoS guaranteed services, our research objective is twofold: 1) the existing bandwidth reservation is not changed to maintain the same QoS guaranteed services. 2) our research work focuses on increasing the bandwidth utilization by utilizing the unused bandwidth. We propose a scheme, named Bandwidth Recycling, which recycles the unused bandwidth while keeping the same QoS guaranteed services without introducing extra delay. The general concept behind our scheme is to allow other SSs to utilize the unused bandwidth left by the current transmitting SS. Since the unused bandwidth is not supposed to occur regularly, our scheme allows SSs with non-real time applications, which have more flexibility of delay requirements, to recycle the unused bandwidth. Consequently, the unused bandwidth in the current frame can be utilized. It is different from the bandwidth adjustment in which the adjusted bandwidth is enforced as early as in the next coming frame. Moreover, the unused bandwidth is likely to be released temporarily (i.e., only in the current frame) and the existing bandwidth reservation does not change. Therefore, our scheme improves the overall throughput while providing the same QoS guaranteed services. There are two types of BRs defined in the IEEE 802.16 standard: incremental and aggregate BRs.

Fig 1: Wireless Mesh Network

The former allow the SS to indicate the extra bandwidth required for a connection. Thus, the amount of reserved bandwidth can be only increased via incremental BRs. On the other hand, the SS specifies the current state of queue for the particular connection via aggregate request. The BS resets its perception of that service's needs upon receiving the request. Consequently, the reserved bandwidth may be decreased.

1.1.Role of Bandwidth

There is not enough bandwidth in use nowadays and it seems that as the more of it could be used. Of course the performance level arises all the time, but with quality of service development the bandwidth that is in hand can be used a lot better and better applications and services can be developed for the customers. Even if everyone knew that in a known period of time, the performance of the communications systems would grow enough for the services that one would like to implement, the developed services could already be developed and tested in the old systems with more optimal usage of the resources in hand. Surely this kind of an approach would lead to an advantage in the field of competition in data communications business, especially for the service providers. Reliability of the transmission media plays an important role in the developed data communications equipment and in the transmission protocols. Reliability is one of the most important things when it comes to the services too. In many services, the low level of reliability makes them unusable. In a way, reliability is a component of quality of service - the more reliable the system, the higher the level of QoS.

1.2. What is IEEE 802.16

IEEE 802.16 standard was designed to support the bandwidth demanding applications with quality of service (QoS). Bandwidth is reserved for each application to ensure the QoS. For this effectively reducing the dropping rate of package can help the multimedia to be played more perfectly and it can achieve the QoS of multimedia service that is expected by users. This stable data transmission relies on the scheduling mechanism of MAC layer for IEEE 802.16x. There are four classes of service defined in the specification of IEEE 802.16x and they are Unsolicited Grant Service (UGS), real-time Polling Service (rtPS), non-real-time Polling Service (nrtPS) and Best Effort (BE), respectively (IEEE Std 802.16-2004, 2004; IEEE Std 802.16e-2005, 2005; Nair et al., 2004).

2. Existing System

Important part in bringing out the network services lies in existing technology. Routing and switching are the main methods of delivering the data through the network. Both have their disadvantages and benefits and there are many variations of them applying in different ways to different situations. Another big issue is the resource handling with QoS. In IP world, there are a few proposals to resource handling problems and besides that there are a few technologies providing different approaches to QoS problems. These include for instance ATM and Gigabit Ethernet.

2.1Switching

Data transmission by purely switching the traffic through the network is the method used traditionally in telecommunications systems. Essentially switching means that a constant bandwidth is allocated from the total bandwidth of the transmission medium and the whole allocated bandwidth is used for data interchange for the time that the bandwidth allocation is taking place. Normally, this kind of bandwidth usage is connection oriented and requires the interchange to contain different phases including connection establishment, data interchange and connection closing. In fact this kind of a switching is normally accomplished at OSI protocol stack layer 2, which is the link layer. Throughout this text this kind of a switching is regarded as layer 2 switching. Actually, layer 2 switching can simply be considered bridging and in this logic, layer 3 switching is routing.

2.3Routing

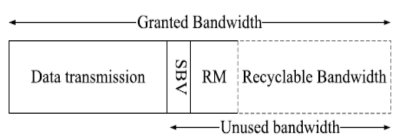
In turn, routing is the main method used in TCP/IP networks nowadays. Routing uses the bandwidth in a different way. It does not allocate constant bandwidth. Instead, in routing, the data is transported in packages that are delivered through the network by searching for the right directions in network nodes that are called routers. Therefore routing is regarded as connectionless and it does not require the data interchange phases that are needed in switching. Routing could be thought as a way of optimizing the bandwidth usage.

Dynamic bandwidth request-allocation algorithm and Priority-based Scheduling Algorithm:

A dynamic bandwidth request-allocation algorithm for real-time services is proposed in. The authors predict the amount of bandwidth to be requested based on the information of the backlogged amount of traffic in the queue and the rate mismatch between packet arrival and service rate to improve the bandwidth utilization. The research works listed above improve the performance by predicting the traffic coming in the future. Instead of prediction, our scheme can allow SSs to accurately identify the portion of unused bandwidth and provides a method to recycle the unused bandwidth. It can improve the utilization of bandwidth while keeping the same QoS guaranteed services and introducing no extra delay.

3. Modules

3.1. Bandwidth utilization Module:

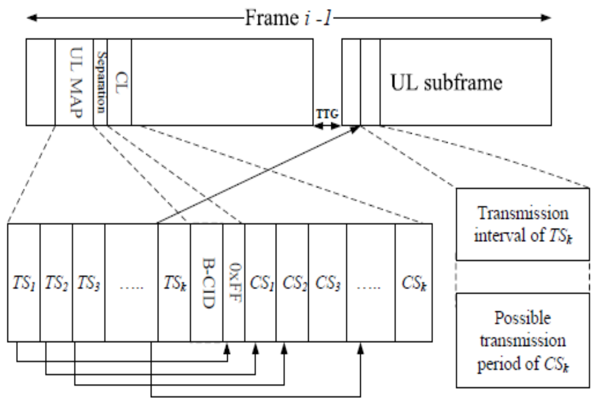


Bandwidth utilization improvements have been proposed in the literature. In, a dynamic resource reservation mechanism is proposed. It can dynamically change the amount of reserved resource depending on the actual number of active connections. The investigation of dynamic bandwidth reservation for hybrid networks is presented in. Evaluated the performance and effectiveness for the hybrid network, and proposed efficient methods to ensure optimum reservation and utilization of bandwidth while minimizing signal blocking probability and signaling cost. In, the enhanced the system throughput by using concurrent transmission in mesh mode.

3.2. Packet creation module:

In this module we split the Data in to N number of fixed size packet with Maximum length of 48 Characters.

3.3. Bandwidth recycling Module:



The complementary station (CS). Waits for the possible opportunities to recycle the unused bandwidth of its corresponding TS in this frame. The CS information scheduled by the BS is resided in a list, called complementary list (CL). The CL includes the mapping relation between each pair of pre-assigned C and TS.

3.4. QoS guaranteed services Module:

It is different from the bandwidth adjustment in which the adjusted bandwidth is enforced as early as in the next coming frame. Moreover, the unused bandwidth is likely to be released temporarily (i.e., only in the current frame) and the existing bandwidth reservation does not change. Therefore, our scheme improves the overall throughput while providing the same QoS guaranteed services.

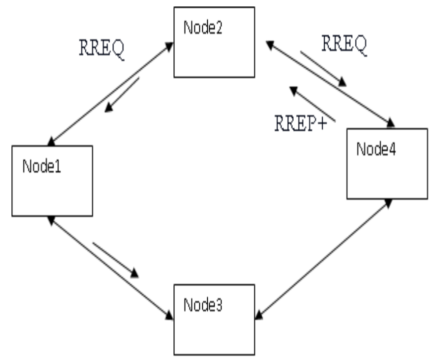
3.5. Traffic and Packet Performance:

The Packet mean data rate of each application but make the mean packet size randomly selected from 512 to 1024 bytes. Thus, the mean packet arrive rate can be determined based on the corresponding mean packet size. As mentioned earlier, the size of each packet is modeled as Poisson distribution and the packet arrival rate is modeled as exponential distribution.
The other factor that may affect the performance of bandwidth recycling is the probability of the RM to be received by the CS successfully.

4. CONCLUSION

We proposed bandwidth recycling to recycle the unused bandwidth once it occurs. It allows the BS to schedule a complementary station for each transmission stations. Each complementary station monitors the entire UL transmission interval of its corresponding TS and standby for any opportunities to recycle the unused bandwidth. Besides the naive priority-based scheduling algorithm, three additional algorithms have been proposed to improve the recycling effectiveness. Our mathematical and simulation results confirm that our scheme can not only improve the throughput but also reduce the delay with negligible overhead and satisfy the QoS requirements.

Data flow Diagram:



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