Intelligent algorithm for allocating bandwidth based on the predictive model in satellite networks DVB-RCS

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Abstract: Nowadays, in communications there is a need for a high-bandwidth communication, good quality, universal coverage and the economic cost are placed in the high degree of importance. Actually ground networks have been disabled in this issue, but telecommunications have proved that they can be very successful in this field. Among the satellite networks DVB-RCS standard is an advanced model that has been recently proposed and demonstrated its high performance. Due to bandwidth sharing between the terminals of the sender, an intelligent mechanism for bandwidth allocation is needed. In this study, an algorithm is proposed to change bandwidth allocation mechanism to improve the delay of packets sent by the terminal in DVB-RCS satellite network. The algorithm, using the predicting method, predicts the expected demand for bandwidth from the terminals. The above-mentioned method in the allocated unit, Performance and available bandwidth is divided between terminals based on a percentage of the number of packages. By The implementation of this algorithm, the burst traffic problems caused by the terminals are reduced. Unlike the existing algorithms, this algorithm performance in different types of traffic is desirable and the same. Network performance of the proposed algorithm on traffic status with the rate constant and the requested model VBDC, improves 15 per cent than the standard allocation method. The efficiency of the proposed algorithm explosive production rate and application model RBDC increases 50 per cent.
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1. Introduction

Standard mechanisms to request and allocate the bandwidth cover many problems related to this field. But a lifelong goal is reducing the delay time of packets in the network.[2] Current satellite bandwidth allocation mechanisms only act according to the demands of a previous terminal stage. But if the request is expected to be the next terminal. In this way, the future terminals will have a better view of the situation demands. Also, the delay time of packets in the network is reduced; this is a topic that has been discussed in this paper.

2. DVB-RCS standard and how to access the bandwidth of sending

Protocols were designed and proposed to provide two-way communication between the user and the satellite which considers the issues related to the physical layers. One of the standards in this field is the European standard DVB-RCS.It includes issues like the definition of classified information frames, control frames and the structure of competition as a mechanism to access the communication channel.[4] The main components of this standard satellite network are: (Fig. 1)

- Send and receive satellite terminals: a terminal for two-way sending and receiving data via satellite link

Network control center for satellite: the satellite network control unit and is responsible for the several satellite terminal control functions, information providers and gateways for the ground connection.[1]

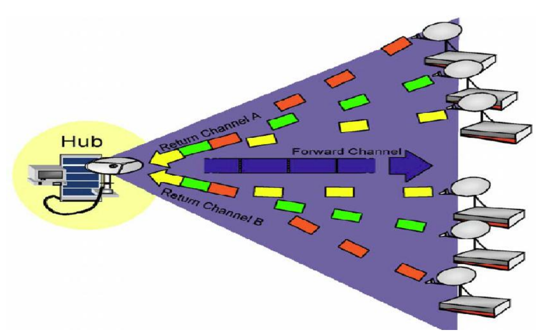

Figure (1): Network satellite (sweep channel)

One of the places for the Implementation schedule algorithm is the network control center, And its duty is to determine the time interval to send And the amount of bandwidth required for each Ground terminal.[3] The control center does this by studying the Received requests from terminals. In other words, in the DVB-RCS standard on all terminals at certain intervals and by sending special control frames, they report the bandwidth required to the control center.

Control center using a special algorithm allocates the available bandwidth to each terminal. And notifies each terminal about the number and location of the allocated intervals in each super frame by sending control frames. Frame structure in satellite communications is often TDMA. The concept of MF-TDMA is used in The DVB-RCS standard.[7] In this structure frames included intervals and different frequencies and therefore are known as super frame. Figure 2 shows the structure of a super frame. Each super frame consists of a frame which located on a different frequency Carrier. Each frame is composed of a number of intervals.

- Send bandwidth request methods
- Continuous Rate Assignment (CRA): In this method, a fixed-rate is allocated to satellite terminal and in each super frame. The allocation of fixed capacity must be agreed in advance between the NCC and RCST. In this case The terminal does not need to send the consecutive requests. And only when it wants to change the amount of bandwidth required sends a request to the control center.
- Rate Based Dynamic Capacity (RBDC): In this method, the dynamic allocation of bandwidth to the terminal after the request is made. In this case The last request was sent from the ground terminal and is the operating criteria. he maximum application rate shall not exceed pre-agreed. In order to avoid unnecessary bandwidth allocation to terminals that are outside of the network, Rates validity period of the demand dynamics in the central station super frame is adjustable between 1 to 15. In this method, the amount of bandwidth required is calculated on the rate of traffic entering terminals.[6]
- Dynamic capacity allocation based on volume (VBDC): In this method, capacity is sent based on the volume of requests in the terminal buffer.

  In this method, the latest request from the terminal is gathered with all the demands that have been sent and not yet received. By allocating the amount of bandwidth by the base station, the volume of data sent by the terminal, the next call volume decreases... This kind of request is suitable for a variety of traffic that has variable rate and explosive properties. [6]
- Dynamic capacity allocation based on full volume (AVBDC): This method is the same as the previous method. But in this case, the terminal sends the total capacity required. In this method, by entering each new request from the terminal, the previous request is canceled. This method is used in situations in which the lack of channel quality, the requests will likely be destroyed earlier.
- Free Capacity Assignment (FCA): The remaining capacity allocation of satellite bandwidth which has been the remaining part after responding to all requests. This procedure is performed by the control center and without request by the terminal. The capacity is quite variable and we have no control over it. Capacity allocated by this method can be used only to reduce the delay of packets. [5]

3. Prepare Your Paper Before Styling Intelligent algorithm for allocating bandwidth based on the predictive model in satellite networks DVB-RCS

There are two channels of sending information in satellite networks. go channel (hub terminal) and back channel (terminal to hub). Go channel is divided by channel sharing method TDMA between terminals and is public broadcasting technique. But the back channel is moved back to a different channel. In this channel Information sender is a multiple terminals and receiver of a channel (hub) is very important to send the schedules. The MF-TDMA method was presented. In this way, the bandwidth is divided between the terminals by applying algorithms bandwidth allocation. The requested algorithms were various and are greatly optimum. However, standard algorithms studied, we found that we can make changes in allocation algorithm to achieve better results. This is due to the frequency allocation algorithm is much higher than the algorithm application. And the allocation algorithm is run several times between two successive requests. Because the information is old, amount of bandwidth allocated to the terminal will not be coordinated to the terminal need. To solve this problem it is proposed to add the predictive function to the allocation algorithm. This function keeps the requests of last 10 stage of each terminal, in order to get a good guess from the terminal bandwidth need between two consecutive requests.

The predictive formulas:

R: the number of terminal packs

T: Last time intervals

$$\bar{R}=\hat{a}+\hat{b}T \quad (1)$$

$$\hat{b} = \frac{\sum T_i R_i - n\bar{T}\bar{R}}{\sqrt{\sum (T_i - \bar{T})^2}} \quad (2)$$

$$\hat{a}=\bar{R} - \hat{b}T \quad (3)$$

We consider points in the implementation of this algorithm to obtain better results. Such as:

- The Initialization of requests stored with zero

- Saving a new request in the First time allocation algorithm after applying request algorithm
- Shifting the values stored in the allocation algorithm re-performances

The algorithm presented in this chapter caused by the change in the number of intervals allocated to each terminal by hub. In the case the value predicted by the previous requests will be replaced instead of the latest request from the terminal. However, this will be conducted in second phase of the allocation algorithm after receiving the request. As a result, this would be like sending a new request and changes the number of slots assigned to the terminal.

4. Simulating bandwidth request algorithms Using the standard allocation method

In this section bandwidth request methods are simulated based on Standard allocation method on satellite networks with different number of terminals with different traffic. In The figures presented the delay mean of packet sending from the terminals at different times are calculated. To calculate the delay time, we subtract the arrival time of packets to the terminal queue from the departure time of the send queue.

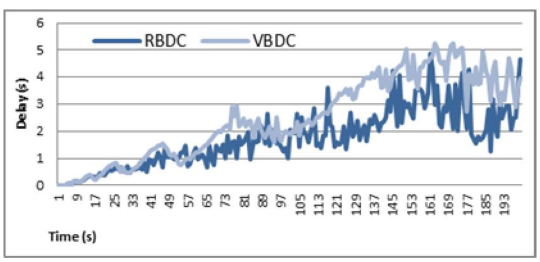

Figure (2): satellite network with 32 terminals and traffic with a rate constant

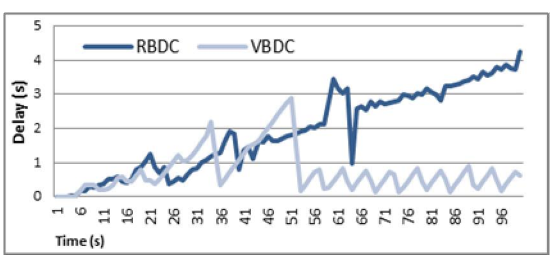

Figure (3): satellite network with 6 terminals and traffic with Explosive production rate

5. Diagram Analysis

We get the following results by analyzing the graphs in the previous section:

- The delay mean of sending packets in RBDC method is up to 30 percent better than VBDC method in the network with rate constant traffic.
- The delay mean of sending packets in VBDC method is about 40 percent better than RBDC method RBDC in the network with explosive production rate traffic.

According to The two results presented we will discover that each of these methods using the standard allocation algorithm has a desirable performance In one category of traffic.

6. The Simulation of bandwidth request algorithms using predictive allocating method

In the following diagrams, bandwidth request algorithms of VBDC and RBDC are simulated using predictive bandwidth allocation algorithm and the delay mean diagrams of sending packet are shown in the network terminals. In order to have a better analysis each request algorithm is simulated by two allocation methods and is shown. The charts below distinguished the request algorithm from predictive allocation by the letter F.

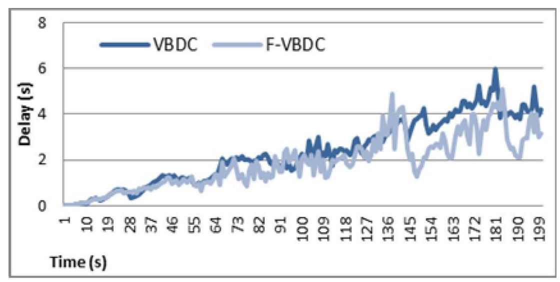

Figure (4): satellite network With 32 terminals and traffic with a rate constant

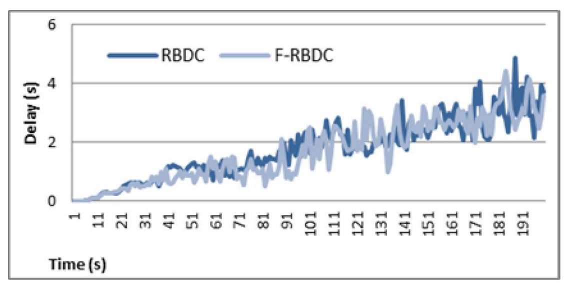

Figure (5): satellite network with 32 terminals an traffic with a rate constant

By calculating the delay mean of the network presented in graphs and some other networks, Percent following improvements were achieved:

- Network with 4 terminals and traffic with a rate constant: there was no recovery in RBDC method
- Network with 4 terminals and traffic with a rate constant: there was 15 % recovery in VBDC method

- Network with 6 terminals and traffic with a rate constant: there was 10 % recovery in RBDC method
- Network with 6 terminals and traffic with a rate constant: there was 15 % recovery in VBDC method
- Network with 8 terminals and traffic with a rate constant: there was no recovery in RBDC method
- Network with 8 terminals and traffic with a rate constant: there was 15 % recovery in VBDC method
- Network with 16 terminals and traffic with a rate constant: there was 10 % recovery in RBDC method
- Network with 16 terminals and traffic with a rate constant: there was 15 % recovery in VBDC method
- Network with 32 terminals and traffic with a rate constant: there was 5 % recovery in RBDC method
- Network with 32 terminals and traffic with a rate constant: there was 15 % recovery in VBDC method

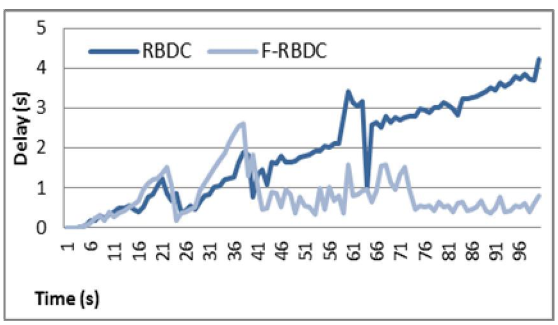

Figure (6): satellite network with 6 terminals and traffic in explosive production rate

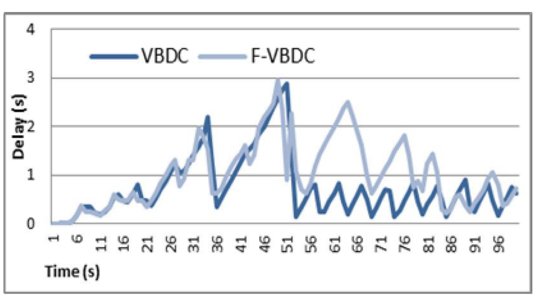

Figure (7): satellite network with 6 terminals and traffic in explosive production rate

By calculating the delay mean of the network presented in graphs and some other networks, the following Percent recoveries was obtained for explosive traffic:

- Network with 6 terminals and traffic in explosive production rate: there was 50 % recovery in RBDC method
- Network with 6 terminals and traffic in explosive production rate: there was no recovery in VBDC method

In the previous simulations, sending bandwidth was about 2Mbps. But it is reduced to around 1Mbps in the new simulation. So the results may be evaluated in a case that has very low bandwidth.

Figure 9 presents the delay mean of packet sending during the simulation time for the bandwidth request algorithm based on VBDC and standard allocation and bandwidth request algorithm based on RBDC and predictive model allocation.

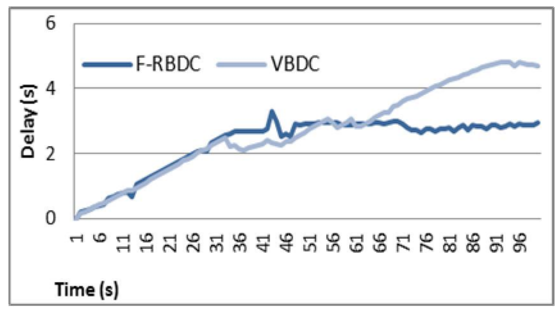

Figure (8): satellite network with a bandwidth of sending 1Mb

Again, the previous result that is achieved that predictive allocation algorithm has better and it has 15 % recovery.

7. CONCLUSION

RBDC request allocation method, with standard allocation in the network with rate constant is better than VBDC methods. VBDC method with the standard allocation in network with explosive rate constant is much better than RBDC method. But the result with predictive allocations is very different. Unlike the standard allocation method which has one desirable performance for each set of traffic and an undesirable performance for another set. In predictive allocation method using RBDC request method has desirable performance in all types of traffic. The following diagrams compare the predictive allocation method with the request method RBDC with RBDC method with standard allocation in constant traffic and VBDC method with constant allocation in explosive traffic. By analyzing this diagram we conclude that Performance of the proposed method in all types of traffic is better than the best request method with the standard allocation of that traffic.

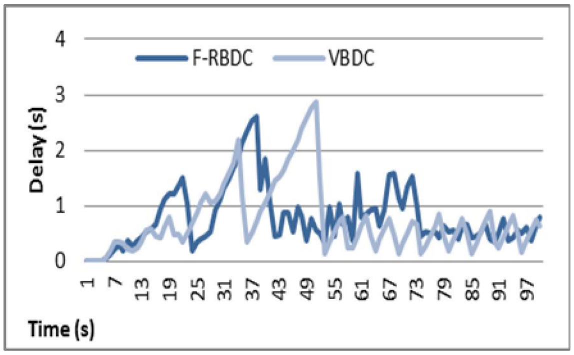

Figure (9): satellite network with explosive traffic rate

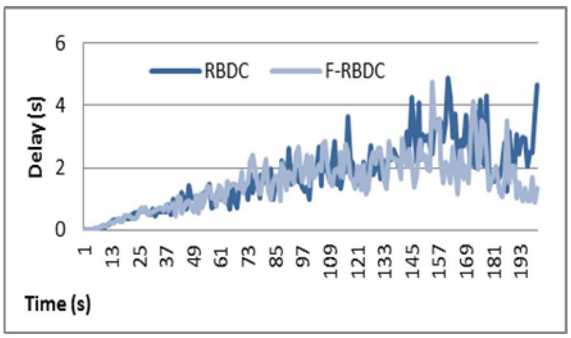

Figure (10): satellite network with constant rate

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