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Analysis of the use of DVB-RCS Resource Assignment Mechanisms for Internet Traffic

Gustavo Chafla A., Fco. Rodriguez Clavijo, Juan Fco. Chafla A.
Pontificia Universidad Católica del Ecuador
gxchafla@puce.edu.ec

Abstract. This paper presents the simulation results of a satellite network based in the Digital Video Broadcast Standard for the outbound channel DVB-S and the return channel DVB-RCS for interactive satellite terminals called RCST. The network model was built under the Network Simulator NS and the main objective was to study the return channel DVB-RCS resource request mechanism and adaptation layer for carrying BE Internet traffic and real time flows. An approach that use rate based (RBDC) requests for traffic with quality of service requirements, and volume based (VBDC) requests for best effort traffic is proposed and evaluated for a corporate scenario that offers services such as voice over ip VoIP, videoconferencing and web surfing.

Keywords: Satellite Communications, Quality of Service, Internet Service, Differentiated Services, Resource Allocation.

1 Introduction

The Digital Video Broadcasting (DVB) standards have greatly fostered the usage of satellite networks for provision of high capacity and quality data services. The DVB-S standard [1] defines a high capacity broadcast channel that can be received by a large set of terminals, and the DVB-RCS (Return Channel via Satellite) standard [2, 3] defines the interaction channel for transmission from the terminals. Several satellite network architectures can be built upon these channels. One of them are the "star-like" topologies, based on gateway nodes transmitting over DVB-S channels to a population of RCS terminals (RCST) that interact with the gateways through the RCS channel. Other architectures are more symmetric and require the usage of On Board Processing (OBP) in the satellite, so that RCST terminals transmit on the RCS channel which is processed on board the satellite, including switching and remultiplexing to a DVB-S channel received by the RCST nodes. This arrangement allows single hop communications among RCSTs.

DVB-RCS uses a multiple access scheme known as MultiFrequency Time Division Multiple Access (MF-TDMA). The standard defines several mechanisms for requesting transmission resources to the Network Control Centre (NCC). These mechanisms can be used for provision of suitable quality of service (QoS) to the upper layers Internet traffic carried over DVB-RCS based satellite networks. This subject has been dealt with both in the proposals (e.g., see [4, 5, 6]) and in recent research projects like IBIS [7] and SATLIFE [8], over the Alcatel Amerhis platform [9]. In addition to the QoS mechanisms used at the DVB-RCS level, there are other relevant issues here: the QoS mechanisms associated to Internet traffic; the mapping between these different QoS mechanisms; and the organization of the satellite resource, including on-board switching and remultiplexing if the architecture is based on OBP.

As for the first issue, there are several proposals for providing QoS support in the Internet: DiffServ [10], RSVP [11], application-aware routers, SIP/COPS [12], NSIS [13,14], etc. Diffserv has no explicit QoS signalling, rather it relies upon traffic differentiation with specific scheduling for each traffic class. In RSVP, SIP/COPS and NSIS, there is explicit QoS signalling, which may be associated to individual data flows or traffic aggregates. In application-aware routers, the devices may infer QoS requirements by capturing explicit QoS signalling or by inferring them implicitly from the traversing flows. Diffserv-like approaches do not keep state associated to flows or flow aggregates, thus they do not show scalability problems, but must consider

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the issues of scheduling configuration and traffic marking. On the other hand, explicit QoS signalling procedures allow a better estimation of QoS demands, at the cost of increased complexity and state to be kept at the implementing devices.

The second issue includes the selection of the underlying DVB-RCS mechanisms (discussed later), the translation of the upper layer QoS parameters to DVB-RCS parameters, and traffic scheduling for transmission. Several schemes have been proposed in the references enumerated before, including sophisticated scheduling strategies [4, 5, 6]. The efficiency of these schemes is also conditioned by the third issue: the organization of the satellite resource (DVB-S/DVB-RCS available resources, carrier configuration parameters, and OBP characteristics, if present).

This paper deals with the efficiency evaluation of a simple scheme supporting both QoS and best effort (BE) Internet traffic, evaluation that will provide useful insight on the behaviour of the DVB-RCS allocation mechanisms. The paper organization is as follows: section 2 presents the DVB-RCS resource request mechanisms. Section 3 describes the Internet QoS signalling mechanisms used in the study and the mapping to DVB-RCS requests. Section 4 describes the simulation framework that has been used for the evaluation. Section 5 presents the results from the simulation study. Finally, section 6 provides the main conclusions.

2 DVB-RCS Resource Request Mechanisms

The DVB-RCS standard [2] defines several mechanisms to assign resources to the RCST clients:

1) VBDC (Volume Based Dynamic Capacity). The RCSTs can use this capacity request when it knows the volume of data to transmit. For instance, the RCST can monitor the behaviour of the queue associated to best effort (BE) traffic and request the number of slots needed to transmit that volume, incrementally from the last VBDC request. There is also an absolute VBDC (AVBDC) capacity request which indicates absolute, not incremental, resource needs. It is useful when VBDC requests have been lost.

2) RBDC (Rate Based Dynamic Capacity). The terminal uses this kind of capacity request, based on rate rather than on data volume. The request needs to be "refreshed" if the allocation needs to be kept.

3) CRA (Continuous Rate Assignment). The capacity is negotiated prior to transmission as a "contract" between the client and the service provider. This kind of capacity request will not be considered here because it is not suitable for serving dynamic requests.

4) FCA (Free Capacity Assignment). If there are some resources which have not been allocated, it is up to the NCC whether to assign or not the free capacity to active stations.

In almost all existing proposals, CRA and RBDC are used for carrying traffic with QoS requirements, with CRA associated usually to permanent connections with guaranteed constant rate. On the other hand, BE traffic can be carried over RBDC or VBDC requests.

These capacity requests are associated to the RCS channel identification (channel_id). According to the RCS usage guidelines [3], the channel_id can be used for provision of different QoS classes, different connection oriented services, or for communication with different gateways. As a result of the request processing, the NCC transmits the resource allocation to the RCSTs using the Terminal Burst Time Plan (TBTP).

At this point the issue is how to map this capacity requests to the corresponding needs of the upper layer applications, in other words, how the satellite terminal can determine which capacity assigned corresponds to each service. The use of the channel identification (channel id) is proposed and this mechanism is according with the DVB-RCS specification. One RCST could manage up to sixteen different channel ids.

The channel id is used in each capacity request of the RCST terminal, in this way the terminal can group the capacity requests taking into the account the type of application. For instance, non real time applications (i.e: web surfing) could use one channel id and real time applications (i.e: VoIP service) could use a different channel. The general idea of using channel id to place capacity request is showing in the picture below:

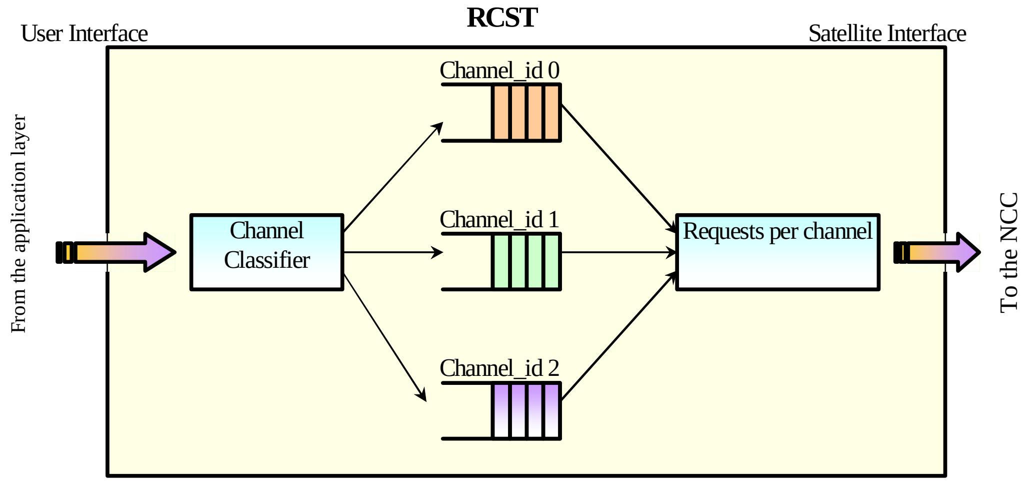

Fig. 1. Channel ID mapping within RCST

The capacity assignment performed by the NCC could also use a mapping between the channel ids and quality service level. In this way processing one channel requests could have priority over another channel id capacity requests. To avoid channel starvation the NCC could use a maximum and minimum bandwidth assigned for each channel.

3 Internet QoS Mapping to DVB-RCS Requests

A first approach for using DVB-RCS resource allocation mechanisms to carry Internet traffic is to differentiate between “QoS” traffic (traffic with strong delay and/or bandwidth requirements) and BE traffic (traffic without such requirements). This is a simple approach, but simulation results will show that this simple approach can yield suitable performance. The proposed DVB-RCS resource allocation for these traffic classes is:

1) Resource requests for QoS traffic are based on RBDC.

2) Resource requests for BE traffic are based on VBDC.

The allocated resources will carry different end-user data flows, with different QoS requirements each, thus two issues must be discussed: QoS handling at higher layers, and the interaction of these higher layer mechanisms with the DVB-RCS signaling. Higher protocol layers in the context of typical internetworking environments refer to Internet QoS. The mechanisms described in section I can be used for Internet QoS. In this study, for evaluation purposes, the Intserv model with explicit QoS signalling based on RSVP has been chosen. In section I several Internet QoS mechanisms were outlined. RSVP is very suitable for evaluating satellite scenarios, as it provides explicit QoS signalling that can be easily used at the RCSTs for estimation of satellite resources and traffic scheduling. In addition, the procedure outlined here can be extrapolated to other QoS mechanisms with explicit QoS signalling like NSIS, or session signalling like SIP/SDP/COPS.

RSVP offers two services: guaranteed service and controlled load service. The former provides strict delay upper limits, but it is complex and demands resources in excess. The latter provides a “lightly loaded” network to QoS traffic, without strict time bounds, but it is more easily implementable, does not take as many resources, and provides a simple aggregation schema for individual QoS demands. So, the controlled load service model has been chosen in this study. Once chosen the RSVP solution for evaluation purposes, the interaction with the satellite resource allocation is defined as follows [15]:

1) DVB-RCS resource requests can be transmitted using SYNC or contention SYNC (CSYNC) bursts, using the Data Unit Labelling Method (DULM). RCSTs use dedicated SYNC bursts to send synchronization information to the NCC. The RCST can also use these slots to transmit capacity requests. Another synchronization procedure is based on the contention sync burst CSYNC. With it, the RCST does not have to wait until the next SYNC to send its request, but collisions are possible. The fastest

method is DULM, which uses a traffic burst already assigned to the RCST to transmit the request. The terminal must have assigned traffic slots in order to send the request, so it has to send at least its first request using the SYNC or CSYNC methods.

2) Resource demand for QoS traffic must be estimated from the RSVP signalling. As resource allocation is done in a per-channel fashion, there may be several aggregated flows sharing the same satellite resources. The combination of the different flow specifications can be done using LUB (Least Upper Bound) [16], also known as minimax. For the RSVP controlled load service, the combination of two or more controlled load flow specifications is the LUB of the involved token buckets. The required steps are: take the maximum transmission rate; take the maximum bucket size; take the maximum peak rate: take the minimum of the minimum packet sizes; and take the minimum of the maximum packet sizes.

In addition, the combination of the flow specifications must take into account the resources needed to support all flows from the different sessions, by summing all TSpec from the applications. This sum is done as follows: sum all bucket transmission rates for all TSpecs; sum all bucket sizes for all TSpecs; sum all peak rates for all TSpecs; take the minimum of all minimum packet sizes for all TSpecs; and take the maximum of all maximum packet sizes for all TSpecs.

3) At each RCST, traffic scheduling is done for each RCS channel identified by the channel_id parameter, as resource requests are associated to channel_ids. For each channel_id, RSVP scheduling is done among the different QoS flows using a Weighted Fair Queuing scheduler. Total QoS requirements are aggregated and translated to RBDC capacity requests. On the other hand, BE traffic is handled by periodically monitoring the length of the BE queue, and translated in terms of VBDC requests to the NCC. The monitoring period has been chosen to a value high enough to be able to receive previous allocations from the NCC. Thus it must be higher than two satellite hops, plus access time to the MF-TDMA frame, which in turn depends on the transmission method (DULM, SYNC, or CSYNC), and the TBTP scheduling from the NCC. In this study, the monitoring period has been set to 680 ms. Additional monitoring is performed just after receiving an assignment, in order to be able to send new requests using DULM. In each new request, the requested VBDC size is calculated from the following expression:

$$VBDC_{size} = Q - AB - PR \tag{1}$$

In the expression (1) Q is the queue length, AB is the already allocated burst, and PR is the size of pending requests. If the resulting quantity is positive, a new request is sent.

The total allocated capacity is shared between QoS and BE traffic. QoS traffic will have guaranteed resources thanks to the scheduling mentioned before. But if there are allocated resources, whether by RBDC or VBDC, and there is no available QoS traffic at that moment, BE traffic can be transmitted on these resources. Here the channel_id is used to differentiate communications with different gateways but not for introducing different QoS service levels.

4 Simulation Model

A simulation study of the proposed QoS handling mechanism has been done in several scenarios: residential, university, small/medium enterprise, and corporate, including different traffic sources: videoconference, VoIP, web and e-mail. A RCS frame configuration has been defined and, for each scenario, several measurements have been done: allocated resources utilization, delays over the satellite channel, and a saturation study. The simulation scenario is based on a network architecture with an OBP satellite with DVB-RCS uplinks, on board remultiplexing and switching, and DVB-S downlinks. A single channel_id is used. This network is used to provide communication services to a corporate scenario shown in Figure 1. Users working in this scenario use applications with delay and bandwidth (QoS) constraints such as VoIP and Videoconference, and also services with less stringent QoS constraints (carried as BE traffic) such as Web surfing (Internet and Intranet traffic) and e-mail

Table 1. Corporate and Client Facility Sessions

	Traffic source	Avg. # of sessions	Std. deviation
Corporate facility	VoIP	2	1
	Internet/Intranet	40	7
	Web server	20	5
	E-mail (SMTP)	40	7
	E-mail (POP3)	20	5
	Videoconference	0.5	0.5
Client facility	VoIP	2	1
	Internet/Intranet	40	7
	E-mail (SMTP)	40	7
	Videoconference	0.5	0.5

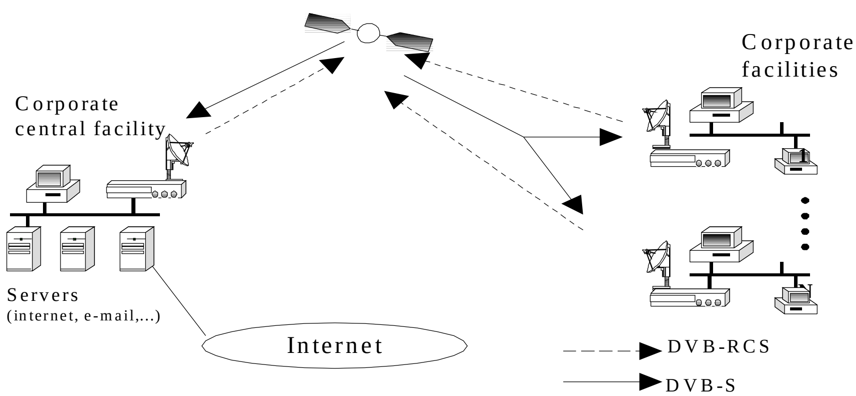

Fig. 2. Corporate scenario.

Table 2. Uplink Carrier Configuration

Rate in Rb (Rb = 270 ksymb/s)	Symbol rate per carrier (270 kbps)	Bit rate per carrier (kbps)	Number of Carriers	Bandwidth (Mhz)
1	270	385,03	52	19,66
2	540	770,06	26	19,66
3	810	1.155,09	17	19,28
8	2160	3.080,25	6	18,14
16	4320	6.160,51	3	18,14

The central facility uses a RCST Corporate station with a maximum transmission rate of 3,080 Mbps (8 times 385 kbps carrier base rate) and each corporate facility uses a RCST High station with a maximum transmission rate of 1155 Mbps (3 times 385 kbps carrier base rate). The uplink configuration is based on a symbol rate of 270 Ksymb/s taking into the account a Network Clock Reference NCR of 27 Mhz. The RCS frame duration is 71 ms with a total of 18 slots (17 traffic slots and 1 slot for signalling using 5 mini-slots). The frame duration is in concordance with the IBIS network [7]. The DVB-RCS uplink configuration of the simulation model is shown in Table 2. The model also takes into account the GEO satellite OBP in order to combine all the DVB-RCS uplinks in one DVB-S downlink [7]. This results in a RCST simpler configuration with only 1 DVB-S receiver. In order to evaluate FCA effects on delay, a simple FCA strategy has been chosen: if enough capacity is available, the latest VBDC request is replicated.

Each facility of this scenario considers 100 employees at any time. Table 1 shows the average number of sessions for the corporate and client facilities. The simulation of this scenario considers the “worst” case: each simulation will use the average number of sessions plus the standard deviation during peak hours. For VoIP traffic the average bit rate is given by the following expression:

$$Mxa + x(1-a) \quad (2)$$

In the expression (1) M and m will be the bit rate during active periods and silence period respectively. The “a” parameter is the activity rate. With the G.723 Codec we use the following values:

$$M=10.66 \quad \textbf{(3)}$$

$$M=6.4 \quad \textbf{(4)}$$

$$a=0.5 \quad \textbf{(5)}$$

All these values correspond to the worst case. The arrival process for VoIP calls are modeled with Poisson process, and call generation rate depends on the hour of the day. The average call duration is 6 minutes for business calls. The HTTP model of a single user consists of two major parts: the first set of parameters describes the session level with the time between two sessions and the number of web requests per session [17], and the second parameter set describes the composition of a web request with the size of the main object and the number of inline objects and their size, the size of the GetRequest and the length of the viewing time for the web page [18]. E-mail traffic is built upon the traffic characterization of Paxson [19] in combination with the model of the University of Würzburg [20]. The former found a lognormal file size distribution and the later characterize the message generation rate per user. In [21] is described an available library of frame size traces of long MPEG-4 and H.263 encoded videos for videoconference traffic. Frame size traces have been generated from several video runs of typically 60 minutes length each. The simulation model has been implemented using the Network Simulator (NS-2) tool, extended with modules for implementation of the DVB-RCS access. The network simulation model is prepared to simulate several networks configuration using different types of RCST stations and scenarios configuration. In the following section we only present results for one of theses configurations. The throughput and delay have been estimated, for both QoS and BE traffic, as a function of the number of users in the network. Also, a resource utilization analysis has been done, by comparing the allocated and the effectively used resources.

5 Adaptation Level and Network signaling

RCST stations in the current proposed architecture work as IP routers, it means, a group of user stations or PCs are behind the satellite terminal which acts as a gateway to the network, this can be accomplish for instance using an Ethernet network. User stations that are connected to the RCST have the same control and data plane that is show in the following picture.

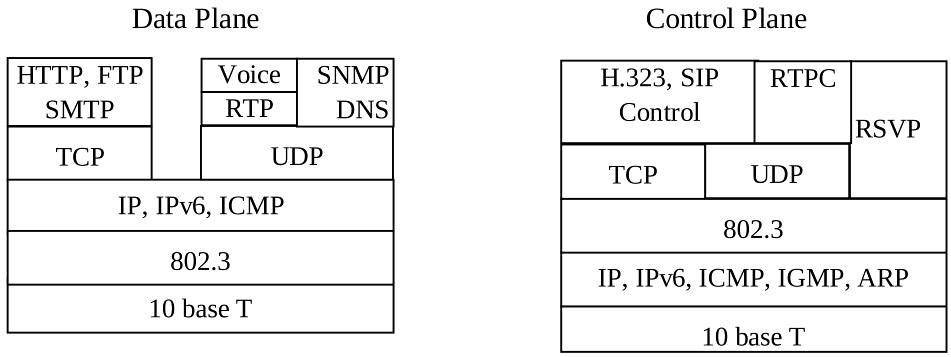

Figure 4. Data and Control Plane for user Stations

If users want to connect to a multicast session they have to start the corresponding application and join to the multicast group by using the IGMP protocol. The RCST should map the IP address to the PID that the multicast session was configured for. This information could be obtained by a local map table or sending a configuration request to the main server or network control center. The RCST should maintain the number of active subscriptions to the multicast session and also it has to send to the active stations session keepalive messages. The number of active participants should be update using the LEAVE IGMP message and when this number reach zero the RCST should release the PID from the active PIDs table for reception and also send a leaver request to the server.

The picture below shows the data and control plane for the RCST. It can be shown that the roll of the sublevel 3c of the OSI reference model corresponds to the IP level. The sublevel 3a corresponds to the signaling level of the satellite network. The interface between the IP Level and the Signaling level is the adaptation layer which corresponds to the sublevel 3b.

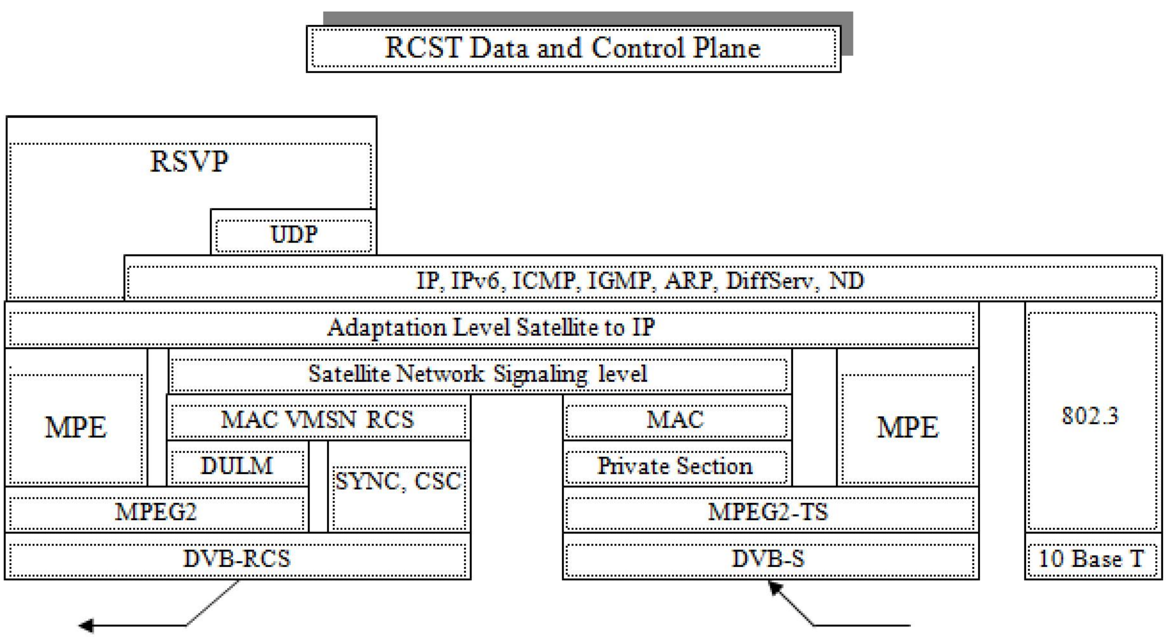

Figure 5. RCSTs Data and Control Plane

RCST stations have at least two interfaces DVB-S and DVB-RCS for interaction with the satellite network, and one Ethernet interface for interaction with the local LAN. Depending on the configuration of the satellite network RCST stations could also have one additional DVB-S interface for receiving signaling information from the NCC and data flows from servers, in this case the satellite network could use different frequencies for those channels. The satellite station could filter signaling information using the logic address of the RCST terminal which is built by the Logon ID + Group ID and the MAC address. Information could also be filter using the PID of the MPEG-2 flow. If the satellite network uses a satellite with onboard remultiplexing, signaling and data packets could be placed in the same DVB-S channel, so in this case only one receiver would be necessary. Picture below shows the general functionality of the adaptation level.

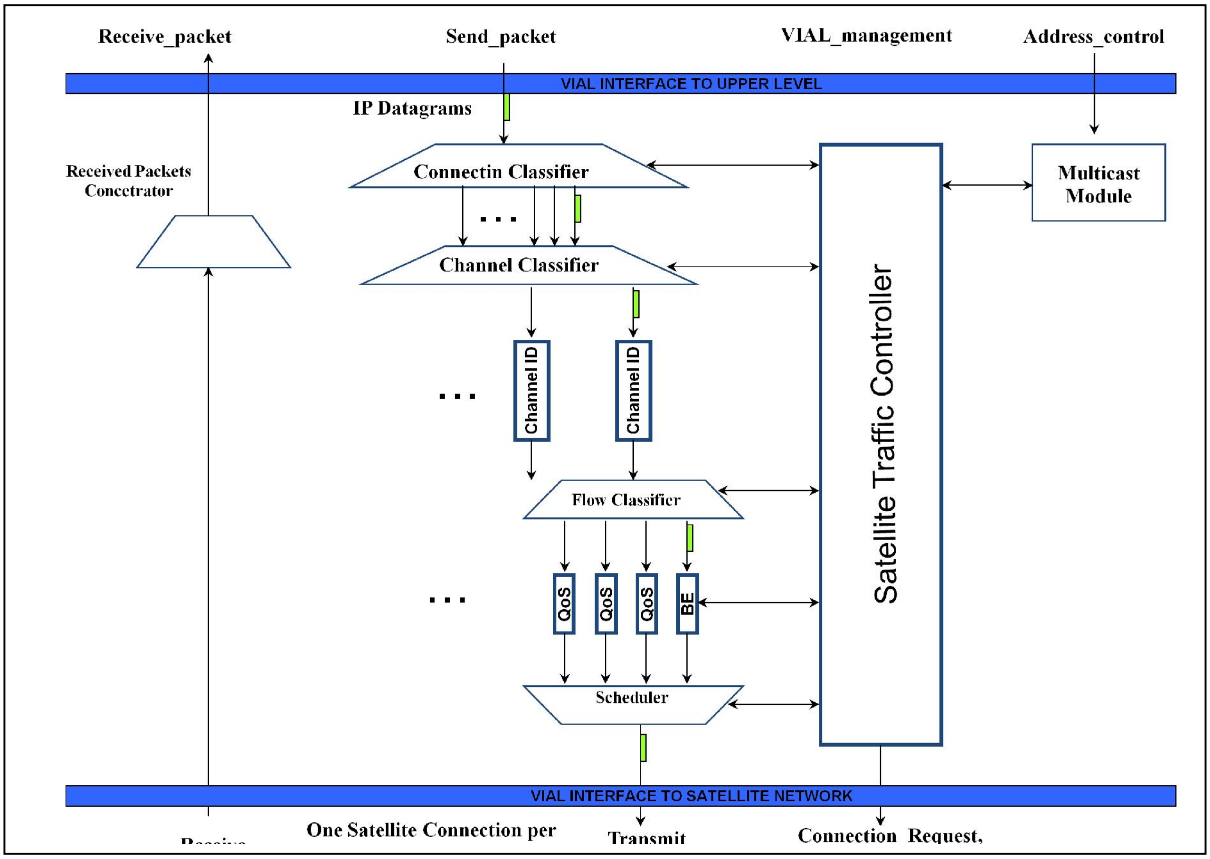

Figure 6. RCST Adaptation Level Diagram

6 Simulation model with Network Simulator NS

The general structure of the RCST NS agent is shown in figure 5, it can be seen that the RCST agent has a direct interaction with the NS entry node, this is fundamental due to this object performs the switch between in an out packets which have information base on the NS address and port number. The RCST agent should filter signaling packets and data packets by establishing satellite connections according with the destination address.

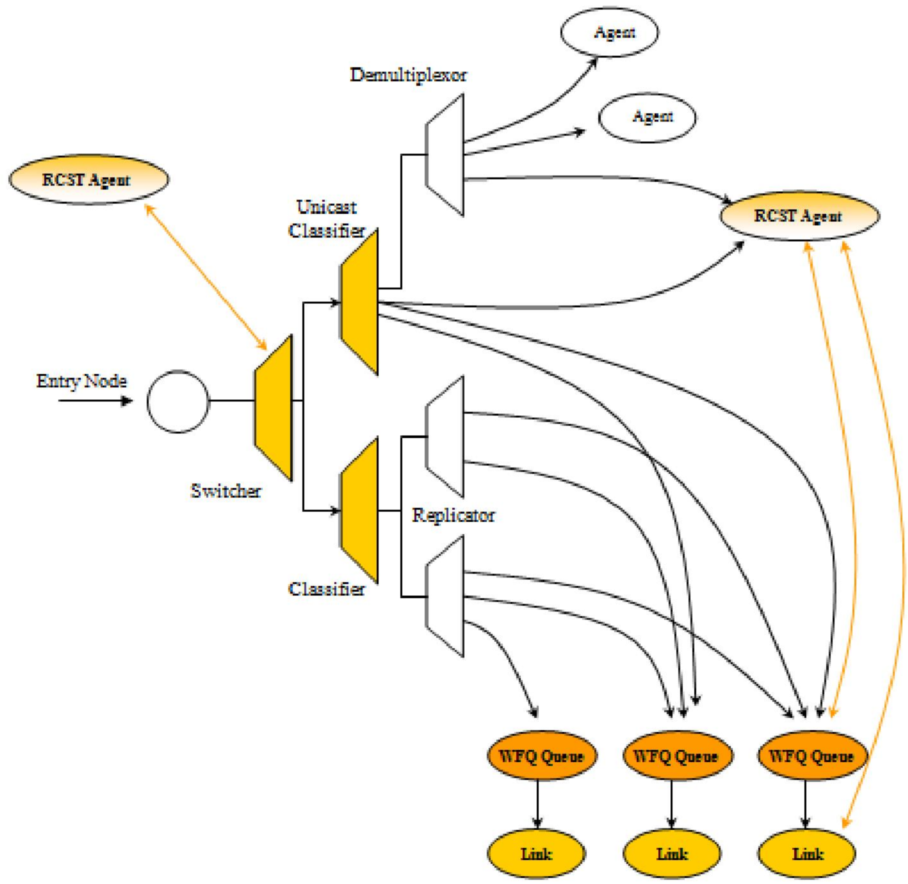

Figure 7. RCST NS Agent Design

Figure 8 shows a NS configuration for a satellite network with Bent Pipe Satellites that has two stars, with different RCST users, that uses two different channels IDs (CHID 1 and CHID 2). The satellite role for the broadcast and return channel is performed by two NS nodes, it means, the NS nodes that use DVB-S channels, such as NCC and servers, has one DVB-S SAT node. It will be necessary to configure as many RCS_SAT nodes as the number of VSAT networks will be necessary, this means that the number of RCS carriers that is used for a number of clients should be simulated using an independent RCS_SAT. In this way, the simulation model used allows to evaluate in an independent way the use of broadcast and return channel of each VSAT network.

Satellite natural broadcasting is simulated by using a Distributor node. The Distributor does not introduce propagation or transmission delay to the node links, only satellite downlinks have a configuration for propagation delay. This feature makes possible to use the NS functionality of terrestrial nodes already implanted in the simulator in this way it is possible to evaluate more easily the bandwidth utilization of downlinks due to they are the only links between the Satellite Node and Distributor.

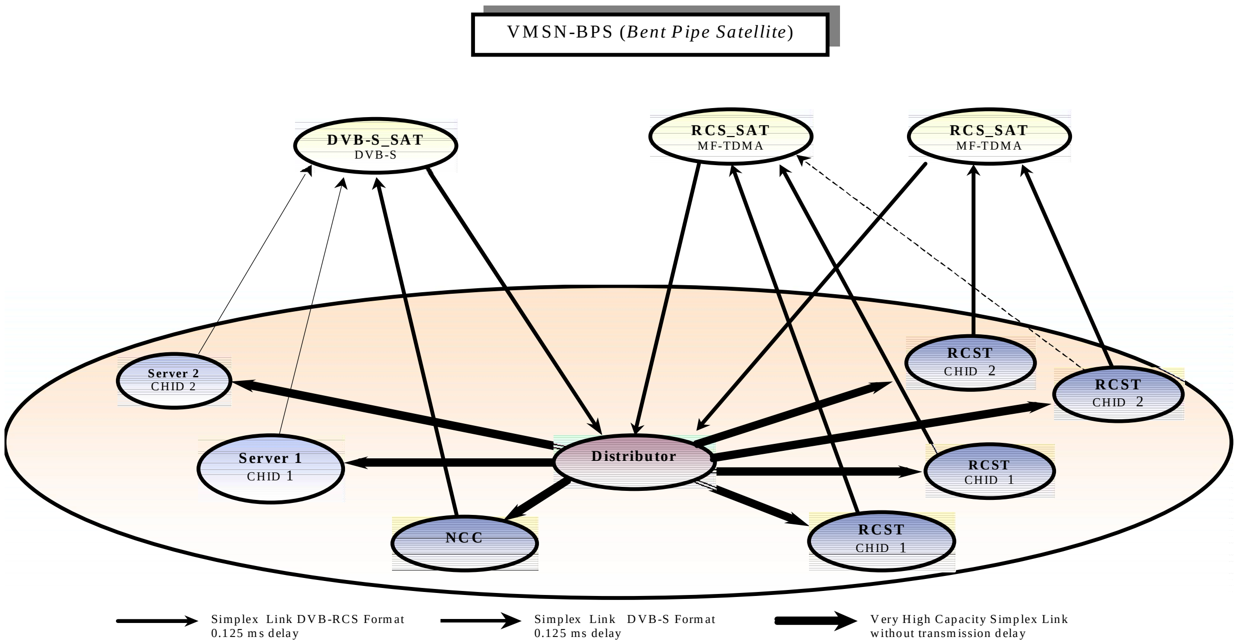

Figure 8. NS Model of DVB Bent Pipe Satellite Network

7 Results

The main results of the simulation study are summarized in the following tables and figures. Table 3 shows delay and throughput measurements for both BE and QoS traffic in a nonsaturated network. It can be seen that FCA improves significantly BE traffic delays. QoS traffic delay, on the other hand, is very stable, as it should. Figures 2 and 3 shows a saturation analysis of BE and QoS traffic delays. Table 4 shows a saturation analysis for the blocking probability (Pb) of VoIP calls as a function of the number of RCSTs, along with the Pb figure from an Erlang-B model with the number of resources equal to the number of used slots. All confidence intervals are for a 95% confidence figure. The simulation study has allowed the evaluation of the efficiency of the DVB-RCS due to the RCS frame configuration, there is a minimum granularity in RBDC allocation (21.39 Kbps in the simulated scenarios) used to carry QoS traffic. VBDC does not have this problem, as its granularity can be as small as one MPEG-2 packet for a whole request. This granularity has several consequences on the observed performance.

1) Allocated resources are greater than the used ones, and the difference depends on the ratio of BE to QoS traffic. Figure 4 shows the allocated and actually used bandwidth in the corporate scenario in a single simulation run. Averaging over a number of simulation runs, for all traffic sources the average resource utilization is 70%. An experiment with only BE traffic (carried over VBDC allocated resources, with a granularity of one MPEG-2 packet) shows an 85% average utilization (utilization does not include the overheads due to MPEG-2 headers and MPE encapsulation).

2) Excess capacity can be used advantageously to carry BE traffic, resulting in lower delays than expected for BE traffic.

3) The resource request methods used by the RCST are also influenced by this fact. DULM is dominant when BE traffic takes advantage of the excess allocation for QoS traffic. When BE traffic is the main component, CSYNC requests increase.

4) Some QoS flows will not be mapped one-to-one to RBDC “units”. For instance, one 13 Kbps VoIP call requires one slot in a frame, but two slots in a frame can carry three VoIP calls. This fact explains the difference among the measured Pb and the theoretical Pb for a model equating used slots to resources.

5) Figures 7 and 8 show the average delays for BE and QoS traffic, from a RCST server, as a function of the number of users. BE delays show the typical saturation behaviour in a queuing system, but QoS traffic has a very stable delay. This validates the simple approach of having RBDC and VBDC RCS resource allocation for QoS and BE traffic, respectively.

Table 3. Delay and Throughput Measurements

	Evaluated Metric	**Avg.**	**Std. dev.**	**C. Interval**
FCA	BE traffic delay from RCST HIGH. (sec)	0.293	1.0 E-02	± 6.4 E-03
	BE traffic delay from RCST CORP. (sec)	0.413	4.0 E-02	± 2.5 E-02
	QoS traffic delay from RCST HIGH. (sec)	0.269	3.0 E-03	± 1.8 E-03
	QoS traffic delay from RCST CORP. (sec)	0.251	6.8 E-04	± 4.2 E-04
	BE traffic throughput from RCST HIGH. (Kbps)	23.1	1.8	± 1.1
	BE traffic throughput from RCST CORP. (Kbps)	2364	132	± 81
	QoS traffic throughput from RCST HIGH. (Kbps)	100	10.6	± 6.6
	QoS VoIP traffic throughput from RCST HIGH. (Kbps)	29.1	2.8	± 2.4
NO FCA	BE traffic delay from RCST HIGH. (sec)	0.412	5.4 E-02	± 3.3 E-02
	BE traffic delay from RCST CORP. (sec)	1.117	4.7 E-02	± 2.9 E-02
	QoS traffic delay from RCST HIGH. (sec)	0.273	7.2 E-03	± 4.5 E-03
	QoS traffic delay from RCST CORP. (sec)	0.260	1.9 E-03	± 1.2 E-03
	BE traffic throughput from RCST HIGH. (Kbps)	19.5	2.3	± 1.4
	BE traffic throughput from RCST CORP. (Kbps)	1953	107	± 66
	QoS traffic throughput from RCST HIGH. (Kbps)	102.9	15.0	± 9.3
	QoS VoIP traffic throughput from RCST HIGH. (Kbps)	28.7	1.8	± 1.4

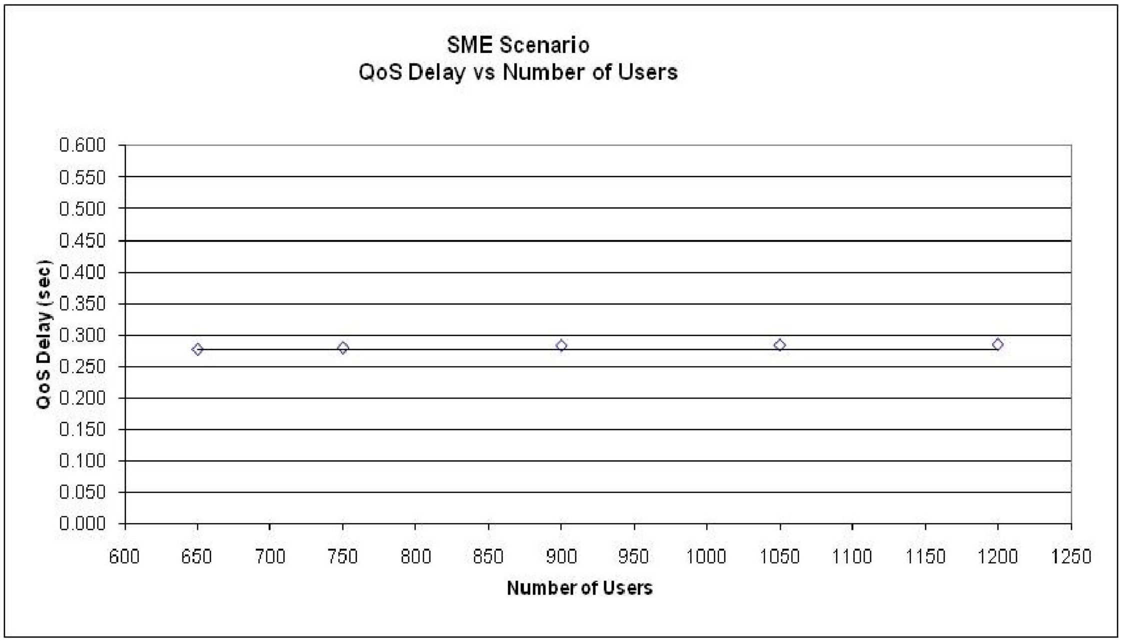

Fig. 7. Average Delay for QoS Traffic.

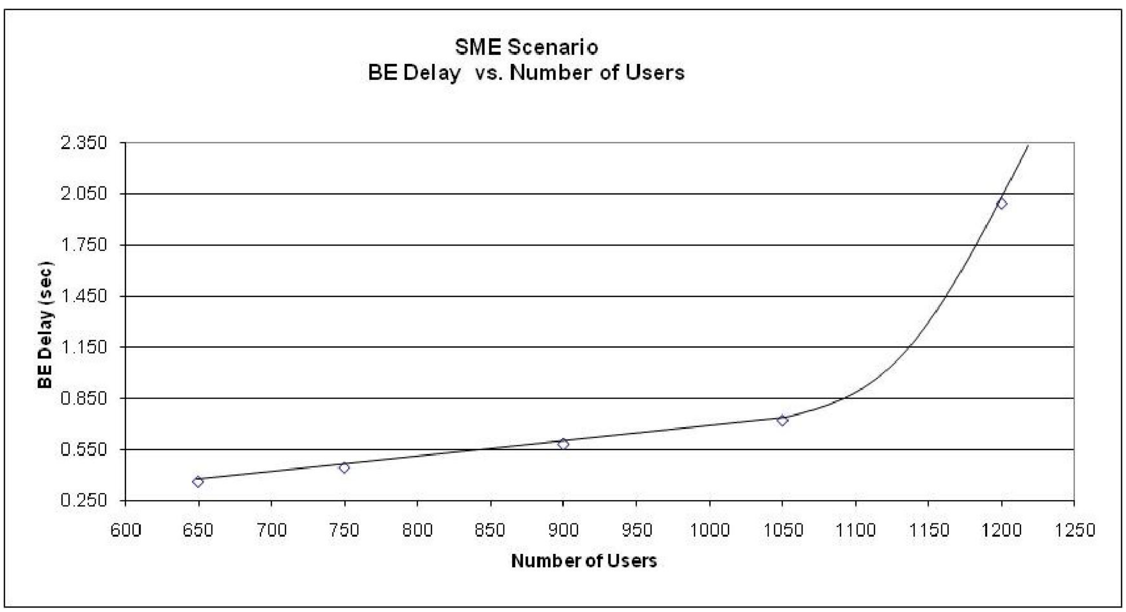

Fig. 8. Average Delay for BE Traffic.

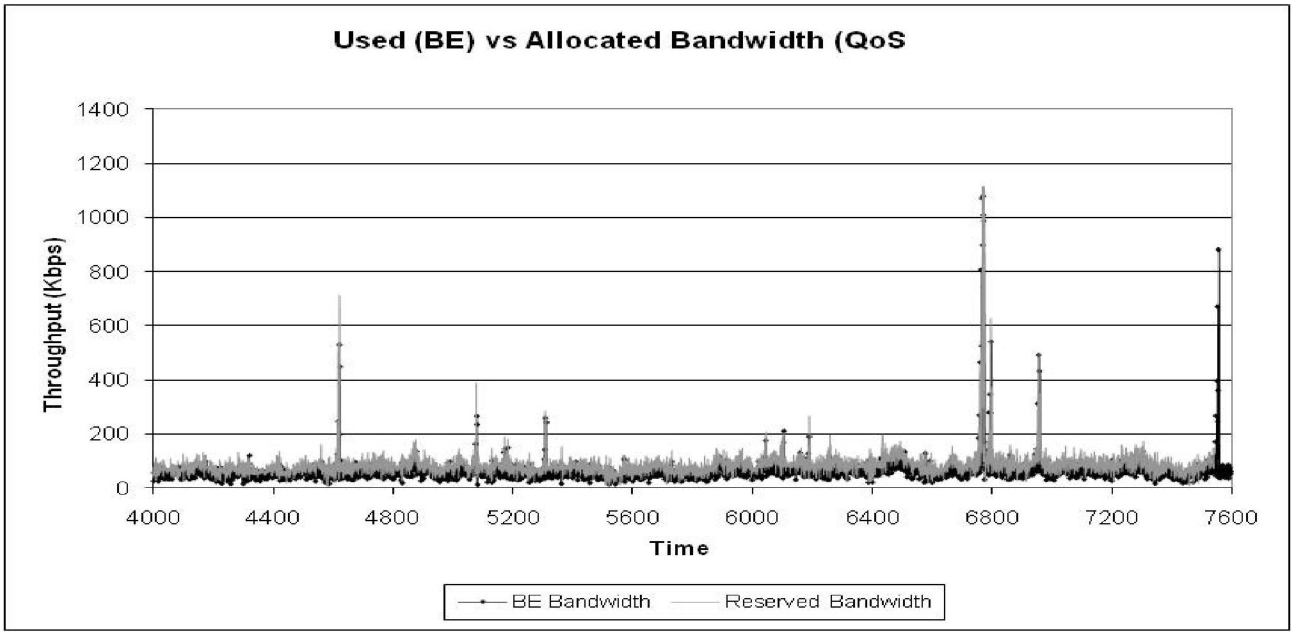

Fig. 9. Used vs. Allocated Bandwidth.

Table 4. Blocking Probabilities for VoIP Calls

RCST number	User number	Traffic (Erls.)	Pb. (Erlang-B)	Pb (simulation)	Std. deviation	Conf. interval
13	1300	26	0.071	0.001	4.7E-04	4.6E-04
14	1400	28	0.104	0.004	1.9E-03	1.8E-03
15	1500	30	0.139	0.013	3.3E-03	3.2E-03
16	1600	32	0.175	0.030	1.8E-03	1.7E-03
17	1700	34	0.211	0.050	3.9E-03	4.4E-03
18	1800	36	0.245	0.075	4.3E-03	4.9E-03
19	1900	38	0.277	0.118	3.9E-03	3.8E-03
21	2100	42	0.336	0.181	3.6E-03	3.5E-03
25	2500	50	0.433	0.304	1.2E-02	1.2E-02
30	3000	60	0.522	0.425	2.0E-03	2.0E-03
36	3600	72	0.599	0.531	3.2E-03	3.1E-03
43	4300	86	0.662	0.608	3.2E-03	3.1E-03
55	5500	110	0.735	0.699	2.3E-03	2.3E-03
63	6300	126	0.768	0.736	2.5E-03	2.5E-03
73	7300	146	0.799	0.777	1.7E-03	1.9E-03

8 Conclusions

The work presented here shows that the proposed handling of DVB-RCS resource request mechanisms can provide a good performance in terms of delay for traffic with QoS requirements with a simpler design than other existing proposals. For BE traffic the observed behavior is as expected in any queuing system. The granularity of the RBDC resource assignment can lead to a resource allocation greater than the effectively used, depending the difference on the ratio between the traffic components (BE vs. QoS). Nevertheless, the simulation study also shows that this excess allocation can be advantageously used for carrying BE traffic with better performance than expected with the basic VBDC mechanism.

It is important to note that all the Satellite DVB NS nodes has been implemented for the purpose of this investigation and a full DVB-S DVB-RCS network can be simulated to obtain different results in a variety of scenarios that can help to establish the utilization of the broadcast and return channel. Also the configuration of bent pipe and remultiplexing satellite can be used in the network built in NS.

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