IP Traffic Shaping Whitepaper

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1 Introduction

This document describes the IP Traffic Shaping feature that is available across the range of Paradise satellite modems. Traffic shaping runs on both the base modem and on the P3714 IP Traffic card. If the IP card is fitted then the base modem IP is disabled, other than for M&C purposes.

Traffic shaping provides greater control over the management of data within the modem. Specifically it provides a guaranteed quality of service for defined IP data streams. It is aligned with all of the major quality of service schemes and can be used to extend terrestrial services over satellite to create fully provisioned end-to-end services, thereby providing direct support for the implementation of customer service level agreements. Key time-based performance metrics are gathered continuously by the modem and can be extracted in order to be assimilated into customer quality of service reports.

2 Traffic Shaping

A satellite modem in general normally acts as a transparent pipe for data, so the data that is finally received at the destination on the terrestrial network at the far end of the link is identical to that which has been supplied to the local modem for transmission over satellite.

This is not necessarily true for IP data. Being packet based, IP naturally supports multiplexing of different data streams. These streams often have different inherent priority levels and competing demands for bandwidth. What is transmitted over satellite often requires careful management, both in terms of what is actually sent (versus what is filtered out) and in relation to the order in which packets from different streams are sent (i.e. the relative priority levels of packets from different streams).

Traffic shaping essentially controls these two key aspects of traffic management, namely, access to satellite bandwidth and the level of delay and jitter that is experienced.

The Paradise traffic shaping feature is available on all current series of Paradise satellite modems and is controlled via the modem web user interface.

2.1 Guaranteed Bandwidth

The allocation of bandwidth to a classified data stream can be controlled via the *Edit/Unit/Advanced/QoS* tab of the web user interface.

The **Commited Information Rate (CIR)** is the guaranteed bandwidth, in bits per second (bps) that will be allocated to the specified data stream. This is the level of bandwidth that is guaranteed under all normal circumstances where the equipment is operating correctly.

The sum of all CIRs for all classified data streams cannot be more that the transmission data rate of the modem.

2.2 Maximum Bandwidth

If excess bandwidth becomes available at any point (i.e. one or more streams do not require their allocated bandwidth), or some of the overall bandwidth has not been allocated to any particular stream, then it is not wasted and it can be allocated in a controlled manner between potentially competing streams.

This setting is called the **Burst Information Rate (BIR)** specified in bits per second (bps). It defines the maximum amount of bandwidth, beyond the guaranteed bandwidth, that a stream should be allocated, should spare bandwidth become available. Each BIR should not be greater than the transmission data rate of the modem.

2.3 Priority

What happens when excess bandwidth does become available (i.e. all guaranteed bandwidths are being met and there is spare capacity) in the situation where several streams have BIRs set (meaning that they are all potentially competing for the same excess bandwidth)? This is determined by the stream **Priority** setting.

In this case, the allocation of the spare bandwidth between competing schemes will be done based on the priority level allocated to each stream. This is done on an absolute basis – if 256kbps of bandwidth is spare and two streams both want an additional 256kbps then all 256kbps will be allocated to the stream with the higher priority.

The priority setting also controls latency and jitter. In the situation where the transmit modem has several packets in its input buffer waiting for transmission over satellite, then the packets will be sent based on their priority, with the highest priority being sent first. Packets are buffered up to a limit, after which packets may be dropped.

The priority value ranges from zero to seven, with seven being the highest priority.

A default data stream exists for any packets not explicitly part of a defined data stream. These get assigned the lowest available priority, namely, zero.

2.4 Stream Classification

How does the modem know which packets belong to which streams? Streams can be classified using one of the four methods described in the following sections. These can be selected using the *Quality of service scheme* dropdown control on the web user interface. The result is that each incoming packet is assigned to one of a number of QoS Classes. Data will be classified as belonging to the first class in the list for which a match is found starting from the top. If no match is found then the packet is assigned a default class that corresponds to a priority level of 0. The default data stream gets a BIR value of the maximum transmit data rate of the modem.

2.4.1 IP Address

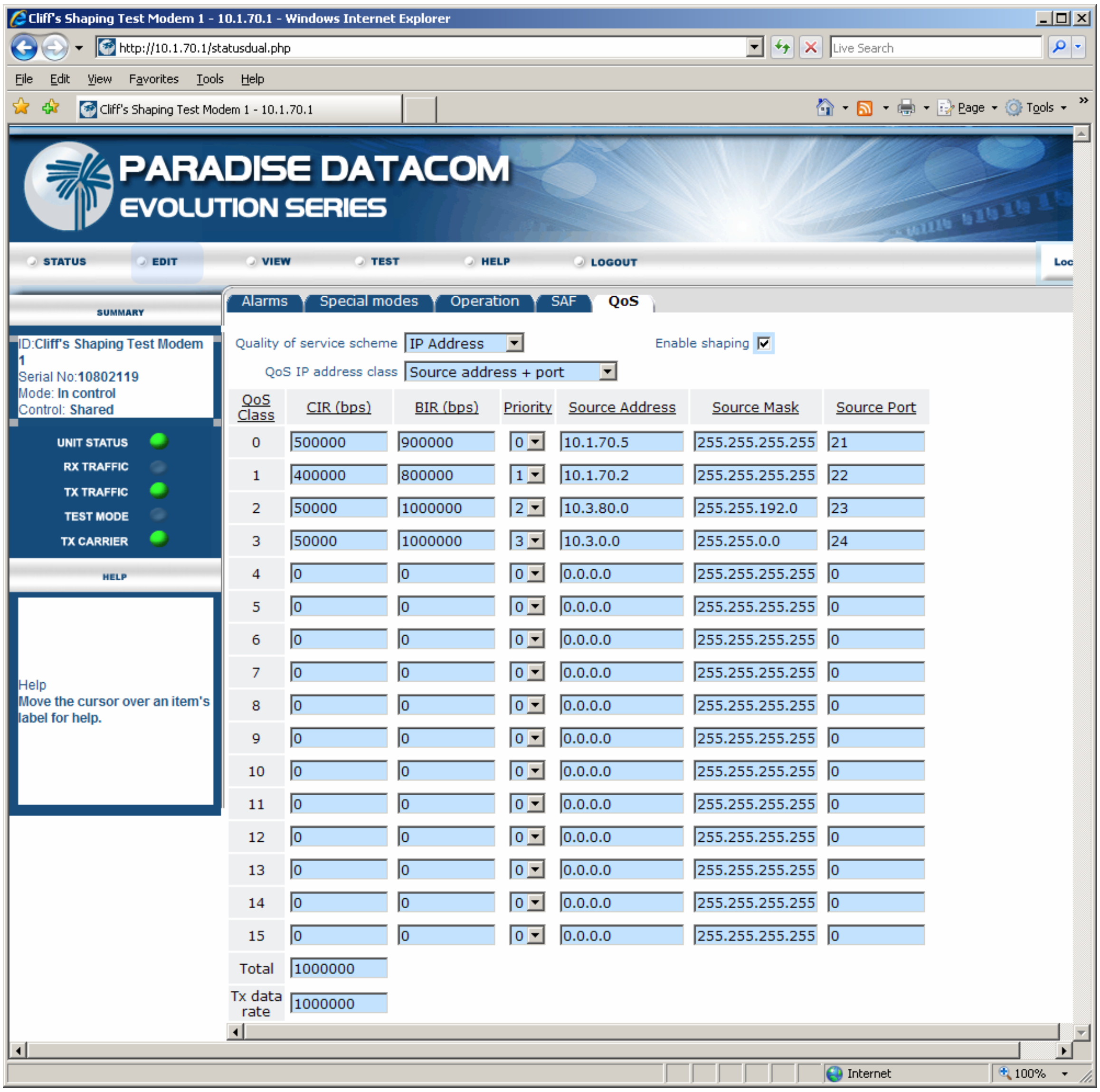
It is possible to classify a data stream based on either the source and/or the destination address in the IP packet as well as the port number of the TCP or UDP header in the packet.

Each address has an associated subnet mask that delimits the particular host subnet from the overall network. For example, if an address is 10.3.0.0 and the mask is 255.255.0.0 then any packet containing the subnet 10.3 will be matched. To match on the whole of an address the mask must be set to 255.255.255.255.

If matching on a port is also selected then the packet will only be classified as part of the data stream if both the address and the port number match.

A maximum of 16 data streams are supported, each of which has its own CIR, BIR and priority level settings.

The following example shows a traffic shaping scheme based on matching on source address and source port number. Note the *Enable shaping* checkbox, which controls whether traffic shaping is enabled or not.



As can be seen, QoS Class 0 is guaranteed a bandwidth of 500 000bps. It may be allocated up to 900 000bps, depending on what is allocated to other QoS classes. If no other data is being received then Class 0 will be allocated up to 900 000bps, if needed.

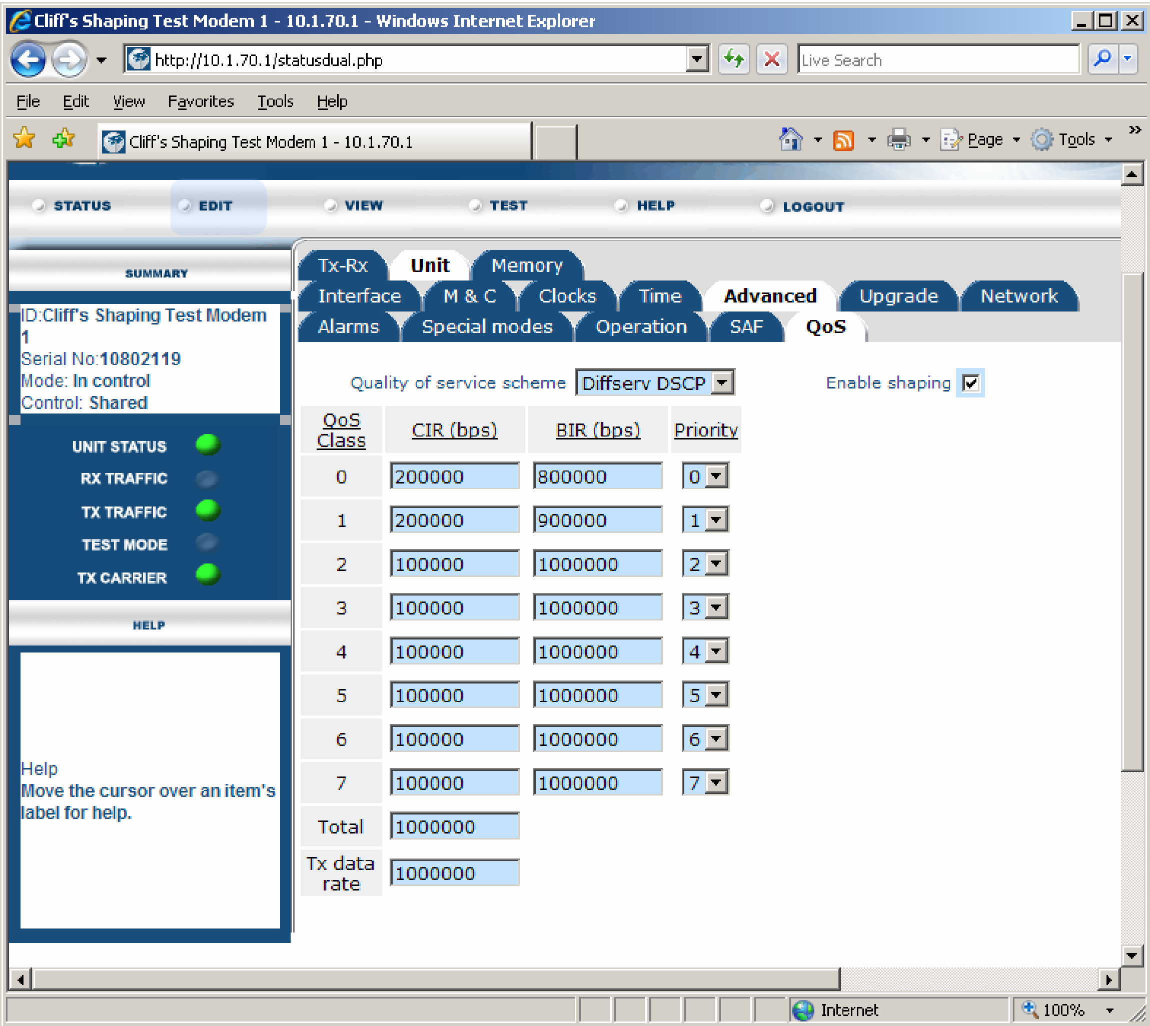
Assume at this point (when Class 0 ideally wants 900 000bps) that the Class 1 data stream is flowing at 350 000bps. Since 350 000bps is less than the CIR of Class 1 then it will get all the bandwidth it needs. Class 0 will get its guaranteed 500 000 bps, but will be allocated only an additional 150 000bps (bringing its total to 650 000bps) because this is all of the spare bandwidth, and is less than the Class 0 BIR value.

In another example, assume Class 2 is being received at 400 000bps and Class 1 at 950 000bps. In this situation the Class 1 data stream will be allocated 800 000bps, its maximum, while Class 2 will be allocated only 200 000bps. The spare bandwidth is allocated to Class 1 first because it has a higher priority. When the BIR of Class 1 is reached, the remaining spare bandwidth will be allocated to Class 2.

2.4.2 Diffserv DSCP Class

It is possible to classify data streams based on the Differentiated Services Code Point (DSCP) value in the IP packet header. The DSCP class bits are the top three bits of the DS field in an IP header (the other three bits of the field indicate drop precedence, which can be mimicked using the Priority setting for the stream in the modem). Each packet passed to the modem must have this field set to the appropriate value in order for the modem to recognize the different data streams. The modem maps the eight possible DSCP classes directly to eight equivalent internal modem classes (each of which can be allocated its own CIR, BIR, etc.). DSCP Class 0 maps to internal modem QoS Class 0, etc., down to DSCP Class 7 which maps to QoS Class 7. Class 7 has the highest priority.

An example traffic shaping scheme based on DSCP classification is shown below.

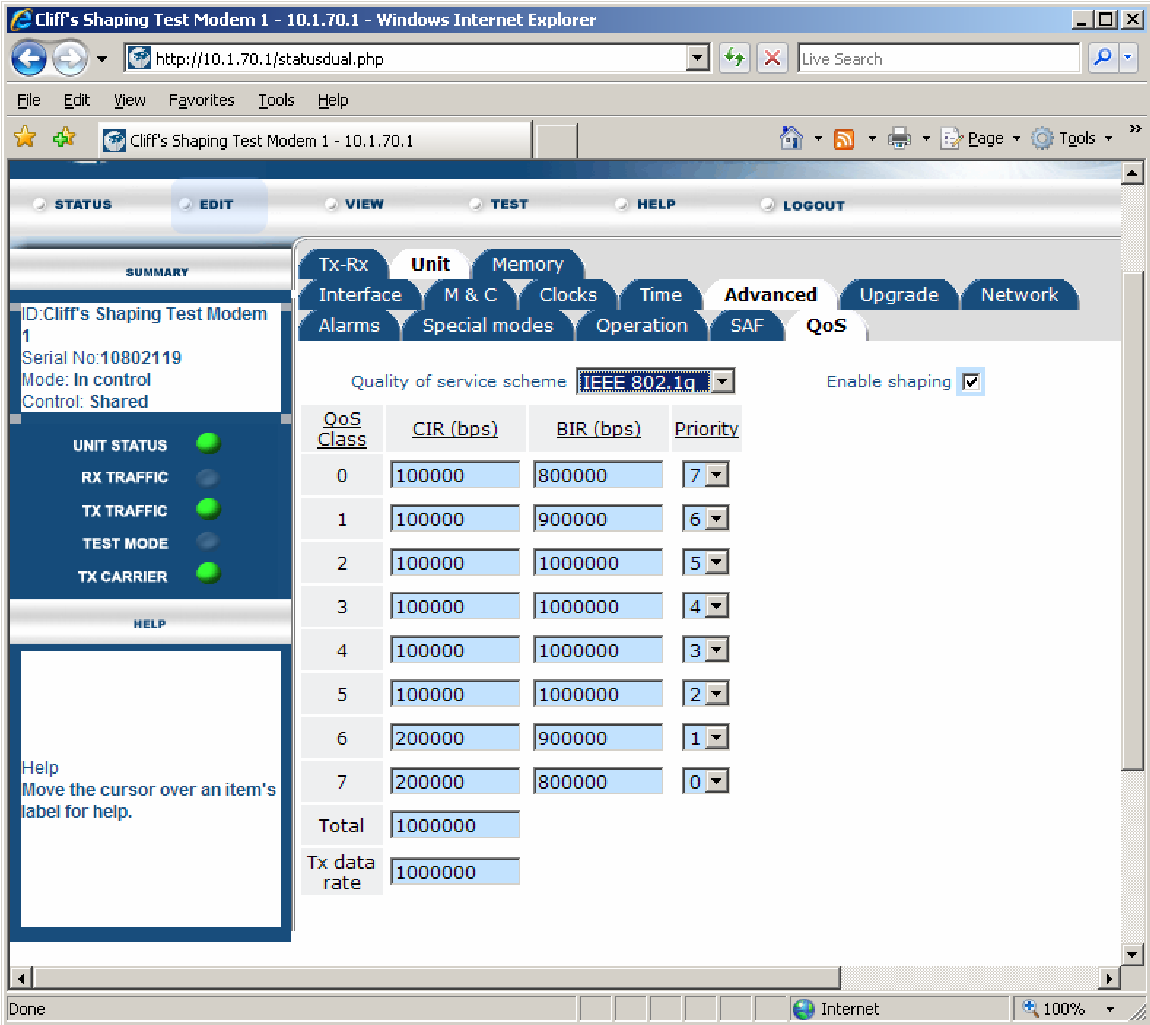


2.4.3 IEEE 802.1p Priority Tag

Classification may be done on the 3-bit Priority Code Point field of an IEEE 802.1q VLAN tag (also referred to as an IEEE 802.1p Priority Tag). This is part of a 32-bit field inserted into an Ethernet frame between the MAC address and length field.

The priority tag has eight possible values, each of which maps directly to an equivalent internal class within the modem (for which a BIR, CIR, etc. can be set). Each packet passed to the modem must have this field set to the appropriate value in order for the modem to recognize the different data streams.

The following example shows a traffic shaping scheme based on priority tagging.



2.4.4 MPLS EXP

Stream classification may be based on MPLS QoS, specifically the 3-bit EXP field in the MPLS header. This is often used to support Diffserv in MPLS networks. The MPLS EXP field has eight possible values, mapping directly to equivalent internal modem classes (0 to 7) each of which can be shaped using its own CIR, BIR, etc.

Each packet passed to the modem must have this field set to the appropriate value in order for the modem to recognize the different data streams.

2.5 Traffic Shaping Graphs

A web graphing facility exists that shows a line graph of throughput (in terms of bps) over time for each QoS class. The data for each class is not superimposed, instead it is necessary to select the particular class to be monitored graphically from a dropdown box. It is easy to switch between graphs for the different classes in order to check that the level of throughput is in line with expectations.

Graphs are time based and are shown in minute, hour, day and month formats. It is intended to add diagnostic graphs per class in the future for errored packets and dropped packets.