

Using the QoS (Quality of Service) feature of the Citadel CL-Series router

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Introduction

Quality of service (QoS) allows network administrators to use their existing resources efficiently, and to guarantee that critical applications receive high-quality service over their networks. Deploying QoS means that network administrators can have better control over their networks, reduce costs, and improve customer satisfaction.

Citadel CL-Series Security and Traffic Shaping router provides Class-Based QoS capability, in order to provide better control of different traffic types over the WAN link – both upstream and downstream.

Implementation

In order to implement QoS, the network administrator first has to identify the network's mission-critical applications, and create a dedicated Traffic Profile for each application (or group of applications).

Using the Citadel router, application types can be defined by TCP/UDP Port, ICMP, IGMP and TOS field of the IP packet (usually used with dynamic-port application like multimedia, VoIP etc.).

In the following example (Figure 1), HTTP and HTTPS were defined as Traffic Profile 1, while SMTP and POP3 protocols were defined as Traffic Profile 2.

Traffic Definition

ToS : (Decimal)

IP Protocol :

Destination Service Port :

Traffic Profile :

Select	ToS	Service Port	IP Protocol	Traffic Profile
<input checked="" type="radio"/>	-	HTTP	TCP	1
<input type="radio"/>	-	HTTPS	TCP	1
<input type="radio"/>	-	SMTP	TCP	2
<input type="radio"/>	-	POP3	TCP	2

Figure 1

After defining the traffic profiles, the administrator can define the amount of bandwidth guaranteed for each profile. In the following example (Figure 2), Traffic Profile 1 (marked as ID 1) has 60% guarantee of the total bandwidth, Traffic Profile 2 has 30% bandwidth guarantee, and the rest of the traffic, which is not defined in any profile (marked as "Default") has only 10% bandwidth guarantee.

This configuration guarantees that under any circumstances, each set of application, defined by the Traffic Profile, will be able to use not less than the amount of bandwidth reserved for this profile. If the link is free, applications will be able to use more bandwidth, if available.

Default	ID	Bandwidth	Priority (1 for highest)
<input type="radio"/>	1	60 %	1
<input type="radio"/>	2	30 %	1
<input checked="" type="radio"/>	3	10 %	1
<input type="radio"/>	4	0 %	1
<input type="radio"/>	5	0 %	1
<input type="radio"/>	6	0 %	1
<input type="radio"/>	7	0 %	1
<input type="radio"/>	8	0 %	1

Apply Cancel

Figure 2

The QoS mechanism of the Citadel router controls outgoing traffic (upstream) by using output queues. Each traffic profile holds a dedicated queue; during congestion of the uplink port, data is stored in these queues according to its matching traffic profile, instead of being dropped. Data packets are then popped-out from the queues according to the defined policy, in a way that each traffic profile will be able to send enough data over the link.

Incoming traffic (downstream) is controlled by dropping data packets which exceed the minimal bandwidth definition during congestion. While no other traffic is loading the incoming link, each traffic profile is able to use up to 100% of the downstream link.

The last step in the QoS implementation process is configuring the upstream and downstream link rates. The following example (Figure 3) matches a 96Kbps/1.5Mbps ADSL connection. Administrator can choose on which interface QoS policy will apply – WAN / WAN2 (CL-200 and CL-200W models only) / Modem or IPSec.

QoS Traffic Shaping Configuration

Interface :

WAN Upstream Speed : (Kbits/s)

WAN Downstream Speed : (Kbits/s)

Traffic Shaping Method : None Auto Class-Based Queue

Figure 3

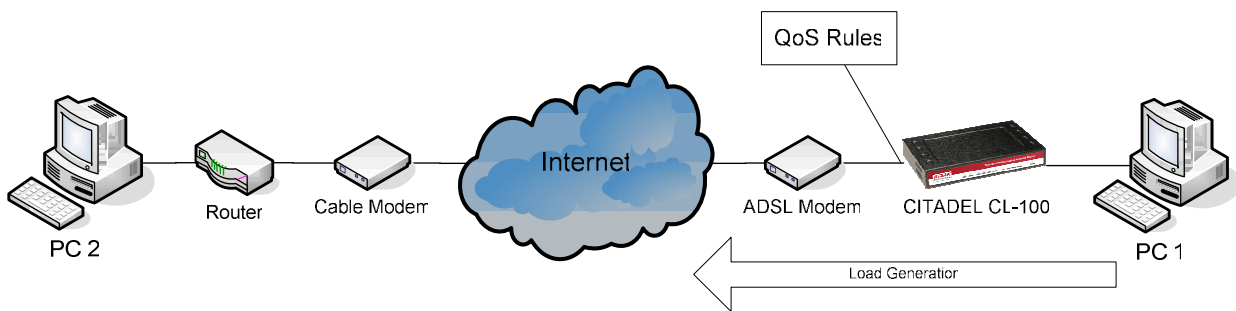
Configuration Examples

The following examples demonstrate the use of QoS in different scenarios.

In order to simulate real-world scenarios, a Citadel router was connected to the internet using PPPoE over a 96Kbps/1.5Mbps ADSL link, and PC1 workstation was connected to the LAN side of the Citadel. PC2 was connected to the Internet using a simple broadband router.

A load generator was installed on PC1 and PC2, and traffic loads were generated from PC1 to PC2, loading the 96Kbps ADSL uplink.

QoS rules were configured on the Citadel router in order to control and prioritize traffic flows. The following diagram illustrates the networks topology used in the examples:



The following traffic profiles were created on the Citadel router:

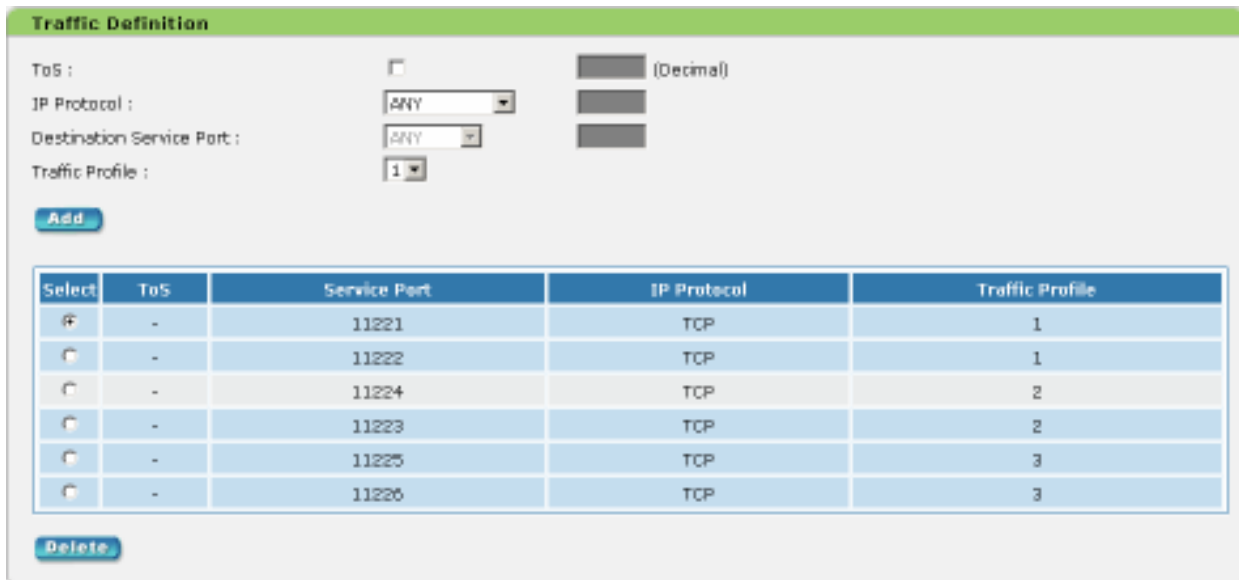


Figure 4

Traffic Profiles summary:

Profile ID	Pairs	Protocol	Port
1	1, 2	TCP	11221, 11222
2	3, 4	TCP	11223, 11224
3	5, 6	TCP	11225, 11226

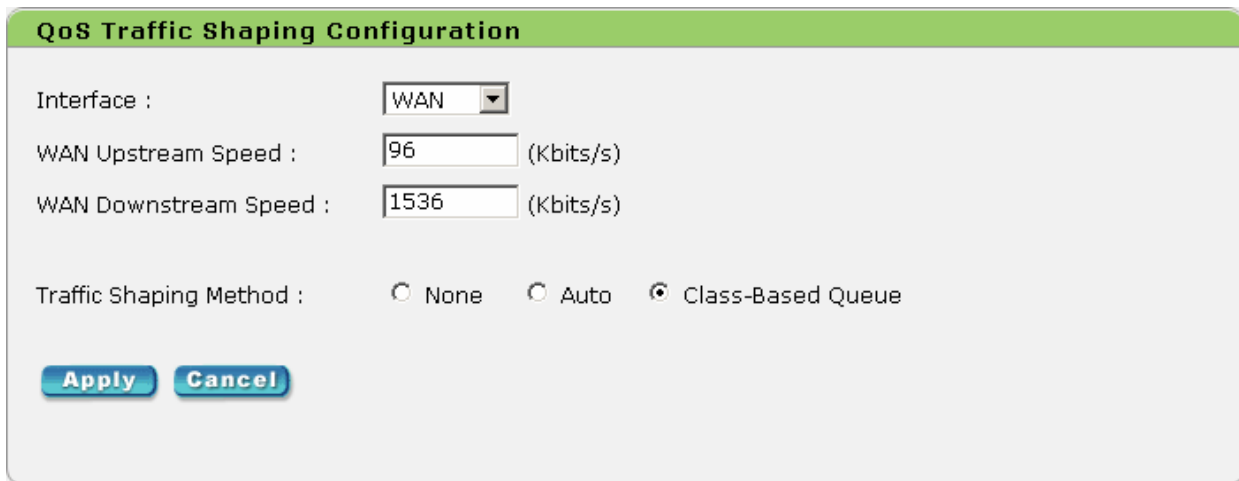
Pairs were configured in the load generator as follows:

Pair no.	Source IP	Source Port	Destination IP	Destination Port
1	PC1	Random	PC2	11221
2	PC2	Random	PC2	11222
3	PC1	Random	PC2	11223
4	PC2	Random	PC2	11224
5	PC1	Random	PC2	11225
6	PC1	Random	PC2	11226

Scenario 1

Description

In this scenario we enabled class-based QoS, with WAN upstream configuration of 96Kbps and downstream of 1.5Mbps. The purpose of this scenario is to demonstrate the efficiency of the QoS bandwidth guarantee – streams can use all free bandwidth, if available.



The screenshot shows a configuration window titled "QoS Traffic Shaping Configuration". It contains the following fields and options:

- Interface : WAN (selected in a dropdown menu)
- WAN Upstream Speed : 96 (Kbits/s)
- WAN Downstream Speed : 1536 (Kbits/s)
- Traffic Shaping Method : None Auto Class-Based Queue
- Buttons: Apply, Cancel

Figure 5

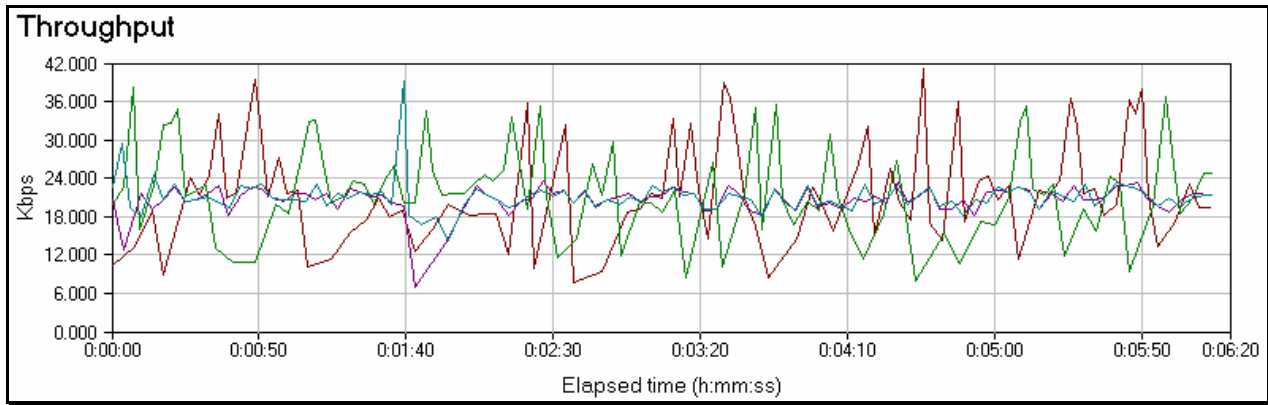
Traffic reservation was configured as follows:

- Pairs 1,2 – 20% of the total bandwidth.
- Pairs 3,4 – 20% of the total bandwidth.
- Other traffic – 60%

Results

As can be seen from the graph (*Graph 1*), flows are being divided evenly over the upstream link since no other traffic is passing through it. Since the QoS logic is bandwidth guarantee, flows can use the total link bandwidth, if available.

Pair Number	Reserved Bandwidth	Actual Throughput (Kbps)	Actual Bandwidth
1	20%	19.035	48.6%
2		19.636	
3	20%	20.224	51.4%
4		20.865	
Total		79.472	100%



Graph 1

Scenario 2

Description

In this scenario, pairs 3 and 4 are simulating a mission-critical application, while pairs 1 and 2 are simulating a less important application. We configured bandwidth guarantee of 20% to pairs 1,2 and 80% to pairs 3,4 (Figure 6). Load was generated using pairs 1,2,3,4.

The screenshot shows a 'Profile Definition' dialog box with a table of 8 rows. Each row has a radio button, an ID, a bandwidth percentage, and a priority dropdown. Row 1: ID 1, 20% bandwidth, priority 1. Row 2: ID 2, 80% bandwidth, priority 1. Row 3: ID 3, 0% bandwidth, priority 1. Row 4: ID 4, 0% bandwidth, priority 1. Rows 5-8: IDs 5-8, all with 0% bandwidth and priority 1. The 'Apply' and 'Cancel' buttons are at the bottom.

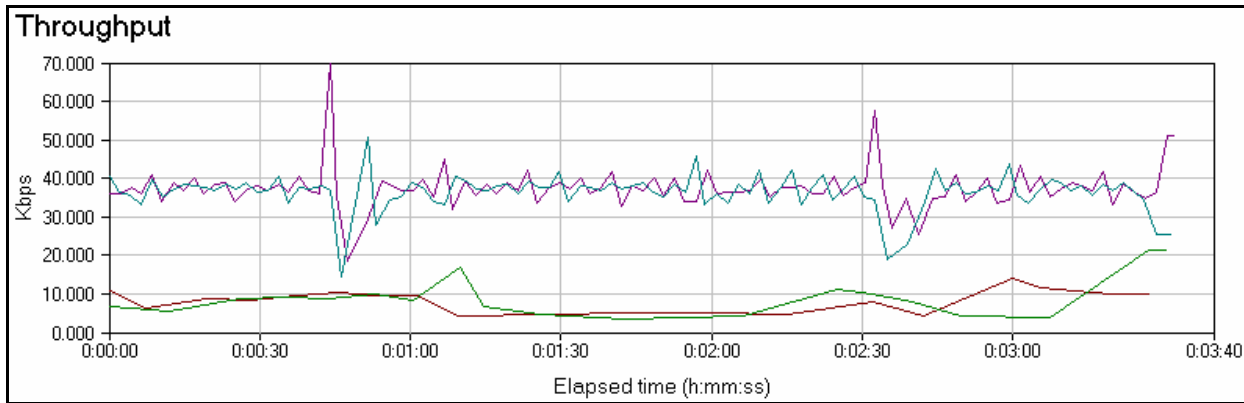
Default	ID	Bandwidth	Priority (1 for highest)
<input type="radio"/>	1	20 %	1
<input type="radio"/>	2	80 %	1
<input checked="" type="radio"/>	3	0 %	1
<input type="radio"/>	4	0 %	1
<input type="radio"/>	5	0 %	1
<input type="radio"/>	6	0 %	1
<input type="radio"/>	7	0 %	1
<input type="radio"/>	8	0 %	1

Figure 6

Results

In this example, since pairs 3, 4 (defined as profile ID 2) has a guarantee of 80% from the total bandwidth, these pairs used more bandwidth than pairs 1, 2 (profile ID 1). The actual results are summarized in the following table:

Pair Number	Reserved Bandwidth	Actual Throughput (Kbps)	Actual Bandwidth
1	20%	7.155	16%
2		6.674	
3	80%	36.828	84%
4		35.834	
Total		86.132	100%



Graph 2

Scenario 3

Description

This scenario is an expansion of the previous scenario. Profile ID 3 (pairs 5, 6) now has 45% guarantee of the total bandwidth, profile ID 2 (pairs 3, 4) have a 35% guarantee of the total bandwidth and profile ID 1 (pairs 1, 2) have a guarantee of 20% of the total upstream bandwidth (Figure 7).

The screenshot shows a 'Profile Definition' dialog box with a table of profile settings. The table has four columns: 'Default', 'ID', 'Bandwidth', and 'Priority (1 for highest)'. There are eight rows representing profile IDs 1 through 8. Profile ID 4 is selected, indicated by a checked radio button and a dashed border. The bandwidth values are 20%, 35%, 45%, 0%, 0%, 0%, 0%, and 0% respectively. All priority values are set to 1. At the bottom of the dialog are 'Apply' and 'Cancel' buttons.

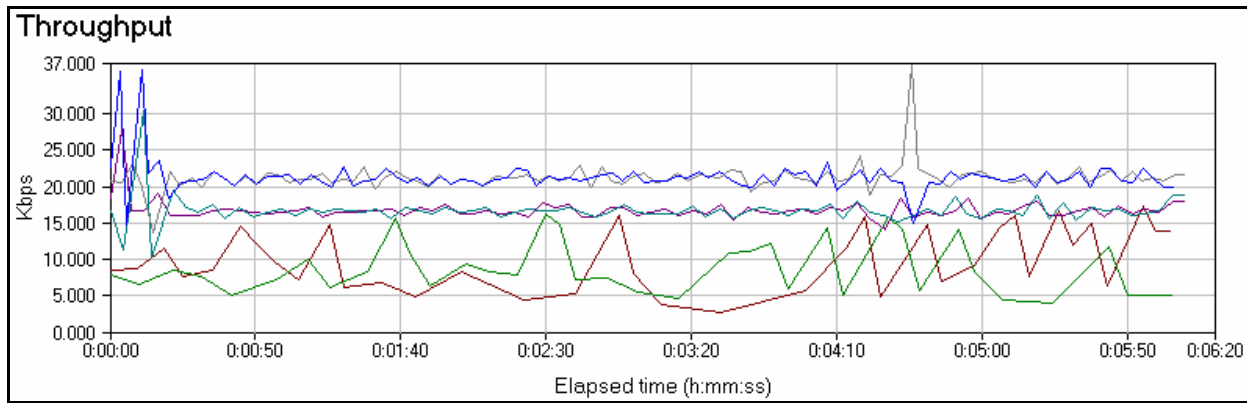
Default	ID	Bandwidth	Priority (1 for highest)
<input type="radio"/>	1	20 %	1
<input type="radio"/>	2	35 %	1
<input type="radio"/>	3	45 %	1
<input checked="" type="radio"/>	4	0 %	1
<input type="radio"/>	5	0 %	1
<input type="radio"/>	6	0 %	1
<input type="radio"/>	7	0 %	1
<input type="radio"/>	8	0 %	1

Figure 7

Results

As can be seen from the following results, each application could use the bandwidth which was reserved for its usage.

Pair Number	Reserved Bandwidth	Actual Throughput (Kbps)	Actual Bandwidth
1	20%	7.912	17.0%
2		7.698	
3	35%	16.687	36.5%
4		16.480	
5	45%	21.124	46.5%
6		21.114	
Total		90.586	100%



Graph 3

Scenario 4 - "P2P Application"

Description

This scenario illustrates a typical configuration for limiting the impact of a P2P applications (like eMule, Kazza, etc.) on the network.

In this example we configured bandwidth guarantee of 80% for the "mission-critical" applications (Pairs 1,2), while all other traffic types will use the remaining 20% during congestion of the uplink port (Figure 8).

Traffic was generated from all Pairs simultaneously.

Default	ID	Bandwidth	Priority (1 for highest)
<input type="radio"/>	1	80 %	1
<input checked="" type="radio"/>	2	20 %	1
<input type="radio"/>	3	0 %	1
<input type="radio"/>	4	0 %	1
<input type="radio"/>	5	0 %	1
<input type="radio"/>	6	0 %	1
<input type="radio"/>	7	0 %	1
<input type="radio"/>	8	0 %	1

Apply Cancel

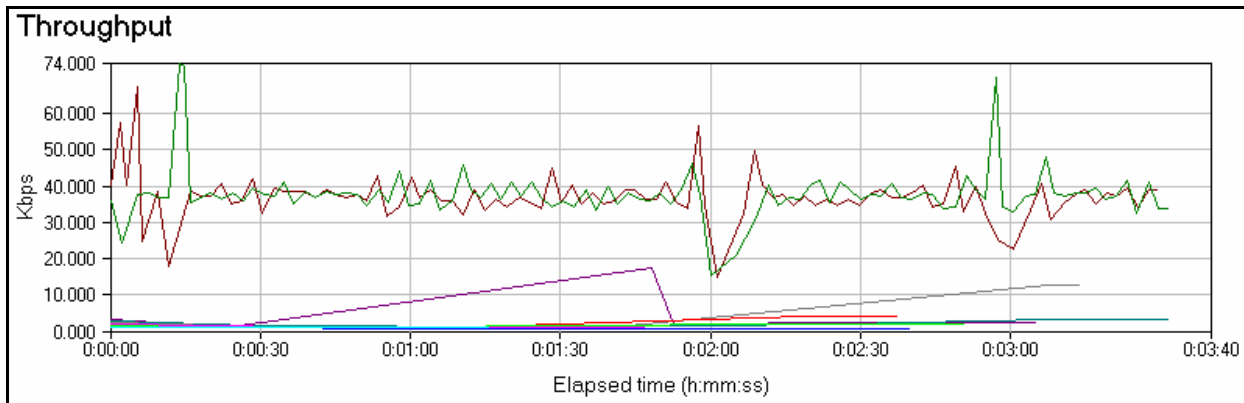
Figure 8

Note: It's important to mark the 20% (Profile ID 2, in the following example) as "Default", so every unknown traffic will match this class.

Results

As can be seen in Graph 4 below, the mission-critical applications (Pair 1,2) could use the amount of reserved bandwidth needed in order to perform well, as configured in the QoS rules. All other sessions (simulation a P2P File Sharing Application) used no more than 20% of the total available bandwidth.

Pair Number	Reserved Bandwidth	Actual Throughput (Kbps)	Actual Bandwidth
1	80%	35.798	89%
2		36.906	
Default	20%	8.81	11%
Total		81.514	100%



Graph 4