

Gentlemen,

As was to be expected, Joseph was correct on all accounts.

My testbed consisted of a 2811 router running 12.4(24)T4 Advanced IP Services, and two PCs connected to it. One PC was used as the traffic generator (D-ITG) and was connected to Fa0/0. Another PC was the flow target, and was connected to Fa0/1.

The configuration of the router at the initial stage was fairly simple (quoting only significant commands, not the entire config):

```
hostname Router
!
interface FastEthernet0/0
  description => Source <=
  ip address 10.0.0.1 255.255.255.0
  duplex auto
  speed auto
!
interface FastEthernet0/1
  description => Destination <=
  ip address 10.0.1.1 255.255.255.0
  duplex auto
  speed auto
!
```

## Test 1

The first test consisted of adding a simple LLQ policy configuration to the Fa0/1 egress with the guaranteed rate of 1000 Kbps while generating traffic that consisted of 1000pps\*540Bpp IP/UDP packets per second (total flow around 4320 Kbps in L3):

```
ip access-list extended acl_PRIO
  permit udp any any eq 8999
!
class-map match-all cm_PRIO
  match access-group name acl_PRIO
!
policy-map pm_Fa0/1-out
  class cm_PRIO
    priority 1000
  class class-default
!
interface FastEthernet0/1
  service-policy output pm_Fa0/1-out
```

After observing the received data flow characteristics on the target PC, it was evident that the **implicit policer in the LLQ queue was not active - the flow was not policed and was delivered at the sender rate**. This was also confirmed by the output of the following show commands:

```
Router#show policy-map int fa0/1
FastEthernet0/1
```

```
Service-policy output: pm_Fa0/1-out
```

```
queue stats for all priority classes:
```

```
Queueing
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 245922/136240788
```

```
Class-map: cm_PRIIO (match-all)
```

```
245922 packets, 136240788 bytes
5 minute offered rate 2534000 bps, drop rate 0 bps
Match: access-group name acl_PRIIO
Priority: 1000 kbps, burst bytes 25000, b/w exceed drops: 0
```

```
Class-map: class-default (match-any)
```

```
39 packets, 3842 bytes
5 minute offered rate 0 bps, drop rate 0 bps
Match: any
```

```
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 51/10490
```

```
Router#show int fa0/1
```

```
FastEthernet0/1 is up, line protocol is up
```

```
Hardware is MV96340 Ethernet, address is 0015.fac0.6159 (bia 0015.fac0.6159)
```

```
Description: => Destination <=
```

```
Internet address is 10.0.1.1/24
```

```
MTU 1500 bytes, BW 100000 Kbit/sec, DLY 100 usec,
reliability 255/255, txload 8/255, rxload 1/255
```

```
Encapsulation ARPA, loopback not set
```

```
Keepalive set (10 sec)
```

```
Full-duplex, 100Mb/s, 100BaseTX/FX
```

```
ARP type: ARPA, ARP Timeout 04:00:00
```

```
Last input 00:00:05, output 00:00:00, output hang never
```

```
Last clearing of "show interface" counters never
```

```
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
```

```
Queueing strategy: Class-based queueing
```

```
Output queue: 0/1000/0 (size/max total/drops)
```

```
5 minute input rate 0 bits/sec, 1 packets/sec
```

```
5 minute output rate 3267000 bits/sec, 749 packets/sec
```

```
567 packets input, 59040 bytes
```

```
Received 422 broadcasts, 0 runts, 0 giants, 0 throttles
```

```
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
```

```
0 watchdog
```

```
0 input packets with dribble condition detected
```

```
600399 packets output, 332434530 bytes, 0 underruns
```

```
0 output errors, 0 collisions, 1 interface resets
```

```
58 unknown protocol drops
```

```
0 babbles, 0 late collision, 0 deferred
```

```
0 lost carrier, 0 no carrier
```

```
0 output buffer failures, 0 output buffers swapped out
```

Notice that no drops are recorded whatsoever. In other words, the implicit policer in the LLQ queue is not active if the interface is not congested. Here, the priority flow exceeded its guaranteed (and allegedly maximum) limit.

## Test 2

In the second test, the flow characteristics were left unchanged. However, an explicit policer was added to the LLQ queue configuration as follows:

```
policy-map pm_Fa0/1-out
  class cm_PRIO
    priority 1000
    police 1000000 conform-action transmit exceed-action drop
  class class-default
```

No other configuration modifications were performed. After performing this test, it was determined that **the explicit policer was active and was limiting the flow down to the configured rate - even if the output interface was not congested**. Observe the following output:

```
Router#show policy-map int fa0/1
FastEthernet0/1
```

```
Service-policy output: pm_Fa0/1-out
```

```
queue stats for all priority classes:
```

```
Queueing
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 43383/24034182
```

```
Class-map: cm_PRIO (match-all)
```

```
192029 packets, 106384066 bytes
5 minute offered rate 2062000 bps, drop rate 1602000 bps
Match: access-group name acl_PRIO
Priority: 1000 kbps, burst bytes 25000, b/w exceed drops: 0
```

```
police:
```

```
  cir 1000000 bps, bc 31250 bytes
  conformed 43383 packets, 24034182 bytes; actions:
    transmit
  exceeded 148646 packets, 82349884 bytes; actions:
  drop
  conformed 610000 bps, exceed 2102000 bps
```

```
Class-map: class-default (match-any)
```

```
32 packets, 2832 bytes
5 minute offered rate 0 bps, drop rate 0 bps
Match: any
```

```
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/0/0
(pkts output/bytes output) 44/9480
```

Drops caused by exceeding the CIR as configured by the explicit policer are now quite obvious. Note, however, that the b/w exceed drops are still 0 on the LLQ class, suggesting that the explicit policer was kicking in even though the LLQ implicit policer did not consider the traffic to be exceeding the bandwidth in this case.

### Test 3

The third test consisted of two flows: one flow at the original 1000pps\*540Bpp rate, another flow at 3000pps\*540Bpp rate. Also, to achieve egress interface congestion, it was reconfigured to 10Mbps/Full Duplex operation. The explicit policer was removed from the LLQ queue configuration:

```
policy-map pm_Fa0/1-out
  class cm_PRI0
    priority 1000
  class class-default
  !
interface FastEthernet0/1
  speed 10
```

After performing the test, it was determined that **the implicit policer in the LLQ was active because of the egress interface congestion and was limiting the priority flow down to 1000Kbps and at the same time, providing the guaranteed bandwidth of 1000Kbps**. The increasing drop counts are visible in the following output:

```
Router#show policy-map int fa0/1
FastEthernet0/1

Service-policy output: pm_Fa0/1-out

queue stats for all priority classes:
Queueing
queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/209052/0
(pkts output/bytes output) 90949/50385746

Class-map: cm_PRI0 (match-all)
300001 packets, 166200554 bytes
5 minute offered rate 2694000 bps, drop rate 1765000 bps
Match: access-group name acl_PRI0
Priority: 1000 kbps, burst bytes 25000, b/w exceed drops: 209052

Class-map: class-default (match-any)
900084 packets, 498607508 bytes
5 minute offered rate 7216000 bps, drop rate 2537000 bps
Match: any

queue limit 64 packets
(queue depth/total drops/no-buffer drops) 0/311864/0
(pkts output/bytes output) 588220/325839242
```

Note the b/w exceed drops in the LLQ queue.

To summarize: the LLQ seems to behave as Joseph suggested. The implicit policer in the LLQ is active only if the egress interface is congested. Otherwise, it allows the priority traffic to go above its limits. The explicit policer kicks in all the time, regardless of the interface congestion.

Best regards,

Peter