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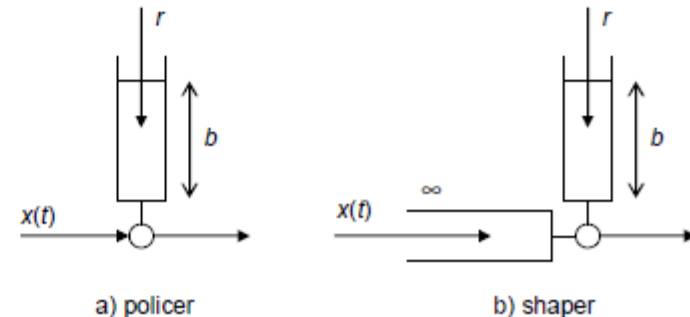
2. Traffic conditioning

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Admission control

- The difficult problem of admission control is determining the admission region, which depends of the statistical characterization of traffic, on the link's capacity, on the SLAs and on the scheduling policy

- The difficulty comes from the complexity of the traditional analytical methods used to carry out the calculation

- The difficulty increases when multi-hop paths are considered (this is the most realistic and common case)

- We will see that with the most recent methods of the statistical network calculus, this problem can be solved in a **relatively** easy way
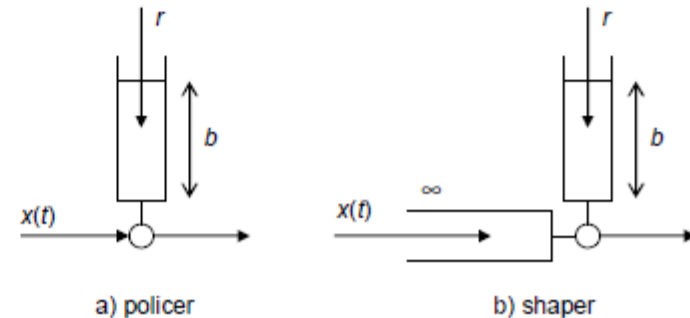
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Policing and shaping

- The token bucket policing regulator (Figure a) has a counter of credits (tokens) with maximum value b [traffic units], an is referred to as *token bucket size*

- The unit measure of b can be bits, bytes or packets

- The credit counter is increased every $1/r$ s, where r is the token rate

- One traffic unit (bit, byte, or packet) of offered traffic is allowed to pass through the regulator if the counter is positive (then, the counter is decremented

- Otherwise, if the counter is equal to zero, the traffic unit is dropped

a) policer   b) shaper

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Policing and shaping

- Figure b shows a shaping regulator
- The credit counter works as for the policer
- An incoming bit passes through the regulator instantaneously if, at its arrival, the counter is positive and the infinite input buffer is empty
- Otherwise, if the buffer is not empty and/or the counter is null, the incoming traffic unit is buffered
- When the input buffer is not empty, one traffic unit is fetched from the buffer as soon as a token is generated.
- The r and b parameters of both types of regulators have an intuitive physical meaning
- The r parameter controls the average rate of the through traffic, as the regulator cannot output more than r bit/s on the average
- The b parameter controls the length of output traffic bursts
- If the token counter is full (i.e., it traffic units at maximum rate
- Then, it must stop to wait further tokens

a) policer   b) shaper

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Policing and shaping: constraint functions

- Both regulators implement a *constraint function*

- This constraint function is the line *b+rt* and it represents the maximum number of traffic units, corresponding to IN traffic, that the regulator lets pass into the network

- In a time interval of duration *t*, the maximum In traffic that the regulator lets pass is equal to *b+rt*

- Excess traffic is OUT traffic

- This OUT traffic is treated differently by the policer and the shaper

a) policer   b) shaper

Cumulative traffic

OUT traffic (red)

b+rt

IN traffic (green)

t(s)
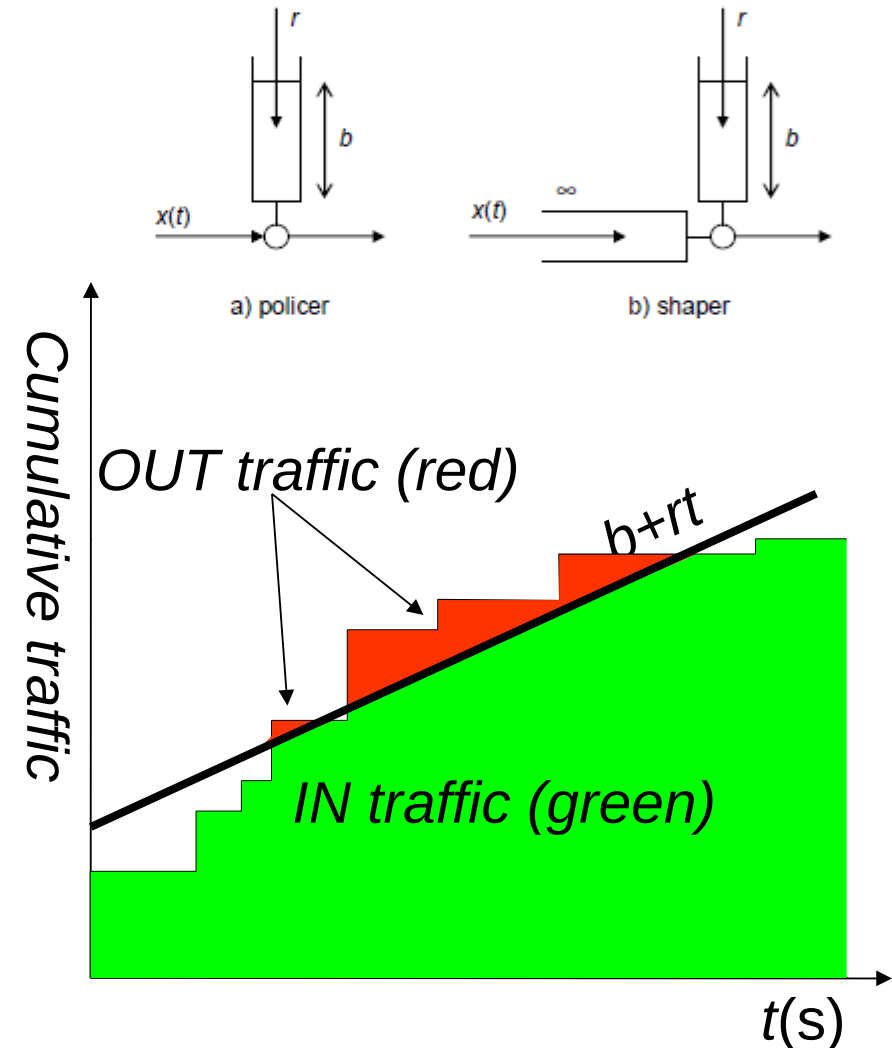
Token bucket policers

- A token bucket policers drops OUT traffic

- In this way, only In traffic enters the network

- The result is shown in the lower figure, representing the cumulative traffic entering the network

- The traffic pattern shown in the lower figure is a Linearly Bounded Arrival Process (LBAP)

- A token bucket policer assures that the traffic offered to the network is linearly bounded

OUT traffic (red)

b+rt

IN traffic (green)

Cumulative traffic

t(s)
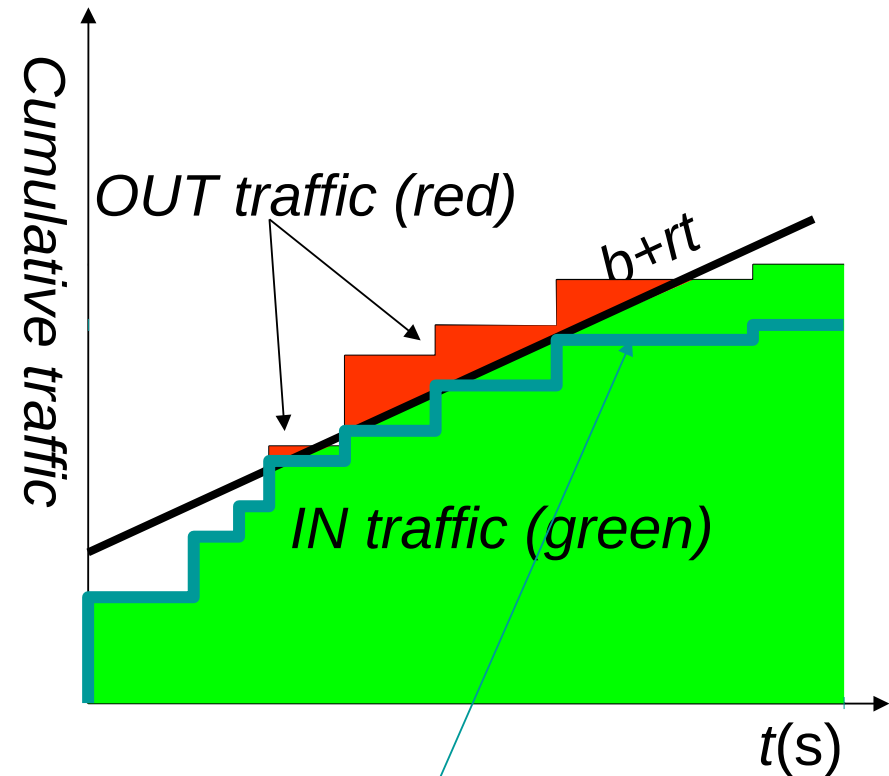
IN traffic actually output by the policer

Token bucket shapers
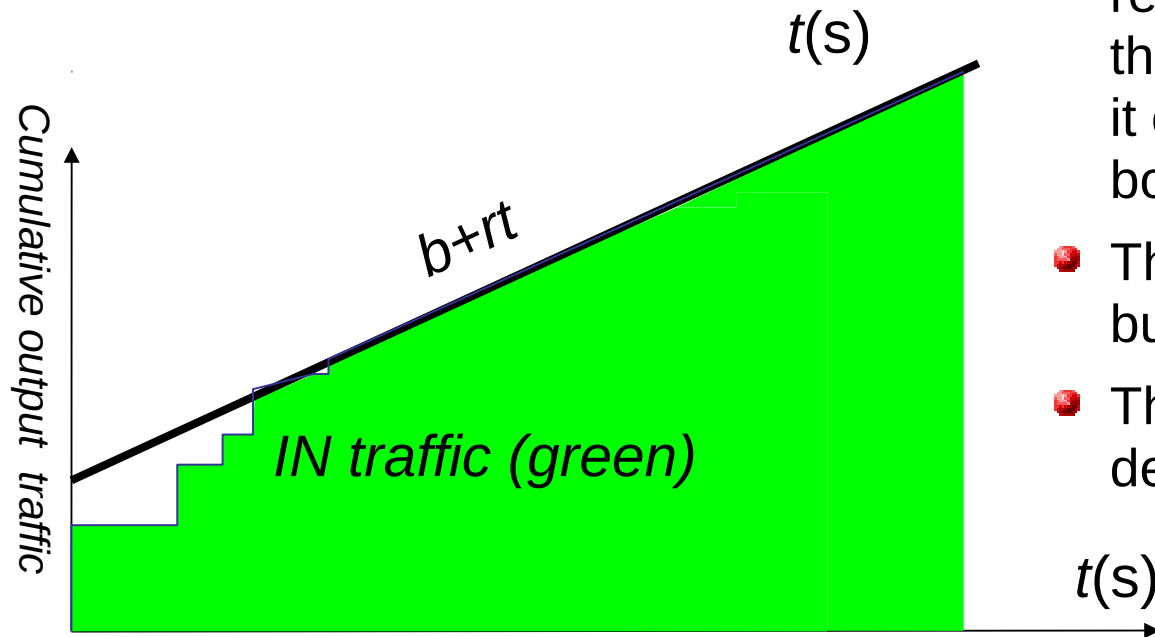
- A token bucket shaper behaves diferently
- OUT traffic is delayed in the regulator's buffer and it is sent into the network when it is possible to do it complying with the LBAP upper bound on cumulative traffic
- The shaper eliminates packet loss but adds delay
- The policer has (practically) no delay but it introduces packet loss

Cumulative output traffic

t(s)

b+rt

IN traffic (green)

t(s)

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Token bucket marker

- A token bucket marker works as the policer does, but it does not drop OUT traffic

- OUT traffic is marked and it is forwarded into the network

- Inside the network, as soon as congestion arises, marked packets are dropped before In packets

OUT traffic (red)

b+rt

Cumulative input traffic

IN traffic (green)
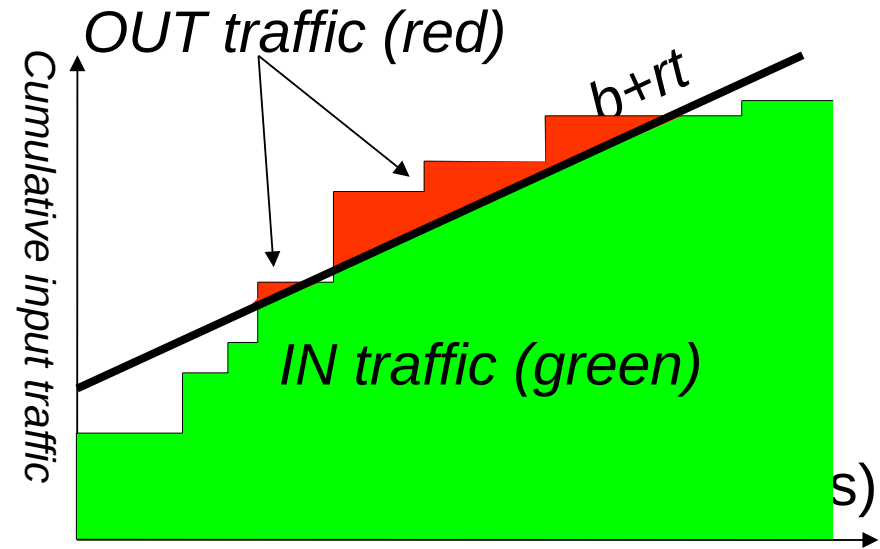
Single-rate three-color marker (srTCM)

- The Single Rate Three Color Marker (srTCM) can be used as component in a Diffserv traffic conditioner
- The srTCM meters a traffic stream and marks its packets according to three traffic parameters
  - Committed Information Rate (CIR) (green)
  - Committed Burst Size (CBS) (yellow)
  - and Excess Burst Size (EBS) (red)
- A packet is marked
  - green if it doesn't exceed the CBS
  - yellow if it does exceed the CBS, but not the EBS
  - red otherwise

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Single-rate three-color marker (srTCM)

- The Meter operates in one of two modes
    - In the **Color-Blind mode**, the Meter assumes that the packet stream is uncolored
    - In the **Color-Aware mode** the Meter assumes that some preceding entity has pre- colored the incoming packet stream so that each packet is either green, yellow, or red

- The Marker (re)colors an IP packet according to the results of the Meter

- The color is coded in the DS field of the packet in a Per-Hop-Behavior specific manner

- This means that green, yellow and red traffic are treated differently in the network

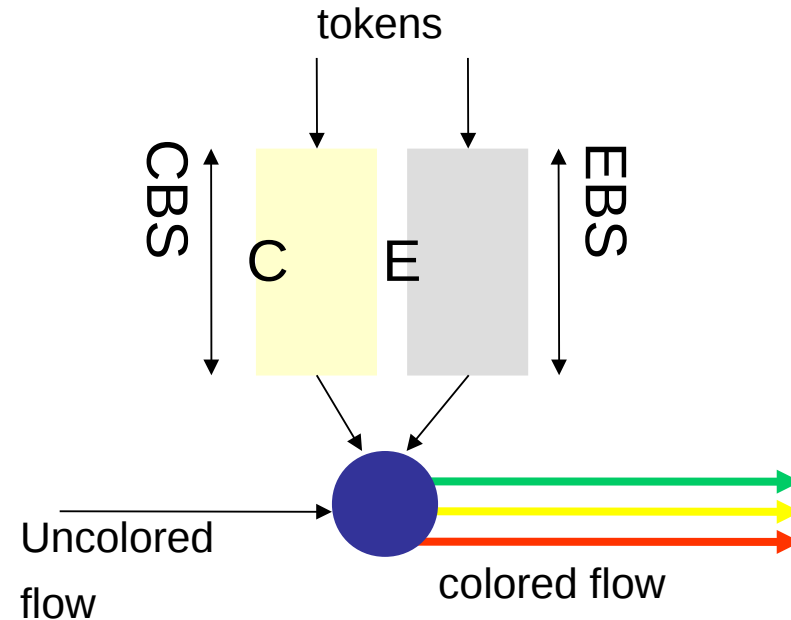- The specific way in which traffic is treated (Per Hop behavior) will be detailed in the following

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Single-rate three-color marker (srTCM)

- The CIR is measured in bytes of IP packets per second, i.e., it includes the IP header, but not link specific headers

- The CBS and the EBS and are measured in bytes

- The CBS and EBS must be configured so that at least one of them is larger than 0

- It is recommended that when the value of the CBS or the EBS is larger than 0, it is larger than or equal to the size of the largest possible IP packet in the stream

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2. Traffic conditioning

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Single-rate three-color marker (srTCM)

- The behavior of the Meter is specified in terms of its mode and two token buckets, C and E, which both share the common rate CIR

- The maximum size of the token bucket C is CBS and the maximum size of the token bucket E is EBS

- The token buckets C and E are initially (at time 0) full, i.e., the token count $Tc(0)$ = CBS and the token count $Te(0)$ = EBS

- Thereafter, the token counts Tc and Te are updated CIR times per second as follows
  - If Tc is less than CBS, Tc is incremented by one, else
  - if Te is less then EBS, Te is incremented by one, else
  - neither Tc nor Te is incremented

tokens

CBS

EBS

C   E

Uncolored flow

colored flow

srTCM operating in the
Color-blind mode

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2. Traffic conditioning
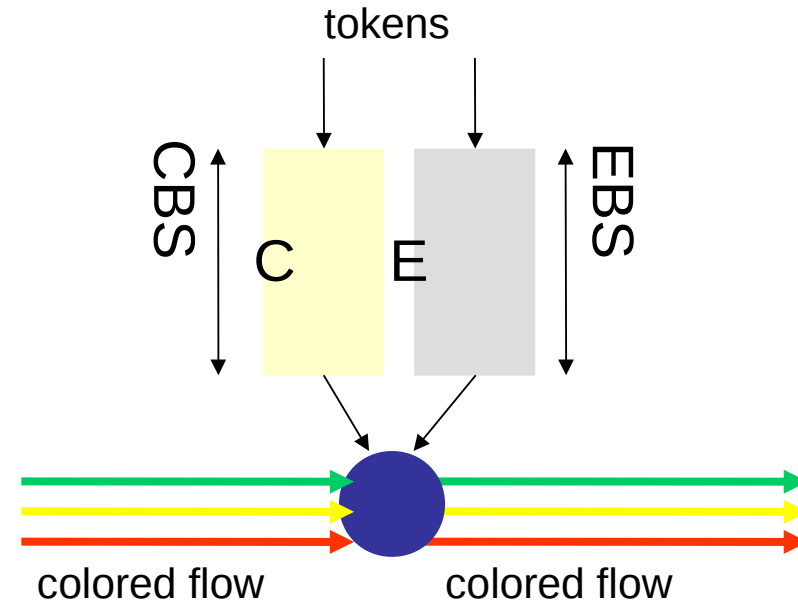
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Single-rate three-color marker (srTCM)

- When a packet of size B bytes arrives at time t, the following happens if the srTCM is configured to operate in the Color-Blind mode:
  - If $T_c(t)-B \geq 0$, the packet is green and T_c is decremented by B down to the minimum value of 0, else
  - if $T_e(t)-B \geq 0$, the packets is yellow and T_e is decremented by B down to the minimum value of 0, else
  - the packet is red and neither T_c nor T_e is decremented

tokens

CBS

EBS

C   E

Uncolored flow

colored flow
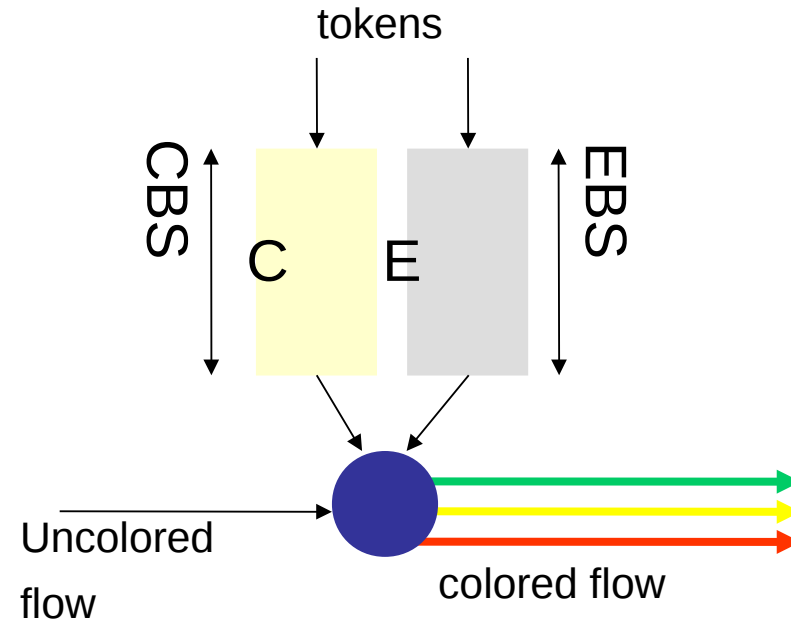
srTCM operating in the Color-blind mode

Single-rate three-color marker (srTCM)
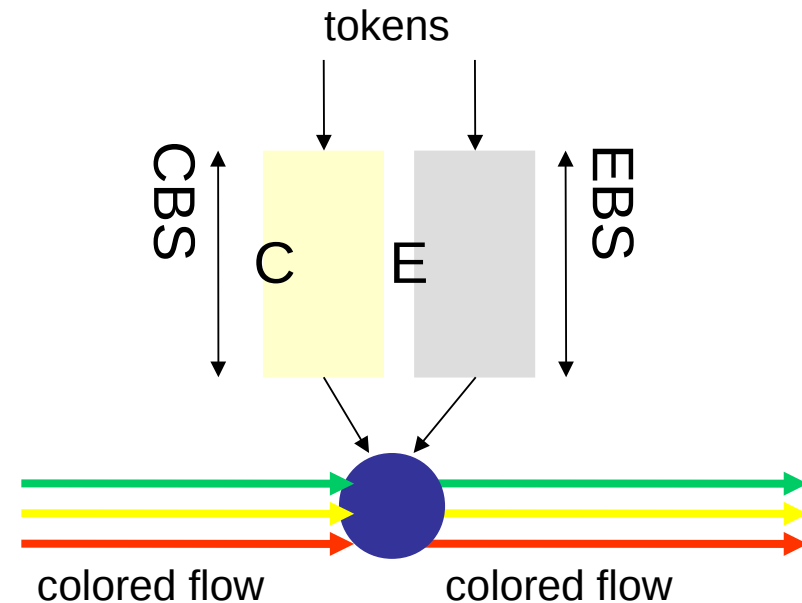
- When a packet of size B bytes arrives at time t, the following happens if the srTCM is configured to operate in the Color-Aware mode:
  - If the packet has been precolored as green and Tc(t)-B >= 0, the packet is green and Tc is decremented by B down to the minimum value of 0, else
  - If the packet has been precolored as green or yellow and if Te(t)-B >= 0, the packets is yellow and Te is decremented by B down to the minimum value of 0, else
  - the packet is red and neither Tc nor Te is decremented

srTCM operating in the Color-aware mode

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Single-rate three-color marker (srTCM)

- The srTCM can be used to mark a packet stream in a service, where different, decreasing levels of assurances are given to packets which are green, yellow, or red

- For example, a service may
  - discard all red packets, because they exceeded both the committed and excess burst sizes
  - forward yellow packets as best effort
  - forward green packets with a low drop probability

tokens

CBS   C   E   EBS

colored flow   colored flow

srTCM operating in the Color-aware mode