Technical Introduction

Token Bucket

About the token bucket mechanism

What is a token bucket

A token bucket is analogous to a container that holds a certain number of tokens. Each token represents one byte. The system puts tokens into the bucket at a constant rate. When the token bucket is full, newly arriving tokens cause the token bucket to overflow. A packet arriving when the bucket has enough tokens is considered as a conforming packet. A packet arriving when the bucket does not have enough tokens is considered as an excess packet. Each packet is colored based on the evaluation result.

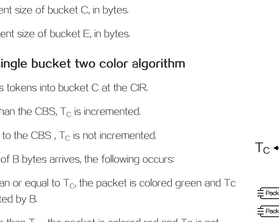
What can a token bucket do

A token bucket is used in the traffic policing, traffic shaping, and rate limit features. A token bucket can color a packet as green, yellow, or red. The coloring result is the basis for performing traffic actions (for example, sending green packets and yellow packets, and dropping read packets). The token bucket mechanism provides effective use of network resources.

Token bucket algorithms

The token bucket mechanism supports the following algorithms:

- Single rate single bucket two color algorithm: Contains one token putting rate (CIR) and one token bucket (C), and colors packets as green or red.
- Single rate two bucket three color algorithm: Contains one token putting rate (CIR) and two token buckets (C and E), and colors packets as green, yellow, or red.
- Two rate two bucket three color algorithm: Contains two token putting rates (CIR and PIR) and two token buckets (C and E), and colors packets as green, yellow, or red.



How does a token bucket work

Basic concepts

- Committed Information Rate (CIR): The rate at which tokens are put into bucket C (buckets C and E in the case of the single rate two bucket three color algorithm), in kbps.
- Peak Information Rate (PIR): The rate at which tokens are put into bucket E, in kbps. The PIR must be greater than the CIR.
- Committed Burst Size (CBS): The maximum size of bucket C, in bytes.
- Excess Burst Size (EBS): The maximum size of bucket E, in bytes. The EBS must be greater than the CBS.
- T_C: The current size of bucket C, in bytes.
- T_E : The current size of bucket E, in bytes.

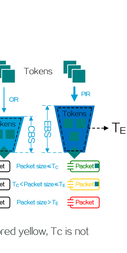
Single rate single bucket two color algorithm

The system puts tokens into bucket C at the CIR.

- If T_C is less than the CBS, T_C is incremented.
- If T_C is equal to the CBS , T_C is not incremented.

When a packet of B bytes arrives, the following occurs:

- If B is less than or equal to T_C, the packet is colored green and Tc is decremented by B.
- If B is greater than T_C , the packet is colored red and Tc is not decremented.



This algorithm does not have bucket E and therefore does not allow excess traffic. No packets will be colored yellow.

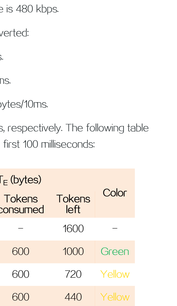
Single rate two bucket three color algorithm

The system puts tokens into bucket C at the CIR and puts tokens into bucket E at the CIR when bucket C is full.

- If T_C is less than the CBS, T_C is incremented.
- If T_C is equal to the CBS and T_E is less than the EBS, T_C is not incremented and T_E is incremented.
- If T_C is equal to the CBS and T_E is equal to the EBS, neither T_C nor T_E is incremented.

When a packet of B bytes arrives, the following occurs:

- If B is less than or equal to T_C, the packet is colored green and Tc is decremented by B.
- If B is greater than T_C and less than or equal to T_E, the packet is colored yellow and T_E is decremented by B.
- If B is greater than T_E , the packet is colored red and neither T_C nor T_E is decremented.



This algorithm has bucket E and therefore allows excess traffic. Packets can be colored yellow.

Two rate two bucket three color algorithm

The system puts tokens into bucket C at the CIR and into bucket E at the PIR.

- If T_C is less than the CBS, T_C is incremented.
- If T_C is equal to the CBS, T_C is not incremented.
- If T_E is less than the EBS, T_E is incremented.
- If T_E is equal to the EBS, T_E is not incremented.

When a packet of B bytes arrives, the following occurs:

- If B is less than or equal to T_C, the packet is colored green and both Tc and T_E are decremented by B.
- If B is greater than T_C and less than or equal to T_E , the packet is colored yellow, Tc is not decremented, and T_E is decremented by B.
- If B is greater than T_E , the packet is colored red, and neither T_C nor T_E is decremented.

This algorithm has bucket E and therefore allows excess traffic. Packets can be colored yellow.

This algorithm has a PIR at which tokens are put into bucket E and provides more flexibility for bursty traffic control.

Token bucket mechanism example

This section takes the two rate two bucket three color algorithm as an example to illustrate how the token bucket mechanism works.

In this example, the CIR is 128 kbps, the PIR is 256 kbps, the CBS is 800 bytes, and the EBS is 1600 bytes. The packet size is 600 bytes, and the packet rate is 480 kbps.

For ease of understanding, the following parameters are converted:

- CIR=128×1000÷8=16000 bytes/s, namely 160 bytes/10ms.
- PIR=256×1000÷8=32000 bytes/s , namely 320 bytes/10ms.
- Packet rate=480×1000÷8=60000 bytes/s , namely 600 bytes/10ms.

Token buckets C and E start full at 800 bytes and 1600 bytes, respectively. The following table illustrates how the token bucket mechanism works during the first 100 milliseconds:

Time (ms)	T_C (bytes)			T_E (bytes)			Color
	Tokens added	Tokens consumed	Tokens left	Tokens added	Tokens consumed	Tokens left	
0	–	–	800	–	–	1600	–
10	0	600	200	0	600	1000	Green
20	160	0	360	320	600	720	Yellow
30	160	0	520	320	600	440	Yellow
40	160	600	80	320	600	160	Green
50	160	0	240	320	0	480	Red
60	160	0	400	320	600	200	Yellow
70	160	0	560	320	0	520	Red
80	160	600	120	320	600	240	Green
90	160	0	280	320	0	560	Red
100	160	0	440	320	600	280	Yellow