Policing Accuracy of trTCM algorithm

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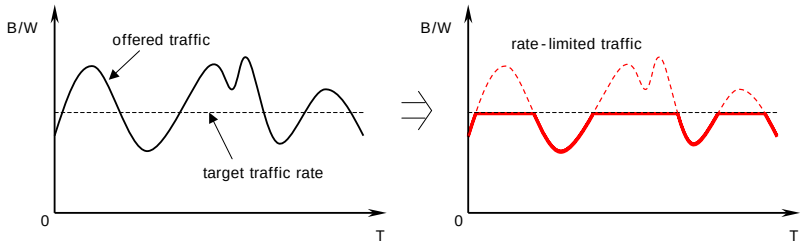
Contents

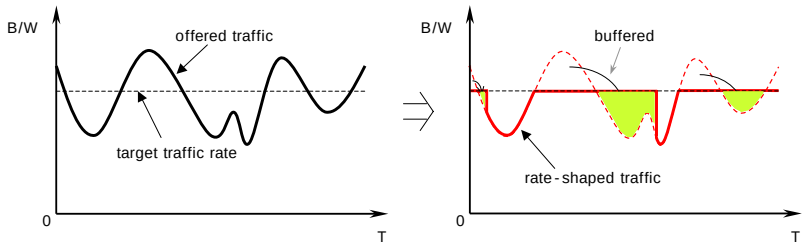
Rate Limiting / Policing – 1

- **Definition**
  - ✓ Policing is the packet-by-packet monitoring function (3) at a network border (ingress point) (2) that ensures a host does not violate its promised traffic characteristics (1).
    – from *Routing and Switching* by Rita Pužmanová

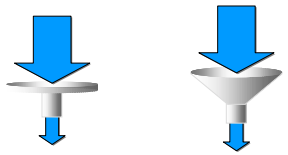


Suitable for Real-Time Applications due to No Queueing Delay !!
NOT Suitable for Loss-Sensitive Application !!

Rate Limiting / Policing – 2



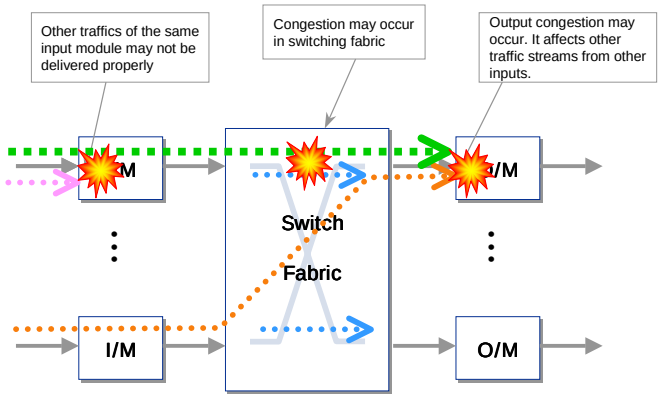
Operation of Traffic Shaping



policing **shaping**

Needs for Policing

Without Rate Limiting…



Problems of Policing

- **Inaccuracy in TCP environment**
  - ✓ 70~80% inaccuracy (i.e., 20~30% accuracy)
    - ✓ Due to the flow control feature of TCP
  - ✓ Settled by queueing → traffic shaping
    - ✓ Cause additional queueing delay
    - ✓ Not suitable for real-time application
- **Inaccuracy in Policer implementation**
  - ✓ ±3%– of inaccuracy due to the processing granularity
    - ✓ Physical limitation of processing chip
    - ✓ Practically impossible to resolve.
  - ✓ Inaccuracy due to improper parameter setting
    - ✓ Network operator are not familiar with policing parameter setting
    - ✓ Resolvable with a guideline

Motivation of this study

Traffic Conditioning

- **What is Traffic Conditioning?**
  - ✓ Policing/Rate Limiting in terms of DiffServ
- **Configuration of the Traffic Conditioner**
  - ✓ Classifier (Classification)
  - ✓ Meter (Metering) and Marker (Marking)
  - ✓ Dropper (Dropping) / Shaper (Shaping)
- **Traffic Conditioning Action (in DiffServ)**
  - ✓ RFC 2597 - Assured Forwarding PHB Group
  - ✓ Discarding, Shaping, Mark-down / Mark-up of Drop Precedence
- **Traffic Conditioners in RFCs**
  - ✓ RFC2697 – A single rate three color marker (srTCM)
  - RFC2698 – A two rate three color marker (trTCM)
  - ✓ RFC2859 – A time sliding window three colour marker (TSWTCM)
  - ✓ RFC2963 – A rate adaptive shaper for differentiated services

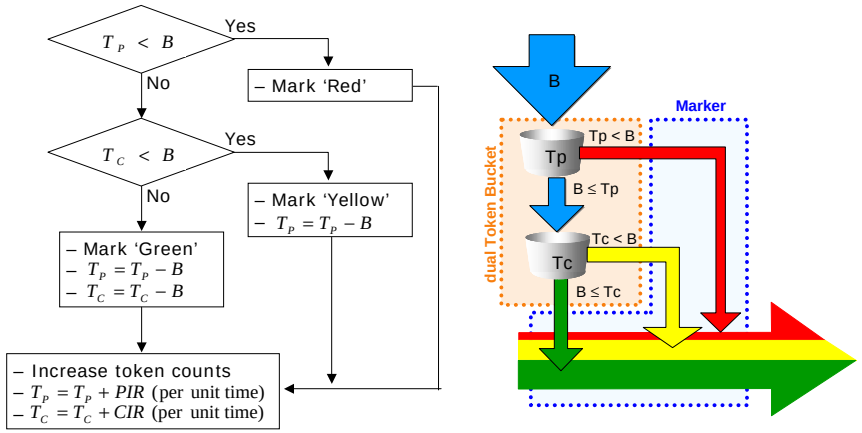
Two-Rate Three-Color Marker

- **RFC2698**
- **Marking is performed based on four parameters:**
  - ✓ CIR, PIR, CBS, and PBS.
    (CIR: committed information rate, PBS: peak burst size)
- **tr-TCM Algorithm**
  - ✓ Dual token bucket system (token buckets C and P)
  - ✓ See next slide.
- **Useful for ingress policing**
  - ✓ The bit rate, not burst length, determines service eligibility.
  - ✓ A peak rate needs to be enforced separately from a committed rate.
- **Operation Modes**
  - ✓ **Color-Blind Mode**
  - ✓ Color-Aware Mode

tr-TCM Algorithm

- **The tr-TCM uses two Token Counters Tc and Tp.**
  - ✓ Initial values: Tc(0) = CBS, Tp(0) = PBS
  - ✓ PBS ≥ CBS ≥ maximum possible packet size
  - ✓ Tc is increased by one CIR times per second up to CBS.
  - ✓ Tp is increased by one PIR times per second up to PBS.
  - ✓ Size of the arrived packet : B
- **Color-Blind Mode**
  - ✓ If Tp(t) – B < 0, then marks red. Else,
  - ✓ If Tc(t) – B < 0, then marks yellow and Tp = Tp – B. Else,
  - ✓ Marks green. Tp = Tp – B. Tc = Tc – B.
- **Color-Aware Mode**
  - ✓ If the arrived packet is pre-colored as red or Tp(t) – B < 0, then mark red. Else,
  - ✓ If the arrived packet is pre-colored as yellow or Tc(t) – B < 0, then mark yellow and Tp = Tp – B. Else,
  - ✓ Mark green, Tp = Tp – B. Tc = Tc – B.

tr-TCM Algorithm



Simulation Environments & Assumptions

- **Objectives of Simulation**
  - ✓ To look into the effect of the tr-TCM parameters on policing accuracy
  - ✓ To find out parameter sets guaranteeing 97% policing accuracy
- **Simulation Environments**
  - ✓ BC++ 6.0
  - ✓ Pentium IV 1.5 GHz

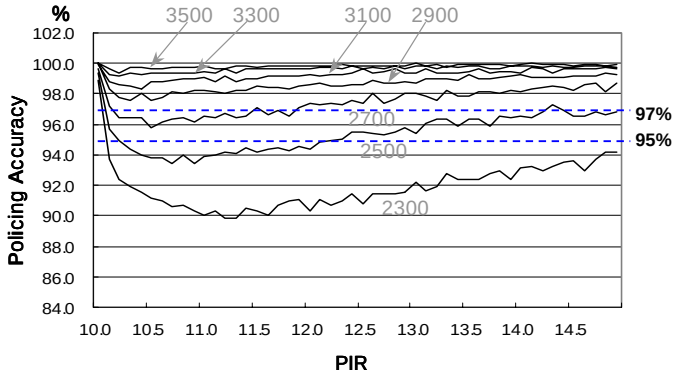
Industrial criteria :
more than **95%** or **97%**
policing accuracy

- **Traffic Flow**
  - ✓ A single traffic flow at the rate of 50 Mbps or 100 Mbps
  - ✓ Composed of either fixed-length packets or variable-length packets
- **Running Time**
  - ✓ 20 seconds to get a result for each situation.
  - ✓ 1 sec is composed of 6×10^6 time slots or ticks.
    - ✓ One time slot (tick) is 1.67×10^{-7}-sec long.
    - ✓ A full set of the trTCM operations is performed during a time slot.

Effect of CBS and PIR

- **Simulation Environments & Assumptions**
  1. The incoming traffic flow is composed of fixed-length packets.
  2. Packet length is fixed to 1500 bytes.
  3. The incoming traffic of 50 Mbps is policed to 10 Mbps.
     - That is, CIR = 10 Mbps (20% of the incoming rate)
  4. CBS is increased by 200 bytes from 2300 bytes to 3500 bytes
  5. PBS is set to equal to CBS.
  6. PIR is increased by 0.1 Mbps from 10.0 Mbps to 15 Mbps.

Result 1



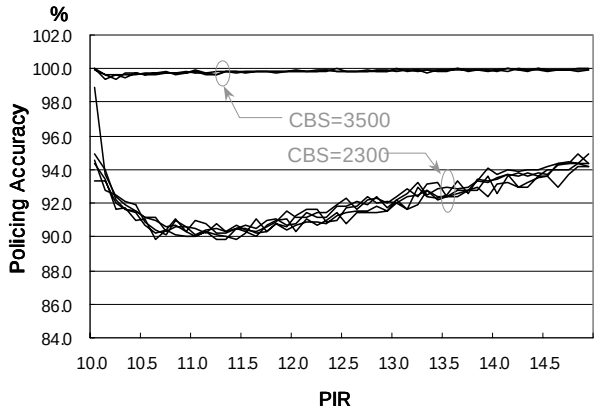
1. A larger CBS yields the more accurate policing result.
2. When CBS is greater than twice the maximum packet size, the tr-TCM guarantees 97% or more policing accuracy.
3. When PIR is equal to CIR, we can get maximum accuracy.

Effect of PBS and PIR

Simulation Environments & Assumptions

1. The incoming traffic flow is composed of fixed-length packets.
2. Packet length is fixed to 1500 bytes.
3. The incoming traffic of 50 Mbps is policed to 10 Mbps.
   - That is, CIR = 10 Mbps
4. CBS is set to either 2300 or 3500 bytes
5. PBS is increased by 200 bytes from CBS.
6. PIR is increased by 0.1 Mbps from 10.0 Mbps to 15 Mbps.

Result 2



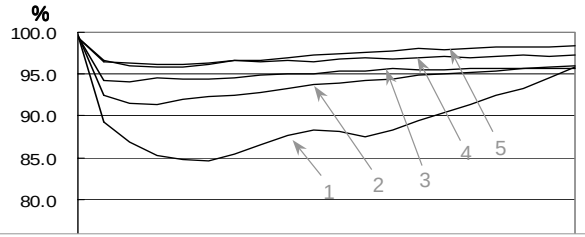
1. PBS has no effect on the policing accuracy.
2. When PIR is equal to CIR, we can get maximum accuracy.

Effect of the Packet Size Distribution

Simulation Environments & Assumptions

1. The incoming traffic flow is composed of variable-length packets.
   - Packet length distribution is based on the table shown later.
   - Average packet length is fixed to 900 bytes in every cases.
2. The incoming traffic of 100 Mbps is policed to 10 Mbps.
   - That is, CIR = 10 Mbps
3. CBS and PBS are set to 1200.
   - It should be larger than 1500 (maximum possible packet length)
4. PIR is increased from CIR to 2×CIR.

Result 3



The trTCM algorithm provides better policing accuracy for the traffic with larger standard deviation

※ Average packet length is fixed to 900 bytes in every cases.

	Curve 1	Curve 2	Curve 3	Curve 4	Curve 5
Possible packet length	Fixed to 900	Random between 600 and 1200	Random among 600, 900, or 1200	Random among 300, 600, 900, 1200, or 1500	Random among 300, 900, or 1500
Standard deviation	0	173.2	245	424.3	490

Summary

- **Policing/Rate Limiting Concept and its Needs**
  - ✓ A procedure to ensure a host does not violate its promised traffic characteristics.
  - ✓ Needed to prevent possible congestion by excessive traffic.
- **Two-Rate Three-Color Marker**
  - ✓ Use 4 parameters of CIR, PIR, CBS, and PBS
- **Simulation Results**
  1. When PIR is equal to CIR, we can get the most accurate policing.
  2. When CBS is greater than twice the maximum packet size, we can guarantee 97%+ policing accuracy.
  3. PBS has no effect on policing accuracy.

Thank You!

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