Bandwidth Management and QOS

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MUM April 2015 – Phnom Penh
ABOUT ME

• Network Engineer at MaxBIT ISP
• Working with MikroTik for few years with both core and edge network
• Certifications
  • MikroTik:
    • Academy Trainer (ACTR0207)
    • MTCNA, MTCRE, MTCTCE, MTCINE
  • Cisco: CCNA, CCNP
  • Juniper: JNCIA-Junos
Objective

- Mangle
- HTB (Hierarchical Token Bucket)
- QOS Packet Flow
- Simple Queue
- Queue Tree
Mangle
What is Mangle?

• The mangle facility allows to mark IP packets with special marks.

• These marks are used by other router facilities like routing and bandwidth management to identified the packets.

• Additionally, the mangle facility is used to modify some fields in the IP header, like TOS (DSCP) and TTL fields.
Mangle Structure

• Mangle rules are organised in chains
• There are five built in chains:
  • Prerouting
  • Postrouting
  • Input
  • Output
  • Forward
• New user-defined chains can be added, as necessary.
Mangle – Winbox view

Mark traffic by traffic type go to IP > firewall > mangle
/ip firewall mangle
add action=jump chain=forward connection-mark=no-mark jump-target=MARK-CONN
add action=jump chain=forward connection-mark=!no-mark jump-target=MARK-PACKET
add action=mark-connection chain=MARK-CONN comment=rest connection-mark= no-mark new-connection-mark=ALL-CONN
add action=mark-connection chain=MARK-CONN comment=voip dst-port= 5060-5061,16000-17000,40012 new-connection-mark=VOIP-CONN protocol=udp
add action=mark-connection chain=MARK-CONN comment=video dst-address-list= AS15169 new-connection-mark=VIDEO-CONN protocol=tcp
add action=mark-connection chain=MARK-CONN comment=Mail dst-port=25,110,143 new-connection-mark=MAIL-CONN protocol=tcp
add action=return chain=conmark
add action=mark-packet chain=MARK-PACKET comment=VO connection-mark=VOIP-CONN new-packet-mark=VO
add action=mark-packet chain=MARK-PACKET comment=VI connection-mark= VIDEO-CONN new-packet-mark=VI
add action=mark-packet chain=MARK-PACKET comment=BE connection-mark=ALL-CONN new-packet-mark=BE
add action=mark-packet chain=MARK-PACKET comment=MAIL connection-mark= MAIL-CONN new-packet-mark=MAIL
HTB
(Hierarchical Token Bucket)
HTB (Hierarchical Token Bucket)

• All quality of service implementation in RouterOS is based on Hierarchical Token Bucket
• HTB allows to create hierarchical queue structure and determine relations between parent and child queues and relation between child queues
• RouterOS v6.x supports 1 virtual HTB (global) while RouterOS v5.x support 3 virtual HTB(global-in, global-total, global-out)
HTB Structure

• As soon as queue have at least one child it become parent queue
• All child queue (don’t matter how many levels of parents they have) are on the same bottom level of HTB
• Child queues make actual traffic consumption, parent queues are responsible only for traffic distribution
• Child queues will get limit-at first and then rest of traffic will distributed by parents
Example

- Max-limit=10M
  - parent=Local-interface
    - Limit-at=8M
      - Max-limit=10M
        - "Queue02"
          - parent=Queue01
            - Limit-at=2M
              - Max-limit=10M
                - Priority=1
                  - "Queue03"
                    - parent=Queue01
            - Limit-at=2M
              - Max-limit=10M
                - Priority=3
                  - "Queue04"
                    - parent=Queue02
            - Limit-at=2M
              - Max-limit=10M
                - Priority=5
                  - "Queue05"
                    - parent=Queue02
Dual Limitation

HTB has two rate limit:

• CIR (Committed Information Rate) – (limit-at in RouterOS) worst case scenario, flow will get this amount of traffic no matter what (assuming we can actually send so much data)

• MIR (Maximal Information Rate) – (max-limit in RouterOS) best case scenario, rate that flow can get up to, if there queue's parent has spare bandwidth

• At first HTB will try to satisfy every child queue’s limit-at-only then it will try to reach max-limit
Dual Limitation

• Maximal rate of the parent should be equal or bigger than sum of committed rates of the children
  • \( \text{MIR (parent)} \geq \text{CIR(child1)} + \ldots + \text{CIR(childN)} \)

• Maximal rate of any child should be less or equal to maximal rate of the parent.
  • \( \text{MIR (parent)} \geq \text{MIR(child1)} \& \text{MIR (parent)} \geq \text{MIR(child2)} \& \ldots \& \text{MIR (parent)} \geq \text{MIR(childN)} \)
Traffic Fundamentals

• Router Inbound traffic - traffic that is received by the router from any side. Any frames serialised by someone else on the wire and travelling towards the router.

• Router Outbound traffic - traffic that goes out of a router's interface, towards the world or towards our clients. This is where we set up limits and manage the bandwidth.

• RuterOS HTB allows us to work with the Outgoing traffic - the traffic that is leaving the router via any interface.
QOS Packet Flow
QOS Packet flow V5
Change in V6

• /queue tree entries with parent=global are performed separately from /queue simple and before /queue simple;
Simple Queue
Simple Queue

• Fast and easy way to control bandwidth
• No need to mark can identify traffic based on dst-address, interface, etc...
• Number of simple queue is not relevant anymore
• We can have thousands of them and we can easily create them either dynamically or by scripts.
• Top level simple queues are now balanced between CPU cores (32 queues 9x faster than 1 queue on CCR1036)
What new in simple queue ROSv6

- Completely new algorithm, build in kernel, faster.
- Better simple queues selection algorithm (hashing);
- “target-addresses” and “interface” parameters are joined into one “target” parameter, and supports multiple interfaces match for one queue
- “dst-address” parameter is changed to “dst” parameter and now supports destination interface matching
- Separate “priority” parameter for download, upload and total
Simple Queue ROSv5
Simple Queue ROSv6
Simple way to add simple queue

In menu Queue Simple

Laptop IP address
Simple Queue – Winbox view
Simple Queue – Script view

```
/queue simple add target=172.30.10.10 name=172.30.10.10 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.11 name=172.30.10.11 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.12 name=172.30.10.12 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.13 name=172.30.10.13 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.14 name=172.30.10.14 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.15 name=172.30.10.15 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.16 name=172.30.10.16 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.17 name=172.30.10.17 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.18 name=172.30.10.18 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.19 name=172.30.10.19 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.20 name=172.30.10.20 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.21 name=172.30.10.21 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.22 name=172.30.10.22 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.23 name=172.30.10.23 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.24 name=172.30.10.24 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.25 name=172.30.10.25 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.26 name=172.30.10.26 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.27 name=172.30.10.27 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.28 name=172.30.10.28 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.29 name=172.30.10.29 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
/queue simple add target=172.30.10.30 name=172.30.10.30 max-limit=1024k/1024k burst-limit=2048k/2048k burst-time=8/8 burst-threshold=1024k/1024k
```
Queue Tree
Queue Tree

• Tree queue is one directional only and can be placed in any of the available HTBs
• Queue Tree queues don't have any order – all traffic is processed simultaneously
• All child queues must have packet marks
• we don't need separate marks per outgoing interface.
• The parent queue is only used to set the max-limit and to group the leaf queues
Queue Tree – Winbox view
Queue Tree Export Script

/queue tree
add max-limit=2048k name=GLOBAL-QUEUE parent=global queue=default
add limit-at=1024k max-limit=2048k name=VIDEO packet-mark=VI parent=GLOBAL-QUEUE priority=3 queue=default
add limit-at=512k max-limit=2048k name=VOICE packet-mark=VO parent=GLOBAL-QUEUE priority=1 queue=default
add limit-at=256k max-limit=2048k name=MAIL packet-mark=MAIL parent=GLOBAL-QUEUE priority=2 queue=default
add limit-at=256k max-limit=2048k name=BEST-EFFORT packet-mark=BE parent=GLOBAL-QUEUE priority=3 queue=default
Summary

• Service type marking
• Service type queuing
• User limiting queuing
Reference

• MikroTik Wiki
• Qos Best Practice and RouterOS v6 presentation by Janis Megis
• QoS in RouterOS presentation by Alfredo Giordano
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