MikroTik RouterOS Workshop
QoS Best Practice
Chicago, IL
MUM USA 2008
Plan

Discuss best QoS practice for
  - Large scale user speed limitations
  - Prioritization of traffic based on traffic type

Implement best practice

You will be able to follow the progress – just connect to SSID “QoS” and open up the Winbox to address 10.1.1.254 (default user name and password)
User Limitation

- You have more than 400 clients
- **Task:**
  - Divide clients into 3 groups
    - Business (4Mbps/1Mbps) connection
    - Standard (750kbps/250kbps) connection
    - Basic (375kbps/125kbps) connection
Simple Queue For Each Client

Each simple queue creates 3 separate queues:

- One in global-in ("direct" part)
- One in Global-out ("reverse" part)
- One in Global-total ("total" part)

Simple queues are ordered - similar to firewall rules

- further down = longer packet processing
- further down = smaller chance to get traffic

(necessary to reduce number of queues)
Possible Solutions

RouterOS have 4 queue types:

- FIFO – First In First Out (for Bytes or for Packets)
- RED – Random Early Detect (or Drop)
- SFQ – Stochastic Fairness Queuing
- PCQ – Per Connection Queuing (MikroTik Proprietary)

Firewall Mangle and Address-lists

Queue Tree
Default Queue Types

[Image of two screenshots showing interface queues and queue types]

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PFIFO

IN

Check Queue Size

Queue Size < PFIFO Limit

Enqueue Packet

OUT

Queue Size ≥ PFIFO Limit

Drop Packet
SFQ

**Behaviour:**
Based on hash value from source and destination address SFQ divides traffic into 1024 sub-streams
Then Round Robin algorithm will distribute equal amount of traffic to each sub-stream
PCQ

Behaviour:
Based on classifier PCQ divides traffic into sub-streams. Each sub-stream can be considered as FIFO queue with queue size specified by “limit” option.

After this PCQ can be considered as FIFO queue where queue size is specified by “total-limit” option.
pcq-rate=0

max-limit=512k

1 user

- 512k

2 users

- 256k
- 256k

7 users

- 73k
- 73k
- 73k
- 73k
- 73k
- 73k
- 73k
pcq-rate=128000

max-limit=512k

2 users
- 128k
- 128k

4 users
- 128k
- 128k
- 128k
- 128k

7 users
- 73k
- 73k
- 73k
- 73k
- 73k
- 73k
- 73k
- 73k
Plan

Create an address list for client classes

Use “connection-mark” (mangle) feature to classify all connections based on client class

Use “packet-mark” (mangle) feature to classify all traffic based on client class

Create a PCQ queue for each client class with rate option specified

→...what about user-user communications???
→...what about unmarked traffic?
Address Lists
Where?

- There are 5 places to mangle
- There are 4 places to limit
Connection-mark rule

[Image of a network configuration tool with highlighted options for connection-marking rules, including fields for action and new connection mark]
Packet-mark rule
Working Mangle - Winbox view

<table>
<thead>
<tr>
<th>#</th>
<th>Action</th>
<th>Chain</th>
<th>New Packet Mark</th>
<th>New Connection Mark</th>
<th>Bytes</th>
<th>Packets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>mark basic client traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mark connection</td>
<td>forward</td>
<td></td>
<td>basic_client_conn</td>
<td>9893.1 MiB</td>
<td>18 599 504</td>
</tr>
<tr>
<td></td>
<td>mark packet</td>
<td>forward</td>
<td></td>
<td>basic_client_traffic</td>
<td>22575.4 MiB</td>
<td>35 292 323</td>
</tr>
<tr>
<td>2</td>
<td>mark standard client traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mark connection</td>
<td>forward</td>
<td></td>
<td>standard_client_conn</td>
<td>825.4 MiB</td>
<td>2 747 515</td>
</tr>
<tr>
<td></td>
<td>mark packet</td>
<td>forward</td>
<td></td>
<td>standard_client_traffic</td>
<td>6396.7 MiB</td>
<td>7 248 925</td>
</tr>
<tr>
<td>3</td>
<td>mark business client traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mark connection</td>
<td>forward</td>
<td></td>
<td>business_client_conn</td>
<td>190.2 MiB</td>
<td>912 903</td>
</tr>
<tr>
<td></td>
<td>mark packet</td>
<td>forward</td>
<td></td>
<td>business_client_traffic</td>
<td>1324.9 MiB</td>
<td>1 929 206</td>
</tr>
<tr>
<td>4</td>
<td>Check for unmarked traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>log</td>
<td>forward</td>
<td></td>
<td></td>
<td>2062.0 KiB</td>
<td>9 014</td>
</tr>
</tbody>
</table>
Working Mangle- Export view

/ ip firewall mangle
add chain=forward src-address-list=Basic_class_client action=mark-connection \ new-connection-mark=basic_client_conn passthrough=yes comment="mark basic client traffic" disabled=no
add chain=forward connection-mark=basic_client_conn action=mark-packet \ new-packet-mark=basic_client_traffic passthrough=no comment="" disabled=no
add chain=forward src-address-list=Standard_class_client \ action=mark-connection new-connection-mark=standard_client_conn \ passthrough=yes comment="mark standard client traffic" disabled=no
add chain=forward connection-mark=standard_client_conn action=mark-packet \ new-packet-mark=standard_client_traffic passthrough=no comment="" \ disabled=no
add chain=forward src-address-list=Business_class_client \ action=mark-connection new-connection-mark=business_client_conn \ passthrough=yes comment="mark bussiness client traffic" disabled=no
add chain=forward connection-mark=business_client_conn action=mark-packet \ new-packet-mark=business_client_traffic passthrough=no comment="" \ disabled=no
add chain=forward action=log log-prefix="" comment="Check for unmarked traffic" disabled=no
Queuing Placement

- Limitation for in mangle chain “forward” marked traffic can be placed in the “global-out” or interface queue

- If queues will be placed in the interface queues
  - queues on the public interface will capture only client upload
  - queues on the local interface will capture only client's download

- If queues will be placed in global-out download and upload will be limited together (separate marks needed)
PCQ Types – Winbox View
Queue Tree – Winbox View

![Queue List](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Parent</th>
<th>Packet Mark</th>
<th>Limit At</th>
<th>Max Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total download</td>
<td>local_ether1</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>basic_client_download</td>
<td>Total_download</td>
<td>basic_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>business_client_download</td>
<td>Total_download</td>
<td>business_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>standard_client_download</td>
<td>Total_download</td>
<td>standard_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total_upload</td>
<td>public_ether3</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>basic_client_upload</td>
<td>Total_upload</td>
<td>basic_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>business_client_upload</td>
<td>Total_upload</td>
<td>business_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>standard_client_upload</td>
<td>Total_upload</td>
<td>standard_client_traffic</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

0 B queued 0 packets queued
Queue Tree – Export View

/ queue tree
  add name="Total_download" parent=local Ether1 packet-mark="" limit-at=0 \ queue=default priority=1 max-limit=0 burst-limit=0 burst-threshold=0 \ burst-time=0s disabled=no
  add name="basic_client_download" parent=Total_download \ packet-mark=basic_client_traffic limit-at=0 queue=PCQ_down_375k priority=8 \ max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no
  add name="standard_client_download" parent=Total_download \ packet-mark=standard_client_traffic limit-at=0 queue=PCQ_down_750k \ priority=4 max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no
  add name="business_client_download" parent=Total_download \ packet-mark=business_client_traffic limit-at=0 queue=default priority=1 \ max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no
  add name="Total_upload" parent=public Ether3 packet-mark="" limit-at=0 \ queue=default priority=8 max-limit=0 burst-limit=0 burst-threshold=0 \ burst-time=0s disabled=no
  add name="basic_client_upload" parent=Total_upload \ packet-mark=basic_client_traffic limit-at=0 queue=PCQ_up_125k priority=8 \ max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no
  add name="standard_client_upload" parent=Total_upload \ packet-mark=standard_client_traffic limit-at=0 queue=PCQ_up_250k \ priority=4 max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no
  add name="business_client_upload" parent=Total_upload \ packet-mark=business_client_traffic limit-at=0 queue=PCQ_up_1M priority=1 \ max-limit=0 burst-limit=0 burst-threshold=0 burst-time=0s disabled=no

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PCQ Queue Size

- It can take only 40 users to fill the queue (because total_limit/limit = 2000/50 = 40)
- It is necessary to increase “total_limit” or (and) decrease the “limit” value
- There must be at least 10-20 packet places in queue available per user

Total_limit = X can take up to X*(2000 bytes + 200 bytes) of RAM

2000 bytes – buffer for 1 packet
200 bytes – service data for 1 packet

total_limit = 2000 <= 4,2MB RAM
total_limit = 5000 <= 10,5MB RAM
PCQ Adjustments

There are ~340 Basic class clients so:

- $\text{pcq\_limit} = 40$
- $\text{pcq\_total\_limit} = 7000 \ (\sim 20 \times 340) \ (\sim 15\text{MB})$

There are ~40 Standard class clients so:

- $\text{pcq\_limit} = 30$
- $\text{pcq\_total\_limit} = 1000 \ (\sim 20 \times 40) \ (\sim 2\text{MB})$

There are ~20 Business class clients so:

- $\text{pcq\_limit} = 20 \ (!!!)$
- $\text{pcq\_total\_limit} = 500 \ (\sim 20 \times 20) \ (\sim 1\text{MB})$
Traffic Prioritization

T3/E3 line

~40 Mbps

~5 Mbps abroad

You have problems with on-line communications (video, audio, VOIP, games)

Task:
Make necessary traffic prioritization
Where?

- There are 5 places to mangle
- There are 4 places to limit
### How?

<table>
<thead>
<tr>
<th>Group</th>
<th>Service</th>
<th>Protocol</th>
<th>Dst-Port</th>
<th>Other_conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>P2P_services</td>
<td>P2P</td>
<td>TCP</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCP</td>
<td>995</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCP</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCP</td>
<td>993</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TCP</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Download_services</td>
<td>Mails</td>
<td>TCP</td>
<td>80</td>
<td>Connection-bytes=500000-0</td>
</tr>
<tr>
<td></td>
<td>HTTP downloads</td>
<td>TCP</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FTP</td>
<td>TCP</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SFTP</td>
<td>TCP</td>
<td>22</td>
<td>Packet-size=1400-1500</td>
</tr>
<tr>
<td>Ensign_services</td>
<td>DNS</td>
<td>TCP</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UDP</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ICMP</td>
<td>ICMP</td>
<td>-</td>
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</tr>
<tr>
<td></td>
<td>HTTPS</td>
<td>TCP</td>
<td>443</td>
<td></td>
</tr>
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<td>Telnet</td>
<td>TCP</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SSH</td>
<td>TCP</td>
<td>22</td>
<td>Packet-size=0-1400</td>
</tr>
<tr>
<td></td>
<td>HTTP requests</td>
<td>TCP</td>
<td>80</td>
<td>Connection-bytes=0-500000</td>
</tr>
<tr>
<td>User_requests</td>
<td>Online game servers</td>
<td>TCP</td>
<td></td>
<td>Dst-address-list=user_requests</td>
</tr>
<tr>
<td>Communication_services</td>
<td>VoIP</td>
<td>TCP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Skype</td>
<td>TCP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Video conferences</td>
<td>TCP</td>
<td></td>
<td></td>
</tr>
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<td>VPN</td>
<td>TCP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MSN</td>
<td>TCP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Priorities

Create packet marks in the mangle chain “Prerouting” for traffic prioritization in the global-in queue

- Ensign_services (Priority=1)
- User_requests (Priority=3)
- Communication_services (Priority=5)
- Download_services (Priority=7)
- P2P_services (Priority=8)