

M i k r o T i k R o u t e r O S W o r k s h o p
Q o S B e s t P r a c t i c e
C h i c a g o , I L
M U M U S A 2 0 0 8

Plan

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

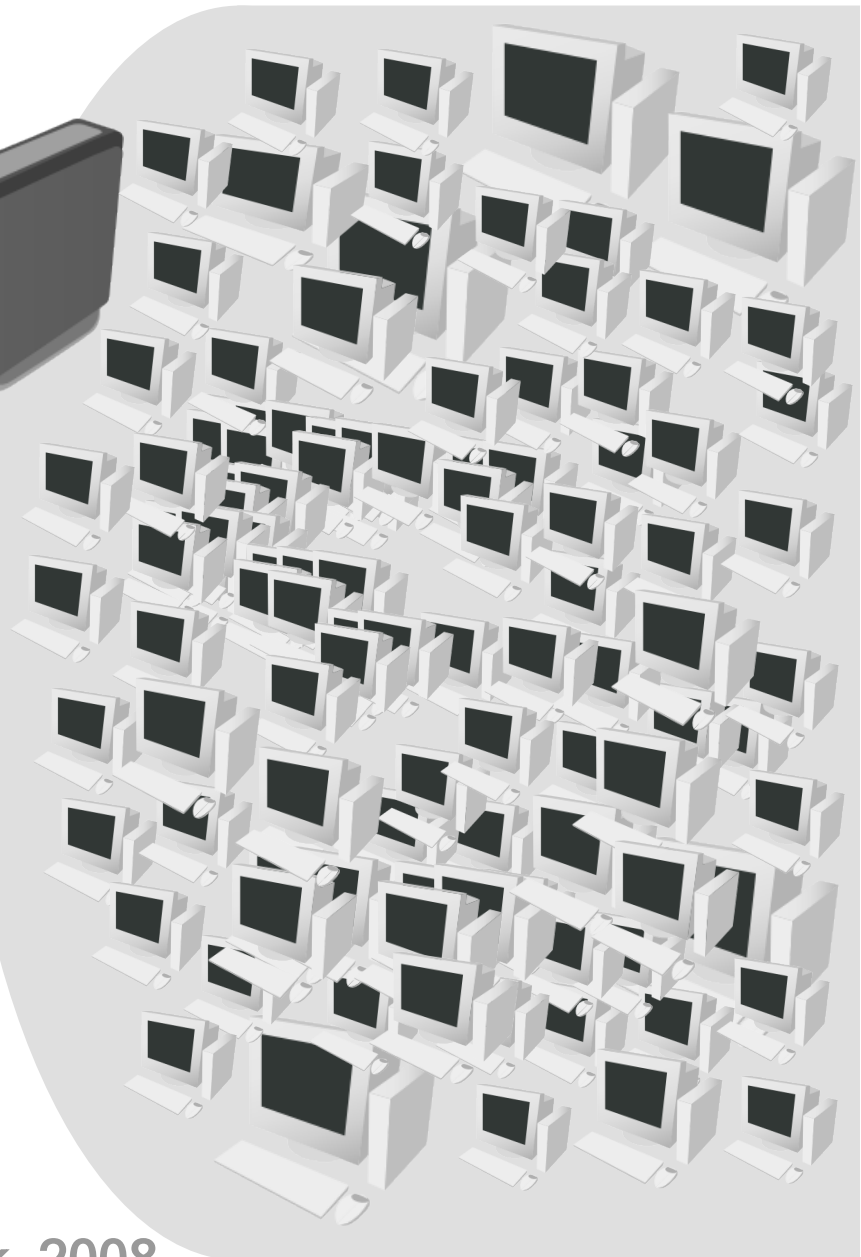
You will be able to follow the progress – just connect to SSID “QoS” and open up the Winbox to address 10.1.1.254 (default user name and password)

User Limitation



T3/E3 line

~40 Mbps



- 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

The top screenshot shows the 'Queue List' window with the 'Interface Queues' tab selected. The table below shows the interface queue types:

Interface	Queue Type
Local_ether3	ethernet-default
Public_ether1	ethernet-default
ether2	ethernet-default
wlan1_HATA	wireless-default

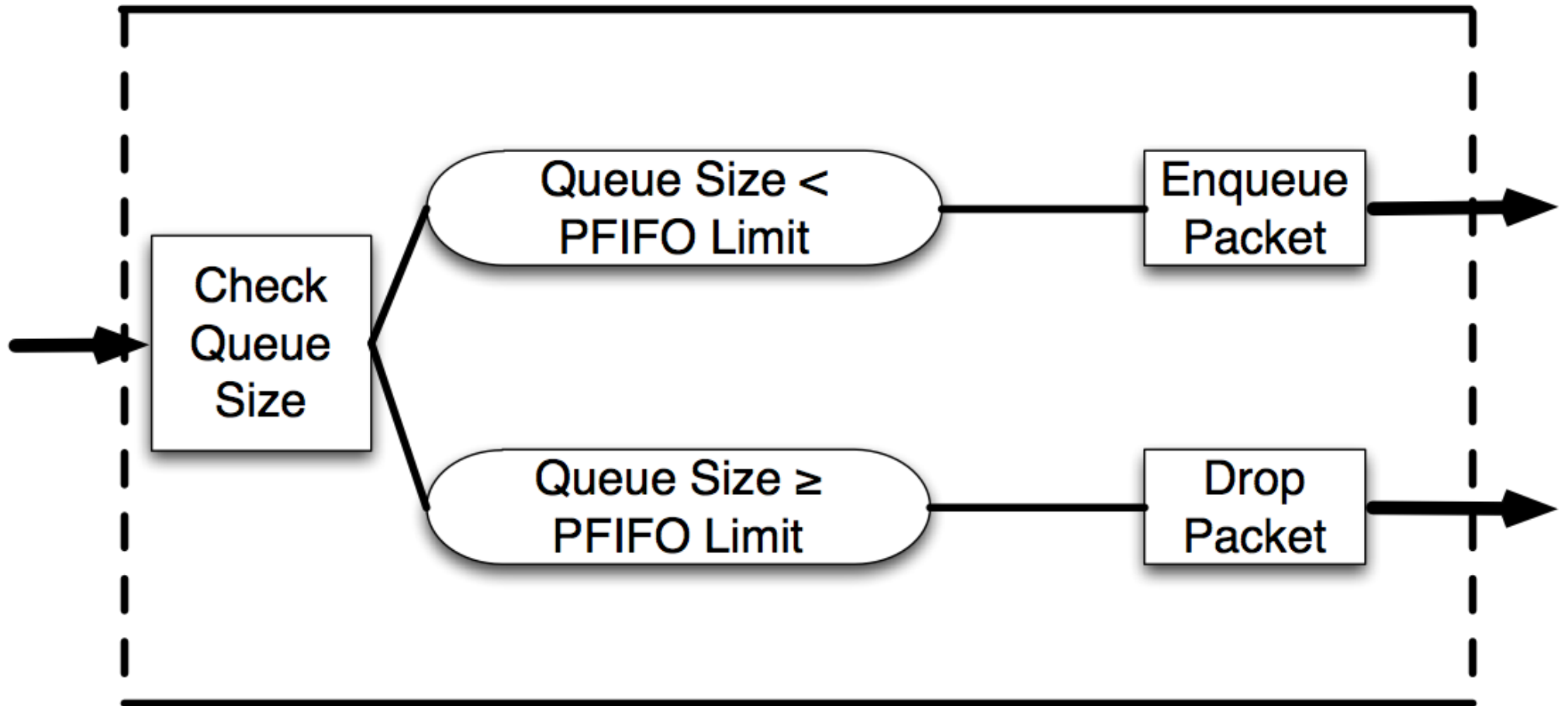
The bottom screenshot shows the 'Queue List' window with the 'Queue Types' tab selected. The table below shows the queue types and their kinds:

Type Name	Kind
default	pfifo
default-small	pfifo
ethernet-default	pfifo
hotspot-default	sfq
queue1	pcq
synchronous-default	red
wireless-default	sfq

PFIFO

IN

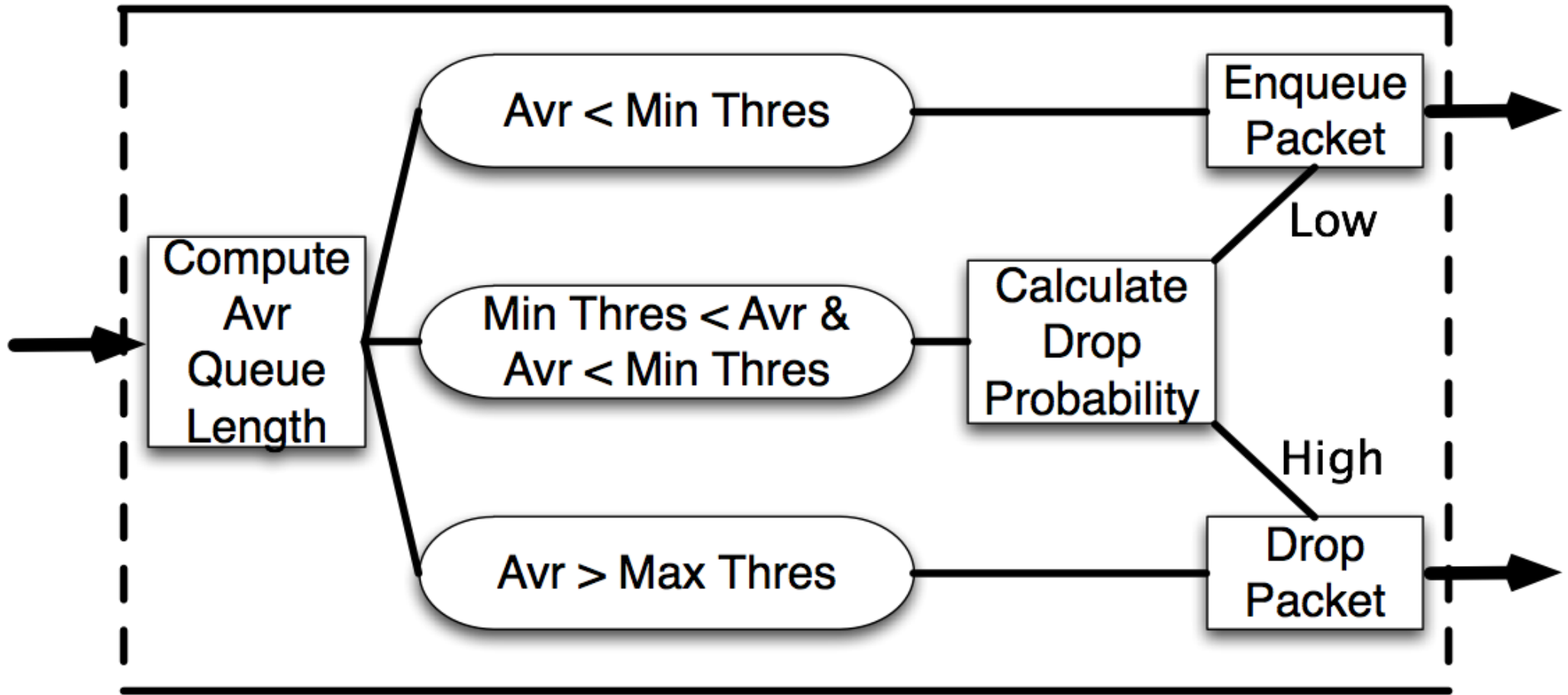
OUT



RED

IN

OUT

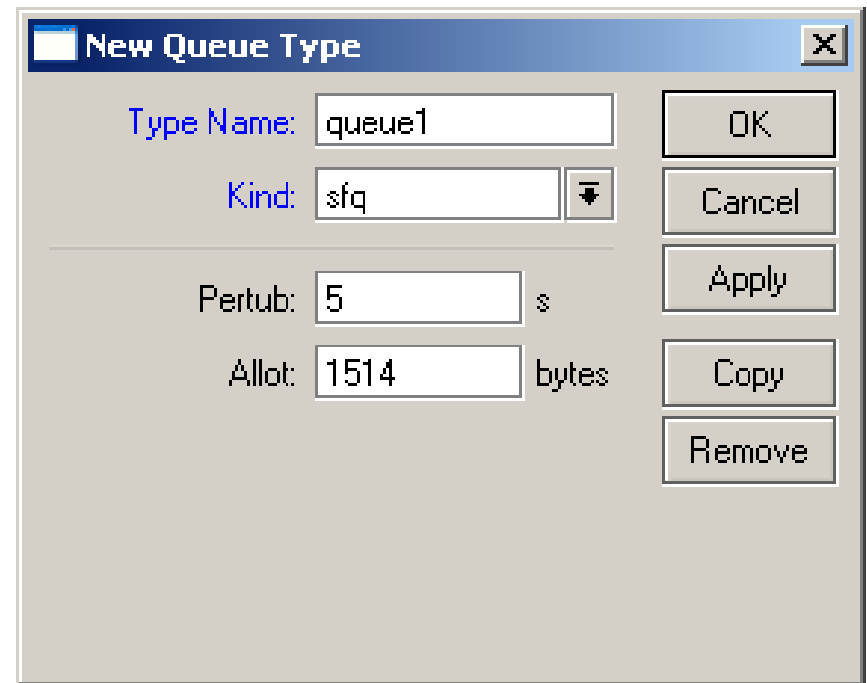


SFQ

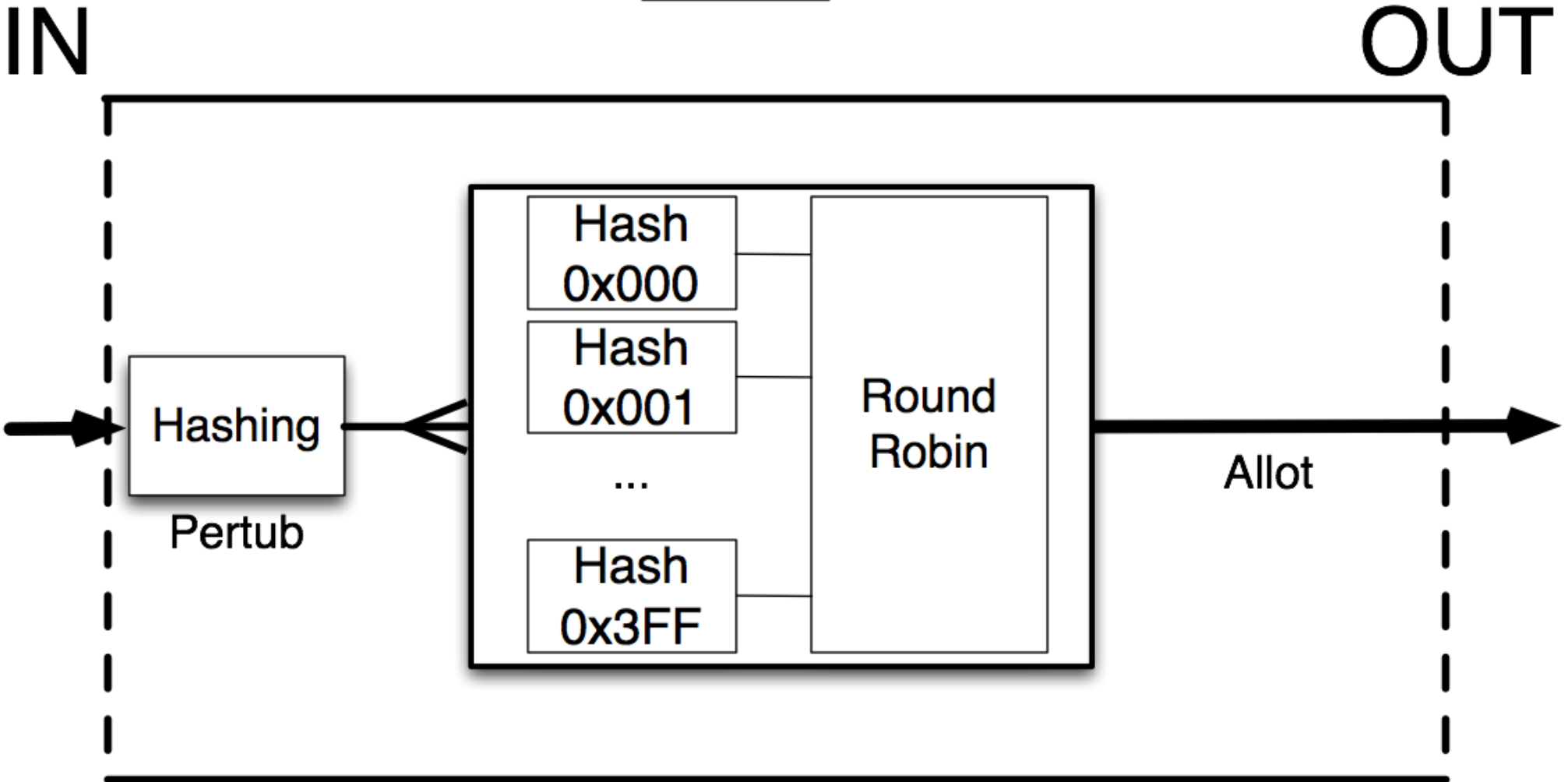
Behaviour:

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



SFQ

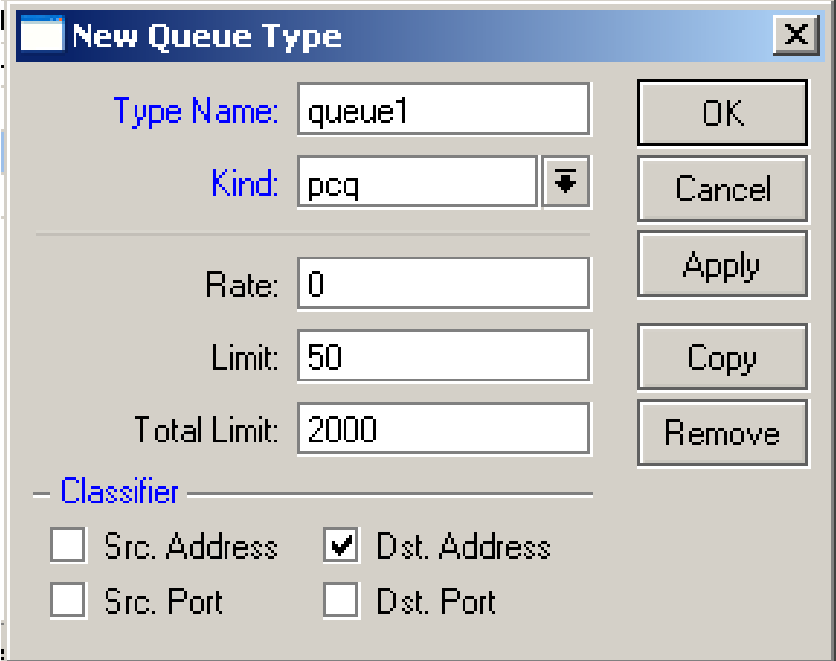


PCQ

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

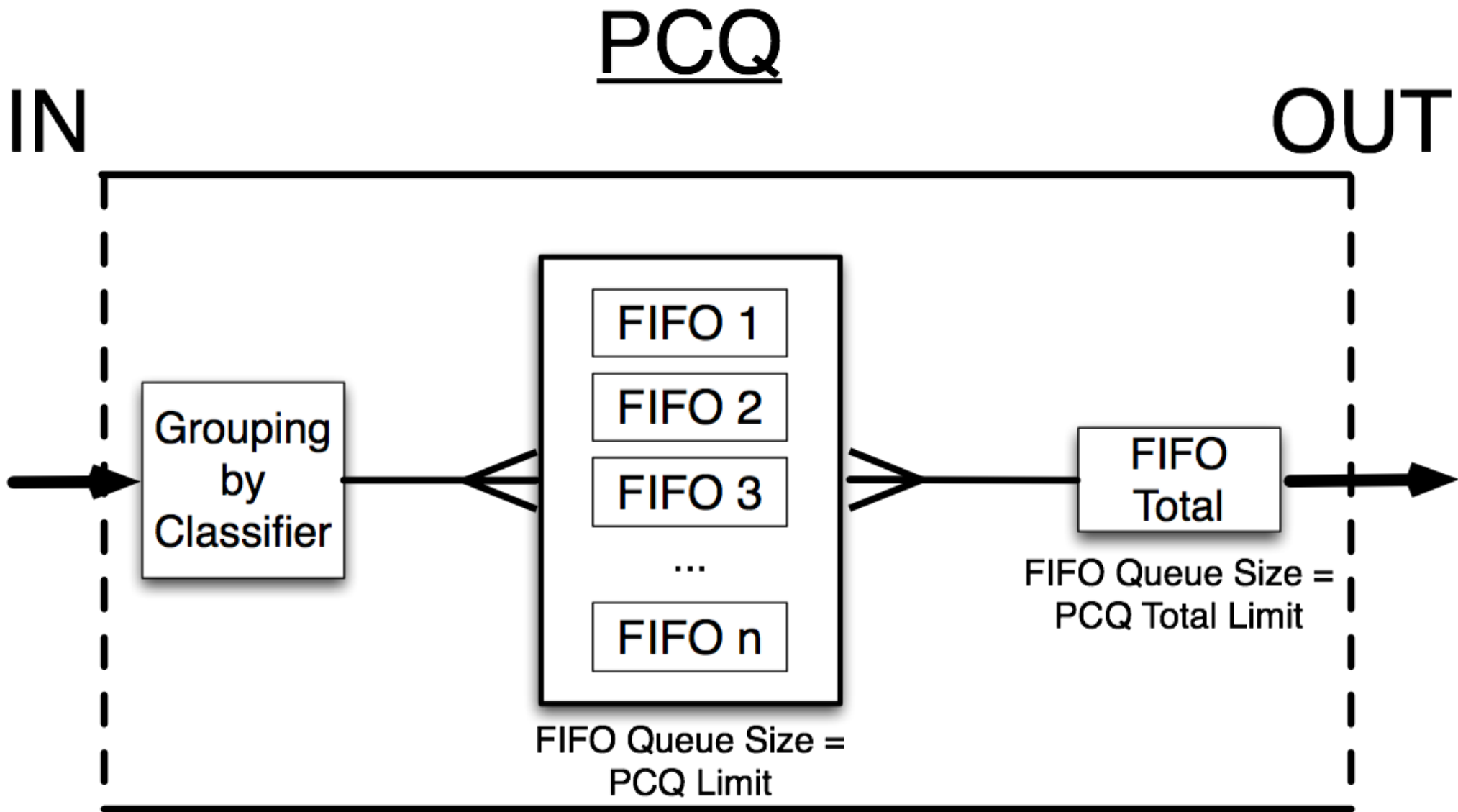
After this PCQ can be considered as FIFO queue where queue size is specified by “total-limit” option.



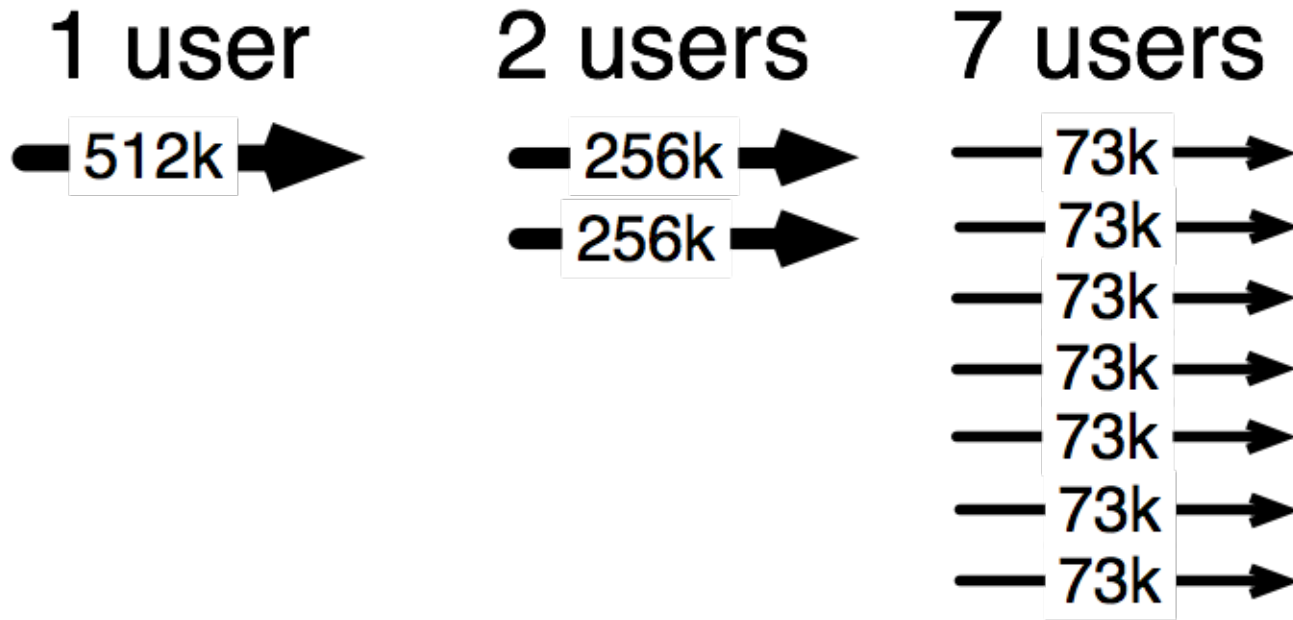
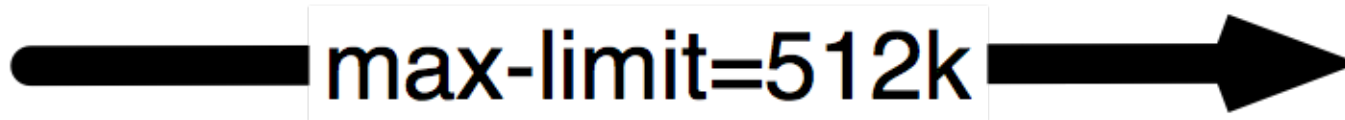
The screenshot shows a 'New Queue Type' dialog box with the following fields and options:

- Type Name: queue1
- Kind: pcq
- Rate: 0
- Limit: 50
- Total Limit: 2000
- Classifier section:
 - Src. Address
 - Dst. Address
 - Src. Port
 - Dst. Port

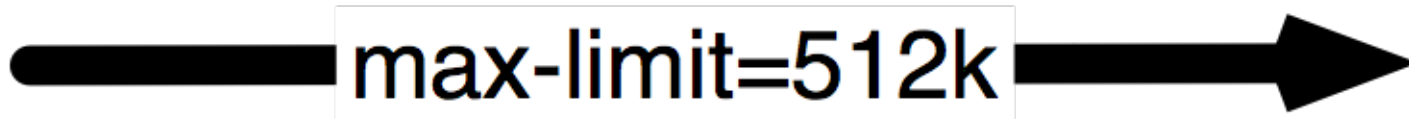
Buttons on the right: OK, Cancel, Apply, Copy, Remove.



pcq-rate=0



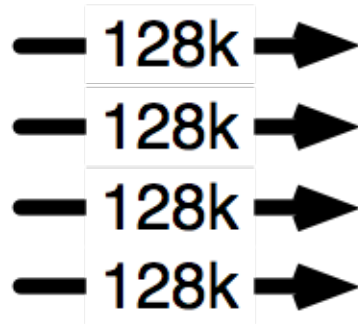
pcq-rate=128000



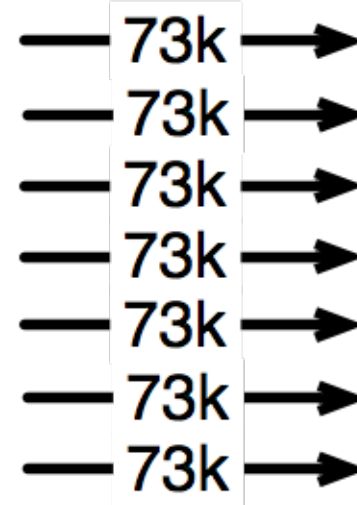
2 users



4 users



7 users



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

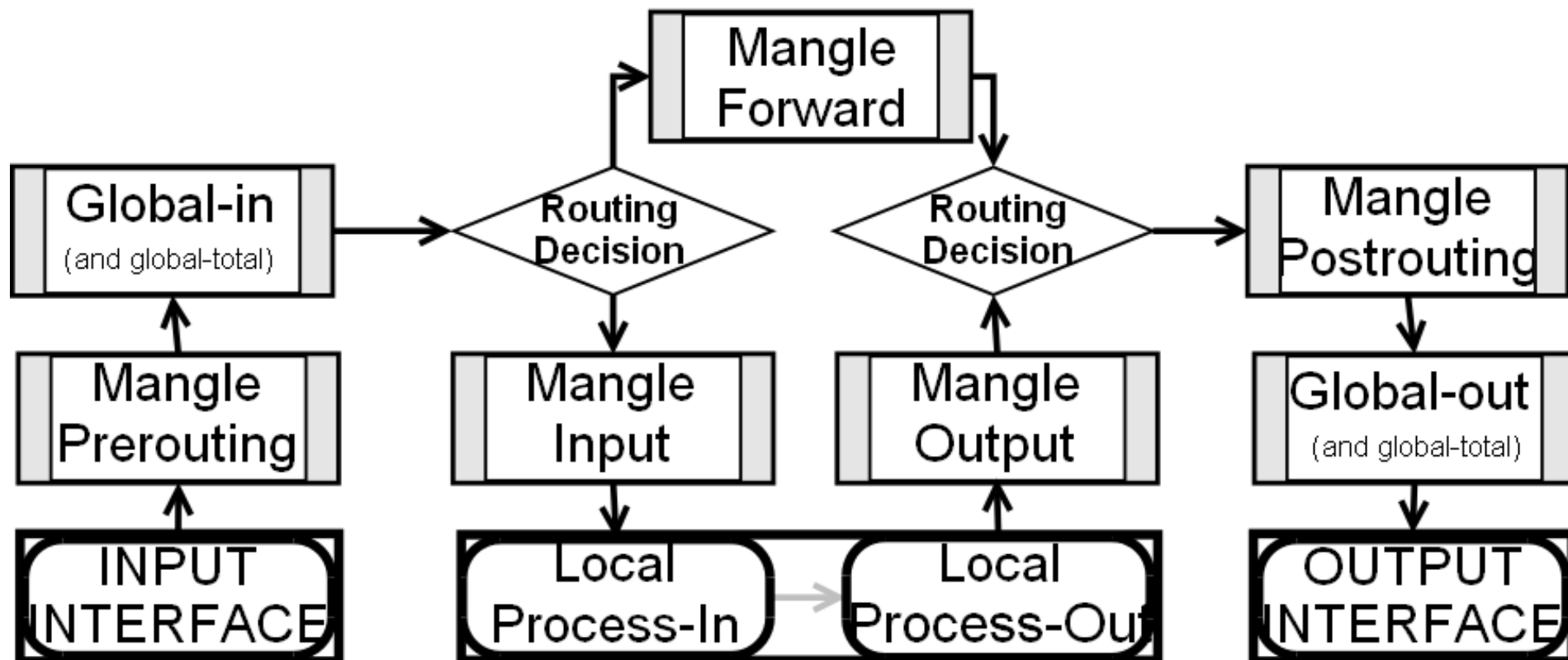
The screenshot displays the RouterOS WinBox interface. The left sidebar shows the 'IP' menu expanded, with 'Firewall' selected. The main window shows the 'Firewall' configuration page, with the 'Address Lists' tab active. A table lists the following address lists:

Name	Address
Basic_class_client	23.1.100.1
Standard_class_client	23.1.100.2
Basic_class_client	23.1.100.3
Standard_class_client	23.1.100.4
Basic_class_client	23.1.100.5
Business_class_client	23.1.100.6
Basic_class_client	23.1.100.7
Basic_class_client	23.1.100.8
Standard_class_client	23.1.100.9
Standard_class_client	23.1.100.10
Standard_class_client	23.1.100.11
Basic_class_client	23.1.100.12
Basic_class_client	23.1.100.13
Basic_class_client	23.1.100.14
Basic_class_client	23.1.100.15
Basic_class_client	23.1.100.16
Business_class_client	23.1.100.17
Basic_class_client	23.1.100.18
Standard_class_client	23.1.100.19
Basic_class_client	23.1.100.20

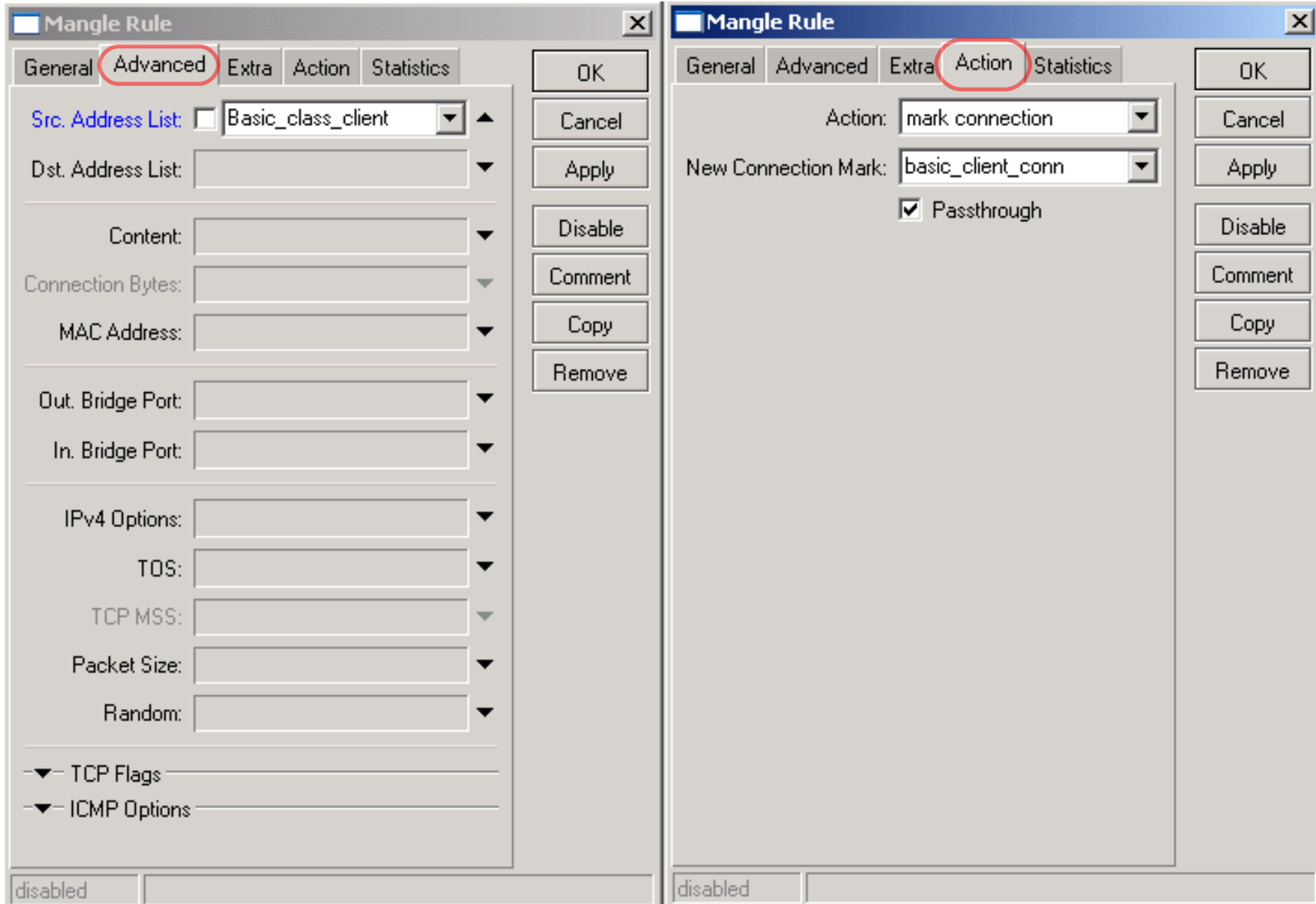
A dialog box titled 'Firewall Address List <Basic_class_cli...' is open, showing the configuration for the 'Business_class_client' address list. The 'Name' field is set to 'Business_class_client' and the 'Address' field is set to '23.1.101.224'. The dialog also includes buttons for OK, Cancel, Apply, Disable, Comment, Copy, and Remove.

Where?

- There are 5 places to mangle
- There are 4 places to limit



Connection-mark rule



Packet-mark rule

The image displays two screenshots of the Mikrotik Mangle Rule configuration window, illustrating the setup of a packet-mark rule.

Left Screenshot (General Tab):

- Chain:** forward
- Src. Address:** (empty)
- Dst. Address:** (empty)
- Protocol:** (empty)
- Src. Port:** (empty)
- Dst. Port:** (empty)
- P2P:** (empty)
- In. Interface:** (empty)
- Out. Interface:** (empty)
- Packet Mark:** (empty)
- Connection Mark:** basic_client_conn
- Routing Mark:** (empty)
- Connection State:** (empty)
- Connection Type:** (empty)

Right Screenshot (Action Tab):

- Action:** mark packet
- New Packet Mark:** basic_client_traffic
- Passthrough

Working Mangle- Winbox view

Firewall

Filter Rules NAT Mangle Service Ports Connections Address Lists

forward ▾

#	Action	Chain	Priority	New Packet Mark	New Connection Mark	Bytes	Packets
::: mark basic client traffic							
	mark connection	forward			basic_client_conn	9893.1 MiB	18 599 504
	mark packet	forward		basic_client_traffic		22575.4 MiB	35 292 323
::: mark standard client traffic							
	mark connection	forward			standard_client_conn	825.4 MiB	2 747 515
	mark packet	forward		standard_client_traffic		6396.7 MiB	7 248 925
::: mark bussiness client traffic							
	mark connection	forward			business_client_conn	190.2 MiB	912 903
	mark packet	forward		business_client_traffic		1324.9 MiB	1 929 206
::: Check for unmarked traffic							
	log	forward				2062.0 KiB	9 014

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

The image shows the Mikrotik Winbox interface for configuring PCQ types. The main window is titled "Queue List" and has four tabs: "Simple Queues", "Interface Queues", "Queue Tree", and "Queue Types". The "Queue Types" tab is active and contains a table of queue types. Two red circles highlight "PCQ_down_4M" and "PCQ_up_1M" in the table. Red arrows point from these circles to two separate "Queue Type" configuration dialog boxes. The top dialog box is for "PCQ_down_4M" and the bottom one is for "PCQ_up_1M". Both dialog boxes have "General" and "Settings" tabs. The "Settings" tab is active in both. In the "PCQ_down_4M" dialog, the "Rate" is set to "4M", "Limit" is "50", and "Total Limit" is "2000". Under the "Classifier" section, "Src. Address" is unchecked and "Dst. Address" is checked. In the "PCQ_up_1M" dialog, the "Rate" is set to "1M", "Limit" is "50", and "Total Limit" is "2000". Under the "Classifier" section, "Src. Address" is checked and "Dst. Address" is unchecked. Both dialog boxes have "OK", "Cancel", "Apply", "Copy", and "Remove" buttons.

Type Name	Kind
PCQ_down_375k	pcq
PCQ_down_4M	pcq
PCQ_down_750k	pcq
PCQ_up_125k	pcq
PCQ_up_1M	pcq
PCQ_up_250k	pcq
default	pfifo
default-small	pfifo
ethernet-default	pfifo
hotspot-default	sfq
sfq	sfq
synchronous-default	red

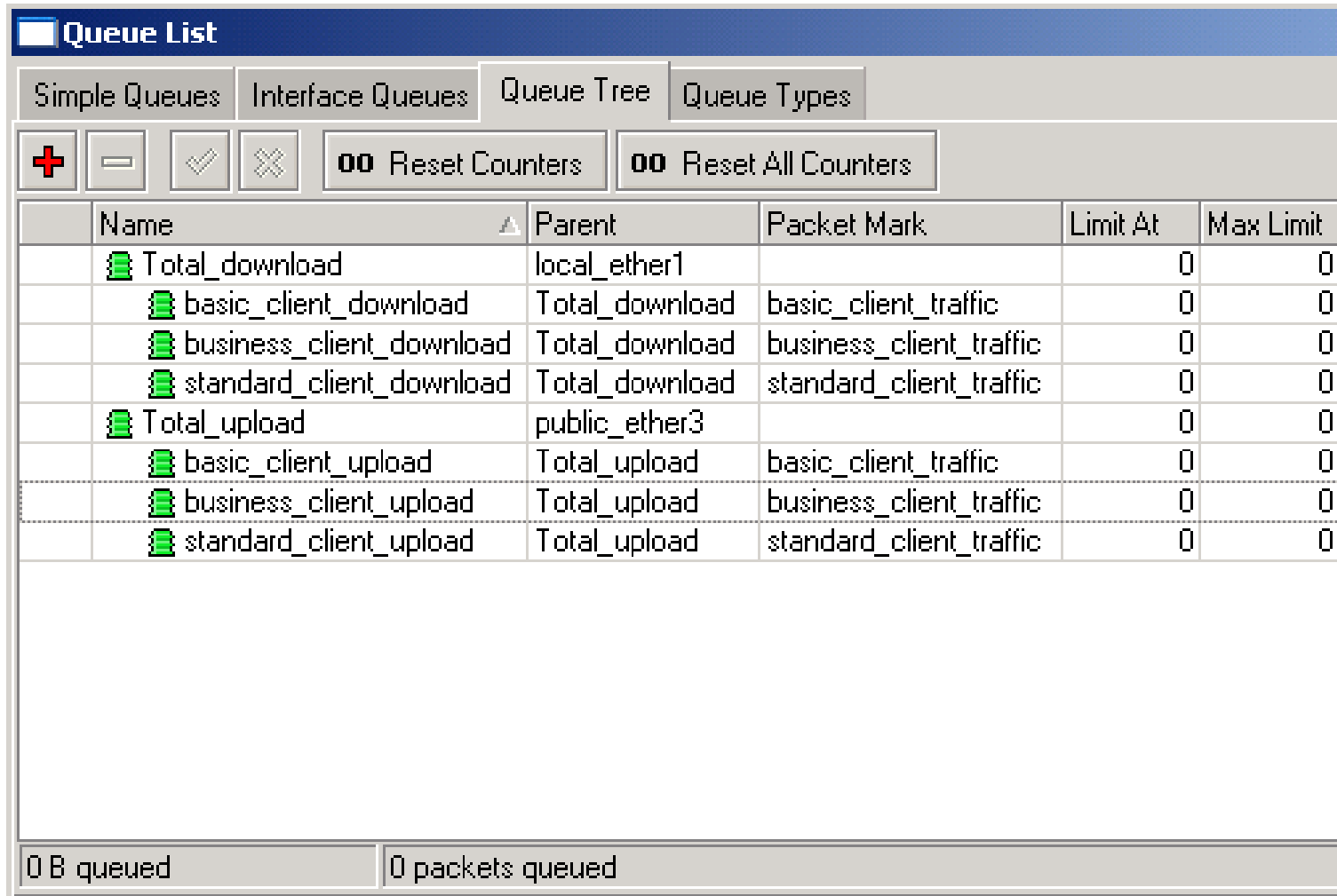
Queue Type <PCQ_down_4M> Settings

- Rate: 4M
- Limit: 50
- Total Limit: 2000
- Classifier:
 - Src. Address
 - Dst. Address
 - Src. Port
 - Dst. Port

Queue Type <PCQ_up_1M> Settings

- Rate: 1M
- Limit: 50
- Total Limit: 2000
- Classifier:
 - Src. Address
 - Dst. Address
 - Src. Port
 - Dst. Port

Queue Tree – Winbox View



The screenshot shows the Mikrotik Winbox interface for the Queue List window. The window title is "Queue List". It has four tabs: "Simple Queues", "Interface Queues", "Queue Tree" (which is selected), and "Queue Types". Below the tabs are several control buttons: a red plus sign, a minus sign, a checkmark, a cross, "Reset Counters", and "Reset All Counters". The main area contains a table with the following columns: Name, Parent, Packet Mark, Limit At, and Max Limit. The table lists a hierarchy of queues for two interfaces: local_ether1 and public_ether3. For local_ether1, there is a "Total_download" queue with three sub-queues: "basic_client_download", "business_client_download", and "standard_client_download". For public_ether3, there is a "Total_upload" queue with three sub-queues: "basic_client_upload", "business_client_upload", and "standard_client_upload". All queues have a "Limit At" and "Max Limit" of 0. At the bottom of the window, there are two status boxes: "0 B queued" and "0 packets queued".

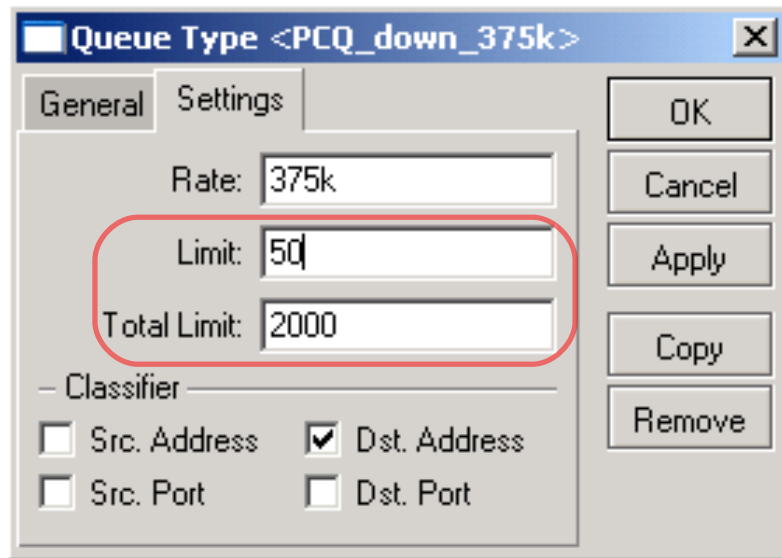
Name	Parent	Packet Mark	Limit At	Max Limit
Total_download	local_ether1		0	0
basic_client_download	Total_download	basic_client_traffic	0	0
business_client_download	Total_download	business_client_traffic	0	0
standard_client_download	Total_download	standard_client_traffic	0	0
Total_upload	public_ether3		0	0
basic_client_upload	Total_upload	basic_client_traffic	0	0
business_client_upload	Total_upload	business_client_traffic	0	0
standard_client_upload	Total_upload	standard_client_traffic	0	0

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
```

PCQ Queue Size



Total_limit = X can take up to
 $X \cdot (2000 \text{ bytes} + 200 \text{ bytes})$ 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

- It can take only 40 users to fill the queue
(because $\text{total_limit}/\text{limit} = 2000/50 = 40$)
- 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

PCQ Adjustments

- There are ~340 Basic class clients so:
 - $pcq_limit = 40$
 - $pcq_total_limit = 7000$ ($\sim 20 * 340$) ($\sim 15MB$)
- There are ~40 Standard class clients so:
 - $pcq_limit = 30$
 - $pcq_total_limit = 1000$ ($\sim 20 * 40$) ($\sim 2MB$)
- There are ~20 Business class clients so:
 - $pcq_limit = 20$ (!!!)
 - $pcq_total_limit = 500$ ($\sim 20 * 20$) ($\sim 1MB$)

Traffic Prioritization



T3/E3 line
~40 Mbps
~5Mbps abroad



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

Task:

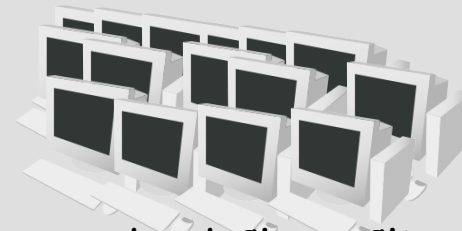
Make necessary traffic prioritization



Business Class Clients

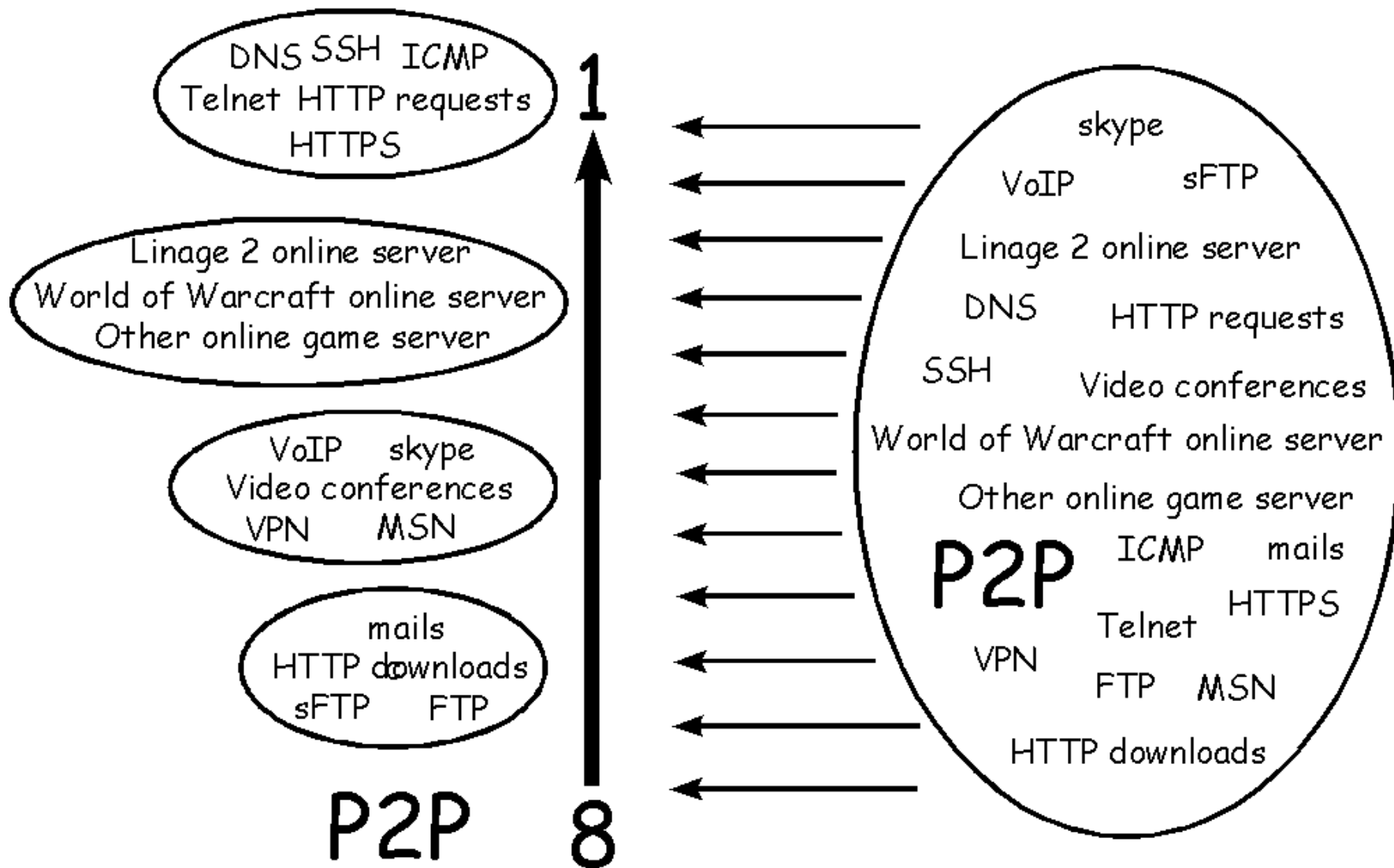


Basic Class Clients



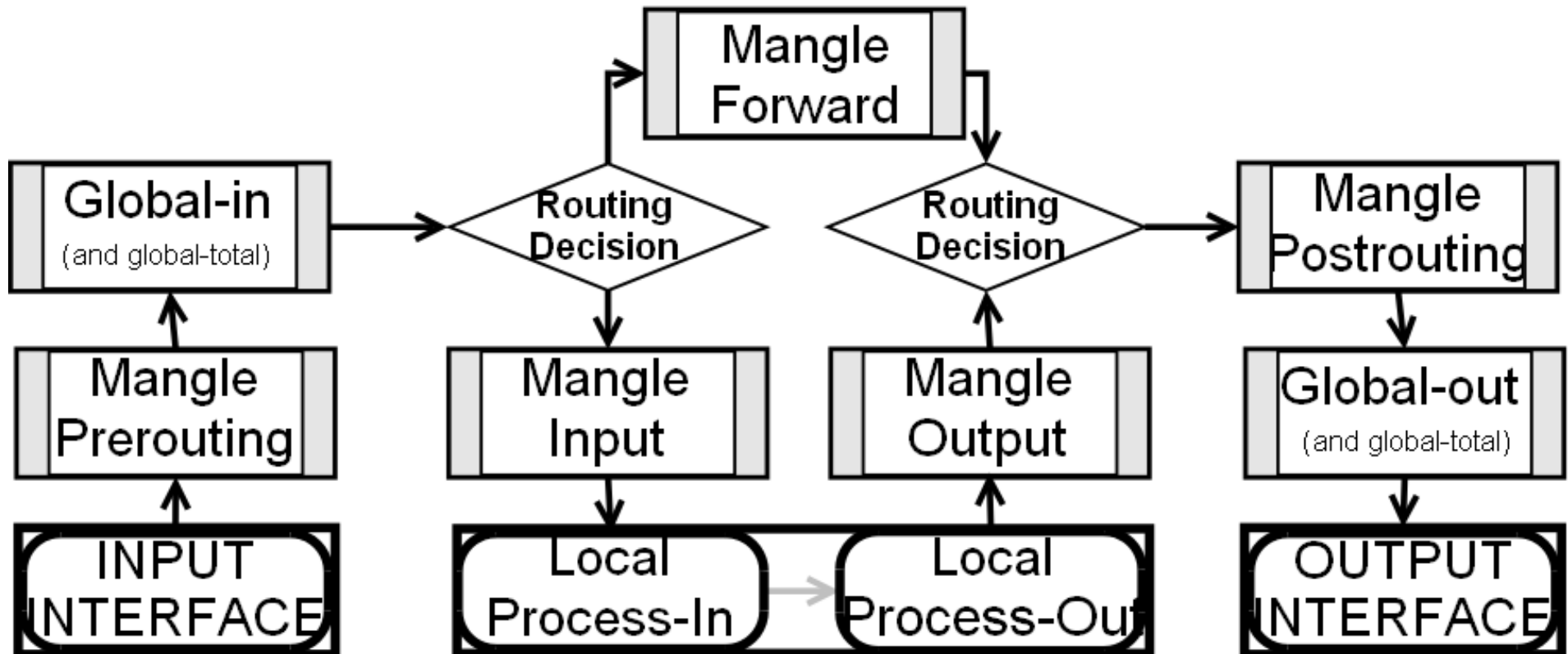
Standard Class Clients

Prioritization plan



Where?

- There are 5 places to mangle
- There are 4 places to limit



How?

Group	Service	Protocol	Dst-Port	Other conditions
P2P_services	P2P			p2p=all-p2p
Download_services	Mails	TCP	110	
		TCP	995	
		TCP	143	
		TCP	993	
		TCP	25	
	HTTP downloads	TCP	80	Connection-bytes=500000-0
	FTP	TCP	20	
		TCP	21	
	SFTP	TCP	22	Packet-size=1400-1500
Ensign_services	DNS	TCP	53	
		UDP	53	
	ICMP	ICMP	-	
	HTTPS	TCP	443	
	Telnet	TCP	23	
	SSH	TCP	22	Packet-size=0-1400
	HTTP requests	TCP	80	Connection-bytes=0-500000
User_requests	Online game servers			Dst-address-list=user_requests
Communication_services	VoIP			
	Skype			
	Video conferences			
	VPN			
	MSN			

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)