

Bandwidth Control

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Why implement bandwidth control?

- You have finite bandwidth that you pay for based on capacity
 - You have to distribute that bandwidth to your AP sites
 - What do you do for your backbone links?
 - Licensed full duplex or unlicensed half duplex
 - What is your download/upload ratio
 - Typically upload is 10% of download (network average)
 - Streaming devices can use bandwidth 24 x 7
 - E.g. Roku video streaming, it does not know if you are watching

Optimize bandwidth utilization and associated revenue

Benefits of Bandwidth Control

- Create different service levels to meet customer requirements
 - Residential Services
 - Asymmetric services
 - Upload speed 25% of download speed
 - Business Services
 - Symmetric bandwidth
- Usage Based Billing or Unlimited Usage
 - Where do you set limits?
 - Is the revenue generated worth the effort?
 - UBB can be used as a marketing message against you

Bandwidth Control Tiers

- Residential Services

- R3 – 3 Mbps
- R6 – 6 Mbps
- R9 – 9 Mbps
- R12 – 12 Mbps
- R18 – 18 Mbps
- R25 – 25 Mbps

- Contract term - Monthly

- Business Services

- B25 – 25 Mbps
- B50 – 50 Mbps
- B100 – 100 Mbps

- Contract term – 1 to 3 years

Do not leave money on the table

Where do you implement Bandwidth Control?

- Data Center (NOC) - Ingress Point
 - Control download bandwidth utilization to customer
- Customer Router - Egress Point
 - Control upload bandwidth utilization from customer
- Ingress and Egress Points
 - Optimum but requires configuration of multiple devices
 - Not worth the effort as upload traffic is typically 10% of download traffic

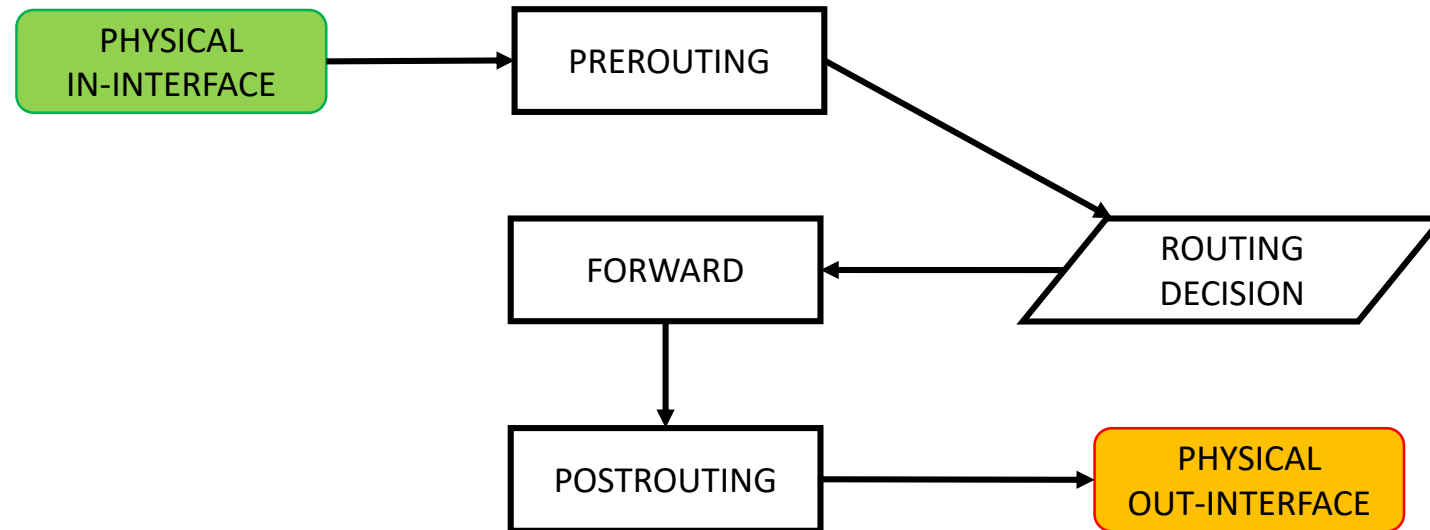
Implement bandwidth control at Data Center (NOC)

Bandwidth Control Implementation Options

- Simple Queues
 - Simplest way to limit data rates for specific IP address and/or subnets
 - Can be used to build advanced QoS applications
 - Each rule checks IP header of every packet to check for match
- Mangle + Queue Trees
 - Uses connection marks and packet marks eliminating need to check every packet
 - Results in lower CPU utilization

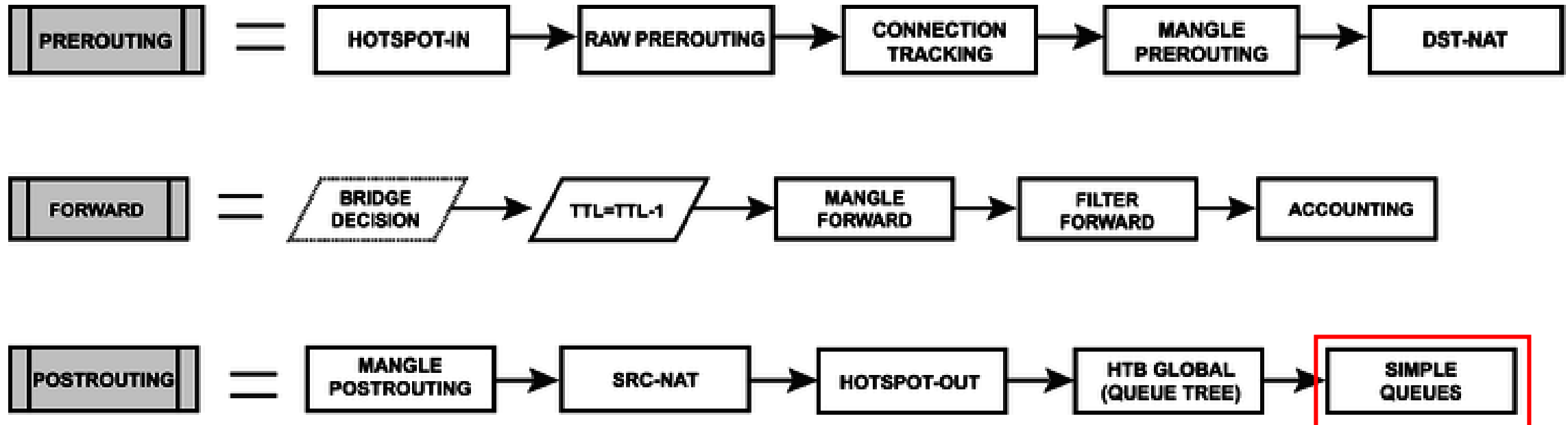
MikroTik Router Implementation

Packet flow diagram in routed environment without IPSEC

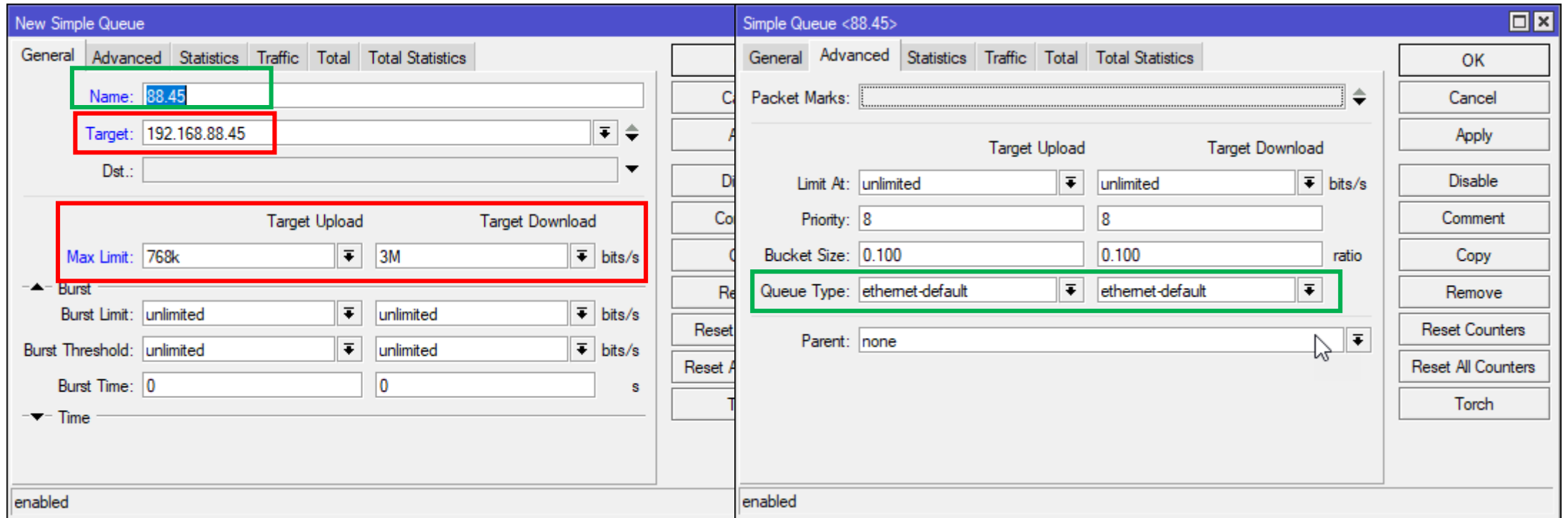


Bandwidth Control – Simple Queues

Packet Flow Chains



Bandwidth Control – Simple Queues



- Only Target and Max Limits required
 - Queue Type can limit performance – recommend ethernet-default

Bandwidth Control – Simple Queues

#	Name	Target	Upload Max Limit	Download Max Limit	Upload Queue Type	Download Queue Type	Total Uploaded Bytes	Total Downloaded Bytes	Comment
0	88.45	192.168.88.45	768k	3M	ethernet-default	ethernet-default	0 B	0 B	John Smith
1	88.202	192.168.88.202	3M	12M	ethernet-default	ethernet-default	0 B	0 B	David Jones
2	88.Other	192.168.88.0/24	384k	768k	default-small	default-small	0 B	0 B	

```
[admin@COV Site Router] /queue simple> pr
Flags: X - disabled, I - invalid, D - dynamic
0   ;;; John Smith
    name="88.45" target=192.168.88.45/32 parent=none packet-marks="" priority=8/8
    queue=ethernet-default/ethernet-default limit-at=0/0 max-limit=768k/3M burst-limit=0/0 burst-threshold=0/0
    burst-time=0s/0s bucket-size=0.1/0.1

1   ;;; David Jones
    name="88.202" target=192.168.88.202/32 parent=none packet-marks="" priority=8/8
    queue=ethernet-default/ethernet-default limit-at=0/0 max-limit=3M/12M burst-limit=0/0 burst-threshold=0/0
    burst-time=0s/0s bucket-size=0.1/0.1

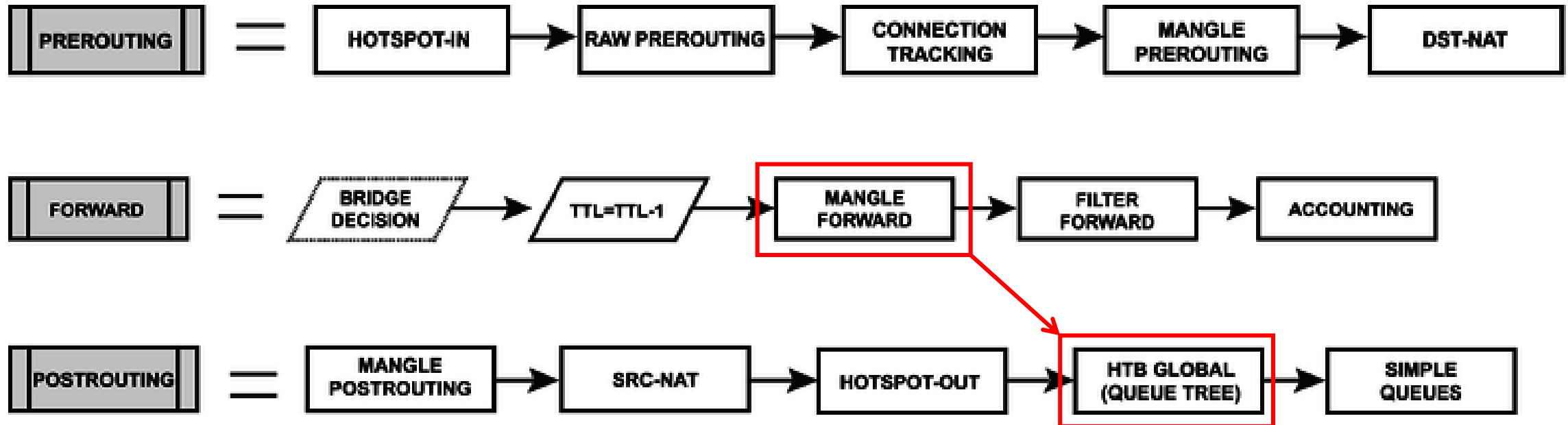
2   name="88.Other" target=192.168.88.0/24 parent=none packet-marks="" priority=8/8
    queue=default-small/default-small limit-at=0/0 max-limit=384k/768k burst-limit=0/0 burst-threshold=0/0
    burst-time=0s/0s bucket-size=0.1/0.1
```

Simple Queue – Pros and Cons

- Pros
 - Simple to configure
 - Utilizes multiple cores in multi-core router e.g. CCR1036
 - Basic bandwidth control can be enhanced with:
 - Traffic prioritization
 - Bursting
 - Time based limits
 - Data rate limitation by protocols, ports, ...
- Cons
 - Each packet has to be checked against each queue rule to find out if there is a match and an action that has to be applied

Bandwidth Control – Mangle + Queue Trees

Packet Flow Chains



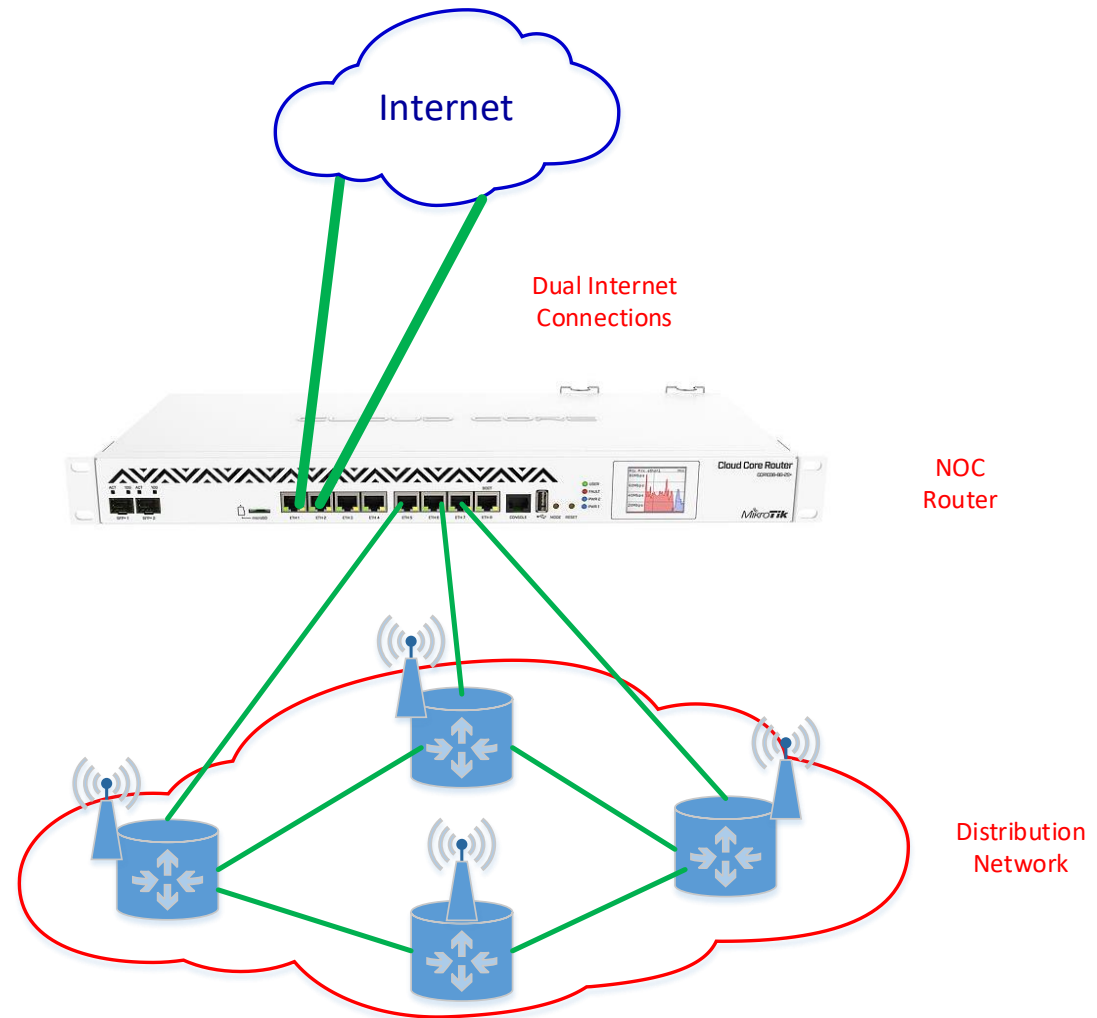
Bandwidth Control – Mangle + Queue Trees

- Configuration sequence for each service level
 - Mark Connection
 - Mark Packets
 - Create Queue Trees
 - Create Queue Types
 - Create Address Lists

How do we handle router interfaces?

Data Center (NOC) Configuration

- Internet
 - Two connections
 - BGP
- Router
 - Could be redundant configuration
- Distribution Network
 - P2P backbone links
 - OSPF
 - Wireless AP



Mangle + Queue Trees Configuration

Inbound Connections

- Two Internet connections
 - Need to be able to view as one interface
 - Create an Interface List “Inbound”

```
/interface list  
add name=Inbound
```

```
/interface list member  
add interface=ether1 list=Inbound  
add interface=ether2 list=Inbound
```

Mangle + Queue Trees Configuration

Outbound Connections

- Three distribution connections
 - Need to be able to view as one interface
 - Create an Interface List “Outbound”

```
/interface list  
add name=Outbound
```

```
/interface list member  
add interface=ether5 list=Outbound  
add interface=ether6 list=Outbound  
add interface=ether7 list=Outbound
```


Mangle + Queue Trees Configuration

Mark Connections

- Mark connections for specific service
 - E.g. Service “R12” which has 12 Mbps download, 3 Mbps upload

```
/ip firewall mangle
```

```
chain=forward action=mark-connection new-connection-mark=Upload-R12 \  
src-address-list=R12 in-interface-list=Outbound connection-state=new \  
passthrough=yes
```

```
chain=forward action=mark-connection new-connection-mark=Download-R12 \  
dst-address-list=R12 out-interface-list=Outbound connection-state=new \  
passthrough=yes
```

Mangle + Queue Trees Configuration

Mark Packets

- Mark packets for specific service
 - E.g. R12 service for which we have marked connections





```
/ip firewall mangle
```

```
chain=forward action=mark-packet new-packet-mark=Upload-R12 \  
connection-mark=Upload-R12 in-interface-list=Outbound passthrough=yes
```

```
chain=forward action=mark-packet new-packet-mark=Download-R12 \  
connection-mark=Download-R12 out-interface-list=Outbound passthrough=yes
```

Mangle + Queue Trees Configuration

Mark Connection and Packets

#	Action	Chain	In. Interface List	Out. Interface List	Connection Mark	Src. Address List	Dst. Address List	New Packet Mark	New Connection ...
0	 mark connection	forward	Outbound			R12			Upload-R12
1	 mark connection	forward		Outbound			R12		Download-R12
2	 mark packet	forward	Outbound		Upload-R12			Upload-R12	
3	 mark packet	forward		Outbound	Download-R12			Download-R12	

Mangle + Queue Trees Configuration

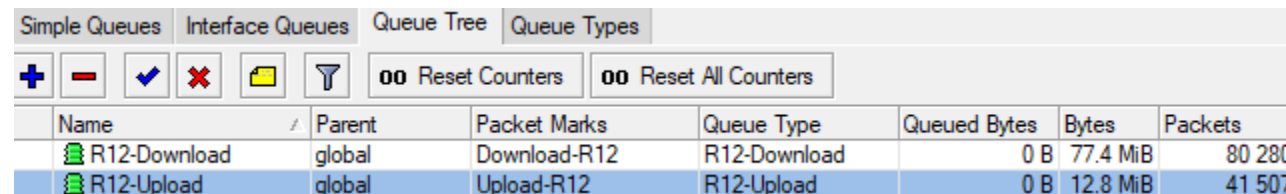
Queue Trees

- Create Queue Trees for specific service
 - E.g. R12 service for which we have marked connections and packets

```
/queue tree
```

```
add name=R12-Download packet-mark=Download-R12 parent=global \  
queue=R12-Download
```

```
add name=R12_Upload packet-mark=Upload-R12 parent=global \  
queue=R12-Upload
```



The screenshot shows the Mikrotik WinBox interface for configuring Queue Trees. The 'Queue Tree' tab is active. The table below displays the configuration for two queue trees: R12-Download and R12-Upload. The R12-Upload row is highlighted in blue.

Name	Parent	Packet Marks	Queue Type	Queued Bytes	Bytes	Packets
R12-Download	global	Download-R12	R12-Download	0 B	77.4 MiB	80 280
R12-Upload	global	Upload-R12	R12-Upload	0 B	12.8 MiB	41 507

Mangle + Queue Trees Configuration

Queue Types

- Create Queue Types for specific service
 - E.g. R12 service with 12 Mbps download and 3 Mbps upload

```
/queue type
```

```
add kind=pcq name=R12-Download pcq-classifier=dst-address \  
pcq-dst-address6-mask=64 pcq-rate=12M pcq-src-address6-mask=64
```

```
add kind=pcq name=R12-Upload pcq-classifier=src-address \  
pcq-dst-address6-mask=64 pcq-rate=3M pcq-src-address6-mask=64
```

Mangle + Queue Trees Configuration

Complete Bandwidth Solution

- Repeat the configured rules for each service level offered
 - Mark connections
 - Mark packets
 - Queue Trees
 - Queue Types
- Create an Address List for each service level which contains IP addresses of the clients on that service level
 - Changing a clients service level is achieved by simply assigning their IP address to the required Address List

Mangle + Queue Trees – Pros and Cons

- Pros
 - Much lower resource utilization as bandwidth limits are established when connection is initiated
 - Extensive advanced control available through the use of mangle, queue tree and type parameters
- Cons
 - More complex configuration

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