WISP TRACON

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 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

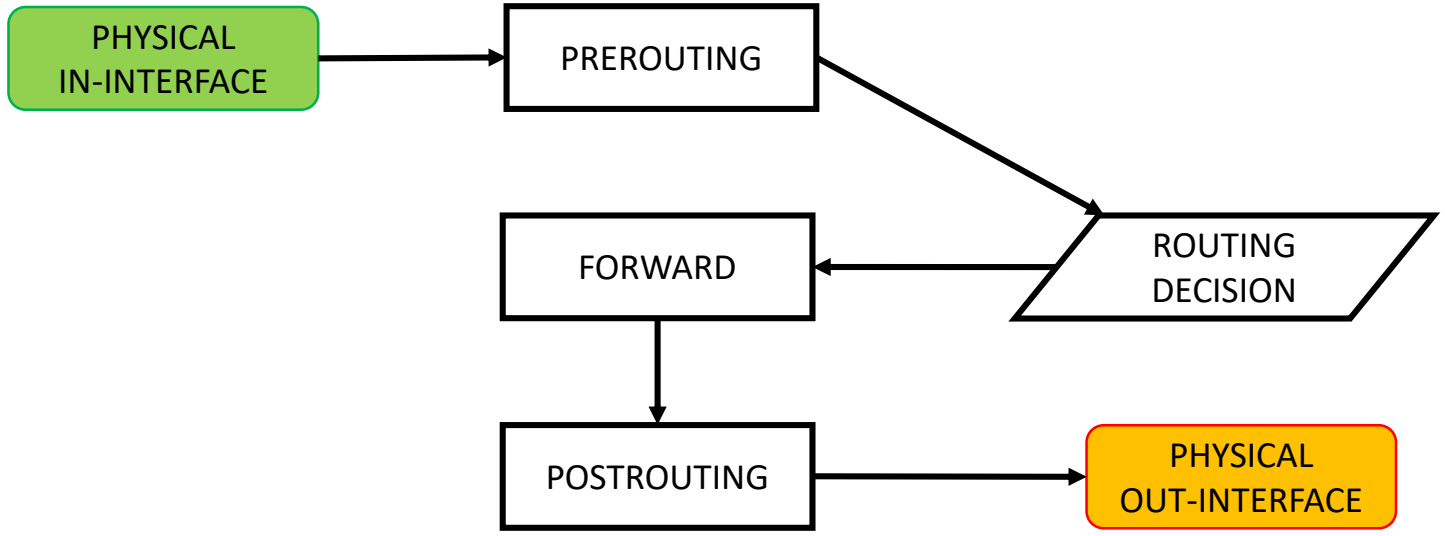
Implement bandwidth control at Data Center (NOC)

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

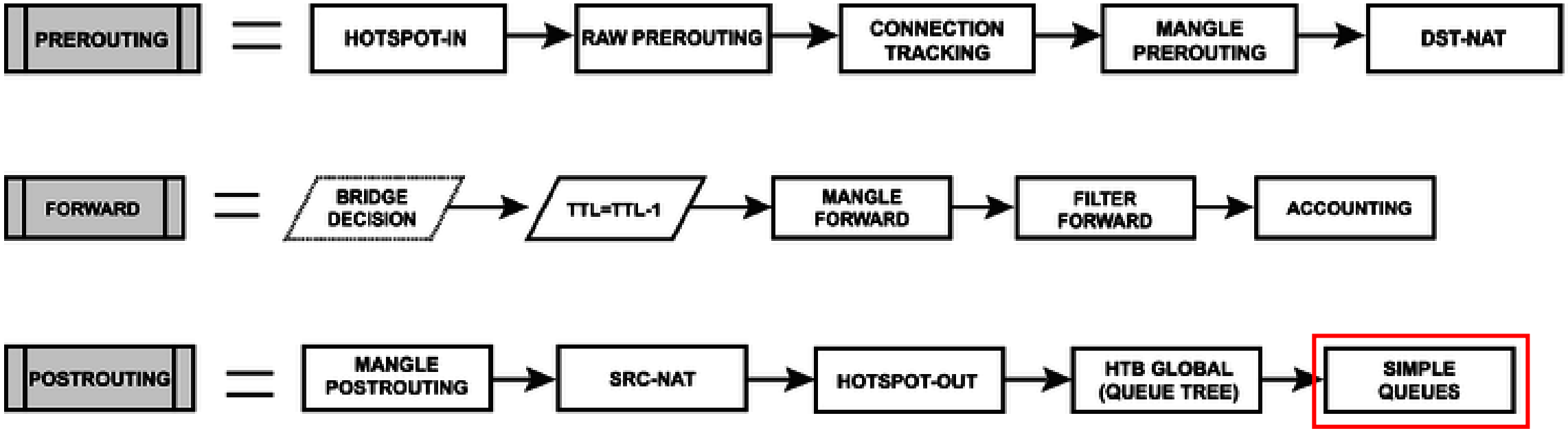
MikroTik Router Implementation

Packet flow diagram in routed environment without IPSEC

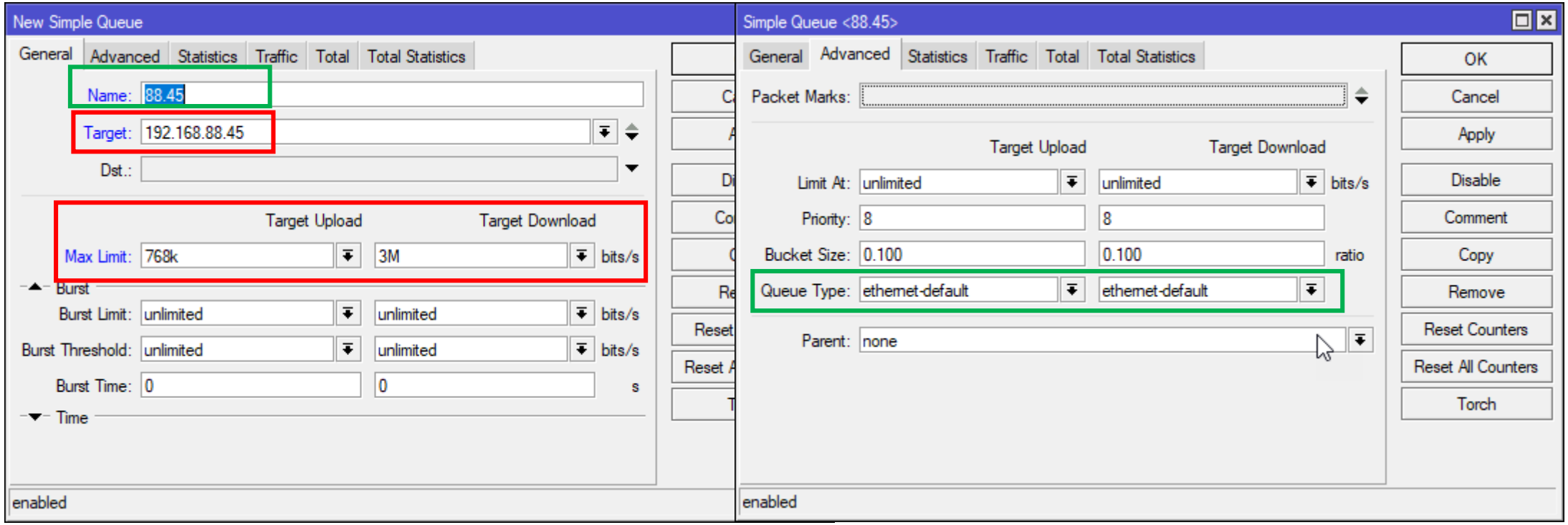


Bandwidth Control – Simple Queues

Packet Flow Chains

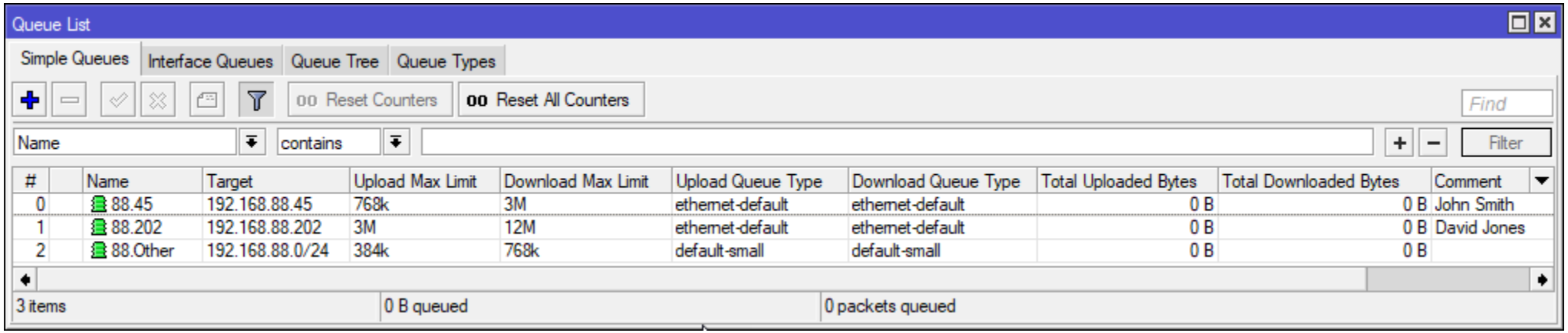


Bandwidth Control – Simple Queues



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

Bandwidth Control – Simple Queues



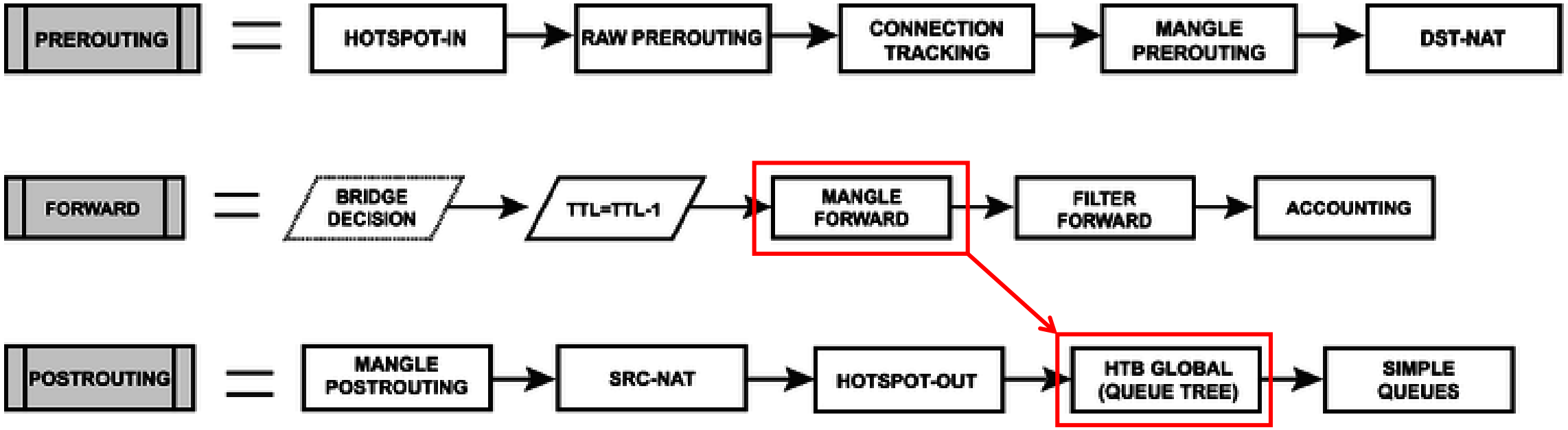

```
[admin@COV Site Router] /queue simple> pr
Flags: X - disabled, I - invalid, D - dynamic
 0    ;;; John Smith
      name="88.45" target=192.168.88.45/32 parent=none packet-marks="" priority=8/8
      queue=ethernet-default/ethernet-default limit-at=0/0 max-limit=768k/3M burst-limit=0/0 burst-threshold=0/0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



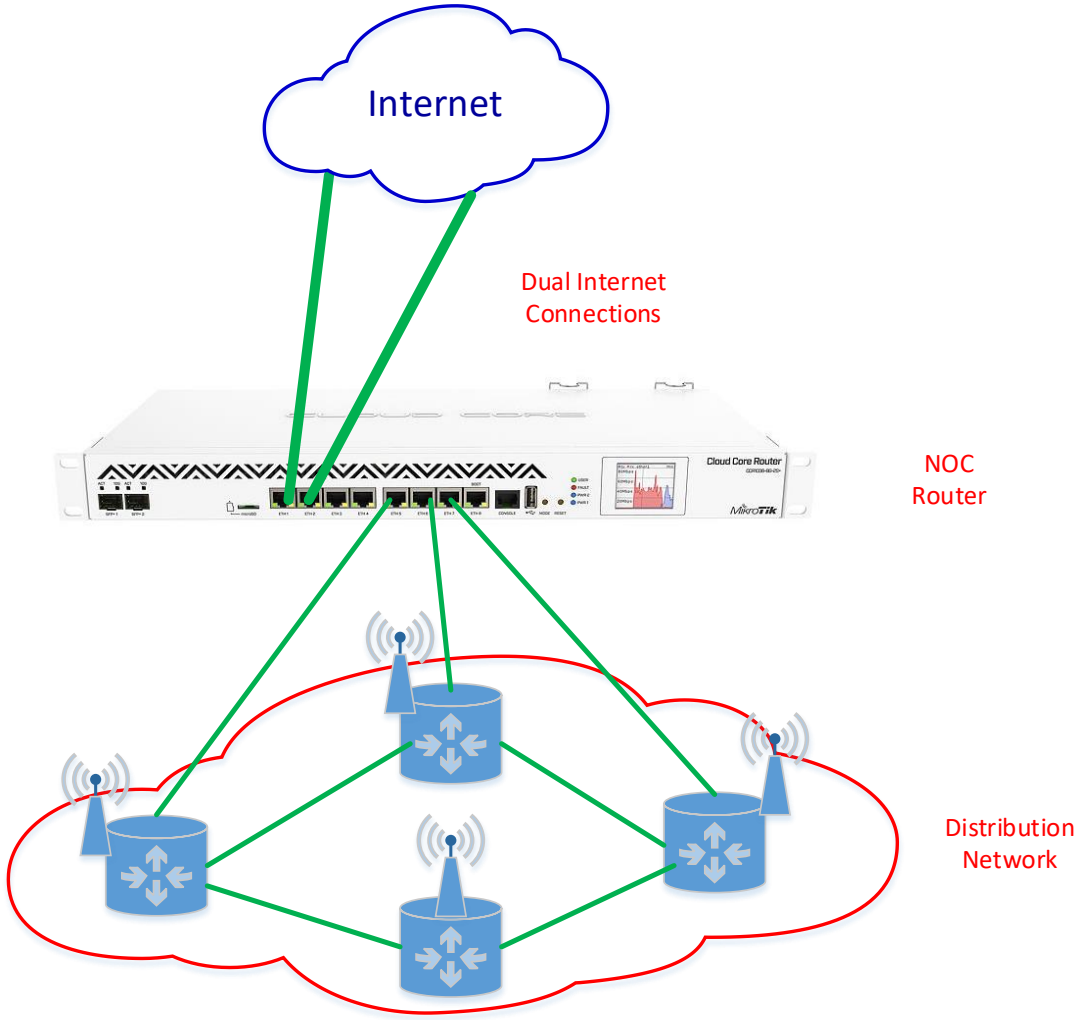
Bandwidth Control – Mangle + Queue Trees

- 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

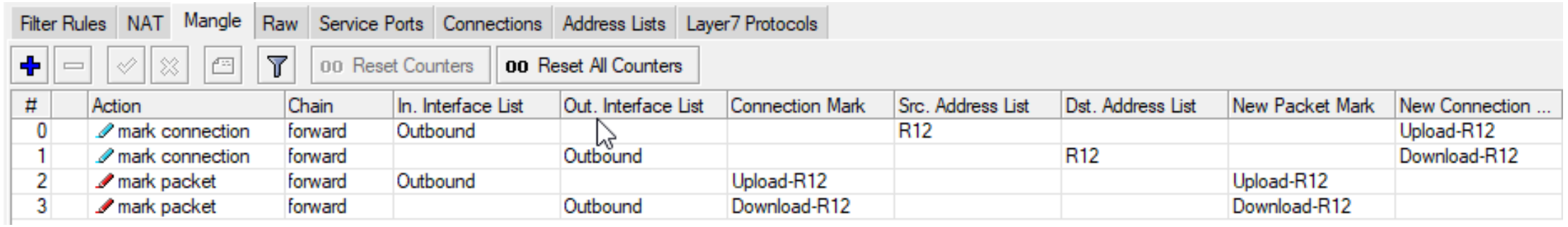
- Mark packets for specific service
  - E.g. R12 service for which we have marked connections

/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	

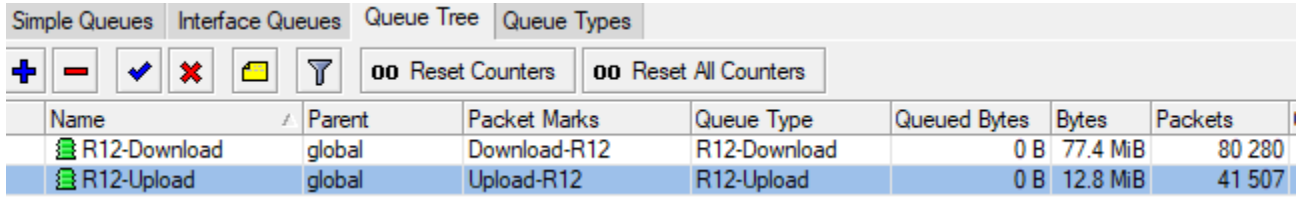
Mangle + Queue Trees Configuration
Queue Trees

- 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



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
  - Market 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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