

Hierarchical Token Bucket

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 - Network Engineer
 - IT Training
 - Data Center
 - Virtualization
 - Data Integrity



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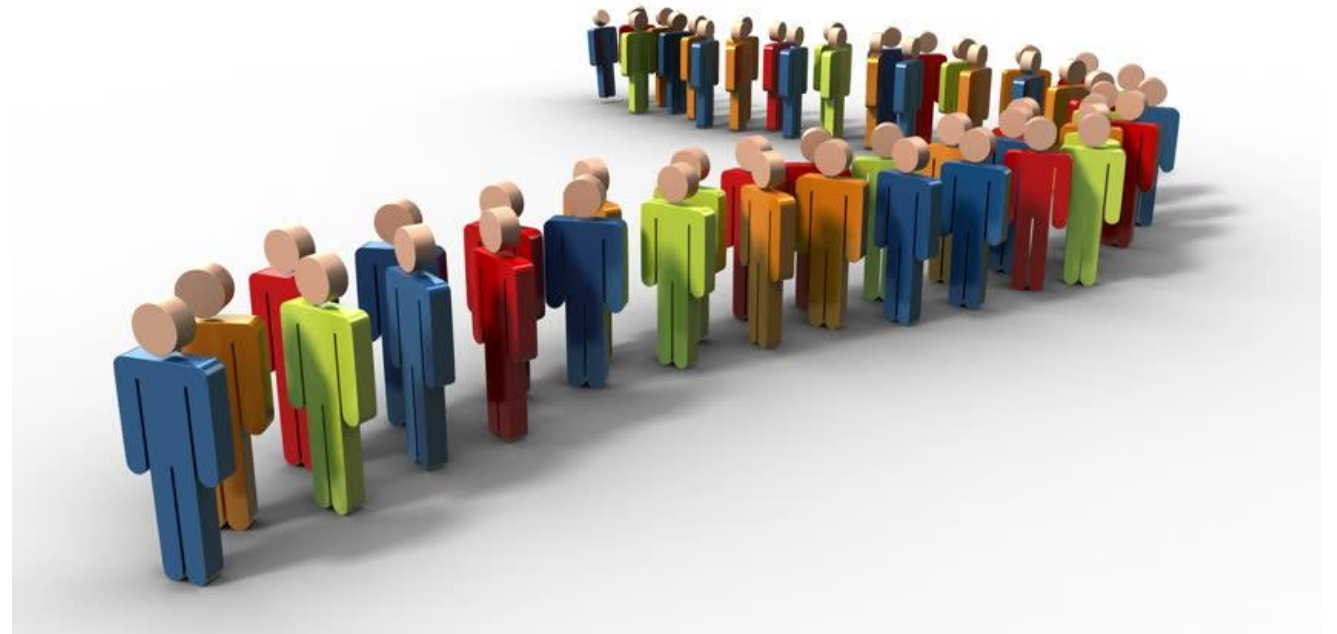
Agenda

- Queue Concepts
- HTB Concepts
- HTB Schematic
- HTB Scenarios



Concepts

- Queue
- Scheduling
- Shaping



Queue Type

- FIFO
- SFQ
- RED
- PCQ

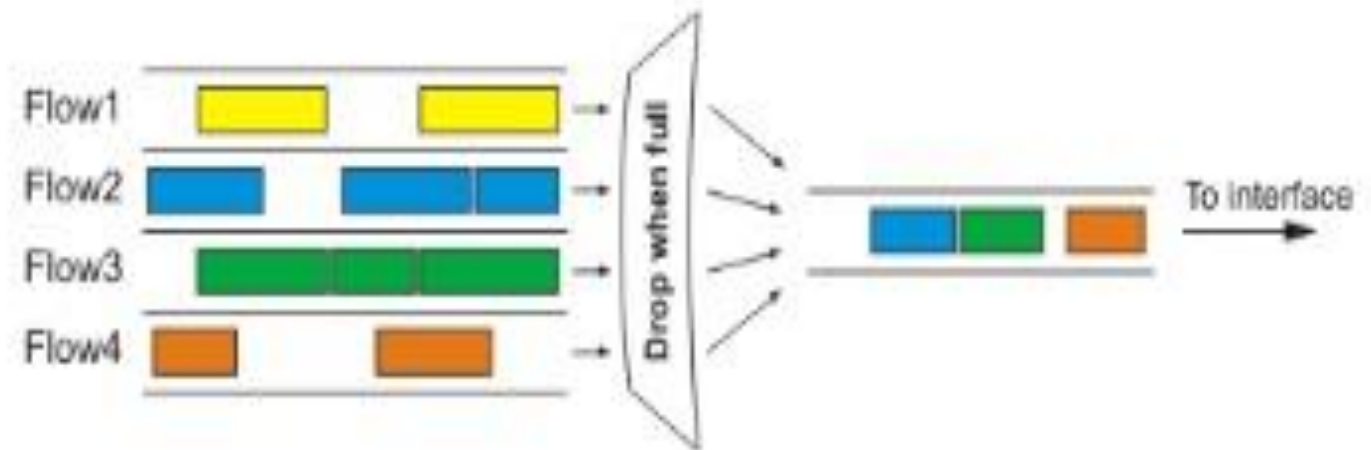
Simple Queues	Interface Queues	Queue Tree	Queue Types
+ - ⌵			
Type Name	Kind		
* default	pfifo		
* default-small	pfifo		
* ethernet-default	pfifo		
* hotspot-default	sfq		
* multi-queue-ethernet-default	mq pfifo		
* only-hardware-queue	none		
* pcq-download-default	pcq		
* pcq-upload-default	pcq		
* synchronous-default	red		
* wireless-default	sfq		

10 items (1 selected)

Linux Term

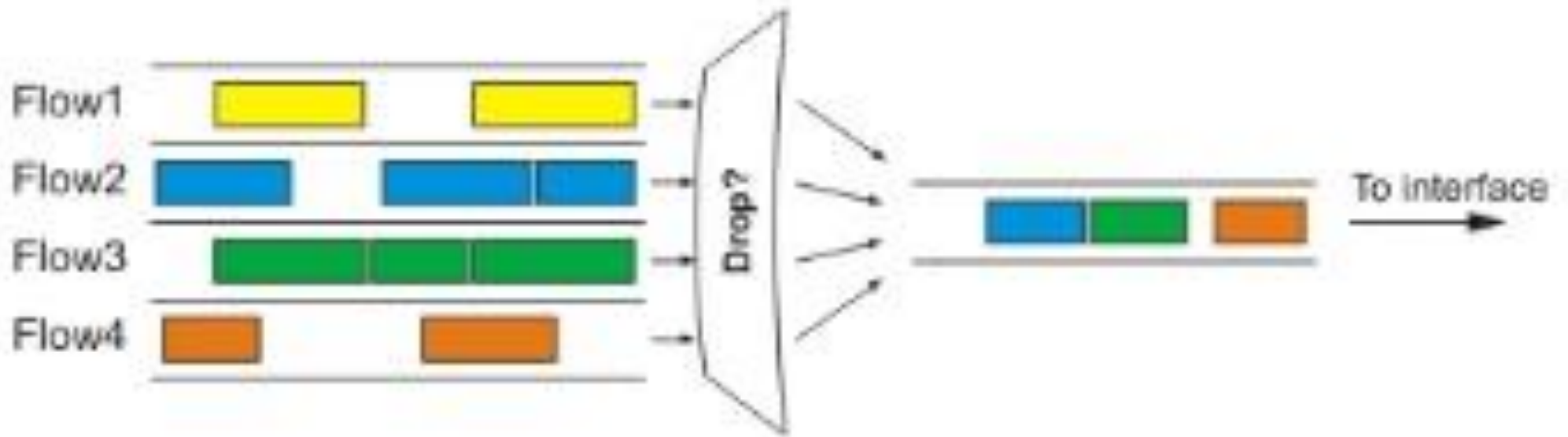
Queue Type

- **PFIFO** - Packets First-In First-Out
- **BFIFO** - Bytes First-In First-Out
- **MQ PFIFO** - PFIFO with multiple transmit queues



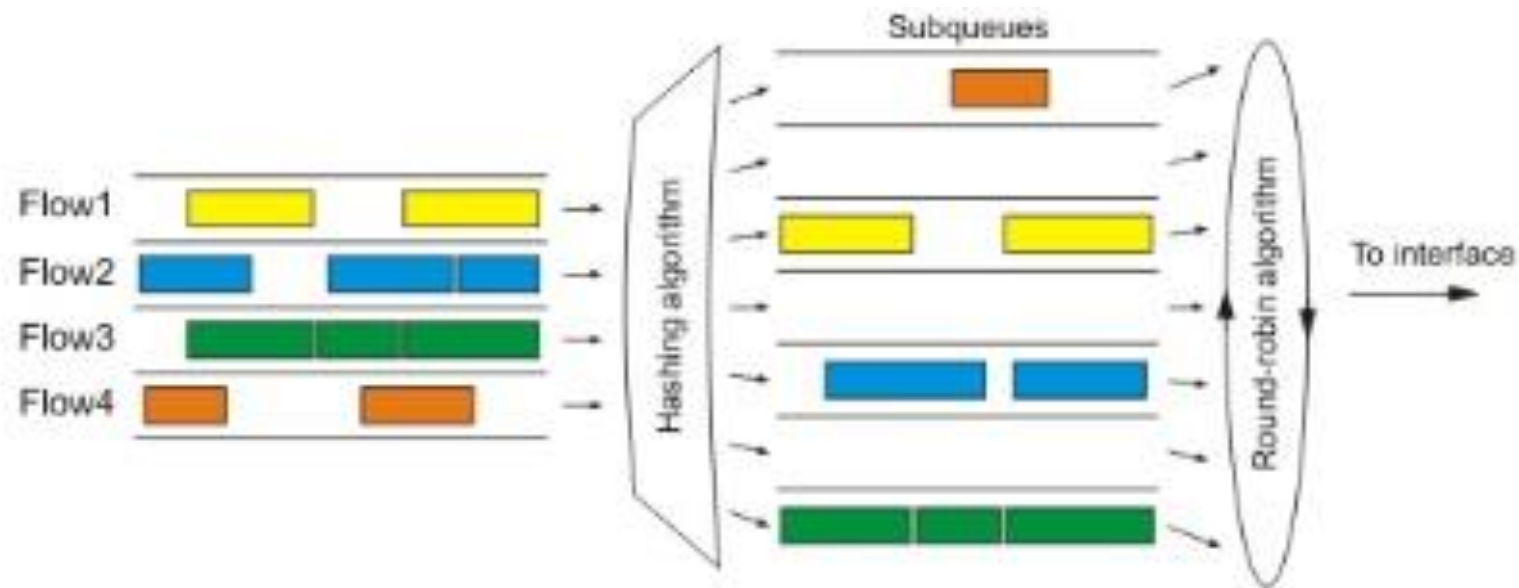
Queue Type

- **RED** - Random Early Detect



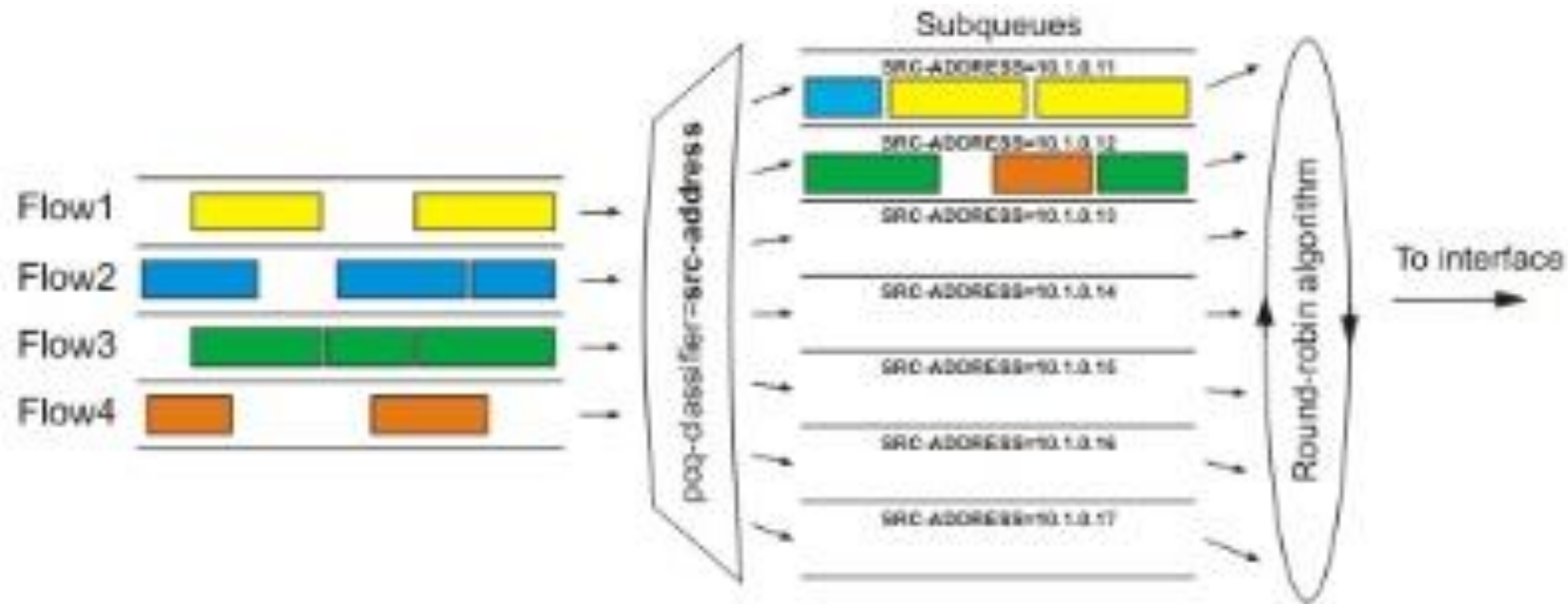
Queue Type

- **SFQ** - Stochastic Fairness Queuing



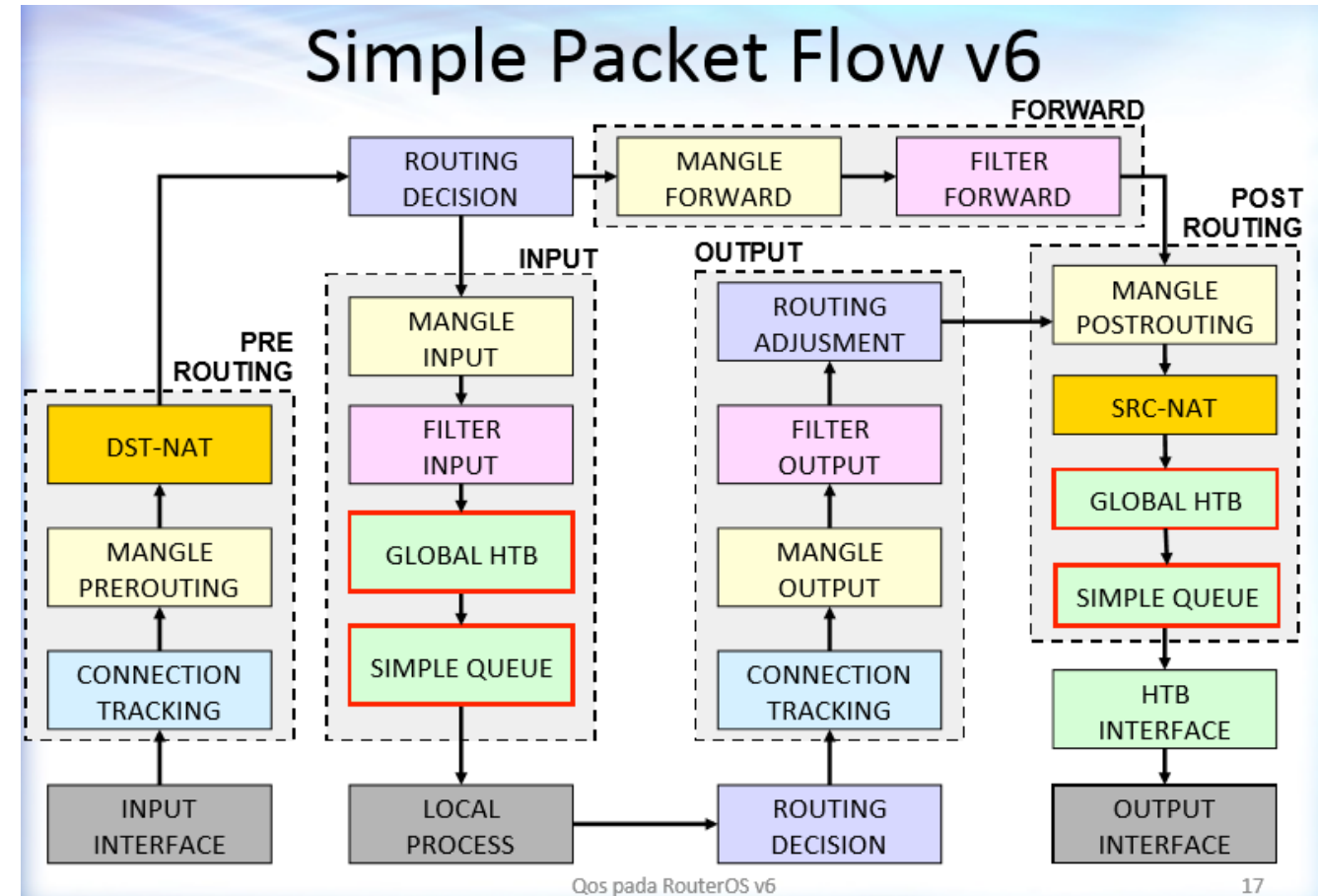
Queue Type

- **PCQ** - Per Connection Queue



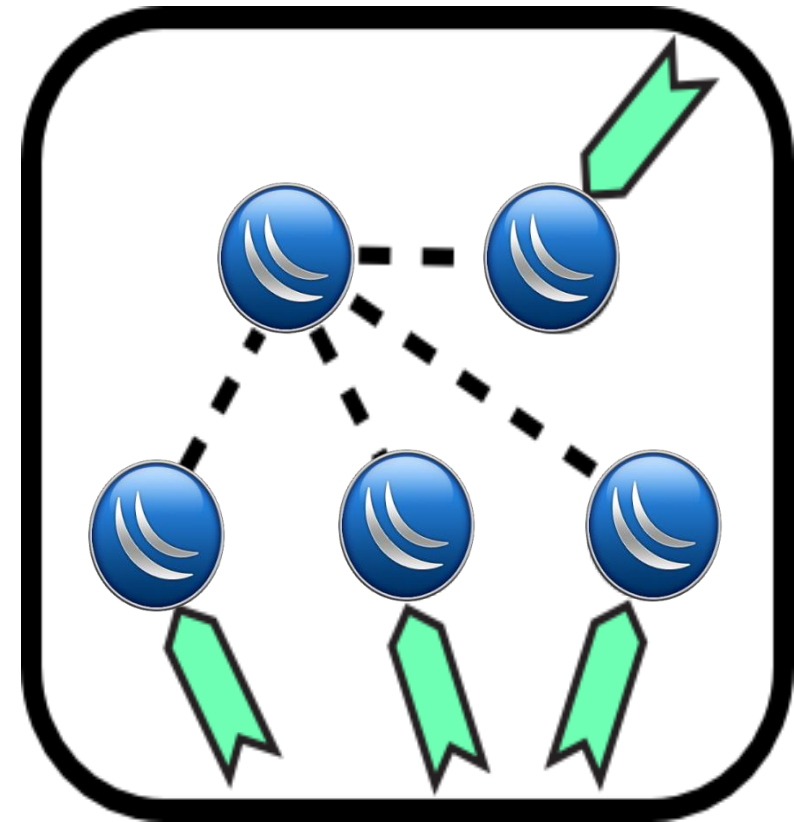
Why we need to Mangle?

- Modify Header Field
- Mark The Packet
- Marked Packet Usage



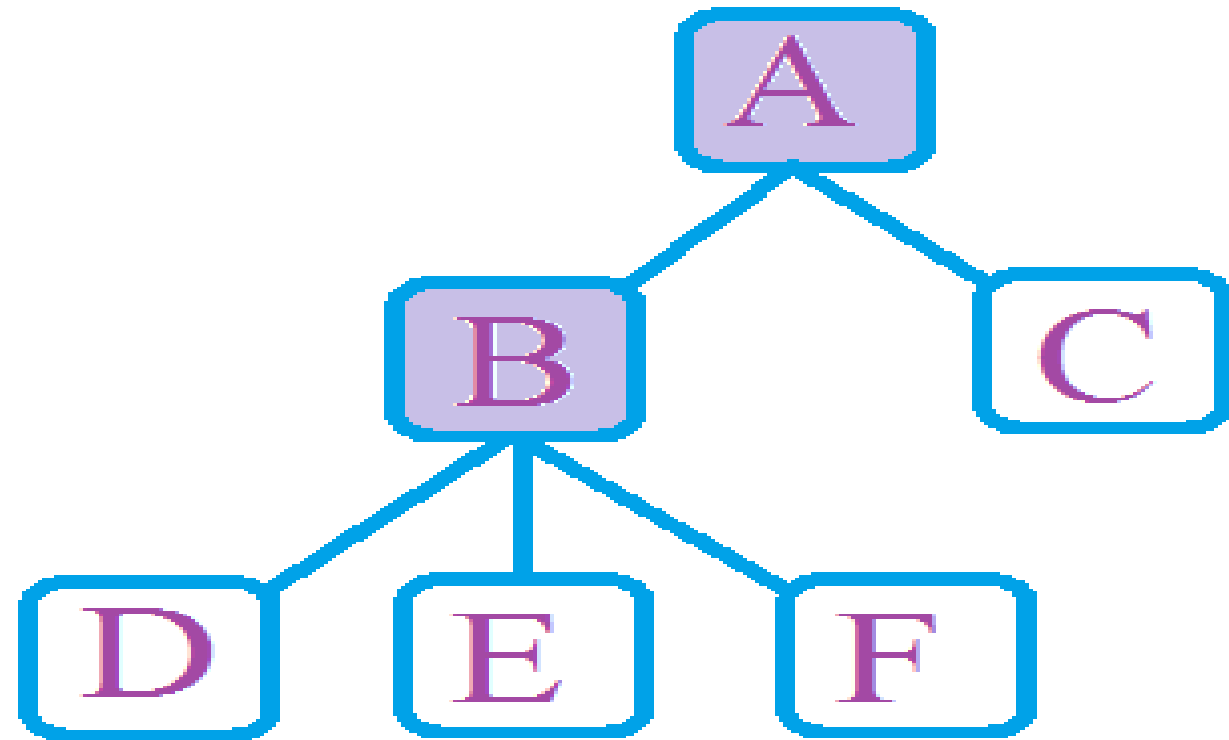
HTB Schematic

- ✓ HTB Queue Type
 - Inner Queue
 - Leaf Queue
- ✓ Level of HTB
- ✓ Inner Queue Responsibility



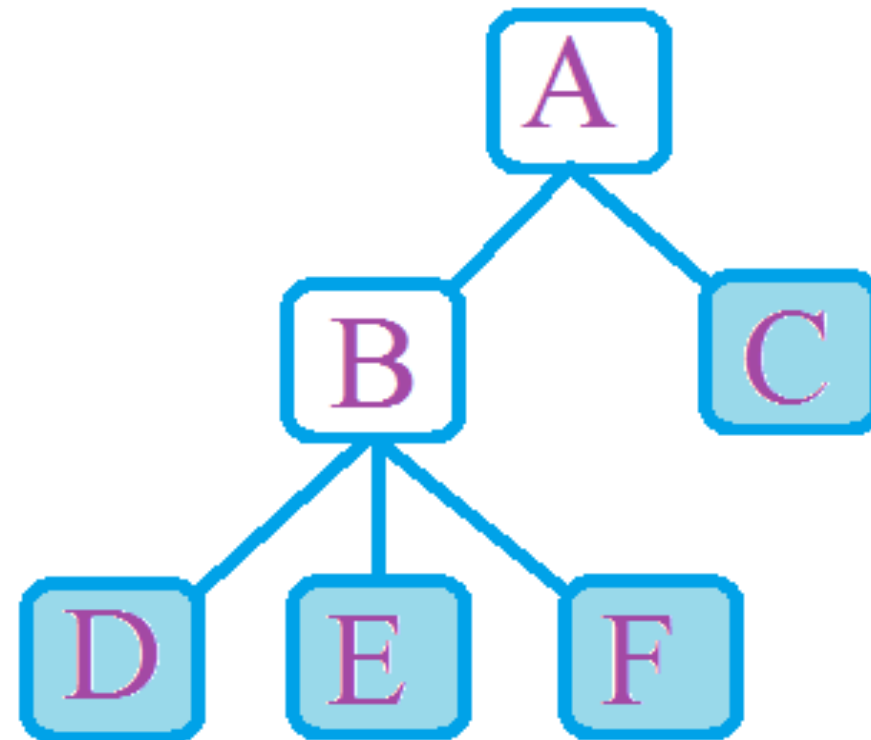
Inner Queue

- What's Inner Queue?
- Packet in Inner Queue
- Priority in Inner Queue

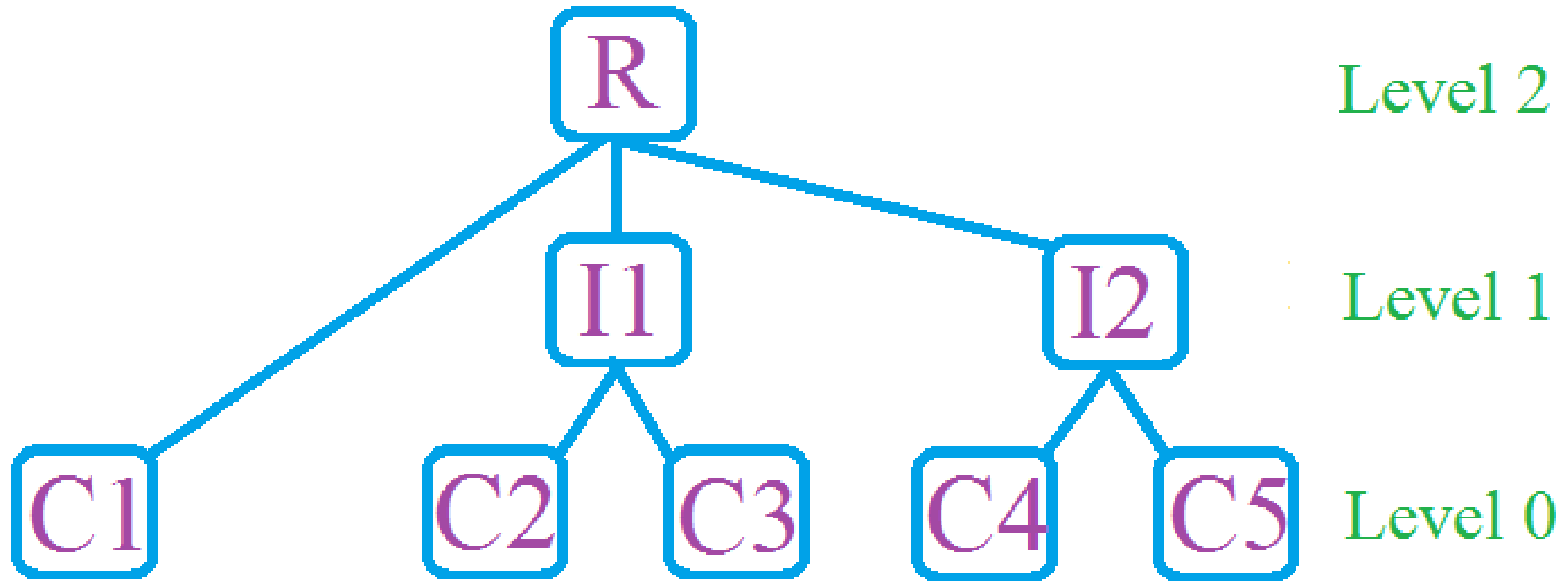


Leaf Queue

- Whats Leaf Queue?
- Where is located?



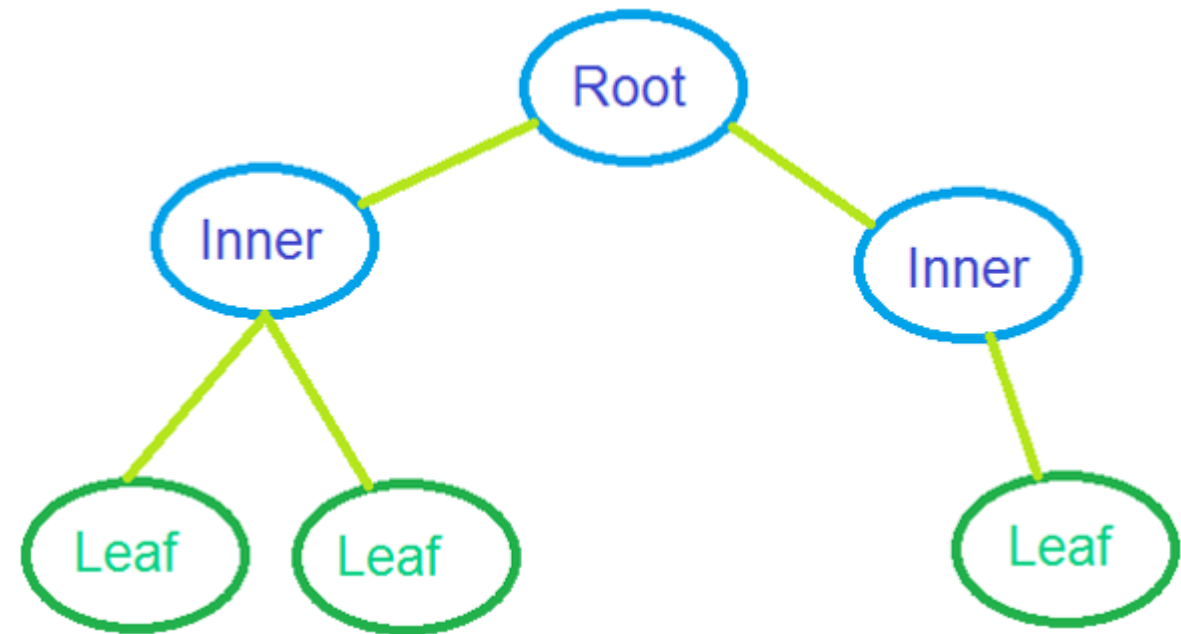
Level of HTB



HTB Parent Responsibility

✓ Traffic Distribution

✓ Set Parent



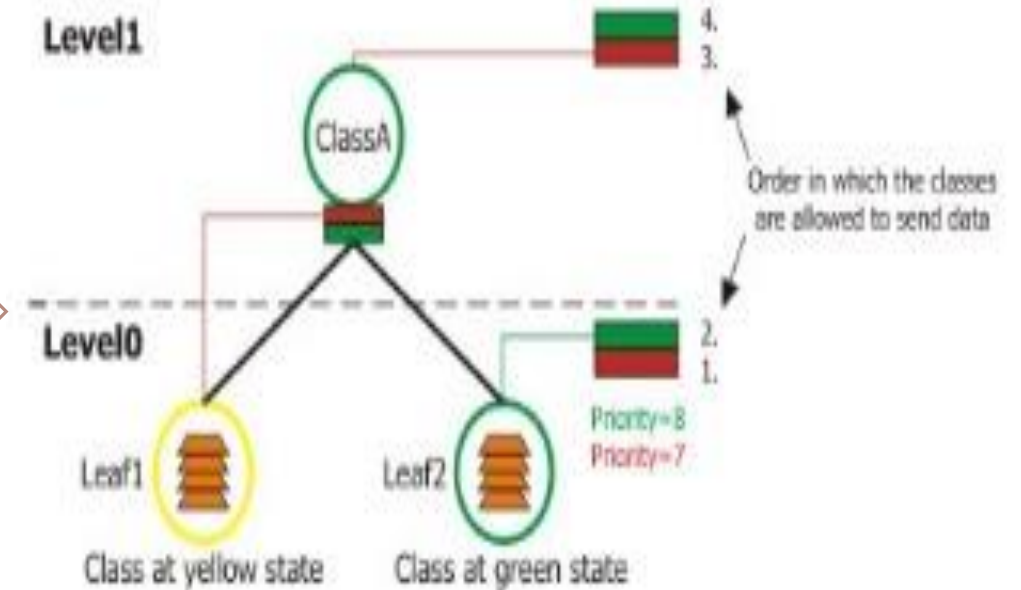
HTB Terms

- ✓ CIR
 - ✓ Committed Information Rate
- ✓ MIR
 - ✓ Maximal Information Rate
- ✓ Burst
- ✓ Limitation Rule
 - ✓ Inner MIR $\geq$ Sum of Leaf CIR
 - ✓ Inner MIR $\geq$ Each Leaf MIR



Priority - HTB Terms

When a Leaf Queue wants to send some traffic (as they are the only classes that hold packets), HTB checks its priority.



HTB or Queue State

✓ green

✓ Yellow

✓ red

Simple Queues Interface Queues Queue Tree Queue Types								
+ - ✓ ✗ 🔍 00 Reset Counters 00 Reset All Counters Find								
	Name ▲	Parent	Packet Mark	Priority	Limit At (...)	Max Limit...	Avg. Rate	Queued Byte: ▼
	 queue-parent	ether3		1		5M	5.0 Mbps	0 B
	 -Q1	queue-parent	C1	1	512k	2M	1981.2 kbps	71.3 KiB
	 l1	queue-parent		8	2M	5M	2.0 Mbps	0 B
	 Q2	l1	C2	8	512k	2M	999.9 kbps	72.7 KiB
	 Q3	l1	C3	8	512k	2M	1000.0 kbps	72.8 KiB
	 l2	queue-parent		8		5M	1024.4 kbps	0 B
	 Q4	l2	C4	2	512k	2M	512.2 kbps	72.7 KiB
	 Q5	l2	C5	2	512k	2M	512.1 kbps	72.7 KiB

Token

- The Token Bucket algorithm is based on an analogy to a bucket where tokens, represented in bytes, are added at a specific rate. The bucket itself has a specified capacity.
- If the bucket fills to capacity, newly arriving tokens are dropped

Bucket

➤ Bucket Size

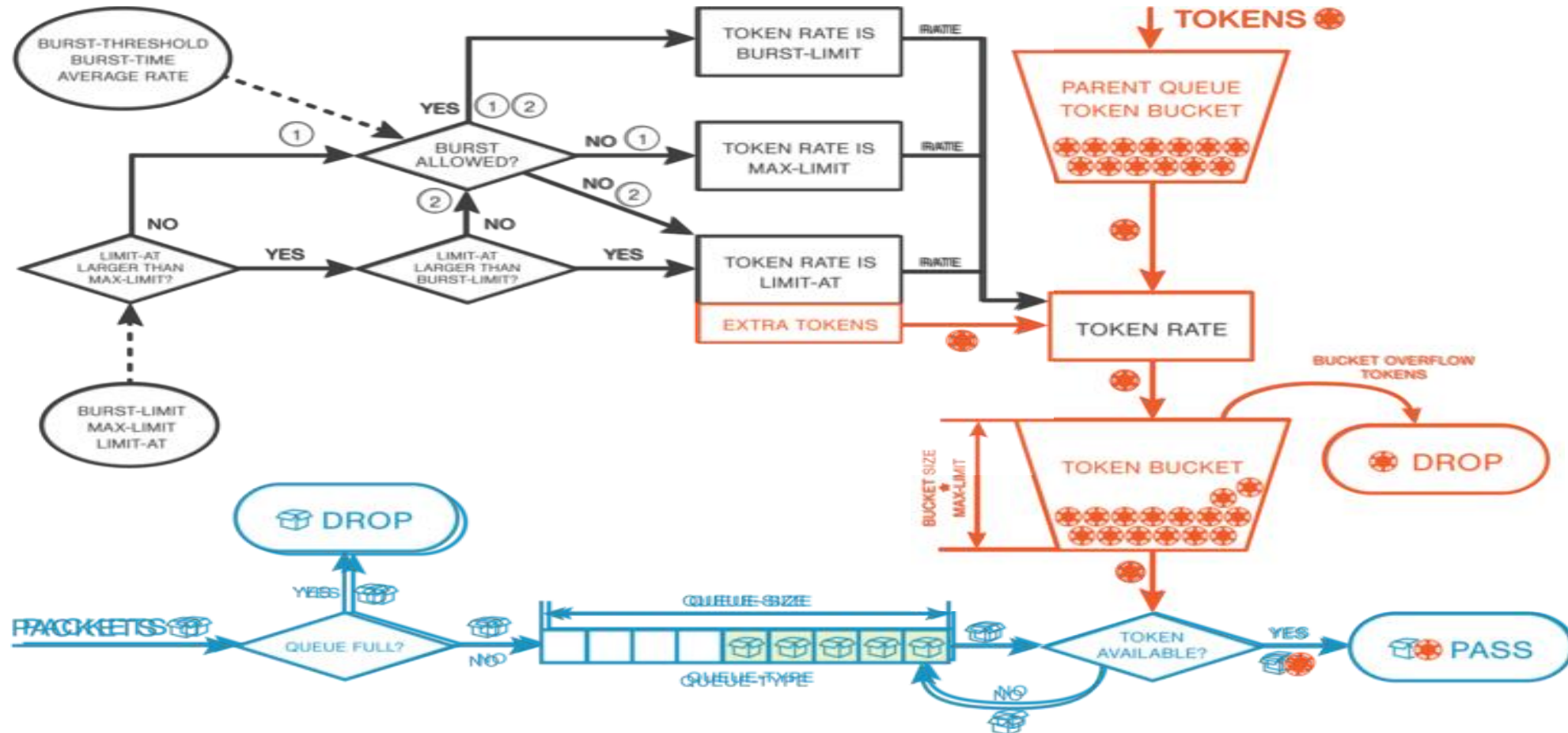
The screenshot shows the MikroTik Queue Manager configuration window. The 'General' tab is selected. The 'Packet Marks' field is empty. The 'Target Upload' and 'Target Download' sections are visible. The 'Limit At' field is set to 'unlimited'. The 'Priority' field is set to '8'. The 'Bucket Size' field is set to '0.100' and is circled in red. The 'Queue Type' field is set to 'default-small'. The 'Parent' field is set to 'none'. The 'enabled' checkbox is checked.

Field	Value
Packet Marks	
Limit At	unlimited
Priority	8
Bucket Size	0.100
Queue Type	default-small
Parent	none
enabled	checked

➤ Bucket Capacity

Bucket Capacity = Bucket-Size * max-Limit(Burst-Limit If exist)

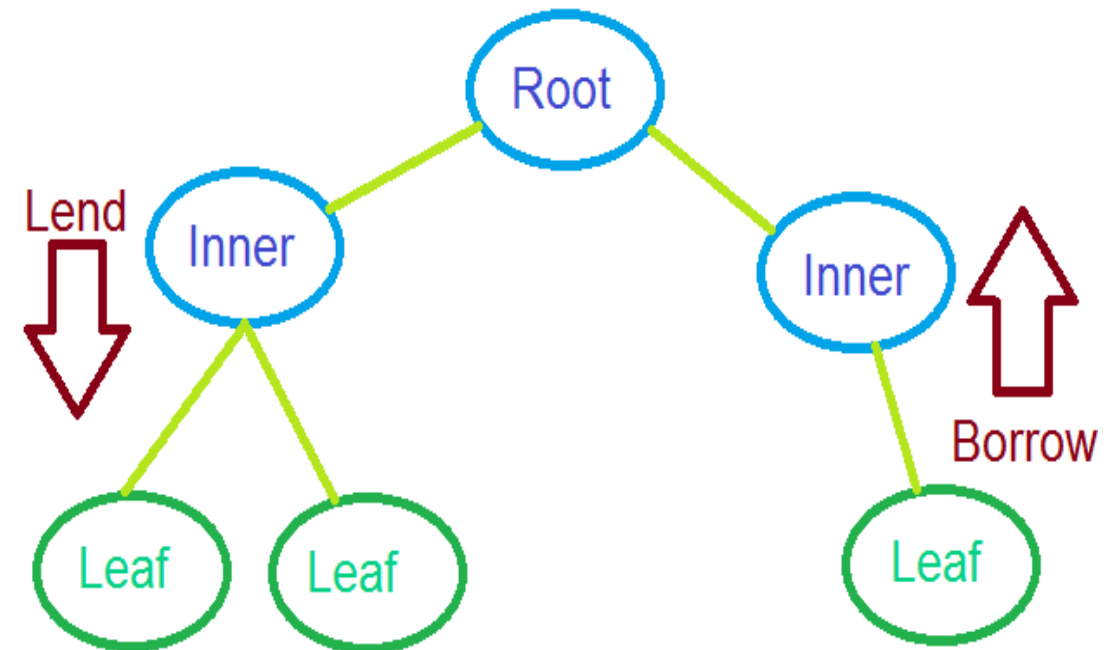
HTB Diagram



HTB Parent Responsibility

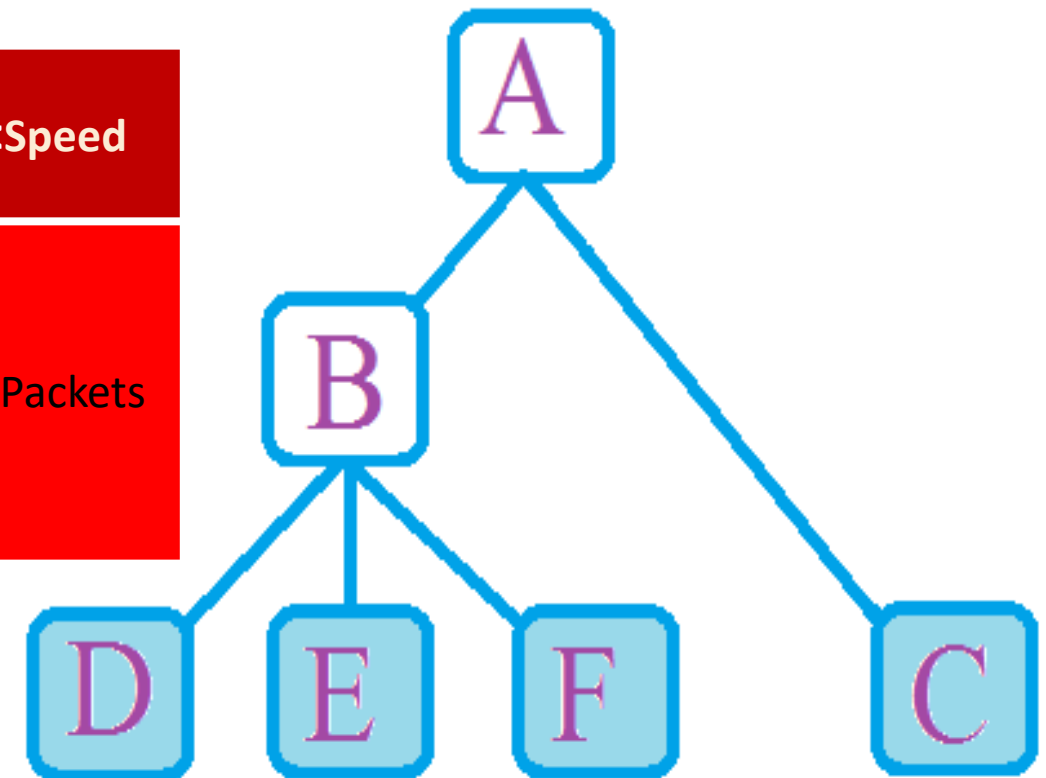
Lending-Barrowing

- ✓ The Inner Queues lend to their Leaf Queue
- ✓ The Leaf Queues Borrow from their Inner Queue
- ✓ Shaping only occurs in Leaf Queue
- ✓ Delay just will see in Leaf Queue



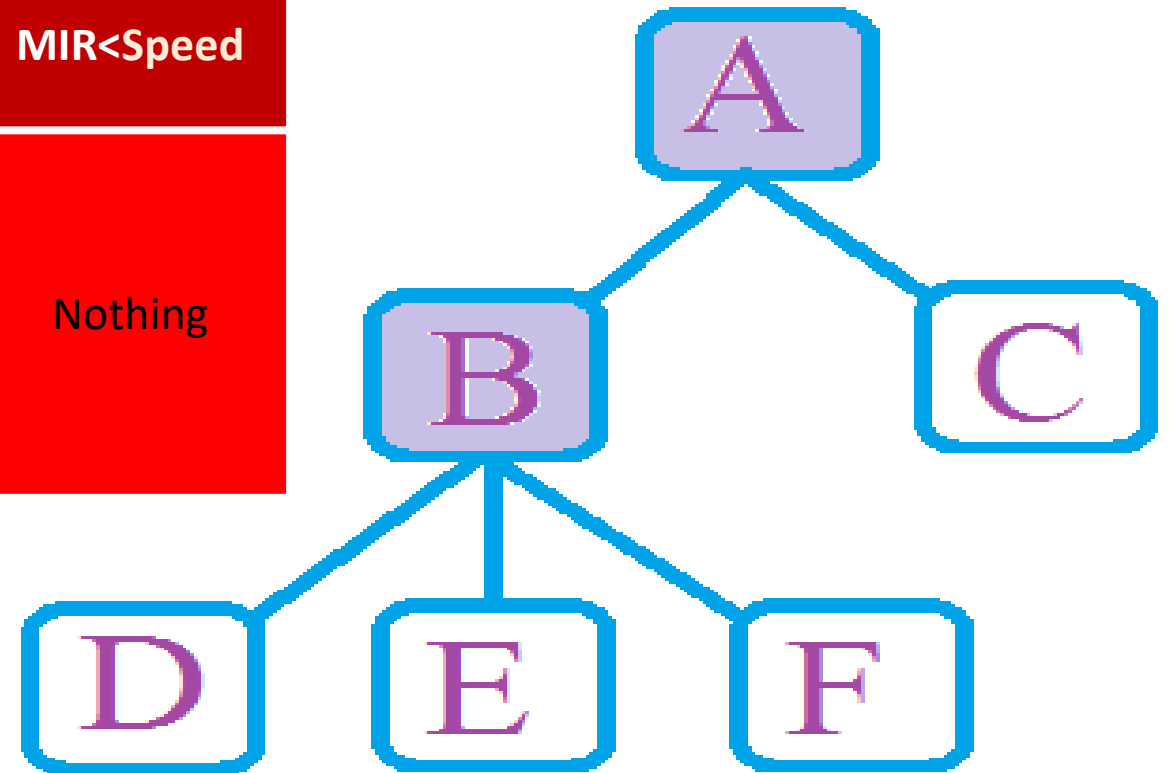
Leaf Queues Scope

Leaf Queue Situation	$Speed < CIR$	$CIR < Speed < MIR$	$MIR < Speed$
Result	Dequeue Function depend on Available Token	If the Token be available, Dequeue Function wants to borrow Token from Inner Queue	Delay Packets

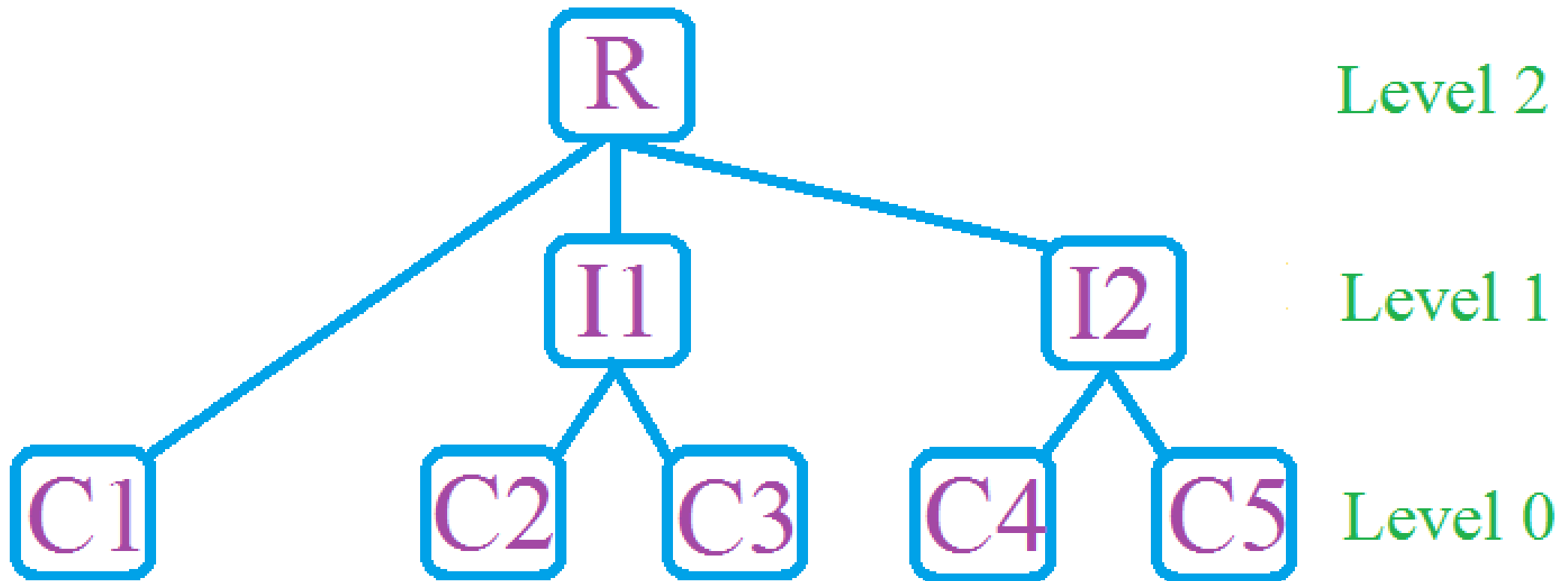


Inner Queues Scope

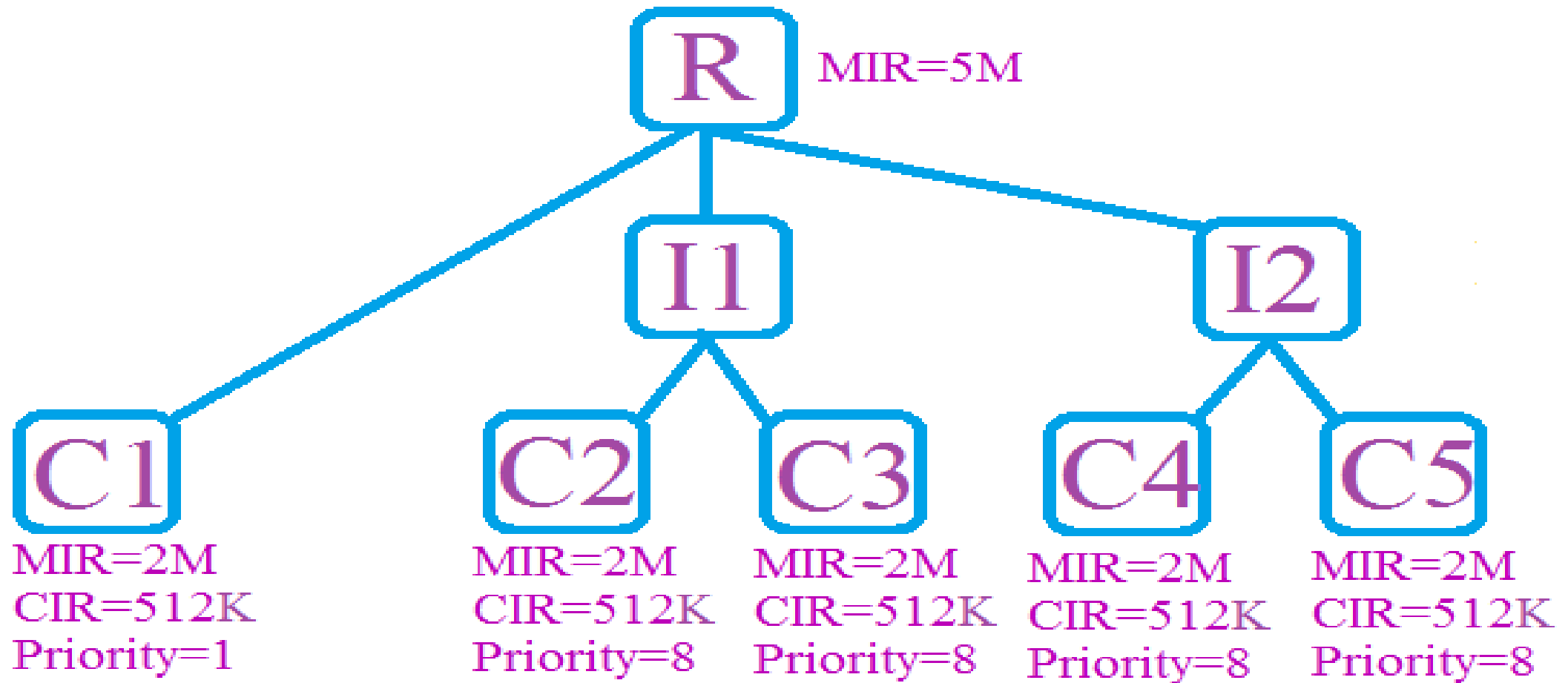
Inner Queue Situation	$Speed < CIR$	$CIR < Speed < MIR$	$MIR < Speed$
Result	Lends Token to Leafs	If the Token be available, Dequeue Function wants to borrow Token from Inner And lend to Leafs	Nothing



Scenario



Scenario 1 (A Leaf with better Priority)

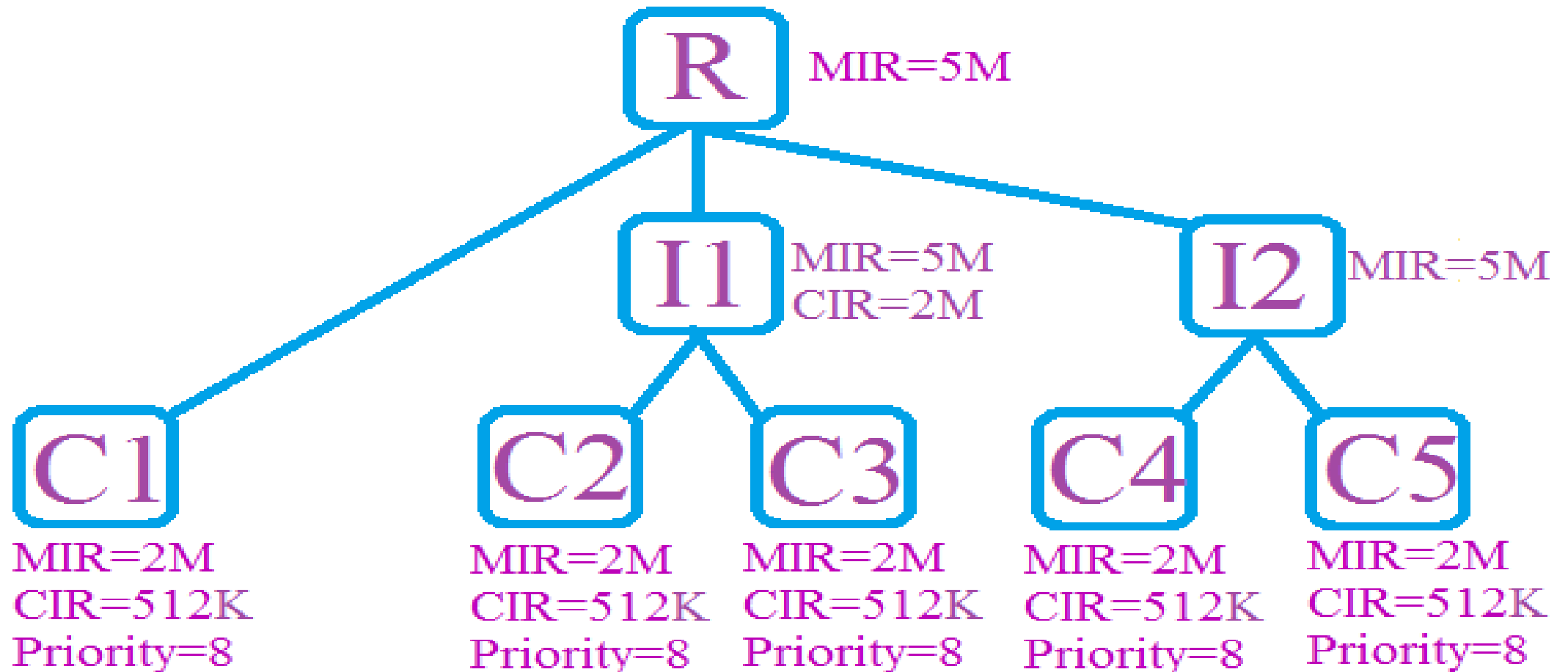


Scenario 1 (A Leaf with better Priority)

- ✓ C1 take the Max Limit
- ✓ Other Capacity Split to other Leaf

Simple Queues Interface Queues Queue Tree Queue Types								
+ - ✓ ✗ 🔍 🔄 Reset Counters 🔄 Reset All Counters Find								
Name	Parent	Packet Mark	Priority	Limit At (...)	Max Limit...	Avg. Rate	Queued Byte:	
queue-parent	ether3		1		5M	5.0 Mbps	0 B	
-Q1	queue-parent	C1	1	512k	2M	2.0 Mbps	54.0 KiB	
I1	queue-parent		8			1500.1 kbps	0 B	
Q2	I1	C2	8	512k	2M	745.4 kbps	72.8 KiB	
Q3	I1	C3	8	512k	2M	760.7 kbps	72.7 KiB	
I2	queue-parent		8			1503.0 kbps	0 B	
Q4	I2	C4	8	512k	2M	757.6 kbps	73.2 KiB	
Q5	I2	C5	8	512k	2M	751.3 kbps	72.8 KiB	

Scenario 2 (Inner with Limit At)



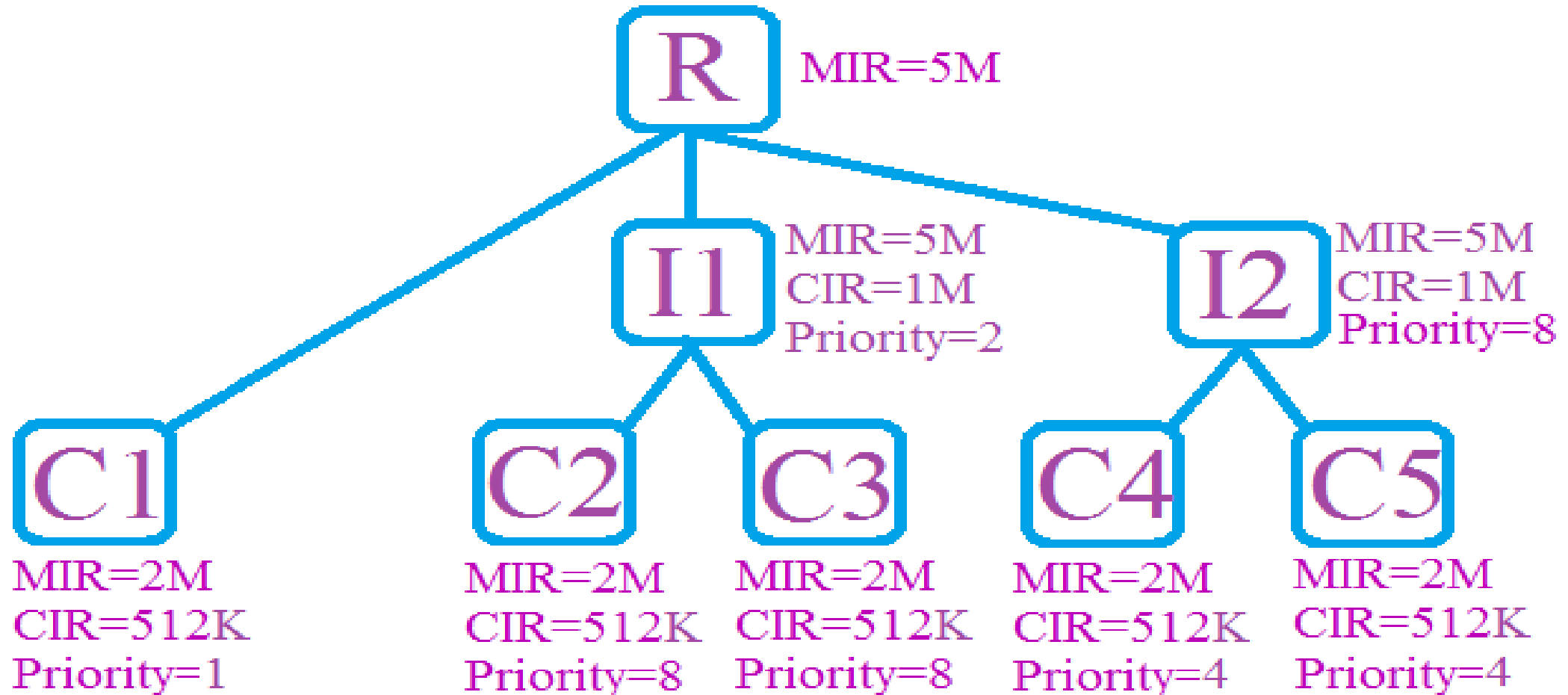
Scenario 2 (Inner with Limit At)

- ✓ Inners with Limit At can bring more capacity for their children

Simple Queues Interface Queues Queue Tree Queue Types								
+ - ✓ ✗ 🔍 Reset Counters Reset All Counters Find								
	Name ▲	Parent	Packet Mark	Priority	Limit At (...)	Max Limit...	Avg. Rate	Queued Byte: ▼
	queue-parent	ether3		1		5M	5.0 Mbps	0 B
	-Q1	queue-parent	C1	1	512k	2M	1981.1 kbps	72.7 KiB
	I1	queue-parent		8	2M	5M	2.0 Mbps	0 B
	Q2	I1	C2	8	512k	2M	1003.0 kbps	72.7 KiB
	Q3	I1	C3	8	512k	2M	1003.1 kbps	72.7 KiB
	I2	queue-parent		8		5M	1027.2 kbps	0 B
	Q4	I2	C4	8	512k	2M	509.1 kbps	72.7 KiB
	Q5	I2	C5	8	512k	2M	512.1 kbps	72.7 KiB

Scenario 3 (Inner with Priority)

Common Mistake



Scenario 3 (Inner with Priority)

Common Mistake

✓ Priority on Inner will not Work

Simple Queues Interface Queues Queue Tree Queue Types									
+ - ✓ ✗ 🔍 Reset Counters Reset All Counters Find									
	Name	Parent	Packet Mark	Priority	Limit At (...)	Max Limit...	Avg. Rate	Queued Byte:	
	queue-parent	ether3		1		5M	5.0 Mbps	0 B	
	-Q1	queue-parent	C1	1	512k	2M	2.0 Mbps	23.7 KiB	
	I1	queue-parent		2	1M	5M	1024.5 kbps	0 B	
	Q2	I1	C2	8	512k	2M	512.2 kbps	72.7 KiB	
	Q3	I1	C3	8	512k	2M	512.2 kbps	72.8 KiB	
	I2	queue-parent		8	1M	5M	1982.0 kbps	0 B	
	Q4	I2	C4	4	512k	2M	993.9 kbps	72.7 KiB	
	Q5	I2	C5	4	512k	2M	987.9 kbps	72.7 KiB	

Resources



- **Wiki.Mikrotik.Com**
- **Linux-IP.Net**
- **MUM.Mikrotik.Com**



Thank You For Your Attention

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