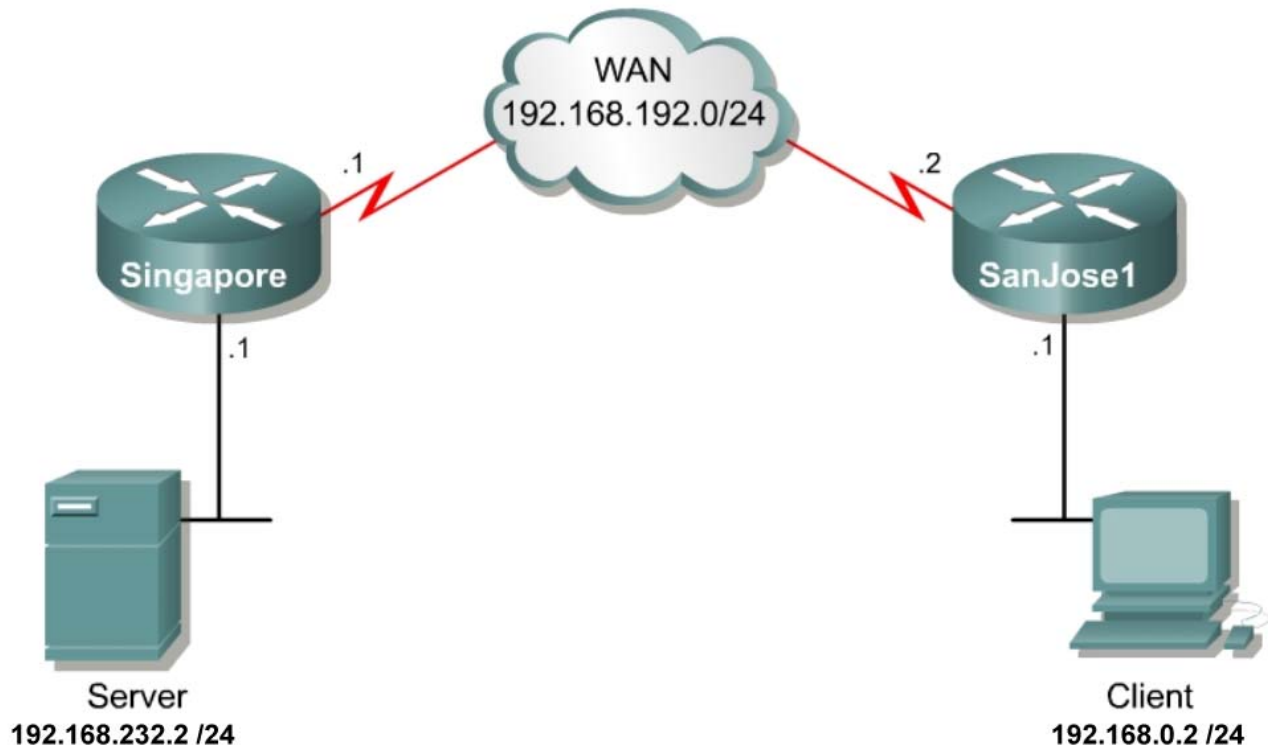


Lab 8.1.10.4 Weighted Fair Queuing



Objective

In this lab, weighted fair queuing (WFQ) is configured and optimized.

Scenario

The network engineer for the International Travel Agency (ITA) is responsible for WAN connectivity. As ITA has grown, traffic has increased on the WAN link. The network technicians have recently reported unreliable Telnet access between San Jose and regional sites. The network engineer discovers that average WAN link utilization between Singapore and SanJose1 is near saturation. While investigating ways to increase bandwidth, the engineer optimizes WFQ as a temporary solution to meet the needs of all users.

Step 1

Build the physical topology as shown in the diagram. Before beginning a lab, the configurations on all the routers should be cleared and then reloaded or power cycled to reset their default configurations. Delete the **vlan.dat** and startup configuration files on the switches before reloading them.

Step 2

Configure the network as shown in the diagram and enable EIGRP with an autonomous system number of 100 as the routing protocol. Confirm connectivity by pinging between the hosts.

```
Router(config)#hostname Singapore
Singapore(config)#interface fastethernet 0/0
Singapore(config-if)#ip address 192.168.232.1 255.255.255.0
Singapore(config-if)#no shutdown
Singapore(config-if)#interface serial 0/0
Singapore(config-if)#ip address 192.168.192.1 255.255.255.0
Singapore(config-if)#clock rate 128000
Singapore(config-if)#no shutdown
Singapore(config-if)#router eigrp 100
Singapore(config-router)#network 192.168.192.0
Singapore(config-router)#network 192.168.232.0

Router(config)#hostname SanJose1
SanJose1(config)#interface fastethernet 0/0
SanJose1(config-if)#ip address 192.168.0.1 255.255.255.0
SanJose1(config-if)#no shutdown
SanJose1(config-if)#interface serial 0/0
SanJose1(config-if)#ip address 192.168.192.2 255.255.255.0
SanJose1(config-if)#clock rate 128000
SanJose1(config-if)#no shutdown
SanJose1(config-if)#router eigrp 100
SanJose1(config-router)#network 192.168.0.0
SanJose1(config-router)#network 192.168.192.0
```

Step 3

View the default queuing strategy on the Singapore WAN link. The default queuing may be WFQ or first-in, first-out (FIFO), depending on the router IOS version and the bandwidth of the interface.

```
Singapore#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:03, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations 0/3/32 (active/max active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
    Available Bandwidth 96 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    325 packets input, 21083 bytes, 0 no buffer
    Received 105 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    341 packets output, 23164 bytes, 0 underruns
    0 output errors, 0 collisions, 11 interface resets
    0 output buffer failures, 0 output buffers swapped out
    4 carrier transitions
  DCD=up DSR=up DTR=up RTS=up CTS=up
```

Issue the **show queue serial 0/0** command to view the queuing configuration on an interface. This command is not supported with FIFO queuing.

```
Singapore#show queue serial 0/0
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
Conversations 0/3/32 (active/max active/max total)
Reserved Conversations 0/0 (allocated/max allocated)
Available Bandwidth 96 kilobits/sec
```

If the serial interface of a router is using FIFO, WFQ can be configured by issuing the **fair-queue** command.

```
Singapore(config)#interface serial 0/0
Singapore(config-if)#fair-queue
```

On a congested FIFO interface, a low-volume, interactive session like Telnet is subject to intolerable delays while high-bandwidth applications like FTP monopolize available bandwidth. WFQ identifies and gives equal access to a variety of application protocols. WFQ can be thought of as statistically multiplexing all applications. Low-volume sessions are given the necessary bandwidth while high-volume sessions share the remainder. However, there is no guarantee of reserved bandwidth. Interfaces that are overwhelmed with traffic may be forced to drop packets.

Each communication session between hosts creates a flow. The router understands a flow as a record of attributes such as source and destination addresses, port numbers, and the inbound interface. The router can then compare subsequent packets to existing flows. After packets are identified as belonging to a certain session, they are buffered accordingly.

To give each session equal router resources, a default maximum of 64 messages or packets can be buffered by any one session. The congestion threshold must be increased to 128 packets for the ITA network. This allows the router to buffer more packets per session, but decreases the number of sessions serviced at a time.

Queuing will not solve this problem because additional bandwidth is required. Queuing may increase performance problems because it demands additional router CPU cycles and forces the router to apply queuing logic to each packet. Therefore, queuing is either a temporary fix or a solution for times when interactive sessions fail due to latency or dropped packets.

Note: Queuing is only active when congestion exists. Congestion exists when any interface has one or more packets buffered in its queue. If all interfaces are clear of buffered packets, queuing is idle.

Output From Singapore Router (DTE) With FIFO Default

```
Singapore#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
Hardware is PowerQUICC Serial
Internet address is 192.168.192.1/24
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:01, output 00:00:01, output hang never
Last clearing of "show interface" counters 00:20:18
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue :0/40 (size/max)
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
  324 packets input, 21109 bytes, 0 no buffer
    Received 115 broadcasts, 0 runts, 0 giants, 0 throttles
  1 input errors, 0 CRC, 1 frame, 0 overrun, 0 ignored, 0 abort
  330 packets output, 21636 bytes, 0 underruns
    0 output errors, 0 collisions, 9 interface resets
```

```
0 output buffer failures, 0 output buffers swapped out
25 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up
```

```
Singapore#show queue serial 0/0
'Show queue' not supported with FIFO queueing.
```

Output From Singapore Router (DTE) After Turning On WFQ. This Should Be Similar On A DCE Router (SanJose1)

```
Singapore(config)#interface serial 0/0
Singapore(config-if)#fair-queue
```

```
Singapore#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
Hardware is PowerQUICC Serial
Internet address is 192.168.192.1/24
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:02, output 00:00:00, output hang never
Last clearing of "show interface" counters 00:14:46
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations 0/1/32 (active/max active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
    Available Bandwidth 96 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
    212 packets input, 13963 bytes, 0 no buffer
    Received 75 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    220 packets output, 14584 bytes, 0 underruns
    0 output errors, 0 collisions, 7 interface resets
    0 output buffer failures, 0 output buffers swapped out
    25 carrier transitions
    DCD=up DSR=up DTR=up RTS=up CTS=up
```

```
Singapore#show queue serial 0/0
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/64/0 (size/max total/threshold/drops)
    Conversations 0/1/32 (active/max active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
    Available Bandwidth 96 kilobits/sec
```

```
Singapore#show queueing fair
Current fair queue configuration:
```

Interface	Discard threshold	Dynamic queues	Reserved queues	Link queues	Priority queues
Serial0/0	64	32	0	8	1
Serial0/1	64	32	0	8	1

Step 4

Use the following command syntax to increase the congestion threshold value to 128 packets on both router WAN links.

```

Singapore(config)#interface serial 0/0
Singapore(config-if)#fair-queue 128

SanJose1(config)#interface serial 0/0
SanJose1(config-if)#fair-queue 128
SanJose1(config-if)#^Z

```

Review the WFQ parameters on Serial 0/0.

```

SanJose1#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/128/0 (size/max total/threshold/drops)
    Conversations 0/1/32 (active/max active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
    Available Bandwidth 96 kilobits/sec
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    481 packets input, 30955 bytes, 0 no buffer
    Received 160 broadcasts, 0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    498 packets output, 33108 bytes, 0 underruns
    0 output errors, 0 collisions, 12 interface resets
    0 output buffer failures, 0 output buffers swapped out
    6 carrier transitions
  DCD=up DSR=up DTR=up RTS=up CTS=up

Singapore#show queue serial 0/0
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/128/0 (size/max total/threshold/drops)
    Conversations 0/1/32 (active/max active/max total)
    Reserved Conversations 0/0 (allocated/max allocated)
    Available Bandwidth 96 kilobits/sec

```

When the WAN link is saturated and queuing is activated, each session will be able to buffer up to 128 packets before dropping any incoming packets. After the 128-packet discard threshold limit is reached for a particular flow, no packets will be buffered until the queue for the flow drops to 25 percent of the discard threshold. In this case, the queue must reach 32 packets, which is 25 percent of 128. If packets are dropped, upper-layer protocols such as TCP may compensate and retransmit undelivered packets. This will successfully change the behavior of WFQ.

```

Singapore#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:01, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:23:08
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0

```

```

Queueing strategy: weighted fair
Output queue: 0/1000/128/0 (size/max total/threshold/drops)
  Conversations 0/1/32 (active/max active/max total)
  Reserved Conversations 0/0 (allocated/max allocated)
  Available Bandwidth 96 kilobits/sec
5 minute input rate 0 bits/sec, 0 packets/sec
5 minute output rate 0 bits/sec, 0 packets/sec
  379 packets input, 24395 bytes, 0 no buffer
  Received 134 broadcasts, 0 runts, 0 giants, 0 throttles
  1 input errors, 0 CRC, 1 frame, 0 overrun, 0 ignored, 0 abort
  387 packets output, 25270 bytes, 0 underruns
  0 output errors, 0 collisions, 12 interface resets
  0 output buffer failures, 0 output buffers swapped out
  25 carrier transitions
  DCD=up DSR=up DTR=up RTS=up CTS=up

```

Singapore#show queueing fair

Current fair queue configuration:

Interface	Discard threshold	Dynamic queues	Reserved queues	Link queues	Priority queues
Serial0/0	128	32	0	8	1
Serial0/1	64	32	0	8	1

SanJose1#show queue serial 0/0

```

Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: weighted fair
Output queue: 0/1000/128/0 (size/max total/threshold/drops)
  Conversations 0/1/256 (active/max active/max total)
  Reserved Conversations 0/0 (allocated/max allocated)
  Available Bandwidth 1158 kilobits/sec

```

SanJose1#show queueing fair

Current fair queue configuration:

Interface	Discard threshold	Dynamic queues	Reserved queues	Link queues	Priority queues
Serial0/0	128	256	0	8	1
Serial0/1	64	256	0	8	1

Step 5

The effect of WFQ and FIFO will be examined. To do so, the client computer will initiate a large file transfer from the Server to generate a large flow of traffic. Configure Windows file sharing on the Singapore host to see the effect of WFQ. Copy a large file or files from the Singapore host to the SanJose1 host. The file(s) should be large enough to take five to ten minutes to copy over the 128-kbps WAN link.

Step 6

Initiate a **Telnet** session between Singapore and SanJose1. The keystrokes should be echoed back in a timely fashion when WFQ is being used.

With WFQ configured, a **ping** from the host should receive a reasonable amount of bandwidth. While the file transfer is in progress, **ping** the Server on Singapore (192.168.232.2) from the SanJose1 host and record the round trip transfer times.

```
C:\WINDOWS\System32\cmd.exe

C:\Documents and Settings>ping 192.168.232.2

Pinging 192.168.232.2 with 32 bytes of data:

Reply from 192.168.232.2: bytes=32 time=194ms TTL=126
Reply from 192.168.232.2: bytes=32 time=154ms TTL=126
Reply from 192.168.232.2: bytes=32 time=115ms TTL=126
Reply from 192.168.232.2: bytes=32 time=183ms TTL=126

Ping statistics for 192.168.232.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 115ms, Maximum = 194ms, Average = 161ms

C:\Documents and Settings>
```

Step 7

Use the **no fair-queue** command to turn off WFQ on each serial interface. This will result in FIFO queuing on the WAN link. Verify that FIFO is enabled by displaying the specifics for the serial interfaces.

```
Singapore#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Singapore(config)#int s0/0
Singapore(config-if)#no fair-queue
Singapore(config-if)#^Z

Singapore#show interfaces serial 0/0
Serial0/0 is up, line protocol is up
  Hardware is PowerQUICC Serial
  Internet address is 192.168.192.1/24
  MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 247/255, rxload 3/255
  Encapsulation HDLC, loopback not set
  Keepalive set (10 sec)
  Last input 00:00:03, output 00:00:00, output hang never
  Last clearing of "show interface" counters 00:51:24
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue :0/40 (size/max)
  5 minute input rate 2000 bits/sec, 6 packets/sec
  5 minute output rate 124000 bits/sec, 11 packets/sec
    15538 packets input, 2271525 bytes, 0 no buffer
    Received 365 broadcasts, 0 runs, 0 giants, 0 throttles
    3 input errors, 0 CRC, 3 frame, 0 overrun, 0 ignored, 0 abort
    23728 packets output, 32665004 bytes, 0 underruns
    0 output errors, 0 collisions, 7 interface resets
    0 output buffer failures, 0 output buffers swapped out
    9 carrier transitions
    DCD=up DSR=up DTR=up RTS=up CTS=up

Singapore#

SanJose1#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
SanJose1(config)#interface s0/0
SanJose1(config-if)#no fair-queue
SanJose1(config-if)#^Z

SanJose1#show interfaces s0/0
Serial0/0 is up, line protocol is up
```



```

Hardware is PowerQUICC Serial
Internet address is 192.168.192.2/24
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,
    reliability 255/255, txload 3/255, rxload 245/255
Encapsulation HDLC, loopback not set
Keepalive set (10 sec)
Last input 00:00:00, output 00:00:00, output hang never
Last clearing of "show interface" counters 00:54:05
Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
Queueing strategy: fifo
Output queue :0/40 (size/max)
5 minute input rate 123000 bits/sec, 10 packets/sec
5 minute output rate 2000 bits/sec, 7 packets/sec
24550 packets input, 33842617 bytes, 0 no buffer
    Received 370 broadcasts, 0 runts, 0 giants, 0 throttles
5 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
16093 packets output, 2300010 bytes, 0 underruns
0 output errors, 0 collisions, 7 interface resets
0 output buffer failures, 0 output buffers swapped out
29 carrier transitions
DCD=up DSR=up DTR=up RTS=up CTS=up

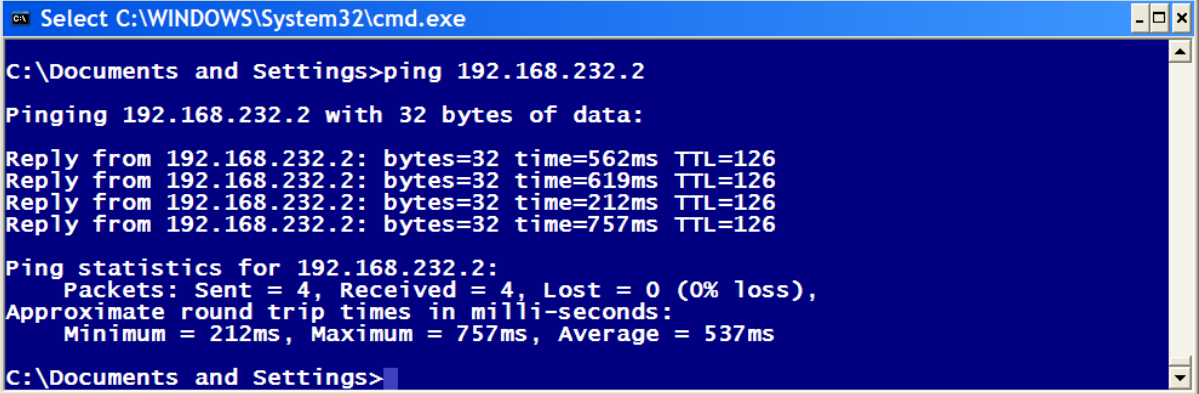
SanJose1#

```

Step 8

Initiate another **Telnet** session between Singapore and SanJose1. The keystrokes should be echoed back after some latency and may be erratic. This makes it difficult to correct typing mistakes by using the **Backspace** key.

Verify that the file transfer is still progressing and **ping** the server again. Compare the round trip times.



```

C:\Documents and Settings>ping 192.168.232.2

Pinging 192.168.232.2 with 32 bytes of data:

Reply from 192.168.232.2: bytes=32 time=562ms TTL=126
Reply from 192.168.232.2: bytes=32 time=619ms TTL=126
Reply from 192.168.232.2: bytes=32 time=212ms TTL=126
Reply from 192.168.232.2: bytes=32 time=757ms TTL=126

Ping statistics for 192.168.232.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 212ms, Maximum = 757ms, Average = 537ms

C:\Documents and Settings>

```

Notice that without WFQ, the pings take much more time. This is because the large file transfer traffic flow is occupying most of the bandwidth.

With WFQ configured, the available bandwidth was divided more evenly between traffic flow.