Advanced Services

UCL / UKERNA

Cisco 12000 QoS Testing - Bedfont Lakes

Version 1.1

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Contents

Document Control

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History

Table 1 Revision History

Version No.	Issue Date	Status	Reason for Change
1.0	19/06/03	First Version	First Version
1.1	23/09/03	Second Version	Documentation of additional testing carried out on 16th September 2003

Review

Table 2 Revision Review

Reviewer's Details	Version No.	Date

Change Forecast: Medium

This document will be kept under revision control.

Testing Objectives

This testing was performed as part of the MB-NG (Managed Bandwidth - Next Generation) project. The objective of this testing was to derive a QoS configuration for the 12000 routers that can be used in the MB-NG network. By testing a single 12000 in the lab, we can have confidence that we understand the QoS characteristics of the 12000 routers in the core of the MB-NG network.

On 17th June 2003, 4 tests were originally planned:

- Test A - 2 x Engine 2 Input, 1 x Engine 2 Output
- Test B - 2 x Engine 2 Input, 1 x Engine 3 Output.
- Test C - 1 x Engine 2, 1 x Engine 3 Input, 1 x Engine 2 Output.
- Test D - Police and Drop Ingress on Engine 3

Tests A and B were successfully completed. Test C requires a very new IOS image, version 12.0(23)SZ. This is an engineering "special" image and is not officially supported by Cisco. Test C will also work on a future supported version of IOS - 12.0(26)S (available August 2003). It is planned to run tests C and D, later this year, when this supported image is available.

On 16th September 2003 further tests were carried out to further investigate WRED profiles and to test the accuracy of the PQ policer.

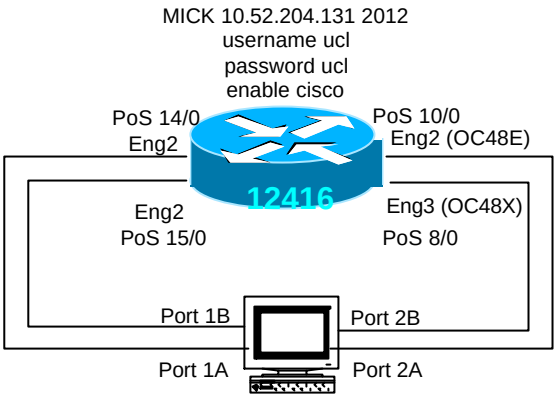
- Test E - WRED [2 x Engine 2 Input, 1 x Engine 2 Output]
- Test F - WRED [2 x Engine 2 Input, 1 x Engine 3 Output]
- Test G - Policer [2 x Engine 2 Input, 1 x Engine 3 Output]
- Test H - Aggressive Policer [2 x Engine 2 Input, 1 x Engine 3 Output]

Method

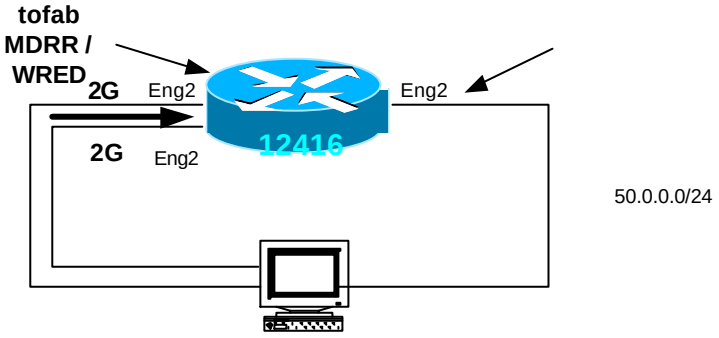
Tests

Physical

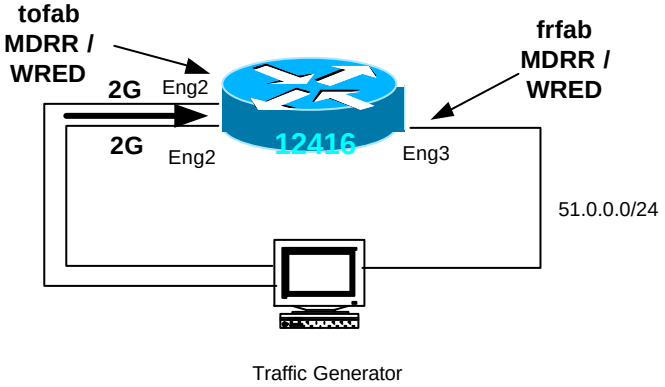
All links POS STM-16
2488.32Mb/s (payload 2405.38)
IP addressing
Router 223.1.slot.1
Traffic Gen 223.1.slot.2



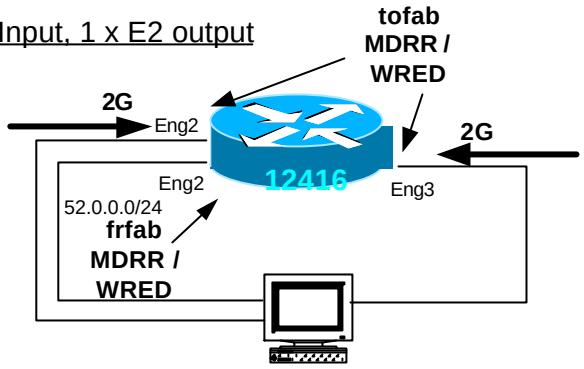
Test A - 2 x E2 Input, 1 x E2 output



Test B - 2 x E2 Input, 1 x E3 output

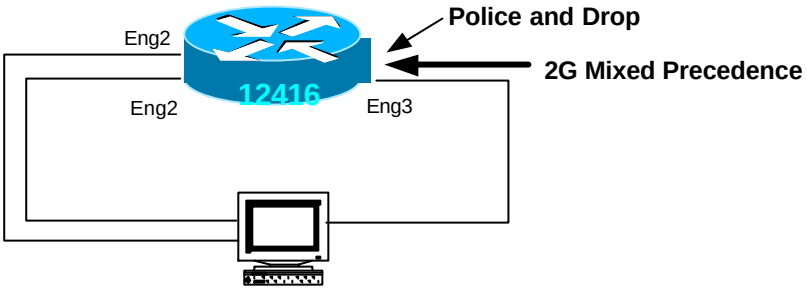


Test C - 1 x E3 input, 1 x E2 Input, 1 x E2 output



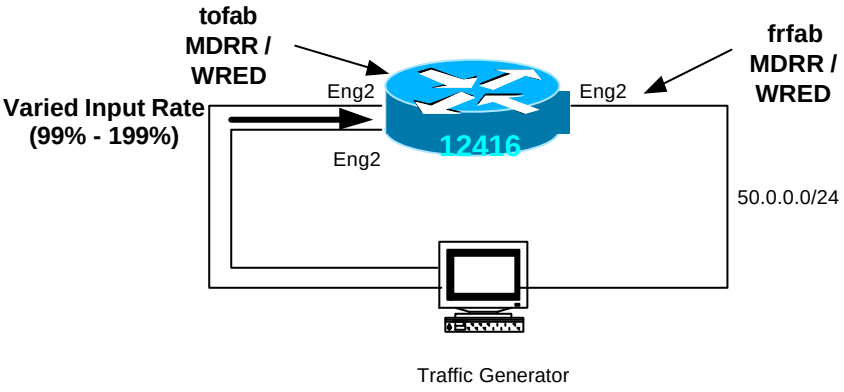
Test not yet carried out.

Test D - Police and Drop ingress on Engine 3

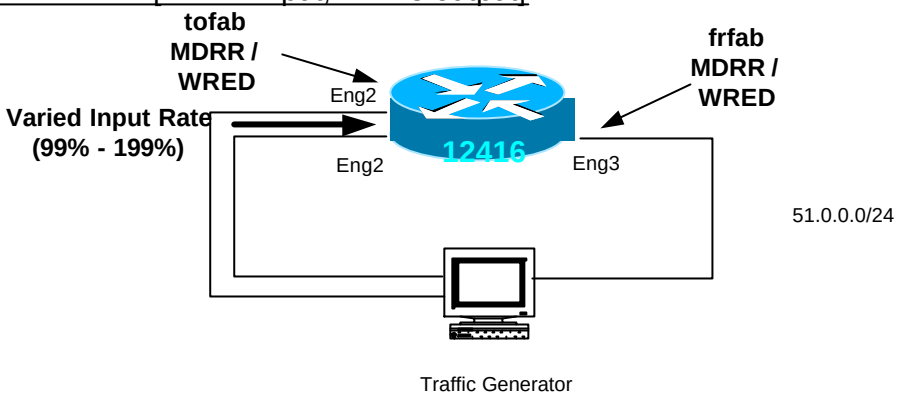


Test not yet carried out

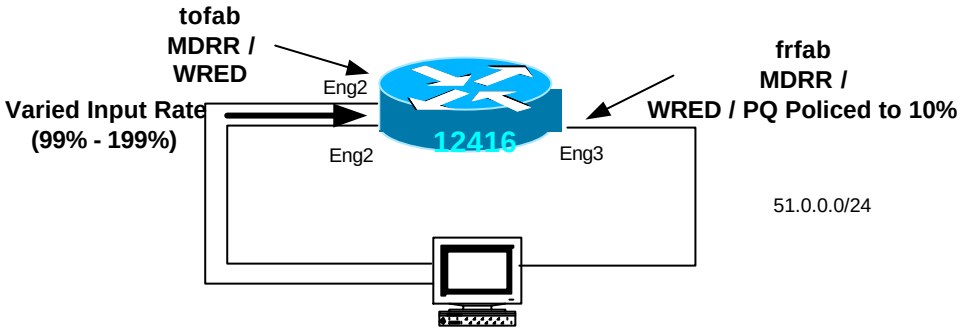
Test E - WRED [2 x E2 Input, 1 x E2 output]



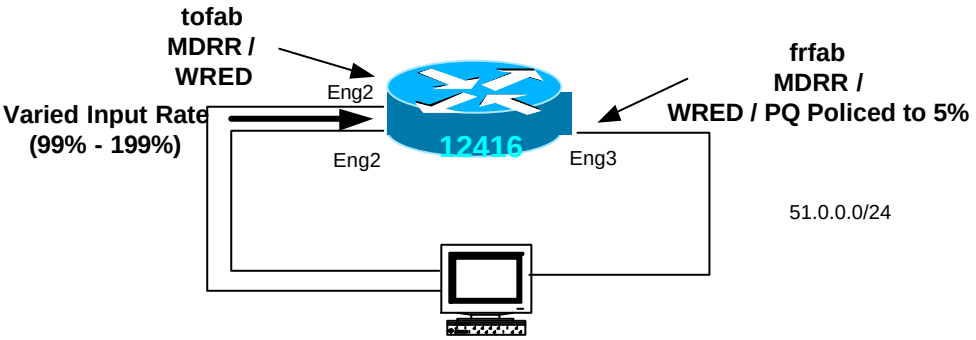
Test F - WRED [2 x E2 Input, 1 x E3 output]



Test G - Policer [2 x E2 Input, 1 x E3 output]



Test H - Aggressive Policer [2 x E2 Input, 1 x E3 output]



Software

Tests A - D	IOS 12.0(21)S7 Service Provider (file name: gsr-p-mz.120-21.S7.bin)
Tests E - H	IOS 12.0(26)S Service Provider (file name: gsr-p-mz.120-26.S.bin)

Traffic Characteristics

Each Port on the traffic generator produced 2G of traffic, with the following characteristics, destined for 50.0.0.1. Tests were performed using an IP streams "blasted" at the unit under test. There was no host TCP/IP stack running on the traffic generator. Packets were sent regardless of what was being received.

Each packet had a length of 1000 bytes.

The traffic classes were based on the classes proposed by UKERNA as part of the JANET QoS development project. http://www.ja.net/development/qos/qos_dev.html The Premium Class is designed for applications that require a low delay and a low jitter. The IP Plus class is a premium data service with low packet loss and a minimum guaranteed throughput. The Best Effort class is the standard data class which may experience significant packet loss. The Less Than BE class is used for applications that do not have tight network requirements, such as bulk file transfer. The BE class has a small lossless minimum bandwidth to ensure long running applications do not time out through loss of keepalives.

Tests A - D

Class	**IP Precedence**	**% of 2G**	**Mb/s**
Network Updates	7 6	0 3	0 60
Premium	5	5	100
Reserved for future use	4	0	0
IP Plus	3	5	100
Reserved for future use	2	0	0
Best Effort	1	86	1,720
Less Than BE	0	1	20

Tests E - H

For tests E - H the traffic classes were simplified to 3 classes.

Class	**IP Precedence**	**% of 2405Mb/s**[1]	**Mb/s**
Reserved for future use	7	0	
Reserved for future use	6	0	
Voice	5	5	
Reserved for future use	4	0	
Reserved for future use	3	0	
Reserved for future use	2	0	
Best Effort	1		
Less Than BE	0	1	

[1] 2405.38 is the theoretical payload of an STM-16. The Traffic Generator reports a maximum IP throughput for an STM-16 as 2347.79Mb/s. This 2.4 % difference may be accounted for by the extra payload that the Traffic Generator adds to the traffic stream.

Within each test E - F, the traffic sent was increased from 89% of an STM-16 to 199% of an STM-16. The increase was made only in a single class of traffic, the BE class. The traffic sent in each test is recorded below.

Class	**% of 2405Mb/s**					
	Load 1	Load 2	Load 3	Load 4	Load 5	Load 6
Voice	10	10	10	10	10	10
Best Effort	69	79	89	99	109	179
Less Than BE	10	10	10	10	10	10
Total %	**89**	**99**	**109**	**119**	**129**	**199**

Within each test G - H, the traffic sent was increased from 99% of an STM-16 to 129% of an STM-16. The increase was made only in a single class of traffic, the voice class. The traffic sent in each test is recorded below.

Class	**% of 2405Mb/s**			
	Load 1	Load 2	Load 3	Load 4
Voice	20	30	40	50
Best Effort	69	79	89	99
Less Than BE	10	10	10	10
Total %	**99**	**109**	**119**	**129**

QoS configuration

Supported Classes Tests A - D

Class Name	**DSCP Value**
Network Updates	6,7
Premium	5
IP Plus	3
Best Effort	1
Less Than BE	0

Supported Classes Tests E - H

Class Name	**DSCP Value**
Voice	5
Best Effort	1
Less Than BE	0

Queuing + Congestion Avoidance Tests A - D

Queue Number	Class	IP Precedence Values	%	Weight[2]	Quantum
0	Network Updates	6, 7	5	37	23040
1	Premium	5	10	PQ	PQ
2	IP Plus, Best Effort	4,3,2 1	84	748	387072
3	Less Than BE	0	1	1	4608

Queuing + Congestion Avoidance Tests E - H

Queue Number	Class	IP Precedence Values	%	Weight	Quantum
2	Voice	5	10	PQ	PQ
1	Best Effort	1	79	69	36403
0	Less Than BE	0	10	1	4608

[2] When calculating MDRR weight values it is important to use the actual MTU size of the interface (in this test 4470 bytes), not the average MTU of the actual traffic (in this test 1000 bytes).

IOS QoS Configuration Templates

From Fabric QoS - MDRR / WRED (Engine 2 Linecards)

```
cos-queue-group stm16-qos
! Assign class to queues
 precedence 0 queue 3
 precedence 1 queue 2
 precedence 2 queue 2
 precedence 3 queue 2
 precedence 4 queue 2
 precedence 5 queue low-latency
 precedence 6 queue 0
 precedence 7 queue 0

! Define Queues (MDRR Bandwidths)
 queue 0 37
 queue 2 748
 queue 3 1
 queue low-latency strict-priority

! Define WRED profiles
 random-detect-label 1 1 2 1
 random-detect-label 2 2000 2001 1

 ! Assign WRED profiles to each class
 precedence 0 random-detect-label 2
 precedence 1 random-detect-label 1
 precedence 2 random-detect-label 2
 precedence 3 random-detect-label 2
 precedence 4 random-detect-label 2
 precedence 5 random-detect-label 2
 precedence 6 random-detect-label 2
 precedence 7 random-detect-label 2

! Apply from fabric MDRR / WRED
int pos x/y
  tx-cos stm16-qos
```

From Fabric QoS - MDRR / WRED (Engine 3 Linecards)

```
! Engine 3 Linecards must be configured using MQC

! Assign class to queues
class-map match-any queue-0
  match ip precedence 6
  match ip precedence 7
class-map match-any queue-1
  match ip precedence 5
class-map match-any queue-2
  match ip precedence 4
  match ip precedence 3
  match ip precedence 2
  match ip precedence 1
class-map match-any queue-3
  match ip precedence 0

! Define Queues and Assign WRED profiles to each class
policy-map e3-stm16-qos
  class queue-0
    bandwidth percent 5
    random-detect
    random-detect precedence 6 2000 2001 1
    random-detect precedence 7 2000 2001 1
 class queue-1
    priority
 ! Need to police here
  police 200000000 2000 2000 conform-action transmit exceed-action drop
  class queue-2
    bandwidth percent 84
    random-detect
    random-detect precedence 1 1 2 1
    random-detect precedence 2 2000 2001 1
    random-detect precedence 3 2000 2001 1
    random-detect precedence 4 2000 2001 1
  class queue-3
    bandwidth percent 1
    random-detect
    random-detect precedence 0 2000 2001 1

! Apply from fabric QoS
int pos x/y
  service-policy output e3-stm16-qos
```

To Fabric QoS - MDRR / WRED

```
! RX QoS on Engine 2 or Engine 3 (E3 requires 12.0(23)SZ)
! 12.0(26)S will be first supported CCO release (due in August)

slot-table-cos rx-table
! Apply "stm16-qos" cos-queue-group as defined earlier to all slots
  destination-slot all stm16-qos

! Apply to fabric QoS to slots 14, 15, 16
rx-cos-slot 14 rx-table
rx-cos-slot 15 rx-table
rx-cos-slot 8 rx-table
```

Results

Overview of Tests Performed

16th - 17th June 2003: Bedfont Lakes

Each test ran for a duration of 20 minutes.
Test A - 2 x Engine 2 Input, 1 x Engine 2 Output
Test B - 2 x Engine 2 Input, 1 x Engine 3 Output.

Future tests:

Test C - 1 x Engine 2, 1 x Engine 3 Input, 1 x Engine 2 Output.
Test D - Police and Drop Ingress on Engine 3

15th - 16th September 2003: Bedfont Lakes

Each test ran for a duration of 20 seconds.
Test E - WRED [2 x Engine 2 Input, 1 x Engine 2 Output]
Test F - WRED [2 x Engine 2 Input, 1 x Engine 3 Output]
Test G - PQ Policer [2 x Engine 2 Input, 1 x Engine 3 Output]
Test H - Aggressive PQ Policer [2 x Engine 2 Input, 1 x Engine 3 Output]

N.B. When loading a new test configuration into the traffic generator we must wait before starting the test. The traffic generator ports are shutdown then re-enabled, which causes the router ports to go down, then come back up. The traffic generator is ready to transmit traffic even before the router has cleared the POS alarms from the router ports. We must wait for the POS alarms to clear on the router ports before starting each test.

Test Results

Test	Description	Src Port	Dest. Port	Prec	Tx Rate[3] (Mb/s)	Rx Rate (Mb/s)	Tx (Frames)	Rx (Frames)	Lost (Frames)	Ave. Latency (uS)	Max Latency (uS)	Min Latency (uS)
A	**2 x Engine 2 Input, 1 x Engine 2 Output**	**1A**	**2A**	**All**	**2,000.00**		**300,000,000**					
	Config: Test-A.xml			7	0	0	0	0	0	0	0	0
	Results: Test-A-20mins.csv			6	60.00	60.00	9,000,000	9,000,000	0	927.81	1866.46	34.44
				5	100.00	100.00	15,000,000	15,000,000	0	80.55	90.62	37.54
				4	0	0	0	0	0	0	0	0
				3	100.00	100.00	15,000,000	15,000,000	0	926.21	1871.88	23.78
				2	0	0	0	0	0	0	0	0
				1	1720.00	907.27	258,000,000	136,094,074	121,905,926	928.00	1873.14	28.26
				0	20.00	20.00	3,000,000	3,000,000	0	924.46	1863.38	30.86
		1B	**2A**	**All**	**2,000.00**		**300,000,000**					
				7	0	0	0	0	0	0	0	0
				6	60.00	60.00	9,000,000	9,000,000	0	927.21	1866.44	31.70
				5	100.00	100.00	15,000,000	15,000,000	0	80.47	90.62	34.78
				4	0	0	0	0	0	0	0	0
				3	100.00	100.00	15,000,000	15,000,000	0	925.63	1867.48	20.52
				2	0	0	0	0	0	0	0	0
				1	1720.00	907.31	258,000,000	136,094,074	121,906,519	927.44	1872.22	25.02
				0	20.00	20.00	3,000,000	3,000,000	0	923.95	1861.00	28.10
		1A+1B	**2A**		**4,000.00**	**2,374.58**	**600,000,000**	**356,187,555**	**243,812,445**			

[3] Throughput readings taken whilst test was running

Test	Description	Src Port	Dest. Port	Prec	Tx Rate[3] (Mb/s)	Rx Rate (Mb/s)	Tx (Frames)	Rx (Frames)	Lost (Frames)	Ave. Latency (uS)	Max Latency (uS)	Min Latency (uS)
B	**2 x Engine 2 Input, 1 x Engine 3 Output**	**1A**	**2B**	**All**	**2,000.00**		**300,000,000**					
	Config: Test-B.xml			7	0	0	0	0	0	0	0	0
	Results: Test-B-20mins.csv			6	60.00	60.00	9,000,000	9,000,000	0	631.38	1281.70	28.38
				5	100.00	100.00	15,000,000	14,999,898	102	88.36	98.48	28.88
				4	0	0	0	0	0	0	0	0
				3	100.00	100.00	15,000,000	15,000,000	0	877.05	1862.78	38.54
				2	0	0	0	0	0	0	0	0
				1	1720.00	907.27	258,000,000	136,088,770	121,911,230	878.87	1866.22	42.14
				0	20.00	20.00	3,000,000	3,000,000	0	1172.29	5036.16	32.36
		1B	**2A**	**All**	**2,000.00**		**300,000,001**					
				7	0	0	0	0	0	0	0	0
				6	60.00	60.00	9,000,001	9,000,001	0	631.45	1280.60	25.10
				5	100.00	100.00	15,000,000	14,999,898	102	88.37	98.44	28.90
				4	0	0	0	0	0	0	0	0
				3	100.00	100.00	15,000,000	15,000,000	0	877.06	1859.34	35.80
				2	0	0	0	0	0	0	0	0
				1	1720.00	907.33	258,000,000	136,097.426	121,902,574	878.95	1866.96	37.34
				0	20.00	20.00	3,000,000	3,000,000	0	1172.68	5211.94	29.10
		1A+1B	**2A**		**4,000.00**	**2,372.60**	**600,000,001**	**356,185,993**	**243,814,008**			
C	**1 x Engine 3 input, 1 x Engine 2 input, 1 x Engine 2 Output**											
	Future Test											
D	**Police and Drop Ingress on Engine 3**											
	Future Test											

Test	Description	Src Port	Dest. Port	Prec	Tx Rate[3] (Mb/s)	Rx Rate (Mb/s)	Tx (Frames)	Rx (Frames)	Lost (Frames)	Ave. Latency (uS)	Max Latency (uS)	Min Latency (uS)

Test E - WRED [2 x Engine 2 Input, 1 x Engine 2 Output]
Load 1 - Results File = ucl-gsr-testE-69.csv. No congestion. As expected no packets in any class were dropped.
Load 2 - Results File = ucl-gsr-testE-79.csv. No congestion. As expected no packets in any class were dropped.
Load 3 - Results File = ucl-gsr-testE-89.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 4 - Results File = ucl-gsr-testE-99.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 5 - Results File = ucl-gsr-testE-109.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 6 - Results File = ucl-gsr-testE-179.csv. Congestion. As expected BE packets were dropped, no drops in any other class.

Test F - WRED [2 x Engine 2 Input, 1 x Engine 3 Output]
Load 1 - Results File = ucl-gsr-testF-69.csv. No congestion. As expected no packets in any class were dropped.
Load 2 - Results File = ucl-gsr-testF-79.csv. No congestion. As expected no packets in any class were dropped.
Load 3 - Results File = ucl-gsr-testF-89.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 4 - Results File = ucl-gsr-testF-99.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 5 - Results File = ucl-gsr-testF-109.csv. Congestion. As expected BE packets were dropped, no drops in any other class.
Load 6 - Results File = ucl-gsr-testF-179.csv. Congestion. As expected BE packets were dropped, no drops in any other class.

Test G - PQ Policer [2 x Engine 2 Input, 1 x Engine 3 Output]
Load 1 - Results File = ucl-gsr-testG-ef20.csv. Congestion. Voice traffic correctly policed, no packets in any other class were dropped.
Load 2 - Results File = ucl-gsr-testG-ef30.csv. Congestion. Voice traffic correctly policed, no packets in any other class were dropped.
Load 3 - Results File = ucl-gsr-testG-ef40.csv. Congestion. Voice traffic correctly policed, packets in other classes were dropped.[4]
Load 4 - Results File = ucl-gsr-testG-ef50.csv. Congestion. Voice traffic correctly policed, packets in other classes were dropped.

Test H - Aggressive PQ Policer [2 x Engine 2 Input, 1 x Engine 3 Output]
Now the PQ policer was made more aggressive, and changed from 10% of the interface bandwidth to 5% of the interface bandwidth.
The results of Test H were identical to those of Test G.

[4] Further ad-hoc testing showed that the scheduler started failing (shown by loss of traffic in the other classes), once the voice traffic reached 33% of the interface speed.

Conclusion

Conclusions from the 17th June Testing

The Cisco 12000 router under test, performed well in both Test A and Test B

In test A we saw no packet loss in any of the classes, except the expected loss in the BE class.

The overall throughput achieved (2,374.58Mbs) was 99% of the payload of an STM-16. [The HDLC headers added to the packets would not have been included in this throughput figure.] The throughput of each non-BE class was as exactly as requested.

The average latency, in any class did not even reach 1 ms. A latency of <1 ms, per multiple hops, will support even the most demanding application delay budget i.e. voice. The maximum latency experienced in the Premium queue was only 90.62us, a very low figure, well within the requirements of the most demanding mainstream applications around today.

In test B we only saw packet loss in the Premium Class and the BE class. The packet loss in the Premium class was unexpected. During the 20 minute test we lost 204 premium class packets. This is a very small percentage of the total premium class packets sent, around 6.8e-6 %. However we would expect to see no packet loss in the premium class. A further test running for 90 minutes showed a 9.3e-6 % premium class packet loss. It is possible that this packet loss is increasing over time, which would be a worrying trend. It is worth noting that in a real network a device would not be under this continuous overload for this length of time. Further investigation is required, although with such a low loss rate it may be hard to determine exactly what is causing the packet loss.

The overall throughput achieved (2,372.60Mbs) was 99% of the payload of an STM-16. The throughput of each non-BE class was as exactly as requested.

Again the latency figures were very good and no class had an average latency greater than 1.2ms. The maximum latency experienced in the Premium queue was only 98.48us.

In both Test A and Test B we expected to drop some LBE traffic as we were sending 40M and only allocating 24M (1%). But we did not drop any LBE. This could be caused by a rounding error or the minimum granularity supported by the queuing scheduler. Further testing showed it was possible to send up to 86M in the LBE class before any traffic was dropped. This is around 3.6% of the throughput of the link. Further investigation is required to determine the cause of this variation between configuration and observed performance.

Whist the tests were running both the "from fabric" and the "to fabric" queues were filling. We could observe this using the "exec slot n sh controllers tofab queue" and "exec slot n sh controllers frfab queue" commands. The queuing in the "from fabric" queues was not expected, as we had approximately the same bandwidth in to the queues - 2.5G (Switch fabric to "from fabric" queues) as out of the queues - 2.5G (fabric queues to Port). The switch fabric to "from fabric" queue bandwidth must be higher, for the from fabric queues to build.

Since all the "to fabric" queues share the same memory address space, it is possible for a single queue to consume all the memory available and cause all the other queues to fail. If the WRED profile for a traffic class is not aggressive enough, then the traffic in this single traffic class can affect all other classes. We saw this during our testing as we were refining our WRED profiles. **To properly isolate**

one traffic class from affecting another traffic class it is very important to apply a correct WRED profile to <u>every</u> traffic class.

The QoS configuration of the router was optimised to cope with a "packet blast" test. For operation on a production network carrying real traffic flows the routers congestion avoidance configuration should be softened. For example the WRED profile applied to the Best Effort Class was very aggressive and under a real network load would start discarding traffic too soon and too fast, to the detriment of the end hosts.

The configuration of the router, and the router IOS version, used during tests A and B, achieved a consistent and reliable QoS performance. It is recommended that this is the initial configuration and IOS version to be deployed in the MB-NG 12000 routers.

Conclusions from the 16th September Testing

In Test E our WRED profile, applied to an Engine 2 card, performed very well. Under conditions of no congestion (89-99% load), as expected we dropped no packets. Under congestion (101-199% load) as expected, we only ever dropped packets in the BE class. *From this we can conclude that frfabric WRED on the Engine 2 linecard works very well, even under the extreme condition of having the interface continuously under a 199% load.* A situation that should not occur on a well implemented network.

Test F had very similar results to Test E. *From this we can conclude that frfabric WRED on the Engine 3 linecard also works very well.*

Test G demonstrated that *the policer applied to the PQ performs well under all PQ traffic volumes delivered to it*. Even when we were oversubscribing the policer 5x, policing the PQ to 10% of line rate and delivering 50% of PQ traffic, the policer performed perfectly.

Test G also demonstrated that the scheduler started to fail when the % of PQ traffic exceeded 33% of the link. This is not entirely unexpected as servicing the PQ is a very intensive task for the scheduler. The current Cisco best practise is to not have a PQ allocated > 30% of any link. In addition to the extra demands placed on the scheduler of having a large % allocation to the PQ, the advantages of having a PQ diminish the greater the % allocation given. In the extreme case, the closer we get to allocating 100% of the interface to the PQ, the closer we get to returning to a simple FIFO queuing mechanism, where we have very little control over QoS characteristics.

Test H was designed to see if allowing the PQ policer to be more aggressive, would allow the scheduler to reach a higher PQ traffic load before failing. The results of Test H were very similar to the results of Test G. *This shows that there is no benefit to the scheduler in using a more aggressive PQ policer.*

The configuration of the router, and the router IOS version, used during tests E - H, achieved a consistent and reliable QoS performance. It is recommended that the WRED configuration is used on the MB-NG 12000 routers. These tests also showed that IOS 12.0(26)S does not seem to suffer from any QoS regression bugs, introduced since IOS 12.0(21)S7 [The version we previously used in Tests A and B]. *We can safely upgrade the MB-NG to IOS 12.0(26)S if features demand.*

Appendix 1 - Useful show commands

```
! Overview of cos
sh cos

! tofab queuing
exec slot 15 sh controllers tofab queue
exec slot 15 sh controllers tofab queue 10

! frfab queuing (engine 2 and engine 3)
exec slot 15 sh controllers frfab queue

! WRED frfab
sh int pos 10/0 random-detect

! Input / Output tx / rx drops
sh int pos 10/0

! to view the from fab queues for pos 10/0
Mick16-5#execute-on slot 10 show controller frfab queue 0
========= Line Card (Slot 10) =========

FrFab Queue
Interface 0
DRR#    Head    Tail    Length  Average         Weight  Deficit
0       208023  208976  2            0.000      4608    0
1       210637  214441  5302      5279.000      36352   16368
2       0       0       0            0.000      9216    0
3       0       0       0            0.000      9216    0
4       0       0       0            0.000      9216    0
5       0       0       0            0.000      9216    0
6       0       0       0            0.000      9216    0
7       217824  234441  0            0.000      9216    0

! to view the to fab queues for pos 15/0
Mick16-5#execute-on slot 15 show controller tofab queue 0
========= Line Card (Slot 15) =========

ToFab Queue
Slot 0 Int 0
DRR#    Head    Tail    Length  Average         Weight  Deficit
0       0       0       0            0.000      4608    0
1       0       0       0            0.000      36352   0
2       0       0       0            0.000      9216    0
3       0       0       0            0.000      9216    0
4       0       0       0            0.000      9216    0
5       0       0       0            0.000      9216    0
6       0       0       0            0.000      9216    0
7       0       0       0            0.000      9216    0
```

Appendix 2 - Router configurations

Final Running Config - 17th June

```
Mick16-5#sh run
Building configuration...

Current configuration : 5976 bytes
!
version 12.0
no service pad
service timestamps debug datetime msec
service timestamps log uptime
service password-encryption
!
hostname Mick16-5
!
boot system flash slot1:gsr-p-mz.120-21.S7.bin
enable secret 5 $1$NB0s$DVgesRDik8vDDxSAb1cA9/
!
username guest privilege 15 password 7 030752180500
!
hw-module slot 11 shutdown
hw-module slot 13 shutdown
!
!
hw-module slot 12 srp
!
!
!
!
ip subnet-zero
no ip domain-lookup
!
class-map match-any queue-0
  match ip precedence 6
  match ip precedence 7
class-map match-any queue-1
  match ip precedence 5
class-map match-any queue-2
  match ip precedence 4
  match ip precedence 3
  match ip precedence 2
  match ip precedence 1
class-map match-any queue-3
  match ip precedence 0
!
!
policy-map nicktemp
```

```
policy-map e3-stm16-qos
  class queue-0
 bandwidth percent 5
 random-detect
 random-detect precedence 6 2000 2001 1
 random-detect precedence 7 2000 2001 1
  class queue-1
 priority
     police 200000000 2000 2000 conform-action transmit exceed-action
drop
  class queue-2
 bandwidth percent 84
 random-detect
 random-detect precedence 1 1 2 1
 random-detect precedence 2 2000 2001 1
 random-detect precedence 3 2000 2001 1
 random-detect precedence 4 2000 2001 1
  class queue-3
 bandwidth percent 1
 random-detect
 random-detect precedence 0 2000 2001 1
!
!
controller SYSCLOCK 3
!
controller SONET 6/0
 clock source line
 framing sonet
 !
 sts-1 1
  mode ct3
 !
 sts-1 2
  mode ct3
 !
 sts-1 3
  mode ct3
!
controller SONET 6/1
 clock source line
 framing sonet
 !
 sts-1 1
  mode ct3
 !
 sts-1 2
  mode ct3
 !
 sts-1 3
  mode ct3
!
!
interface Loopback0
 ip address 223.2.5.1 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
```

```
interface POS0/0
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS0/1
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS0/2
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS0/3
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS1/0
 description OC-192 Noam pos 1/0
 ip address 223.45.1.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
!
interface POS3/0
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS3/1
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS3/2
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS3/3
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
```

```
interface POS5/0
 description OC-12 Noam pos 5/0
 ip address 223.45.5.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/1
 description OC-12 Noam pos 5/1
 ip address 223.45.5.3 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/2
 description OC-12 Noam pos 5/2
 ip address 223.45.5.5 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/3
 description OC-12 Noam pos 5/3
 ip address 223.45.5.7 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/0
 description OC-3 Noam pos 7/0
 ip address 223.45.7.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/1
 description OC-3 Noam pos 7/1
 ip address 223.45.7.3 255.255.255.254
```

```
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/2
 description OC-3 Noam pos 7/2
 ip address 223.45.7.5 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/3
 description OC-3 Noam pos 7/3
 ip address 223.45.7.7 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS8/0
 ip address 223.1.8.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 service-policy output e3-stm16-qos
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
 no cdp enable
!
interface POS10/0
 description OC-48 Till pos 1/3
 ip address 223.1.10.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 tx-queue-limit 1000
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
 tx-cos stm16-qos
!
interface SRP12/0
 no ip address
 no ip directed-broadcast
 shutdown
!
```

```
interface POS14/0
 ip address 223.1.14.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS15/0
 ip address 223.1.15.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
 tx-cos stm16-qos
!
interface Ethernet0
 ip address 10.52.204.144 255.255.255.224
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
ip classless
ip route 50.0.0.0 255.255.255.0 223.1.10.2
ip route 51.0.0.0 255.255.255.0 223.1.8.2
ip route 52.0.0.0 255.255.255.0 223.1.15.2
!
rx-cos-slot 8 rx-table
rx-cos-slot 14 rx-table
rx-cos-slot 15 rx-table
!
slot-table-cos rx-table
 destination-slot all stm16-qos
!
cos-queue-group stm16-qos
 precedence 0 random-detect-label 2
 precedence 1 random-detect-label 1
 precedence 2 random-detect-label 2
 precedence 3 random-detect-label 2
 precedence 4 random-detect-label 2
 precedence 5 queue low-latency
 precedence 5 random-detect-label 2
 precedence 6 random-detect-label 2
 precedence 7 random-detect-label 2
 random-detect-label 1 1 2 1
 random-detect-label 2 2000 2001 1
 queue 0 37
 queue 2 748
 queue 3 1
 queue low-latency strict-priority
!
!
line con 0
 exec-timeout 0 0
 login local
```

```
line aux 0
line vty 0 4
 login local
```

Final Running Config - 16th September

```
Mick16-5#sh run
Building configuration...

Current configuration : 6491 bytes
!
version 12.0
no service pad
service timestamps debug datetime msec
service timestamps log uptime
service password-encryption
!
hostname Mick16-5
!
boot-start-marker
boot-end-marker
!
redundancy
 mode rpr
enable secret 5 $1$NB0s$DVgesRDik8vDDxSAb1cA9/
!
username guest privilege 15 password 7 030752180500
username ucl secret 5 $1$g7K8$Q1zFkD4Gl.A3iHur9FHlU.
!
hw-module slot 11 shutdown
hw-module slot 13 shutdown
!
!
hw-module slot 12 srp
!
!
!
!
ip subnet-zero
no ip domain-lookup
!
class-map match-all BE
  match ip precedence 1
class-map match-all LBE
  match ip precedence 0
class-map match-all stm16
class-map match-all voice
  description Voice traffic
  match ip precedence 5
!
!
policy-map stm16
  class BE
    bandwidth 1965520
    random-detect
    random-detect precedence 1 2000 packets 20000 packets 1
```

```
  class LBE
    bandwidth 248000
    random-detect
    random-detect precedence 0 2000 packets 20000 packets 1
  class voice
    priority
     police cir 249984000 bc 4470 be 4470 conform-action transmit
exceed-action
 drop
!
!
controller SYSCLOCK 3
!
controller SONET 6/0
 clock source line
 ais-shut
 framing sonet
 !
 sts-1 1
  overhead j1 message Router6/0/1
  mode ct3
 !
 sts-1 2
  overhead j1 message Router6/0/2
  mode ct3
 !
 sts-1 3
  overhead j1 message Router6/0/3
  mode ct3
!
controller SONET 6/1
 clock source line
 ais-shut
 framing sonet
 !
 sts-1 1
  overhead j1 message Router6/1/1
  mode ct3
 !
 sts-1 2
  overhead j1 message Router6/1/2
  mode ct3
 !
 sts-1 3
  overhead j1 message Router6/1/3
  mode ct3
!
!
interface Loopback0
 ip address 223.2.5.1 255.255.255.255
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
interface POS0/0
 no ip address
 no ip directed-broadcast
 shutdown
```

```
 crc 32
!
interface POS0/1
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS0/2
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS0/3
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS1/0
 description OC-192 Noam pos 1/0
 ip address 223.45.1.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
!
interface GigabitEthernet2/2/0
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet2/2/1
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet2/2/2
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet2/3/0
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface POS3/0
 no ip address
 no ip directed-broadcast
 shutdown
```

```
 crc 32
!
interface POS3/1
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS3/2
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface POS3/3
 no ip address
 no ip directed-broadcast
 shutdown
 crc 32
!
interface GigabitEthernet4/0
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet4/1
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet4/2
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface GigabitEthernet4/3
 no ip address
 no ip directed-broadcast
 shutdown
 negotiation auto
!
interface POS5/0
 description OC-12 Noam pos 5/0
 ip address 223.45.5.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/1
 description OC-12 Noam pos 5/1
 ip address 223.45.5.3 255.255.255.254
```

```
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/2
 description OC-12 Noam pos 5/2
 ip address 223.45.5.5 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS5/3
 description OC-12 Noam pos 5/3
 ip address 223.45.5.7 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/0
 description OC-3 Noam pos 7/0
 ip address 223.45.7.1 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/1
 description OC-3 Noam pos 7/1
 ip address 223.45.7.3 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/2
 description OC-3 Noam pos 7/2
 ip address 223.45.7.5 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
```

```
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS7/3
 description OC-3 Noam pos 7/3
 ip address 223.45.7.7 255.255.255.254
 no ip directed-broadcast
 no keepalive
 shutdown
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS8/0
 ip address 223.1.8.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
 no cdp enable
 service-policy output stm16
!
interface POS10/0
 description OC-48 Till pos 1/3
 ip address 223.1.10.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 tx-queue-limit 1000
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
 tx-cos stm16e2
!
interface SRP12/0
 no ip address
 no ip directed-broadcast
 shutdown
!
interface POS14/0
 ip address 223.1.14.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 crc 32
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface POS15/0
 ip address 223.1.15.1 255.255.255.0
 no ip directed-broadcast
 no keepalive
 crc 32
```

```
 clock source internal
 pos ais-shut
 pos scramble-atm
!
interface Ethernet0
 ip address 10.52.204.144 255.255.255.224
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
!
ip classless
ip route 50.0.0.0 255.255.255.0 223.1.10.2
ip route 51.0.0.0 255.255.255.0 223.1.8.2
ip route 52.0.0.0 255.255.255.0 223.1.15.2
!
!
!
rx-cos-slot 14 rx-table-e2
rx-cos-slot 15 rx-table-e2
!
slot-table-cos rx-table
!
slot-table-cos rx-table-e2
 destination-slot all stm16e2
!
cos-queue-group stm16e2
 precedence 0 random-detect-label 1
 precedence 1 queue 1
 precedence 1 random-detect-label 1
 precedence 5 queue low-latency
 random-detect-label 1 2000 20000 1
 queue 0 1
 queue 1 63
 queue low-latency strict-priority
!
!
!
line con 0
 exec-timeout 0 0
 login local
line aux 0
line vty 0 4
 login local
!
end
```