Cambium Networks™

Medusa Flood Test

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1 INTRODUCTION

This document describes the flood test implemented in the Medusa AP.

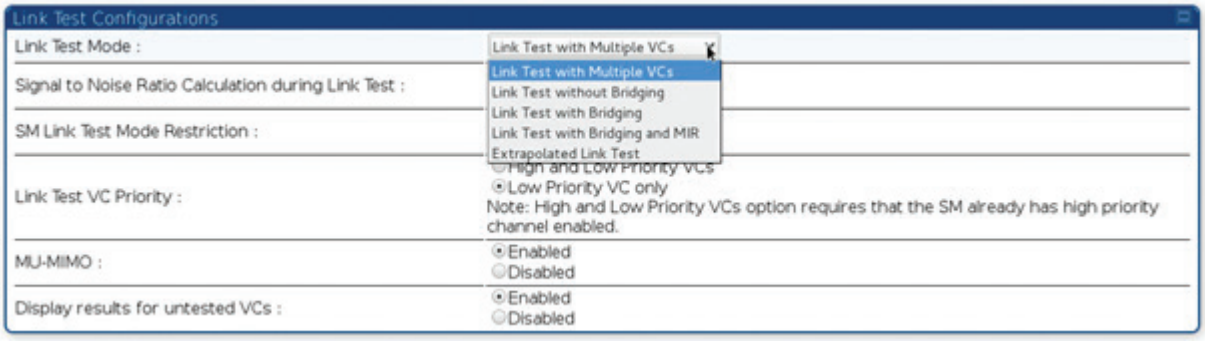


FIGURE 1 - LINK TEST MODE OPTIONS

2 LINK TEST AND FLOOD TEST

LINK TEST MODE OPTIONS	CORRESPONDING MODELS	COMMENTS
Link Test with Multiple VCs	PMP 450m	Also called Flood Test.
Link Test without Bridging	PMP 450, PMP 450i, PMP 450m	Only link tests to one VC are supported. Software link test task has higher priority than the bridge (see below).
Link Test with Bridging	PMP 450, PMP 450i, PMP 450m	Only link tests to one VC are supported. Software link test task has higher priority than the bridge (see below).
Link Test with Bridging and MIR	PMP 450, PMP 450i, PMP 450m	Only link tests to one VC are supported. Software link test task has higher priority than the bridge (see below).
Extrapolated Link Test	PMP 450, PMP 450i, PMP 450m	Only link tests to one VC are supported.

TABLE 1 - LINK TEST MODE OPTIONS

In the PMP 450/450i/450m AP, the link/flood test option is under Tools → Link Capacity Test.

The Link Test Mode supports the options listed in Table 1.

In the link tests with and without bridging, the link test task in software has higher priority than the bridge, which means that the traffic coming into the bridge will not be transferred to the MAC queues. Only the link test traffic to the designated VC (Virtual Circuit) is added to the MAC queue, and it is the only traffic going over the RF link. Note that if there was traffic in the MAC queue prior to the start of the link test, that data will be scheduled first. After that data is transferred, only link test data is sent over the link for the duration of the link test.

In the Link Test with Bridging and MIR, once the MIR (Maximum Information Rate) is met for the VC, user traffic is also sent over the link.

In the Extrapolated Link Test, 64 packets are transmitted to the VC, and the corresponding performance extrapolated to determine the expected throughput that would have been achieved if the queue were completely full. The transmission of these packets does not interrupt the transmission of user traffic.

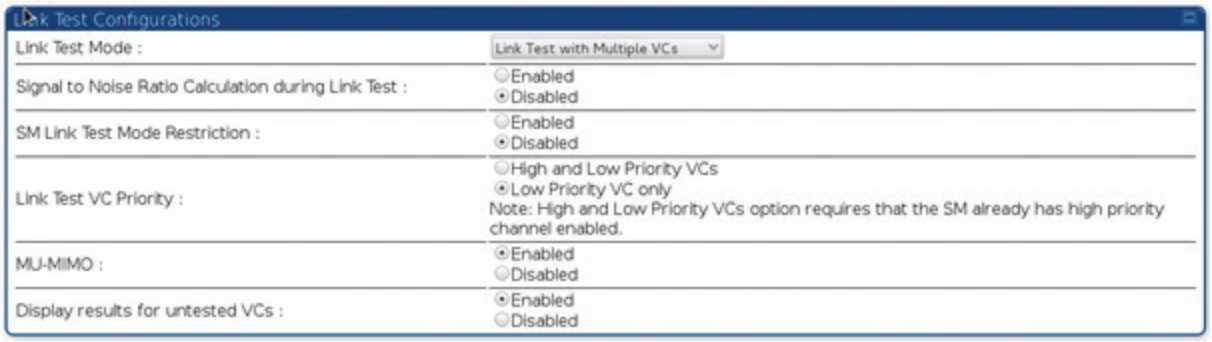


FIGURE 2 - LINK TEST CONFIGURATION PARAMETERS

The four link test options behave the same way in PMP 450, PMP 450i and in PMP 450m.

Important configuration parameters for the flood test are:

- **Link Test VC priority:** Options are High and Low Priority VCs or Low Priority VC only
  Note that if the High and Low Priority VCs option is selected, all queues all filled, but the high priority VCs will be scheduled first. Because those queues are filled, the scheduler never reaches the queues of the low priority VCs, unless CIR is configured for the low priority VCs. Also, high priority VCs are not scheduled in MU-MIMO mode, which means that no grouping is possible for these VCs.

  To test the MU-MIMO functionality, select Low Priority VC only.

- **MU-MIMO:** Options are Enabled or Disabled. If MU-MIMO is disabled, the AP communicates to each VC in sector mode with no grouping; if MU-MIMO is enabled, the AP will attempt to group the VCs according to their spatial frequency.

- **Display results for untested VCs:** Options are Enabled or Disabled
  In case the flood test involves a subset of the VCs registered in the sector, enabling this option adds the display of the traffic directed to the VCs that are not involved in the flood test.

3 HOW THE FLOOD TEST WORKS

In the PMP 450m AP, the packets flow through two queues: the VC queue, and the MAC queue. The VC queue is filled by the bridge, the MAC queues is emptied when data is scheduled and acknowledged.

During the flood test duration, the MAC queue is refilled once per TDD (Time Division Multiplex) cycle. Any space available in the queue is filled first with any packets in the VC queue, and, if there is still room, with flood test packets.

Figure 3 shows how the MAC queues are filled during the flood test.

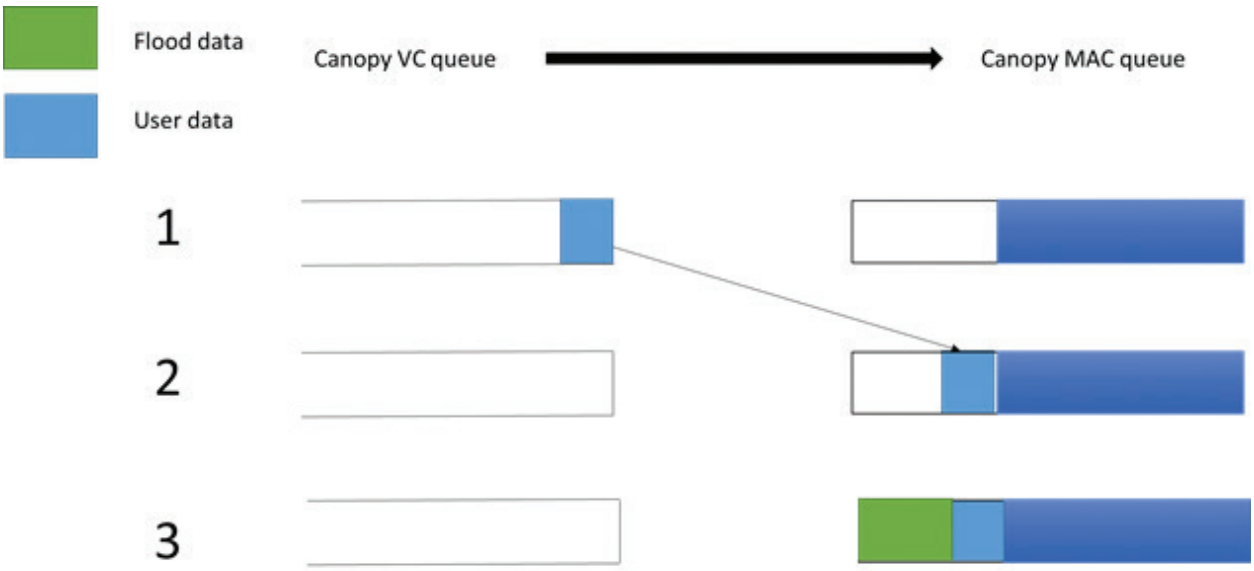


FIGURE 3 - VC AND MAC QUEUES DURING FLOOD TEST

Figure 3 shows the status of the VC queue to the left and the MAC queue to the right.

In step 1, the MAC queue is partially filled, but it also has some free space. Every time packets are sent and an acknowledgement has been received, the packets are removed from the queue.

The VC queue has some user data.

In step 2, user data is transferred (by pointer only) from the VC queue to the MAC VC queue. These packets could potentially fill the whole MAC VC queue.

In step 3, any space still left in the MAC queue is filled with flood test packets.

Note that these steps are repeated in every TDD cycle.

4 DATA TRANSFER DURING FLOOD TEST

The transfer of user data is more or less affected during the flood test, depending on the amount of traffic generated.

- **Case 1:** The VC queue is empty

  In this case, the MAC queue is completely filled with flood test packets.

- **Case 2:** User traffic generated at low rate (e.g. ping)

  In this case, user data is transferred to the MAC queue when available, and the remaining portion of the queue is repeatedly filled with flood test packets.

- **Case 3:** VC queues are full

  User data is transferred to the MAC queues, and there is no space left for additional flood test packets. No flood test traffic goes over the link.

Figure 4 shows these cases, where the green section of the queue represents flood test packets and the blue section of the queue represents user data.

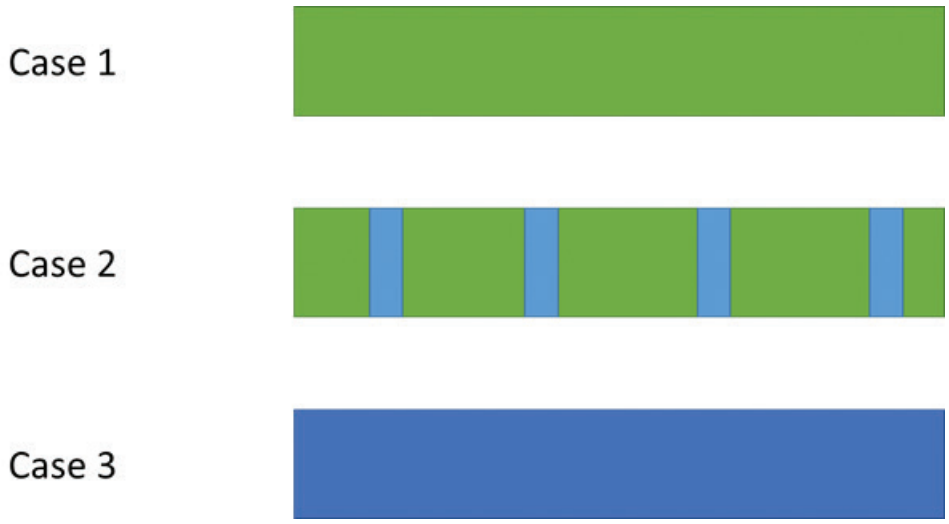


FIGURE 4 - EXAMPLES OF DATA TRANSFER DURING FLOOD TEST

5 FLOOD TEST SETUP

The setup used to collect data for the following tests has one PMP 450m AP connected to seven PMP 450 SMs. The location of the SMs has been selected so that their spatial frequency is sufficiently separated that in MU-MIMO mode they can be grouped into a single group of seven VCs.

Each SM is configured with a high priority (HP) and a low priority (LP) VCs. No CIR or MIR is configured for any of the VCs.

6.1 TEST 1: FLOOD TEST TO 7 LP VCS WITH MU-MIMO DISABLED

In this test, the MU-MIMO feature is disabled. This means that the AP communicates in sector mode with all VCs, and the VCs are not grouped.

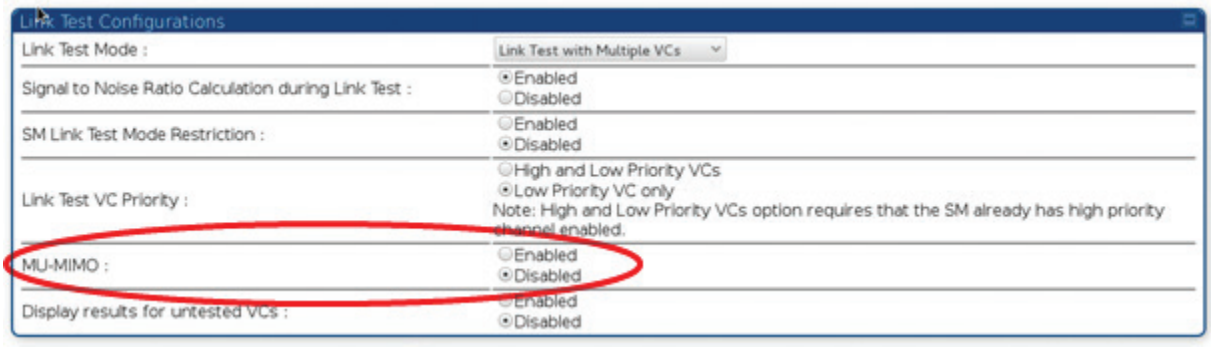


FIGURE 5 - TEST 1 CONFIGURATION

VC	Throughput	Efficiency	Fragments		Downlink Rate
			Transmit	Received	SU-MIMO
Total VCs	**93.54 Mbps**	**99%**	**1827947**	**1826984**	
19 (Low Priority)	13.26 Mbps	99%	259210	259155	8X/8X MIMO-B
21 (Low Priority)	13.31 Mbps	99%	260342	260072	8X/8X MIMO-B
22 (Low Priority)	13.56 Mbps	99%	265056	264920	8X/8X MIMO-B
28 (Low Priority)	13.34 Mbps	99%	260707	260572	8X/8X MIMO-B
30 (Low Priority)	13.19 Mbps	99%	257780	257661	8X/8X MIMO-B
37 (Low Priority)	13.31 Mbps	99%	260164	259976	8X/8X MIMO-B
38 (Low Priority)	13.54 Mbps	99%	264688	264628	8X/8X MIMO-B

FIGURE 6 - TEST 1 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	100.0	57
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0

FIGURE 7 - TEST 1 SLOT GROUPING

All SMs can communicate in the DL at 8x modulation, as shown in the results table in the SU-MIMO (single user MIMO) column. The AP is configured with 57 DL slots, which makes the maximum DL throughput around 93 Mbps.

The results table shows that the available throughput is evenly divided among the seven users, with about 13 Mbps each.

The slot grouping table shows the percentage of symbols used for each size group. As in this case no MU-MIMO grouping occurs, 100% of symbols are used with groups of size 1.

6.2 TEST 2: FLOOD TEST TO 7 LP VCS + 7 HP VCS WITH MU-MIMO DISABLED

In this test, the flood test is repeated selecting the Link Test VC priority option as High and Low priority VCs. Because HP VCs have their queues full, the scheduler always schedules HP VCs, and never schedules LP VCs. The available throughput is now evenly divided among the seven HP VCs, while the LP VCs do not receive any traffic.

MU-MIMO grouping is again disabled here, but the HP VCs cannot be grouped anyway. The slot grouping table shows again 100% of groups with size 1.

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate
			Transmit	Received	SU-MIMO
Total VCs	**94.89 Mbps**	**99%**	**370840**	**370679**	
245 (High Priority)	13.64 Mbps	99%	53296	53282	8X/8X MIMO-B
246 (High Priority)	13.52 Mbps	99%	53312	52829	8X/8X MIMO-B
247 (High Priority)	13.51 Mbps	99%	52840	52809	8X/8X MIMO-B
249 (High Priority)	13.51 Mbps	99%	52856	52803	8X/8X MIMO-B
252 (High Priority)	13.52 Mbps	99%	52832	52819	8X/8X MIMO-B
253 (High Priority)	13.63 Mbps	100%	52840	53277	8X/8X MIMO-B
255 (High Priority)	13.53 Mbps	99%	52864	52860	8X/8X MIMO-B
18 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
20 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
23 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
28 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
33 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
37 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B
38 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B

FIGURE 8 - TEST 2 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	100.0	57
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0

FIGURE 9 - TEST 2 SLOT GROUPING

6.3 TEST 3: FLOOD TEST TO 7 LP VCS WITH NO USER TRAFFIC

In this test, the MU-MIMO option is enabled. The flood test runs with seven LP VCs, when no user traffic is present on the link.

Because the spatial frequency of the SMs allows it, the seven SMs are grouped into one single group of seven 100% of the time, as shown in the slot grouping table.

In MU-MIMO mode the seven SMs communicate in 6x mode, not in 8x mode, as they did in SU-MIMO mode. The reason is that the residual noise in the grouping calculation reduces the SNR and does not allow the link to sustain 8x modulation.

The throughput of each SM is now 13.3/(8/6)x7 = 70 Mbps. The 8/6 factor accounts for the change in modulation, from 8x to 6x, and the factor of 7 accounts for the fact all groups always have seven VCs. The total throughput is now 497 Mbps, 5.3 times higher than the SU-MIMO case.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.87 Mbps**	**99%**	**9733458**	**9724087**			
19 (Low Priority)	71.12 Mbps	99%	1390476	1389086	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	71.15 Mbps	99%	1390594	1389757	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	71.04 Mbps	99%	1390478	1387556	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	71.14 Mbps	99%	1390478	1389546	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	71.13 Mbps	99%	1390476	1389436	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	71.13 Mbps	99%	1390478	1389381	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	71.13 Mbps	99%	1390478	1389325	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 10 - TEST 3 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 11 - TEST 3 SLOT GROUPING

6.4 TEST 4: FLOOD TEST TO 7 LP VCS + 7 HP VCS WITH NO USER TRAFFIC

In this test, the Link Test VC Priority option is selected as High and Low Priority VCs. All 14 queues are filled, but the scheduler always schedules HP VCs, as long as they have data to send. This results in the seven HP VCs dividing the available resources, and the LP VCs never being scheduled.

Even if the MU-MIMO option is enabled, because only HP data is scheduled, and HP VCs cannot be grouped, the grouping table shows 100% of the groups is a size of 1.

Current Results Status

Test Duration: 2 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**94.88 Mbps**	**99%**	**370808**	**370664**			
245 (High Priority)	13.51 Mbps	99%	52824	52812	8X/8X MIMO-B	8X/1X MIMO-A	0%
246 (High Priority)	13.52 Mbps	99%	52832	52815	8X/8X MIMO-B	8X/1X MIMO-A	0%
247 (High Priority)	13.52 Mbps	99%	52848	52817	8X/8X MIMO-B	8X/1X MIMO-A	0%
249 (High Priority)	13.52 Mbps	99%	53312	52838	8X/8X MIMO-B	8X/1X MIMO-A	0%
252 (High Priority)	13.64 Mbps	99%	53312	53297	8X/8X MIMO-B	8X/1X MIMO-A	0%
253 (High Priority)	13.64 Mbps	100%	52832	53287	8X/8X MIMO-B	8X/1X MIMO-A	0%
255 (High Priority)	13.51 Mbps	99%	52848	52798	8X/8X MIMO-B	8X/1X MIMO-A	0%
18 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
20 (Low Priority)	0 bps	0%	0	0	8X/4X MIMO-B	8X/2X MIMO-B	0%
23 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
28 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
33 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
37 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/4X MIMO-B	0%
38 (Low Priority)	0 bps	0%	0	0	8X/4X MIMO-B	8X/4X MIMO-B	0%

FIGURE 12 - TEST 4 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	100.0	57
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0

FIGURE 13 - TEST 4 SLOT GROUPING

6.5 TEST 5: FLOOD TEST TO 7 LP VCS WITH 10 MBPS USER TRAFFIC TO 7 LP VCS

In this test, the flood test is run to the seven LP VCs, but now all seven VCs have user traffic on the link. Each VC is configured with a 10 Mbps constant stream in the downlink direction.

As explained above, the queues for each VC are first filled with user traffic, and then with flood traffic. Each VC is still receiving about 71 Mbps of traffic, out of which 10 Mbps are user traffic and 61 Mbps are flood traffic. The results table does not differentiate between the two types of traffic; it combines them into the total traffic directed to each VC.

Because the queues are always full, the seven VCs are grouped into one group of size 7 100% of the time.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.87 Mbps**	**99%**	**9733458**	**9724087**			
19 (Low Priority)	71.12 Mbps	99%	1390476	1389086	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	71.15 Mbps	99%	1390594	1389757	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	71.04 Mbps	99%	1390478	1387556	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	71.14 Mbps	99%	1390478	1389546	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	71.13 Mbps	99%	1390476	1389436	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	71.13 Mbps	99%	1390478	1389381	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	71.13 Mbps	99%	1390478	1389325	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 14 - TEST 5 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 15 - TEST 5 SLOT GROUPING

Not shown here is the case in which the Link Test VC Priority option is selected as High and Low Priority VCs. In this case, the HP VCs have full queues, and the scheduler will always schedule them, even if the HP queues are filled with flood traffic only, while the LP queues are filled party with user traffic and party with flood traffic. The VC priority takes precedence, and the low priority user traffic is not scheduled during the flood test.

6.6 TEST 6: FLOOD TEST TO 4 LP VCS WITH 10 MBPS USER TRAFFIC TO 7 LP VCS

In this test, the 10 Mbps of user traffic to each of the seven LP VCs is not changed. The only difference is that now only four of the seven VCs are included in the flood test.

In order to select a subset of VCs for a flood test, the VC numbers can be listed in the VC list field in the Link Test Settings section.

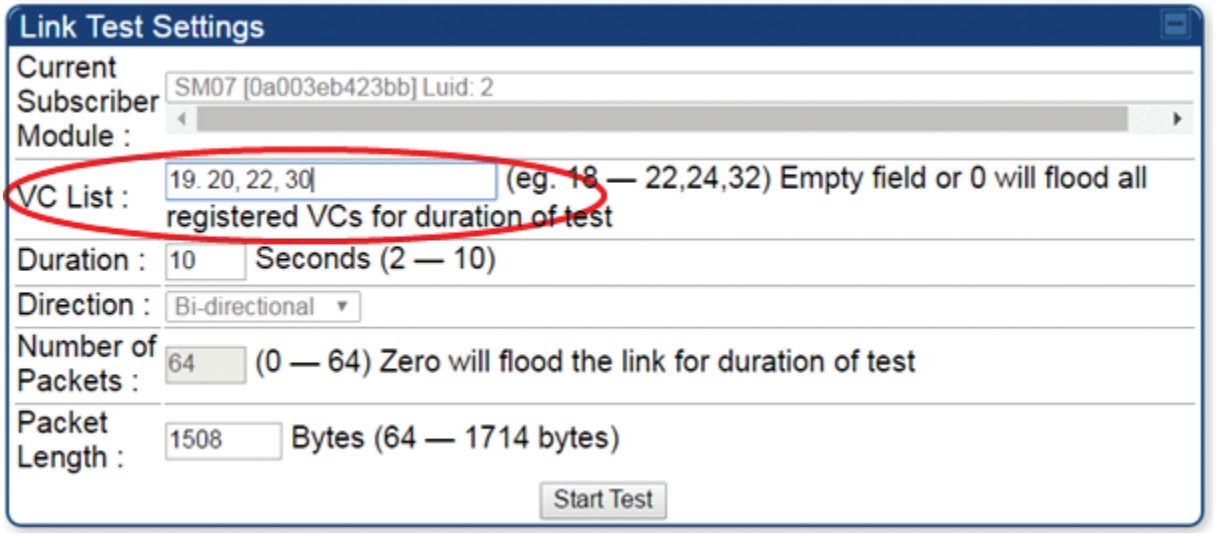


FIGURE 16 - TEST 6 VC LIST SETTINGS

Also, because not all registered VCs are included in the flood test, the Display results for untested VCs in the Link Test Configuration section should be enabled. This allows to display user traffic directed to VCs that are not included in the flood test.

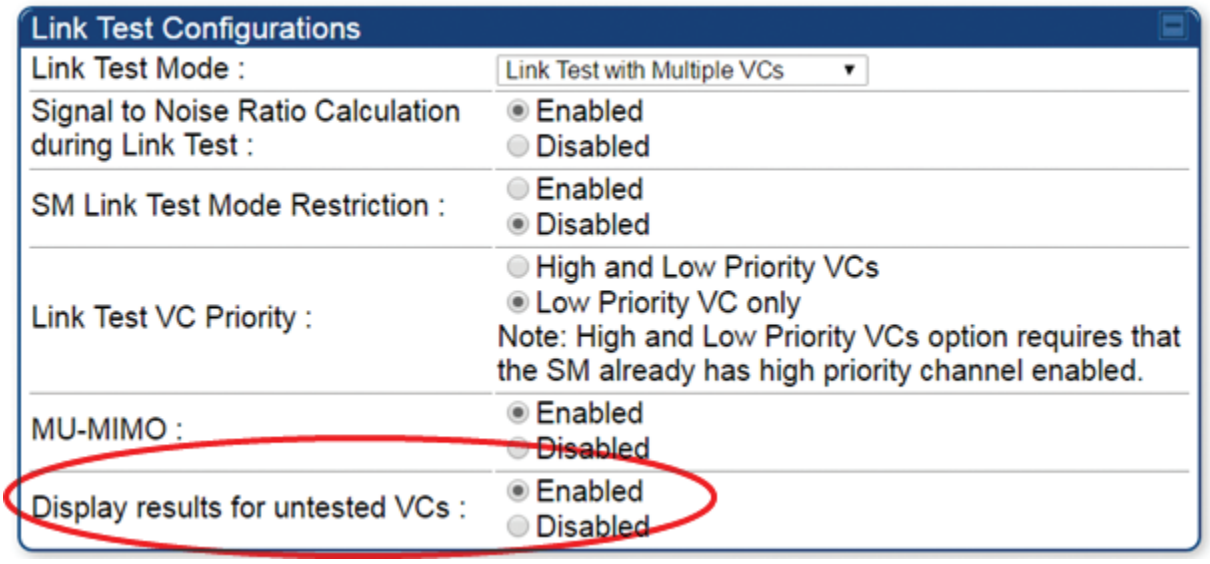


FIGURE 17 - TEST 6 ENABLING DISPLAY RESULTS FOR UNTESTED VCS

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**284.47 Mbps**	**99%**	**5561928**	**5556160**			
19 (Low Priority)	71.13 Mbps	99%	1390540	1389260	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	71.14 Mbps	99%	1390540	1389613	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	71.06 Mbps	99%	1390424	1387933	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	71.13 Mbps	99%	1390424	1389354	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 18 - TEST 6 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

Aggregate Throughput: 314.83 Mbps

Unicast traffic to untested VCs

VC	Throughput
Total VCs	**30.35 Mbps**
28 (Low Priority)	10.11 Mbps
37 (Low Priority)	10.11 Mbps
38 (Low Priority)	10.11 Mbps

FIGURE 19 - TEST 6 SLOT GROUPING AND TRAFFIC TO UNTESTED VCS

The Unicast traffic to untested VCs table shows that the three VCs that are not used in the flood test have a throughput of 10 Mbps, as expected, as this is the user traffic for these VCs.

The other four VCs, the ones used in the flood test, are always grouped and have a throughput of 71 Mbps. This is 10 Mbps of user traffic plus 61 Mbps of flood traffic.

One interesting observation is that the scheduler schedules a group of size 7 100% of the time, as shown in the Slot Grouping table. This may seem counter-intuitive, as four VCs carry 71 Mbps of traffic while three VCs carry 10 Mbps of traffic, and all are grouped all the time. The reason is that, even if the queues of the three VCs not used in the flood test are not completely full all the time, they are never completely empty when the scheduler runs at the beginning of every frame. Having any data in the queue makes the VC eligible for grouping, and because the spatial frequency allows it, they will be grouped with the others. During the transmission of the group, the four VCs used in the flood test will have more data to send than the other three VCs, whose queues empty faster. For those three VCs, the data in the group is repeated to fill the size of the allocation. This means that the seven VCs receive data all the time, but the four VCs in the flood test receive some user data and some flood data, while the other three VCs receive user data only, repeated a number of times to completely fill the DL.

The total aggregate throughput for the time the flood test runs is 314 Mbps.

The four VCs used in the flood test have a throughput of 4x71 Mbps = 284 Mbps, plus the three other VCs have a 10 Mbps of user traffic each: 284 + 3x10 = 314 Mbps.

6.7 TEST 7: FLOOD TEST TO 4 LP VCS WITH 2 MBPS USER TRAFFIC TO 7 LP VCS

The previous test is now repeated, with the only difference of sending 2 Mbps of user traffic to each of the LP VCs, instead of 10 Mbps.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**281.47 Mbps**	**99%**	**5500668**	**5497509**			
19 (Low Priority)	70.36 Mbps	99%	1375142	1374379	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	70.37 Mbps	99%	1375142	1374472	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	70.35 Mbps	99%	1375130	1374139	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	70.37 Mbps	99%	1375254	1374519	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 20 - TEST 7 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	29.1	16
5	32.7	18
6	25.5	14
7	12.7	7

Aggregate Throughput: 287.55 Mbps

Unicast traffic to untested VCs

VC	Throughput
Total VCs	**6.08 Mbps**
22 (Low Priority)	2.03 Mbps
28 (Low Priority)	2.02 Mbps
30 (Low Priority)	2.02 Mbps

FIGURE 21 - TEST 7 SLOT GROUPING AND TRAFFIC TO UNTESTED VCS

The four VCs in the flood test have a similar throughput as in the previous case, around 70 Mbps. Now this throughput comes from 2 Mbps of user traffic and 68 Mbps of flood traffic.

The other three VCs have a user traffic of 2 Mbps each; the total traffic on the link is now 70x4 + 2x3 = 286 Mbps.

One difference between this case and the previous one is in the grouping distribution. Because the three VCs not used in the flood test have less traffic than before, there are times when their queues are completely empty. In this cases, they are not used for grouping, and the group size will be less than 7.

The Slot Grouping table shows that the group size is at least 4 all the time, because the 4 VCs in the flood test always have data. Depending on which of the other VCs have data at a specific time, the group can grow to 5, 6 or 7 VCs.

6.8 TEST 8: FLOOD TEST TO 7 LP VCS WITH 90 MBPS USER TRAFFIC TO 1 HP VC

In this test, user traffic is sent to one HP VC only, in the amount of 90 Mbps. All seven LP VCs are included in the flood test.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**19.68 Mbps**	**99%**	**384936**	**384442**			
19 (Low Priority)	2.81 Mbps	99%	55002	54913	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	2.81 Mbps	99%	55054	54972	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	2.80 Mbps	99%	54956	54837	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	2.81 Mbps	99%	54990	54938	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	2.81 Mbps	99%	54976	54932	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	2.81 Mbps	99%	54966	54920	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	2.81 Mbps	99%	54992	54930	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 22 - TEST 8 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	96.5	55
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	3.5	2

Aggregate Throughput: 110.75 Mbps

Unicast traffic to untested VCs

VC	Throughput
252 (High Priority)	91.06 Mbps

FIGURE 23 - TEST 8 SLOT GROUPING AND TRAFFIC TO UNTESTED VCS

Because the scheduler schedules HP traffic first, the HP VC receives around 91 Mbps of user traffic, which consumes 96.5% of the available slots. The remaining 3.5% of slots are used for a group of size 7, which includes the seven LP VCs. Only 2 slots on average are allocated for the group; therefore, the throughput to each of the LP VCs is only 2.8 Mbps.

The total throughput on the link is 91 + 2.8x7 = 110 Mbps.

6.9 TEST 9: FLOOD TEST TO 7 LP VCS WITH 10 MBPS USER TRAFFIC TO 1 HP VC AND 7 LP VCS

In this test, user traffic in the amount of 10 Mbps is sent to all seven LP VCs plus one of the HP VCs, for a total of 8 VCs. The flood test runs with all seven LP VCs.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**444.16 Mbps**	**99%**	**8683176**	**8675163**			
19 (Low Priority)	63.45 Mbps	99%	1240486	1239328	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	63.48 Mbps	99%	1240478	1239866	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	63.39 Mbps	99%	1240382	1238146	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	63.46 Mbps	99%	1240376	1239579	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	63.46 Mbps	99%	1240380	1239501	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	63.46 Mbps	99%	1240692	1239482	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	63.45 Mbps	99%	1240382	1239261	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 24 - TEST 9 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	10.5	6
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	89.5	51

Aggregate Throughput: 454.28 Mbps

Unicast traffic to untested VCs

VC	Throughput
252 (High Priority)	10.11 Mbps

FIGURE 25 - TEST 9 SLOT GROUPING AND TRAFFIC TO UNTESTED VCS

The HP VC is scheduled first, and it receives the 10 Mbps of user traffic. This uses 10.5% of the slots, 6 out of 57. The remaining 89.5% of the slots, 51 out of 57, are used for a group of seven LP VCs. Using the 51 slots, each LP VC achieves a throughput of around 63.5 Mbps, making the total throughput 63.5x7 + 10 = 454 Mbps. Note that the 63 Mbps for each LP VC is composed of 10 Mbps of user traffic and 53 Mbps of flood traffic.

6.10 TEST 10: FLOOD TEST TO 4 LP VCS WITH 10 MBPS USER TRAFFIC TO 1 HP VC AND 7 LP VCS

The previous test is now repeated with the only change that only four of the seven LP VCs are included in the flood test.

VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**253.93 Mbps**	**99%**	**4964912**	**4959702**			
19 (Low Priority)	63.49 Mbps	99%	1241084	1240074	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	63.50 Mbps	99%	1241278	1240352	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	63.43 Mbps	99%	1241072	1238872	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	63.50 Mbps	99%	1241478	1240404	8X/8X MIMO-B	8X/6X MIMO-B	100%

FIGURE 26 - TEST 10 RESULTS

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	10.5	6
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	89.5	51

Aggregate Throughput: 294.41 Mbps

Unicast traffic to untested VCs

VC	Throughput
Total VCs	**40.47 Mbps**
252 (High Priority)	10.11 Mbps
28 (Low Priority)	10.11 Mbps
37 (Low Priority)	10.11 Mbps
38 (Low Priority)	10.11 Mbps

FIGURE 27 - TEST 10 SLOT GROUPING AND TRAFFIC TO UNTESTED VCS

In this case, the HP VCs receives its 10 Mbps of user traffic, and so do the three VCs not included in the flood test. The HP VC again uses 10.5% of the slots, and the remaining 89.5% of the slots always carry a group of 7. As explained above, this happens because the 10 Mbps of user traffic is enough to never have the queues empty, which makes these VCs always eligible for grouping.

Each of the seven VCs uses the 51 symbols for the group, but in different ways. The four VCs in the flood test have 10 Mbps of user traffic and 53.5 Mbps of flood data; the three VCs not in the flood test have 10 Mbps of user traffic, repeated to fill the allocation.

The total throughput is therefore 4x63.5 + 3x10 + 10 (HP) = 294 Mbps.

7 FLOOD TEST RESULTS WHEN CIR IS CONFIGURED

If a Committed Information Rate (CIR) is configured for one or more VCs, the results of the flood test will be different, because the scheduler gives priority to the VCs with CIR configured, until the CIR requirements are met. Some examples are presented here, to show the effect of configuring CIR.

7.1 TEST 1: FLOOD TEST TO HP AND LP VC WITH CIR CONFIGURED ON 3 LP VCS

In this test, the PMP 450m AP is connected to seven SMs with spatial frequencies that allow the AP to group them into one single MU-MIMO group. All SMs have both the LP and the HP VC configured, and three of the seven LP VCs have a CIR of 10 Mbps.

Current Results Status

Test Duration: 2 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**154.15 Mbps**	**99%**	**603934**	**602186**			
245 (High Priority)	11.62 Mbps	101%	44944	45408	8X/8X MIMO-B	8X/1X MIMO-A	0%
246 (High Priority)	11.61 Mbps	99%	45408	45389	8X/8X MIMO-B	8X/1X MIMO-A	0%
247 (High Priority)	11.49 Mbps	99%	44944	44921	8X/8X MIMO-B	8X/1X MIMO-A	0%
249 (High Priority)	11.49 Mbps	98%	45392	44911	8X/8X MIMO-B	8X/1X MIMO-A	0%
252 (High Priority)	11.61 Mbps	99%	45400	45369	8X/8X MIMO-B	8X/1X MIMO-A	0%
253 (High Priority)	11.50 Mbps	99%	44952	44938	8X/8X MIMO-B	8X/1X MIMO-A	0%
255 (High Priority)	11.50 Mbps	99%	44952	44945	8X/8X MIMO-B	8X/1X MIMO-A	0%
18 (Low Priority)	10.49 Mbps	99%	40986	40982	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	10.50 Mbps	99%	41216	41033	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	10.42 Mbps	98%	41332	40723	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	10.48 Mbps	99%	40986	40944	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	10.49 Mbps	99%	40986	40977	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	10.46 Mbps	99%	41218	40892	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	10.43 Mbps	98%	41218	40754	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	86.0	49
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	14.0	8

FIGURE 28 - CIR TEST 1 RESULTS

The three LP VCs with CIR configured are VCs 18, 20 and 23. The scheduler will schedule these VCs first, until their CIR is met. Because of their spatial frequencies, the three VCs are always grouped together. However, since the scheduler attempts to group up to seven VCs per group, the other four VCs are always scheduled together with the three with CIR, even if the others do not have their CIR configured. Since they can be grouped, instead of leaving resources unused, the scheduler will transmit data to those VCs as well. This is the reason why all seven LP VCs have a throughput of 10 Mbps, despite that fact that some have CIR configured and others do not.

After meeting the CIR requirements for the LP VCs, the scheduler schedules the HP VCs only, because their queues are full. Each HP VC will have a throughput of (93-10*8/6)/7 = 11.4 Mbps, where 93 Mbps is the link capacity at 8x modulation, 10 Mbps is the CIR of the LP VCs, 8/6 is the factor that takes into account that the group of LP VCs communicates at 6x rate, not 8x, and finally the factor of 7 considers that there are 7 HP VCs.

This example shows that VCs without CIR may experience better than expected throughputs when they can be grouped with VCs with CIR.

7.2 TEST 2: 14 SMS, FLOOD TEST TO 14 LP VCS WITH CIR CONFIGURED ON 3 LP VCS

The sector is now changed by adding seven more SMs. These seven SMs have the same spatial frequencies as the previous seven SMs, and can also be grouped into a single MU-MIMO group. The 14 LP VCs now form two groups of seven, as shown in the flood test before CIR is configured on any VC.

Current Results Status

Test Duration: 5 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.20 Mbps**	**99%**	**4864578**	**4855529**			
18 (Low Priority)	35.52 Mbps	99%	347004	346936	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	35.43 Mbps	99%	347656	346061	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	35.51 Mbps	99%	347236	346824	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	35.56 Mbps	99%	347424	347327	8X/8X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	35.49 Mbps	99%	347234	346604	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	35.48 Mbps	99%	347656	346564	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	35.51 Mbps	99%	348120	346856	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	35.42 Mbps	99%	347234	345976	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	35.50 Mbps	99%	347236	346772	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	35.49 Mbps	99%	347236	346667	8X/8X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	35.54 Mbps	99%	347350	347093	8X/8X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	35.57 Mbps	99%	347648	347368	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	35.55 Mbps	99%	347656	347195	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	35.56 Mbps	99%	347888	347286	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 29 - 14 SMS NO CIR CONFIGURED

The Slot Grouping table shows that the AP always creates groups of seven VCs. In this case, the two groups of seven are scheduled at alternate frames, splitting the 71 Mbps of available throughput at 6x into two groups of 35.5 Mbps.

Current Results Status

Test Duration: 5 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.32 Mbps**	**99%**	**4864954**	**4856710**			
18 (Low Priority)	40.08 Mbps	99%	392282	391493	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	35.57 Mbps	99%	347442	347393	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	35.53 Mbps	99%	347386	347045	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	35.52 Mbps	99%	347270	346878	8X/8X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	35.53 Mbps	99%	347674	347062	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	39.99 Mbps	99%	392602	390607	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	30.96 Mbps	99%	303356	302399	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	30.85 Mbps	99%	302572	301362	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	35.53 Mbps	99%	347040	346987	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	40.05 Mbps	99%	392514	391195	8X/8X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	35.53 Mbps	99%	347040	347001	8X/8X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	30.97 Mbps	99%	302892	302511	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	35.57 Mbps	99%	347442	347414	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	35.56 Mbps	99%	347442	347363	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 30 – CIR TEST 2 RESULTS

A CIR of 10 Mbps is now configured on VCs 18, 28 and 33.

When forming groups, the AP now has two cases:

- For four of the seven spatial frequencies, both VCs have no CIR configured: the AP will alternate scheduling the two VCs, meaning that each VC is scheduled 50% of the time
- For three of the seven spatial frequencies, one VC has a CIR and the other doesn't: the AP continues scheduling the same VC until the CIR is met; after that, the AP resumes scheduling the VCs in alternate frames.

The eight VCs that fall into the first case do not change their throughput from the case in which no CIR is configured; they still receive 35.5 Mbps.

The three VCs with 10 Mbps of CIR will receive (71-10)/2+10 = 40 Mbps, where 71 is the total throughput at 6x, 10 Mbps is the CIR, and 2 is the number of VCs at the same spatial frequency.

The three VCs without CIR configured, but at the same spatial frequency as the ones with CIR configured will receive (71-10)/2 = 30.5 Mbps.

This test shows that VCs at the same spatial frequency with VCs with high CIR will experience a lower throughput because the VCs with higher CIR are scheduled more often.

7.3 TEST 3: FLOOD TEST WITH HP AND LP VCS

The same configuration of test 2 is used here, but the flood test runs to both HP and LP VCs.

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**152.32 Mbps**	**99%**	**1492330**	**1487509**			
245 (High Priority)	7.38 Mbps	99%	72144	72123	8X/8X MIMO-B	8X/1X MIMO-A	0%
246 (High Priority)	7.39 Mbps	99%	72264	72242	8X/8X MIMO-B	8X/1X MIMO-A	0%
247 (High Priority)	7.39 Mbps	100%	71800	72256	8X/8X MIMO-B	8X/1X MIMO-A	0%
248 (High Priority)	7.35 Mbps	99%	71840	71790	8X/8X MIMO-B	8X/1X MIMO-A	0%
249 (High Priority)	7.38 Mbps	99%	72176	72149	8X/8X MIMO-B	8X/1X MIMO-A	0%
250 (High Priority)	7.40 Mbps	99%	72312	72304	8X/8X MIMO-B	8X/1X MIMO-A	0%
251 (High Priority)	7.40 Mbps	99%	72360	72332	8X/8X MIMO-B	8X/1X MIMO-A	0%
252 (High Priority)	7.38 Mbps	99%	72136	72103	8X/8X MIMO-B	8X/1X MIMO-A	0%
253 (High Priority)	7.39 Mbps	99%	72272	72251	8X/8X MIMO-B	8X/1X MIMO-A	0%
254 (High Priority)	7.35 Mbps	99%	71856	71788	8X/8X MIMO-B	8X/1X MIMO-A	0%
255 (High Priority)	7.40 Mbps	99%	72312	72309	8X/8X MIMO-B	8X/1X MIMO-A	0%
18 (Low Priority)	10.09 Mbps	99%	99556	98632	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	5.06 Mbps	98%	50030	49430	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	5.08 Mbps	99%	49986	49644	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	5.08 Mbps	99%	49686	49669	8X/8X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	5.08 Mbps	99%	49986	49641	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	10.10 Mbps	98%	99904	98710	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
30 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
31 (Low Priority)	5.08 Mbps	99%	49686	49676	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	10.15 Mbps	99%	100018	99163	8X/8X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	5.08 Mbps	99%	49686	49682	8X/8X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	35.63 kbps	100%	348	348	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	5.08 Mbps	99%	49986	49641	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	5.08 Mbps	99%	49986	49626	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	86.0	49
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	14.0	8

FIGURE 31 - TEST 3 RESULTS WITH 10 MBPS OF CIR

Because the flood test now includes the HP VCs as well, the AP will first guarantee the 10 Mbps of CIR to the three LP VCs, and then moves on to scheduling the HP VCs only.

When scheduling the three LP VCs with CIR, the scheduler always groups them (because their spatial frequency allows it). In addition, four more VCs will be scheduled every time out of the ones in the four remaining spatial frequencies. Since there are two VCs for each spatial frequency, the two VCs will be scheduled in alternate frames.

The results table shows that VCs 18, 28 and 33 receive 10 Mbps, because these are the ones with CIR configured. VCs 19, 20, 23, 27, 31, 34, 37 and 38 receive 5 Mbps each, because the 10 Mbps are divided between the two VCs at each spatial frequency. VCs 29, 30 and 36 are never scheduled, because they share the same spatial frequency as the VCs with CIR configured, which have higher priority. After the CIR is met, the AP only schedules HP VCs; each of these VCs receives (93-10*8/6)/11 = 7.3 Mbps. Here 93 Mbps is the total throughput at 8x, 10 Mbps is the CIR, the factor of 8/6 takes into account that the grouped traffic is transmitted at 6x, not 8x, and 11 is the number of HP VCs. In this scenario, only 11 of the 14 SMs have the HP VC enabled. If all SMs had the HP VC enabled, the throughput would simply have been divided by 14.

The Slot Grouping table shows the time used for transmission to the groups of LP VCs and the time for transmission to the HP VCs, which are ungrouped (group of size 1).

These examples show again how VCs that can be grouped with VCs with high CIR are scheduled more often and receive higher throughput compared to the case in which they are grouped with VCs with no CIR. On the other hand, VCs that share the same spatial frequency with VCs with high CIR are scheduled less frequently as they have lower priority in the grouping algorithm.

A similar test is run, with now a CIR of 20 Mbps to the same three VCs. The results are consistent with the results from the previous case. The time used for transmission to the MU-MIMO group is now doubled, as the CIR is doubled.

The three VCs with CIR receive the expected 20 Mbps. The three VCs that share the same spatial frequency as the three VCs with CIR are never scheduled. The other VCs are scheduled in alternate frames, and receive 20/2 = 10 Mbps. Each of the 11 HP VCs receive (93-20*8/6)/11 = 6 Mbps.

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**207.09 Mbps**	**99%**	**2028856**	**2022457**			
245 (High Priority)	6.21 Mbps	99%	60672	60668	8X/8X MIMO-B	8X/1X MIMO-A	0%
246 (High Priority)	6.21 Mbps	99%	60696	60690	8X/8X MIMO-B	8X/1X MIMO-A	0%
247 (High Priority)	6.21 Mbps	99%	60672	60670	8X/8X MIMO-B	8X/1X MIMO-A	0%
248 (High Priority)	6.19 Mbps	99%	60648	60526	8X/8X MIMO-B	8X/1X MIMO-A	0%
249 (High Priority)	6.21 Mbps	99%	60688	60647	8X/8X MIMO-B	8X/1X MIMO-A	0%
250 (High Priority)	6.20 Mbps	100%	60632	60632	8X/8X MIMO-B	8X/1X MIMO-A	0%
251 (High Priority)	6.20 Mbps	99%	60624	60590	8X/8X MIMO-B	8X/1X MIMO-A	0%
252 (High Priority)	6.25 Mbps	100%	60616	61040	8X/8X MIMO-B	8X/1X MIMO-A	0%
253 (High Priority)	6.21 Mbps	99%	60680	60663	8X/8X MIMO-B	8X/1X MIMO-A	0%
254 (High Priority)	6.21 Mbps	99%	60688	60665	8X/8X MIMO-B	8X/1X MIMO-A	0%
255 (High Priority)	6.20 Mbps	99%	60616	60604	8X/8X MIMO-B	8X/1X MIMO-A	0%
18 (Low Priority)	19.78 Mbps	99%	194336	193226	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	9.92 Mbps	99%	96936	96927	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	9.94 Mbps	99%	97978	97124	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	9.92 Mbps	99%	97284	96915	8X/8X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	9.92 Mbps	99%	96936	96896	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	19.70 Mbps	98%	194684	192463	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
30 (Low Priority)	0 bps	0%	0	0	8X/8X MIMO-B	8X/6X MIMO-B	0%
31 (Low Priority)	9.92 Mbps	99%	96936	96924	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	19.81 Mbps	99%	194682	193498	8X/8X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	9.92 Mbps	99%	96936	96915	8X/8X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	35.63 kbps	100%	348	348	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	9.92 Mbps	99%	97284	96916	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	9.92 Mbps	99%	97284	96910	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	71.9	41
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	28.1	16

FIGURE 32 - CIR TEST 3 WITH 20 MBPS OF CIR

7.4 TEST 4: 19 SMS IN THE SECTOR

For this test, five more SMs are added to the sector, for a total number of 19 SMs. The additional five SMs have spatial frequency common to the SMs that were already present in the sector. This means that, out of the seven spatial frequencies, five of them have three SMs, and two of them have two SMs.

First, a flood test is run to all 19 LP VCs, before configuring CIR to any of them.

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.18 Mbps**	**99%**	**4864646**	**4855361**			
18 (Low Priority)	23.62 Mbps	99%	231742	230761	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	23.63 Mbps	99%	231742	230802	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	23.71 Mbps	99%	231672	231630	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	23.68 Mbps	99%	231568	231264	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	23.68 Mbps	99%	231904	231341	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	35.50 Mbps	99%	347236	346748	8X/8X MIMO-B	8X/6X MIMO-B	100%
26 (Low Priority)	23.71 Mbps	99%	231904	231570	8X/4X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	35.53 Mbps	99%	347632	347022	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	23.63 Mbps	99%	231448	230823	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	35.54 Mbps	99%	347632	347140	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	23.64 Mbps	99%	231510	230926	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	23.65 Mbps	99%	231742	231008	8X/8X MIMO-B	8X/6X MIMO-B	100%
32 (Low Priority)	23.69 Mbps	99%	232020	231416	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	35.51 Mbps	99%	347234	346820	8X/4X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	23.63 Mbps	99%	231858	230820	8X/8X MIMO-B	8X/6X MIMO-B	100%
35 (Low Priority)	23.65 Mbps	99%	231904	230964	8X/4X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	23.67 Mbps	99%	231454	231217	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	23.71 Mbps	100%	231222	231555	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	23.70 Mbps	100%	231222	231534	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 33 - FLOOD TEST TO LP VCS WITH 19 SMS

The Slot Grouping table shows that the AP schedules groups of size 7 all the time.

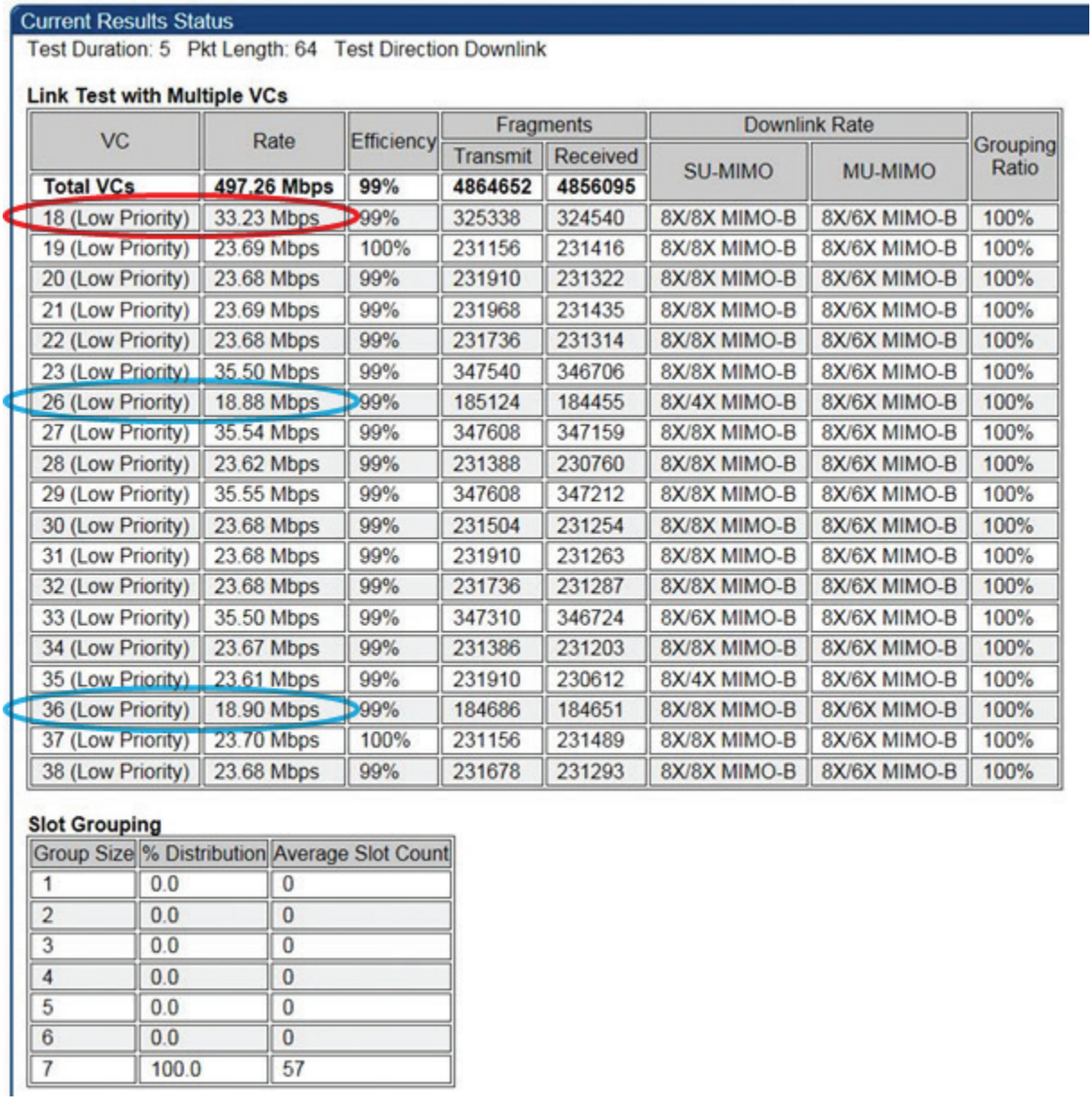
The 15 VCs that have a spatial frequency common to three SMs are scheduled every third frame. They receive a throughput of 71/3 = 23.6 Mbps, where 71 Mbps is the total throughput at 6x, and the factor of 3 comes from the fact that there are three VCs at the same spatial frequency, scheduled in a round robin fashion.

The 4 VCs that have spatial frequency common to two SMs are scheduled every other frame. They receive a throughput of 71/2 = 35.5 Mbps, as in the case with 14 SMs, because they are scheduled in alternate frames.

A CIR of 15 Mbps is now configured to one of the VCs that share a spatial frequency with two more VCs. This is VC 18, which has the same spatial frequency of VCs 26 and 36.

The only change in throughput occurs for these three VCs; all other VCs keep the same throughput as in the previous case. VC 18 now receives (71-15)/3+15 = 33 Mbps, where 71 Mbps is the total throughput at 6x, 15 Mbps is the CIR, and 3 is the number of VCs at the same spatial frequency.

The two other VCs at the same spatial frequency, VCs 26 and 36, receive (71-15)/3 = 18.6 Mbps, because the AP will keep scheduling VC 18 until the 15 Mbps of CIR is met, and then it will schedule each of the three VCs in every frame in a round robin fashion.



Current Results Status

Test Duration: 5 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.26 Mbps**	**99%**	**4864652**	**4856095**			
18 (Low Priority)	33.23 Mbps	99%	325338	324540	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	23.69 Mbps	100%	231156	231416	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	23.68 Mbps	99%	231910	231322	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	23.69 Mbps	99%	231968	231435	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	23.68 Mbps	99%	231736	231314	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	35.50 Mbps	99%	347540	346706	8X/8X MIMO-B	8X/6X MIMO-B	100%
26 (Low Priority)	18.88 Mbps	99%	185124	184455	8X/4X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	35.54 Mbps	99%	347608	347159	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	23.62 Mbps	99%	231388	230760	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	35.55 Mbps	99%	347608	347212	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	23.68 Mbps	99%	231504	231254	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	23.68 Mbps	99%	231910	231263	8X/8X MIMO-B	8X/6X MIMO-B	100%
32 (Low Priority)	23.68 Mbps	99%	231736	231287	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	35.50 Mbps	99%	347310	346724	8X/6X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	23.67 Mbps	99%	231386	231203	8X/8X MIMO-B	8X/6X MIMO-B	100%
35 (Low Priority)	23.61 Mbps	99%	231910	230612	8X/4X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	18.90 Mbps	99%	184686	184651	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	23.70 Mbps	100%	231156	231489	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	23.68 Mbps	99%	231678	231293	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 34 - CIR TEST 4 WITH CIR CONFIGURED ON VC 18

Now the CIR of 15 Mbps is configured on a VC that shares spatial frequency with only one other VC. This is VC 23, and the other VC at the same spatial frequency is VC 27.

These two VCs are the only ones with a different throughput compared to the case in which no CIR is configured; all other VCs receive the same throughput.

VC 23 receives now (71-15)/2+15 = 43 Mbps, while VC 27 receives (71-15)/2 = 28 Mbps. The reason is that the AP will always consider VC 23 for grouping until the CIR is met; at that point, it alternates VCs as when no CIR was configured.

Current Results Status

Test Duration: 5 Pkt Length: 64 Test Direction Downlink

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**497.03 Mbps**	**99%**	**4863946**	**4853873**			
18 (Low Priority)	23.67 Mbps	99%	231676	231204	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	23.70 Mbps	100%	231192	231470	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	23.67 Mbps	99%	231618	231226	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	23.67 Mbps	99%	231676	231182	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	23.68 Mbps	99%	231676	231318	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	42.51 Mbps	99%	418806	415195	8X/8X MIMO-B	8X/6X MIMO-B	100%
26 (Low Priority)	23.70 Mbps	100%	231192	231500	8X/6X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	28.35 Mbps	99%	277300	276934	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	23.61 Mbps	99%	231676	230647	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	35.54 Mbps	99%	347536	347109	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	23.68 Mbps	100%	231192	231286	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	23.67 Mbps	99%	231618	231211	8X/8X MIMO-B	8X/6X MIMO-B	100%
32 (Low Priority)	23.63 Mbps	99%	231850	230833	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	35.51 Mbps	99%	346950	346851	8X/6X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	23.70 Mbps	100%	231192	231472	8X/8X MIMO-B	8X/6X MIMO-B	100%
35 (Low Priority)	23.61 Mbps	99%	231848	230627	8X/6X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	23.67 Mbps	99%	231848	231168	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	23.68 Mbps	99%	231424	231340	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	23.68 Mbps	99%	231676	231300	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 35 - CIR TEST 4 WITH CIR CONFIGURED ON VC 23

One more example shows the case in which the CIR of 15 Mbps is configured in two of three VCs sharing the same spatial frequency.

In this case, the VCs with a change in throughput are the two VCs with CIR configured (VCs 18 and 26), and VC 36, which shares the same spatial frequency.

VCs 18 and 26 will receive (71-2x15)/3+15 = 28.6 Mbps, while VC 36 receives (71-2x15)/3 = 14 Mbps. Again, the test shows how VCs that share spatial frequency with VCs with high CIR configured end up being scheduled less frequently.

Link Test with Multiple VCs

VC	Rate	Efficiency	Fragments		Downlink Rate		Grouping Ratio
			Transmit	Received	SU-MIMO	MU-MIMO	
Total VCs	**496.92 Mbps**	**99%**	**4862212**	**4852780**			
18 (Low Priority)	28.61 Mbps	99%	279840	279447	8X/8X MIMO-B	8X/6X MIMO-B	100%
19 (Low Priority)	23.64 Mbps	99%	231676	230890	8X/8X MIMO-B	8X/6X MIMO-B	100%
20 (Low Priority)	23.70 Mbps	100%	231174	231504	8X/8X MIMO-B	8X/6X MIMO-B	100%
21 (Low Priority)	23.68 Mbps	99%	231670	231343	8X/8X MIMO-B	8X/6X MIMO-B	100%
22 (Low Priority)	23.61 Mbps	99%	231404	230660	8X/8X MIMO-B	8X/6X MIMO-B	100%
23 (Low Priority)	35.46 Mbps	99%	347026	346361	8X/4X MIMO-B	8X/6X MIMO-B	100%
26 (Low Priority)	28.14 Mbps	98%	278010	274900	8X/8X MIMO-B	8X/6X MIMO-B	100%
27 (Low Priority)	35.55 Mbps	99%	347262	347215	8X/8X MIMO-B	8X/6X MIMO-B	100%
28 (Low Priority)	23.58 Mbps	99%	231674	230286	8X/8X MIMO-B	8X/6X MIMO-B	100%
29 (Low Priority)	35.53 Mbps	99%	347610	347024	8X/8X MIMO-B	8X/6X MIMO-B	100%
30 (Low Priority)	23.67 Mbps	99%	231438	231182	8X/8X MIMO-B	8X/6X MIMO-B	100%
31 (Low Priority)	23.69 Mbps	99%	231438	231385	8X/8X MIMO-B	8X/6X MIMO-B	100%
32 (Low Priority)	23.66 Mbps	99%	231404	231104	8X/8X MIMO-B	8X/6X MIMO-B	100%
33 (Low Priority)	35.48 Mbps	99%	347026	346506	8X/8X MIMO-B	8X/6X MIMO-B	100%
34 (Low Priority)	23.65 Mbps	99%	231444	231054	8X/8X MIMO-B	8X/6X MIMO-B	100%
35 (Low Priority)	23.69 Mbps	100%	231174	231423	8X/8X MIMO-B	8X/6X MIMO-B	100%
36 (Low Priority)	14.13 Mbps	99%	138060	138028	8X/8X MIMO-B	8X/6X MIMO-B	100%
37 (Low Priority)	23.66 Mbps	99%	231444	231075	8X/8X MIMO-B	8X/6X MIMO-B	100%
38 (Low Priority)	23.69 Mbps	99%	231438	231393	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	100.0	57

FIGURE 36 - CIR TEST 4 WITH CIR CONFIGURED ON VCS 18 AND 26

8 COMPARISON BETWEEN LINK TEST AND FLOOD TEST TO ONE VC

The following tests have the goal to show the difference between a Link Test and a Flood test to one VC.

First, a Link Test runs to one of the VCs registered in the sector, when there is no user traffic in the sector.

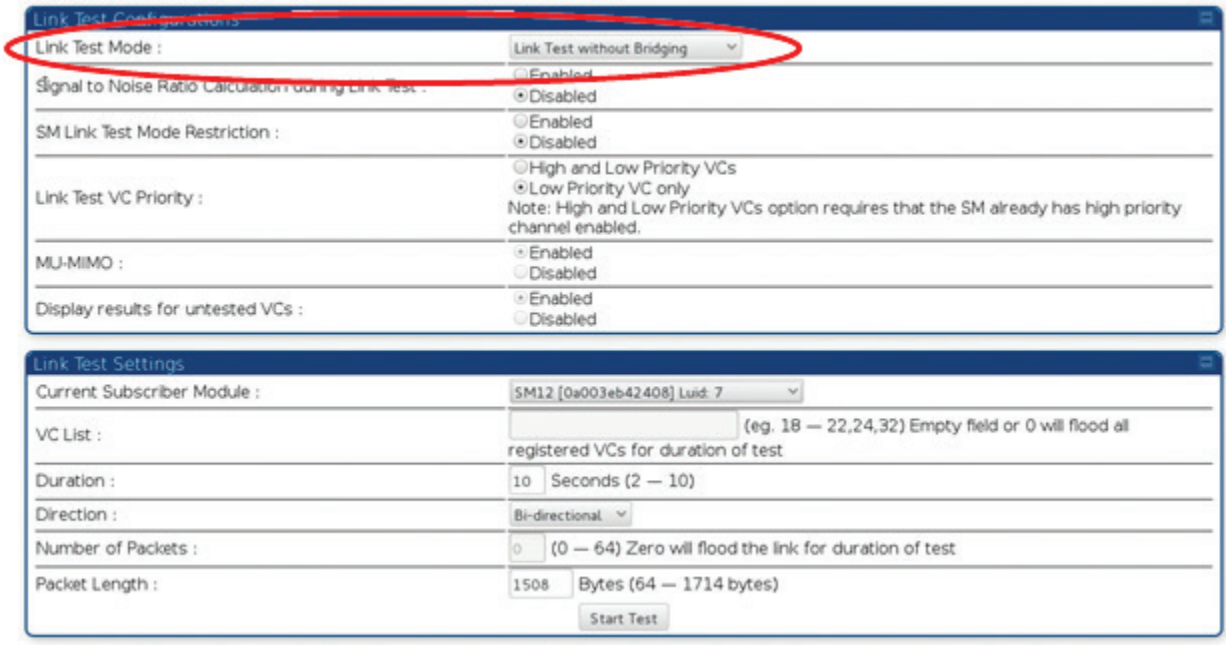


FIGURE 37 - LINK TEST CONFIGURATION

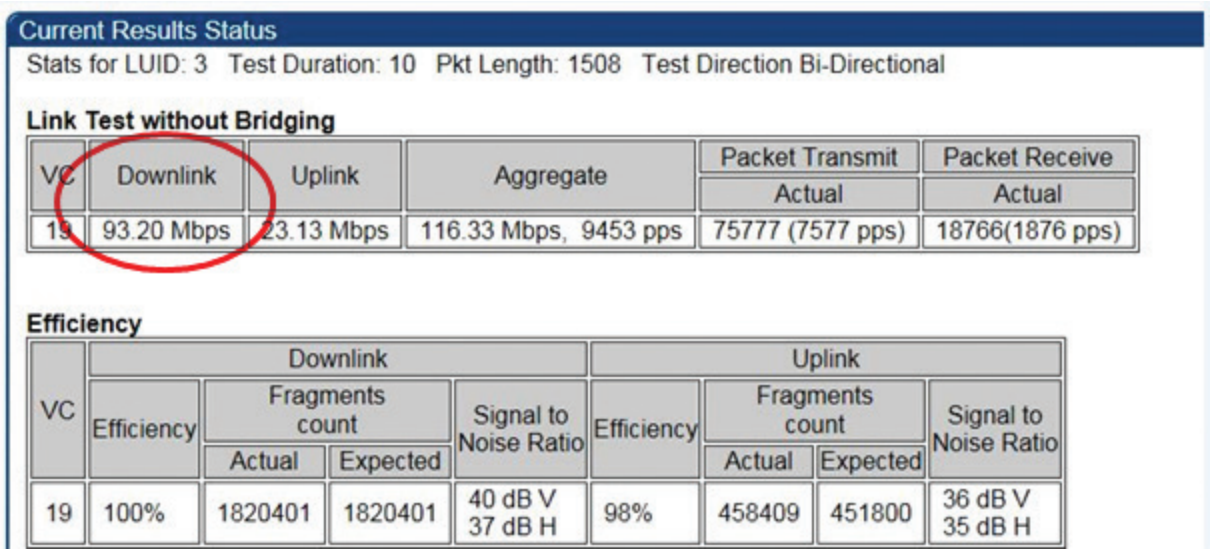


FIGURE 38 – LINK TEST RESULTS

From the Link Test Mode drop down menu, the Link Test without Bridging option is selected, as the flood test also is without bridging. The results section is structured slightly differently for a Link test, compared to a flood test, but the DL throughput is shown as 93 Mbps, as expected.

Next, the flood test is run, selecting as subset of VCs only the one VC that was used for the link test above.

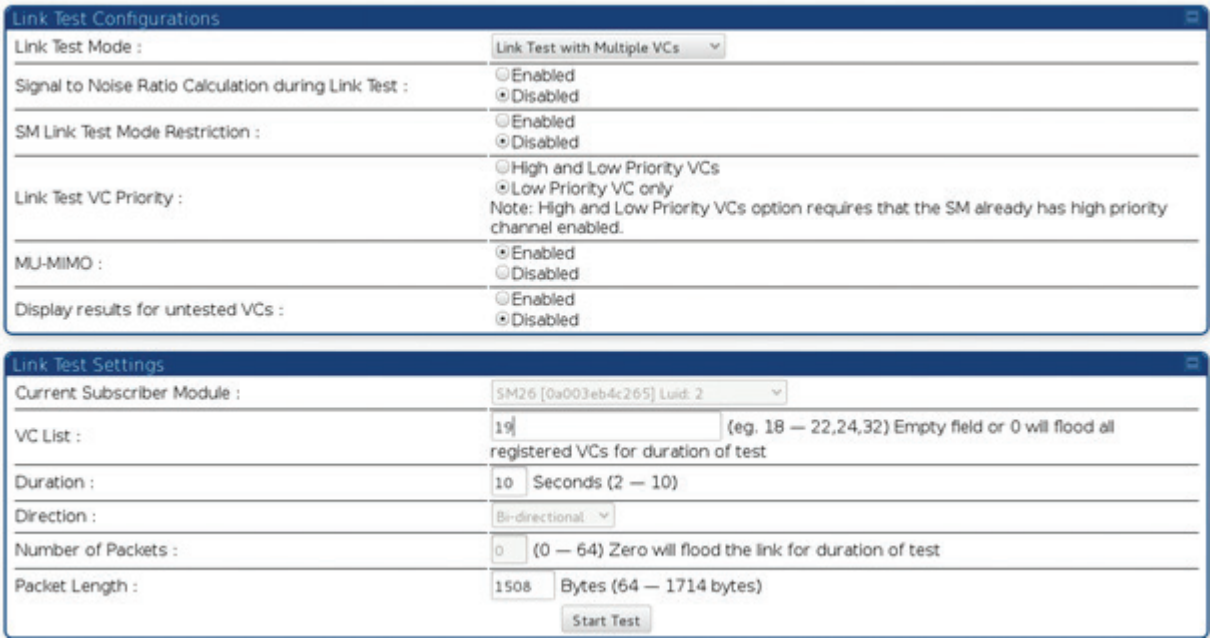


FIGURE 39 - CONFIGURATION OF FLOOD TEST TO ONE VC

Link Test with Multiple VCs

Subscriber Module	VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
				Transmit	Received	SU-MIMO	MU-MIMO	
SM19 - [0a-00-3e-b4-25-c7] - LUID: 003	19 (Low Priority)	94.50 Mbps	99%	1846596	1845847	8X/8X MIMO-B	8X/6X MIMO-B	0%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	100.0	57
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	0.0	0
7	0.0	0

FIGURE 40 - FLOOD TEST TO ONE VC RESULTS

As there is no user traffic in the link, and only one VC is part of the flood test, all groups have a size of 1, and the VC throughput is around 94 Mbps.

Without traffic, the link test and the flood test to one VC give the same result.

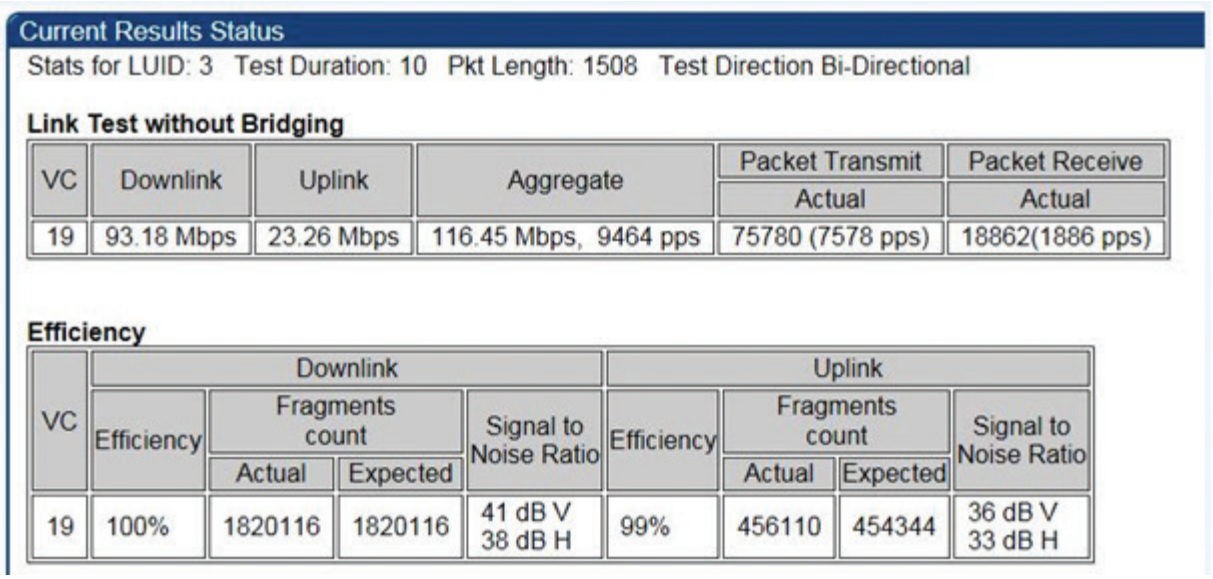
Let's now add user traffic in the amount of 10 Mbps to five of the seven LP VCs in the sector. The link test is run first, and then the flood test, to one of the five VCs with user traffic.

The main difference between the link test and the flood test is that the link test stops the user traffic, and fills the queues with test data; on the other hand, the flood test transfers the user data first, and fills only the empty portion of the queues with test data.

The link test result shows again that the VC can receive 93 Mbps in the DL, the same as in the case with no traffic. The AP stops all five streams of data to the five VCs, and fills the queue of the VC it is running the link test with.

The flood test results show that the four VCs with user traffic that are not used in the flood test receive the expected 10 Mbps, and only the VC used in the flood test uses the remaining resources. As explained in a previous example, the slot grouping shows that 100% of the time the group size is 5. All five VCs with traffic are always grouped, but the VC in the flood test has 10 Mbps of user traffic plus 61 Mbps of flood traffic, while the other four VCs have 10 Mbps of user traffic repeated a number of times to fill the allocation. The total throughput is 71 Mbps + 4x10 = 111 Mbps.

Note the difference between the two tests. The link test shows the maximum throughput the VC can achieve in SU-MIMO mode (93 Mbps), but in order to show this capability the user traffic is interrupted. The flood test also shows the maximum throughput the VC can achieve in MU-MIMO mode (71 Mbps), but in order to shows this capability user traffic is not stopped, and the other four VCs receive the expected 10 Mbps. Additionally, the VC in the flood test also receives its 10 Mbps of user traffic during the test, while during the link test the VC does not receive its own user data.



Current Results Status

Stats for LUID: 3 Test Duration: 10 Pkt Length: 1508 Test Direction Bi-Directional

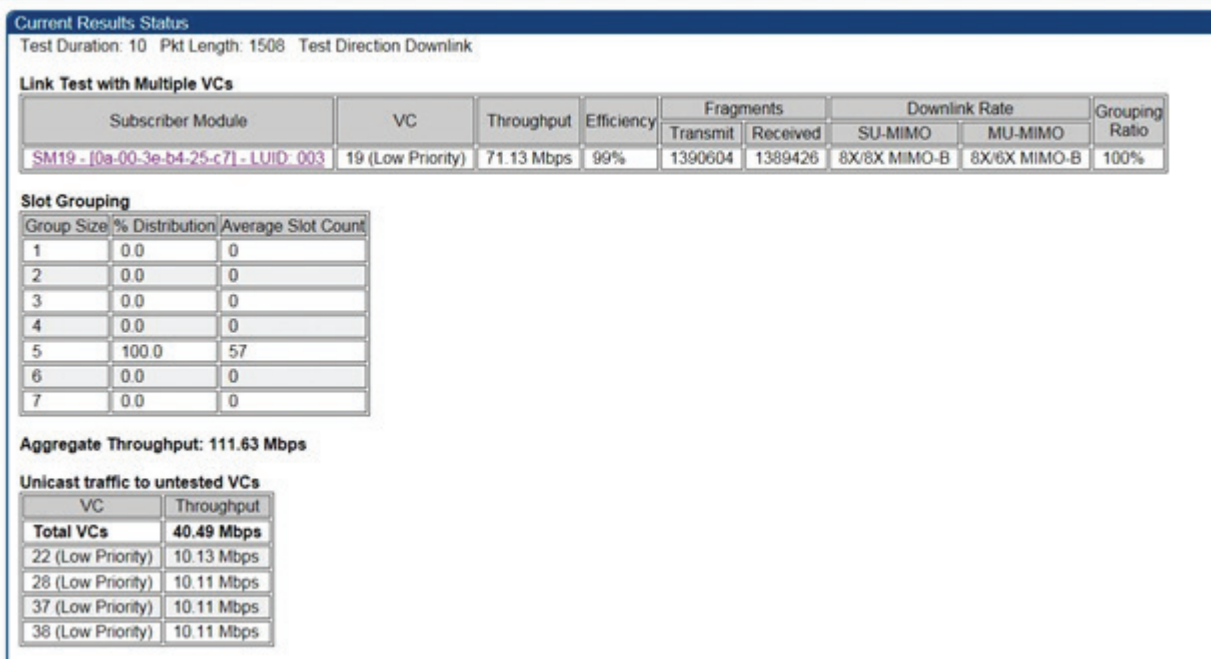
Link Test without Bridging

VC	Downlink	Uplink	Aggregate	Packet Transmit	Packet Receive
				Actual	Actual
19	93.18 Mbps	23.26 Mbps	116.45 Mbps, 9464 pps	75780 (7578 pps)	18862(1886 pps)

Efficiency

VC	Downlink				Uplink			
	Efficiency	Fragments count		Signal to Noise Ratio	Efficiency	Fragments count		Signal to Noise Ratio
		Actual	Expected			Actual	Expected	
19	100%	1820116	1820116	41 dB V 38 dB H	99%	456110	454344	36 dB V 33 dB H

FIGURE 41 - LINK TEST TO ONE VC WITH TRAFFIC - TRAFFIC TO 5 VCS



Current Results Status

Test Duration: 10 Pkt Length: 1508 Test Direction Downlink

Link Test with Multiple VCs

Subscriber Module	VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
				Transmit	Received	SU-MIMO	MU-MIMO	
SM19 - [0a-00-3e-b4-25-c7] - LUID: 003	19 (Low Priority)	71.13 Mbps	99%	1390604	1389426	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	100.0	57
6	0.0	0
7	0.0	0

Aggregate Throughput: 111.63 Mbps

Unicast traffic to untested VCs

VC	Throughput
Total VCs	**40.49 Mbps**
22 (Low Priority)	10.13 Mbps
28 (Low Priority)	10.11 Mbps
37 (Low Priority)	10.11 Mbps
38 (Low Priority)	10.11 Mbps

FIGURE 42 - FLOOD TEST TO ONE VC WITH TRAFFIC - TRAFFIC TO 5 VCS

The test is now repeated with the only difference that the VC used in the link test and flood test is not one of the five VCs with traffic, but it is one of the two remaining VCs with no traffic.

The link test results are the same as in the previous case. Since the link test stops all user traffic to all VCs, the link is filled with test data for the one VC in the test, regardless if it has user data or not. The other five VCs do not receive user data for the duration of the link test, and the DL throughput shown for the VC is 93 Mbps as expected.

Current Results Status

Stats for LUID: 5 Test Duration: 10 Pkt Length: 1508 Test Direction: Bi-Directional

Link Test without Bridging

VC	Downlink	Uplink	Aggregate	Packet Transmit	Packet Receive
				Actual	Actual
21	93.16 Mbps	23.28 Mbps	116.44 Mbps, 9465 pps	75783 (7578 pps)	18876(1887 pps)

Efficiency

VC	Downlink				Uplink			
	Efficiency	Fragments count		Signal to Noise Ratio	Efficiency	Fragments count		Signal to Noise Ratio
		Actual	Expected			Actual	Expected	
21	100%	1819638	1819638	43 dB V 38 dB H	99%	455624	454776	36 dB V 32 dB H

FIGURE 43 - LINK TEST TO ONE VC WITHOUT TRAFFIC - TRAFFIC TO 5 OTHER VCS

Current Results Status

Test Duration: 10 Pkt Length: 1508 Test Direction: Downlink

Link Test with Multiple VCs

Subscriber Module	VC	Throughput	Efficiency	Fragments		Downlink Rate		Grouping Ratio
				Transmit	Received	SU-MIMO	MU-MIMO	
SM15 - [0a-00-3e-b4-26-22] - LUID: 005	21 (Low Priority)	71.15 Mbps	99%	1390430	1389650	8X/8X MIMO-B	8X/6X MIMO-B	100%

Slot Grouping

Group Size	% Distribution	Average Slot Count
1	0.0	0
2	0.0	0
3	0.0	0
4	0.0	0
5	0.0	0
6	100.0	57
7	0.0	0

Aggregate Throughput: 121.75 Mbps

Unicast traffic to untested VCs

VC	Throughput
Total VCs	**50.60 Mbps**
19 (Low Priority)	10.11 Mbps
22 (Low Priority)	10.13 Mbps
28 (Low Priority)	10.11 Mbps
37 (Low Priority)	10.11 Mbps
38 (Low Priority)	10.11 Mbps

FIGURE 44 – FLOOD TEST TO ONE VC WITHOUT TRAFFIC - TRAFFIC TO 5 OTHER VCS

In the flood test case, traffic to the other five VCs is not stopped, they each receive the 10 Mbps of user traffic as shown in the Unicast traffic to untested VC table. The flood test to the tested VC shows 71 Mbps of throughput, which is 71 Mbps of flood data, as there is no user data for this VC.

The slot grouping table shows 100% of groups of size 6. The five VCs with user traffic and the one VC with flood traffic are always grouped. The one VC fills the DL allocation with flood traffic; the other five VCs repeat their user data to fill the allocation.

The total throughput is therefore 71 + 5x10 = 121 Mbps.

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