Qualcomm Technologies, Inc.

QCAT LTE Analysis

User Guide

80-N3091-2 B

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Revision history

Revision	Date	Description
A	June 2014	Initial release
B	June 2017	Added Sections 2.3, 2.6, 3. 5, 3.19, 3.26

Note: There is no Rev. I, O, Q, S, X, or Z per Mil. standards.

Contents

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1 Introduction

1.1 Purpose

This document describes all analyzers that are available in the LTE section of the *QCAT6 User Guide (*80-V1233-6). It describes how fields are calculated and what data is used for plotting.

1.2 Conventions

Function declarations, function names, type declarations, and code samples appear in a different font, e.g., `#include`.

Shading indicates content that has been added or changed in this revision of the document.

1.3 Technical assistance

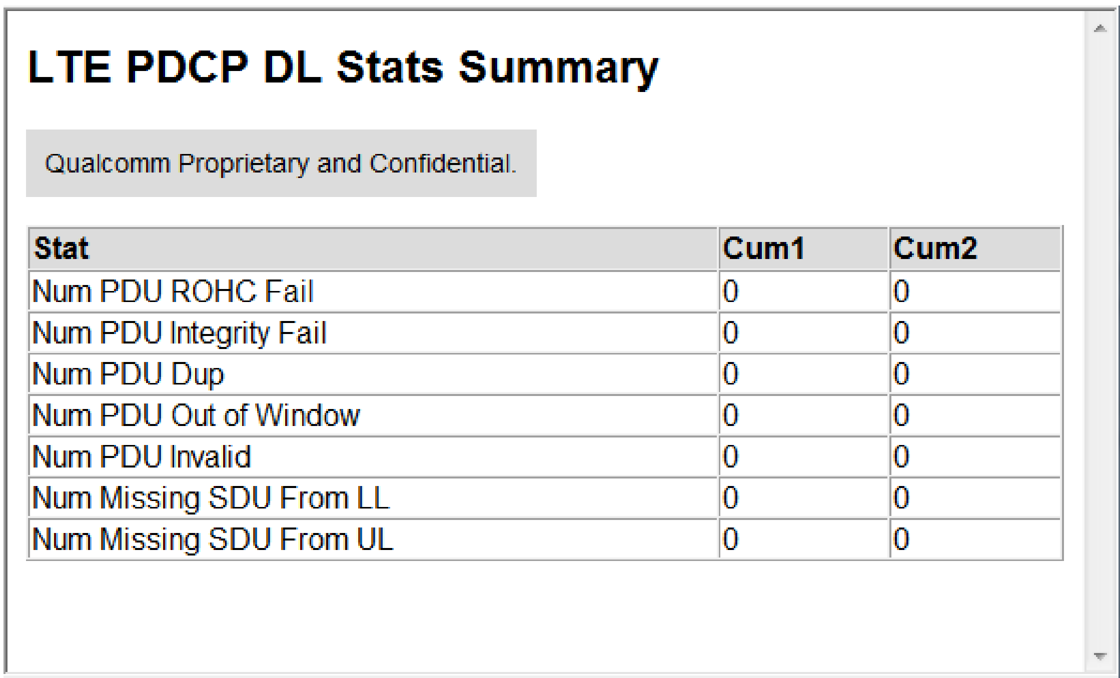
For assistance or clarification on information in this document, submit a case to Qualcomm Technologies, Inc. (QTI) at https://createpoint.qti.qualcomm.com/.

If you do not have access to the CDMATech Support website, register for access or send email to support.cdmatech@qti.qualcomm.com.

2 Text Outputs

2.1 LTE PDCP DL Stats Summary

This analyzer shows the cumulative statistics from the last instance of LTE PDCP DL Statistics (0xB0A4) before each reset and at the end of the log. A reset is defined as an instance of LTE RRC OTA Packet (0xB0C0) with an rrcConnectionRelease or rrcConnectionRequest. An example of the output is shown in Figure 2-1.

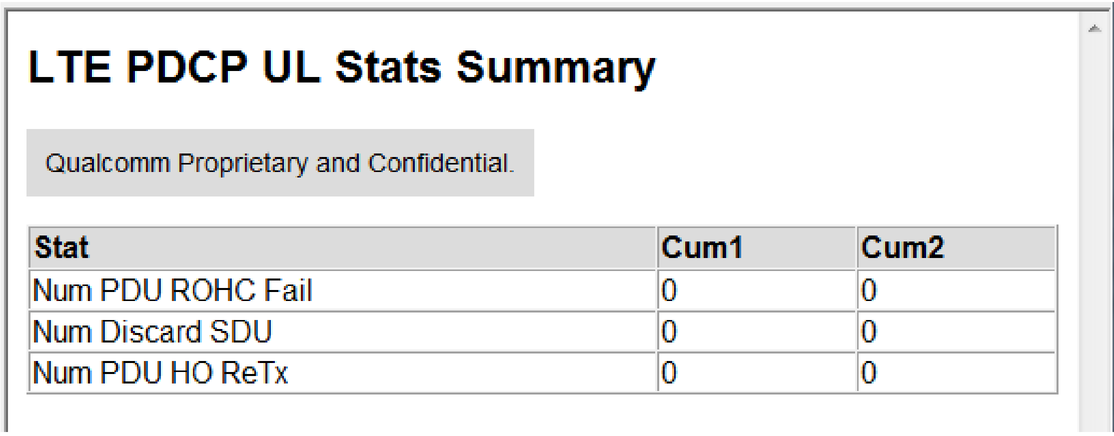


Stat	Cum1	Cum2
Num PDU ROHC Fail	0	0
Num PDU Integrity Fail	0	0
Num PDU Dup	0	0
Num PDU Out of Window	0	0
Num PDU Invalid	0	0
Num Missing SDU From LL	0	0
Num Missing SDU From UL	0	0

Figure 2-1 LTE PDCP DL Stats Summary

2.2 LTE PDCP UL Stats Summary

This analyzer shows the cumulative statistics from the last instance of LTE PDCP UL Statistics (0xB0B4) before each reset and at the end of the log. A reset is defined as an instance of LTE RRC OTA Packet (0xB0C0) with an rrcConnectionRelease or rrcConnectionRequest. An example of the output is shown in Figure 2-2.



LTE PDCP UL Stats Summary

Qualcomm Proprietary and Confidential.

Stat	Cum1	Cum2
Num PDU ROHC Fail	0	0
Num Discard SDU	0	0
Num PDU HO ReTx	0	0

Figure 2-2 LTE PDCP UL Stats Summary

2.3 LTE PDCP UL Delay Summary

Average packet delay

The average packet delay is calculated as a weighted average over all the bins with the different packet delays.

The packet delays are logged as an array (PDCP_DELAY_PKT_CNT) having values that determine the number of packets with the delay PDCP_DELAY_PKT_CNT [<10, 10-19,20-29,30-39,40-49,50-59,60-69,70-79,80-89,90-99, …,190-199, >=200] ms.

Average packet delay =

$$\frac{\mathrm{PDCP\_WM\_DELAY\_PKT\_CNT}[0] * 5 + \mathrm{PDCP\_WM\_DELAY\_PKT\_CNT}[1] * 15 + \ldots . + \mathrm{PDCP\_WM\_DELAY\_PKT\_CNT}[20] * 205}{PDCP\_WM\_DELAY\_PKT\_CNT[0] + PDCP\_WM\_DELAY\_PKT\_CNT[1] + \ldots . + PDCP\_WM\_DELAY\_PKT\_CNT[20] * 205}$$

Absolute number of packets delayed

The value is just a diff of the values in the PDCP_DELAY_PKT_CNT array from the previous log packet to the current log packet.

For(i=0,i<11,i++)

```
{
  If(PDCP_DELAY_PKT_CNT[i](n) != 0)
  {
    PDCP_DELAY_PKT_CNT[i]diff(n) = PDCP_DELAY_PKT_CNT[i](n) -
PDCP_DELAY_PKT_CNT[i](n-1)
  }
  Else
  {
    PDCP_DELAY_PKT_CNT[i] = 0
  }
}
```

2.4 LTE RLC DL Stats Summary

This analyzer shows the cumulative statisticss from the last instance of LTE RLC DL Statistics (0xB087) before each reset and at the end of the log less the values from the first instance of LTE RLC DL Statistics (0xB087). A reset is defined as an instance of LTE RRC OTA Packet (0xB0C0) with an rrcConnectionRelease or rrcConnectionRequest or when any of the fields from the table drop in value. An example of the output is shown in Figure 2-3.

LTE RLC DL Stats Summary

Qualcomm Proprietary and Confidential.

Stat	Cum1	Cum2
Num Invalid PDU	0	0
Num ReTx PDU	0	0
Num Dup PDU	0	0
Num Dropped PDU	0	0
Num Dropped PDU FC	0	0
Num NonSeq SDU	0	0
Num Complete NACK	0	0
Num Segments NACK	0	0
Num T Reorder Expired	0	0

Figure 2-3 LTE RLC DL Stats Summary

2.5 LTE RLC UL Stats Summary

This analyzer shows the cumulative statistics from the last instance of LTE RLC UL Statistics (0xB097) before each reset and at the end of the log less the values from the first instance of LTE RLC UL Statistics (0xB097). A reset is defined as an instance of LTE RRC OTA Packet (0xB0C0) with an rrcConnectionRelease or rrcConnectionRequest or when any of the fields from the table drop in value. A second table contains the Call Num Complete NACK, which is the sum of all columns of “Num Complete NACK” in the first table. An example of the output is shown in Figure 2-4.

LTE RLC UL Stats Summary

Qualcomm Proprietary and Confidential.

Stat	Cum1	Cum2
Num Invalid Ctrl PDU	0	0
Num ReTx PDU	0	0
Num T Poll ReTx Expiry	0	0
Num Complete NACK	0	0
Num Segment NACK	0	0

Figure 2-4 LTE RLC UL Stats Summary

2.6 LTE Wht Channel Correlation Summary

NOTE: This section was added to this document revision.

The "LTE Wht Channel Correlation Summary" computes Rx correlation magnitude among the whitened-channels of different Rx antennas, which is averaged across all Tx antennas. The range of the normalized correlation value is [0, 1].

Similarly, Tx correlation is calculated as correlation among the whitened-channels of different Tx antennas averaged across all Rx antennas.

Since the above correlation is computed from whitened-channel matrix (0xB14C), it provides overall correlation including noise whitening. This correlation should not be interpreted as the direct channel correlation between the Rx or Tx antenna pairs. In most typical test scenarios, this log packet is not enabled or recommended because it is resource intensive to use. An example of the output is shown below, where the table title is interpreted as "Rx / Tx cross-correlation magnitude: Carrier (Number of Rx Antennas x Number of Tx Antennas)".

LTE Wht Channel Correlation Summary

Qualcomm Proprietary and Confidential.

Rx cross-correlation magnitude: PCC (2 x 4)			
1.00	0.44		
0.44	1.00		
Tx cross-correlation magnitude: PCC (2 x 4)			
0.50	0.44	0.39	0.40
0.44	0.50	0.38	0.41
0.39	0.38	0.50	0.40
0.40	0.41	0.40	0.50
Rx cross-correlation magnitude: PCC (4 x 4)			
1.00	0.81	0.54	0.28
0.81	1.00	0.65	0.30
0.54	0.65	1.00	0.50
0.28	0.30	0.50	1.00
Tx cross-correlation magnitude: PCC (4 x 4)			
1.00	0.63	0.57	0.45
0.63	1.00	0.81	0.64
0.57	0.81	1.00	0.82
0.45	0.64	0.82	1.00

Figure 2-5 LTE Wht Channel Correlation Summary

3 Grid/Plot Outputs

3.1 LTE BSR Index vs Time

This time output plots the BSR field from the UL Transport Block subpacket (ID 8) in the LTE MAC UL Transport Block (0xB064) log packet vs time for each logical group ID in the log file. It is useful for getting a quick overview of the BSR reported values for all logical groups. An example of the time grid is shown in Figure 3-1 and an example of the plot is shown in Figure 3-2.

LTE BSR Index vs. Time

Time	BSR Index LG0	BSR Index LG1	BSR Index LG2	BSR Index LG3
00:05:26.435	0	0	0	0
00:05:26.436	0	0	0	0
00:05:26.437	0	0	0	0
00:05:26.438	0	0	0	0
00:05:26.439	0	0	0	0
00:05:26.440	0	0	0	0
00:05:26.441	0	0	0	0
00:05:26.442	0	0	0	0
00:05:26.467			62	
00:05:26.488			59	
00:05:26.491			58	
00:05:26.506			54	
00:05:26.523	0	0	0	0
00:05:26.524	0	0	0	0
00:05:26.525	0	0	0	0
00:05:26.526	0	0	0	0
00:05:26.534			0	
00:05:26.535	0	0	0	0
00:05:26.536	0	0	0	0
00:05:26.537	0	0	0	0
00:05:26.538	0	0	0	0
00:05:26.542			52	
00:05:26.562			59	
00:05:26.577			51	
00:05:26.597			57	
00:05:26.612			40	
00:05:26.632			55	
00:05:26.653			50	

Figure 3-1 LTE BSR Index vs Time grid

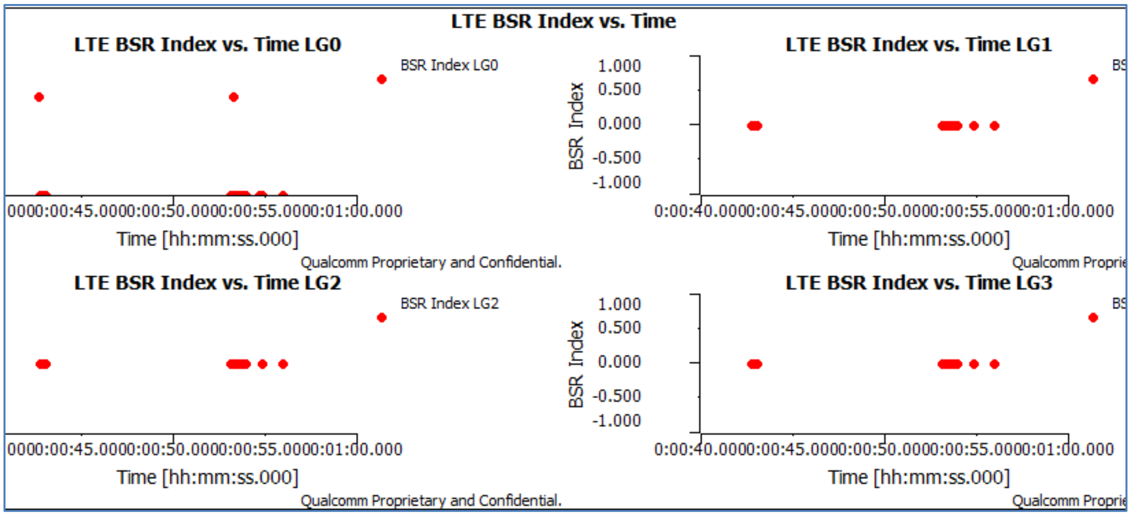


Figure 3-2 LTE BSR Index vs Time plot

3.2 LTE DCI Info vs Time

The LTE DCI Info vs Time grid shows statistics from the LTE DCI Information Report (0xB16C) packets, with their corresponding TB size from the LTE GM TX Report (0xB16D). The Scheduling Request information from LTE GM TX Report (0xB16D) is included in the grid. To find the appropriate TB size for each UL grant scheduling, the grid checks the K value in field K of the LTE DCI Information Report and computes the corresponding PUSCH transmissions with the following logic (assuming UL grant is scheduled in frame *N*, subframe *n*):

- If *n* + K is greater than or equal to 10, PUSCH transmission frame = *N* +1, and subframe = (*n* + K)%10, extract the TB size information from the Transport Block Size field in the matched Tx SFN and Tx Sub-fn of the 0xB16D log packet nearby in the timestamp.
- If *n* + K is less than 10, PUSCH transmission frame = *N* , and subframe = (*n* + K)%10, extract the TB size information from the Transport Block Size field in the matched Tx SFN and Tx Sub-fn of the 0xB16D log packet nearby in the timestamp.

The Scheduling Request uses the frame number/subframe number on which it is reported from the PUCCH payload in the LTE GM Tx Report (0xB16D).

This analyzer is helpful to better understand and more easily use PDCCH/PUSCH analyzers, which indicate the uplink schedule and transmission or retransmission state. An example of the output is shown in Figure 3-3.

LTE DCI Info vs. Time
Qualcomm Proprietary and Confidential.

Time	Frame Number	Subframe Number	MCS	HARQ ID	Modulation Type	TB Size
01:49:35.044	3	3	17	0	BPSK	2052
01:49:35.045	3	4	17	1	BPSK	2052
01:49:35.046	3	5	17	2	BPSK	2052
01:49:35.047	3	6	17	3	BPSK	2052
01:49:35.048	3	7	17	4	BPSK	2052
01:49:35.049	3	8	17	5	BPSK	2052
01:49:35.050	3	9	17	6	BPSK	2052
01:49:35.051	4	0	17	7	BPSK	2052
01:49:35.052	4	1	17	0	BPSK	2052
01:49:35.053	4	2	17	1	BPSK	2052

Figure 3-3 LTE DCI Info vs Time grid

3.3 LTE DL BLER Vs Subfr

The LTE DL BLER per SubFrame shows the DL BLER per SubFrame per carrier from the LTE PDSCH Stat Indication packet (0xB173). The DL BLER is calculated by dividing the number of CRC failures in that subframe by the total number of scheduled download blocks in that subframe for each carrier. The number of CRC failures in a subframe is incremented when CRC Result = FAIL && Discarded retX Present = NONE.

It also shows the subframe BLER percentage per carrier, calculated as the number of failures in the given subframe divided by all failures across all subframes. An example of the grid is shown in Figure 3-4 and an example of the plot is shown in Figure 3-5.

- For PCC, only instances of the log where **carrier index == 0 (PCC)** are considered.
- For SCC, only instances of the log where **carrier index == 1 (SCC)** are considered.

The respective plot is divided into two plots for PCC and SCC. The top subplot will show the PCC's related values and the bottom one will show the SCC's related values.

LTE DL BLER Vs Subfr
Qualcomm Proprietary and Confidential.

SubFrame	DL Bler PCC	DL Bler SCC	Subframe BLER % PCC	Subframe BLER % SCC
0	0.149254	51.5302	0.014892	4.99599
1	0	26.7424	0	2.83079
2	0.148368	50.2642	0.014892	5.34082
3	0	76.0181	0	8.0834
4	0.0746269	51.5221	0.00744602	5.42903
5	0	48.4195	0	2.70249
6	0.074239	47.8523	0.00744602	5.09222
7	0	26.6515	0	2.81476
8	0.150038	52.2468	0.014892	5.5012
9	0	74.9811	0	7.95509

Figure 3-4 LTE DL BLER Vs Subfr

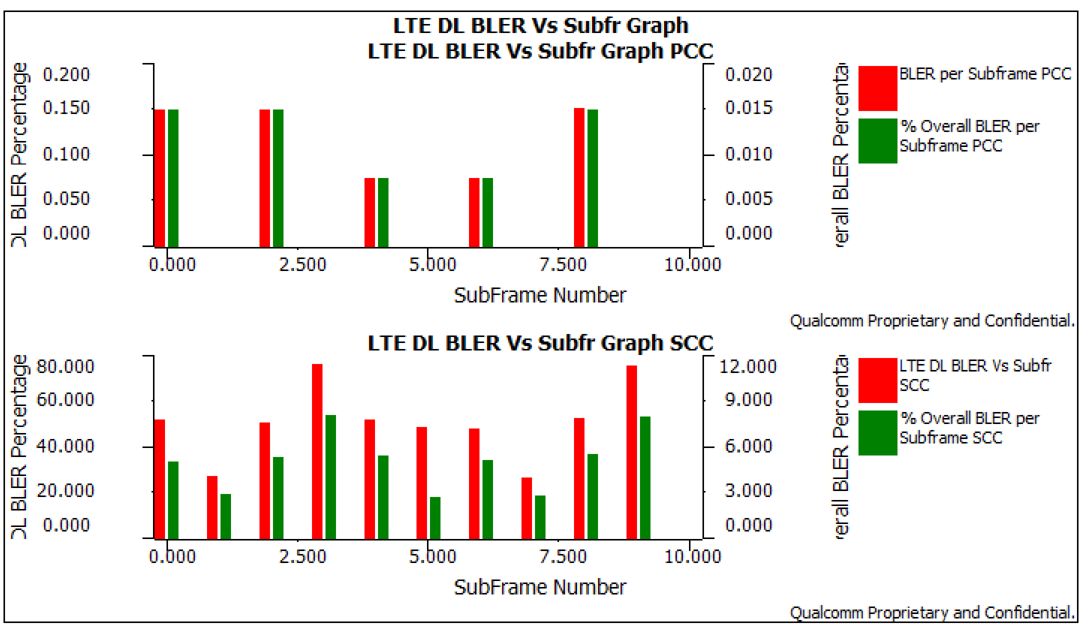


Figure 3-5 LTE DL BLER Vs Subfr

3.4 LTE DL Throughput vs. Time

This analzyer shows throughput across the physical layer, RLC layer, and PDCP layer. It is useful for providing a comprehensive view across all layers when troubleshooting field problems. The throughput calculations are described below. An example of the grid is shown in Figure 3-6 and an example of the plots is shown in Figure 3-7.

- Total Throughput (kbps) – Total physical layer throughput from both PCC and SCC. It is the PCell Throughput (kbps) + SCell Throughput (kbps).
- Total Throughput Avg (kbps) – The average of the previous N values of Total Throughput, where N can be set in the analyzer's configuration. N is 6 by default.
- PCell Throughput (kbps) – The sum of all TB Sizes for PCell in an instance of LTE PDSCH Stat Indication (0xB173) divided by the packet's duration. The duration is calculated based on 1 ms subframe numbers from the first record to the last record.
- PCell Throughput Avg (kbps) – The average of the previous N values of PCell Throughput, where N can be set in the analyzer's configuration. N is 6 by default.
- SCell Throughput (kbps) – The sum of all TB Sizes for SCell in an instance of LTE PDSCH Stat Indication (0xB173) divided by the packet's duration. The duration is calculated based on 1 ms subframe numbers from the first record to the last record.
- SCell Throughput Avg (kbps) – The average of the previous N values of SCell Throughput, where N can be set in the analyzer's configuration. N is 6 by default.
- Total RLC Throughput (kbps) – The sum of throughput across all RBs in LTE RLC DL Statistics (0xB087). For Throughput calculation, see the RLC Tput (kbps) RB Cfg Idx below.
- Total PDCP Throughput (kbps) – The sum of the throughput across all RBs in the LTE PDCP DL Statistics Pkt (0xB0A4). For throughput calculation, see PDCP Tput (kbps) RB Cfg Idx below.
- RLC Tput (kbps) RB Cfg Idx N – The throughput of RB Cfg Idx N, where N is for each RB Cfg Idx value seen in LTE RLC DL Statistics (0xB087). Throughput is calculated as (Data PDU Bytes with RB Cfg Idx = N – Data PDU Bytes from previous instance of 0xB087 with RB Cfg Idx = N)/(packet timestamp – previous 0xB087 timestamp) * 8 (bits per byte).
- PDCP Tput (kbps) RB Cfg Idx N – The throughput of RB Cfg Idx N, where N is for each RB Cfg Idx value seen in LTE PDCP DL Statistics Pkt (0xB0A4). Throughput is calculated as (Data PDU Bytes with RB Cfg Idx = N – Data PDU Bytes from previous instance of 0xB0A4 with RB Cfg Idx = N)/(packet timestamp – previous 0xB0A4 timestamp) * 8 (bits per byte).

LTE DL Throughput vs. Time
Qualcomm Proprietary and Confidential.

Time	Total Throughput (kbps)	Total Throughput Avg (kbps)	PCell Throughput (kb
13:35:00.085			
13:35:00.145			
13:35:00.155	102.088	102.088	102.088
13:35:00.455	73.9326	88.0103	73.9326
13:35:00.645			
13:35:00.985	220.893	132.305	220.893
13:35:01.055	5968	1591.23	5968
13:35:01.145			
13:35:01.355	61.6615	1285.32	61.6615
13:35:01.365			
13:35:01.645			
13:35:01.655	83	1084.93	83
13:35:01.955	115	1087.08	115
13:35:02.145			
13:35:02.255	52.155	1083.45	52.155
13:35:02.555	161.791	1073.6	161.791

Figure 3-6 LTE DL Throughput vs. Time grid

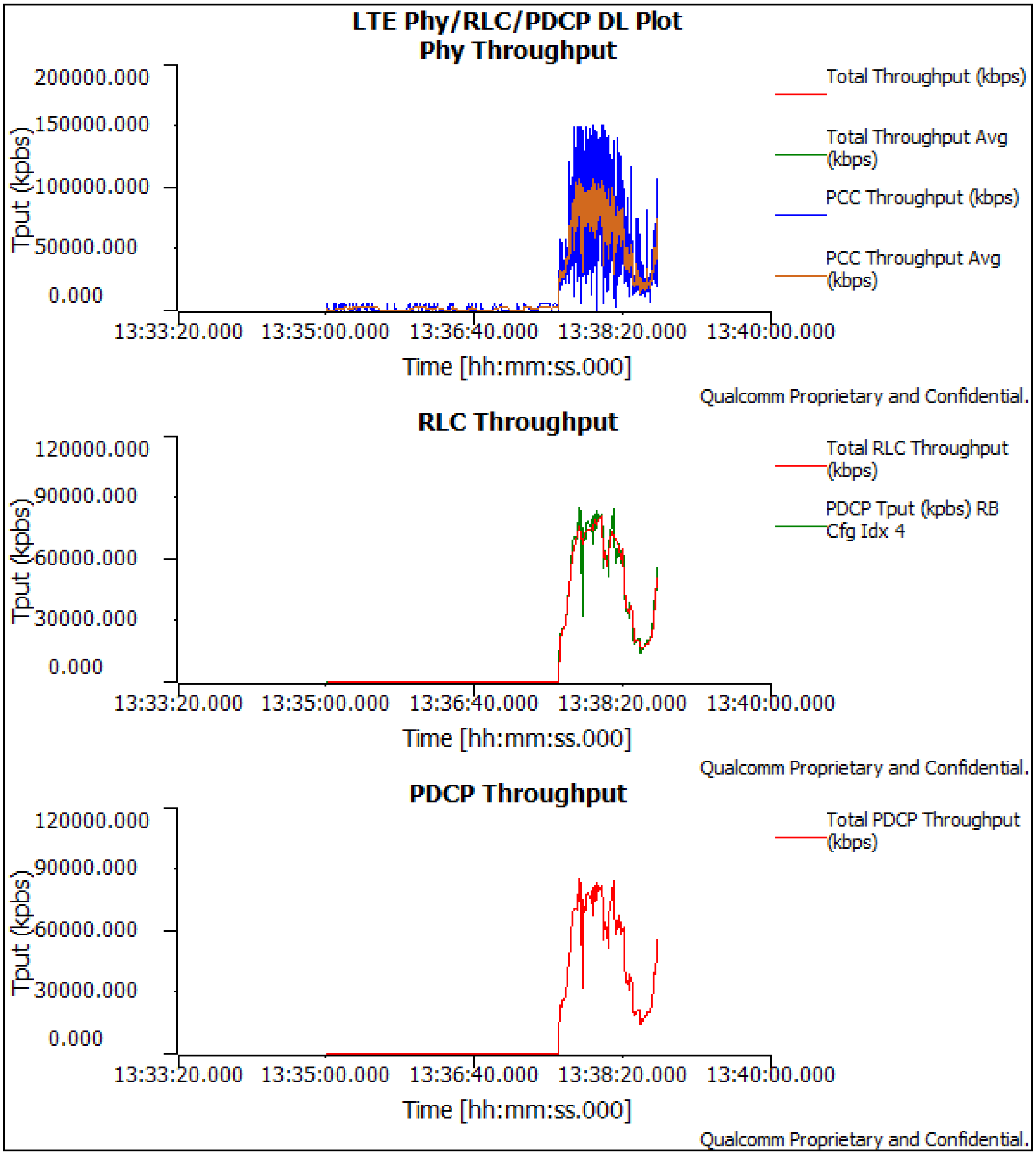


Figure 3-7 LTE DL Throughput vs. Time Plot

3.5 LTE DSDS Analysis vs Time

3.5.1 LTE FTL SNR TA vs Time

This obtains the starting and ending events which determine the start and end of the UE in RRC Connected mode:

Start event

Either of the two following events indicates that the UE enters RRC connected mode.

```
2014 Jan 29  07:27:04.844  [00]  0x1FFB  Event  --  EVENT_LTE_RRC_STATE_CHANGE
07:27:04.844 Event  0 : EVENT_LTE_RRC_STATE_CHANGE (ID=1606)  Payload = 0x04
Payload String = RRC State = Connected

2014 Jan 29  02:14:47.465  [00]  0x1FFB  Event  --  EVENT_LTE_RRC_NEW_CELL_IND
02:14:47.465 Event  0 : EVENT_LTE_RRC_NEW_CELL_IND (ID=1611)  Payload = 0x02 94
9D E0 00
Payload String = Cause = handover, Frequency = 40340, Cell ID = 224 – This is
the start event for Cell ID 224
```

End event

One of the three following events indicates that the UE leaves RRC connected mode.

```
2014 Jan 15  09:56:32.153  [00]  0x1FFB  Event  -
-  EVENT_LTE_RRC_STATE_CHANGE
09:56:32.153 Event  0 : EVENT_LTE_RRC_STATE_CHANGE (ID=1606)  Payload =
0x07
Payload String = RRC State = Closing

2014 Jan 20  14:11:41.651  [00]  0x1FFB  Event  -
-  EVENT_LTE_RRC_RADIO_LINK_FAILURE
14:11:41.651 Event  0 : EVENT_LTE_RRC_RADIO_LINK_FAILURE (ID=1608)  Payload
= 0x01 00
Payload String = Counter = 1

2013 Dec 23  19:19:41.563  [00]  0xB0C0  LTE RRC OTA Packet  --  DL_DCCH
RRC Release Number.Major.minor = 10.7.1
Radio Bearer ID = 1, Physical Cell ID = 164 – This is the end event for
Cell ID 164
Freq = 2175
SysFrameNum = N/A, SubFrameNum = 1
PDU Number = DL_DCCH Message,    Msg Length = 45
SIB Mask in SI =  0x00

Interpreted PDU:

value DL-DCCH-Message ::=
{
```

```
message c1 : rrcConnectionReconfiguration :
      {
        rrc-TransactionIdentifier 0,
        criticalExtensions c1 : rrcConnectionReconfiguration-r8 :
            {
              measConfig
              {
                measObjectToRemoveList
                {
                  1
   },
                ... ...
mobilityControlInfo   Mobility to EUTRAN (HO) RRC message
{
 targetPhysCellId 156,
```

At the beginning of the UE log, if there are not any start events indicated, the UE is in Connected mode and the first relevant event seen in the UE log is an end event for the UE in connected mode. In this case, consider the UE to be in Connected mode already and use the log packets given below to derive TDD ULDL config and SNR measurements per subframe accordingly for that Cell ID.

Look for [0xB0C0] LTE RRC OTA Packet – BCCH_DL_SCH with subfield message c1 : systemInformationBlockType1

This is called SIB1 message in LTE; match the Physical Cell ID in this SIB1 with the one found in Step 1. If it matches, then look for subfield tdd-Config in the same log packet. If tdd-Config cannot be located, it means that it is an FDD cell. If tdd-Config is located, it is a TDD cell and captures the subframeAssignment and specialSubframePatterns. The example below shows sa1 and ssp7:

```
tdd-Config
{
  subframeAssignment sa1,
  specialSubframePatterns ssp7
},
```

Depending on subframeAssignment config (which corresponds to UL/DL CFG in the table below), there are many different scenarios.

UL/DL CFG	DL->UL Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1		D	S	U	U	D	D	S	U	U	D
2		D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4		D	S	U	U	D	D	D	D	D	D
5		D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Figure 3-8 TDD UL/DL Config

The sa1 above represents UL/DL CFG 1, sa2 represents UL/DL CFG2, etc. The D and S in the above table represent Downlink and U represents Uplink.

In cases where this log packet is not available in the UE log prior to UE RRC Connected mode beginning events (in order to derive TDD ULDL configuration), consider the first LTE LL1 Rx AGC log packet [0xB11B] for the corresponding Cell ID with Number of records = 20. This occurs immediately after the UE RRC Connected mode starts the event.

In this log packet, two consecutive rows correspond to a single subframe. The starting subframe is two subframes less than that given by (System Frame Number, Sub Frame Number) in the log packet, i.e., starting subframe is (Sub Frame Number + 8) mod. For example:

```
2014 Jan 29  07:27:04.844  [00]  0x1FFB  Event  -
-  EVENT_LTE_RRC_STATE_CHANGE
      07:27:04.844 Event  0 : EVENT_LTE_RRC_STATE_CHANGE (ID=1606)  Payload
= 0x04
            Payload String = RRC State = Connected

2014 Jan 29  07:27:04.844  [00]  0x1FFB  LTE LL1 Rx Agc Log
Version                    = 21
Number of Records          = 20
AGC Mode                   = Traffic
System Frame Number        = 691
Sub Frame Number           = 5       starting subframe = (5 + 8) mod 10 = 3
Inner Loop Gain            = 0.000000      From mapping of SF type with
corresponding subframe, we can derive the ULDL configuration.
Outer Loop Gain            = 0.000000
Carrier Index              = PCC
Records
   --------------------------------------------------------------
   |       |     |        |         |Broadband|Measured|Measured|
   |Rx     |LNA  |        |         |RSSI     |Total   |Inband  |
   |Antenna|Gain |        |         |Estimate |RSSI    |RSSI    |
   |Index  |State|SF Type |DVGA (dB)|(dBm)    |(dBm)   |(dBm)   |Sub-frame
   --------------------------------------------------------------
   |    Rx0|    0|      DL|     5.30|   -76.00|  -71.25|  -84.75| 3
   |    Rx1|    0|      DL|     5.02|   -76.56|  -72.00|  -86.75| 3
   |    Rx0|    0|      DL|     5.30|   -84.19|  -71.25|  -85.00| 4
   |    Rx1|    0|      DL|     5.02|   -86.75|  -72.25|  -86.25| 4
```

```
    |     Rx0|     0|       DL|      5.34|    -79.63|  -71.50|  -85.00| 5
    |     Rx1|     0|       DL|      5.09|    -82.00|  -72.25|  -85.50| 5
    |     Rx0|     0| Special|      5.40|    -86.81|  -71.50|     N/A| 6
    |     Rx1|     0| Special|      5.16|   -121.06|  -72.25|     N/A| 6
    |     Rx0|     0|       UL|      5.46|    -53.88|  -71.50|     N/A| 7
    |     Rx1|     0|       UL|      5.22|    -61.75|  -72.25|     N/A| 7      ->
This implies ULDL config = 2
    |     Rx0|     0|       DL|      5.47|    -76.00|  -71.50|  -84.25| 8
    |     Rx1|     0|       DL|      5.23|    -79.19|  -72.25|  -84.75| 8
    |     Rx0|     0|       DL|      5.47|    -75.13|  -71.50|  -79.75| 9
    |     Rx1|     0|       DL|      5.23|    -75.94|  -72.25|  -81.25| 9
    |     Rx0|     0|       DL|      5.49|    -74.38|  -71.50|  -83.00| 0
    |     Rx1|     0|       DL|      5.26|    -75.63|  -72.50|  -82.50| 0
    |     Rx0|     0| Special|      5.53|    -75.06|  -71.50|     N/A| 1
    |     Rx1|     0| Special|      5.28|    -78.44|  -72.50|     N/A| 1
    |     Rx0|     0|       UL|      5.55|    -52.00|  -71.50|     N/A| 2
    |     Rx1|     0|       UL|      5.29|    -53.00|  -72.50|     N/A| 2
```

Look for 0xB182 LTE ML1 Multisim Packet

Look for subfield ta_event = TUNEAWAY_END, the following gets logged only for ta_event = TUNEAWAY_END.

If the above subfield is found **and** if the ta_type = TA_QTA, look for:

```
ta_event = TUNEAWAY_END
ta_type = TA_QTA
lte_state = IDLE_DRX_STATE
suspend_cause = TAM_QTA
reserved_0 = 0
chain_mask = Pcell Chain 0 | Pcell Chain 1
spv_timer_value = 0
trm_release_sclk = 0
ta_transition_time_gap_start = 20
ta_transition_time_gap_end = 20
TA Start {
   sfn = 885
   sub_fn = 5
   sclk_time = 1120208
}
TA End {
   sfn = 890
   sub_fn = 5
   sclk_time = 1123438
}
ta_duration = 50 ms
Unlock Info {
   tao_start_sfn = 0
```

```
        tao_start_sub_fn = 0
        unlock_schdlr_sclk = 0
        ta_relative = 0 ms
    }
```

In the above example, tune-away starts at frame 885, subframe 5, and ends at 890,5. Frame numbers run from 0 to 1023 and subframe numbers run from 0 to 9. If ta_type is not TA_QTA, then skip that log packet and move to the other [0xB182] log packet.

Capture the frame and subframe number for TA start and TA end, also capture the timestamp of the above log packet, TA duration, and TA type as highlighted.

Look for 0xB11B LTE LL1 Serving Cell FTL Results around the timestamp captured in previous step

For the TDD case only, the starting subframe in the list of FTL records is given by (Sub-frame number + 9) mod 10; for FDD case, the starting subframe is the actual one.

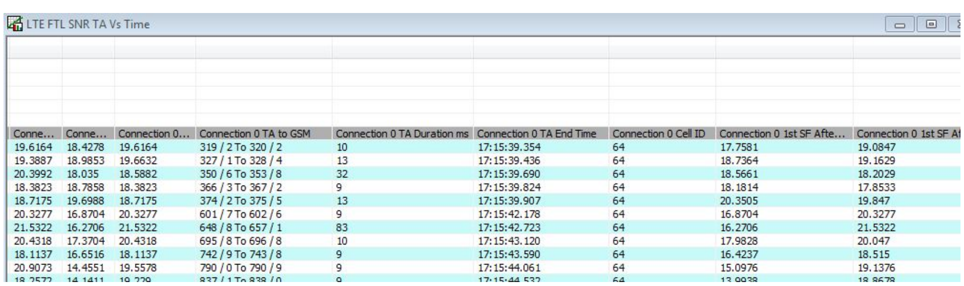
Capture Combined SNR[0] and Combined SNR[1] from the log packet for 8 subframes before the frame/subframes captured in step5 for TA start and put these values in a table “FTL SNR before tuneaway to GSM”; also capture SNR[0] and SNR[1] for 8 subframes after the frame/subframes captured in Step 4 for TA end and put these values in a table “FTL SNR after tuneback from GSM”.

For example, capture SNR[0] and SNR[1] for 885/4, 885/3, 885/2, 885/1, 884/9, 884/8, 884/7, 884/6 and put it in table “FTL SNR before tuneaway to GSM”. Also, capture SNR[0] and SNR[1] for 890/6, 890/7, 890/8, 890/9, 891/0, 891/1, 891/3, 891/4 and put it in table “FTL SNR after tuneback from GSM”.

If it is the TDD cell, the FTL SNR would not be logged for UL subframes defined in Table 1 above. So depending on the UL/DL config (meaning the subframeAssignment in SIB1), FTL SNR would not be seen being logged for subframes corresponding to UL.

For example, an SNR for subframes 2, 3, 7, and 8 for UL/DL CFG1 would not be visible. Move to the next/previous subframe accordingly, create a mapping algorithm when developing the analyzer which looks at the subframeAssignment from SIB1 and extracts FTL SNR for all DL subframes.

An example of the time grid is shown in Figure 3-9.


LTE FTL SNR TA Vs Time

Conne...	Conne...	Connection 0...	Connection 0 TA to GSM	Connection 0 TA Duration ms	Connection 0 TA End Time	Connection 0 Cell ID	Connection 0 1st SF Afte...	Connection 0 1st SF Af
19.6164	18.4278	19.6164	319 / 2 To 320 / 2	10	17:15:39.354	64	17.7581	19.0847
19.3887	18.9853	19.6632	327 / 1 To 328 / 4	13	17:15:39.436	64	18.7364	19.1629
20.3992	18.035	18.5882	350 / 6 To 353 / 8	32	17:15:39.690	64	18.5661	18.2029
18.3823	18.7858	18.3823	366 / 3 To 367 / 2	9	17:15:39.824	64	18.1814	17.8533
18.7175	19.6988	18.7175	374 / 2 To 375 / 5	13	17:15:39.907	64	20.3505	19.847
20.3277	16.8704	20.3277	601 / 7 To 602 / 6	9	17:15:42.178	64	16.8704	20.3277
21.5322	16.2706	21.5322	648 / 8 To 657 / 1	83	17:15:42.723	64	16.2706	21.5322
20.4318	17.3704	20.4318	695 / 8 To 696 / 8	10	17:15:43.120	64	17.9828	20.047
18.1137	16.6516	18.1137	742 / 9 To 743 / 8	9	17:15:43.590	64	16.4237	18.515
20.9073	14.4551	19.5578	790 / 0 To 790 / 9	9	17:15:44.061	64	15.0976	19.1376
18.2572	14.1411	19.229	837 / 1 To 838 / 0	9	17:15:44.532	64	13.9938	18.8678

Figure 3-9 LTE FTL SNR TA vs Time

3.5.2 LTE DSDS PMI TA vs Time

Algorithm for this analyzer:

1. Have a table and plot for the PMIs 4 subframes before and after Tune-Aways (TA).
2. Locate TA.
   a. Locate TAs in [0xB182] LTE ML1 Multisim Packet containing "**ta_event = TUNEAWAY_END**".
   b. [0xB182] shows the **Start sfn and sub_fn (= TA_S) or TA_S(i)** where "i" is the index of TA.
      - Capture 4 PMIs before TA_S.
   c. 0xB182 shows the **End sfn and sub_fn (= TA_E) or TA_E(i)** which "i" is index of TA
      - Capture 4 PMIs after TA_E.
3. Capture PMIs before **TA_S**.
   a. PMI comes in either 0xB14E LTE LL1 PUSCH CSF or [0xB14D] LTE LL1 PUCCH CSF packets depending on network configuration; review both.
   b. In [0xB14E], look for the value of Single WB PMI.
   c. In [0xB14D], look for the value of Wideband PMI.
   d. They show the PMI value after "=", e.g., 0, 1, or number.
   e. Have 4 PMI values before TA_S that can be from either [0xB14E], [0xB14D], or both. (PMI_before[0], PMI_before[-1], PMI_before[-2], PMI_before[-3]).
4. Capture PMIs after **TA_E**.
   a. The PMI comes in either [0xB14E] LTE LL1 PUSCH CSF or [0xB14D] LTE LL1 PUCCH CSF packets depending on network configuration; review both.
   b. In [0xB14E], look for the value of Single WB PMI.
   c. In [0xB14D], look for the value of Wideband PMI.
   d. They show the PMI value after "=", e.g., 0, 1, or number.
   e. Have 4 PMI values after TA_S that can be from either [0xB14E], [0xB14D], or both. (PMI_after[0], PMI_after[1], PMI_after[-2], PMI_after[-3]).
5. Create a table with TA times, TA indices (i), PMI_before(j), and PMI_after(j). j is the PMI before and after TA(i). j is -3, -2, -1, -0, 0, 1, 2, 3.
   - TA times exist in [0xB182], e.g., 2014 Feb 21 *18:27:09.336* [84] [0xB182] LTE ML1 Multisim Packet.
6. Plot the average of all PMI_before[j]s with their index, and average of all PMI_after[j]s.

A	B	C	D	E	F	G
	LTE DSDS PMI T...					
	Qualcomm Pro...					
	PMI bf[-3]	PMI bf[-2]	PMI bf[-1]	PMI bf[0]	TA_S(i)	Index
	3	3	3	3	770 2	0
	3	3	3	3	817 2	1
	3	3	3	3	865 7	2
	3	3	3	3	912 7	3
	3	3	3	3	959 8	4
	3	3	3	3	1006 9	5
	3	3	3	3	30 0	6
	3	3	3	3	77 0	7
	3	3	3	3	124 1	8
	3	3	3	3	171 2	9
	0	3	3	3	218 3	10
	3	3	0	3	265 3	11
	0	3	3	3	312 4	12
	3	3	0	0	359 5	13
	3	3	3	3	406 6	14
	3	3	3	3	453 7	15
	3	3	3	3	500 7	16
	3	3	0	3	547 8	17

3.5.3 LTE DSDS SR TA vs Time

The algorithm for this analyze is:

1. Have a table and plot of Scheduling Requests (SR) for 4 frames after TA and 1 frame before TA.
2. Locate TA.
   a. Locate TAs in the [0xB182] LTE ML1 Multisim Packet containing "**ta_event = TUNEAWAY_END**".
   b. [0xB182] shows the **Start sfn and sub_fn (= TA_S) or TA_S(i)** where "i" is the index of TA.
      – Capture 4 PMIs before TA_S.
   c. [0xB182] shows the **End sfn and sub_fn (= TA_E) or TA_E(i)** where "i" is the index of TA.
      – Capture 4 PMIs after TA_E.
3. Calculate SRs before **TA_S**.
   a. Locate [0xB173] LTE PDSCH Stat Indication.
   b. Calculate the average of SRs in 4 frames between "**TA_S(i)", start of TA and "TA_S(i)-0", 1 frames (10 subframes) before TA_S(i).**
4. Calculate SRs after **TA_S.**
   a. Locate [0xB173] LTE PDSCH Stat Indication.
   b. Calculate the average of DL MCSs in 4 frames between "**TA_E(i)" start of TA and "TA_S(i)+40", 4 frames (40 subframes) before TA_S(i).**
   c. Divide by 40 (the max available) and multiply by 100 to show in percentage.
5. Create a table with TA times, TA duration, and number of SRs before and after TA.
6. TA times exist in [0xB182], e.g., 2014 Feb 21 *18:27:09.336* [84] [0xB182] LTE ML1 Multisim Packet.

LTE DSDS SR TA...
Qualcomm Pro...

Num SRs Befor...	TA Time	TA Duration (ms)	Num SRs After ...
0	2014/04/18 19:0...	29	0
0	2014/04/18 19:0...	35	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	10	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	10	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	10	0
0	2014/04/18 19:0...	10	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	10	0
0	2014/04/18 19:0...	9	0
0	2014/04/18 19:0...	9	0

3.6 LTE Inst Meas RSRP vs Time

This time output plots the Inst Measured RSRP from the Serving Cell Measurement Result subpacket (ID 25) and the Inst Measured RSRP from the Connected Neighbor Meas Response subpacket (ID 31) for each Cell ID and EARFCN pair from LTE ML1 Idle Serving Cell Meas Response (0xB193) and LTE ML1 Connected Neighbor Meas Request/Response (0xB195). It is used as a measure of instantaneous power seen by the UE. An example of the time grid is shown in Figure 3-10 and an example of the plot is shown in Figure 3-11.

LTE Inst Meas RSRP vs. Time

LTE Inst Meas RSRP vs. Time
Qualcomm Proprietary and Confidential.

Time	Serving Cell ID	Cell 97 EARFCN 5770	Cell 162 EARFCN 5790
17:55:03.998	97	-104.5	
17:55:05.278	97	-105.25	
17:55:06.558	97	-104.625	
17:55:07.838	97	-105	
17:55:09.118	97	-104.063	
17:55:10.398	97	-103.438	
17:55:11.678	162		-106
17:55:12.958	162		-104.25
17:55:14.238	162		-102.375
17:55:15.518	162		-102.125
17:55:16.798	162		-104.25
17:55:18.078	162		-103.313
17:55:19.358	162		-104.438
17:55:20.638	97	-106.938	
17:55:21.918	97	-107.375	
17:55:23.198	97	-104.313	
17:55:24.478	97	-106.625	
17:55:25.758	97	-103.938	
17:55:27.038	97	-104.125	
17:55:28.318	97	-106.375	
17:55:29.598	162		-104.375
17:55:30.878	162		-104.25
17:55:32.158	162		-104.813
17:55:33.438	162		-104.375
17:55:34.718	162		-106.25
17:55:35.998	162		-102.625
17:55:37.278	162		-104.313
17:55:38.558	97	-105	
17:55:39.838	97	-105.563	
17:55:41.118	97	-104.313	
17:55:42.398	97	-106.188	
17:55:43.678	97	-104.875	
17:55:44.958	97	-106.938	

Figure 3-10 LTE Inst Meas RSRP vs Time grid

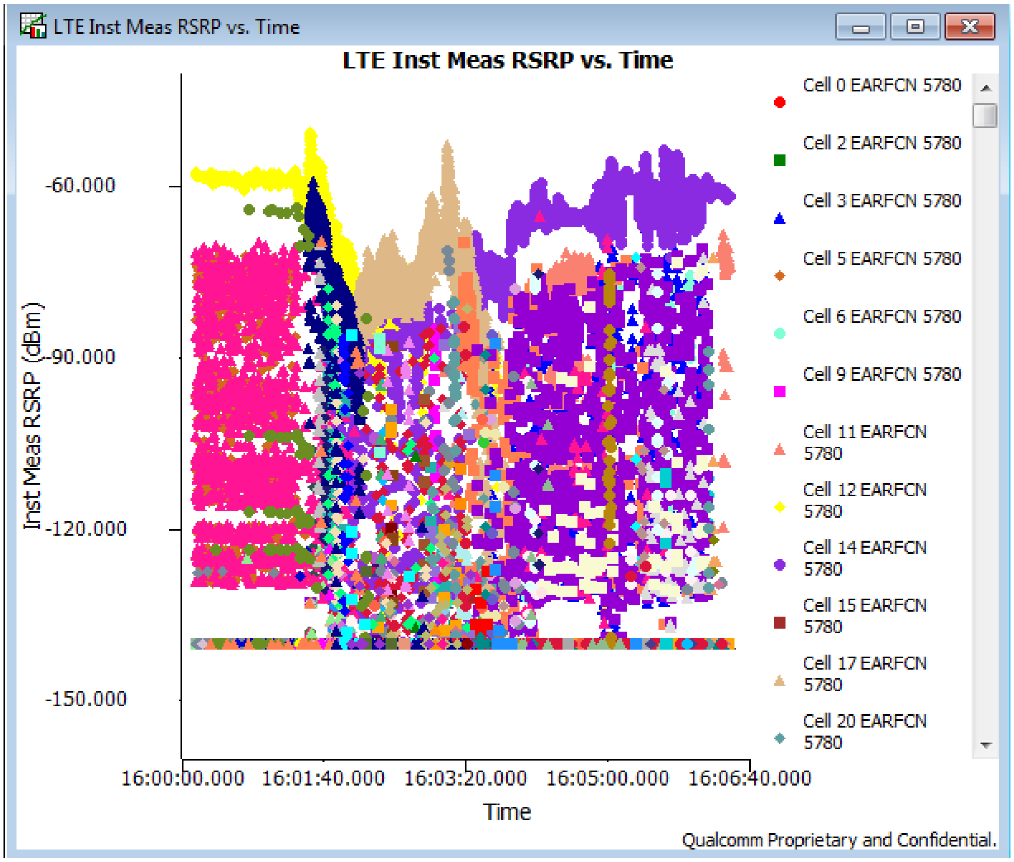


Figure 3-11 LTE Inst Meas RSRP vs Time plot

3.7 LTE Inst Meas RSRQ vs Time

This time output plots the Inst Measured RSRQ from the Serving Cell Measurement Result subpacket (ID 25) and the Inst Measured RSRQ from the Connected Neighbor Meas Response subpacket (ID 31) for each Cell ID and EARFCN pair from LTE ML1 Idle Serving Cell Meas Response (0xB193) and LTE ML1 Connected Neighbor Meas Request/Response (0xB195). It is used as a measure of instantaneous channel quality seen by the UE. An example of the time grid is shown in Figure 3-12 and an example of the plot is shown in Figure 3-13.

LTE Inst Meas RSRQ vs. Time

LTE Inst Meas RSRQ vs. Time
Qualcomm Proprietary and Confidential.

Time	Cell 12 EARFCN 5780	Cell 14 EARFCN 5780	Cell 15 EARFCN 5780
16:02:13.687			
16:02:13.689	-11.5625		
16:02:13.734			
16:02:13.736	-10.0625	-30	
16:02:13.774			
16:02:13.776	-9.25	-30	
16:02:13.814			
16:02:13.816	-9.1875	-30	
16:02:13.847			
16:02:13.849	-9.6875	-30	
16:02:13.894			
16:02:13.896	-8.25		-30
16:02:13.934			
16:02:13.936	-8.875		-30
16:02:13.974			
16:02:13.976	-8.5		-30
16:02:14.007			
16:02:14.009	-7.8125		-30
16:02:14.054			
16:02:14.056	-6.125	-30	
16:02:14.094			
16:02:14.096	-7.5	-30	
16:02:14.134			
16:02:14.136	-8.8125	-30	

Figure 3-12 LTE Inst Meas RSRQ vs Time grid

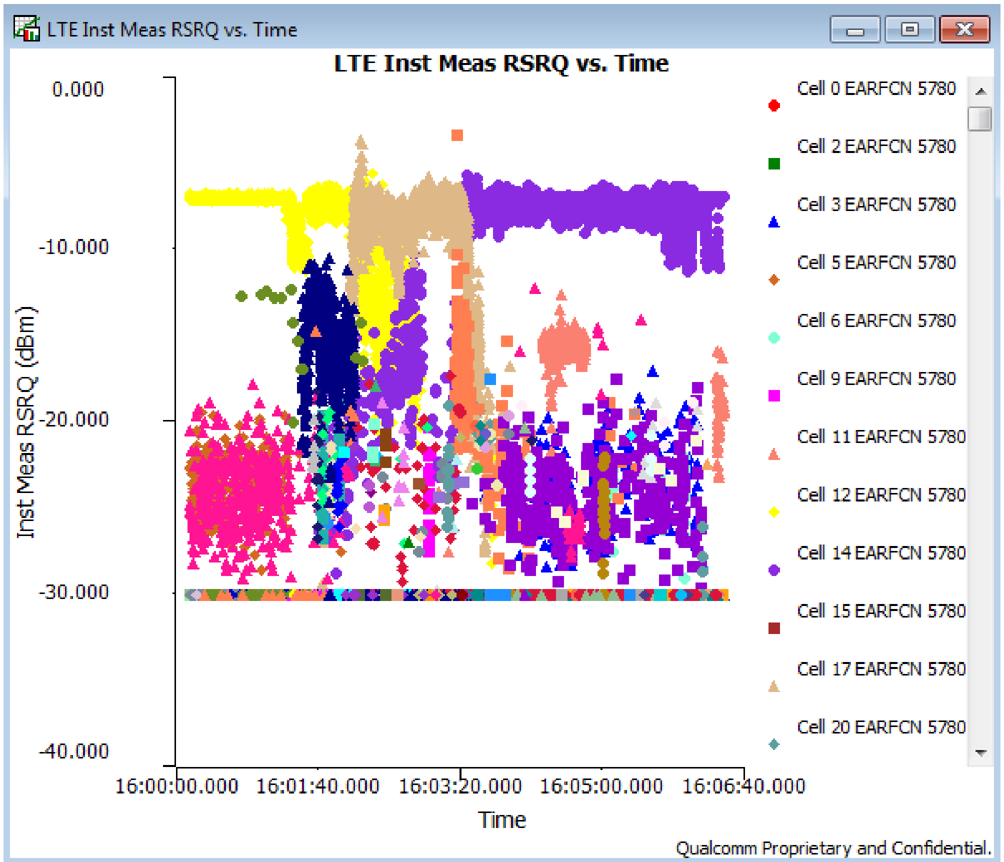


Figure 3-13 LTE Inst Meas RSRQ vs Time plot

3.8 LTE LC Buf Status vs Time

This time output plots the Total bytes field from the UL Buffer Status subpacket (ID 10) in the LTE MAC UL Buffer Status Internal (0xB066) log packet vs time for each logical channel ID in the log file. It is used as a measure of total data in the UE buffer for transmission on the UL and can be used to identify potential data stack issues. An example of the time grid is shown in Figure 3-14 and an example of the plot is shown in Figure 3-15.

LTE LC Buf Status vs. Time

Time	Total Bytes LC1	Total Bytes LC2	Total Bytes LC3
00:04:59.575	0	0	39125
00:04:59.576	0	0	44945
00:04:59.577	0	0	48161
00:04:59.578	0	0	52677
00:04:59.579	0	0	59799
00:04:59.580	0	0	83
00:04:59.581	0	0	1999
00:04:59.582	0	0	2666
00:04:59.583	0	0	64909
00:04:59.584	0	0	61615
00:04:59.585	0	0	58321
00:04:59.586	0	0	55025
00:04:59.587	0	0	51731
00:04:59.588	0	0	51731
00:05:00.355	0	0	3596
00:05:00.356	0	0	923
00:05:01.215	0	0	60835
00:05:01.216	0	0	58898
00:05:01.217	0	0	55604
00:05:01.218	0	0	52308
00:05:01.219	0	0	49014
00:05:01.220	0	0	45360
00:05:01.221	0	0	41706
00:05:01.222	0	0	38050
00:05:01.223	0	0	34396
00:05:01.224	0	0	30742
00:05:01.225	0	0	27090
00:05:01.226	0	0	23436

Figure 3-14 LTE LC Buf Status vs Time

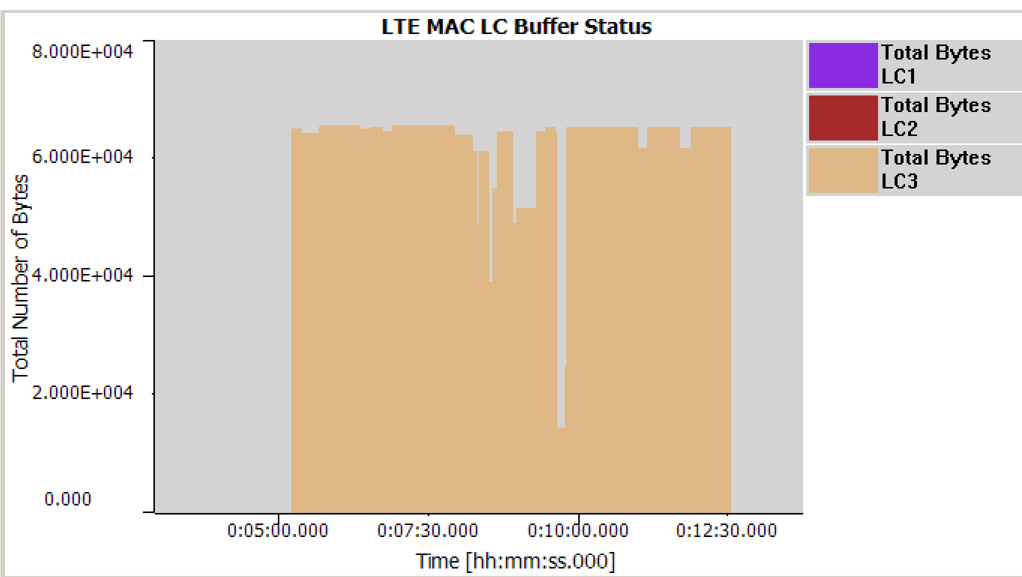


Figure 3-15 LTE MAC LC Buffer Status

3.9 LTE L1 CQI RI and MCS vs Time

This time output plots the CQI and RI per CC from LTE LL1 PUCCH CSF (0xB14D) and LTE LL1 PUSCH CSF (0xB14E) and MCS from LTE PDSCH Stat Indication (0xB173). It relates the CQI and rank reported by the UE to the MCS allocated by the network on the DL. An example of the time grid is shown in Figure 3-16 and an example of the plot is shown in Figure 3-17.

For 0xB14D and 0xB14E:

- For PCC values, only instances of the log where **carrier index == 0 (PCC)** are considered.
- For SCC values, only instances of the log where **carrier index == 1 (SCC)** are considered.

For 0xB173:

- For PCC values, only instances of the log where **Serving Cell Index == 0 (PCell)** are considered.
- For SCC values, only instances of the log where **Serving Cell Index > 0 (1-7, SCell)** are considered.

The respective plots are divided into two plots for PCC and SCC. The top subplot will show the PCC's related values and the bottom one will show SCC's related values.

MCS Avg values are the average of the previous 12 MCS values for the given configuration relative to number of layers and number of TBs used

CQI Avg values are the average of the previous 12 CQI values for the given Rank.

NOTE: The SCC plot is shown only if at least one log packet with **carrier index == 1 (SCC)** appears in the log files.

LTE L1 CQI RI and MCS vs. Time
Qualcomm Proprietary and Confidential.

Time	PCC Rank Index	PCC CQI CW0	PCC CQI CW1	PCell MCS0	PCell MCS1	PCell MCS2	SCC Rank Index	SCC CQI CW0	SCC CQI CW1	SCell MCS0	SCell MCS1	SCell MCS2
00:00:23.584				27						28		
00:00:23.585				27						28		
00:00:23.586				27						28		
00:00:23.587				27						28		
00:00:23.588				27						28		
00:00:23.589				27								
00:00:23.590				27						28		
00:00:23.591				27						28		
00:00:23.592				27						28		
00:00:23.593				27						28		
00:00:23.594				27						28		
00:00:23.595				27						28		
00:00:23.596				27						28		
00:00:23.597				27						28		
00:00:23.598				27						28		
00:00:23.599				27						28		
00:00:23.600				27						28		
00:00:23.601				27						28		
00:00:23.602				27						28		
00:00:23.603				27						28		
00:00:23.604				27						28		
00:00:23.605				27						28		

Figure 3-16 LTE L1 CQI RI and MCS vs Time grid

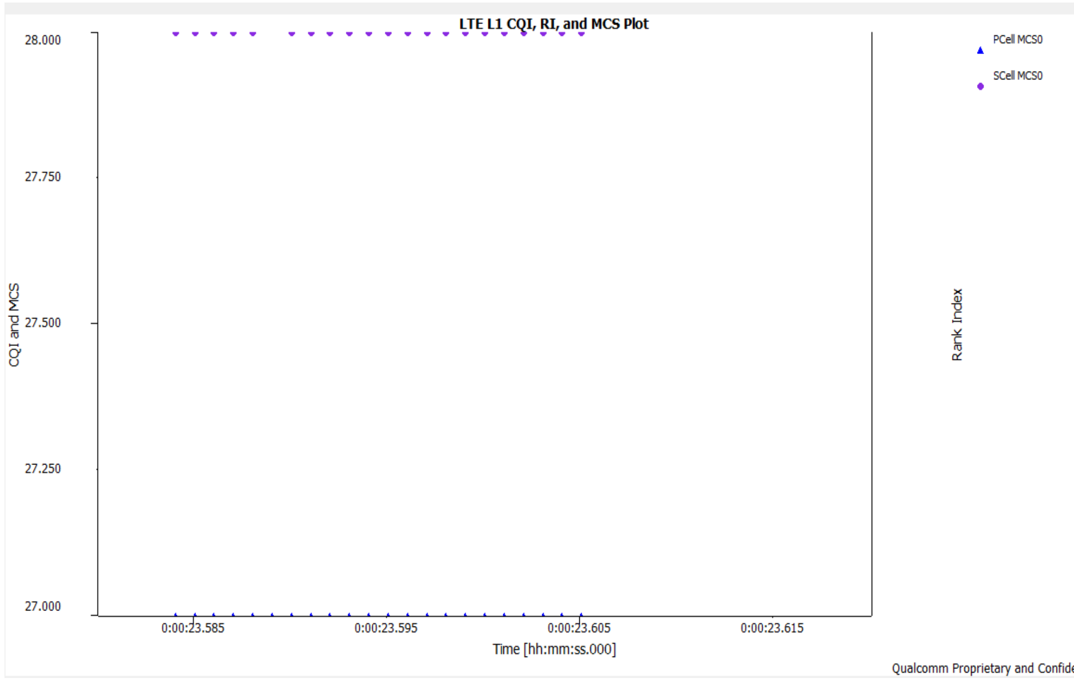


Figure 3-17 LTE L1 CQI, RI, and MCS Plot

3.10 LTE L1 Tput and BLER vs Time

This time output plots the Throughput, BLER, and Discarded TBs per serving cell from LTE PDSCH Stat Indication (0xB173). It can be used to evaluate the impact of BLER on throughput in the DL. An example of the time grid is shown in Figure 3-18 and an example of the plot is shown in Figure 3-19.

- Total Throughput (kpbs):

  Total Bytes = sum(TB Size from all reported blocks where CRC == PASS and ReTX != Present)

  Elapsed Time = Time of last record – Time of first record + 1 ms (this is the common case, but for the uncommon case it is somewhat not accurate, as there are some heuristics for calculating this with 0xB173, but they are well tested).

  Throughput = Total Bytes * 8 / 1000 / Elapsed Time in seconds

- Total Throughput Avg – The average value of the previous N Total Throughput values where N can be set in the analyzer's configuration. N is 6 by default.
- PCell Throughput (kpbs): Uses the same calculation as Total Throughput, but adds the restriction of Cell Index == PCell when summing the TB Size field
- PCell Throughput Avg – The average value of the previous N PCell Throughput values where N can be set in the analyzer's configuration. N is 6 by default.
- PCell BLER (%) = (Count of records where Serving Cell Index==0 and CRC Result == 0 and Discarded ReTx Present == false) / (Count of all transport block records where Serving Cell Index==0 – (Count of records where Serving Cell Index==0 and CRC Result == 0 and Discarded ReTx Present == true)) * 100
- PCell Discarded TBs (%) = Count of records where Serving Cell Index==0 and Discarded ReTx Present == 1 / Count of all transport block records where Serving Cell Index==0 * 100
- SCell Throughput (kbps): Uses the same calculation as Total Throughput, but adds the restriction of Cell Index > 0 when summing the TB Size field
- SCell Throughput Avg – The average value of the previous N SCell Throughput values where N can be set in the analyzer's configuration. N is 6 by default.
- SCell BLER (%) = (Count of records where Serving Cell Index>0 and CRC Result == 0 and Discarded ReTx Present == false) / (Count of all transport block records where Serving Cell Index>0 – (Count of records where Serving Cell Index>0 and CRC Result == 0 and Discarded ReTx Present == true)) * 100
- SCell Discarded TBs (%) = Count of records where Serving Cell Index>0 and Discarded ReTx Present == 1 / Count of all transport block records where Serving Cell Index==0 * 100
- PCell MIMO % **-** The number of PCell records where TB = 2 divided by the total number of PCell records
- SCell MIMO % **-** The number of SCell records where TB = 2 divided by the total number of Scell records

LTE L1 Tput and BLER vs. Time
Qualcomm Proprietary and Confidential.

Time	Total Throughput (kbps)	PCell Throughput (kbps)	PC
00:00:22.735	63.1304	63.1304	0
00:00:23.035	345.81	345.81	0
00:00:23.335	339.816	339.816	0
00:00:23.403	31244.7	31244.7	0
00:00:23.425	31397.8	31397.8	0
00:00:23.448	31244.7	31244.7	0
00:00:23.470	31397.8	31397.8	0
00:00:23.495	25363.2	25363.2	9.(
00:00:23.516	31244.7	31244.7	0
00:00:23.538	31397.8	31397.8	0
00:00:23.560	31397.8	31397.8	0
00:00:23.581	29956.7	29956.7	0
00:00:23.595	31142.7	31142.7	0
00:00:23.605	-33.771	-33.771	0
00:00:23.615	-33.771	-33.771	0
00:00:23.626	28781.3	28781.3	0

Figure 3-18 LTE L1 Tput and BLER vs Time

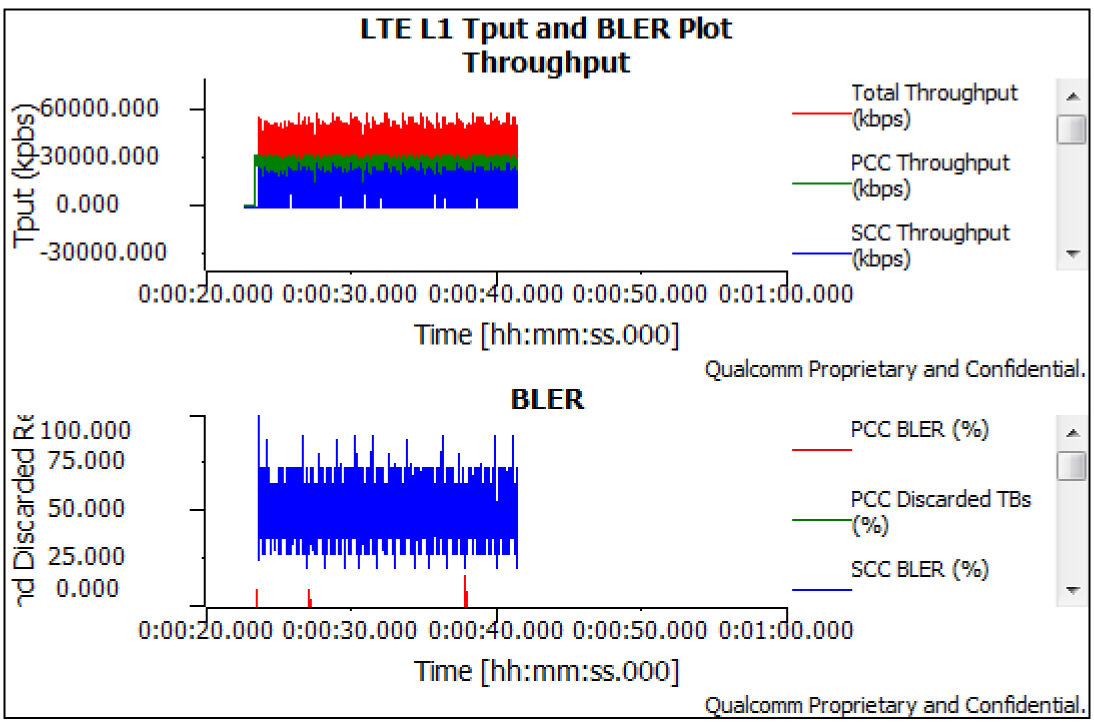


Figure 3-19 LTE L1 Tput and BLER plot

3.11 LTE MAC UL Grant vs Time

This time output plots the Grant field and padding (calculated as Grant – padding) from the UL Transport Block subpacket (ID 8) in the LTE MAC UL Transport Block (0xB064) log packet vs time. It is useful for seeing grant utilization and checking SR Triggers and grant assignment. An example of the time grid is shown in Figure 3-20 and an example of the plot is shown in Figure 3-21.

A	B	C	D
	LTE MAC UL Grant vs. Time		
	Time	Grant (bytes)	Utilized Grant (bytes)
	00:05:26.435	3963	5
	00:05:26.436	3963	5
	00:05:26.437	3963	5
	00:05:26.438	3963	5
	00:05:26.439	3963	5
	00:05:26.440	3963	5
	00:05:26.441	3963	5
	00:05:26.442	3963	5
	00:05:26.467	2292	2292
	00:05:26.475	3302	3302
	00:05:26.476	3302	3302
	00:05:26.477	3302	3302
	00:05:26.478	3302	3302
	00:05:26.479	3302	3302
	00:05:26.480	3302	3302
	00:05:26.481	3302	3302

Figure 3-20 LTE MAC UL Grant vs Time

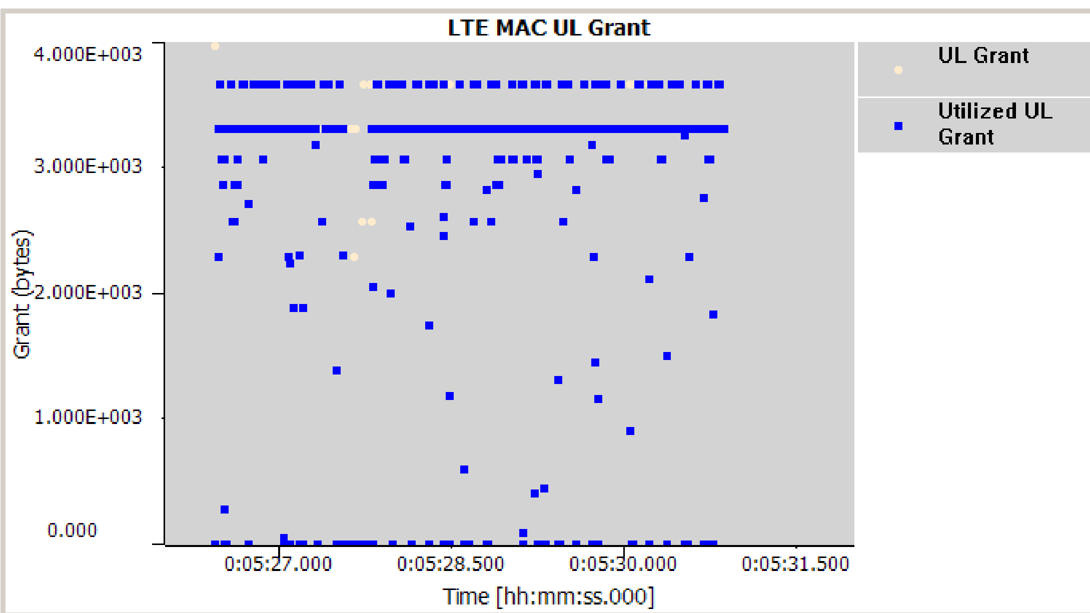


Figure 3-21 LTE MAC UL Grant

3.12 LTE MAC UL Grant with BSR Idx

This time output plots the information from the LTE MAC UL Grant vs Time (Section 3.11) along with the BSR Index from each logical group in terms of bytes, as in the LTE BSR Index vs Time analyzer (Section 3.1). It is useful for debugging SR/BSR related or UL scheduler issues. An example of the output is shown in Figure 3-22.

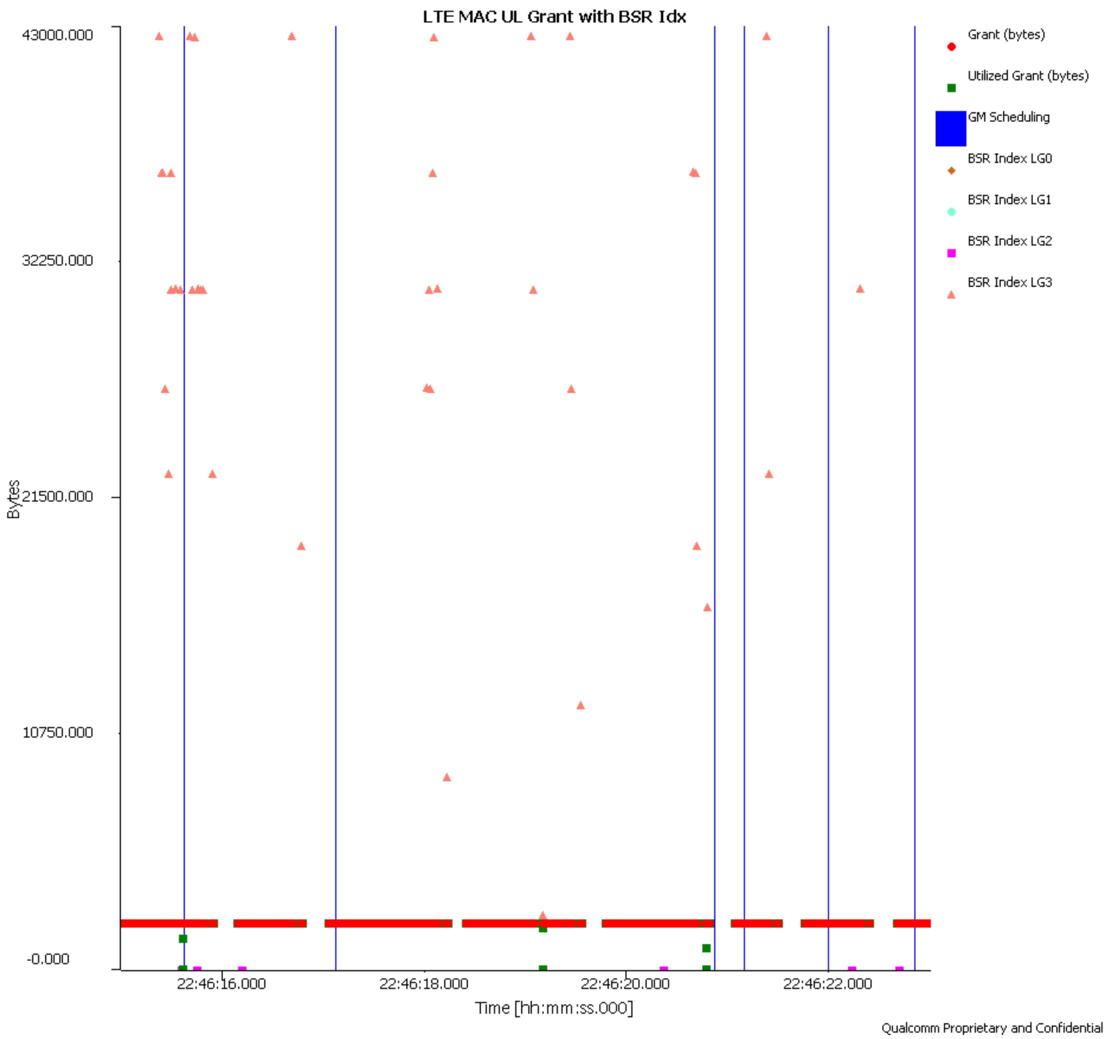


Figure 3-22 LTE MAC UL Grant with BSR Idx

3.13 LTE MAC UL RLC PDUs vs Time

This time output plots the RLC PDUs field from the UL Transport Block subpacket (ID 8) in the LTE MAC UL Transport Block (0xB064) log packet vs time. It is useful for visualizing the number of RLC PDUs contained in each MAC PDU packet. An example of the time grid is shown in Figure 3-23 and example of the plot is shown in Figure 3-24.

A	B	C
	LTE MAC UL RLC PDUs vs. Time	
	Time	RLC PDUs
	00:05:26.435	0
	00:05:26.436	0
	00:05:26.437	0
	00:05:26.438	0
	00:05:26.439	0
	00:05:26.440	0
	00:05:26.441	0
	00:05:26.442	0
	00:05:26.467	1
	00:05:26.475	1
	00:05:26.476	1
	00:05:26.477	1
	00:05:26.478	1
	00:05:26.479	1
	00:05:26.480	1
	00:05:26.481	1

Figure 3-23 LTE MAC UL RLC PDUs vs Time

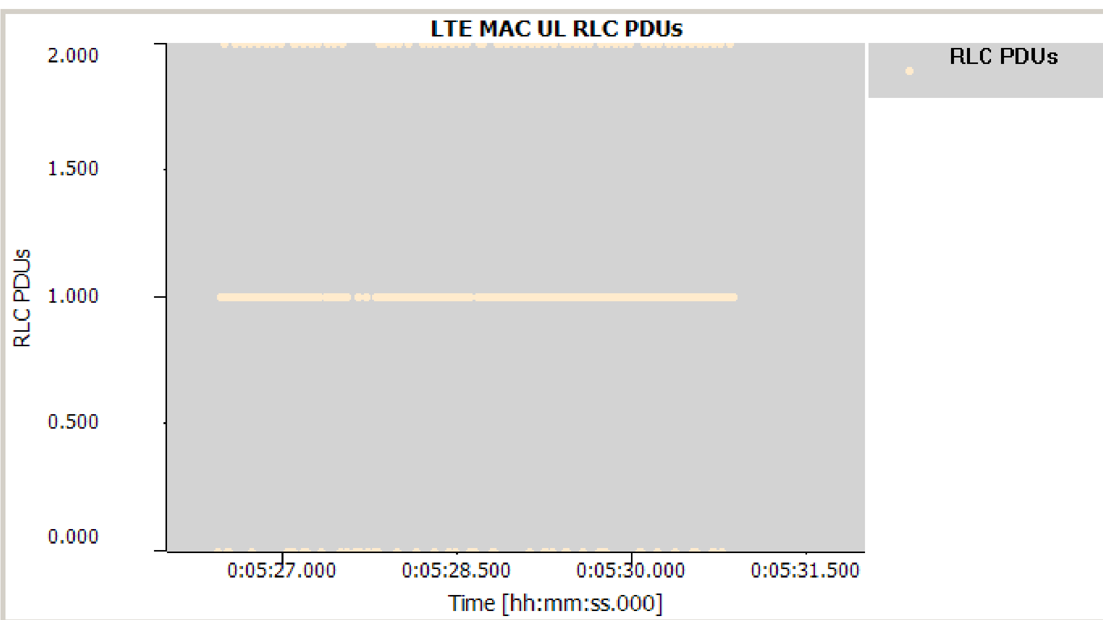


Figure 3-24 LTE MAC UL RLC PDUs

3.14 LTE Pdsch Stat Indication vs Time

This time-grid analyzer displays all the 0xB173 (LTE PDSCH STAT INDICATION) log packet's fields along with the time of the log-packet. It gives an overall picture of the DL on the PDSCH as seen by the UE. An example of the time grid for LTE Pdsch Stat Indication vs Time is shown in Figure 3-25.

LTE Pdsch Stat Indication vs. Time
Qualcomm Proprietary and Confidential.

Time	Sub Frame Num	Frame Num	Num Rbs	Num Layers	Num Blocks	Serv Cell Index	HARQ ID	RV	NDI	CRC Result	RNTI Type	TB Index	Discarded reTx	Did Recombining	TB Size	MCS
00:00:23.584	0	338	44	2	1	0	6	0	0	Pass	C	0	None	No	3542	27
00:00:23.584	0	338	50	2	1	1	1	0	1	Fail	C	0	None	No	4587	28
00:00:23.585	1	338	50	2	1	0	7	0	0	Pass	C	0	None	No	3963	27
00:00:23.585	1	338	44	2	1	1	2	0	1	Fail	C	0	None	No	4107	28
00:00:23.586	2	338	50	2	1	0	0	0	1	Pass	C	0	None	No	3963	27
00:00:23.586	2	338	50	2	1	1	3	0	1	Fail	C	0	None	No	4587	28
00:00:23.587	3	338	50	2	1	0	1	0	1	Pass	C	0	None	No	3963	27
00:00:23.587	3	338	50	2	1	1	4	0	1	Fail	C	0	None	No	4587	28
00:00:23.588	4	338	50	2	1	0	5	0	1	Pass	C	0	None	No	3963	27
00:00:23.588	4	338	50	2	1	1	5	0	1	Fail	C	0	None	No	4587	28
00:00:23.589	5	338	44	2	1	0	2	0	1	Pass	C	0	None	No	3542	27
00:00:23.590	6	338	50	2	1	0	3	0	1	Pass	C	0	None	No	3963	27
00:00:23.590	6	338	50	2	1	1	6	0	1	Fail	C	0	None	No	4587	28
00:00:23.591	7	338	50	2	1	0	4	0	1	Pass	C	0	None	No	3963	27
00:00:23.591	7	338	50	2	1	1	0	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.592	8	338	50	2	1	0	6	0	1	Pass	C	0	None	No	3963	27
00:00:23.592	8	338	50	2	1	1	1	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.593	9	338	50	2	1	0	7	0	1	Pass	C	0	None	No	3963	27
00:00:23.593	9	338	44	2	1	1	2	2	1	Fail	C	0	None	Yes	4107	28
00:00:23.594	0	339	50	2	1	0	0	0	0	Pass	C	0	None	No	3963	27
00:00:23.594	0	339	50	2	1	1	3	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.595	1	339	50	2	1	0	1	0	0	Pass	C	0	None	No	3963	27
00:00:23.595	1	339	50	2	1	1	4	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.595	2	339	50	2	1	0	5	0	0	Pass	C	0	None	No	3963	27
00:00:23.595	2	339	50	2	1	1	5	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.596	3	339	50	2	1	0	2	0	0	Pass	C	0	None	No	3963	27
00:00:23.596	3	339	50	2	1	1	7	0	1	Fail	C	0	None	No	4587	28
00:00:23.597	4	339	50	2	1	0	3	0	0	Pass	C	0	None	No	3963	27
00:00:23.597	4	339	50	2	1	1	6	2	1	Fail	C	0	None	Yes	4587	28
00:00:23.598	5	339	50	2	1	0	4	0	0	Pass	C	0	None	No	3963	27
00:00:23.598	5	339	50	2	1	1	0	3	1	Fail	C	0	None	Yes	4587	28
00:00:23.599	6	339	50	2	1	0	6	0	0	Pass	C	0	None	No	3963	27
00:00:23.599	6	339	50	2	1	1	1	3	1	Fail	C	0	None	Yes	4587	28

Figure 3-25 LTE Pdsch Stat Indication vs Time

3.15 LTE PUSCH BLER vs Subframe

The LTE PUSCH BLER vs Subframe analyzer shows the UL BLER per subframe from the LTE PDCCH-PHICH Indication Report (0xB16B). The UL BLER is calculated by dividing the number of PHICH NAK records in that subframe by the total number of scheduled uplink blocks in that subframe. The subframe number is determined by the following logic:

Check Duplex mode and TDD ULDL config, if applicable.

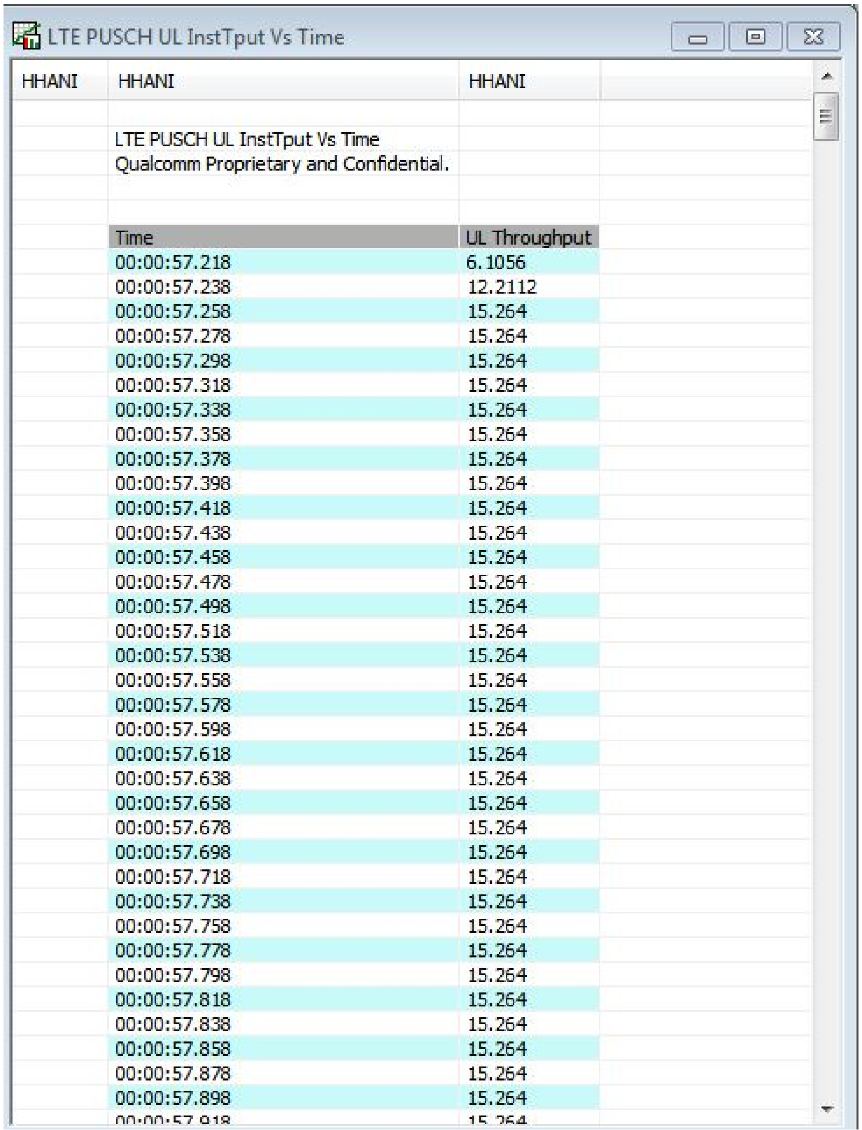
- If Duplex mode shows FDD (if the Duplex mode field does not exist, FDD is assumed), then the PHICH location and ACK/NACK decisions on subframe *n* correspond to PUSCH subframe *(n-4)mod10*. The number of PUSCH transmissions of subframe *(n-4)mod10* is incremented by 1 and the total number of NACK is incremented by 1 if the PHICH value shows NACK. For example, if n=2, then the subframe 2 PHICH ACK/NACK correspond to the subframe 8 PUSCH in the previous frame.
- If Duplex mode shows TDD, check the TDD ULDL Config field.
  - If ULDL Config is between 1 and 6, PHICH ACK/NACK decisions on subframe *n* correspond to PUSCH subframe *(n-a)mod10*, where *a* is shown in Table 3-1. If the number of PUSCH transmission of subframe *(n-a)mod10* is incremented by 1, the total number of NACK is incremented by 1 if the PHICH value shows NACK.

Table 3-1 Table for *a*

ULDL Cfg	Sub_fn 0	Sub_fn 1	Sub_fn 2	Sub_fn 3	Sub_fn 4	Sub_fn 5	Sub_fn 6	Sub_fn 7	Sub_fn 8	Sub_fn 9
1	invalid	4	invalid	invalid	6	invalid	4	invalid	invalid	6
2	invalid	invalid	invalid	6	invalid	invalid	invalid	invalid	6	invalid
3	6	invalid	invalid	invalid	invalid	invalid	invalid	invalid	6	6
4	invalid	invalid	invalid	invalid	invalid	invalid	invalid	invalid	6	6
5	invalid	invalid	invalid	invalid	invalid	invalid	invalid	invalid	6	invalid
6	6	4	invalid	invalid	invalid	7	4	invalid	invalid	6

3.16 LTE PUSCH UL InstTput vs Time

This time output shows the instantaneous physical throughput of the sum of TB size (bits) for all records in each packet from LTE PUSCH TX Report (0xB139). The throughput is shown for each 20 ms window. The results are displayed as a grid in Figure 3-26.

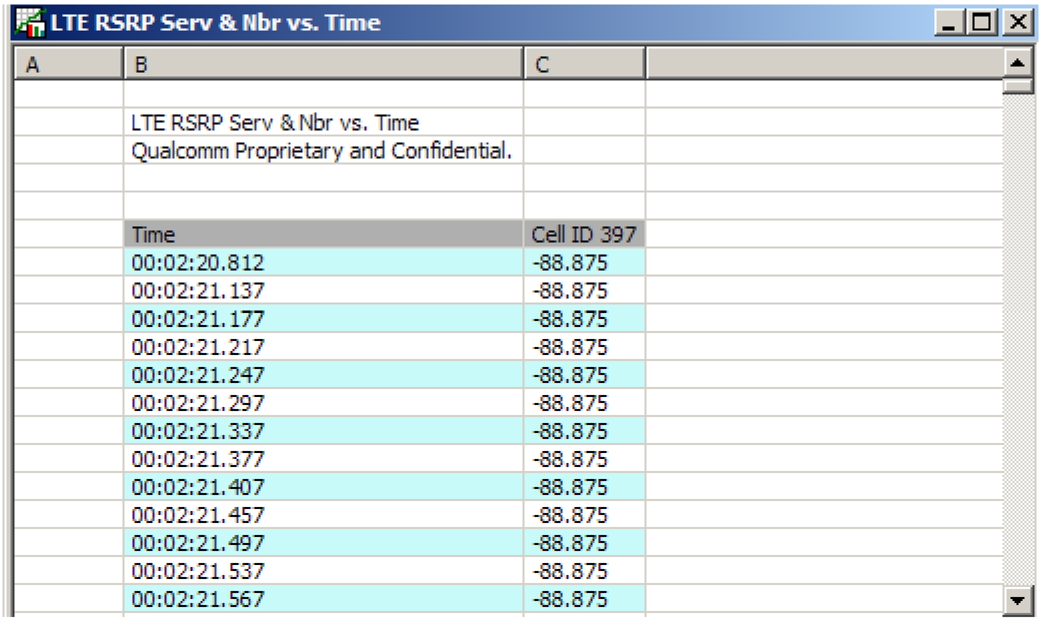


Time	UL Throughput
00:00:57.218	6.1056
00:00:57.238	12.2112
00:00:57.258	15.264
00:00:57.278	15.264
00:00:57.298	15.264
00:00:57.318	15.264
00:00:57.338	15.264
00:00:57.358	15.264
00:00:57.378	15.264
00:00:57.398	15.264
00:00:57.418	15.264
00:00:57.438	15.264
00:00:57.458	15.264
00:00:57.478	15.264
00:00:57.498	15.264
00:00:57.518	15.264
00:00:57.538	15.264
00:00:57.558	15.264
00:00:57.578	15.264
00:00:57.598	15.264
00:00:57.618	15.264
00:00:57.638	15.264
00:00:57.658	15.264
00:00:57.678	15.264
00:00:57.698	15.264
00:00:57.718	15.264
00:00:57.738	15.264
00:00:57.758	15.264
00:00:57.778	15.264
00:00:57.798	15.264
00:00:57.818	15.264
00:00:57.838	15.264
00:00:57.858	15.264
00:00:57.878	15.264
00:00:57.898	15.264
00:00:57.918	15.264

Figure 3-26 PUSCH UL InstTput vs Time grid

3.17 LTE RSRP Serv & Nbr vs Time

This time output plots the Inst Measured RSRP from the Idle Neighbor Meas Result subpacket (ID 27) for each LTE Idle Neighbor Cell Meas Response/Request (0xB192), Serving Cell Measurement Result subpacket (ID 25) and the Inst Measured RSRP from the Connected Neighbor Meas Response subpacket (ID 31) for each Cell ID from LTE ML1 Idle Serving Cell Meas Response (0xB193) and LTE ML1 Connected Neighbor Meas Request/Response (0xB195). It gives an overall picture of the serving and neighbor powers seen by the UE. An example of the time grid is shown in Figure 3-27 and an example of the plot is shown in Figure 3-28.



LTE RSRP Serv & Nbr vs. Time

A	B	C
	LTE RSRP Serv & Nbr vs. Time	
	Qualcomm Proprietary and Confidential.	
	Time	Cell ID 397
	00:02:20.812	-88.875
	00:02:21.137	-88.875
	00:02:21.177	-88.875
	00:02:21.217	-88.875
	00:02:21.247	-88.875
	00:02:21.297	-88.875
	00:02:21.337	-88.875
	00:02:21.377	-88.875
	00:02:21.407	-88.875
	00:02:21.457	-88.875
	00:02:21.497	-88.875
	00:02:21.537	-88.875
	00:02:21.567	-88.875

Figure 3-27 LTE RSRP Serv & Nbr vs Time grid

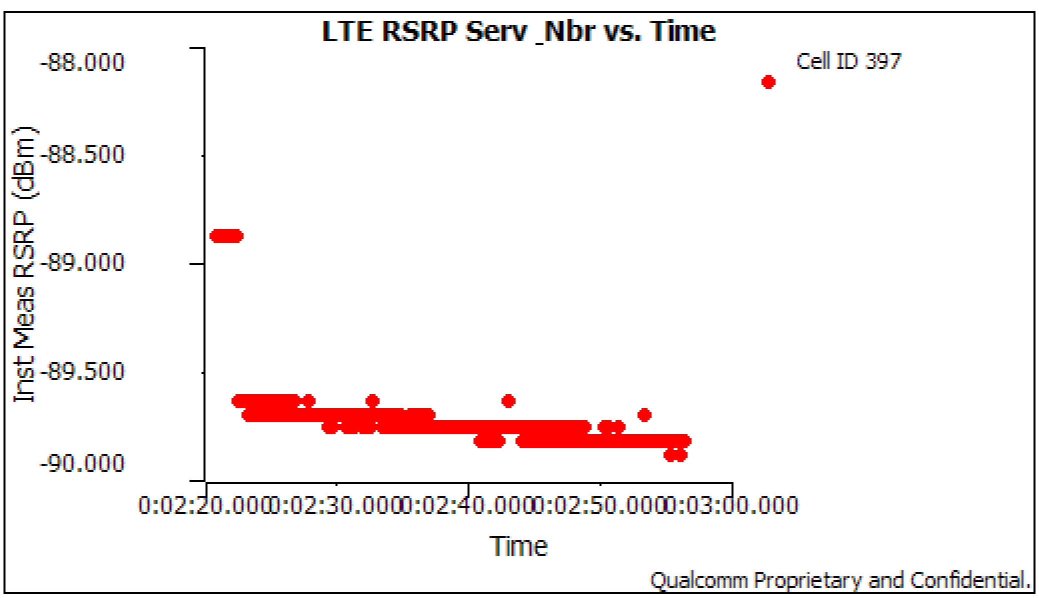
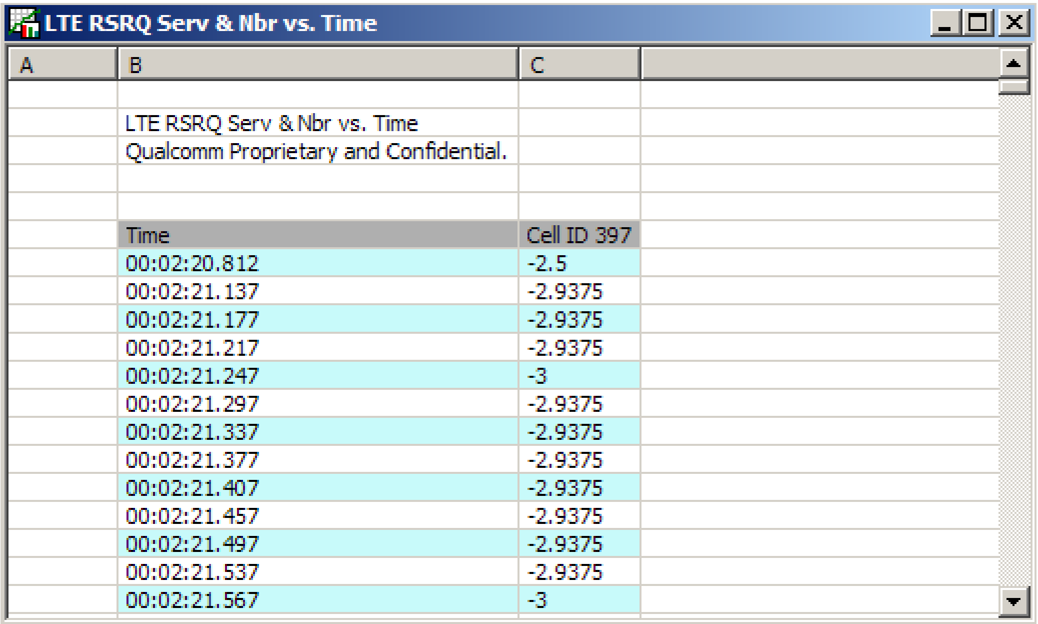


Figure 3-28 LTE RSRP Serv & Nbr vs Time plot

3.18 LTE RSRQ Serv & Nbr vs Time

This time output plots the Inst Measured RSRQ from the Idle Neighbor Meas Result subpacket (ID 27) for each LTE Idle Neighbor Cell Meas Response/Request (0xB192), Serving Cell Measurement Result subpacket (ID 25) and the Inst Measured RSRP from the Connected Neighbor Meas Response subpacket (ID 31) for each Cell ID from LTE ML1 Idle Serving Cell Meas Response (0xB193) and LTE ML1 Connected Neighbor Meas Request/Response (0xB195). It gives an overall picture of the serving and neighbor quality seen by the UE. An example of the time grid is shown in Figure 3-29 and an example of the plot is shown in Figure 3-30.



LTE RSRQ Serv & Nbr vs. Time

A	B	C
	LTE RSRQ Serv & Nbr vs. Time	
	Qualcomm Proprietary and Confidential.	
	Time	Cell ID 397
	00:02:20.812	-2.5
	00:02:21.137	-2.9375
	00:02:21.177	-2.9375
	00:02:21.217	-2.9375
	00:02:21.247	-3
	00:02:21.297	-2.9375
	00:02:21.337	-2.9375
	00:02:21.377	-2.9375
	00:02:21.407	-2.9375
	00:02:21.457	-2.9375
	00:02:21.497	-2.9375
	00:02:21.537	-2.9375
	00:02:21.567	-3

Figure 3-29 LTE RSRQ Serv & Nbr vs Time grid

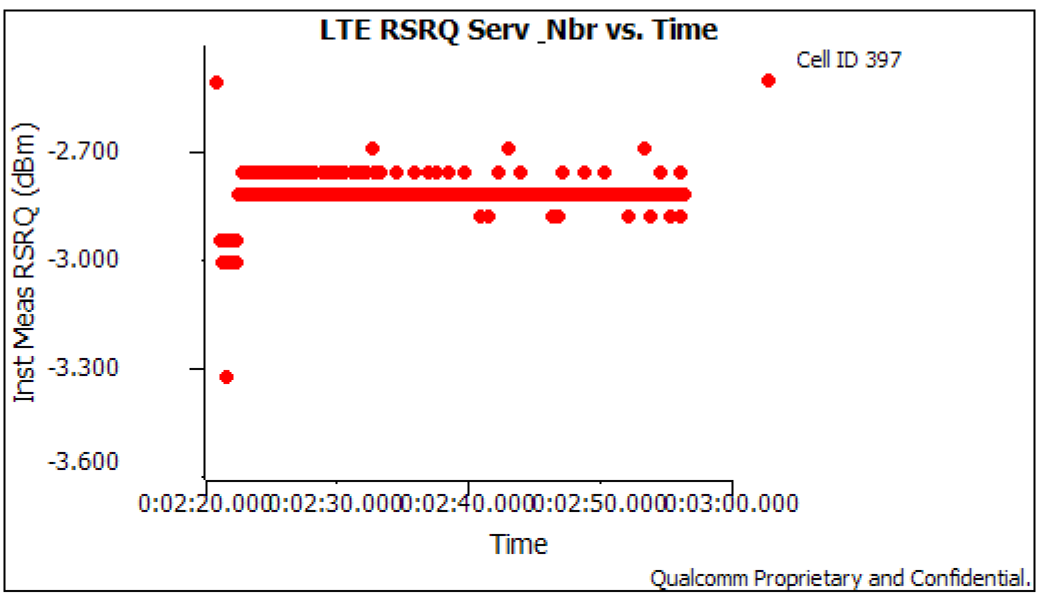


Figure 3-30 LTE RSRQ Serv & Nbr vs Time plot

3.19 LTE SCell Activation vs. Time

The LTE SCell Activation vs. Time grid shows the percentage of time the SCell was active for each second. SCell Active time is determined by when the To State = ACTIVE in EVENT_LTE_SCELL_STATE_CHANGE_ENHANCED (ID 2590). An example of the grid is shown in Figure 3-31 and an example of the plot is shown in Figure 3-32.

A	B	C	D
	LTE SCell Activation vs. Time		
	Qualcomm Proprietary and Confidential.		
	Time	S-Cell activatio...	
	14:18:18.000	0	
	14:18:19.000	0	
	14:18:20.000	85.6891	
	14:18:21.000	0	
	14:18:22.000	0	
	14:18:23.000	0	
	14:18:24.000	0	

Figure 3-31 LTE SCell Activation vs. Time grid

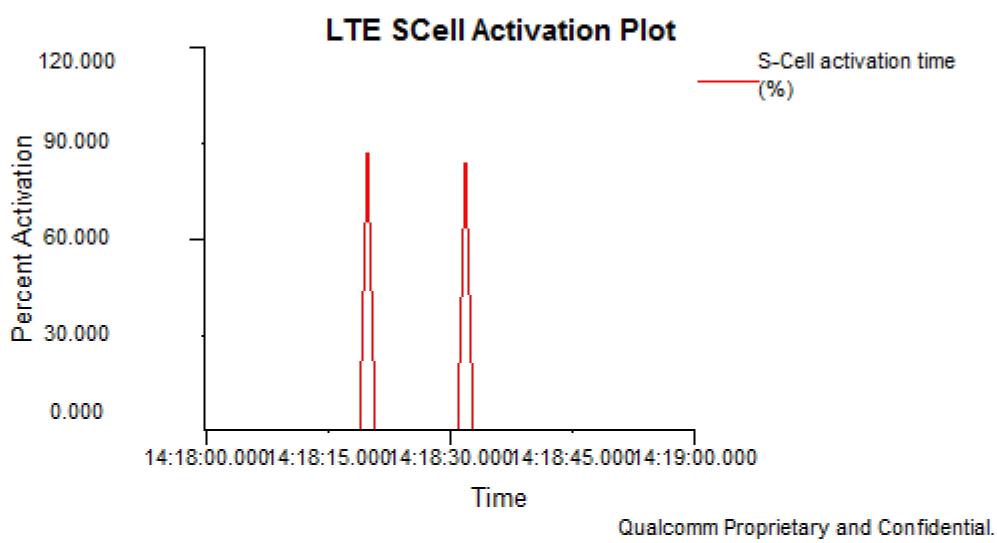
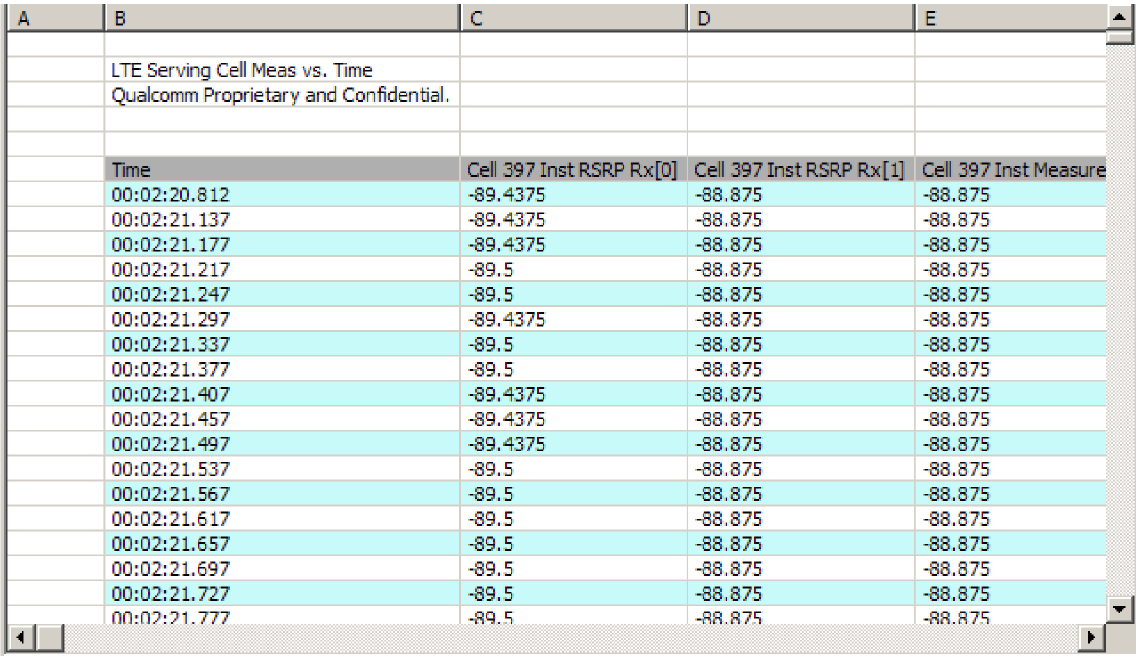


Figure 3-32 LTE SCell Activation Plot

3.20 LTE Serving Cell Meas vs Time

This time grid displays the Radio Link Failures from EVENT_LTE_RRC_RADIO_LINK_FAILURE (1608) with the Inst RSRP, Inst RSRQ, and Inst RSSI fields per EARFCN/Cell ID combination from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. It gives the serving cell conditions seen by the UE. An example of the time grid is shown in
Figure 3-33. These fields are used to generate the following plots in this section.



A	B	C	D	E
	LTE Serving Cell Meas vs. Time			
	Qualcomm Proprietary and Confidential.			
	Time	Cell 397 Inst RSRP Rx[0]	Cell 397 Inst RSRP Rx[1]	Cell 397 Inst Measure
	00:02:20.812	-89.4375	-88.875	-88.875
	00:02:21.137	-89.4375	-88.875	-88.875
	00:02:21.177	-89.4375	-88.875	-88.875
	00:02:21.217	-89.5	-88.875	-88.875
	00:02:21.247	-89.5	-88.875	-88.875
	00:02:21.297	-89.4375	-88.875	-88.875
	00:02:21.337	-89.5	-88.875	-88.875
	00:02:21.377	-89.5	-88.875	-88.875
	00:02:21.407	-89.4375	-88.875	-88.875
	00:02:21.457	-89.4375	-88.875	-88.875
	00:02:21.497	-89.4375	-88.875	-88.875
	00:02:21.537	-89.5	-88.875	-88.875
	00:02:21.567	-89.5	-88.875	-88.875
	00:02:21.617	-89.5	-88.875	-88.875
	00:02:21.657	-89.5	-88.875	-88.875
	00:02:21.697	-89.5	-88.875	-88.875
	00:02:21.727	-89.5	-88.875	-88.875
	00:02:21.777	-89.5	-88.875	-88.875

Figure 3-33 LTE Serving Cell Meas vs Time grid

3.20.1 LTE Serv Inst RSRP Rx plot

This plot shows the Inst RSRP Rx[0] and Inst RSRP Rx[1] fields per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. It gives the RSRP of serving cell for both the antennas. An example of the plot is shown in Figure 3-34.

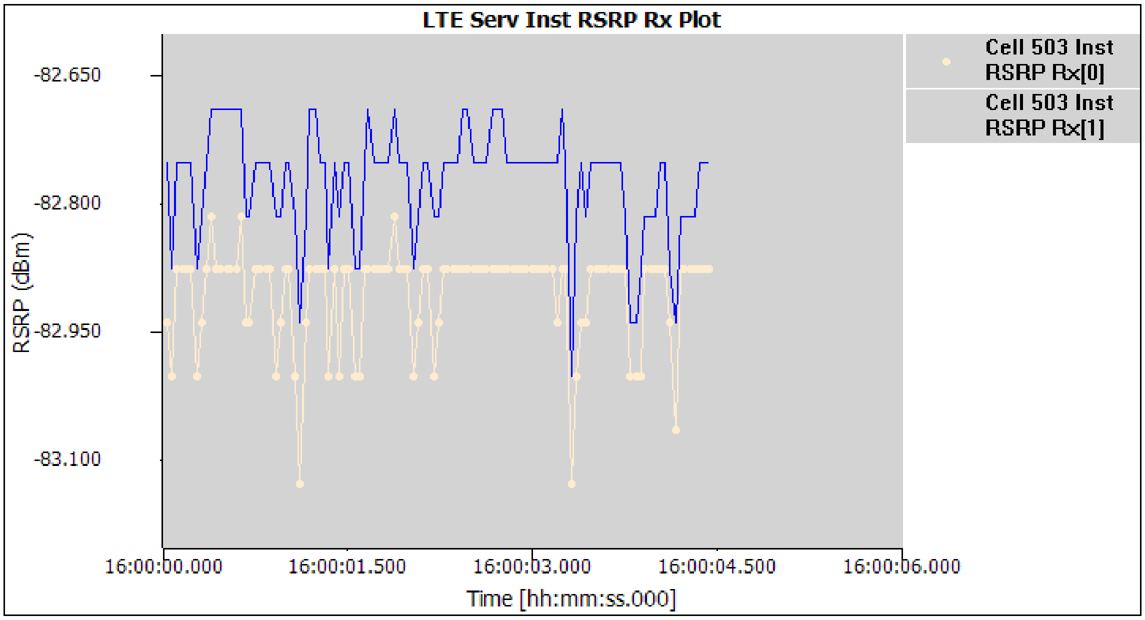


Figure 3-34 LTE Serv Inst RSRP Rx plot

3.20.2 LTE Serv Inst Meas RSRP plot

This plot shows the Inst Measured RSRP field per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. An example of the plot is shown in Figure 3-35.

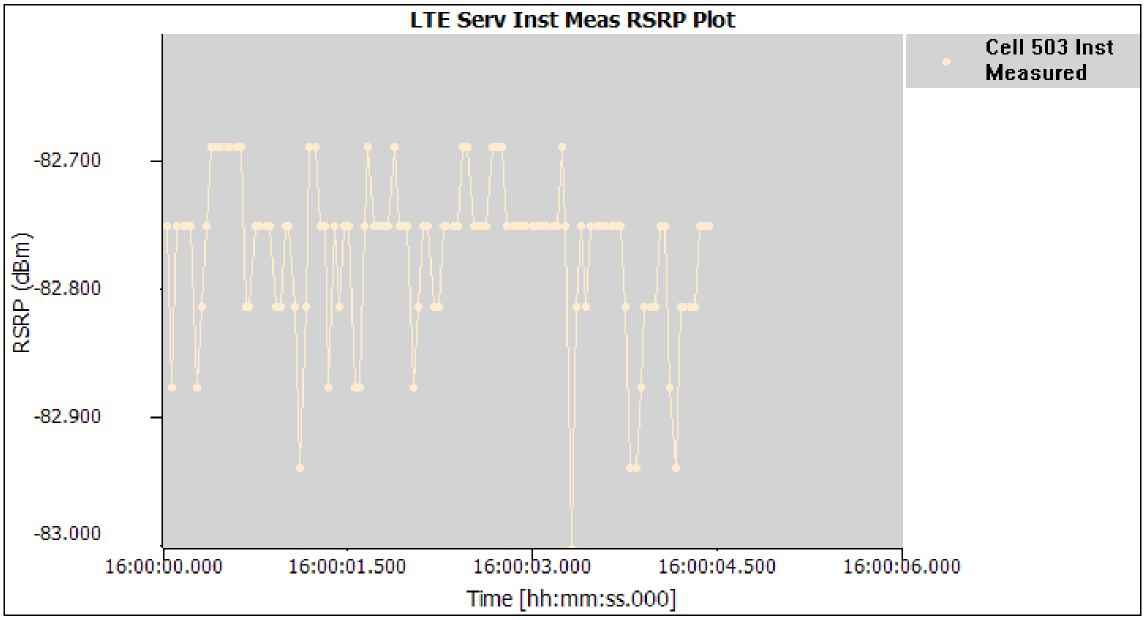


Figure 3-35 LTE Serv Inst Meas RSRP plot

3.20.3 LTE Serv Inst RSRQ Rx plot

This plot shows the Inst RSRQ Rx[0] and Inst RSRQ Rx[1] fields per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. It gives the RSRQ of serving cell for both the antennas. An example of the plot is shown in Figure 3-36.

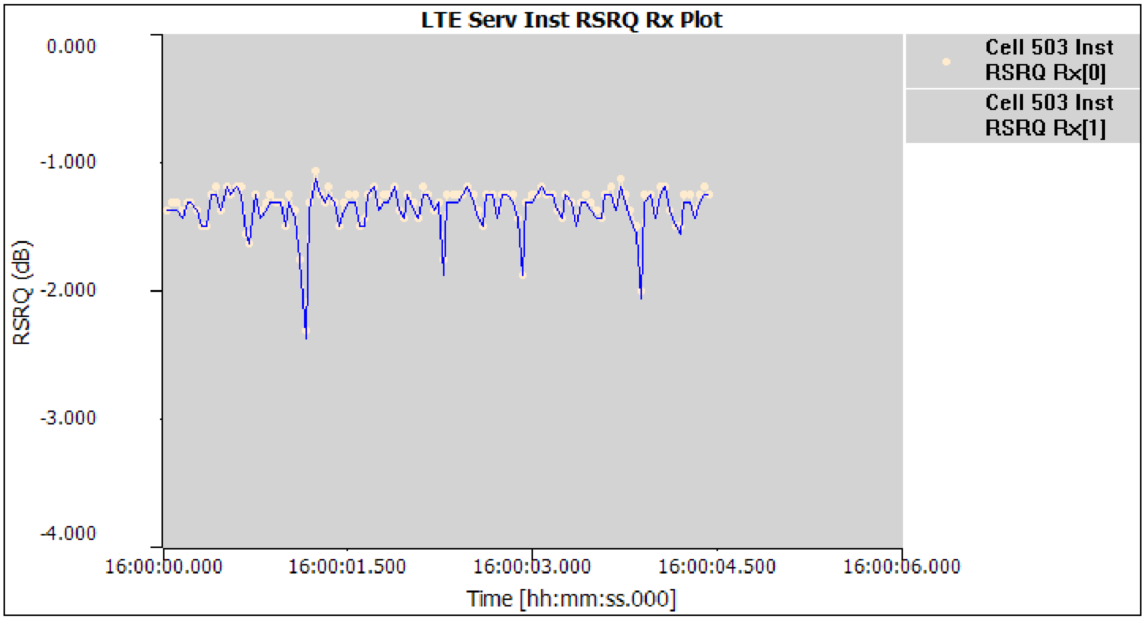


Figure 3-36 LTE Serv Inst RSRQ Rx plot

3.20.4 LTE Serv Inst Meas RSRQ plot

This plot shows the Inst Measured RSRQ field per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. An example of the plot is shown in Figure 3-37.

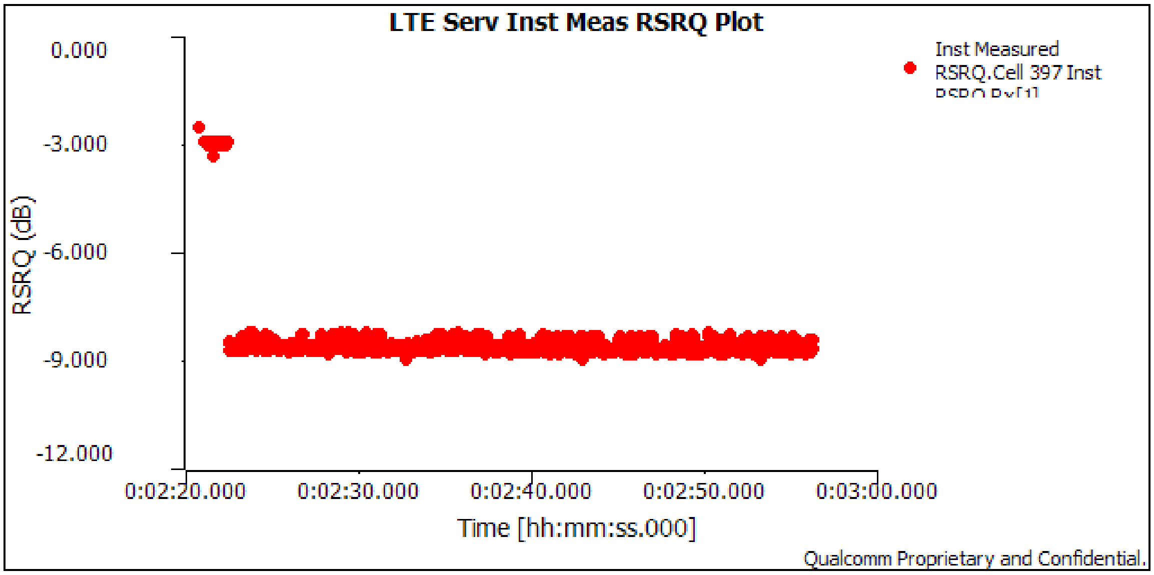


Figure 3-37 LTE Serv Inst Meas RSRQ plot

3.20.5 LTE Serv Inst RSSI Rx plot

This plot shows the Inst RSSI Rx[0] and Inst RSSI Rx[1] fields per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. It gives the RSSI of serving cell for both the antennas. An example of the plot is shown in Figure 3-38.

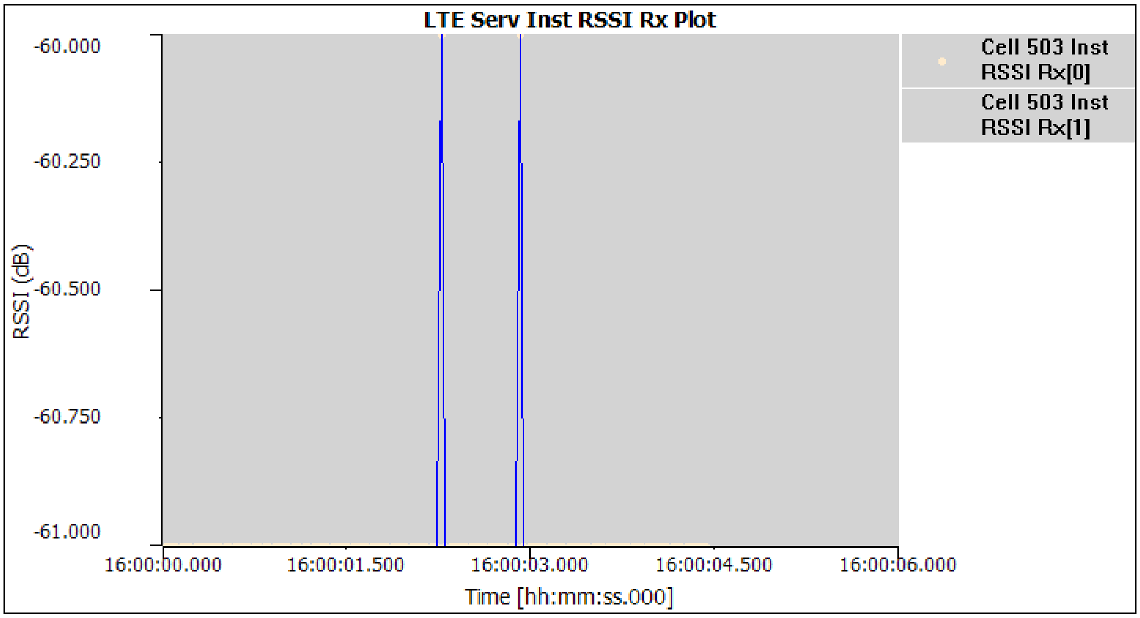


Figure 3-38 LTE Serv Inst RSSI Rx plot

3.20.6 LTE Serv Inst Meas RSSI plot

This plot shows the Inst Measured RSSI field per Cell ID from the Serving Cell Measurement Result subpacket (subpacket ID 25) from log LTE ML1 Idle Serving Cell Meas Response (0xB193) vs time. An example of the plot is shown in Figure 3-39.

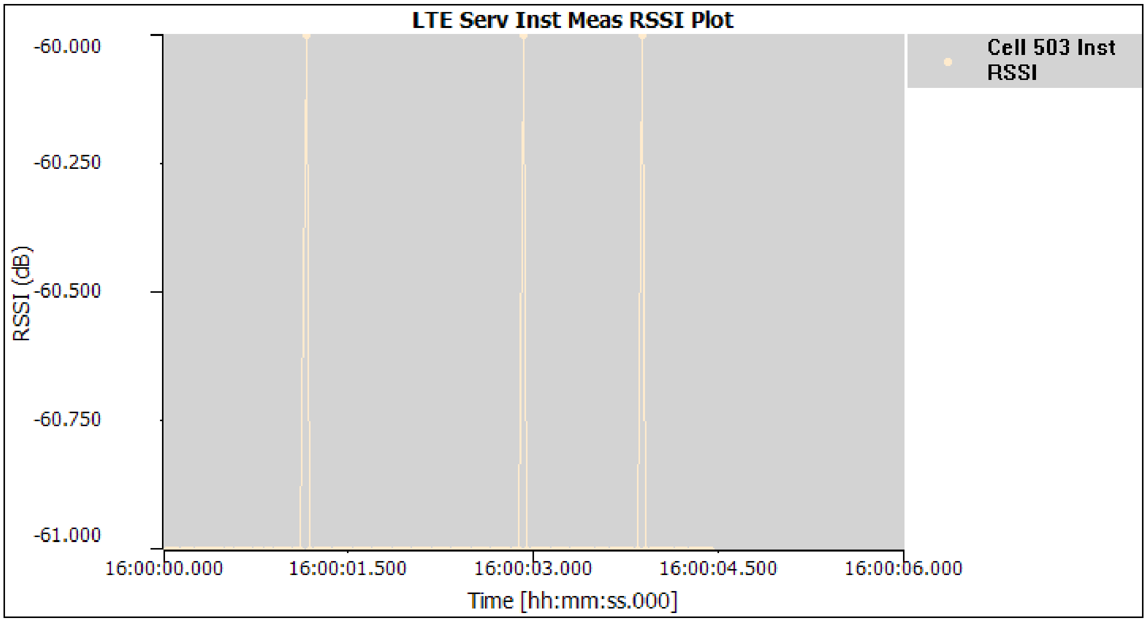


Figure 3-39 LTE Serv Inst Meas RSSI plot

3.21 LTE Total Buf Status vs Time

This time output plots the Total bytes field accumulated from each logical channel ID per record from the UL Buffer Status subpacket (ID 10) in the LTE MAC UL Buffer Status Internal (0xB066) log packet vs time. It is useful for debugging any UL buffer-related issue, as it shows the data flow per logical channel. An example of the time grid is shown in Figure 3-40.

A	B	C
	LTE Total Buf Status vs. Time	
	Time	Total Number of Bytes
	00:05:26.400	4
	00:05:36.640	4
	00:05:46.880	4
	00:05:57.120	4
	00:06:07.360	4
	00:06:17.600	4
	00:06:27.840	4
	00:06:38.080	4
	00:06:48.320	4
	00:06:58.560	4
	00:07:08.800	0
	00:06:44.804	0
	00:07:19.040	0
	00:07:29.280	0
	00:07:39.520	0
	00:07:49.760	0
	00:08:00.000	0
	00:08:10.240	0
	00:08:20.480	0

Figure 3-40 LTE Total Buf Status vs Time

3.22 LTE UL Avg BlerTputPwr vs Time

This time output plots the average UL BLER, UL PHY Throughput and UL Tx Power vs Time. Average UL BLER is a moving average over the last 100 subframes entries and starts from entry #100. UL PHY throughput is calculated by multiplying PUSCH TB size by 8 and dividing by 1000 to convert units to Mbps. It is used to relate throughput, BLER, and power on the UL. An example of the time grid is shown in Figure 3-41. An example of the plot is shown Figure 3-42.

LTE UL Avg BlerTputPwr Vs Time
Qualcomm Proprietary and Confidential.

Time	SFN SF	Re-Tx Index	PUSCH TB Size	PUSCH Tx Power	Avg UL BLER	Avg UL PHY Throughput
00:04:29.331	1056	FOURTH	2124	-40	0.83	16.99
00:04:29.332	1057	FOURTH	2124	-40	0.84	16.99
00:04:29.333	1058	FOURTH	2124	-40	0.84	16.99
00:04:29.334	1059	FOURTH	2124	-40	0.84	16.99
00:04:29.335	1060	FIFTH	2124	-40	0.84	16.99
00:04:29.336	1061	FOURTH	2124	-40	0.84	16.99
00:04:29.337	1062	FIFTH	2124	-40	0.84	16.99
00:04:29.338	1063	FIFTH	2124	-40	0.84	16.99
00:04:29.339	1064	FIFTH	2124	-40	0.84	16.99
00:04:29.340	1065	FIFTH	2124	-40	0.84	16.99
00:04:29.341	1066	FIFTH	2124	-40	0.84	16.99
00:04:29.342	1067	FIFTH	2124	-40	0.84	16.99
00:04:29.343	1068	FIRST	2124	-40	0.83	16.99
00:04:29.344	1069	FIFTH	2124	-40	0.83	16.99
00:04:29.345	1070	FIRST	2124	-40	0.82	16.99
00:04:29.346	1071	FIRST	2124	-40	0.81	16.99
00:04:29.347	1072	FIRST	2124	-40	0.80	16.99
00:04:29.348	1073	FIRST	2124	-40	0.79	16.99
00:04:29.349	1074	FIRST	2124	-40	0.78	16.99
00:04:29.350	1075	FIRST	2124	-40	0.77	16.99
00:04:29.351	1076	SECOND	2124	-40	0.77	16.99

Figure 3-41 LTE UL Avg BlerTputPwr vs Time grid

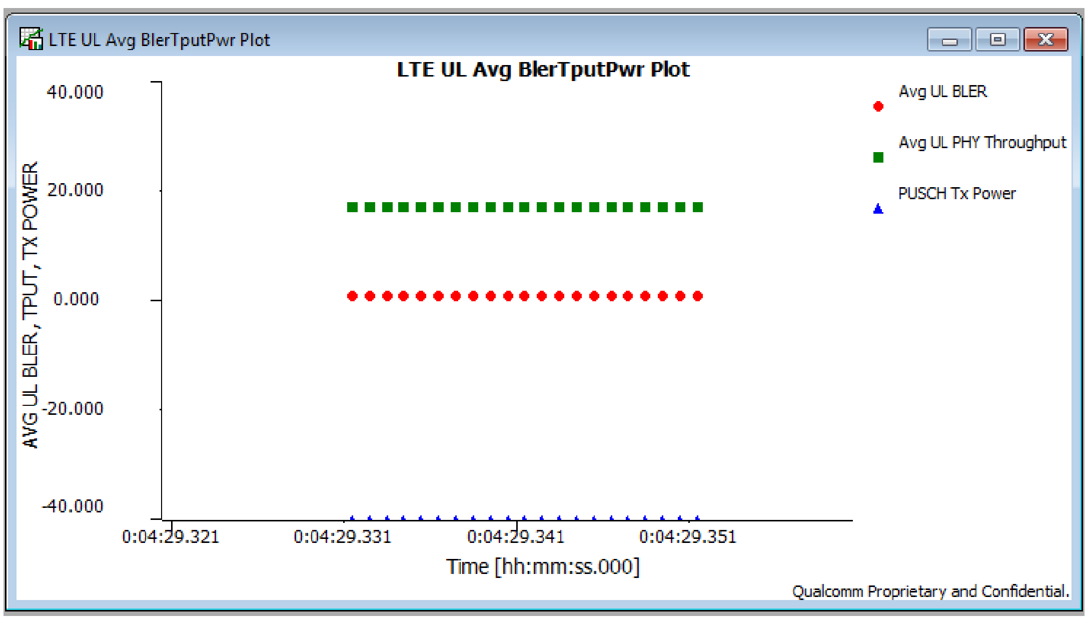


Figure 3-42 LTE UL Avg BlerTputPwr plot

3.23 LTE UL Inst BlerTputPwr vs Time

This time output plots the Instantaneous UL BLER, Instantaneous UL PHY Throughput and UL Tx Power vs Time. UL BLER sets to 1 if the Re-Tx Index is anything other than “first” and sets to 0 if Re-Tx Index is “first” or “Non” that was filled above. UL PHY throughput is calculated from multiple PUSCH TB size by 8 and divided by 1000 to convert units to Mbps. It is used to relate instantaneous throughput, BLER, and power on the UL. An example of the time grid is shown in Figure 3-43 and an example of the plot is shown in Figure 3-44.

LTE UL Inst BlerTputPwr Vs Time						
Qualcomm Proprietary and Confidential.						
Time	SFN SF	Re-Tx Index	PUSCH TB Size	PUSCH Tx Power	UL BLER	UL PHY Throughput
00:04:29.232	957	FIRST	2124	-44	0	16.99
00:04:29.233	958	SECOND	2124	-44	1	16.99
00:04:29.234	959	SECOND	2124	-44	1	16.99
00:04:29.235	960	SECOND	2124	-44	1	16.99
00:04:29.236	961	SECOND	2124	-44	1	16.99
00:04:29.237	962	SECOND	2124	-44	1	16.99
00:04:29.238	963	SECOND	2124	-44	1	16.99
00:04:29.239	964	THIRD	2124	-44	1	16.99
00:04:29.240	965	SECOND	2124	-44	1	16.99
00:04:29.241	966	THIRD	2124	-44	1	16.99
00:04:29.242	967	THIRD	2124	-44	1	16.99
00:04:29.243	968	THIRD	2124	-44	1	16.99
00:04:29.244	969	THIRD	2124	-44	1	16.99
00:04:29.245	970	THIRD	2124	-44	1	16.99
00:04:29.246	971	THIRD	2124	-44	1	16.99
00:04:29.247	972	FOURTH	2124	-44	1	16.99
00:04:29.248	973	THIRD	2124	-44	1	16.99
00:04:29.249	974	FOURTH	2124	-44	1	16.99
00:04:29.250	975	FOURTH	2124	-44	1	16.99
00:04:29.251	976	FOURTH	2124	-44	1	16.99
00:04:29.252	977	FOURTH	2124	-44	1	16.99
00:04:29.253	978	FOURTH	2124	-44	1	16.99
00:04:29.254	979	FOURTH	2124	-44	1	16.99
00:04:29.255	980	FIFTH	2124	-44	1	16.99
00:04:29.256	981	FOURTH	2124	-44	1	16.99
00:04:29.257	982	FIFTH	2124	-44	1	16.99
00:04:29.258	983	FIFTH	2124	-44	1	16.99
00:04:29.259	984	FIFTH	2124	-44	1	16.99
00:04:29.260	985	FIFTH	2124	-44	1	16.99
00:04:29.261	986	FIFTH	2124	-44	1	16.99
00:04:29.262	987	FIFTH	2124	-44	1	16.99
00:04:29.263	988	FIRST	2124	-44	0	16.99
00:04:29.264	989	FIFTH	2124	-44	1	16.99

Figure 3-43 LTE UL Inst BlerTputPwr vs Time grid

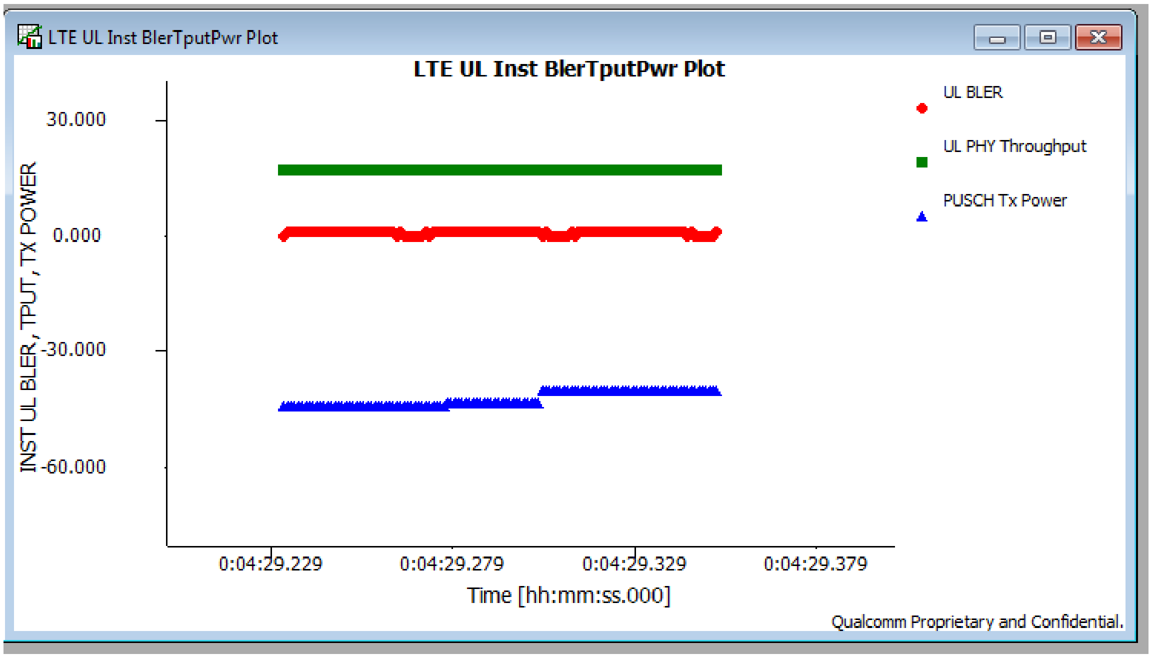


Figure 3-44 LTE UL Inst BlerTputPwr plot

3.24 LTE UL MCS and RB vs Time

This time output plots the Number of Resource Blocks and MCS Index fields vs time for each instance of LTE DCI Information Report (0xB16C) in the log file. It gives a quick plot for the MCS and RB usage on the UL. An example of the time grid is shown in Figure 3-45 and an example of the plot is shown in Figure 3-46.

A	B	C	D
	LTE UL MCS and RB vs. Time		
	Time	Num RBs	MCS
	00:05:26.420	80	17
	00:05:26.423	81	17
	00:05:26.495	81	15
	00:05:26.503	81	19
	00:05:26.504	81	19
	00:05:26.505	81	19
	00:05:26.506	81	19
	00:05:26.507	81	19
	00:05:26.508	81	19
	00:05:26.509	81	19
	00:05:26.510	80	19
	00:05:26.535	81	13
	00:05:26.543	81	17
	00:05:26.544	81	17
	00:05:26.545	81	17
	00:05:26.440	81	17
	00:05:26.441	81	17

Figure 3-45 LTE UL MCS and RB vs Time grid

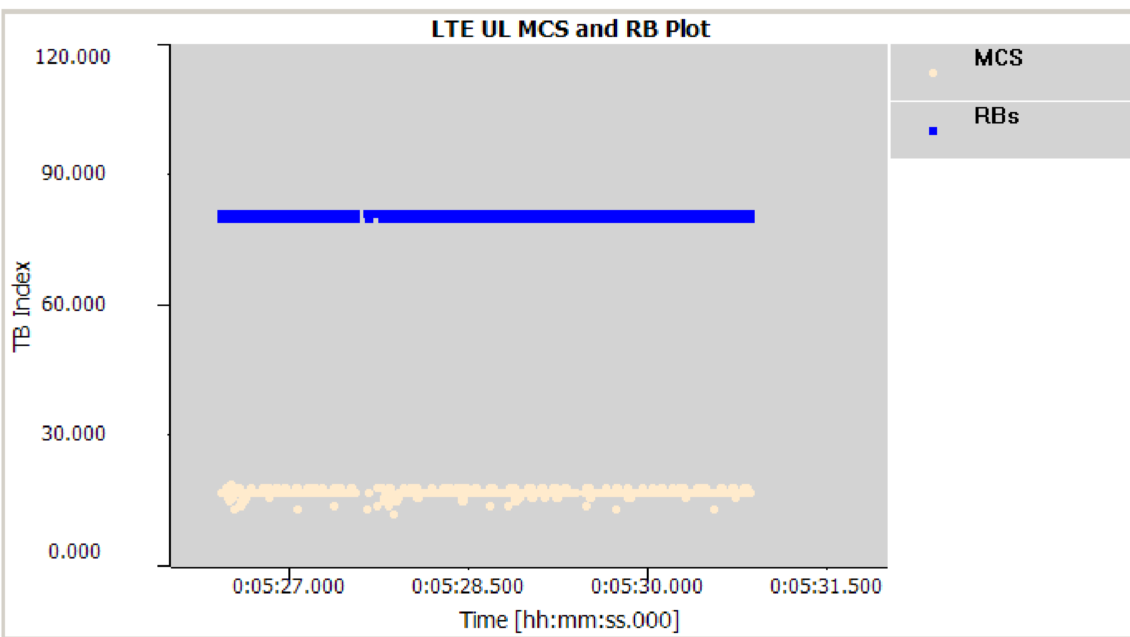


Figure 3-46 LTE UL MCS and RB plot

3.25 LTE UL Throughput vs. Time

This analyzer shows throughput across the physical layer, RLC layer, and PDCP layer. It is useful for providing a comprehensive view across all layers when troubleshooting field problems. The throughput calculations are described below. An example of the grid is shown in Figure 3-47 and an example of the plots is shown in Figure 3-48.

- Total Throughput (kbps) – Calculated as the sum of PUSCH TB Size field from each record of LTE LL1 PUSCH Tx Report (0xB139) divided by the duration of the log packet, where the duration is calculated by the difference between the frame number and subframe number between the first and last records using a 1 ms subframe.
- Total Throughput Avg (kbps) – The average of the previous N values of Total Throughput, where N can be set in the analyzer's configuration. N is 6 by default.
- Total RLC Throughput (kbps) – The sum of the throughput across all RBs in LTE RLC UL Statistics (0xB097). For Throughput calculation, see RLC Tput (kbps) RB Cfg Idx below.
- Total PDCP Throughput (kbps) – The sum of the throughput across all RBs in LTE PDCP UL Statistics Pkt (0xB0B4). For throughput calculation, see PDCP Tput (kbps) RB Cfg Idx below.
- RLC Tput (kbps) RB Cfg Idx N – The throughput of RB Cfg Idx N, where N is for each RB Cfg Idx value seen in LTE RLC UL Statistics (0xB097). Throughput is calculated as (Data PDU Bytes with RB Cfg Idx = N – Data PDU Bytes from previous instance of 0xB097 with RB Cfg Idx = N)/(packet timestamp – previous 0xB097 timestamp) * 8 (bits per byte).
- PDCP Tput (kbps) RB Cfg Idx N – The throughput of RB Cfg Idx N, where N is for each RB Cfg Idx value seen in LTE PDCP UL Statistics Pkt (0xB0B4). Throughput is calculated as (Data PDU Bytes with RB Cfg Idx = N – Data PDU Bytes from previous instance of 0xB0B4 with RB Cfg Idx = N) / (packet timestamp – previous 0xB0B4 timestamp) * 8 (bits per byte).

LTE UL Throughput vs. Time
Qualcomm Proprietary and Confidential.

Time	Total Throughput (kbps)	Total Throughput Avg (kbps)	Total RLC Throughp
13:34:53.983	6320	3151	
13:34:54.003	12640	6314	
13:34:54.023	12872	7953.5	
13:34:54.043	13704	9103.6	
13:34:54.063	12752	9711.67	
13:34:54.083	11616	11650.7	
13:34:54.103	12256	12640	
13:34:54.110			
13:34:54.123	13536	12789.3	
13:34:54.143	12320	12697.3	
13:34:54.163	13344	12637.3	
13:34:54.183	15584	13109.3	
13:34:54.203	13024	13344	
13:34:54.223	13600	13568	
13:34:54.243	13600	13578.7	

Figure 3-47 LTE UL Throughput vs Time grid

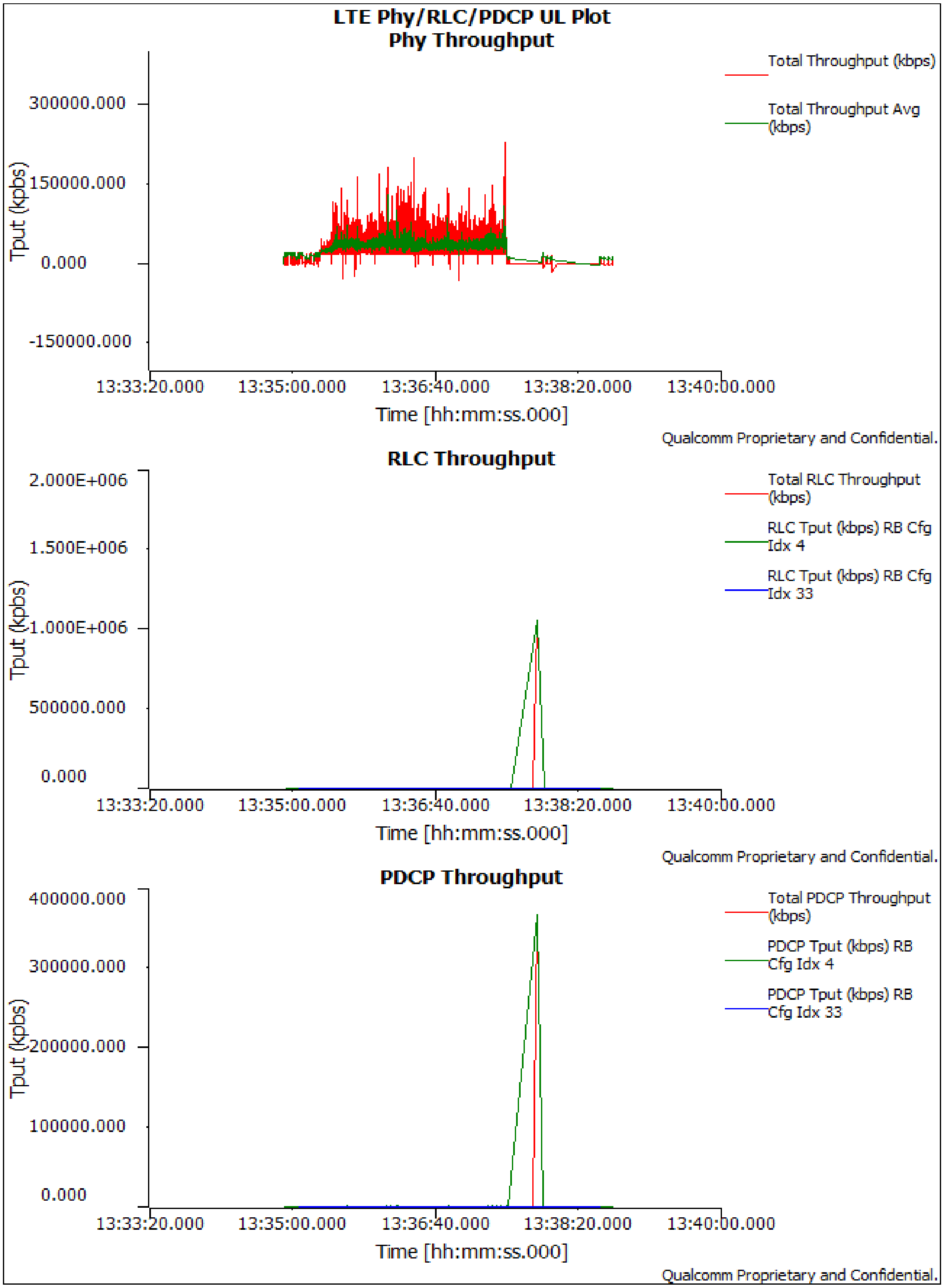


Figure 3-48 LTE UL Throughput vs Time Plot

3.26 LTE Spectral Efficiency Analysis

3.26.1 LTE TM2 SPEFF Cal vs Time

This analyzer uses the calculated fields from log packet [0xB14C] LTE LL1 Whitened Matrices.

2014 Mar 27 **11:35:13.666** [74] 0xB14C LTE LL1 Whitened Matrices

```
...
Matrices[0]
     FEEAFD68,   00F901C4
     0252FC98,   FE56FEED    → H0
   SNR Est = 21.2 dB
Matrices[1]
     FF96FC0A,   037C039B
     0264FBC5,   FC25FD05    → H1
   SNR Est = 25.5 dB
```

Calculating RANK 1 SE:

For each whitened matrix perform the following

{
. Convert the whitened channel matrix $\mathbf{H}_i$ into its actual complex value
. Compute SE for subband i

$$SE_i = \min\left(6, \log_2(1+\text{Frobenius\_norm}(\mathbf{H}_i)^2)\right)$$

}
. Compute SE for whole band (wideband SE)as the linear average of all SE_i

A	B	C	D	E	F	G	H
	LTE TM2 SPEFF ...						
	Qualcomm Pro...						
	Time	WB SE	SE 0	SE 1	SE 2	SE 3	SE 4
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6
	1980/01/06 00:0...	6.00	6	6	6	6	6

3.26.2 LTE TM3 SPEFF Cal vs Time

Similar to LTE TM2 SPEFF Cal vs Time, the formula used to calculate SE is as follows:

```
For each whitened matrix perform the following
{
Compute effective whitened channel G = HP, where

                  P = [0.5 0.5 ; 0.5 -0.5]

Compute effective SNR per CW = LMMSE SNR per CW based on G
In other words,
```

$$SNR_0 = e_0 - e_{01}/(1+e_0)$$

$$SNR_1 = e_1 - e_{01}/(1+e_1)$$

where $\mathbf{G} = [g_0\ g_1]$ such that g_0 and g_1 are the 1st and 2nd columns of $\mathbf{G}$, respectively, $e0 = g_0'g_0$, $e_1 = g_1'g_1$, $e_{01} = |g_0'g_1|^2$, where g' is the conjugate-transpose of g.

Compute spectral efficiency per CW in bps/Hz using the constrained capacity (SNR) function i.e.

$$SE_i = \min(6, \log_2(1+SNR_0)) + \min(6, \log_2(1+SNR_1))$$

}

Compute SE for whole band (wideband SE) as the linear average of all SE_i

A	B	C	D	E	F	G	H
	LTE TM3 SPEFF ...						
	Qualcomm Pro...						
	Time	WB SE	SE 0	SE 1	SE 2	SE 3	SE 4
	1980/01/06 00:0...	11.85	12	12	12	12	12
	1980/01/06 00:0...	11.65	12	12	12	12	11.0719
	1980/01/06 00:0...	12.00	12	12	12	12	12
	1980/01/06 00:0...	11.86	12	12	12	12	12
	1980/01/06 00:0...	11.74	12	12	12	12	12
	1980/01/06 00:0...	11.83	12	12	12	12	11.9534
	1980/01/06 00:0...	11.93	12	12	12	12	12
	1980/01/06 00:0...	11.85	12	12	12	12	12
	1980/01/06 00:0...	11.84	12	12	11.7684	11.0394	12
	1980/01/06 00:0...	11.67	12	12	12	12	12
	1980/01/06 00:0...	11.77	12	12	11.3209	10.186	12
	1980/01/06 00:0...	11.87	12	12	12	12	12
	1980/01/06 00:0...	11.71	12	12	12	12	12
	1980/01/06 00:0...	11.89	10.1614	11.3567	11.6595	12	12
	1980/01/06 00:0...	12.00	12	12	12	12	12
	1980/01/06 00:0...	11.95	12	12	12	12	12
	1980/01/06 00:0...	12.00	12	12	12	12	12
	1980/01/06 00:0...	11.77	12	12	11.1701	12	12

3.26.3 LTE SP Eff Log R1 vs Time

The most important step is to convert the logged whitened matrices and the logged CSF into their actual values. Note that the whitened matrices were logged in **S16_7**.

RANK 1 logged SE is the immediate transformation of the values in **0xB14B LTE LL1 CSF Spectral Efficiency TxMode 1, 2, 7**.

LTE SP Eff Log ...					
Qualcomm Pro...					
Time	WB SE	SE 0	SE 1	SE 2	SE 3
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022
1980/01/06 00:5...	3.00	3.0022	3.0022	3.0022	3.0022

RANK 2 logged SE is the transformation of the values in **0xB149 LTE LL1 CSF Spectral Efficiency TxMode 4, 5, 6 Rank 1** times 2 to account for RANK 2.

LTE SP Eff Log ...							
Qualcomm Pro...							
Time	WB SE	SE 0	SE 1	SE 2	SE 3	SE 4	SE 5
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00366	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439
1980/01/06 00:5...	6.00	6.00439	6.00439	6.00439	6.00439	6.00439	6.00439

A References

A.1 Related documents

Document	
Qualcomm Technologies, Inc.	
QCAT6 User Guide	80-V1233-6
QCAT WCDMA Analysis Guide	80-V5400-3