Qualcomm TECHNOLOGIES, INC

LTE Cell Reselection and Redirection Overview

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Revision History

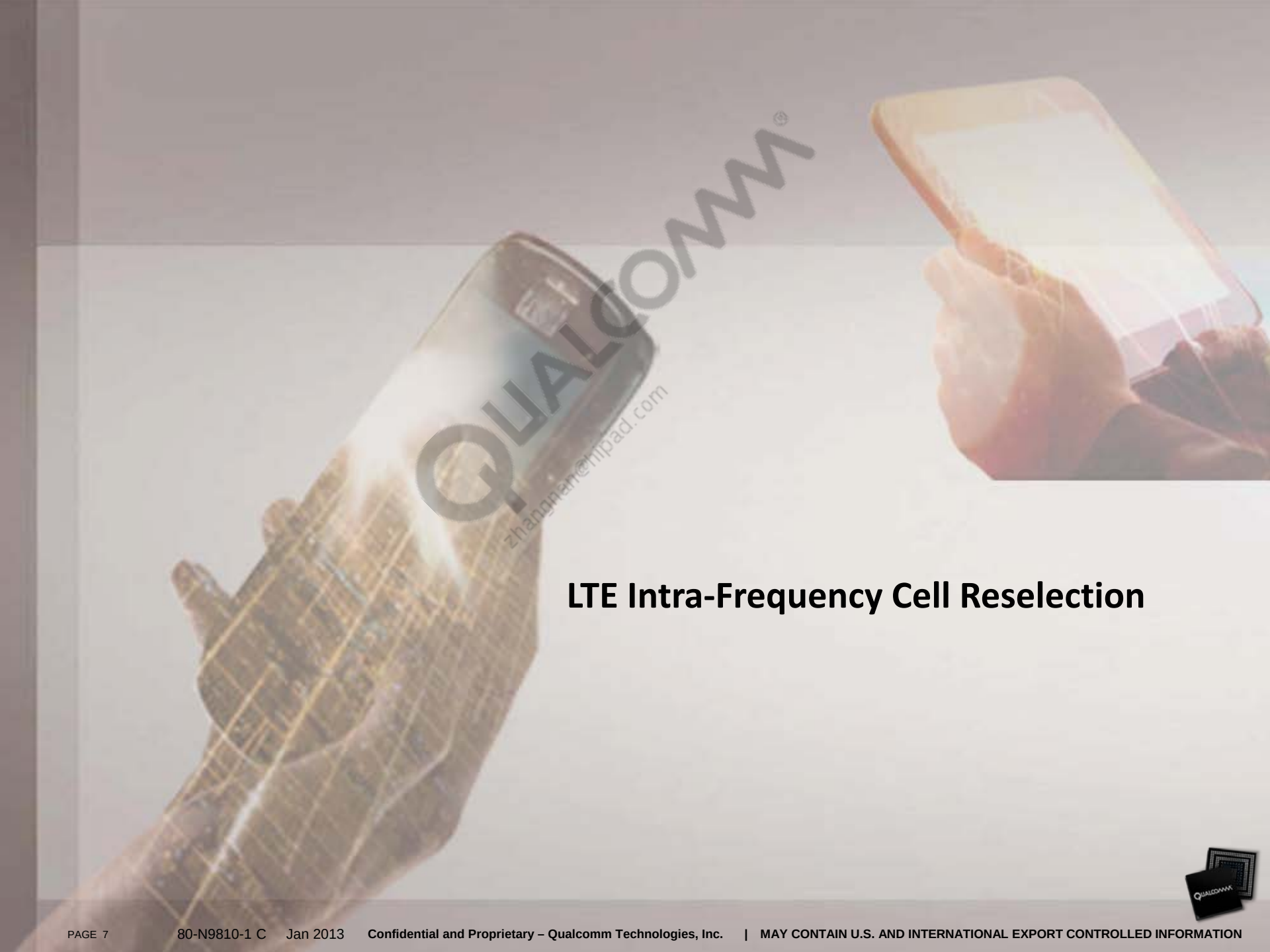
Version	Date	Description
A	Feb 2012	Initial release
B	Jun 2012	Added slides 39 to 47
C	Jan 2013	Updated slides 6, 60, and 70; added slides 30 to 51

Contents

Introduction

Introduction

- Cell Reselection is a process by which the UE detects and measures surrounding neighbor cells as given by the network and autonomously selects a better cell.
  - LTE Intra-Frequency Cell Reselection (covered in this presentation)
  - LTE Inter-Frequency Cell Reselection (covered in this presentation)
  - LTE→UTRAN Cell Reselection and vice-versa (covered in this presentation)
  - LTE→GERAN Cell Reselection and vice-versa (covered in this presentation)
  - LTE→cdma2000 Cell Reselection and vice-versa (not covered in this presentation)
- Cell Redirection is a network-directed procedure where the UE is asked to go and acquire a target RAT.
  - LTE Intra-Frequency Cell Redirection (covered in this presentation)
  - LTE Inter-Frequency Cell Redirection (covered in this presentation)
  - LTE→UTRAN Cell Redirection and vice-versa (only LTE→UTRAN covered)
  - LTE→GERAN Cell Redirection and vice-versa (only LTE→GERAN covered)
  - LTE→cdma2000 Cell Redirection and vice-versa (not covered in this presentation)



LTE Intra-Frequency Cell Reselection

Suitability Criteria

- The Cell Selection criterion S is fulfilled when:
  - $S_{rxlev} > 0$ *and* $S_{qual} > 0$
  - $S_{rxlev} = Q_{rxlevmeas} – (Q_{rxlevmin} + Q_{rxlevminoffset}) – P_{compensation}$
  - $S_{qual} = Q_{qualmeas} – (Q_{qualmin} + Q_{qualminoffset})$

Srxlev	Cell selection RX level value (dB)
Squal	Cell selection quality value (dB)
$Q_{rxlevmeas}$	Measured cell RX level value (RSRP)
$Q_{qualmeas}$	Measured cell quality value (RSRQ)
$Q_{rxlevmin}$	Minimum required RX level in the cell (dBm)
$Q_{qualmin}$	Minimum required quality level in the cell (dB)
$Q_{rxlevminoffset}$	Offset to the signalled $Q_{rxlevmin}$ taken into account in the Srxlev evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN [5]
$Q_{qualminoffset}$	Offset to the signalled $Q_{qualmin}$ taken into account in the Squal evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN [5]
Pcompensation	$\max(P_{EMAX} – P_{PowerClass}, 0)$ (dB)
P_{EMAX}	Maximum TX power level an UE may use when transmitting on the uplink in the cell (dBm) defined as P_{EMAX} in [TS 36.101]
$P_{PowerClass}$	Maximum RF output power of the UE (dBm) according to the UE power class as defined in [TS 36.101]

Note: For more information, see [R1].

Cell Reselection Measurement Rules and Cell Reselection Criteria

- Cell Reselection measurement rules
  - If the serving cell fulfills Srxlev > SIntraSearchP and Squal > SIntraSearchQ, the UE may choose not to perform intra-frequency measurements.
  - Otherwise, the UE shall perform intra-frequency measurements.
- Cell Reselection criteria
  - The cell-ranking criterion Rs for serving cell and Rn for neighboring cells is defined by:
    - Rs = Qmeas,s + Qhyst
    - Rn = Qmeas,n – Qoffset

    Where: Qmeas : RSRP measurement quantity used in cell reselections and
    Qhyst/Qoffset : broadcasted in the system information messages
  - The UE shall perform ranking of all cells that fulfill the cell selection criterion S.
  - The cells shall be ranked according to the R criteria specified above, deriving Qmeas,n and Qmeas,s and calculating the R values using averaged RSRP results.
  - UE shall reselect the new cell, only if the following conditions are met:
    - The new cell is better ranked than the serving cell during a time interval $T_{reselectionRAT}$
    - More than 1 sec has elapsed since the UE camped on the current serving cell

System Information Parameters for LTE Intra-Frequency Cell Reselection

- Qoffsets,n
  - Offset between the two cells
- Qoffsetfrequency
  - Frequency specific offset for equal priority E-UTRAN frequencies
- Qhyst
  - Hysteresis value for ranking criteria
- TreselectionRAT
  - Cell reselection timer value during which neighbor cell has to be better ranked than serving cell to trigger cell reselection
- SIntraSearchP
  - Srxlev threshold (in dB) for intra-frequency measurements
- SIntraSearchQ
  - Squal threshold (in dB) for intra-frequency measurements

Log Analysis – LTE Intra-Frequency Cell Reselection

```
1980 Jan  6  00:09:31.115  [00]  0xB0C0  LTE RRC OTA Packet  --  BCCH_DL_SCH
message c1 : systemInformationBlockType1 :
:
cellSelectionInfo
        {
          q-RxLevMin -53      ← Actual value is 2*IE = -106
        },
        freqBandIndicator 4,
        schedulingInfoList
        {
          {
            si-Periodicity rf16,
            sib-MappingInfo
            {
            }
          },
          {
            si-Periodicity rf32,
            sib-MappingInfo
            {
              sibType3          ← SIB3 is also scheduled. Hence UE needs to read SIB3
            }
          }
        },
        si-WindowLength ms20,
        systemInfoValueTag 0
      }
}
```

Log Analysis – LTE Intra-Frequency Cell Reselection (cont.)

```
1980 Jan  6  00:09:33.791  [00]  0xB0C0  LTE RRC OTA Packet  --  BCCH_DL_SCH
value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
           sib3 :
                {
                  cellReselectionInfoCommon
                  {
                    q-Hyst dB0                          ← For measuring Ranking of Serving cell
                  },
                  cellReselectionServingFreqInfo
                  {
                    threshServingLow 0,
                    cellReselectionPriority 4
                  },
                  intraFreqCellReselectionInfo
                  {
                    q-RxLevMin -53,                 ← For Calculating S_rxlev of Ncell  (actual value is IE*2 = -106)
                    presenceAntennaPort1 FALSE,
                    neighCellConfig '01'B,
                    t-ReselectionEUTRA 0      ← T_reselection timer
                  }
                }
            }
          }
      }
}
```

Log Analysis – LTE Intra-Frequency Cell Reselection (cont.)

//Camped on PCI0

00:09:33.214	lte_rrc_csp.c	8703	X	CSP: Camped on physical cell ID 0 on earfcn 2175

//Read cell reselection paramters for Serving cell (SIB1)

00:09:33.208	lte_ml1_mdb_idle.c	1517	H	Serv Cell Cfg update: Qrxlevmin -106 Qrxlemin_off 0 p_max 23

//$S_{rxlev}=Q_{meas}-Q_{rxlevmin}$ = -87-(-106) = 19.
//$Rank_{(s)}=Q_{meas}+Qh_{yst}$ = -87+0 = -87

00:09:34.309	lte_ml1_mdb_idle.c	5275	H	Serv cell (2175,0) prio 4 S 19 rsrp -87 Mob 1 Qhyst 0 rank -86.5078

//S_{intra} is not broadcasted , so we go ahead and measure Ncell.

00:09:34.309	lte_ml1_mdb_idle.c	4244	H	Meas Rules: C=0 N=1: serv S 19.4921 # drx S fail 0 Nserv 2 Sintra 255 Snonintra 255
00:09:34.310	lte_ml1_md.c	1491	H	Ngbr srch req (earfcn 2175) num half frames 4

//S_{rxlev} (ncell) = $Q_{meas}-Q_{rxlevmin}$ (SIB3)= -81-(-106) = 25.
//$Rank_{(n)} = Q_{meas}-Q_{off}$ = -81-0 = -81

//$Rank_{(n)} > Rank_{(s)}$, we start T_{resel}

00:09:34.343	lte_ml1_mdb_idle.c	5474	H	pci 2 S 25 rsrp -81 Qoff 0 rank -80.1640 Tresel 0

//Layer 1 indicates to RRC about reselection candidate

00:09:34.343	lte_ml1_mdb_idle.c	5505	H	Resel candidate prio 4 freq 2175 pci 2
00:09:34.343	lte_ml1_sm_idle.c	3618	H	ML1 CELL RESEL IND, rat 0 freq 2175 id 2

//Camp on new cell PCI2

00:09:34.549	lte_rrc_csp.c	8703	X	CSP: Camped on physical cell ID 2 on earfcn 2175
00:09:34.550	emm_rrc_handler.c	1170	H	EMM: Initing TAU - Srving TA not in TAL

Log Analysis – LTE Intra-Frequency Cell Reselection (cont.)

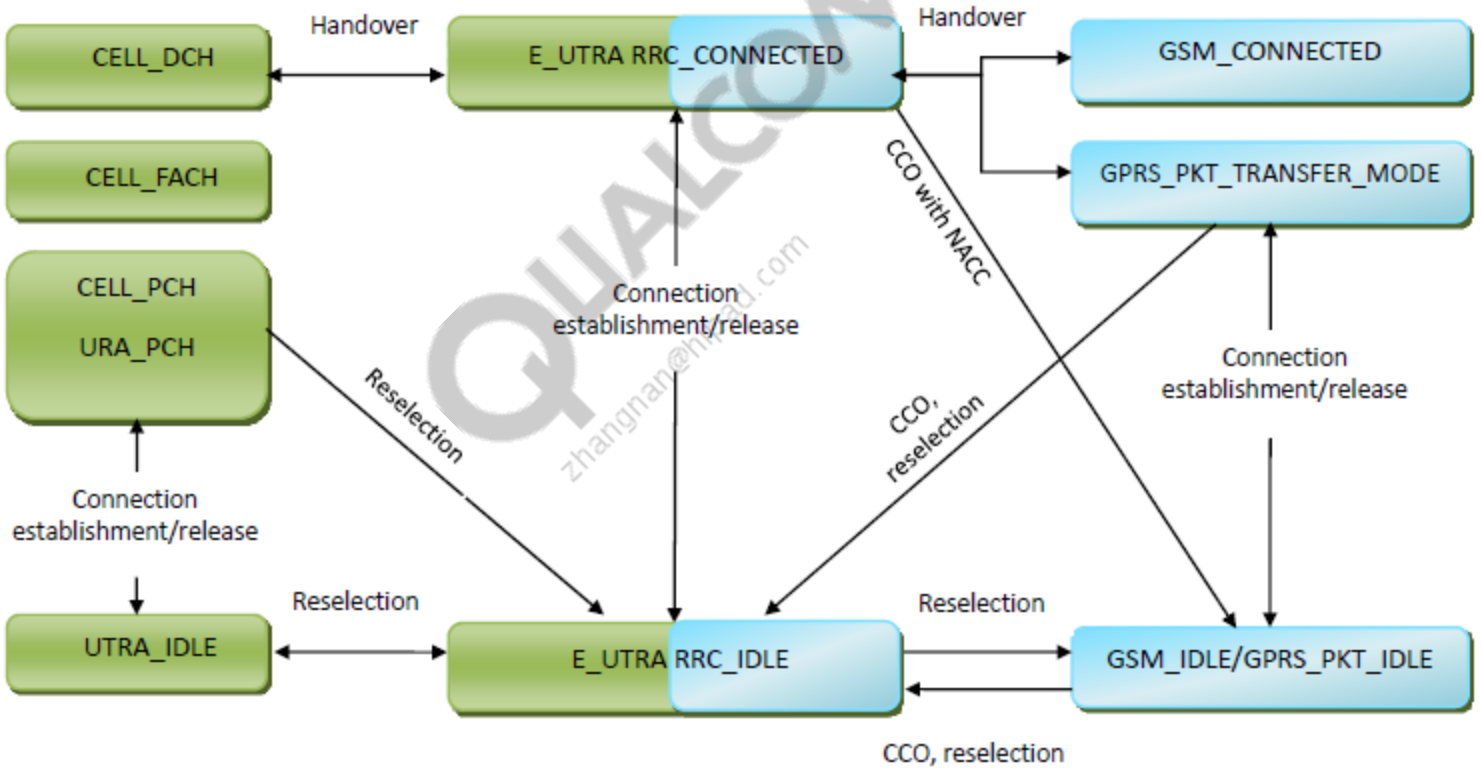
1980 Jan 6 00:09:34.343 [00] 0xB181 LTE ML1 Intra Frequency Cell Reselection

```
Version              = 1
Number of SubPackets = 3
SubPacket ID         = 10
Idle Mode Reselection Measurements Common
   Version                        = 1
   SubPacket Size                 = 8 bytes
   Serving Cell E-ARFCN           = 2175
   Serving Cell Physical Cell ID  = 0
   Current UE Mobility State      = Normal Mobility
   Priority Categories Evaluated  = Equal
SubPacket ID         = 5
Idle Meas Serving Frequency Resel Info
   Version                 = 1
   SubPacket Size          = 8 bytes
   Serving Cell Priority   = 4
   S Non-Intra Search      = 254 dB
   Thresh Serving Low      = 0 dB
SubPacket ID         = 11
Idle Mode Reselection Measurements LTE Frequency
   Version              = 1
   SubPacket Size       = 44 bytes
   E-ARFCN              = 2175
   Treselection         = 0 s
   Q Offset Frequency   = 0 dB
   Priority             = 4
   Number of Cells      = 3
   Neighbor Cells
```

#	Physical ID	Srxlev (dB)	RSSI Inst (dBm)	RSRP Average (dBm)	RSRP Inst (dBm)	RSRQ Average (dBm)	RSRQ Inst (dBm)	Q Offset	Rank	Treselection (s)
0	0	19	-62.13	-86.50	-86.50	-10.31	-10.31	0 dB	-87	63
1	2	25	-44.00	-80.13	-80.13	-3.94	-3.94	0 dB	-81	0
2	498	6	-44.00	-99.31	-99.31	-22.44	-22.44	0 dB	-100	63

LTE→WCDMA/GERAN and Inter-Frequency Cell Reselection

LTE Inter-RAT Mobility Diagram



Priority-Based Cell Reselection

- UE in E-UTRA RRC_IDLE performs cell reselection to identify a cell for UE to camp on
- Cell reselection criteria involves measurement of the serving and neighbor cells
- Absolute priority-based cell reselection
  - Inter-RAT/Inter-Frequency cell reselection evaluation will be performed only on those cells for which priority has been assigned
  - Equal priority between RATs is not supported
  - Priorities of different Inter-RAT/Inter-Frequency cells can be given by:
    - System information of serving cell
    - Dedicated signaling (RRCConnectionRelease) with validity timer (optional) (T320 in EUTRA, T322 in UTRA, and T3230 in GERAN)

Cell Reselection Measurement Rules

- Perform cell reselection measurement based on the priority
  - For the higher-priority Inter-RAT/Inter-Frequency neighbor cell
    - UE shall always perform cell reselection measurement for higher-priority cell
  - For the lower-priority Inter-RAT and equal or lower priority Inter-Frequency neighbor cell
    - If $S_{nonintrasearch}$ is sent in the serving cell and $S_{rxlev} > S_{nonintrasearch}$, UE may not perform cell reselection measurement
    - If $S_{nonintrasearch}$ is not sent in the serving cell, UE shall perform cell reselection measurement
    - S_{rxlev} value of serving cell = $Q_{rxlevmeas} - Q_{rxlevmin} + Q_{rxlevminoffset} - P_{compensation}$

Cell Reselection Criteria

- Cell Reselection to a higher-priority Inter-RAT/Inter-Frequency cell
  - If threshServingLowQ is provided in SystemInformationBlockType3
    - If target cell is UTRAN RAT or E-UTRAN frequency
      - S_{qual} > $Thresh_{X,\ HighQ}$ during a time interval $T_{reselectionRAT}$
    - If target cell is GERAN RAT
      - Srxlev > $Thresh_{X,\ HighP}$ during a time interval $T_{reselectionRAT}$
    - More than 1 sec has elapsed since the UE camped on the current serving cell
  - Srxlev > ThreshX, HighP during a time interval TreselectionRAT
- Cell Reselection to an equal priority Inter-Frequency cell shall follow the ranking criteria discussed for Intra-Frequency cell reselection
- Cell Reselection to a lower-priority Inter-RAT/Inter-Frequency cell
  - threshServingLowQ is provided in SystemInformationBlockType3
    - If target cell is UTRAN RAT or E-UTRAN frequency
      - Serving cell Squal < $Thresh_{Serving,\ LowQ}$
      - Target cell Squal > $Thresh_{X,\ LowQ}$ for $T_{reselection\ RAT}$
    - If target cell is GERAN RAT
      - Serving cell Srxlev < $Thresh_{Serving,\ LowP}$
      - Target cell Srxlev > $Thresh_{X,\ LowP}$ during a time interval TreselectionRAT
    - More than 1 sec has elapsed since the UE camped on the current serving cell

LTE RRC/WRRC and GRR Requirements

- LTE RRC requirements
  - RRC shall provide SIB-related parameters to L1
  - LTE RRC shall inform WRRC/GRR to trigger cell selection due to Inter-RAT reselection
  - Deactivate LTE stack on the successful Inter-RAT reselections
- WRRC/GRR requirements
  - Upon receiving a reselection request, it shall activate the corresponding stack and perform cell selection
  - RRC/RR shall send service indication so NAS can perform RAU if necessary

Recap – Cell Reselection Parameters

Parameters	Description	Value
$cell_{ReselectionPriority}$	Absolute priority for: ▪ E-UTRA/UTRA frequency ▪ Group of GERAN frequencies ▪ Band class of cdma2000 HRDP (cdma2000 1xRTT)	Integer (0..7)
$T_{reselection\ RAT}$	Cell reselection timer value for each RAT	Integer (0..7) sec
$Thresh_{x,high}$	Threshold value for higher-priority frequency X	Integer (0..62 by step of 2) dB
$Thresh_{x,\ low}$	Threshold value for lower-priority frequency X	Integer (0..62 by step of 2) dB
$Thresh_{serving,\ low}$	Threshold value of serving cell when reselection evaluation to low-priority Inter-RAT cell	Integer (0..62 by step of 2) dB
$S_{nonintrasearch}$	Threshold for Inter-RAT measurement	Integer (0..62 by step of 2) dB

Log Analysis – LTE→WCDMA Cell Reselection

```
1980 Jan  6  00:02:35.885  [00]  0xB0C0  LTE RRC OTA Packet  --  BCCH_DL_SCH
message c1 : systemInformation :
      {
        criticalExtensions systemInformation-r8 :
          {
            sib-TypeAndInfo
            {
              sib3 :
                {
                  cellReselectionInfoCommon
                  {
                    q-Hyst dB0
                  },
                  cellReselectionServingFreqInfo
                  {
                    threshServingLow 9,  ← Threshold value of SCell when reselection evaluation to Low priority cell

                    cellReselectionPriority 0   ← Cell Reselection Priority of Serving cell
                  },
                  intraFreqCellReselectionInfo
                  {
                    q-RxLevMin -70,
                    presenceAntennaPort1 FALSE,
                    neighCellConfig '01'B,
                    t-ReselectionEUTRA 0
                  }
                }
            }
          }
      }
}}
```

Log Analysis – LTE→WCDMA Cell Reselection (cont.)

```
1980 Jan  6  00:03:36.636  [00]  0xB0C0  LTE RRC OTA Packet  --  BCCH_DL_SCH
value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
      {
        criticalExtensions systemInformation-r8 :
          {
            sib-TypeAndInfo
            {
              sib6 :     ← SIB for  WCDMA Ncell Info (cell reselection)
                {
                  carrierFreqListUTRA-FDD
                  {
                    {
                      carrierFreq 4400,    ← UARFCN of NCell
                      cellReselectionPriority 5,    ← Absolute priority of NCell
                      threshX-High 2,    ← Threshold to use if Ncell is high priority cell : Actual value : 2*2 = 4dB
                      threshX-Low 1,     ← Threshold to use if Ncell is low priority cell : Actual value : 2*1 = 2dB
                      q-RxLevMin -40,    ← To calculate S criteria (S_rxlev) of W cell
                      p-MaxUTRA 21,
                      q-QualMin -24      ← To calculate S criteria(S_qual) of W cell
                    }
                  },
                  t-ReselectionUTRA 0    ← Treselection timer for UTRA
                }
            }
          }
      }
}
```

Log Analysis – LTE→WCDMA Cell Reselection (cont.)

\\ LTE RRC reads SIB6 Ncell parameters and passes to ML1

00:04:07.680	lte_rrc_meas.c	16358	M	WCDMA FDD CarrierFreqList processed successfully
00:04:07.680	lte_rrc_meas.c	7304	M	SIB6 (WCDMA) parameters processed successfully
00:04:07.680	lte_rrc_meas.c	1809	H	WCDMA freq layer 4400, Resel priority 5 being passed to ML1

\\ LTE ML1 checks priority of neighbor W cell and starts measurement

00:04:07.680	lte_ml1_mdb_idle_wcdma.c	1008	H	IRAT_WCDMA: Received config msg (SIB6) from RRC
00:04:07.680	lte_ml1_mdb.c	2509	M	SM MDB: RAT 1, added layer at priority 5
00:04:08.225	lte_ml1_sm_idle_stm.c	2856	M	SM_IDLE: Start IRAT measurement

\\ UE searches for PSC on requested UARFCN

00:04:08.228	lte_ml1_md_wcdma.c	241	M	IRAT_WCDMA: Sending srch req freq 4400,peak_elim_num_psc 0
00:04:08.260	lte_ml1_md_wcdma_driver.c	3229	H	L2W: Step1 peak[0]->pos: 6532 cx8 eng:4277 (Keep. eng >= 70)
00:04:08.260	lte_ml1_md_wcdma_driver.c	3047	H	L2W: nastt_search() Step1 peaks:6 NAS-TT tasks:6 peaks_per_task:4
00:04:08.278	lte_ml1_md_wcdma_driver.c	2876	H	L2W: Num NAS-TT peaks:24 (max:32) RSSI:-60 dBm Raw RxAGC:-54 db10
00:04:08.278	lte_ml1_md_wcdma_driver.c	2894	H	L2W: NAS-TT peak[0] psc:146 eng:4533 pos:231812 cx8 (Keep. eng >= 49)
00:04:08.278	lte_ml1_mdb_idle_wcdma.c	1904	M	IRAT_WCDMA: Freq 4400,i 0, psc 146,pn_pos 231812, energy 4533 tresel_init 255
00:04:08.280	lte_ml1_md_wcdma_driver.c	2790	H	L2W: PN peak[0] psc:146 raw eng:3081 pos:231812 cx8 2*Ec/Io:-9 dBm 2*RSCP:-130 (Keep)
00:04:08.281	lte_ml1_sm_idle_irat_stm.c	2518	M	IRAT_WCDMA: Completed w srch/meas

\\ Evaluates Reselection criteria : S_{qual} of Wcell > $Thresh_x$ for T_{resel}
\\ S_{qual} of W = E_c/I_o-$Q_{Qualmin}$ = -4.5-(-24) = 19.5 > 4

00:04:08.286	lte_ml1_mdb_idle_wcdma.c	2648	H	IRAT_WCDMA: freq 4400 Prio 5 Thresh_X 4 Mob 1 Tresel 0
00:04:08.286	lte_ml1_mdb_idle_wcdma.c	2662	H	IRAT_WCDMA: Updated the Tresel for Freq 4400 PSC 146 Tresel 255
00:04:08.286	lte_ml1_mdb_idle_wcdma.c	2728	H	IRAT_WCDMA: PSC 146 2*EcNo -9 Tresel 0

\\ W cell meets the Treselection criteria and ML1 indicates reselection to LTE RRC

00:04:08.286	lte_ml1_mdb_idle_wcdma.c	2753	H	IRAT_WCDMA: Resel candidate prio 5 Freq 4400 PSC 146 PN_POS 231812
00:04:08.286	lte_ml1_sm_idle.c	3887	H	ML1 CELL RESEL IND, rat 1 freq 4400 id 146

Log Analysis – LTE→WCDMA Cell Reselection (cont.)

\\ LTE RRC prepares for reselection to W RRC

00:04:08.288	lte_rrc_irat_to_w_mgr.c	3518	M	IRAT_LTE_TO_W : **********
00:04:08.288	lte_rrc_irat_to_w_mgr.c	3520	H	IRAT_LTE_TO_W : * IRAT RESELECTION START *
00:04:08.288	lte_rrc_irat_to_w_mgr.c	3522	M	IRAT_LTE_TO_W : **********
00:04:08.288	lte_rrc_irat_to_w_mgr.c	3525	H	IRAT_LTE_TO_W : Rcvd. IRAT Reselection Request from CSP
00:04:08.288	lte_rrc_irat_to_w_mgr.c	410	H	IRAT_LTE_TO_W : Resel Req from CSP
00:04:08.288	lte_rrc_irat_to_w_mgr.c	414	H	IRAT_LTE_TO_W : (Rat type) = (1)
00:04:08.288	lte_rrc_irat_to_w_mgr.c	418	H	IRAT_LTE_TO_W : (W Freq) = (4400)
00:04:08.288	lte_rrc_irat_to_w_mgr.c	422	H	IRAT_LTE_TO_W : (W PSC) = (146)

\\ LTE RRC in SUSPENDED state indicate reselection in progress; W RRC is activated

00:04:08.288	lte_rrc_controller.c	1446	H	RRCC: LTE_RRC_SUSPENDED_DUE_TO_RESEL_FROM_LTE_TO_W
00:04:08.300	rrcmcm.c	4014	H	LTOW:WCDMA_RRC_LTE_RESEL_REQ from LTE RRC, Initial Substate,rrc_mode 0

\\ NAS receives ACTIVATION_IND from W RRC. Suspends any PS session and deactivates LTE RRC stack.

00:04:09.811	mmcoord.c	8665	H	MM: received RRC_ACTIVATION_IND activating WCDMA, enter i-RAT from LTE to W
00:04:09.811	mmsend.c	2556	H	=MM= MM sent CM_PS_DATA_SUSPEND_IND for PS data suspend
00:04:09.811	emm_rrc_if.c	1151	H	EMM: Sent LTE_RRC_DEACTIVATE_REQ with reason = 7

\\ NAS sends ACTIVATION_RSP to W RRC once LTE stack is deactivated.

00:04:09.825	mmrrcconn.c	624	H	=MM= MM sent RRC_ACTIVATION_RSP to RRC

\\ Once W RRC provides SERVICE_IND to NAS, NAS initiates RRC Conn EST for RAU.

00:04:09.828	mmcoord.c	4701	H	=MM= Revd RRC_SERVICE_IND w/ SRV-AC = 3
00:04:09.830	mmrrcconn.c	451	H	=MM= MM sent RRC_EST_REQ to RRC

Log Analysis – LTE→WCDMA Cell Reselection (cont.)

```
980 Jan  6  00:04:07.680  [00]  0xB187  LTE MI1 Idle IRAT Measurement Request
ersion                  = 1
ubPacket ID             = 34
dle Meas WCDMA Config
 Version = 1
 SubPacket Size = 16 bytes
 T Reselection    = 0
 SF Medium        = 1.0
 SF High          = 1.0
 Num WCDMA Freq   = 1
 Frequencies
    ---------------------------------------------------------------
    |   |         |          |         |         |Q Rx   |   |     |
    |   |         |Call      |         |         |Lev    |   |Q    |
    |   |         |Reselection|Threshold|Threshold|Min    |P  |Qual|
    |#  |Frequency|Priority  |High     |Low      |Actual|Max|Min  |
    ---------------------------------------------------------------
    |  0|     4400|         5|        4|        2|   -79| 21| -24|
```

```
1980 Jan  6  00:04:08.286  [00]  0xB186  LTE ML1 Reselection Candidates
Version                        = 2
Serving E-ARFCN                = 2175
Serving Cell ID                = 1
Num Reselection Candidates     = 1
Candidates[0] {
   Candidate Priority    = 5
   RAT Type              = UTRAN
   WCDMA Resel Cell Data {
      U ARFCN            = 4400
      PSC                = 146
   }
}
```

Log Analysis – LTE→GERAN Cell Reselection – SIB7 GERAN Cell Reselection Parameters

```
1980 Jan  6  00:00:14.979  [00]  0xB0C0  LTE RRC OTA Packet  --  BCCH_DL_SCH
value BCCH-DL-SCH-Message ::=
sib-TypeAndInfo
            {
              sib7 :
                {
                  t-ReselectionGERAN 0,    ← Tresel
                  carrierFreqsInfoList
                  {
                    {
                      carrierFreqs
                      {
                        startingARFCN 512,
                        bandIndicator pcs1900,
                        followingARFCNs explicitListOfARFCNs :    ← List of ARFCNs
                          {
                            515,
                            530,
                            590,
                            600,
                            610,
                            655,
                            690,
                            730
                          }
                      },
                      commonInfo
                      {
                        cellReselectionPriority 1,    ← Cell Reselection Priority
                        ncc-Permitted '11111111'B,
                        q-RxLevMin 0,
                        threshX-High 0,                    ← Thresholds for cell reselection
                        threshX-Low 0
                      }

}
```

Log Analysis – LTE→GERAN Cell Reselection

\\ LTE RRC prepares ARFCN List from SIB7

00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 512 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 515 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 530 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 590 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 600 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 610 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 655 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 690 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14549	H	MEAS: GSM ARFCN 730 of band 4 added to the list
00:00:14.980	lte_rrc_meas.c	14903	H	GERAN CarriersFreqList processed successfully
00:00:14.980	lte_rrc_meas.c	5870	H	SIB7 (GSM) parameters processed successfully

\\ LTE ML1 stores info regarding cell reselection priority

00:00:23.741	lte_ml1_mdb_idle.c	2598	H	Priority sorted layer add num 1 ptr 37332464 prio 0 RAT 0
00:00:23.741	lte_ml1_mdb_idle.c	2598	H	Priority sorted layer add num 2 ptr 37333136 prio 1 RAT 2

\\ LTE ML1 also notes the Threshold values along with Tresel

00:00:23.741	lte_ml1_mdb_gsm.c	637	H	L2G Idle Freq Group threshx high: 0, threshx low: 0 Tresel: 0, pmax: 23, qrxlevmin: -115

\\ GSM Driver yields the following RSSI and ML1 calculates Srxlev of those cells.

00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 512, rssi: -1791, Snonservingcellx 4
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 515, rssi: -1798, Snonservingcellx 3
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 530, rssi: -1808, Snonservingcellx 2
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 590, rssi: -1127, Snonservingcellx 45
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 600, rssi: -1814, Snonservingcellx 2
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 610, rssi: -1811, Snonservingcellx 2
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 655, rssi: -1799, Snonservingcellx 3
00:00:24.383	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 690, rssi: -1798, Snonservingcellx 3
00:00:24.388	lte_ml1_mdb_gsm.c	347	H	L2G Meas Results: arfcn 730, rssi: -1770, Snonservingcellx 5

Log Analysis – LTE→GERAN Cell Reselection (cont.)

\\ Able to decode FCCH and SCH and UE confirms BSIC

00:00:24.448	lte_ml1_mdb_gsm.c	479	H	L2G TD Results FCCH Decoded, arfcn: 590 tone_offset: 16300 freq_offset: -22 SCH Decoded ncc: 0 bcc:5 SNR: 28052

\\ LTE ML1 starts Tresel , Tresel expires and informs LTE RRC of reselection candidate

00:00:24.755	lte_ml1_sm_gsm.c	440	H	L2G arfcn: 590 Treselection running : 0 ms
00:00:24.755	lte_ml1_sm_gsm.c	1292	H	L2G Reselection Candidate arfcn: 590
00:00:24.755	lte_ml1_sm_idle.c	3899	H	ML1 CELL RESEL IND, rat 2 freq 590 id 65284

\\ LTE RRC prepares to send reselection request to GRR

00:00:24.755	lte_rrc_csp.c	14100	X	CSP: Reselection to GERAN
00:00:24.756	lte_rrc_irat_to_G_mgr.c	984	H	IRAT_LTE_TO_G:ARFCN: 590
00:00:24.756	lte_rrc_irat_to_G_mgr.c	991	H	IRAT_LTE_TO_G:BCC: 5
00:00:24.756	lte_rrc_irat_to_G_mgr.c	998	H	IRAT_LTE_TO_G:NCC: 0
00:00:24.756	lte_rrc_irat_to_G_mgr.c	1005	H	IRAT_LTE_TO_G:RSSI: 0
00:00:24.764	lte_rrc_irat_to_G_mgr.c	3020	H	IRAT_LTE_TO_G:Sending Resel request to GSM RR

\\ GRR receives resel request

00:00:24.764	rr_gprs_debug.c	2745	H	IMsg: GERAN_GRR_LTE_RESEL_REQ in state INACTIVE(New)

WCDMA→LTE Inter-RAT Cell Reselection

Cell Reselection Measurement Rules – Absolute Priority-Based

- Absolute priority can be given by BCCH (SIB 19) or Dedicated Signaling message (UTRAN Mobility Information).
- If the UE has received absolute priority information for inter-RAT layers, the UE shall:
  - Perform measurements for inter-RAT layers with a priority higher than the priority of the current serving cell
  - For inter-RAT layers with a priority lower than the priority of the current serving cell, perform IRAT measurements
    - If $Srxlev_{\mathbf{ServingCell}} > S_{prioritysearch1}$ and $Squal_{\mathbf{ServingCell}} > S_{prioritysearch2}$, the UE may choose not to perform measurements of inter-frequency layers of equal or lower priority.
    - If $Srxlev_{\mathbf{ServingCell}} \leq S_{prioritysearch}1$ or $Squal_{\mathbf{ServingCell}} \leq S_{prioritysearch2}$, the UE shall perform measurements of inter-frequency layers of equal or lower priority.
- The UE shall not perform measurements of inter-frequency layers for which the UE has no absolute priority.

Cell Reselection Criteria – Absolute Priority-Based

- The following definitions apply for the layers for which $Thresh_{x,high2}$ or $Thresh_{x,low2}$ are *not* provided:
  - If E-UTRA cell has higher priority
    - $Srxlev_{nonServingCell,x}$ *of E-UTRA cell* > $Thresh_{x,high}$ *for* $T_{reselection}$ *interval*
  - If E-UTRA cell has lower priority
    - $Srxlev_{ServingCell} < Thresh_{serving,low}$ *or* $Squal_{ServingCell} < 0$
      and
    - $Srxlev_{nonServingCell,}x$ *of E-UTRA cell* > $Thresh_{x,low}$ *for* $T_{reselection}$
- When $Thresh_{x,high2}$ or $Thresh_{x,low2}$ are provided:
  - If E-UTRA cell has higher priority
    - $Squal_{nonServingCell,x}$ *of E-UTRA cell* > $Thresh_{x,high2}$ *for* $T_{reselection}$ *interval.*
  - If E-UTRA cell has lower priority
    - $Squal_{ServingCell} < Thresh_{serving,low2}$
      and
    - $Squal_{nonServingCell,}x$ *of E-UTRA cell* > $Thresh_{x,low2}$ *for* $T_{reselection}$

Cell Measurement Occasion

- Measurements on detected cells are made every $T_{measureEUTRA}$ based on DRX Cycle Length
- DRX cycle lengths 0.08 sec, 0.16 ses, and 0.32 sec are not supported in Idle mode

DRX cycle length [s]	$T_{measureEUTRA}$ [s] (# of DRX cycles)
0.08	2.56 (32 DRX cycles)
0.16	2.56 (16)
0.32	5.12 (16)
0.64	5.12 (16)
1.28	6.4 (5)
2.56	7.68 (3)
5.12	10.24 (2)

WCDMA RRC and LTE RRC Requirements

- WCDMA RRC requirements
  - RRC shall store the contents and shall use the E-UTRA cell list indicated in SIB19 if SIB19 is scheduled and broadcasted by the network.
  - RRC shall store the dedicated priority information and T322 value received in UTRAN MOBILITY INFORMATION (UMI) OTA.
  - RRC shall configure WL1 with priority information of serving frequency, inter-frequency layers, inter-RAT GSM layers, and inter-RAT E-UTRA layers.
  - RRC shall handle the inter-RAT E-UTRA reselection indication from WL1.
  - Upon receiving a reselection indication from WL1, RRC shall send a reselection request to LTE RRC.
- LTE RRC requirements
  - LTE RRC shall be able to handle the reselect request from WCDMA RRC.
  - If the cell selection to the target cell fails, LTE RRC shall send reject to W RRC with the appropriate failure cause.
  - If cell selection succeeds, inform NAS by sending an activation indication and wait for activation response and on activation response, notify NAS with service status.
  - LTE RRC shall use the dedicated priority information sent by W RRC once cell selection is successful.

Log Analysis – WCDMA→LTE Inter-RAT Cell Reselection System Information Block 19

```
4199 Nov 25  01:48:01.965  [00]  0x412F  WCDMA Signaling Messages  --  Complete SIB (254)
                    Channel Type = Complete SIB (254), Radio Bearer ID = 40, Message Length = 9
Interpreted PDU:
value SysInfoType19 ::=
{
  utra-PriorityInfoList
  {
    utra-ServingCell
    {
      priority 3,
      s-PrioritySearch1 8,
      threshServingLow 4   ← W Serving Cell Priority
    }
  },
  eutra-FrequencyAndPriorityInfoList
  {
    {
      earfcn 2175,
      priority 4,    ← Neighbor Cell Priority
      qRxLevMinEUTRA -53,
      threshXhigh 12,
      threshXlow 8,
      eutraDetection TRUE
    }
  }
}
```

Log Analysis – WCDMA→LTE Inter-RAT Cell Reselection

\\ WRRC gets Cell Reselection information from SIB19

01:47:01.530	rrcsibproc.c	3800	H	sib19:Sched present for SIB19 in MIB, bit mask val =1
01:47:01.755	lte_rrc_utils.c	750	H	UTILS: LTE Band Check for EARFCN (2175)
01:47:01.755	lte_rrc_utils.c	806	H	UTILS: EARFCN belogs to Band4 and is supported
01:47:01.755	rrcmeas.c	33872	H	ABSOL_PRI:valid earfcn found 2175

\\ There is no reselection priority provided through Dedicated signaling

01:47:01.755	rrcmeas.c	33390	H	ABSOL_PRI: Dedicated priority validity: 0

:

\\ RRC saves cell reselection parameters

01:47:01.755	rrcmeas.c	33432	H	ABSOL_PRI: RSRQ thresh_servinglow2 0
01:47:01.755	rrcmeas.c	33451	H	ABSOL_PRI: Serving cell priority :3
01:47:01.755	rrcmeas.c	33456	H	ABSOL_PRI:Actual s_prioritysearch1 16, thresh_servinglow 8, s_prioritysearch2 0
01:47:01.755	rrcmeas.c	32952	H	ABSOL_PRI: EARFCN 2175 added in list
01:47:01.755	rrcmeas.c	32985	H	ABSOL_PRI: EARFCN 2175, priority 4
01:47:01.755	rrcmeas.c	32989	H	ABSOL_PRI: Actual q_rxlevmin -106 threshx_low 16, **threshx_high 24**

//RRC sends to WL1 the received info from SIB19

01:47:01.760	srchmeas.c	5714	H	Rx'ed PRIORITY_EUTRA_MEAS_REQ, processing now
01:47:01.760	srchcr.c	21277	H	Printing Serving cell contents from SIB19. **priority(3),** s_prioritysearch1(16), s_prioritysearch2(0), thresh_servinglow(8), thresh_servinglow2(0)
01:47:01.760	srchcr.c	21310	H	No Prior Info for InterF
01:47:01.760	srchcr.c	21359	H	No Prior Info for GSM
01:47:01.760	wsrchlte.c	1710	H	ABS_PRIO: (1) LTE FDD and (0) LTE TDD Freq's being considered: 0x1 (in bitmask)
01:47:01.760	wsrchlte.c	1407	H	ABS_PRIO: Add LTE freq 2175
01:47:01.760	wsrchlte.c	1742	H	ABS_PRIO: {**priority: 4**, EARFCN: 2175, bandwidth: 0}
01:47:01.760	wsrchlte.c	1747	H	RRC Freq Info blacklist contained 0 cell(s)
01:47:01.760	srchcr.c	21399	H	MEAS_REQ proc done nlayers 1 ncarrier 1

Log Analysis – WCDMA→LTE Inter-RAT Cell Reselection (cont.)

\\ WL1 starts search on LTE for measurements

01:48:10.215	wsrchltedrv.c	718	H	WSRCHLTEDRV: sending LTE_SEARCH_REQ message
01:48:10.243	wsrchlte.c	998	H	LTEMEAS Res: Cell ID 0: **RSRP=-75db** RSRQ=-3db RSSI=-64db freq_off=0Hz
01:48:10.243	wsrchltedrv.c	993	H	WSRCHLTEDRV: sending LTE_CLEANUP_REQ message

\\ WL1 calculates Srxlev of LTE cell.

Srxlev of LTE = RSRP – RXLEVMIN (LTE)

= -75 – (-106) = 31

01:48:10.250	wsrchlte.c	4493	H	ABS_PRIO: RSRP -75, rxlev min -106, max tx pwr 0, **s_rxlev 31**, RSRQ -3, Qqualmin 255, s_qual 255

\\ Since LTE is higher priority , criteria is Srxlev (LTE) > Threshx_high.

Here Srxlev (LTE) is 31 > 24 (Threshx_high)

\\ L1 starts Tresel and upon expiry sends RESEL IND to W RRC

01:48:10.250	srchcr.c	5652	H	ABS_PRIO: CR:Start Tresel on LTE Freq=2175 Cell_id=0 t=0 Tresel=0 frms start_sfn 154
01:48:10.251	srchcr.c	12388	H	ABS_PRIO: CEL RESEL IND for LTE Freq: 2175, Cell_id: 0
01:48:10.251	srchcr.c	13043	H	ABS_PRIO: Ranking Step-1 (AP mode), Cell resel triggered in HIGH_PRIORITY_LAYER

Log Analysis – WCDMA→LTE Inter-RAT Cell Reselection (cont.)

\\ W RRC sends RESEL REQ to LTE RRC

01:48:10.265	rrccsp.c	21713	H	WTOL: LTE_RRC_WCDMA_RESEL_REQ sent to LTE RRC

\\ LTE RRC receives REQ from W RRC

01:48:10.265	lte_rrc_irat_from_w_mgr.c	3053	H	IRAT_LTE_FROM_W : INITIAL - Reselection Request from WCDMA

\\ LTE RRC begins activation

01:48:10.266	lte_rrc_irat_from_w_mgr.c	3098	H	IRAT_LTE_FROM_W : INITIAL - Activate LTE to begin IRAT

\\ LTE RRC begins cell selection on Target LTE Cell

01:48:10.274	lte_rrc_irat_from_w_mgr.c	811	H	IRAT_LTE_FROM_W : Reselection Request for CSP
01:48:10.274	lte_rrc_irat_from_w_mgr.c	815	H	IRAT_LTE_FROM_W : Cell Freq : (2175)
01:48:10.274	lte_rrc_irat_from_w_mgr.c	817	H	IRAT_LTE_FROM_W : Cell Id : (0)

:

\\ Once LTE Cell is deemed suitable , UE proceeds to camp and reselection is a success!

01:48:10.510	lte_rrc_csp.c	13609	L	CSP: Suitable cell
01:48:10.510	lte_rrc_csp.c	13623	L	CSP: Proceeding to camped
01:48:10.519	lte_rrc_irat_from_w_mgr.c	5111	H	IRAT_LTE_FROM_W : IRAT Resel to LTE Success!!

GERAN→LTE Inter-RAT Cell Reselection

Cell Reselection Measurement Rules

- When camped on GSM, the UE shall regularly measure the serving cell and other G and inter-RAT (including LTE) cells based on the E-UTRAN Neighbor cell list obtained in the Measurement Information message or SI2quater message.
- Cell reselections can be performed by the UE when in GSM or GPRS Idle or Packet Transfer modes.
- One or more instances of an SI2quater message may provide E-UTRAN frequencies and zero or more ‘not allowed’ physical layer cell identities for each E-UTRAN frequency.
- The E-UTRAN cell reselection list may contain up to eight frequencies.
- For each E-UTRAN frequency, zero or more E-UTRAN neighbor cells may be specified that are not allowed for cell reselection. The list of ‘not allowed’ cells is defined in the ‘not allowed’ cells IEs.

Cell Reselection Measurement Rules (cont.)

- Priority-based cell reselection
- Serving cell and EUTRA cell priority is broadcasted in priority and E-UTRAN parameters description IE in the SI2QUATER or in dedicated signaling, like the Channel Release message
- The mobile station shall use the parameters provided in E-UTRAN measurement parameters description IE for inter-RAT cell reselection toward E-UTRAN

Cell Reselection Measurement Rules (cont.)

- When EUTRA is of higher priority
  - The mobile station shall monitor cells of inter-RAT frequencies of higher priority than the serving cell once every (60*Nhpf) sec, where Nhpf is the number of inter-RAT frequencies of higher priority.
- When E-UTRA is of lower priority
  - When Received Level Average (RLA_C for GSM, RLA_P for GPRS mode) of the serving cell is above the threshold, the mobile station is allowed not to monitor cells of inter-RAT frequencies of lower priority than the serving cell.

S-Value

- The following parameters must be calculated for the serving cell and each neighbor cell appropriately before cell reselection criteria may be evaluated:
  - S_GSM – This is defined as the C1 value for a GSM cell.
  - S_non_serving_EUTRAN – This is the measured RSRP value for an E-UTRAN cell, minus E-UTRAN_QRXLEVMIN for the cell's frequency.

Note: These shall be referred to as the 'S-value' of a cell.

Cell Reselection Criteria

- If E-UTRA is of higher priority
  - The S-value of one or more cells of a higher priority inter-RAT frequency > THRESH_XXX_high during a time interval T_reselection.
- If E-UTRA is of lower priority
  - Serving G Cell S_GSM < THRESH_GSM_low during a time interval T_reselection

    and
  - S_non-serving_XXX > THRESH_XXX_low during a time interval T_reselection
  - If no cells satisfy the criterion above, inter-RAT cells for which during a time interval T_reselection, S_non-serving_XXX > S_GSM for the serving cell by at least a specific hysteresis H_PRIO.

Cell Reselection Parameters

THRESH_GSM_low	A threshold below which the MS is allowed to reselect to lower priority layers, 0 = 0 dB, 1 = 2 dB, 2 = 4 dB, …, 13 = 26 dB, 14 = 28 dB, 15 = ∞ (always).	0-15	4	BCCH D/L
THRESH_priority_search	A threshold for the serving cell that controls measurement of inter-RAT cells or frequencies of lower priority when the priority-based cell reselection algorithm is used, 0 = -98 dBm, 1 = -95 dBm, 2 = -92 dBm, …, 13 = -59 dBm, 14 = -56 dBm, 15 = ∞ (always).	0-15	4	BCCH D/L
GERAN_PRIORITY	Priority of GSM cells, 0 = lowest priority, …, 7 = highest priority.	0-7	3	BCCH D/L
E-UTRAN_QRXLEVMIN	Minimum required RX level for cells on the target E-UTRAN frequency (dBm), 0 = -140 dBm, 1 = -138 dBm, 2 = -136 dBm, …, 30 = -80 dBm, 31 = -78 dBm. Default value = -140 dBm.	0-31	5	BCCH D/L
THRESH_E-UTRAN_high, THRESH_E-UTRAN_low	Reselection thresholds towards E-UTRAN FDD or TDD cells, 0 = 0 dB, 1 = 2 dB, 2 = 4 dB, 3 = 6 dB, …, 30 = 60 dB, 31 = 62 dB. Default value of THRESH_E-UTRAN_low = value of THRESH_E-UTRAN_high.	0-31	5	BCCH D/L
E-UTRAN_PRIORITY	Priority of a E-UTRAN frequency layer, 0 = lowest priority, …, 7 = highest priority.	0-7	3	BCCH D/L

GERAN RR and LTE RRC Requirements

- GERAN RR
  - Upon receiving UTRAN or E-UTRAN information set, from SI2quater instances GRR shall rebuild the UTRAN/E-UTRAN reselection list and send to GL1
  - On receiving measurement indications from GL1, GRR should apply priority-based reselection algorithm for inter-RAT cell reselection if priority information is available to the MS and threshold information is provided by the network
  - When GRR decides to reselect to an inter-RAT cell, it should deactivate GL1 and send reselection request to LTE RRC
- LTE RRC requirements
  - LTE RRC shall be able to handle the reselect request from GERAN RR
  - Upon receiving the LTE reselection request, LTE RRC will use ML1 to attempt acquisition on the specified LTE cell
  - If the cell selection to the target cell fails, LTE RRC shall send reject to GERAN RR with the appropriate failure cause
  - If cell selection succeeds, inform NAS by sending an activation indication and wait for activation response and on activation response, notify NAS with service status

Log Analysis – GERAN→LTE Inter-RAT Cell Reselection, SI2 Quarter

1980 Jan 6 00:13:39.728 [00] 0x512F GSM RR Signaling Message -- System Information Type 2quater

rr_man_prot

SYSTEM_INFORMATION_2QUATER

:

priority_and_e_utran_parameters_description_present = 1 (0x1)

Priority and E-UTRAN Parameters Description

serving_cell_priority_parameters_description_present = 1 (0x1)

Serving Cell Priority Parameters Description

GERAN_PRIORITY = 2 (0x2) **//Serving GERAN cell Priority**

THRESH_Priority_Search = 15 (0xf) **//Threshold to control measurements on Low Priority cell (always)**

THRESH_GSM_low = 0 (0x0) **//Threshold for Serving C1 to be below a value for resel. (0dBm)**

H_PRIO = 0 (0x0)

T_Reselection = 0 (0x0) **//(0 = 5 secs)**

_3g_priority_parameters_description_present = 0 (0x0)

:

:

Log Analysis – GERAN→LTE Inter-RAT Cell Reselection, SI2 Quarter (cont.)

e_utran_parameters_description_present = 1 (0x1)
E-UTRAN Parameters Description
struct0_count = 1 (0x1)
struct0[0]
const_1 = 1 (0x1)
Repeated E-UTRAN Neighbour Cells
struct0_count = 1 (0x1)
struct0[0]
const_1 = 1 (0x1)
EARFCN = 2175 (0x87f) **//EARFCN of the Target EUTRA Cell**
measurement_bandwidth_present = 1 (0x1)
Measurement Bandwidth = 2 (0x2)
const_0 = 0 (0x0)
e_utran_priority_present = 1 (0x1)
E-UTRAN_PRIORITY = 6 (0x6) **// Reselection Priority of the EUTRA Cell**
THRESH_E-UTRAN_high = 2 (0x2) **//Threshold for reselection for high priority LTE Cell**
thresh_e_utran_low_present = 1 (0x1)
THRESH_E-UTRAN_low = 2 (0x2) **//Threshold for reselection for low priority LTE cell**
e_utran_qrxlevmin_present = 1 (0x1)
E-UTRAN_QRXLEVMIN = 15 (0xf) **// Qrxlevmin of EUTRA cell : -140+2*15 = -110**

Log Analysis – GERAN→LTE Inter-RAT Cell Reselection

\\SI2Q decoded

00:13:39.728	rr_decode_ie.c	7064	H	Received SI2q(Index=0, Count=0)
00:13:39.728	rr_general.c	8782	H	All SI2quater instances containing LTE parameter have been received

:

\\ Serving Cell Information

00:13:39.728	rr_general.c	9172	M	Priority and Threshold Information:
00:13:39.728	rr_general.c	9174	M	GERAN Information:
00:13:39.728	rr_general.c	9175	M	**GERAN Priority: 2**
00:13:39.728	rr_general.c	9176	M	THRESH Priority Search: 15
00:13:39.728	rr_general.c	9177	M	THRESH_GSM_low: 0
00:13:39.728	rr_general.c	9179	M	T_Reselection: 5000

\\ Neighboring Cell EUTRA Information

00:13:39.729	rr_general.c	9203	M	E-UTRAN Information:
00:13:39.729	rr_general.c	9209	M	EARFCN: 2175
00:13:39.729	rr_general.c	9218	M	Measurement Bandwidth: Not Present
00:13:39.729	mcpm_npa.c	1219	H	MCPM_NPA: Sched Bus req for 1000 MBps
00:13:39.729	rr_general.c	9224	M	**Priority: 6**, THRESH_HIGH: 2, THRESH_LOW: 2
00:13:39.729	rr_general.c	9225	M	QRXLEVMIN: 15 // 0 = 140... 140 - (2*15) = -110

\\ Since LTE is higher priority cell , UE will calculate S (LTE) and compare it with THRESH_HIGH

00:13:40.729	rr_g2w.c	2344	H	[0] RAT: LTE, E-ARFCN: 2175, PCID: 0, **S-value: 16,** Priority: 6, High **Threshold: 4**, Low Threshold: 4, Timers: 0x000000

\\ T_reselection started

00:13:40.729	rr_g2w.c	3574	M	Cell 0: Starting thresh_high_timer (0x50) duration 5000 ms

Log Analysis – GERAN→LTE Inter-RAT Cell Reselection (cont.)

\\ G2L MEAS is initiated by GL1

00:13:40.758	l1_send.c	3301	M	LTE_CPHY_IRAT_MEAS_G2L_MEAS_REQ num_cells 1

\\ GL1 finds the cell and measures RSRP

00:13:40.768	lte_ml1_md.c	2330	H	X2L Ngbr meas upd PCI - (0) RSRP -94 RSRQ -4 RSSI[0,1] [-82,-81] RSRPx16[0,1] [-1516,-1508] ant0_samp_off 216800 ant1_samp_off 216800
00:13:40.768	l1_sc_irat.c	13644	M	LTE_CPHY_IRAT_MEAS_MEAS_CNF

\\ GRR receives the meas results from L1

00:13:40.769	rr_g2w.c	1999	H	Received 1 LTE measurements for EARFCN 2175
00:13:40.769	rr_g2w.c	2029	H	PCID: 0, RSRP: -94, RSRQ: -4
00:13:40.769	rr_g2w.c	2133	M	New RSRP: -94 for LTE cell 2175,0
00:13:40.769	rr_g2w.c	2187	M	LTE Measurements:
00:13:40.769	rr_g2w.c	2197	H	EARFCN: 2175, PCID: 0, RSRP: -94, RSRQ: -4

\\ S of LTE Cell = RSRP – QRXLEVMIN

= -94 –(-110) = 16

Log Analysis – GERAN→LTE Inter-RAT Cell Reselection (cont.)

\\ T_reseleciton timer expires and GRR prepares for reselection

00:13:45.729 rr_gprs_debug.c 2888 H Timer RR_IRAT_PRIORITY_RESEL_THRESH_HIGH_TIMER_1 expired in state CAMPED

00:13:45.729 rr_resel.c 5169 H EV_CELL_RESELECTION rxd

\\ GRR sends RESEL REQ to LTE RRC

00:13:45.770 rr_msgr.c 78 H OMsg: LTE_RRC_G_RESEL_REQ

\\ GRR deactivates GSM mode

00:13:45.770 rr_resel.c 11576 H EV_GSM_MODE_DEACTIVATED rxd

00:13:45.770 rr_resel_g2w.c 2030 H RRState: rr_resel_g2w_control(DEACTIVATING->RESELECTING)

\\ LTE RRC receives the request and starts reselection

00:13:45.771 lte_rrc_irat_from_G_mgr.c 903 H IRAT_G_TO_LTE:Reselection STARTED

00:13:45.771 lte_rrc_irat_from_G_mgr.c 4202 H IRAT_G_TO_LTE:LTE cell id is 0 \n

00:13:45.771 lte_rrc_irat_from_G_mgr.c 4205 H IRAT_G_TO_LTE:LTE frequency is 2175 \n

00:13:45.771 lte_rrc_controller.c 1421 H RRCC: LTE_RRC_ACTIVATED_DUE_TO_IRAT_TO_LTE

:

\\ Camps on intended cell after reselection

00:13:45.928 lte_rrc_csp.c 17876 L CSP: Camped after To LTE cell reselection

00:13:45.928 lte_rrc_csp.c 17904 L CSP: Camped on physical cell ID 0 on earfcn 2175

Inter-RAT Redirection Procedure

What is Redirection

- Redirections are an alternate to handovers, which provide the ability for the network to move the UE from LTE (to another network in the case of Inter-RAT redirections).
- Redirections happen during RRC connection release.
- RRC Connection Release IE – A UE in Connected mode in an LTE network can receive an RRC Connection Release with optional IE, “redirectedCarrierInfo”, which indicates that the UE is being redirected to camp on a different frequency *and/or* RAT once the active connection has been released.

```
RRCConnectionRelease-r8-IEs ::=     SEQUENCE {
 releaseCause                       ReleaseCause,
 redirectedCarrierInfo              RedirectedCarrierInfo              OPTIONAL,   --
Need ON
 idleModeMobilityControlInfo        IdleModeMobilityControlInfo        OPTIONAL,   --
Need OP
 nonCriticalExtension               SEQUENCE {}                        OPTIONAL    --
Need OP
}
```

LTE Inter-RAT Redirections

- Redirected Carrier Info IE – If the UE is being redirected, the IE "redirectedCarrierInfo" will further contain details on to which frequency and RAT the UE is being redirected.

```
    eutra                                   ARFCN-ValueEUTRA,
    geran                                   CarrierFreqsGERAN,
    utra-FDD                                ARFCN-ValueUTRA,
    utra-TDD                                ARFCN-ValueUTRA,
    cdma2000-HRPD                           CarrierFreqCDMA2000,
    cdma2000-1xRTT                          CarrierFreqCDMA2000,
    ...
```

Log Analysis – LTE→WCDMA Redirection Log

```
1980 Jan  6  01:38:39.026  [00]  0xB0C0  LTE RRC OTA Packet  --  DL_DCCH
Pkt Version = 2
RRC Release Number.Major.minor = 9.5.0
Radio Bearer ID = 1, Physical Cell ID = 0
Freq = 2000
SysFrameNum = N/A, SubFrameNum = 0
PDU Number = DL_DCCH Message,    Msg Length = 5

Interpreted PDU:

value DL-DCCH-Message ::=
{
  message c1 : rrcConnectionRelease :
      {
        rrc-TransactionIdentifier 0,
        criticalExtensions c1 : rrcConnectionRelease-r8 :
            {
              releaseCause other,
              redirectedCarrierInfo utra-FDD : 9888
            }
      }
}
```

Log Analysis – LTE→WCDMA Redirection Log (cont.)

```
\\ Cell Redirection Procedure initiates redirection procedure
01:38:39.027  lte_rrc_crp.c              1807  H  CRP: redirectionInformation present
01:38:39.027  lte_rrc_crp.c              1876  X  CRP: LTE -> UTRA_FDD redirection
01:38:39.027  lte_rrc_crp.c              1877  H  IRAT: LTE -> UTRA FDD redirection
01:38:39.096  lte_rrc_crp.c              519   H  CRP: Connection Relese due to redir to RAT Type:(2)
:
\\ Deactivate LTE and redirection to WCDMA begins
01:38:39.096  lte_rrc_csp.c              13163 H  CSP: Release cause is InterRAT Redirection
01:38:39.097  lte_rrc_irat_to_w_mgr.c   3427  H  IRAT_LTE_TO_W : **********************************
01:38:39.097  lte_rrc_irat_to_w_mgr.c   3429  H  IRAT_LTE_TO_W : *    IRAT REDIRECTION START    *
01:38:39.097  lte_rrc_irat_to_w_mgr.c   3431  H  IRAT_LTE_TO_W : **********************************
01:38:39.097  lte_rrc_irat_to_w_mgr.c   3434  H  IRAT_LTE_TO_W : INITIAL - Redirection Request
01:38:39.097  lte_rrc_irat_to_w_mgr.c   431   H  IRAT_LTE_TO_W :    Redir Req from CSP
01:38:39.097  lte_rrc_irat_to_w_mgr.c   435   H  IRAT_LTE_TO_W :     (Rat type)    = (2)
01:38:39.097  lte_rrc_irat_to_w_mgr.c   439   H  IRAT_LTE_TO_W :     (ARFCN)       = (9888)
:
\\ Camp on WCDMA Success
01:38:39.799  lte_rrc_irat_to_w_mgr.c   582   H  IRAT_LTE_TO_W : **********************************
01:38:39.799  lte_rrc_irat_to_w_mgr.c   584   H  IRAT_LTE_TO_W : *    IRAT REDIRECTION END      *
01:38:39.799  lte_rrc_irat_to_w_mgr.c   586   H  IRAT_LTE_TO_W : **********************************
01:38:39.799  lte_rrc_irat_to_w_mgr.c   5312  H  IRAT_LTE_TO_W :    Redirection Success
```

Log Analysis – LTE→GERAN Redirection Log

```
1980 Jan  6  04:22:59.539  [00]  0xB0C0  LTE RRC OTA Packet  --  DL_DCCH
PDU Number = DL_DCCH Message,    Msg Length = 5

Interpreted PDU:

value DL-DCCH-Message ::=
{
  message c1 : rrcConnectionRelease :
      {
        rrc-TransactionIdentifier 0,
        criticalExtensions c1 : rrcConnectionRelease-r8 :
            {
              releaseCause other,
              redirectedCarrierInfo geran :
                {
                  startingARFCN 590,
                  bandIndicator pcs1900,
                  followingARFCNs explicitListOfARFCNs :
                    {
                    }
                }
            }
      }
}
```

Log Analysis – LTE→GERAN Redirection Log (cont.)

```
\\ Redirection info present
04:22:59.539  lte_rrc_crp.c              1807        H          CRP: redirectionInformation present
04:22:59.539  lte_rrc_crp.c              1373        X          CRP: LTE -> GERAN redirection
04:22:59.539  lte_rrc_crp.c              1374        H          IRAT: LTE -> GERAN redirection
04:22:59.539  lte_rrc_crp.c              1414        X          CRP: GSM PCS 1900 band specified
04:22:59.539  lte_rrc_crp.c              1458        H          CRP: Added freq 590 , band 48
:
\\ LTE RRC processing the freq/band info
04:22:59.609  lte_rrc_irat_to_G_mgr.c    727         H          IRAT_LTE_TO_G: Redir List -- Band 1 0x1
04:22:59.609  lte_rrc_irat_to_G_mgr.c    731         H          IRAT_LTE_TO_G: Redir List -- Freq 1 0x24e
:
\\ LTE RRC sends redirection request to GRR
04:22:59.609  lte_rrc_irat_to_G_mgr.c    772         H          IRAT_LTE_TO_G:Redirection STARTED
04:22:59.625  lte_rrc_irat_to_G_mgr.c    3198        H          IRAT_LTE_TO_G:Sending Redir request to GSM RR
04:22:59.625  lte_rrc_irat_to_G_mgr.c    3204        M          IRAT_LTE_TO_G:Sent Redir request to GSM RR

\\ UE needs to acquire the channel (FCCH /SCH decode followed by BSIC verification)
04:23:00.493  gl1_msg_acq.c              1316        H          GL1_XO_ACQ: Tone seen: arfcn=590 snr=9961 fe=79Hz

04:23:00.511  l1_acq.c                   587         M          SCH Decoded, ARFCN=590 NCC=0 BCC=5
:
\\Redirection completed
04:23:02.067  lte_rrc_irat_to_G_mgr.c    3807        H          IRAT_LTE_TO_G:Redirection COMPLETED
```

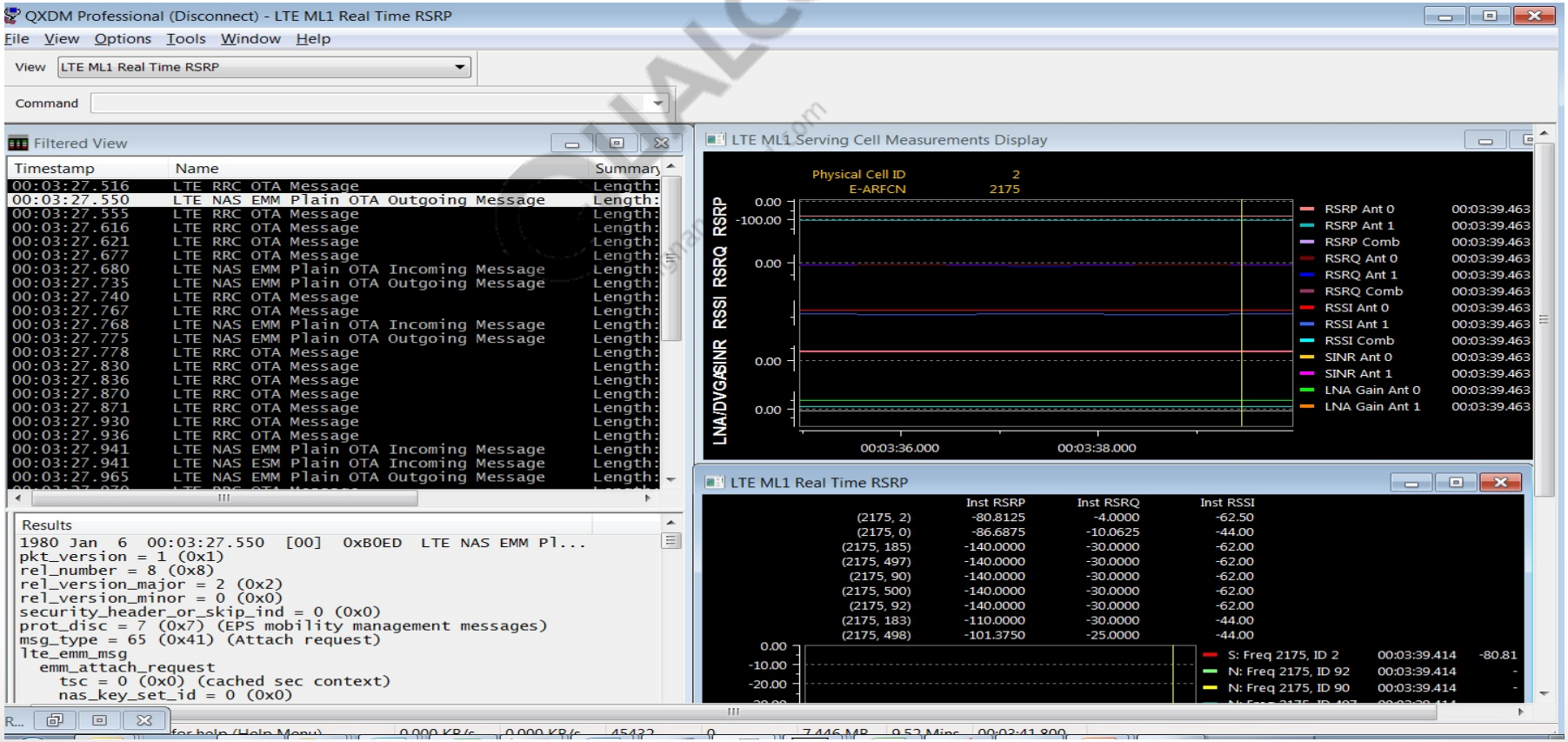
Search String

Search Strings (F3)

- LTE→WCDMA
  - rrc conn|sib6|camped on phy|IRAT_WCDMA:|L2W:|acq succ|cell resel ind|IRAT_LTE_TO_W :|activation_ind|activation_rsp|Deactivate Confirm|CRP:
- LTE→GERAN
  - rrc conn|sib7|camped on phy|cell resel ind|L2G|IRAT_LTE_TO_G:|lte_resel|tone seen|sch decoded|sending rau|deactivate confirm|rr_service_ind|activation_rsp
- GERAN→LTE
  - Si2Q|rr_resel|rr_general|g2l|g2w|CELL_RESELECTION|tau|lte_rrc_irat|camped on phy|_service on
- WCDMA→LTE
  - sib19|W2L|lte_rrc_irat|cel resel ind|tracking area|rrc conn|_service on|IRAT_LTE_FROM_W :|ABSOL_PRI:|WTOL:|wsrchlte|ABS_PRIO:

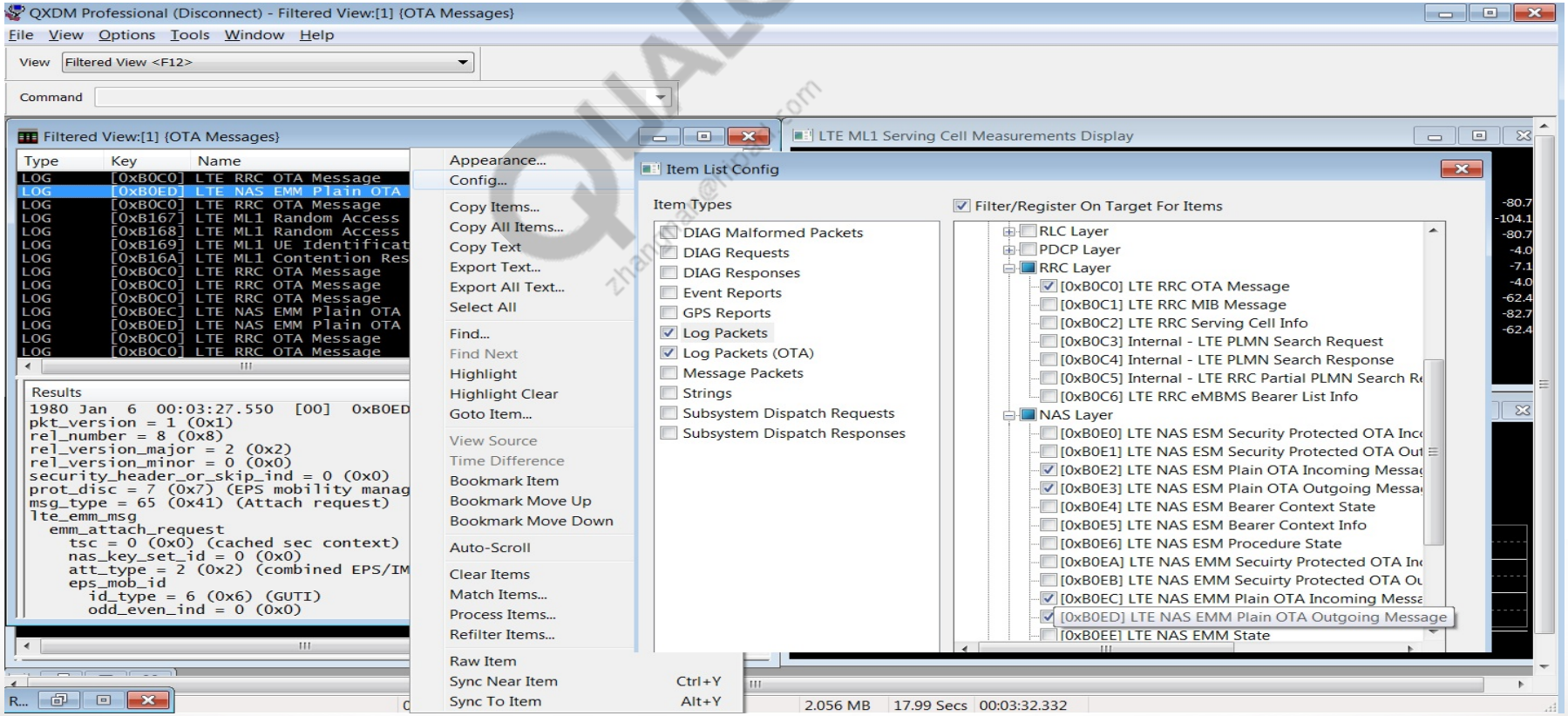
LTE Cell Reselection: Intra-Frequency Cell Reselection – QXDM Professional™ (QXDM Pro) Dashboard

- LTE Filtered View window to filter out LTE Over-the-Air (OTA) messages
- LTE ML1 (Layer 1 Manager) Serving Cell Measurements display
- LTE ML1 Real-Time RSRP display



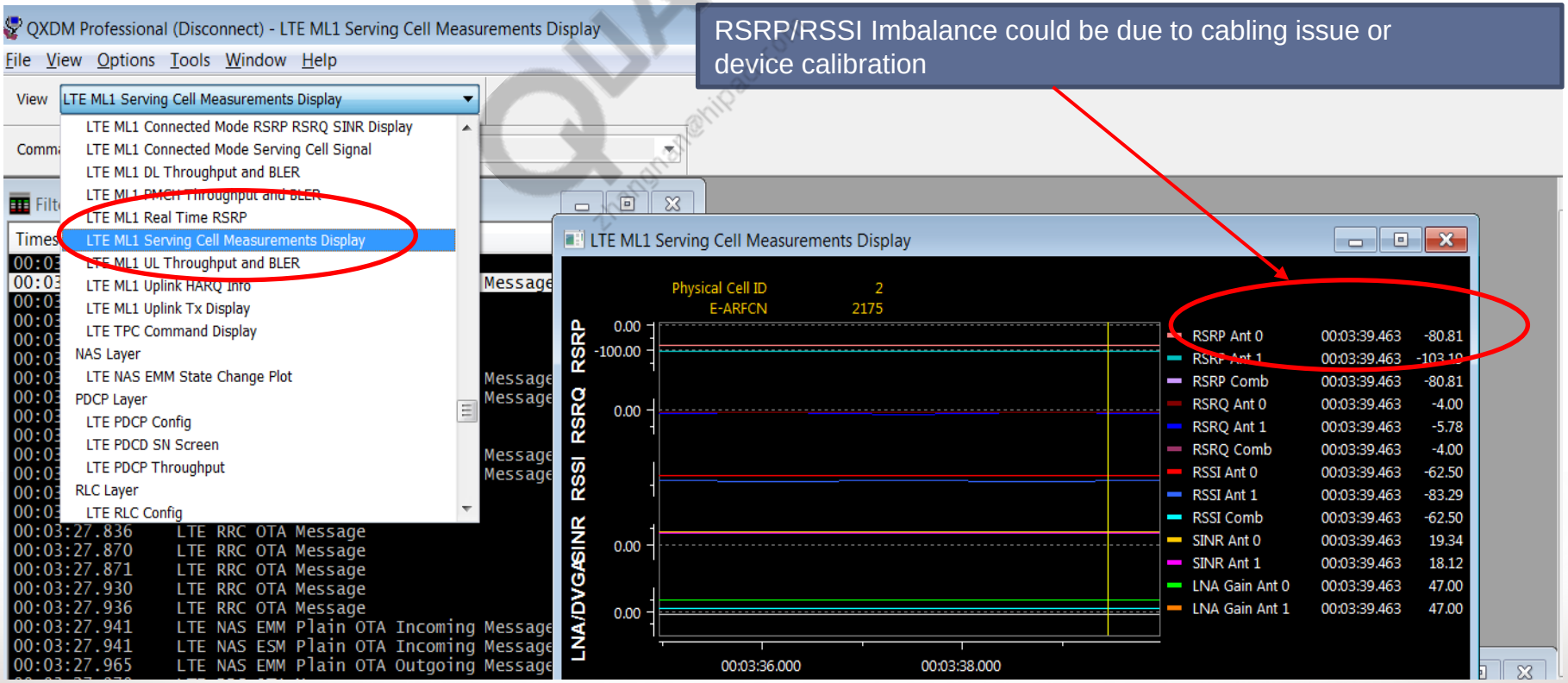
LTE Cell Reselection – Intra-Frequency Cell Reselection, Filtered View

- Right-click the Filtered View window and select Config.
- Under Item List Config, select RRC OTA and ESM/EMM Plain OTA messages.
- You can also add GERAN and WCDMA OTA by selecting the respective packets.



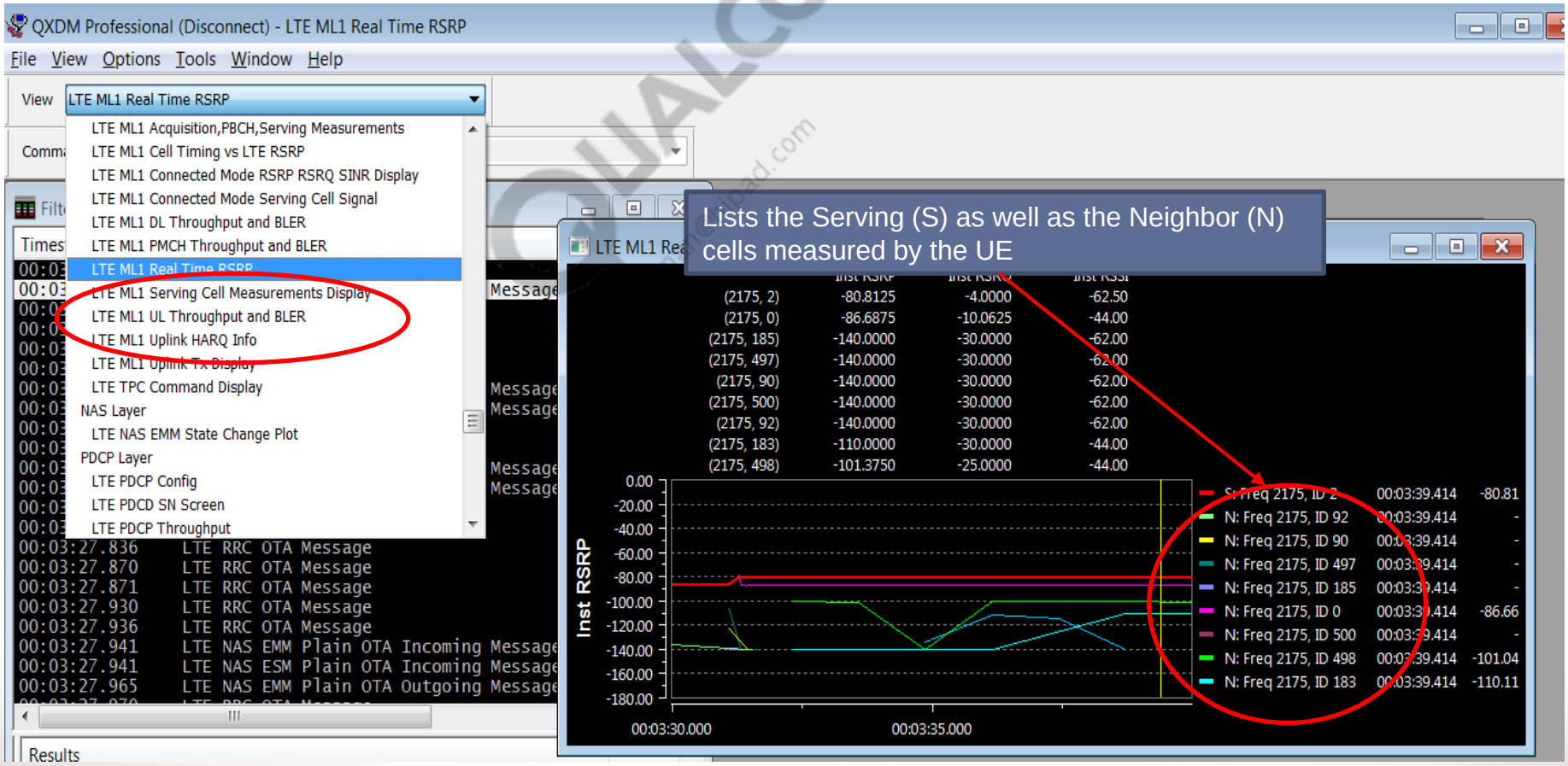
LTE Cell Reselection – Intra-Frequency Cell Reselection, LTE ML1 Serving Cell Measurements Display

- Window shows the instantaneous values of the **serving** LTE Cell (given by the Physical Cell ID and EARFCN).
- Important thing to note is that *if* both primary and secondary cables are connected from the test system to the UE, then RSRP/RSSI across the two chains should be fairly balanced.
- This can be selected from the View tab under LTE.



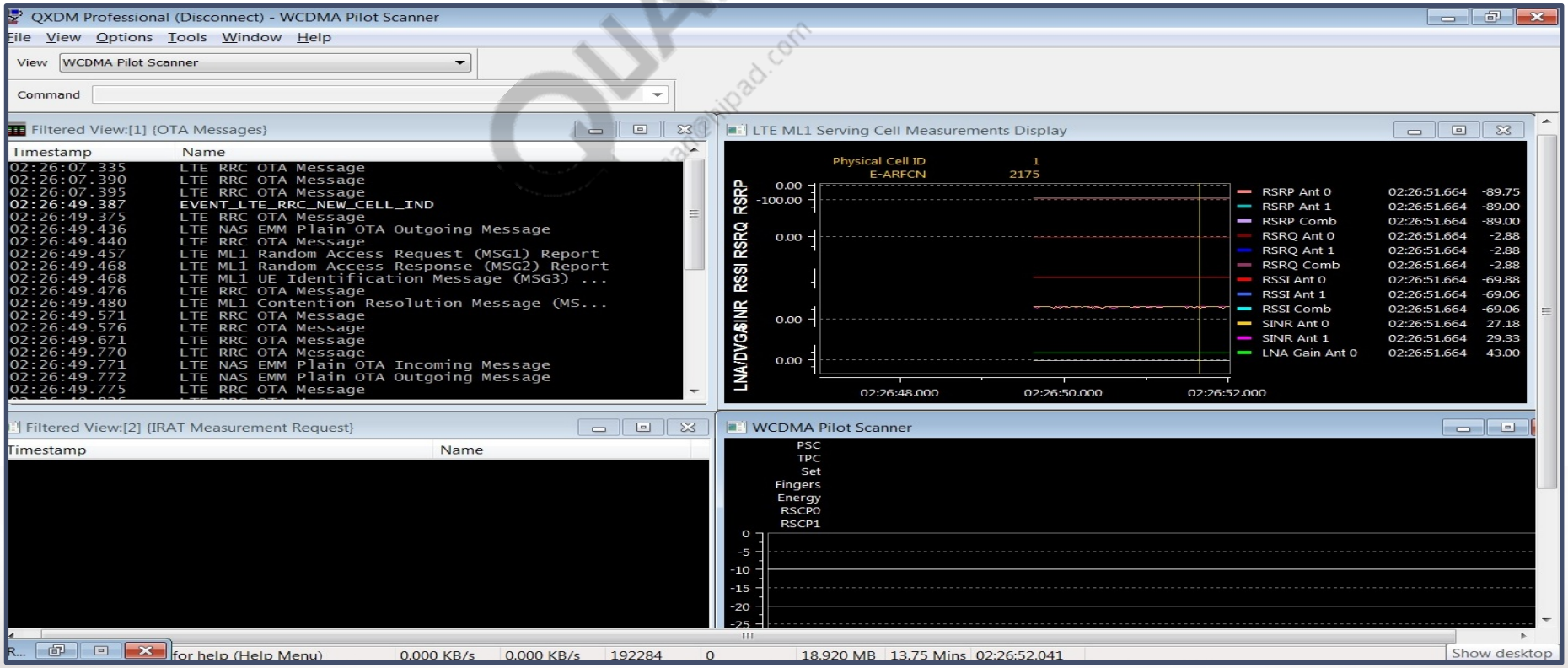
LTE Cell Reselection – Intra-Frequency Cell Reselection, LTE ML1 Real-Time RSRP

- Window tells you the cell power measurements of the Serving as well as the Neighbor cells as measured by the UE
- Can be selected from the View Tab under LTE



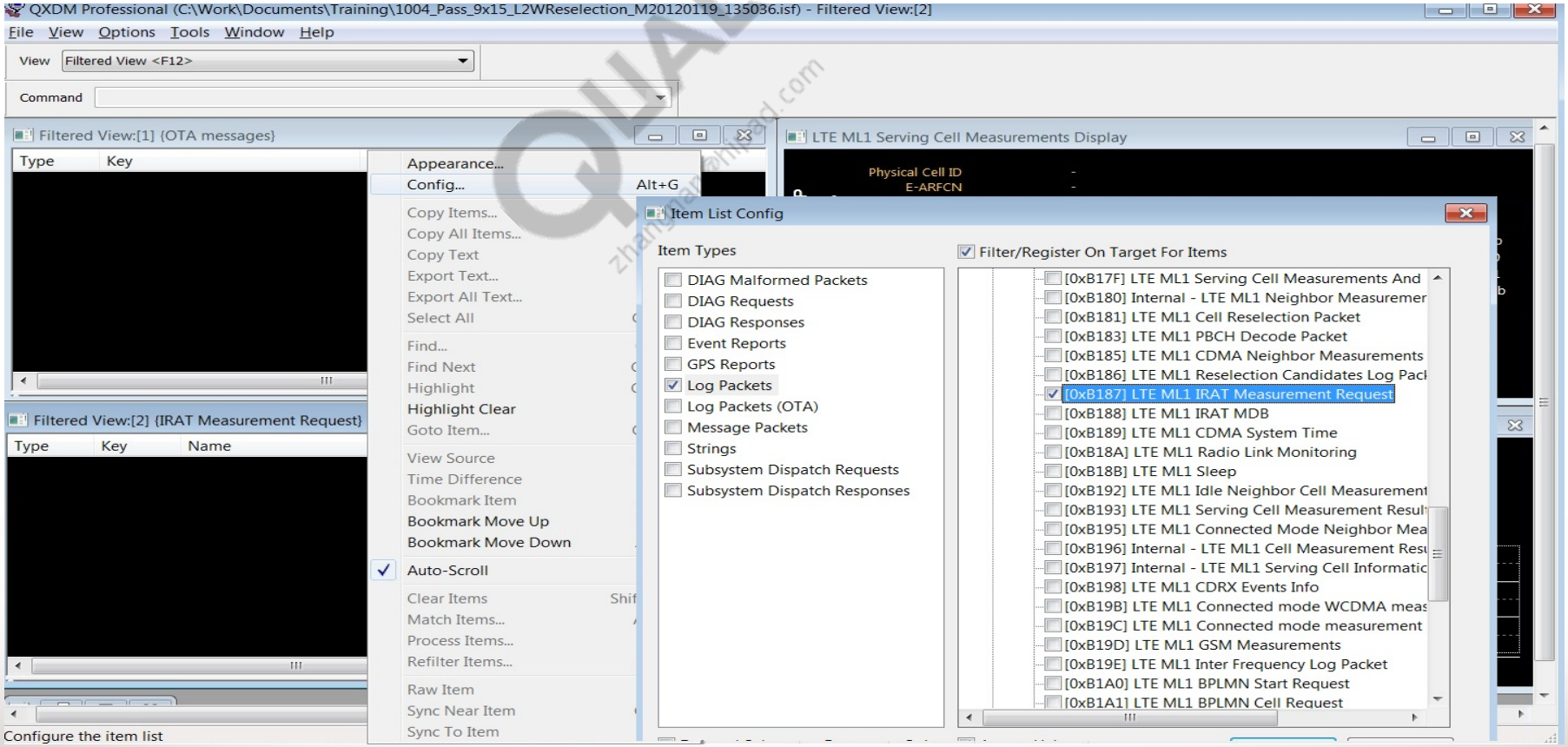
LTE Cell Reselection – LTE↔WCDMA Cell Reselection, QXDM Pro Dashboard

- Filtered View for displaying OTA messages in LTE and WCDMA (see previous slides)
- IRAT Measurement Request window (to ensure UE started measurements)
- LTE ML1 Serving Cell Measurements Display (see previous slides)
- WCDMA Pilot Scanner window



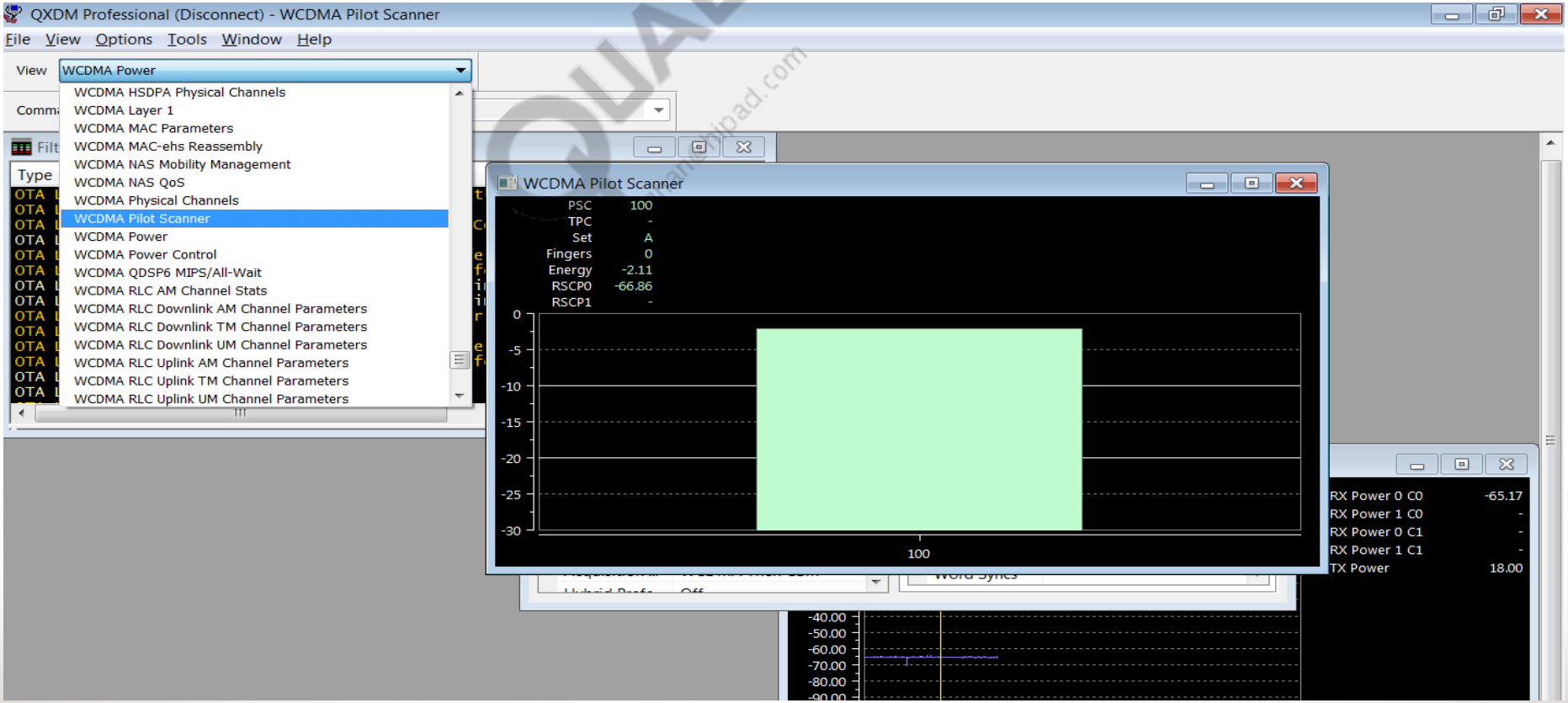
LTE Cell Reselection – LTE↔WCDMA Cell Reselection, IRAT Measurement Request

- IRAT Measurement Request Filtered View window tells you that the device has started measurement of inter-RAT neighbor cells
- Window can be created by right-clicking Filtered View→Config. Then under Item List Config, Log Packets→LTE ML1→LTE ML1 IRAT Measurement Request



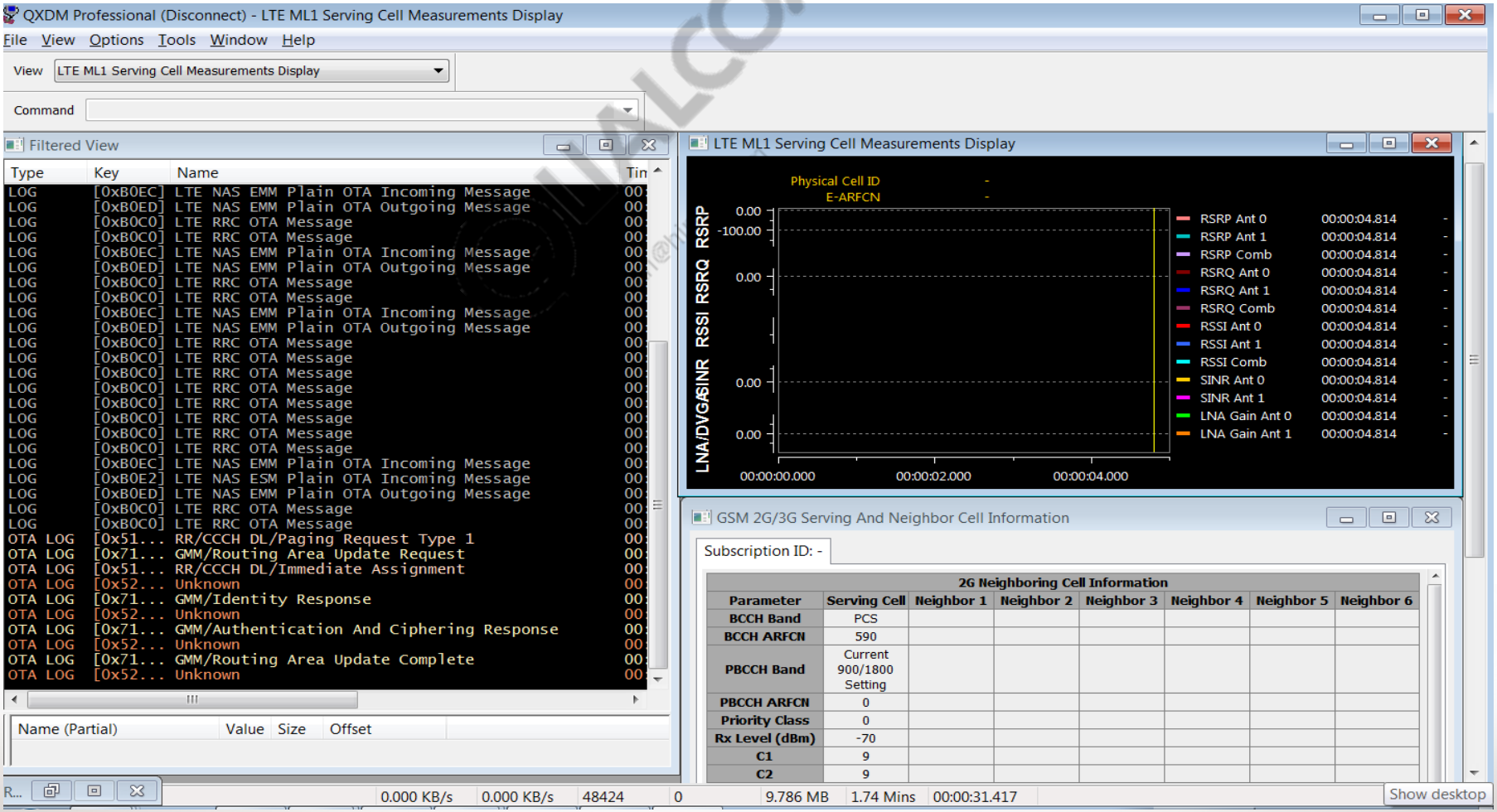
LTE Cell Reselection – LTE↔WCDMA Cell Reselection, WCDMA Pilot Scanner Window

- Tells you on which Primary Scrambling Code (PSC) the UE has acquired
- Gives acquired cell's Energy-per-chip-to-ilterference (E_cI_o) ratio and Received Signal Code Power (RSCP) measurements
- Select from the drop-down list on the View Tab



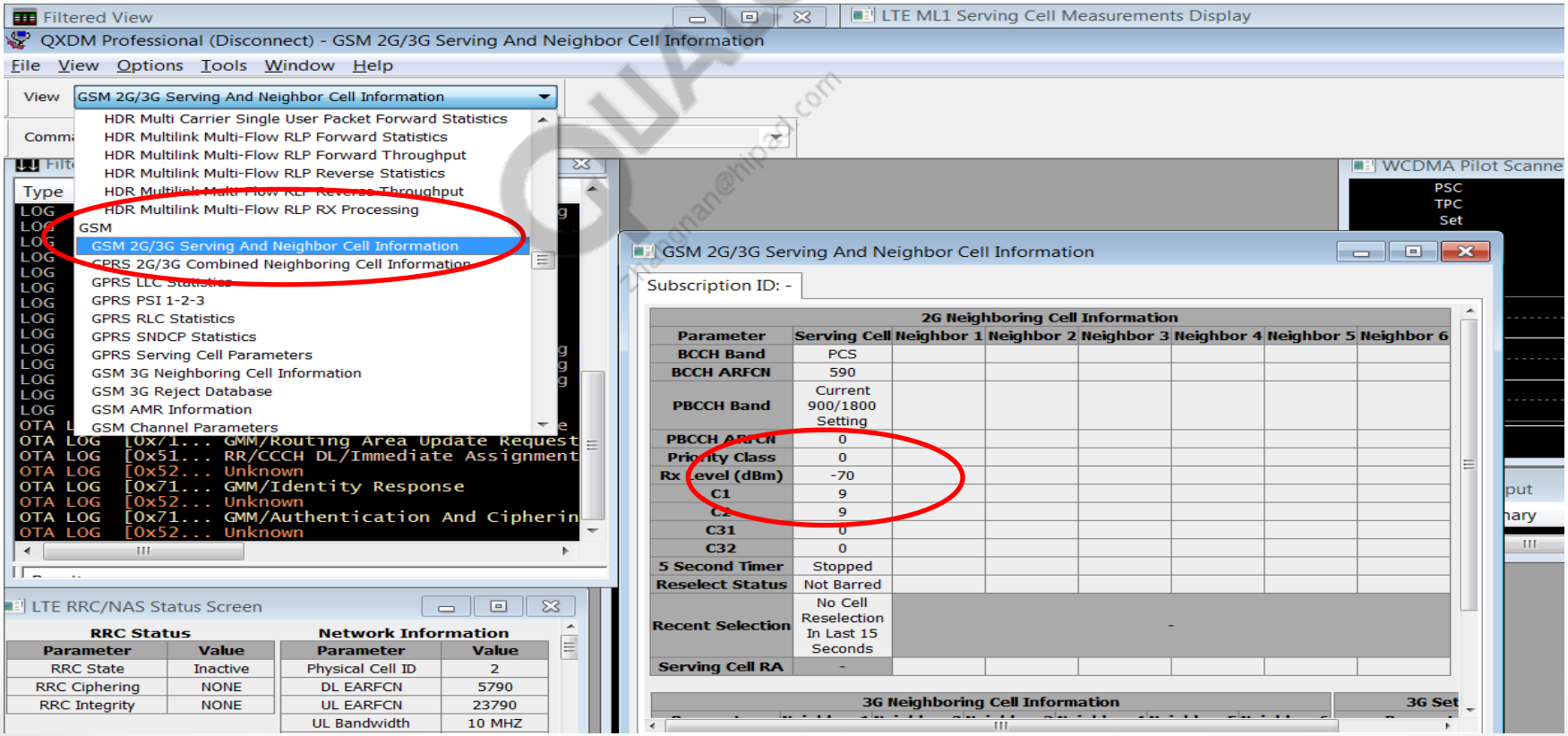
LTE Cell Reselection – LTE↔GERAN Cell Reselection, QXDM Pro Dashboard

- LTE Filtered View showing OTA messages in LTE and GERAN (see previous slides)
- LTE ML1 Serving Cell Measurement window showing LTE cell power (see previous slides)
- GSM 2G/3G Serving and Neighbor Cell Information, showing GERAN cell power



LTE Cell Reselection – LTE↔GERAN Cell Reselection, GSM 2G/3G Serving and Neighbor Cell Information

- Can be selected from the drop-down list on the View tab
- Gives information about Band, ARFCN, and, more importantly, Rx Level
- Need to ensure UE measures cell power as expected by the test case
- Can be selected from the View tab under GSM



References

Ref.	Document	
Qualcomm		
Q1	*Application Note: Software Glossary for Customers*	CL93-V3077-1
Q2	*Presentation: LTE IRAT Overview*	80-VR386-1
Resources		
R1	*Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) Procedures In Idle Mode*	3GPP TS 36.304
R2	*Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control*	3GPP TS 36.331
R3	*Radio Resource Control (RRC); Protocol Specification*	3GPP TS 25.133
R4	*Digital cellular telecommunications system (Phase 2+); Radio Subsystem Link Control*	3GPP TS 45.008
R5	*Digital Cellular Telecommunications System (Phase 2+); Mobile Radio Interface Layer 3 Specification; Radio Resource Control (RRC) Protocol*	3GPP TS 44.018

Questions?

https://support.cdmatech.com

