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LTE TDD Inter-RAT Overview

80-NE407-7 A

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Revision History

Revision	Date	Description
A	Jan 2013	Initial release
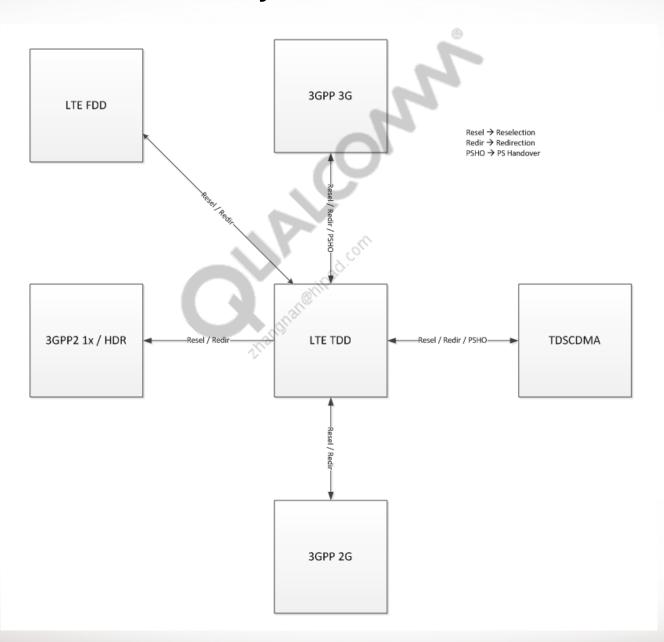
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- LTE TDD↔TD-SCDMA IRAT – LTE TDD↔TD-SCDMA Cell Redirection
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- LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA Reselection
- LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA Redirection
- LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA PS HO
- LTE TDD↔GERAN IRAT – LTE TDD↔GERAN Reselection
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Introduction

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LTE TDD Inter-RAT Mobility

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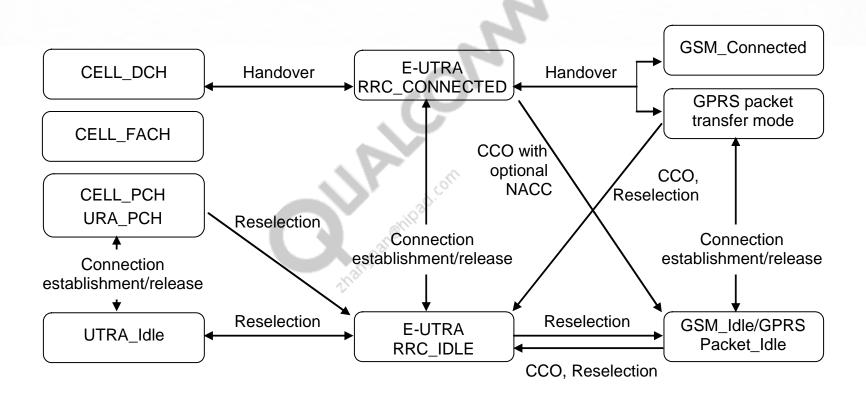
LTE TDD Inter-RAT Mobility (cont.)
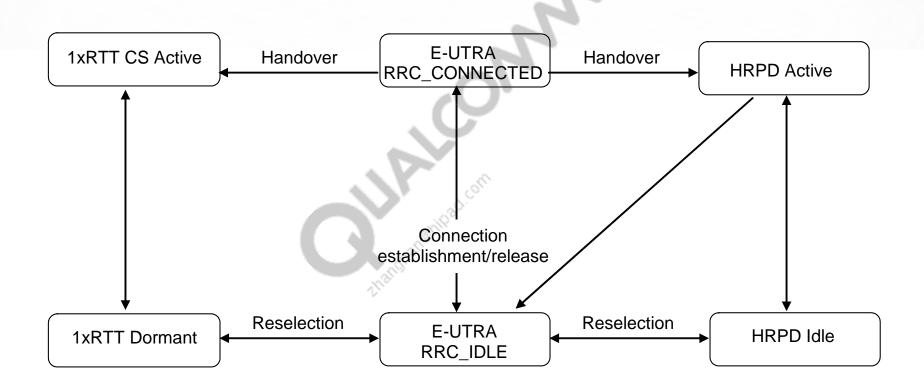
- LTE TDD↔TD-SCDMA redirection
- LTE TDD↔TD-SCDMA cell reselection
- LTE TDD↔TD-SCDMA PSHO
- LTE TDD↔WCDMA redirection
- LTE TDD↔WCDMA cell reselection
- LTE TDD↔WCDMA PSHO
- LTE TDD↔GSM redirection without measurement
- LTE TDD↔GSM cell reselection
- LTE TDD→DO/1X cell reselection
- LTE TDD→DO/1X redirection without measurement

E-UTRA↔GSM/UTRA (3GPP) Inter-RAT Mobility Procedures

E-UTRA↔CDMA2000 Inter-RAT Mobility Procedures

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┌──────────────────┐    Handover      ┌──────────────────┐    Handover      ┌──────────────────┐
│  1xRTT CS Active │ ◄─────────────── │     E-UTRA       │ ───────────────► │   HRPD Active    │
│                  │                  │  RRC_CONNECTED   │                  │                  │
└──────────────────┘                  └──────────────────┘                  └──────────────────┘
        ▲                                      │                                      ▲
        │                              Connection                                    │
        │                         establishment/release                             │
        ▼                                      ▼                                      ▼
┌──────────────────┐   Reselection    ┌──────────────────┐   Reselection    ┌──────────────────┐
│  1xRTT Dormant   │ ◄──────────────► │     E-UTRA       │ ◄──────────────► │    HRPD Idle     │
│                  │                  │    RRC_IDLE      │                  │                  │
└──────────────────┘                  └──────────────────┘                  └──────────────────┘
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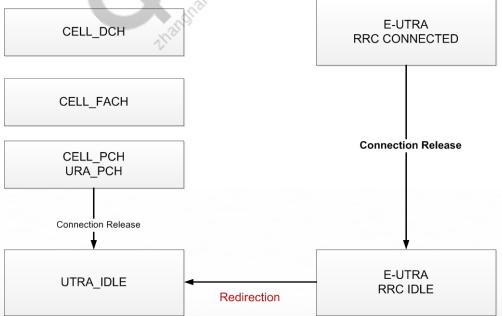
LTE TDD↔TD-SCDMA IRAT – LTE TDD ↔TD-SCDMA Cell Redirection
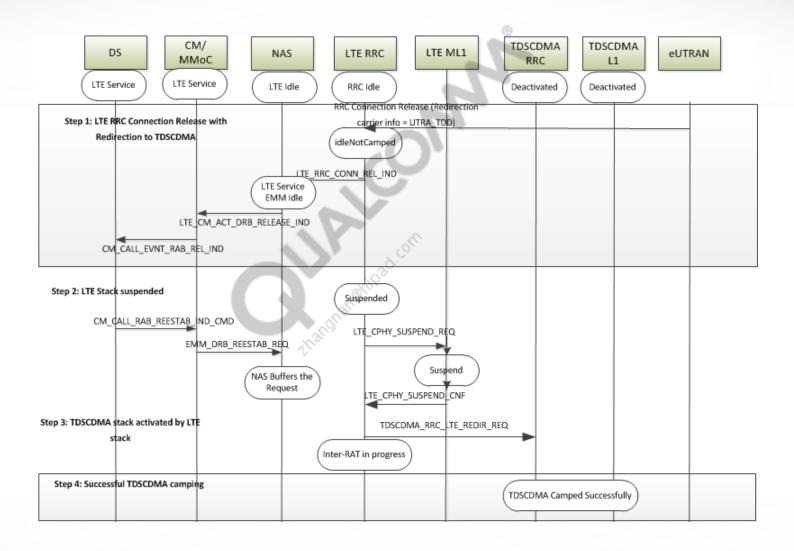
LTE TDD→TD-SCDMA Redirection

- "ConnectionReleaseMessage" will have "RedirectedCarrierInfo"
  - RedirectedCarrierInfo will provide carrier information for UTRA TDD (contains ARFCN).
  - Redirection will go through if the provided target ARFCN is part of the UE supported bands.
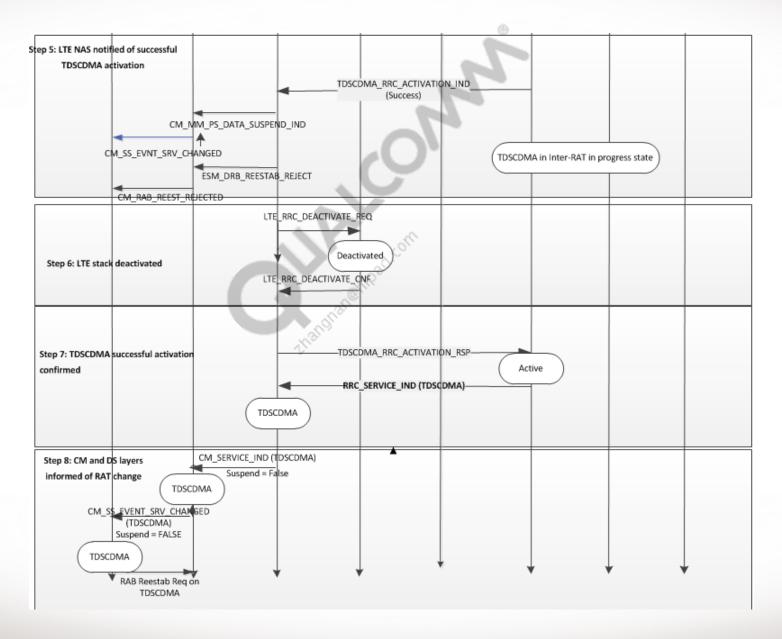- L-RRC will also provide UTRA TDD neighbors received from SIB6 to TD-SCDMA.
- See [Q2] and [Q3] for more details.
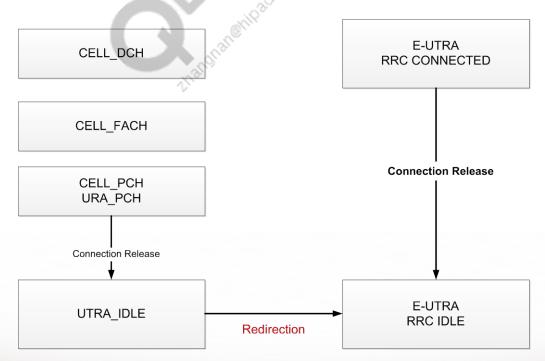
Call Flow for LTE→TD-SCDMA Redirection

Call Flow for LTE→TD-SCDMA Redirection (cont.)

Step 5: LTE NAS notified of successful TDSCDMA activation

TDSCDMA_RRC_ACTIVATION_IND (Success)

CM_MM_PS_DATA_SUSPEND_IND

CM_SS_EVNT_SRV_CHANGED

TDSCDMA in Inter-RAT in progress state

ESM_DRB_REESTAB_REJECT

CM_RAB_REEST_REJECTED

LTE_RRC_DEACTIVATE_REQ

Step 6: LTE stack deactivated

Deactivated

LTE_RRC_DEACTIVATE_CNF

Step 7: TDSCDMA successful activation confirmed

TDSCDMA_RRC_ACTIVATION_RSP

Active

RRC_SERVICE_IND (TDSCDMA)

TDSCDMA

Step 8: CM and DS layers informed of RAT change

CM_SERVICE_IND (TDSCDMA)
Suspend = False

TDSCDMA

CM_SS_EVENT_SRV_CHANGED (TDSCDMA)
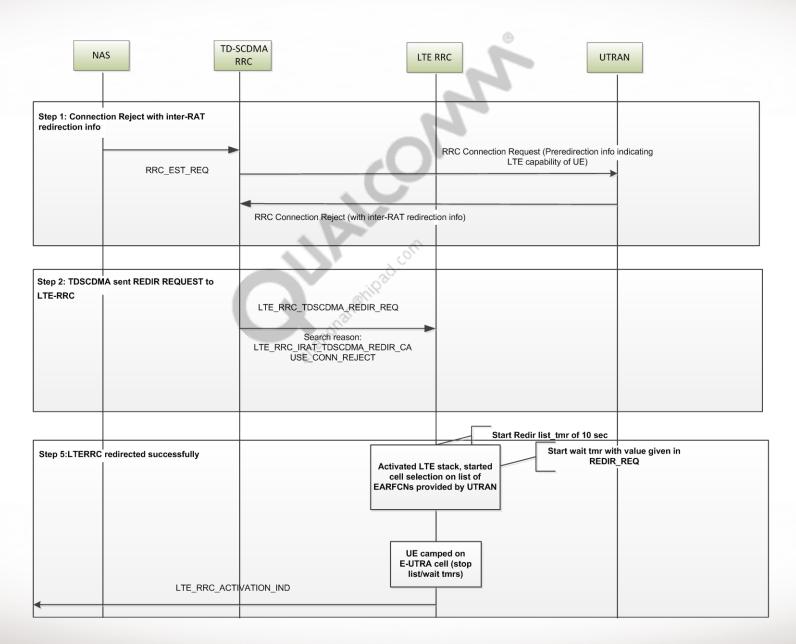Suspend = FALSE

TDSCDMA

RAB Reestab Req on TDSCDMA
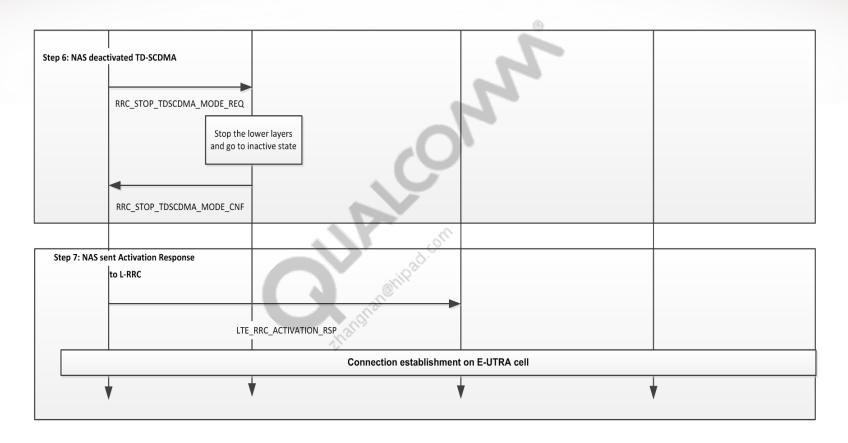
TD-SCDMA→LTE TDD Redirection

- "ConnectionReleaseMessage" will have IE "RedirectionInfointerRATInfo"
  - RedirectionInfointerRATInfo will provide carrier information "eutra-TargetFreqInfoList" for E-UTRA TDD (contains EARFCN).
  - Redirection will go through if the provided target EARFCN is part of the UE supported bands.
- TDS RRC will also provide E-UTRA TDD neighbors received from SIB19 to LTE.

TD-SCDMA→LTE Redirection

Step 1: Connection Reject with inter-RAT redirection info

RRC_EST_REQ

RRC Connection Request (Preredirection info indicating LTE capability of UE)

RRC Connection Reject (with inter-RAT redirection info)

Step 2: TDSCDMA sent REDIR REQUEST to LTE-RRC

LTE_RRC_TDSCDMA_REDIR_REQ

Search reason:
LTE_RRC_IRAT_TDSCDMA_REDIR_CA
USE_CONN_REJECT

Start Redir list_tmr of 10 sec

Start wait tmr with value given in REDIR_REQ

Step 5:LTERRC redirected successfully

Activated LTE stack, started cell selection on list of EARFCNs provided by UTRAN

UE camped on E-UTRA cell (stop list/wait tmrs)

LTE_RRC_ACTIVATION_IND

TD-SCDMA→LTE Redirection (cont.)

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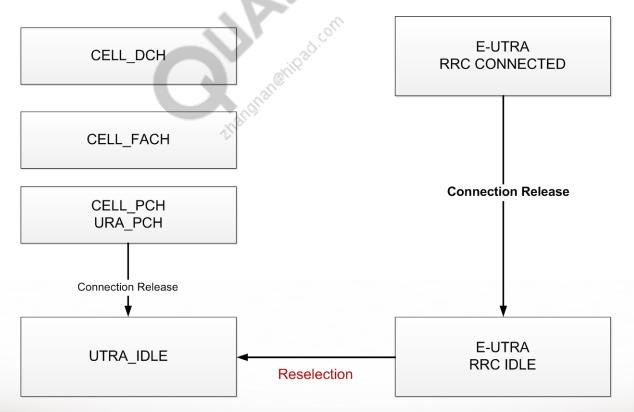
LTE TDD↔TD-SCDMA IRAT – LTE↔TD-SCDMA Cell Reselection

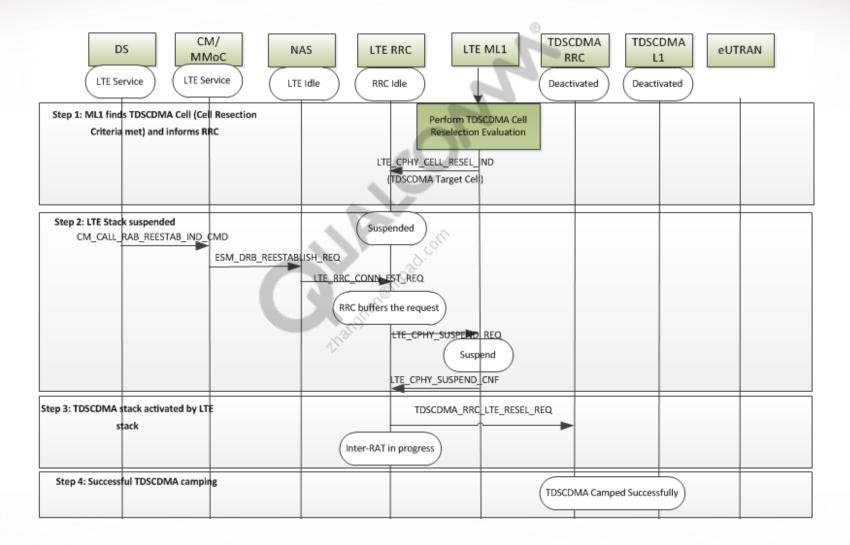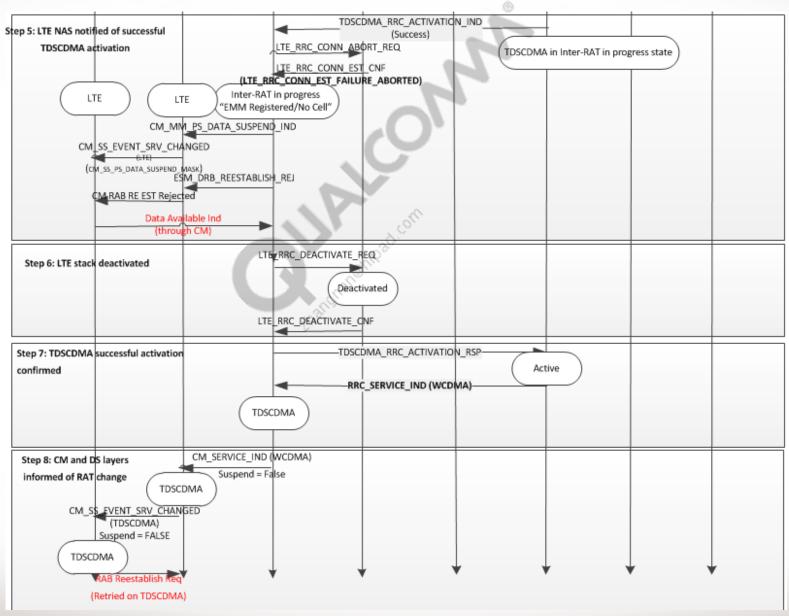# LTE→TD-SCDMA Cell Reselection

- Reselection will be triggered from ML1 using Idle mode measurements.
- L-RRC will do Idle mode measurement configuration at ML1 using system information.
- SIB6 will provide the UTRA-TDD neighbors to the UE.
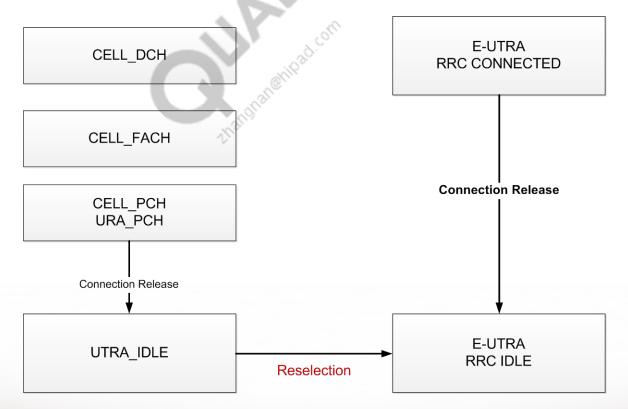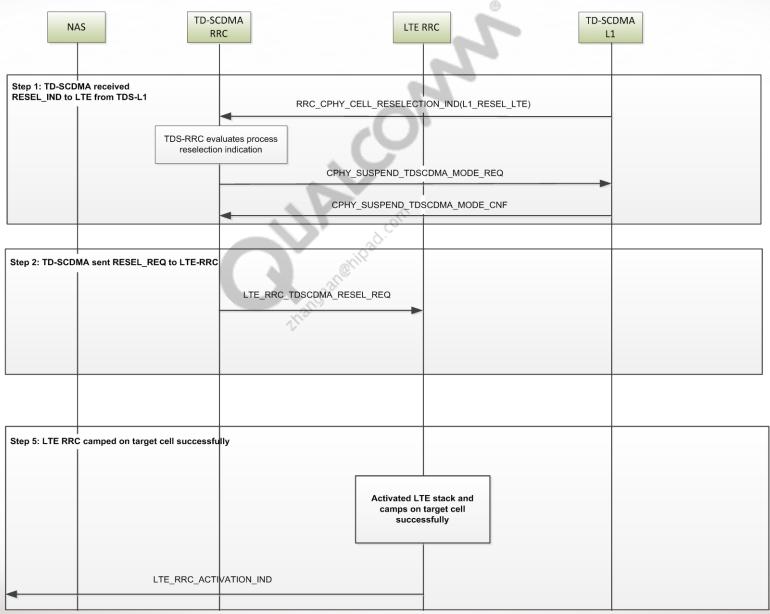- See [Q4] for more details.

Call Flow for LTE→TD-SCDMA Reselection
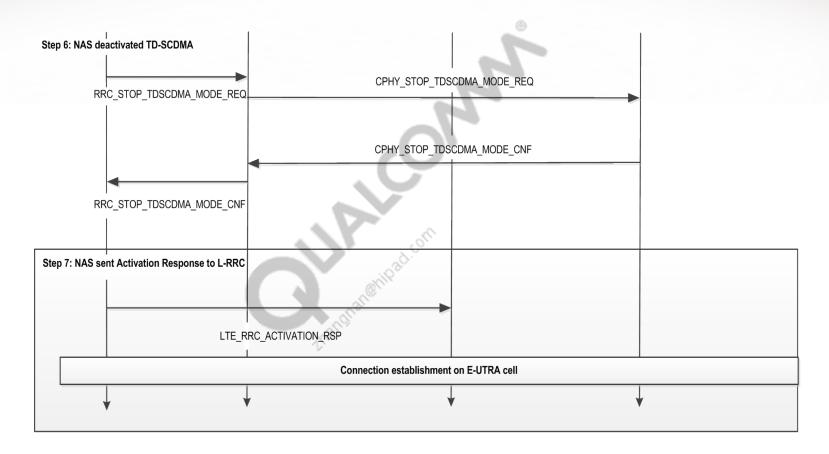
TD-SCDMA→LTE Cell Reselection

- Reselection will be triggered from ML1 using Idle mode measurements.
- TDS-RRC will do Idle mode measurement configuration at ML1 using system information.
- SIB19 will provide the E-UTRA-TDD neighbors and measurement configuration.

Call Flow for TD-SCDMA→LTE Reselection

| NAS | TD-SCDMA RRC | LTE RRC | TD-SCDMA L1 |

Step 1: TD-SCDMA received RESEL_IND to LTE from TDS-L1

RRC_CPHY_CELL_RESELECTION_IND(L1_RESEL_LTE)

TDS-RRC evaluates process reselection indication

CPHY_SUSPEND_TDSCDMA_MODE_REQ

CPHY_SUSPEND_TDSCDMA_MODE_CNF

Step 2: TD-SCDMA sent RESEL_REQ to LTE-RRC

LTE_RRC_TDSCDMA_RESEL_REQ

Step 5: LTE RRC camped on target cell successfully

Activated LTE stack and camps on target cell successfully

LTE_RRC_ACTIVATION_IND

Call Flow for TD-SCDMA→LTE Reselection (cont.)

Step 6: NAS deactivated TD-SCDMA

RRC_STOP_TDSCDMA_MODE_REQ

CPHY_STOP_TDSCDMA_MODE_REQ

CPHY_STOP_TDSCDMA_MODE_CNF

RRC_STOP_TDSCDMA_MODE_CNF

Step 7: NAS sent Activation Response to L-RRC

LTE_RRC_ACTIVATION_RSP

Connection establishment on E-UTRA cell
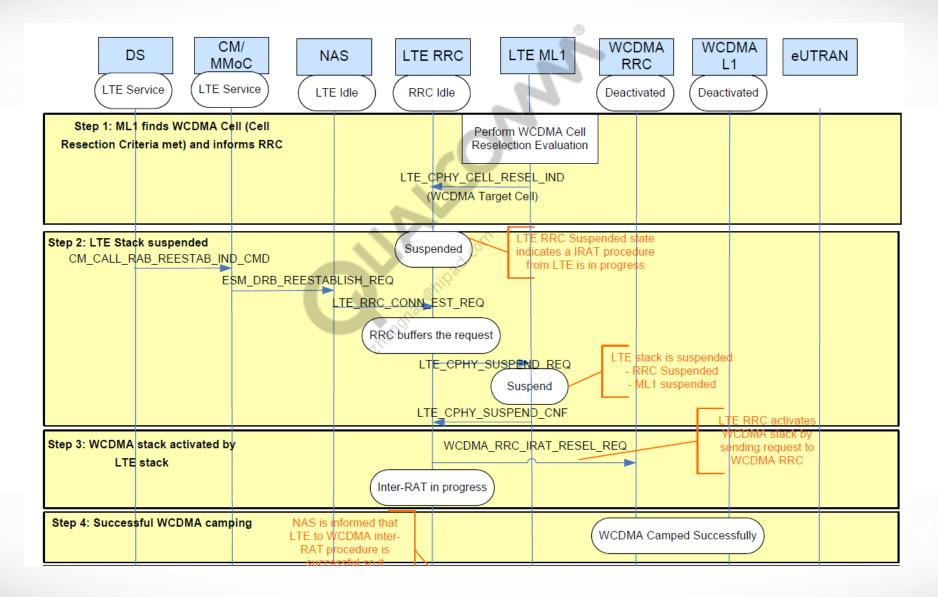
LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA Reselection

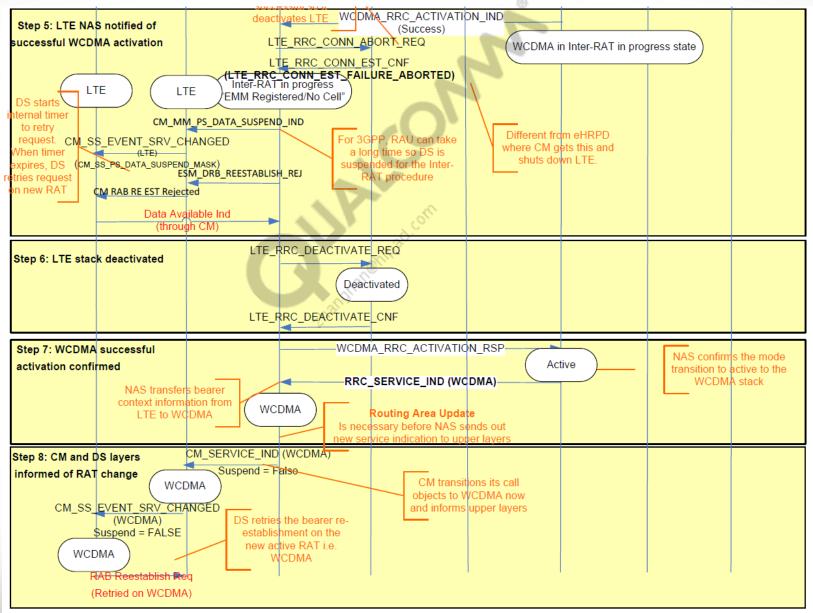# LTE TDD→WCDMA Cell Reselection

- Reselection will be triggered from ML1 using Idle mode measurements.

- L-RRC will do Idle mode measurement configuration at ML1 using system information.

- SIB6 will provide the UTRA-FDD neighbors to the UE.

- L-RRC shall suspend ML1 before sending the reselection request to WCDMA RRC.

- Activate WCDMA RRC and trigger cell selection due to inter-RAT reselection.

- WCDMA RRC shall handle reselection requests from LTE.

- Upon receiving a reselection request, WCDMA RRC shall activate WCDMA stack and perform cell selection.

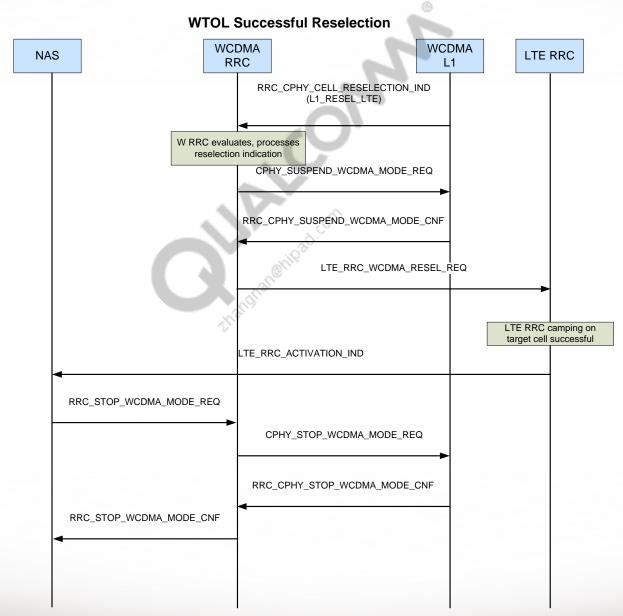- See [Q5] for more details.

Call Flow for LTE→WCDMA Cell Reselection

Call Flow for LTE→WCDMA Cell Reselection (cont.)

WCDMA→LTE TDD Reselection

- WCDMA RRC shall handle the inter-RAT E-UTRA TDD reselection indication from WL1.

- WCDMA RRC shall store the contents and use the E-UTRA TDD cell list indicated in SIB19 if SIB19 is scheduled and broadcast by the network.

- Upon receiving the reselection indication from WL1, WCDMA RRC shall send the reselection request to LTE RRC.

- LTE RRC shall be able to handle the reselect request from WCDMA RRC.

- If cell selection succeeds, LTE RRC informs NAS by sending an activation indication and waiting for an activation response and, on activation response, notifies NAS with the service status.
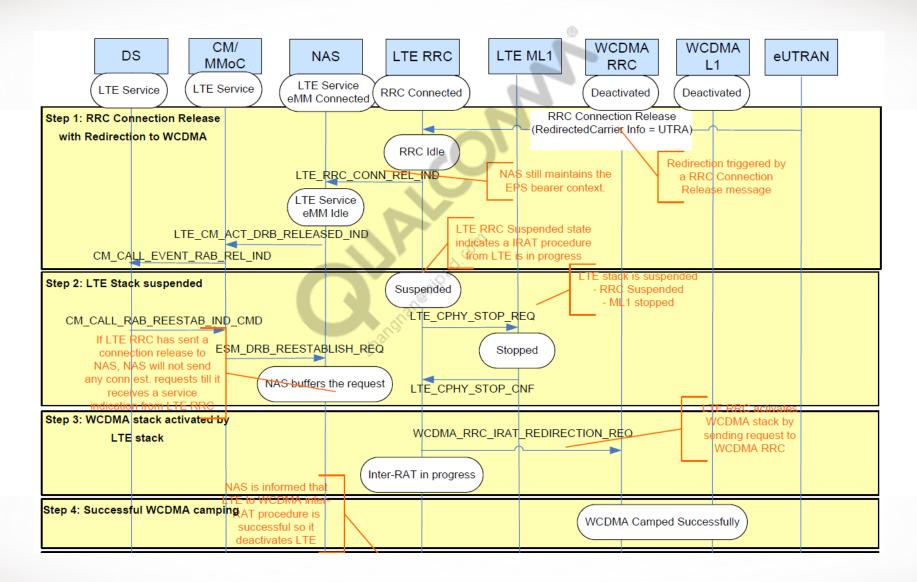
Call Flow for WCDMA→LTE Reselection

WTOL Successful Reselection

| NAS | WCDMA RRC | WCDMA L1 | LTE RRC |

RRC_CPHY_CELL_RESELECTION_IND
(L1_RESEL_LTE)

W RRC evaluates, processes reselection indication

CPHY_SUSPEND_WCDMA_MODE_REQ

RRC_CPHY_SUSPEND_WCDMA_MODE_CNF

LTE_RRC_WCDMA_RESEL_REQ

LTE RRC camping on target cell successful

LTE_RRC_ACTIVATION_IND

RRC_STOP_WCDMA_MODE_REQ

CPHY_STOP_WCDMA_MODE_REQ

RRC_CPHY_STOP_WCDMA_MODE_CNF

RRC_STOP_WCDMA_MODE_CNF

LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA Redirection
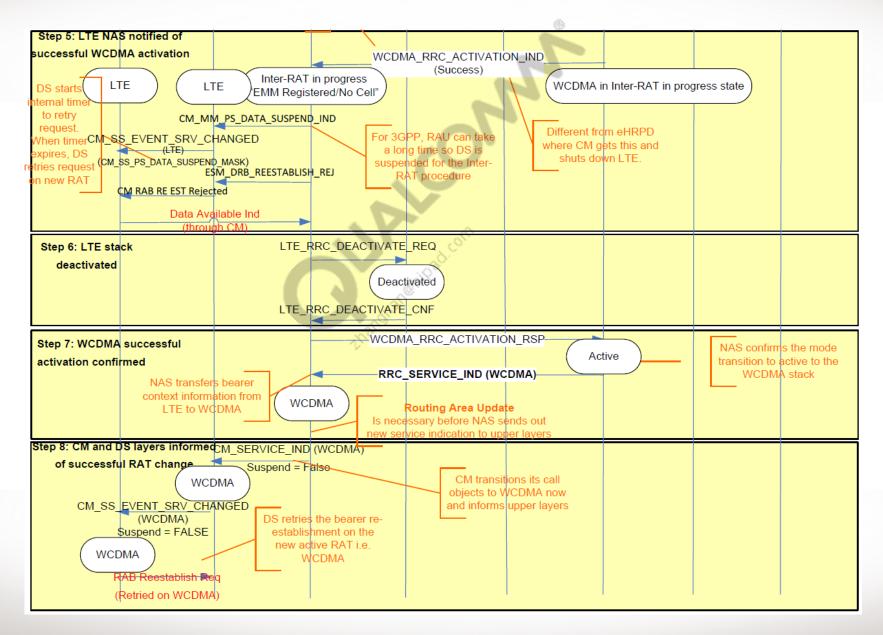
LTE→WCDMA Redirection

- The network uses redirection to move the UE from LTE when it is in the E-UTRA RRC_CONNECTED state to UTRAN by sending the *RRCConnectionRelease* message with Redirection Information IE to UTRA.

- The Redirection Information points to a UTRA FDD carrier frequency and the UE moves by means of cell selection after leaving the LTE RRC_CONNECTED state.

- The LTE RRC module initiates the inter-RAT redirection procedure with its peer WCDMA RRC module.

- If WCDMA successfully camps, it informs the common NAS layer about being activated because of the inter-RAT redirection.

- NAS is the common glue between LTE RRC and WCDMA RRC, so it shuts down LTE and gives a go-ahead to the WCDMA stack.

- After a successful registration, NAS informs upper layers of the RAT change.

- See [Q6] for more details.

LTE→WCDMA Redirection Success

LTE→WCDMA Redirection Success (cont.)
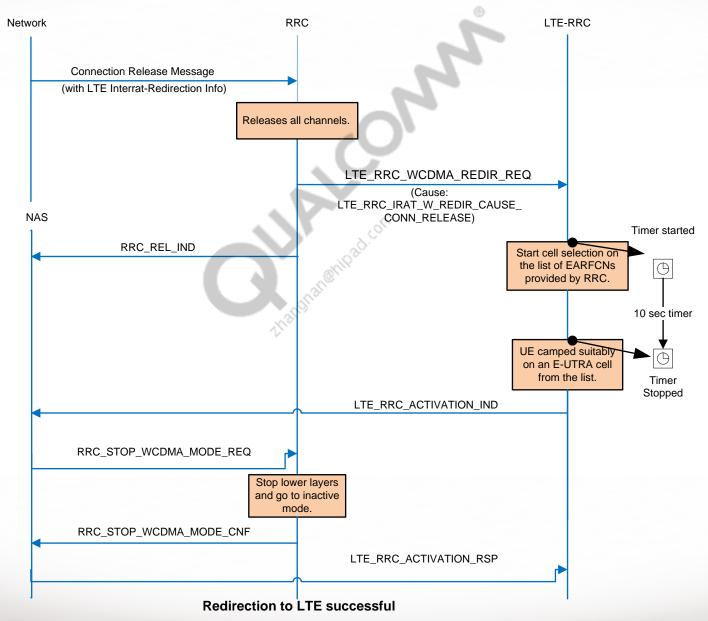
WCDMA→LTE Redirection

- WCDMA Connecting state and Connected state to LTE redirection using IE "*Redirection info" RRCConnectionReject* and *RRCConnectionRelease*.

- If RRC Connection Release OTA contains "Redirection info" IE present in the RRC connection release message, it indicates W→LTE redirection, and if E-UTRA target info IE is present, the UE shall start W→LTE redirection.

- If the E-UTRA target frequency list is present in the OTA, the UE shall search for suitable cells on these frequencies. The UE also needs to ignore cells that are present in the blacklisted cell list per frequency given by UTRAN.

WCDMA→LTE Redirection (cont.)

Network   **RRC**   **LTE-RRC**

Connection Release Message
(with LTE Interrat-Redirection Info)

Releases all channels.

LTE_RRC_WCDMA_REDIR_REQ
(Cause:
LTE_RRC_IRAT_W_REDIR_CAUSE_
CONN_RELEASE)

NAS

RRC_REL_IND

Timer started

Start cell selection on the list of EARFCNs provided by RRC.

10 sec timer

UE camped suitably on an E-UTRA cell from the list.

Timer Stopped

LTE_RRC_ACTIVATION_IND

RRC_STOP_WCDMA_MODE_REQ

Stop lower layers and go to inactive mode.

RRC_STOP_WCDMA_MODE_CNF

LTE_RRC_ACTIVATION_RSP

Redirection to LTE successful

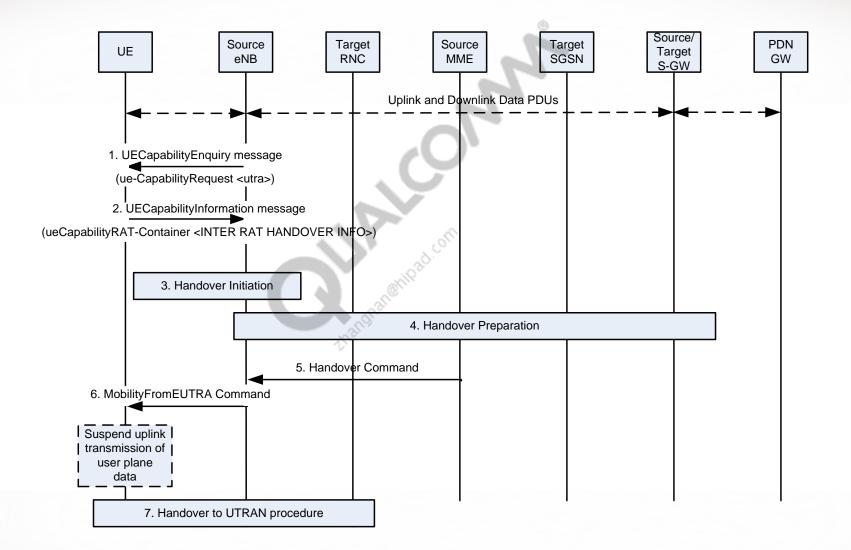# LTE TDD↔WCDMA IRAT – LTE TDD↔WCDMA PS HO

LTE TDD→WCDMA Handover

- In RRC_CONNECTED state, the UE shall follow the measurement parameters specified by RRC directed from the E-UTRAN (IE.measConfig).

- The UE performs inter-RAT neighbor cell measurements during the measurement gap provided by E-UTRAN.

  - E-UTRAN provides the measurement configuration with the *RRCConnectionReconfigurationmessage* IE

- The source eNodeB (eNB) sends the Mobility From EUTRA Command message to the UE, instructing the UE to handover to the target access network.

- The UE moves to the target UTRAN system, performs access to UTRAN, and executes the handover according to the parameters provided by the eNB command message.

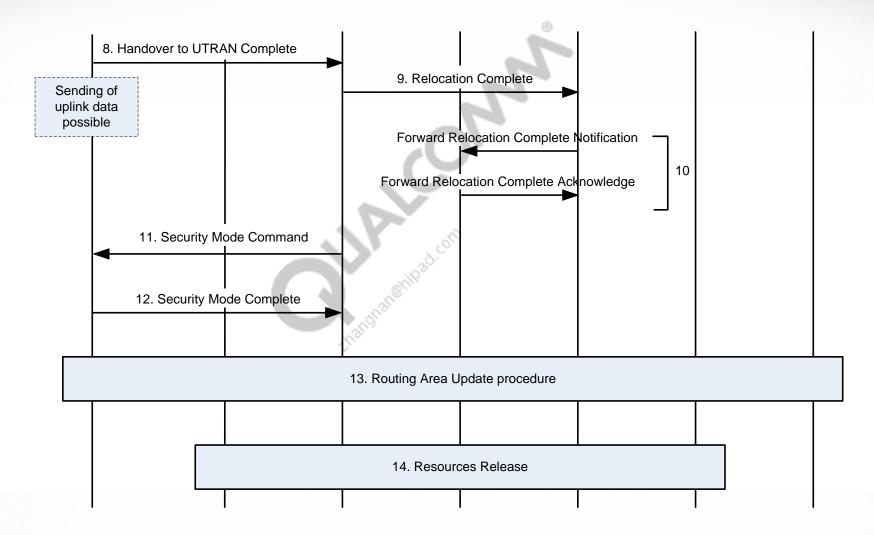- See [Q7] for more details.

LTE Measurement Report

- Depends on the measurement gap pattern and UE measurement capability; the measurement requirement for the neighbor RAT cell can be different
- CPICH measurement for UTRAN
- Measurement reporting type
  - Periodic reporting
  - Event-triggered periodic reporting
  - Event-triggered reporting (Events B1 and B2)

Event B1	• Report Inter-RAT neighbor cell becomes better than absolute threshold
Event B2	• Serving becomes worse than absolute threshold1 and Inter-RAT neighbor cell becomes better than another absolute threshold2

Call Flow for LTE↔WCDMA PS HO

Call Flow for LTE↔WCDMA PS HO (cont.)

8. Handover to UTRAN Complete

Sending of uplink data possible

9. Relocation Complete

Forward Relocation Complete Notification

Forward Relocation Complete Acknowledge

10

11. Security Mode Command

12. Security Mode Complete

13. Routing Area Update procedure

14. Resources Release

WCDMA→E-UTRAN TDD Handover

- UTRAN configures inter-RAT measurements using the *MeasurementControl* message.

- E-UTRAN *RSRP* or *RSRQ* measurements are scheduled during Compressed mode gaps.

- Compressed mode pattern is configured by UTRAN using:
  - *PhysicalchannelReconfiguration* message
  - *MeasurementControl* message

- Events 3A and 3B are used to report inter-RAT measurements.

- See [Q8] for more details.

LTE TDD↔GERAN IRAT – LTE TDD↔GERAN Reselection
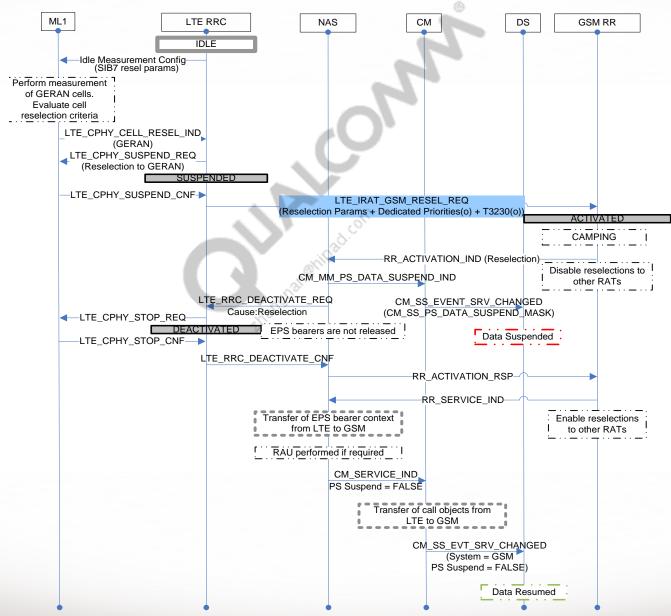
LTE→GSM Reselection Procedure

1. The UE camps on LTE.

2. LTE RRC (L3) reads SIB7 information and updates LTE L1 with the GERAN neighbors priority information, reselection thresholds, and speed scaling factors, etc., to aid in measurements and reselection to GERAN.

3. LTE L1 will schedule and trigger measurements on GERAN cells based on the cell reselection priority provided.

4. LTE L1 will trigger GERAN measurements during DRX cycles. The measurements of the GERAN cells will be performed by GL1.

5. LTE L1 will evaluate cells for reselection.

6. The GERAN cell chosen for reselection will then be sent in an indication to LTE RRC.

7. LTE RRC will initiate the GERAN cell reselection process with GSM RR.

8. GSM RR will notify NAS with "Activation Indication" if reselection is successful.

9. GSM RR will notify LTE RRC with "Reselection Reject" if reselection fails.
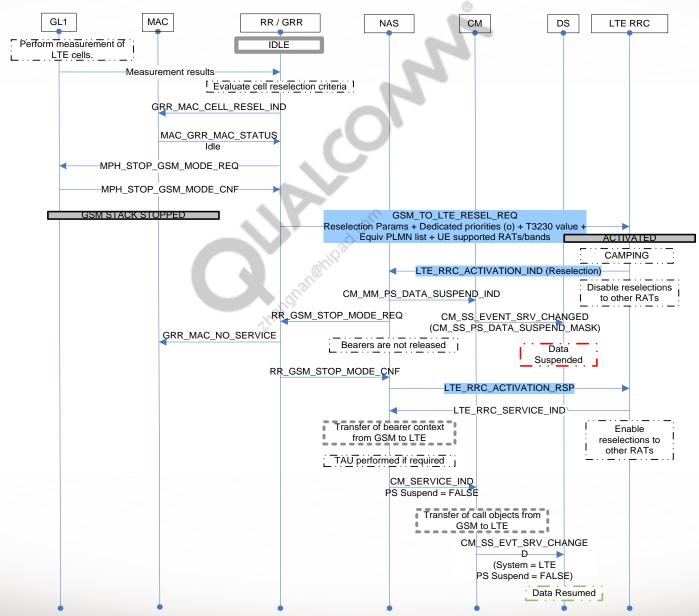
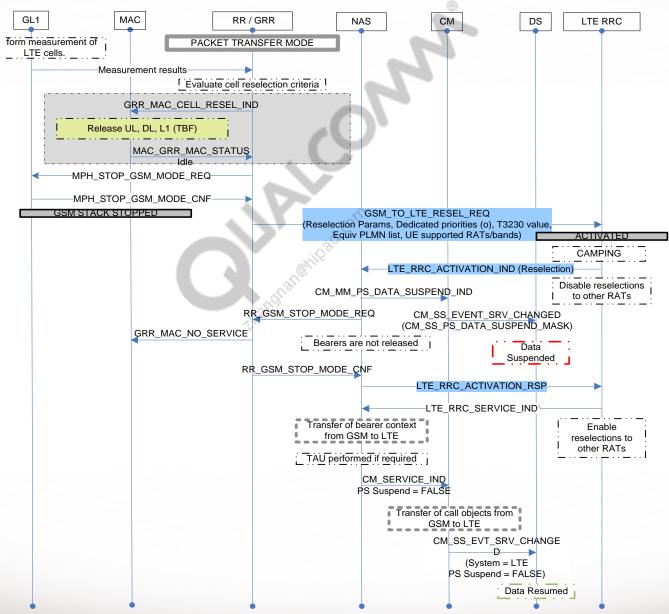- See [Q9] for more details.

Successful LTE→GERAN Reselection

GSM→LTE Reselection Procedure

1. The UE is camped on GSM and is in GSM/GPRS Idle or Packet Transfer mode.

2. GSM RR gets the E-UTRAN neighbor cell list and priority information from the network through an SI2quater message.

3. The list of not allowed cells is defined in the Not Allowed Cells list.

4. RR commands GL1 to do measurements on E-UTRAN cells based on the E-UTRAN neighbor cell list and priority information, excluding the not allowed cells.

5. GL1 sends the measurement results of the E-UTRAN cells as well as the results of the serving GSM cell and other GSM neighbor cells to GSM RR.

6. Under certain conditions (serving cell becomes bad or E-UTRAN cells become better), the G→LTE reselection could be triggered by GSM RR, based on measurement results.

- See [Q9] for more details.

Successful GSM/GPRS IDLE→LTE Reselection
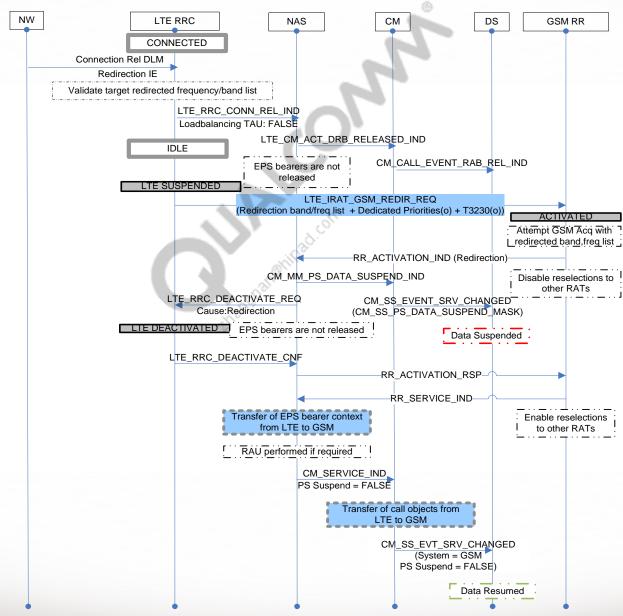
Successful GPRS Packet Transfer Mode→LTE Reselection

LTE TDD↔GERAN IRAT – LTE↔GERAN Redirection

LTE→GSM Redirection

- RRC Connection Release IE – The 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 GSM RAT once the active connection has been released.

- Redirected Carrier Info IE – If the UE is being redirected, the IE "*redirectedCarrierInfo*" will contain further details on to which frequency of GSM RAT the UE is being redirected.
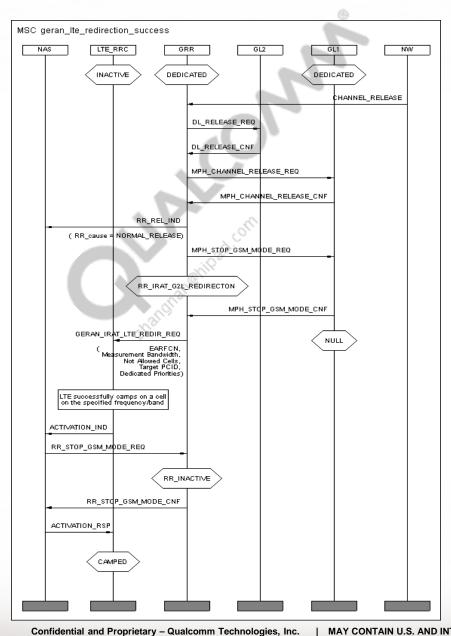
- See [Q10] for more details.

Successful LTE→GERAN Redirection

GSM→LTE Redirection Procedure

1. The GERAN network may initiate the channel release procedure to the UE in RR Dedicated mode.

2. GERAN GSM_CONNECTED to LTE using *CHANNEL RELEASE* IE *"Cell selection indicator after release of all TCH and SDCCH"* is used.

3. When a Channel Release message is received, if it contains a Cell Selection Indicator IE, then this will be stored.

4. Once the Channel Release procedure has completed, GSM RRC will check that cell selection should take place on LTE, then the GERAN→LTE redirection procedure shall proceed.
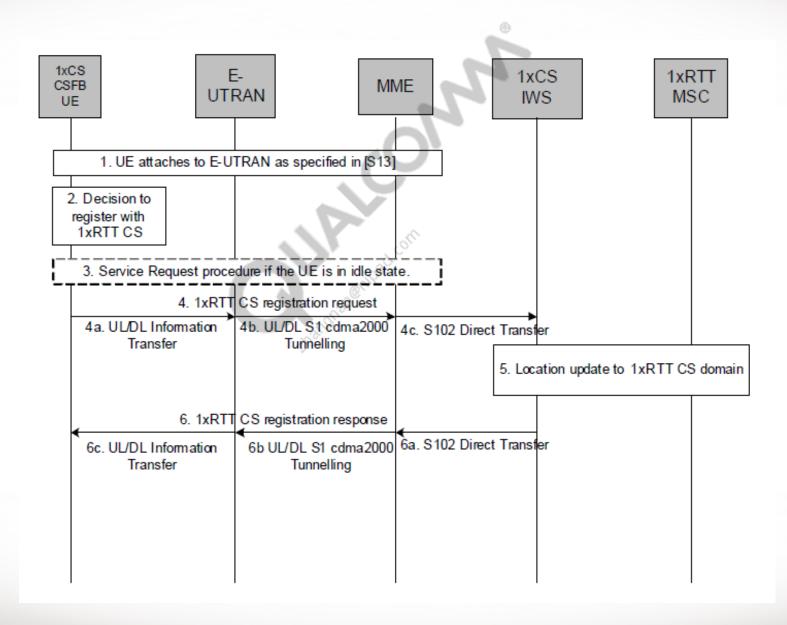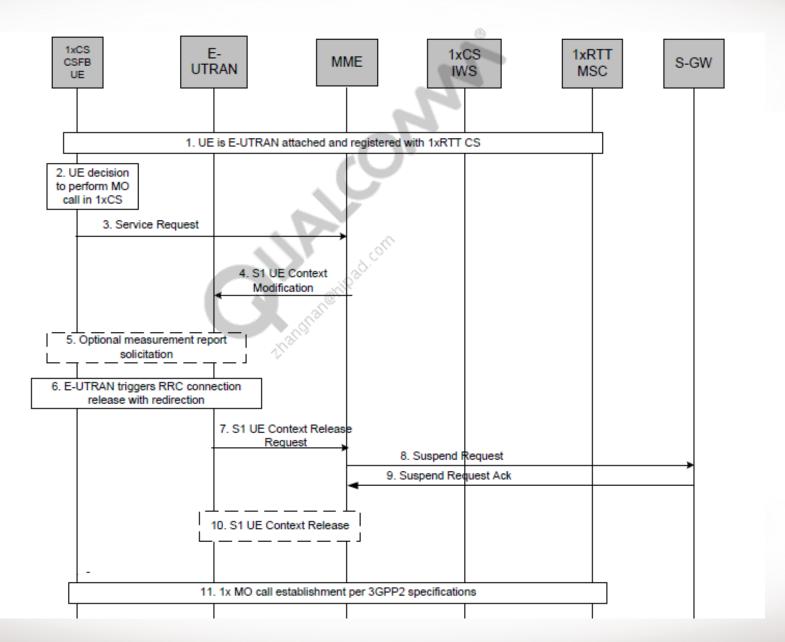
Successful GERAN→LTE Redirection

LTE TDD↔cdma2000 1xRTT/HRPD IRAT

1xRTT CSFB

- LTE RRC CONNECTED mode to other RAT *redirectedCarrierInfo* in *RRCConnectionrelease* is used to redirect the UE from E-UTRA RRC_CONNECTED to cdma2000 (HRPD Idle/1xRTT Dormant mode).

- Circuit-Switched Fallback (CSFB) for 1xRTT enables the delivery of CS domain services when the UE is being served by the E-UTRAN.

- The UE preregisters in the 1xRTT CS domain while the UE is attached to E-UTRAN.

- 1xRTT signaling (preregistration and paging) between the UE and the CDMA network is transparent to E-UTRAN.

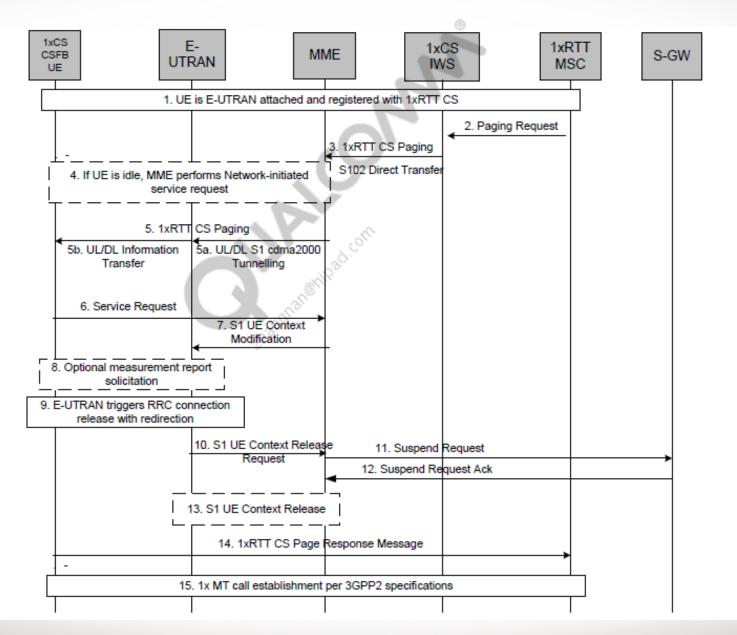- E-UTRAN redirects the connection using *RRCConnectionRelease* for 1xRTT CSFB.

Preregistration for CSFB→1xRTT

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MO Call with 1xRTT CSFB

MT Call with 1xRTT CSFB

References

Ref.	Document	
Qualcomm Technologies		
Q1	*Application Note: Software Glossary for Customers*	CL93-V3077-1
Q2	*Presentation: LTE TDD IRAT – TD-SCDMA Redirection→LTE*	80-NE407-2
Q3	*Presentation: LTE TDD IRAT – LTE TDD CSFB*	80-NE407-4
Q4	*Presentation: LTE TDD IRAT – LTE TDD↔TD-SCDMA Idle Mode Reselection*	80-NE407-1
Q5	*Presentation: LTE to/from WCDMA Cell Reselection*	80-N6386-1
Q6	*Presentation: WCDMA to/from LTE Redirection Procedure*	80-N5576-19
Q7	*Presentation: LTE to WCDMA PS HO*	80-N7981-1
Q8	*Presentation: WCDMA-to-LTE PS HO Overview*	80-ND296-1
Q9	*Presentation: GERAN-to-LTE Reselection*	80-N5853-1
Q10	*Presentation: GERAN to LTE Redirection*	80-N5852-1
Standards		
S1	*Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol Specification*	3GPP TS 36.331
S2	*LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) Procedures in Idle mode*	3GPP TS 36.304
S3	*Universal Mobile Telecommunications System (UMTS); User Equipment (UE) Procedures in Idle mode and Procedures for Cell Reselection in Connected mode*	3GPP TS 25.304
S4	*Universal Mobile Telecommunications System (UMTS); Radio Resource Control (RRC); Protocol Specification*	3GPP TS 25.331

Questions?

https://support.cdmatech.com