

# **GSM-UMTS Cell Reselection and Handover**

## **Purpose of GSM-UMTS Cell Reselection and Handover:**

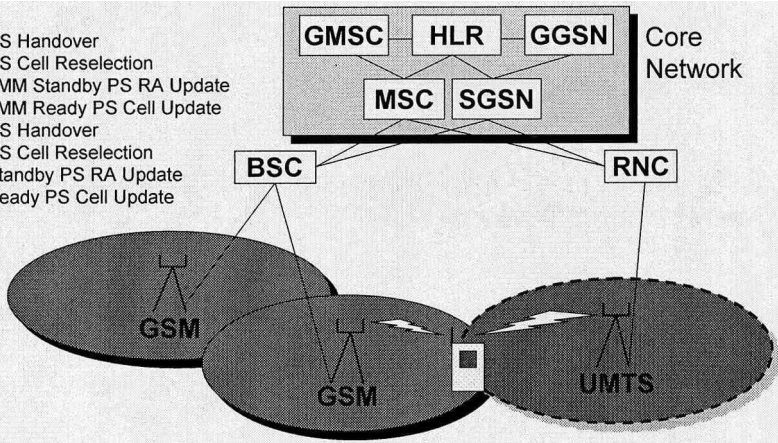
- Pave the way for introduction of UMTS!
- Use the existing GSM network as last resort (coverage fall-back) when introducing UMTS
- Load regulate traffic between GSM and UMTS networks

# Concepts

- **CPICH Ec/No** CPICH Ec/No is the received energy per chip on the Common Pilot Channel (CPICH) divided by the power density in the band. This quantity measures the quality of a neighbor UTRAN cell
- **CPICH RSCP** A Multi-RAT MS measures Received Signal Code Power on neighboring UTRAN cells in order to evaluate inter system cell reselection candidates. RSCP is the average power of the received signal after despreading and combining
- **UTRAN FDD** UTRAN has two modes, FDD and TDD, for operating with paired or unpaired bands respectively. FDD is a duplex method whereby uplink and downlink transmissions use two separated radio frequencies

# GSM-UMTS Cell Reselection and Handover

UMTS=>GSM CS Handover  
UMTS=>GSM CS Cell Reselection  
UMTS=>GPRS MM Standby PS RA Update  
UMTS=>GPRS MM Ready PS Cell Update  
GSM=>UMTS CS Handover  
GSM=>UMTS CS Cell Reselection  
GSM=>UMTS Standby PS RA Update  
GSM=>UMTS Ready PS Cell Update



The parameter **COEXUMTS**, set per BSC, enables the feature

## Measurements on UTRAN Cells

The parameter **QSI** and **QSC** controls when measurements on UTRAN neighboring cells shall be performed. This is used to:

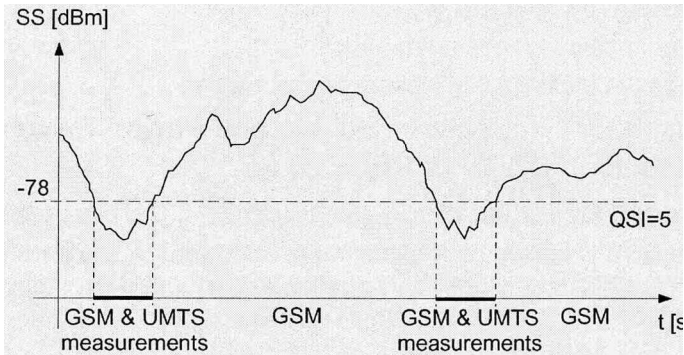
- avoid unnecessary measurements
- optimize the Multi-RAT MS battery consumption
- QSI is used for Circuit Switched idle and Packet Switched modes (send on BCCH or PBCCH)
- QSC is used for active mode (send on SACCH)
  - Before QSC is known after changing to active mode, the parameter **QSCI** controls if measurements should be performed according to QSI (QSCI=0) or always (QSCI=1) until QSC is received

## Measurements on UTRAN Cells (cont.)

- There are four different scenarios to choose from:
  1. UTRAN neighboring cells are measured only when the signal strength of the GSM serving cell is *above* the threshold set by QSI and QSC
  2. UTRAN neighbor cells are measured only when the signal strength of the GSM serving cell is *below the* threshold set by QSI and QSC .
  3. UTRAN neighbor cells are always measured.
  4. UTRAN neighbor cells are never measured. This can be used to turn off the cell reselection/handover to UMTS, per cell, even if COEXUMTS is ON for the BSC.

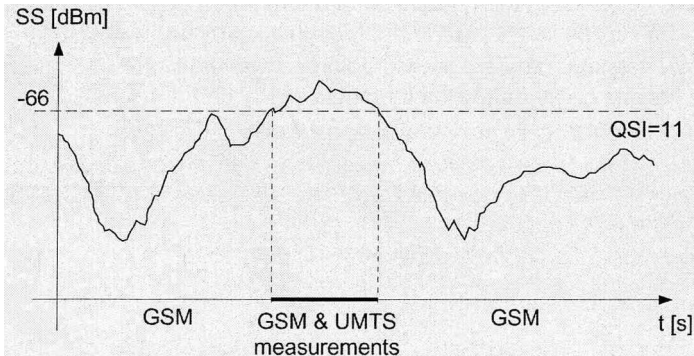
## Example 1

- When QSI or QSC = 5, UTRAN Cell measurements are performed when SS of serving GSM cell is below -78 dBm



## Example 2

- When QSI or QSC = 11, the measurements are performed when SS is above -66 dBm





# PLMN Selection

1. Home PLMN. The Multi-RAT MS shall search for the Home PLMN using all access technologies it is capable of and start its search using the "access technologies priority list" stored in the Subscriber Identity Module (SIM)
2. Each PLMN in the "user controlled PLMN list" stored in the SIM in priority order. The Multi-RAT MS shall try find each PLMN using the "access technologies priority list" stored for each PLMN in the SIM.
3. Each PLMN in the "operator controlled PLMN list" stored in the SIM in priority order. The Multi-RAT MS shall try find each PLMN using the "access technologies priority list" stored for each PLMN in the SIM.
4. Other PLMN/access technology combinations with received high quality signal in random order. For GSM: SS > -85 dBm and WCDMA: CPICH RSCP > -95 dBm.
5. All other PLMN/access technology combinations in order of decreasing signal strength.

## Cell Reselection to UMTS

- The algorithm for inter system cell reselection to UMTS is controlled by the network with the parameters **FDDQMIN** and **FDDQOFF**.
  - **FDDQMIN** is the minimum quality of a UTRAN cell for cell reselection. This parameter should not be used to control the cell reselection, but provide a sufficient quality of the candidate UTRAN cell.
  - **FDDQOFF** is the key parameter to control the behavior of inter system cell reselection. It defines an offset between signal quality of UTRAN and GSM cells.

## Cell Reselection to UMTS (cont.)

Two criteria must be fulfilled if a Multi-RAT capable MS should reselect a suitable UTRAN cell

$$\begin{aligned} & \textbf{CPICH } E_c/N_o > \textbf{FDDQMIN} \\ & \text{and} \\ & \textbf{CPICH RSCP} > \textbf{RLA}_{(s+n)} + \textbf{FDDQOFF} \end{aligned}$$

- **$\text{CPICH } E_c/N_o$**  is the received energy per chip on the Common Pilot Channel (CPICH) divided by the power density in the band.
- **$\text{CPICH RSCP}$**  is a measure of the signal strength for a UTRAN cell.
- **$\text{RLA}=\text{RLA\_C}$**  for GSM attached Multi-RAT MSs and  **$\text{RLA}=\text{RLA\_P}$**  for GPRS/EGPRS attached Multi-RAT MSs


## Cell Reselection to UMTS (cont.)

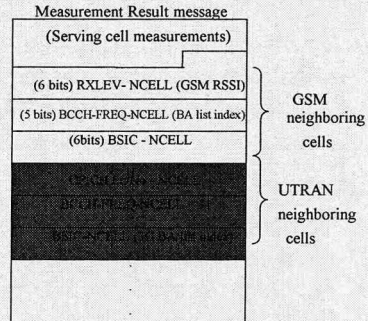
- RLA is the average of the received signal levels measured in dBm. This is done for all fq:s in the BA-list
  - $RLA = RLA\_C$  if GSM attached
  - $RLA = RLA\_P$  if GPRS attached
- CPICH RSCP must exceed  $RLA + \mathbf{FDDQOFF}$  for both serving cell and the 6 strongest GSM/GPRS cells if a cell reselection to an UTRAN cell shall occur

## Handover to UMTS

- A list of UMTS cells is send to the Multi-RAT MS on the SAACH (can be different from idle mode 3G-BA list)
- The Multi-RAT MS can report 0-3 UMTS cells, set by the parameter **FDDMRR**
- The remaining positions (6 - **FDDMRR**) will be used for GSM cells

# Measurement Reporting

- Existing Measurement Report is extended with the possibility to include UMTS cells.
- 2G BA list from SI2/5, SI2/5bis, SI2/5ter
- GSM cells are reported as normal
- 3G BA list from Measurement Information message
- UTRAN cells are reported as shown in figure 
- The number of reported cells per RAT is defined by the multi-RAT reporting parameter in Measurement Information message

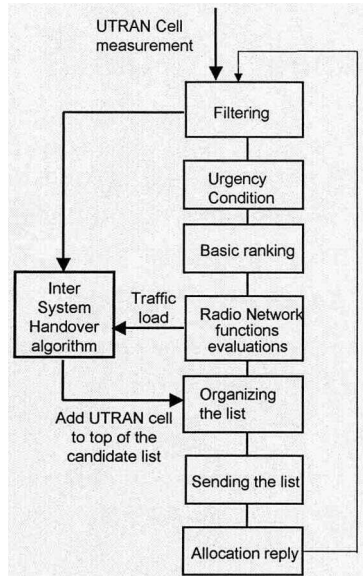


# Inter System Handover (GSM -> UMTS)

- Two criteria must be fulfilled:
  1. Idle TCH:s in serving cell  $\leq$  **ISHOLEV**
  2. CPICH  $E_c/N_o$  > **MRSL**

Note: Only when the first criteria is fulfilled, the second one is checked for each (reported) UTRAN cell

=> The final candidate list is created by adding UTRAN cells on top of the list



## Example: controlling the coverage/load between GSM and UMTS

- Example 1:
  - To off-load GSM traffic and extend UMTS coverage, **ISHOLEV** should be set to the wanted traffic threshold, **QSC** should be set to 7 (always), or to values 8-14 if the cells are co-sited. This is because no GSM signal level criterion is needed.
- Example 2:
  - To extend UMTS coverage with GSM, **ISHOLEV** should be set to 99 in order to prioritize UMTS all the time. Both **QSC** and **QSI** should be set to 7, or 8-14 if the cells are co-sited. **FDDQOFF** can be -inf since all MSs are to be thrown back to UMTS in idle mode as well.



## **GSM-UMTS HO, O&M interface:**

GSM-UMTS HO activated in the BSC (optional feature):

- RAEPC:COEXUMTS;
- Define UMTS external cells, RLDEI+RLDEC
  - FDDARFCN
  - SCRCODE
  - UTRANID
- Define UMTS-cells as neighbors (single), RLNRI
- Set locating parameter per GSM cell
  - MRSL, RLDEC
  - ISHOLEV, RLLOC

# LA and Ra update procedures

- Location Area:
  - Possible to configure GSM and UMTS cells to the same Location Area (i.e same **LAI**)
  - The Multi-RAT MS doesn't need to perform Location Update when changing between UMTS and GSM cell belonging to the same LA
- Routing Area:
  - Possible to configure GSM and UMTS cells to the same Routing Area (i.e same **RAI**)
    - **UMTS PS-Connected** corresponds to **GPRS Ready State**
    - **UMTS PS-Idle State** corresponds to **GPRS Standby State**
  - Same procedures used at inter system cell reselection as for GPRS cell reselection

## Related Counters

- Three new counters, in the new object NUCELLRELCNT are introduced:
  - The number of handover commands sent to the neighboring UTRAN cell (**HOVERCNTUTRAN**).
  - The number if successful handovers to the neighboring UTRAN cell (**HOVERSUCUTRAN**).
  - The number of handover attempts to the neighboring UTRAN cell when the MS returned to the old channel (**HORTTOCHUTRAN**).

## Parameter Summary

- **COEXUMTS** is used to determine if cell reselection and handovers from GSM to UMTS is allowed (=ON) or not (=OFF) in the BSC. The parameter is a BSC exchange property. 0 is OFF and 1 is ON
- **SPRIO** indicates if 3G cells may be searched when BSIC decoding is required. This parameter is defined per GSM cell.

## Parameter Summary, Cell reselection

- **UMFI** (MFDDARFCN-MSCRCODE-DIVERSITY) defines the frequency, scrambling code and diversity information for a UTRAN neighboring cell.
  - MFDDARFCN indicates the absolute RF channel number of the neighboring UTRAN cell to be measured on by Multi-RAT MSs.
  - MSCRCODE is the scrambling code for the neighboring cell. The scrambling code has 512 combinations.
  - DIVERSITY indicates if diversity is applied for the UTRAN cell, or not.
- **FDDQMIN** defines the minimum threshold for the "quality" measure  $E_c/N_o$  for cell reselection to UTRAN. This parameter is defined per GSM cell and applies for all UTRAN neighbors.
- **FDDQOFF** defines cell reselection offset to UTRAN cells. This parameter is defined per GSM cell and applies for all UTRAN neighbors.
- **QSI** defines if the monitoring of UMTS cells will be performed if the signal level is below (0-6) or above the threshold (8-14), always (7) or never (15). This parameter is defined per GSM cell.

## Parameter Summary, Handover 1(2)

- **COEXUMTSINT** is used to control the time interval between traffic load checking. This parameter is a BSC exchange property.
- **FDDARFCN** indicates the absolute RF channel number of the neighboring UTRAN cell in GSM active mode. There are 12 frequencies (bandwidth 5 MHz) in the UMTS spectrum (2110-2170MHz). To calculate the absolute RF channel number the expression  $5 \times (\text{Frequency in MHz})$  can be used.
- **FDDMRR** defines how many measured neighboring UTRAN cell should be included in measurement reports.
- **ISHOLEV** defines the traffic load threshold of the serving GSM cell that needs to be exceeded in order to evaluate UMTS measurements for handovers.
- **MRSLS** defines a minimum threshold for the "quality" measure  $E_c/N_0$  for handovers to UTRAN. This parameter is defined per UTRAN cell.

## Parameter Summary, Handover 2(2)

- **SCRCODE** is the scrambling code for the neighboring UTRAN cell in active mode. The scrambling code has 512 combinations.
- **CELL** Cell Designation.
- **UTRANID** present the Identity of the neighboring UTRAN cell in active mode. It consists of the RNC Identity (RNCID), Cell Identity within the RNC (CI), MCC, MNC and LAC.
- **QSC** defines if the monitoring of UMTS cells will be performed if the signal level is below (0-6) or above the threshold (8-14). always (7) or never (15). This parameter is defined per GSM cell.
- **QSCI** defines the control of UTRAN measurement after entering active mode, before reading the first QSC. In that period UTRAN measurements can always be performed (=1) or according to QSI value (=0).
- **GPRSPRIO** GPRSPRIO is a BSC Exchange property that controls whether on-demand PDCHs shall be regarded as idle or busy

Parameter name	Default value	Recommended value	Value range	Unit
COEXUMTS	0 (OFF)	-	0 (OFF). 1 (ON)	
COEXUMTSINT	1000	-		ms

**/ Parameters for inter system cell reselection to UMTS**

	Default value	Recommended value	Value range	Unit
UMFI (MFDDARFCN-MSRCODE- DIVERSITY)			MFDDARFCN: 0 to 16383 MSRCODE: 0 to 511 DIVERSITY: DIV, NODIV	
FDDQMIN	0 (-20dB)	-	0 to 7 (-20dB to -13dB)	dB
FDDQOFF	8 (OdB)	•	0 to 15 (-inf, -28dB to +28dB in steps of 4dB)	dB
SPRIO	-	-	YES, NO	
QSI	15 (never)		0 to 6 (below -98dBm to -74dBm in steps of 4dBm) 7 (always) 8 to 14 (above -78dBm to -54dBm in steps of 4dBm) 15 (never)	dBm



**Parameters for inter system handover to UMTS**

Parameter name	Default value	Recommended value	Value range	Unit
UCELL	-			
FDDARCN	-		0 to 16383	
SCRCODE		-	0 to 511	
UTRANID (RNCID-CI-MCC-MNC-LAC)	-		RNCID:0 to 4095 CI: 0 to 65535 MCC MNC LAC	
MRSL	-	-	0 to 49 (-24dB to OdB)	
ISHOLEV	20	-	0 to 99	%
FDDMRR	0	-	0 to 3	
QSC	15(never)		0 to 6 (below -98dBm to -74dBm in steps of 4dBm) 7 (always) 8 to 14 (above -78dBm to -54dBm in steps of 4dBm) 15 (never)	
QSCI	0	-	0(QSI), 1(always)	

## Commands and parameters

COEXUMTS	RAEPC	BSC exchange property
COEXUMTSINT	RAEPC	BSC exchange property
FDDARFCN	REDEC	Cell
ISHOLEV	RLLOC	Cell
MRS�	RLDEC	Cell
SCRCODE	RLDEC	Cell
UTRANID	RLDEC	Cell
UTRAN	RLDEP	Cell