GSM Idle Mode Behavior

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Introduction

While the MS is in idle mode it will continuously make measurements on the BCCH-carriers of serving and neighboring cells to decide on which cell to camp It will also, if necessary, register its presence in the location area of the chosen cell by performing a location updating. The purpose of camping on a cell is: Enables the MS to receive system information from the network, MS can initiate a call by accessing the network on the Random Access Channel (RACH) of the cell on which it is camped, Network will know the location area of the cell in which the MS is camped and can therefore page the MS when an incoming call is received.

Idle mode- Powered on but not allocated a dedicated channel

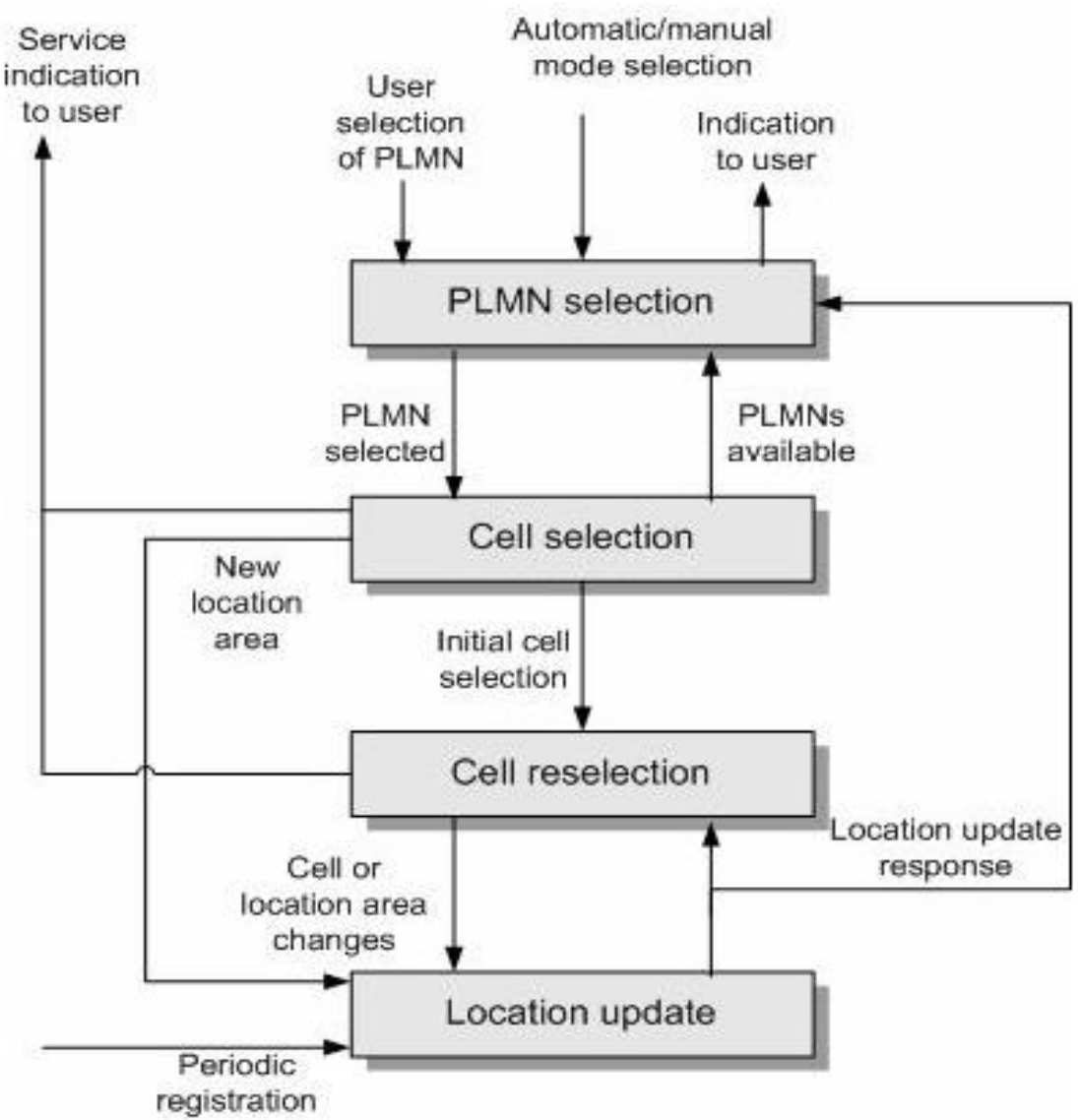
- It enables the MS to receive system information from the network
- the MS can initiate a call by accessing the network on the Random Access Channel (RACH)
- the network will know the location area of the cell in which the MS is camped (unless the MS has entered a limited service state) and can therefore page the MS

Idle Mode Tasks

The idle mode task can be subdivided into four processes:

- PLMN selection
- Cell selection
- Cell reselection
- Location updating.

Idle Mode Process



PLMN Selection

PLMN SELECTION

There are two modes of PLMN selection; these are automatic and manual. The power on the MS selects the registered PLMN and attempts to perform location updating regardless of selection mode. The registered PLMN is the network used at power off and is given in the MCC+MNC part of LAI, which is stored on the SIM card at the last successful location updating.

- Powered on
- Requested by user
- Recovery from lack of coverage
- To return to home PLMN (periodic attempt)

*The periodic attempt is controlled by a timer stored in the SIM and only the service provider is able to set the timer value. A value of T minutes may be stored in the SIM. T is either 6 minutes to 8 hours (in 6 minute steps) or indicates that no periodic attempts shall be made. If no values is stored in the SIM, a default value of 30 minutes is used.

PLMN Selection: Automatic/Manual Mode

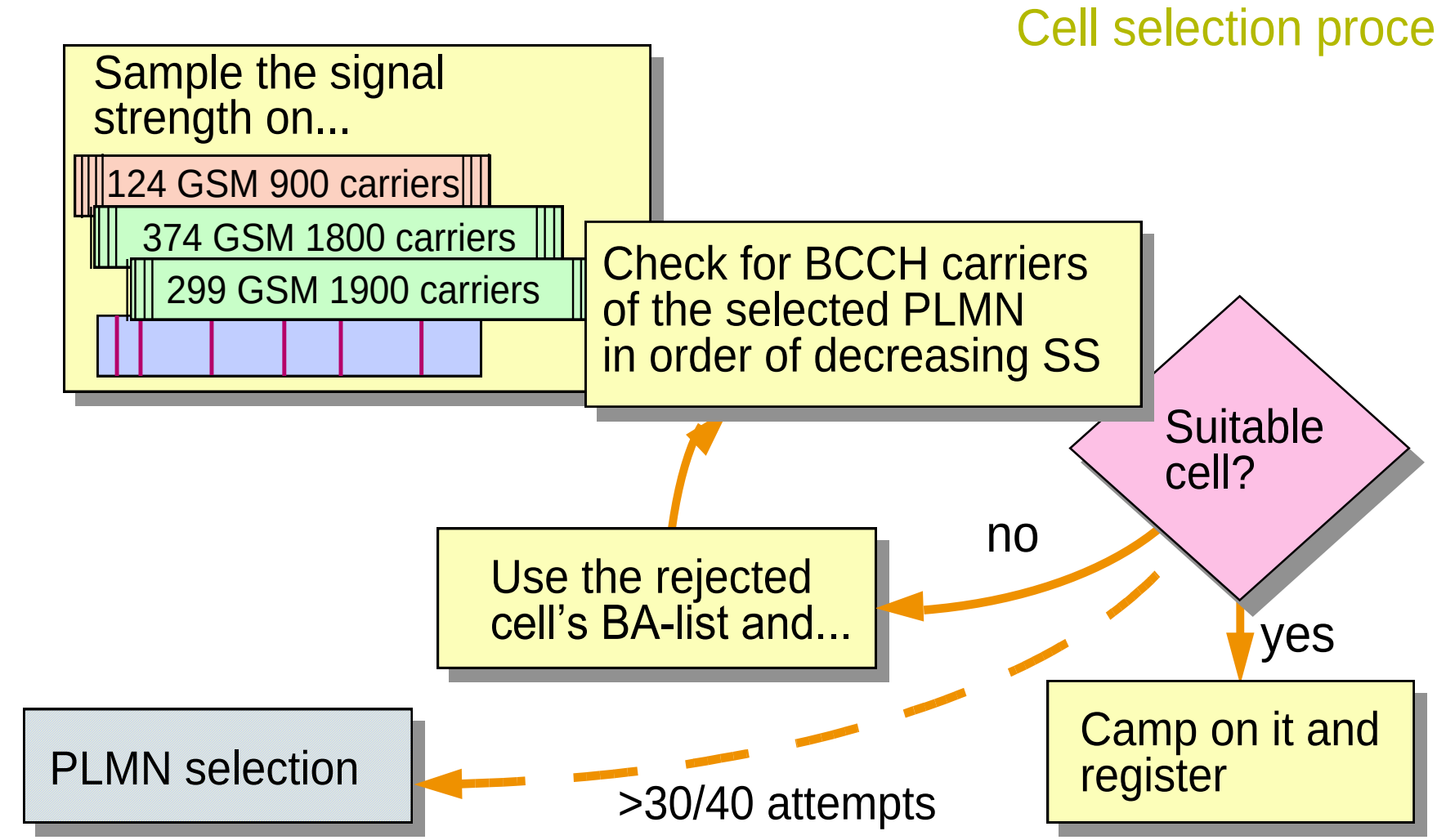
Automatic mode: if no **last registered PLMN** exists or is available

- home PLMN
- each PLMN that has been stored in the Subscriber Identity Module (SIM) in priority order
- other PLMNs with received signal level above -85 dBm in random order
- all other PLMNs in order of decreasing signal strength.

Manual mode:

User choice

PLMN Selection: Normal/Stored List



Cell Selection

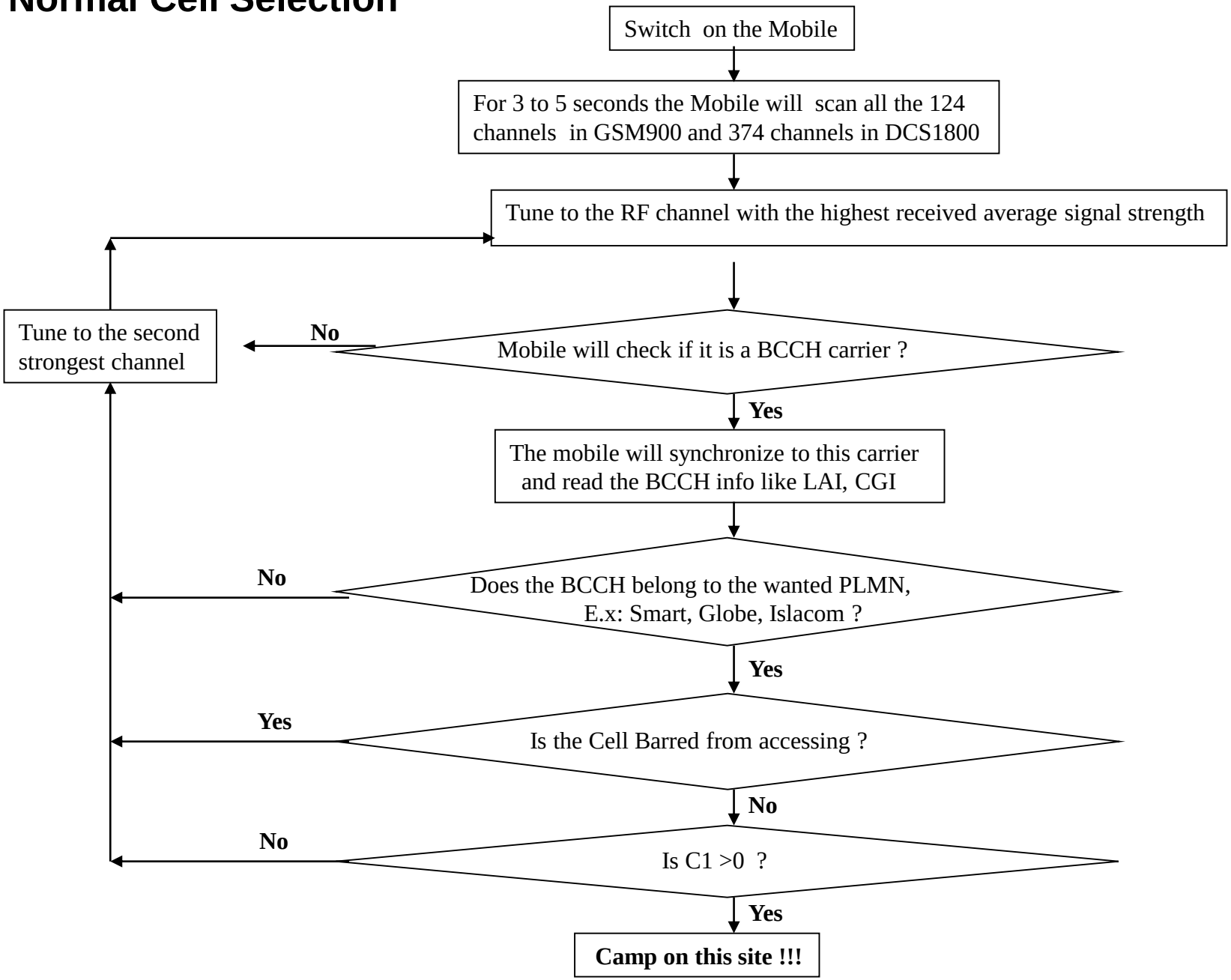
Cell Selection

When an MS is powered on or enters the network coverage area, it scans all the frequencies allowed by the PLMN and selects a suitable cell to camp on. This procedure is called cell selection.

- After selecting PLMN, MS will search for a suitable cell.
- For Cell selection, MS does have a BA list available so it will scan all RF signals in it.
- At least five samples per frequency will be taken and among them, MS will check whether the RF frequency is BCCH or not. It will also try to decode BSIC.
- If not, it will go for another frequency.
- The cell selection criterion is C1 which is as follows:

C1 = RXLEV - RXLEV_ACCESS_MIN - MAX((MS_TXPWR_MAX_CCH - P), 0)

Normal Cell Selection



Cell Selection: Suitable Cell Criteria

- it belongs to the selected PLMN,
- it is not barred (when a cell is barred it will not be camped on by an MS in idle mode but a MS in dedicated mode can perform handover to it),
- it does not belong to a location area included in the list of "forbidden location areas for roaming",
- the cell selection criterion (**C1>0**) is fulfilled.

Cell Selection: C1 Criterion

C1 = (***received signal level*** - **ACCMIN**) – max (**CCHPWR** - ***P***, 0)

ACCMIN- is the cell parameter that indicates the minimum received signal level at the MS required for accessing the system.

CCHPWR - is the cell parameter that indicates the maximum transmitting power that an MS is allowed to use when accessing the system.

P - is the maximum power output of the MS according to its class.

Parameter(HUAWEI)	Parameter Value(HUAWEI)	Parameter(Ericsson)	Ericsson Value	Consequence	Short Des.
RXLEV_ACCES_MIN	0	ACCMIN	-110	If set to higher value, performance will improve but Traffic will decrease	Min Access level

Cell selection…Cell Bar and Access

CBQ	CELLBARACCESS2	Cell Selection Priority	Cell Reselection Priority
0	0	Normal	Normal
0	1	Forbidden	Forbidden
1	0	Low	Normal
1	1	Low	Normal

HUAWEI topology

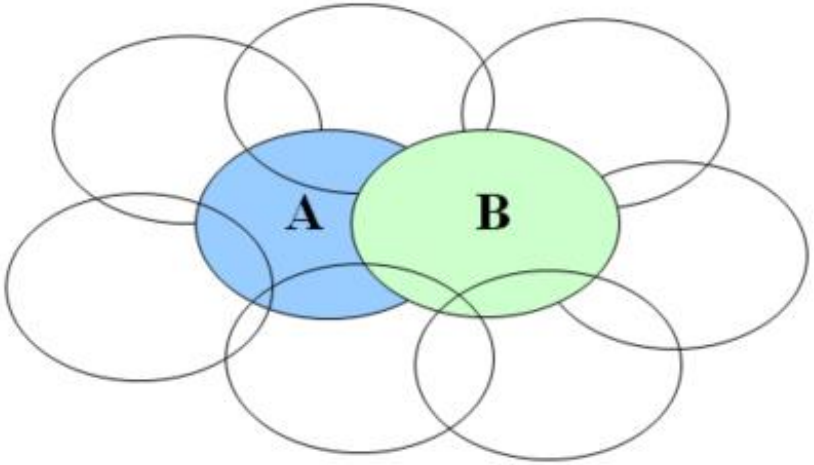
Map:
In Ericsson CBQ=HIGH, In HUAWEI CBQ=0
In Ericsson CB=No, In HUAWEI CELL BAR ACCESS= 0

Table 1 Behaviour of the MS for different combinations of CBQ and CB

CBQ	CB	At cell selection	At cell reselection
HIGH	NO	Normal	Normal
HIGH	YES	Barred	Barred
LOW	NO	Low	Normal
LOW	YES	Low	Normal

Ericsson topology

Application of CBQ



The traffic of cell A and B is heavy. Set these two cells with CBA="No", CBQ="No".

Each circle in the diagram indicates a cell. For some causes, the traffic in cell A and that of cell B are obviously higher than those of the adjacent cells. To make the traffic of the entire area distributed on average, set the priorities of cell A and cell B as "Low" and those of other cells as "Normal". In this way, the services in the shadow areas in the diagram will be shared by the adjacent cells. It must be pointed out that this setting will reduce the actual coverage areas of cell A and cell B, which is different from decreasing the transmitting powers of cell A and cell B.

Cell Reselection

Cell Reselection

After a cell has been successfully selected, the MS will start the cell reselection tasks. It will continuously make measurements on its current serving cell and neighboring cells, in order to initiate cell reselection if necessary. For multiband MSs the strongest non serving carriers may belong to different frequency bands.

The MS continuously monitors all neighboring BCCH carriers, as indicated by the BA list, in addition to the BCCH carrier of the serving cell, to detect if it is more suitable to camp on another cell. At least five received signal level measurement samples are required for each defined neighboring cell. A running average of the received signal level will be maintained for each carrier in the BA list.

- The serving cell becomes barred;
- The MS has unsuccessfully tried to access the network the allowed number of times, as defined by the **MAXRET** parameter;
- The MS detects a downlink signaling failure (fails to decode CCCH)
- ***C1* < 0** for 5 seconds
- ***C2*** of serving cell < ***C2*** of neighbor cell for 5 seconds.

Cell Reselection: C2 Criterion

$$C2 = C1 + \mathbf{CRO} - \mathbf{TO} * H(\mathbf{PT} - T) \qquad \text{for } \mathbf{PT} \neq 31 \qquad (2)$$

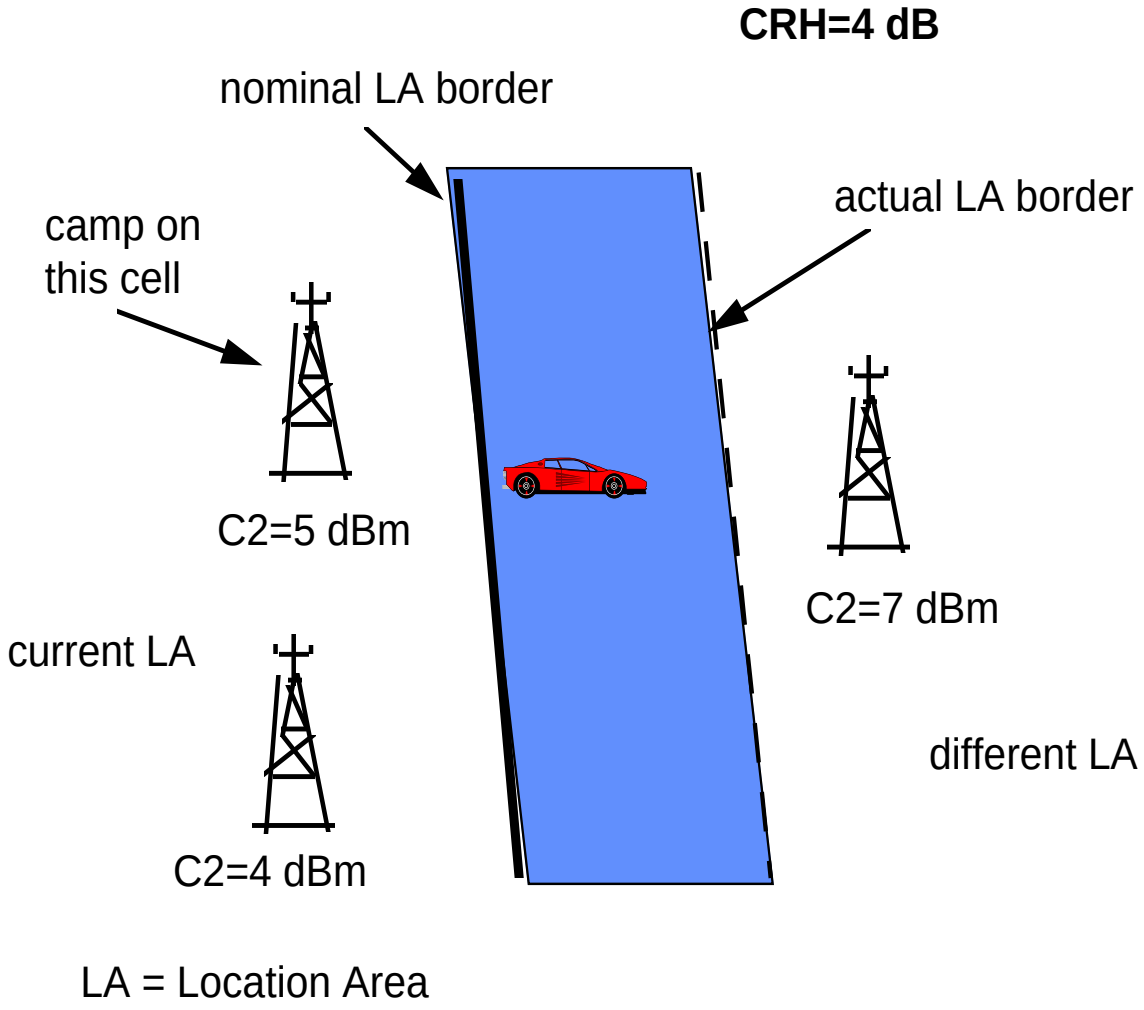
$$C2 = C1 - \mathbf{CRO} \qquad \text{for } \mathbf{PT} = 31 \qquad (3)$$

where $C1$ is defined by Eq. 1,

$$H(x) = \begin{cases} 0, x < 0 \\ 1, x \geq 0 \end{cases}$$

CRO applies an offset to the ***C2*** reselection quantity for the cell.
TO applies a temporary negative offset to ***C2*** for the duration of **PT** . This prevents fast moving MSs from selecting the cell.
PT = 31is reserved to change the sign of **CRO**

LAC border: Cell Reselect Hysteresis



[***C2*** of serving cell < ***C2*** of neighbor cell + CRH] for 5 seconds

Limited Service State

- PLMN not allowed
- No SIM card inserted
- Illegal MS
- IMSI unknown in HLR
- .....

Location Updating

Location Updating

To make it possible for the mobile subscriber to receive a call, the network must know where the MS is located. To keep the network updated on the location of the MS, the system is informed by the MS on a regular basis. This is called Location Updating. There are three different types of location updating defined; normal, periodic registration and IMSI attach. The MS may also inform the network when it enters an inactive state, IMSI detach.

- Location updating is done by MS in order to save unnecessary paging .
- Location updating is done in three ways

1. **Normal Updating**: When MS enters a new LA. It compares the value wit the stored LAI and the report to system
2. **Periodic registration**: After a fixed time period, MS informs the system to indicate whether it is active or not. Defined by T3212 parameter
3. **IMSI attach/detach**: MS will do IMSI attach/detach during switch on/off state. System can also implicitly detach MS if no successful communication takes place during BDTM+GDTM.

Value of BDTM+GTDM must be greater than T3212.

BTDM is the base time duration of implicit detach of a mobile subscriber by the network. It is an MSC parameter (Ericsson MSC only).
GTDM is the guard time for implicit detach. It is an MSC parameter (Ericsson MSC only).

Location Updating

- Normal- changing location area
- Periodic- based on timer T3212
- IMSI Attach/Detach

When T3212 is changed, the mobile's timer is reloaded:
New_timer = Old_timer.modulo.New_T3212 This prevent updating peaks.

The timer is reset whenever a mobile goes from dedicated mode to idle mode.

IMSI attach/detach is possible to turn off. This is done by the parameter ATT broadcasted on SI3

Implicit detach

MSC Supervision time = BTDM + GTDM
where BTDM = T3212

Locating Update Flow diagram

1. When the MS initiates a location area update request, an immediate assignment procedure is started. The BTS sends the BSC an Establish Indication message, which contains the content of the Location Updating Request message.

2. The BSC establishes an SCCP link over the A interface. Then, the BSC sends the MSC a Complete Layer3 Information message, which contains the cell global identity (CGI) of the current cell.

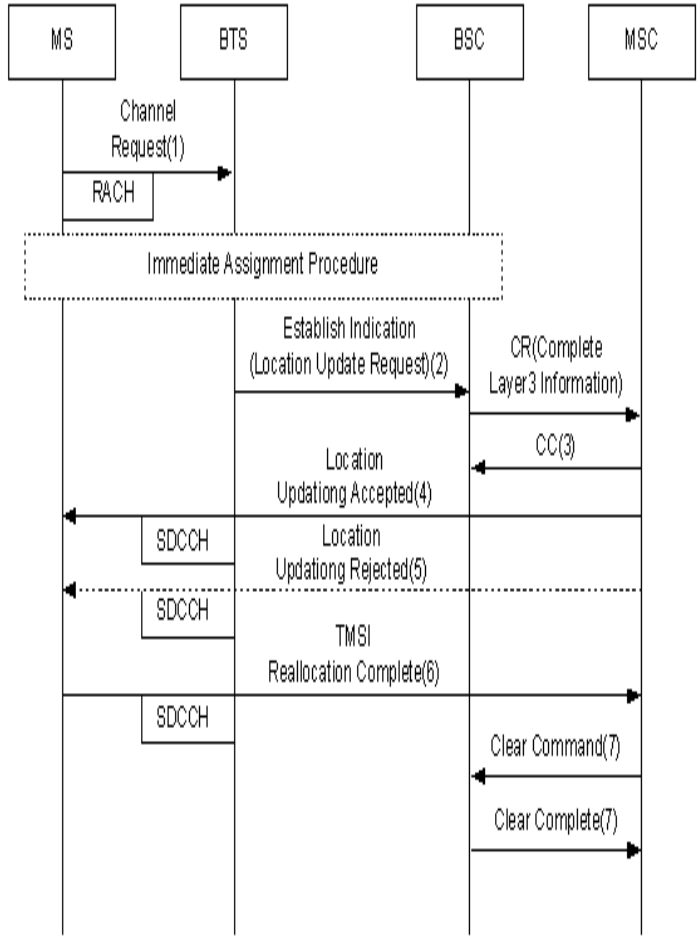
3. The MSC responds to the BSC with a **Connection Confirm** message.

4. The MSC sends the MS a Location Updating Accepted message, indicating that the location area update is successful.

5. If the network rejects the location area update request, it sends a Location Updating Rejected message to the MS.

6. If the TMSI allocation in the case of location area update is enabled on the MSC side, a TMSI Reallocation Complete message is sent to the MSC in the location area update procedure.

7. The MSC sends the BSC a Clear Command message to start the resource release procedure on the network side.



Paging.....

After an MS tunes to the BCCH carrier and decodes the system information data, it performs an evaluation, taking into account the IMSI number, which determines to which paging group it belongs. The particular method, by which an MS determines to which paging group it belongs, and hence, which particular CCCH block of the available blocks on the paging channel that is to be monitored, is defined in 3GPP TS 45.002. When there are no paging messages to be transmitted to MSs in a certain paging group, dummy pagings will be sent instead. The MS stays in sleep mode to minimize power consumption in the time gap between when its own paging group occurs. However, the MS must still read the BCCH data sent by the serving cell at least every 30 seconds.

Number of Paging Groups=(9-BSAGBLKSRES)*BSPAMFRAMS

The paging group belongs to a MS= ((IMSI mod 100)mod(Number of paging group))div BSPAMFRAMS

BSC calculated the paging sub group within the determined paging group based on IMSI and then pages in that group. The IMSI/TMSI mapping is there in the VLR.

The smaller the value of BSPAMFRAMS, the less paging groups will be generated and less time delay occurs between two consecutive time delay

Service performance will increase but battery backup of MS will be less as it will have less time to remain in DRX mode.

While configuring the parameter, we also should look about the system overload and optimize where needed.

Default value of BSPAMFRAMS is 2.

Paging is done in three different modes.

Common paging mode: Paging is done in the defined paging group

Complete paging mode: Paging is done in all the paging groups of the BTS

Spacing paging mode: Paging is done in N or N+2 paging group.

Paging Function

- Paging Queue function is implemented by BTS.
- Paging messages can only be transferred in the channel defined for the paging group.
- But the paging message has to be sent before PAGINGLIFETIME is expired.
- This timer has to be shorter than T3113 by 1or 2 sec.
- If Paging is unsuccessful, then it will be transmitted after PAGTIMES period. If set higher, system performance will degrade.
- Paging can also be done in local/Global end.
- Paging can be done both by IMSI/TMSI. TMSI handles larger number but it declined performance to some extent.
- Combination of IMSI/TMSI is preferable for paging.

Important Parameters…

Parameter(HUAWEI)	Parameter Value(HUAWEI)	Parameter(Ericsson)	Ericsson Value	Consequence	Short Des.
ATT	YES	ATT	YES	If set to no, no IMSI Attach/Detach message will be sent	If IMSI Attach/Detach message is not sent unnecessary paging will take place
T3212	50*6min	T3212	50 deci hours	If set lower, System load will be higher	Periodic Registration time
PI	YES	PI	YES	If set to No, the cell reselection will be done by C1 value	Whether C1/C2 will be used during cell reselection
BSAGBLKSRES	1	AGBLK	1	If set to higher, paging capacity reduce	The setting of this parameter affects the MS paging response and performance of the system. A large value decreases the number of paging blocks, paging capacity, and paging success rate.
BSPAMFRAMS.	2	MFRMS	2	If set to higher, paging group will increase but signaling failure criterion will decrease	Determines Paging group number and determines downlink signaling failure criterion

System Information

All GSM base stations forward continuously informations about their current system configuration and other informations needed by the mobile phones before they are allowed to access the network. These informations are organized in six different SYSTEM INFORMATION words containing specific parameters. Type 1 to 4 are transmitted within the BCCH (broadcast control channel). Type 5 and 6 are only transmitted during an established individual radio link in downlink direction in a multiplexed service channel called SACCH (slow associated control channel). To transfer one system information word four bursts are needed. In a BCCH these four bursts are available within one 51-multiframe, in a SACCH one system information word is spread over four 26-multiframes.

GSM System Information message type	**SI Description**
System information-1(SI1)	Cell ARFCN, RACH parameters required to access the system by MS and hopping related information are sent in this SI message.
System information-2(SI2)	Neighbour BCCH frequencies and PLMN information are sent in this SI. MS uses these frequencies for signal strength measurements required for handover.
System information-2bis(SI-2bis)	RACH control and BCCH extension on neighbor cells
System information-2ter(SI-2ter)	Information of BCCH extended allocated on which neighbor cells are provided in this SI. Broadcasted optionally on BCCH by the network to all the MSs.
System information-2 Quarter (SI-2Quater)	3G neighbor cell related information
System information-3 (SI3)	Carry following : 1. LAI of the current location area, 2. Cell identity, 3. Control channel information required to calculate paging group, 4. Cell options to achieve good performance in the cell, 5. cell selection parameters required by MS.
System information-4 (SI4)	CBCH and CBCH related frequency information, LAI, Cell selection parameters and RACH control information are carried by this SI4 message.
System information-5 (SI5)	It carries neighbor cell informations. In active mode, MS sends measurement reports in the uplink and output power/timing advance information in the downlink (on SACCH). Also gets BCCH carrier related information of the neighbor cells.
System information-6 (SI6)	Information on LAI, cell options, Cell identity and PLMN permitted or not is transmitted on this SI.
System information-7 (SI7)	Cell re-selection parameters needed by MS are sent on this SI.
System information-8 (SI8)	Cell re-selection parameters needed by MS are sent on this SI.
System information-9 (SI9)	Scheduling related some of the informations are sent on this SI.
System information-13 (SI13)	Carry GPRS related information needed for PS call.

System Information

System Information 1: Sent on BCCH

√ BA list

√ MSMAXRETRAN-maximum retransmission of MS

√ CELLBARACCESS2- Cell Bar access

√ COMMACC and SPECACC-Whether access class is supported or not

√ CALLRESTABDIS-Reestablishment allowed or not

√ ERGCALLDIS-Whether Emergency call is allowed

System Information 2: Sent on BCCH

√ Neighbor cell information(BA list)-SI 2bis,2ter,2querter

√ NCC permitted data

√ RACH control parameter

√ MBR- indicating dual band MS to report about dual band neighbor. Default value of MBR is 0.

System Information

System Information 3: Sent on BCCH

√ LAI

√ CI

√ ATT

√ AGBLK and MFRMS

√ RLT

√ FMSMAXOPCC- Maximum transmit power of MS

√ HRATESPT- NECI data indicating whether MS is GSM phase 1 or phase 2.

√ Cell selection and reselection parameters(PI,CBQ,CB,TO,PT, Send 2 TER/2 quarter etc)

System Information 4: Sent on BCCH

√ LAI and CI

√ Cell selection and reselection parameter

√ CBCH

System Information

System Information 8: Sent on BCCH about cell reselection

System Information 13: Sent on BCCH

√ RAC

√ NCO- Network Control Mode

√ In addition, System Information Type 13 also contains parameters such as GPRS Mobile Allocation, GPRS Cell Options, GPRS Power Control Parameters , and PBCCH Description

.

MEASUREMENTS in IDLE and Active mode

MEASUREMENTS Contents

1. Coding Level and Quality
2. MS Measurements in Idle Mode
3. MS Measurements in Dedicated Mode

MEASUREMENTS
Coding of Level and Quality

LEVEL

P (dBm)	FS (dBuV/m)	BSC RXLEV
-110	27	0
-109	28	1
-108	29	2
.	.	.
.	.	.
.	.	.
-49	88	61
-48	89	62
-47	90	63

P=Power
FS= Field Strength
LEV= Level

QUALITY

BER (%) RANGE	BER (%) MEAN	BSC RXQUAL
< 0.2	0.14	0
0.2-0.4	0.28	1
0.4-0.8	0.57	2
0.8-1.6	1.13	3
1.6-3.2	2.26	4
3.2-6.4	4.53	5
6.4-12.8	9.05	6
> 12.8	18.1	7

The relationship between Field Stregth (measured in dBuV/m) and Received Power (measured in dBm) is

FS (dBuV/m) = RxLev (dBm) +77,2+20Log[freq(MHz)]

Based on the formula above for GSM 1800 "P" corresponds to "FS" values different from GSM 900 case.

MS Measurements in IDLE Mode
(GSM Specs)

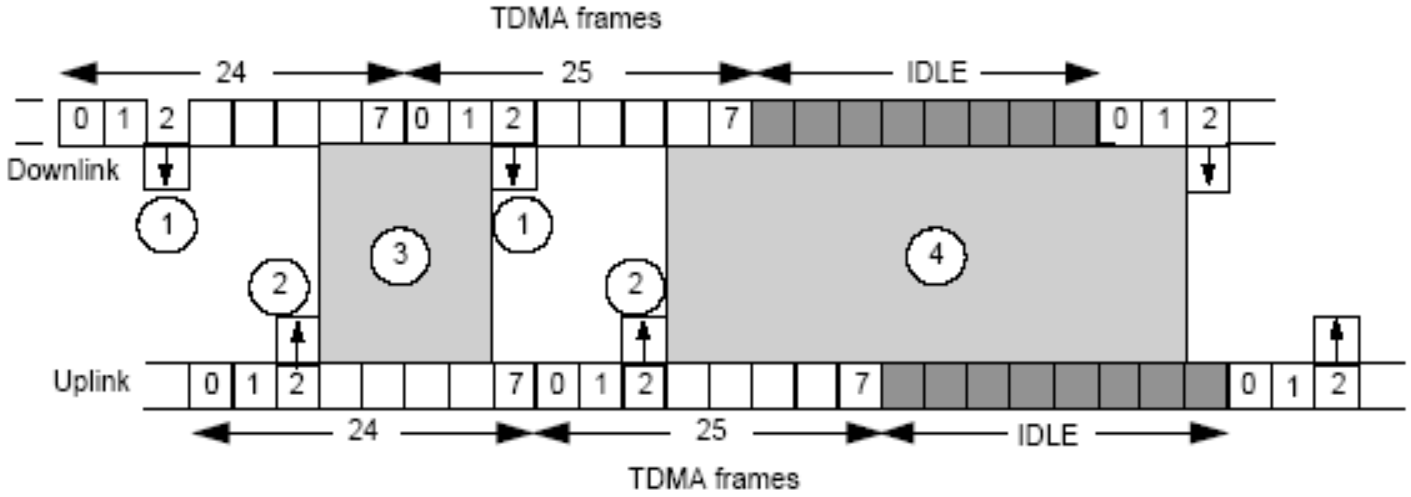
- MS decodes BCCH of serving (camped)cell every 30 s (read system information messages to get changes in cell parameters)
- Decodes BCCH of six strongest neighbours at least every 5 min

  (parameters affecting cell re-selection)
- Pre-synchronization and BSIC decoding of neighbours Once in 30 s (to confirm that it is still monitoring the same cell)
- New neighbour within six strongest- BCCH decoding in 30 s

MS Measurements in DEDICATED Mode (1)

- Measures the RxLev and RxQual of the Server
- Measures the RxLev of all defined neighbours (BA list from System Info 5)
- BSIC-decoding of adjacent cells Once in 10 s
- Measurement results of 6 best neighbours will be sent to BSC Every SACCH period 480 msec.
- Detects whether DTX is used

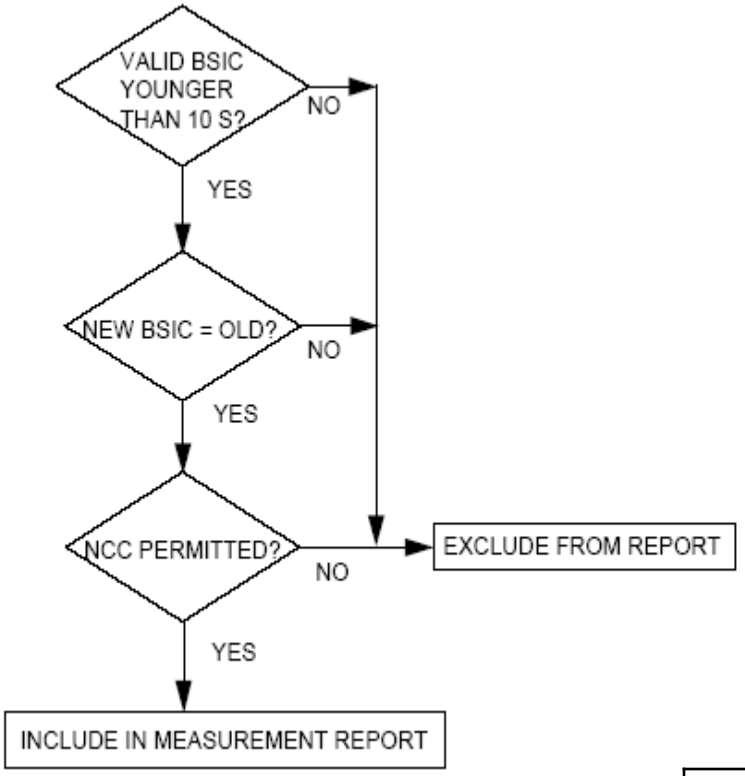
MS Measurements in DEDICATED Mode (2)



The MS activities marked 1-4 in Figure 5-43 are:

1. MS receives and measures signal strength on serving cell, TS 2 downlink.
2. MS transmits, TS 2 uplink.
3. MS measures signal strength for at least one of the surrounding cells.
4. MS tries to read BSIC on SCH (TS 0, c0) for one of the six strongest surrounding cells.

MS Measurements in DEDICATED Mode (2)



Summary

	Idle mode		Active mode	
	BSIC	BCCH	BSIC	BCCH
Serving cell	-	every 30 s	-	-
Six neighbors	every 30s	every 5 min	every 10 s	-


Thank
you