

Testing Mobile Station Cell Transitions and Handovers

Application Note

Introduction

The handover procedure is what makes a mobile station (MS) mobile. Successful handovers facilitate uninterrupted voice service to the user even while traveling across cell boundaries. Unsuccessful handovers are often the cause of dropped calls. Cell transition procedures are also crucial to allowing the MS to change to neighboring cells when the quality and strength of the current cell's signal degrades beyond the MS's threshold.

Historically, the requirement has focused on supporting inter-cell handover and cell transitions for a given cellular technology. The situation has now changed with the requirement to support the inter-RAT handover and cell transitions and seamlessly encompass different wireless technologies—GSM/GPRS/EGPRS and W-CDMA/HSDPA.

Testing the ability to perform cell transition and handover procedures between cells of the same or different radio access technologies (RATs) is now easy using two 8960s to create a two-cell test system.

Two 8960 test sets can be connected via LAN to simulate two cells in a network. The two-cell test system can be configured to emulate two GSM/GPRS/EGPRS cells, or one GSM/GPRS/EGPRS cell and a W-CDMA/HSDPA cell. (At this time you cannot emulate handovers or cell transitions between two W-CDMA/HSDPA cells.) This two-cell test system provides the ability to test an MS's behavior while transitioning to a different cell via a handover or cell selection/reselection procedures.

By connecting the two test sets to a PC loaded with Agilent's Wireless Protocol Advisor (WPA) software, all over-the-air protocol can be captured and logged. Agilent's WPA version A.05.51 allows protocol logging of one or both 8960s in the two-cell test system. WPA supplies the ability to see all of the data exchange in real time with full decodes of the messages. It also can be used to store, retrieve, and analyze previously captured message logs.

This configuration provides a powerful analysis and testing tool for cell selections/reselections and handovers. This paper explains cell selections, cell reselections, and handovers, and how to test them using the 8960.

The paper also explains how the two-cell test system can be used to

- simulate two network cells for the MS to transition between
- send/receive real data to/from external servers
- test cell selection and reselection processes
- test circuit switched (CS) voice handovers and dual transfer mode (DTM) handovers
- monitor the mobile station's behavior during cell transitions using the WPA



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Cell Selections

Figure 1 shows the cell selection process and the many states that the GSM/GPRS/EGPRS MS transitions between as defined in 3GPP TS 03.22 version 8.7.0 Release 99. These states include:

normal cell selection – The MS searches all RF channels for a suitable cell on which it can camp normally. The most suitable cell is the RF channel with the strongest received signal level.

stored list cell selection – The MS initially selects a suitable cell for the Public Land Mobile Network (PLMN) from the broadcast control channel (BCCH) carrier information, which is stored in the MS (i.e. the broadcast allocation (BA) list.)

camped normally – The MS is camped on a cell of the registered PLMN and can make and receive calls as soon as the location registration process is complete. This is when the MS monitors the received level and the system information, and checks whether cell reselection is needed.

normal cell reselection – The MS attempts to camp on a new, more suitable cell.

choose cell – The MS has returned to idle mode from the connected mode and is choosing a suitable cell on which to camp.

any cell selection – The MS is either unable to camp normally on any cell of the selected PLMN, or cannot obtain service because of certain responses to a location registration attempt. It searches for a cell of any PLMN to camp on so that emergency calls can be made.

camped on any cell – The MS has camped on a cell irrespective of its PLMN identity, so that emergency calls can be made.

any cell reselection – The MS attempts to reselect a cell, irrespective of PLMN identity.

choose any cell – The MS has returned to idle mode, after having entered connected mode from the “camped on any cell” state to make an emergency call. It is attempting to find an acceptable cell on which to camp.

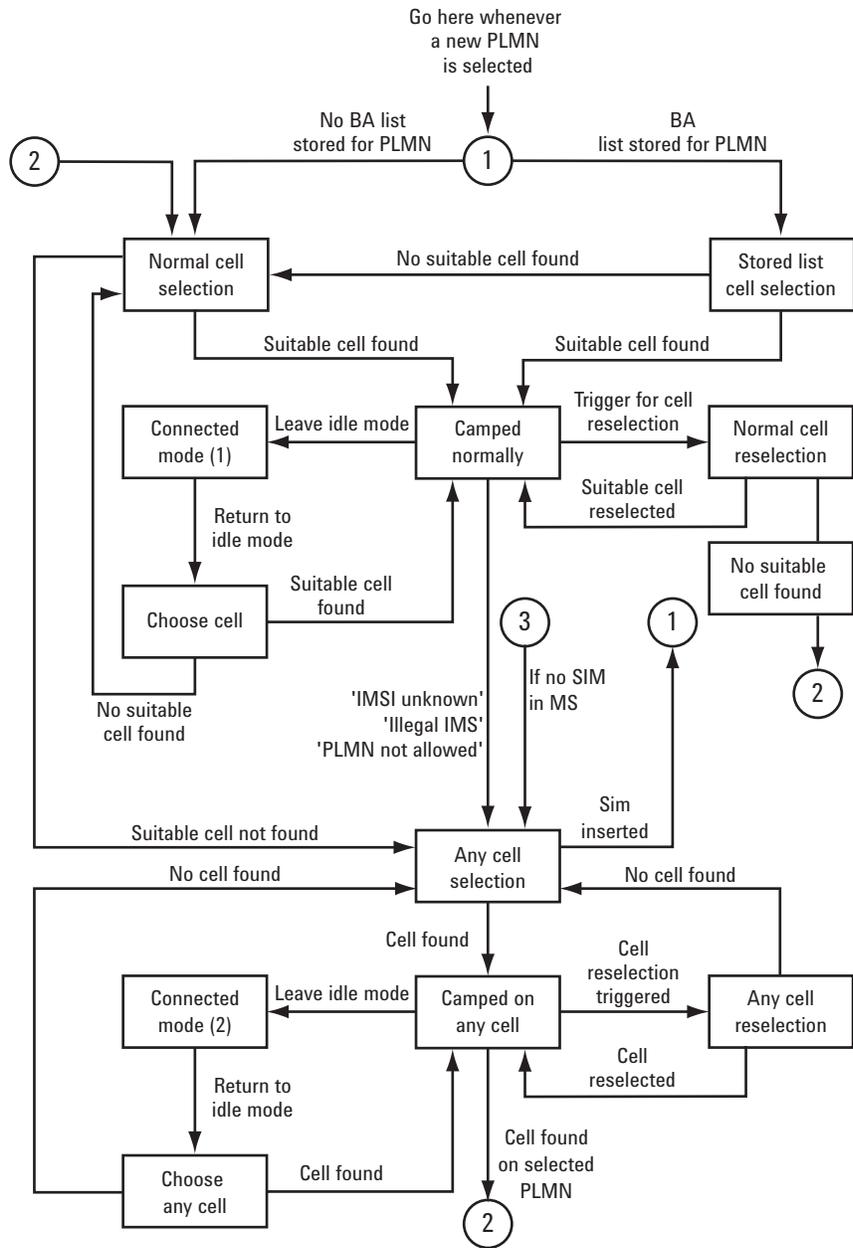


Figure 1. GSM/GPRS/EGPRS cell selection process.

Figure 2 shows the cell selection process and the many states that the W-CDMA/HSDPA MS transitions between as defined in 3GPP TS 25.304 version 3.e.0 Release 99.

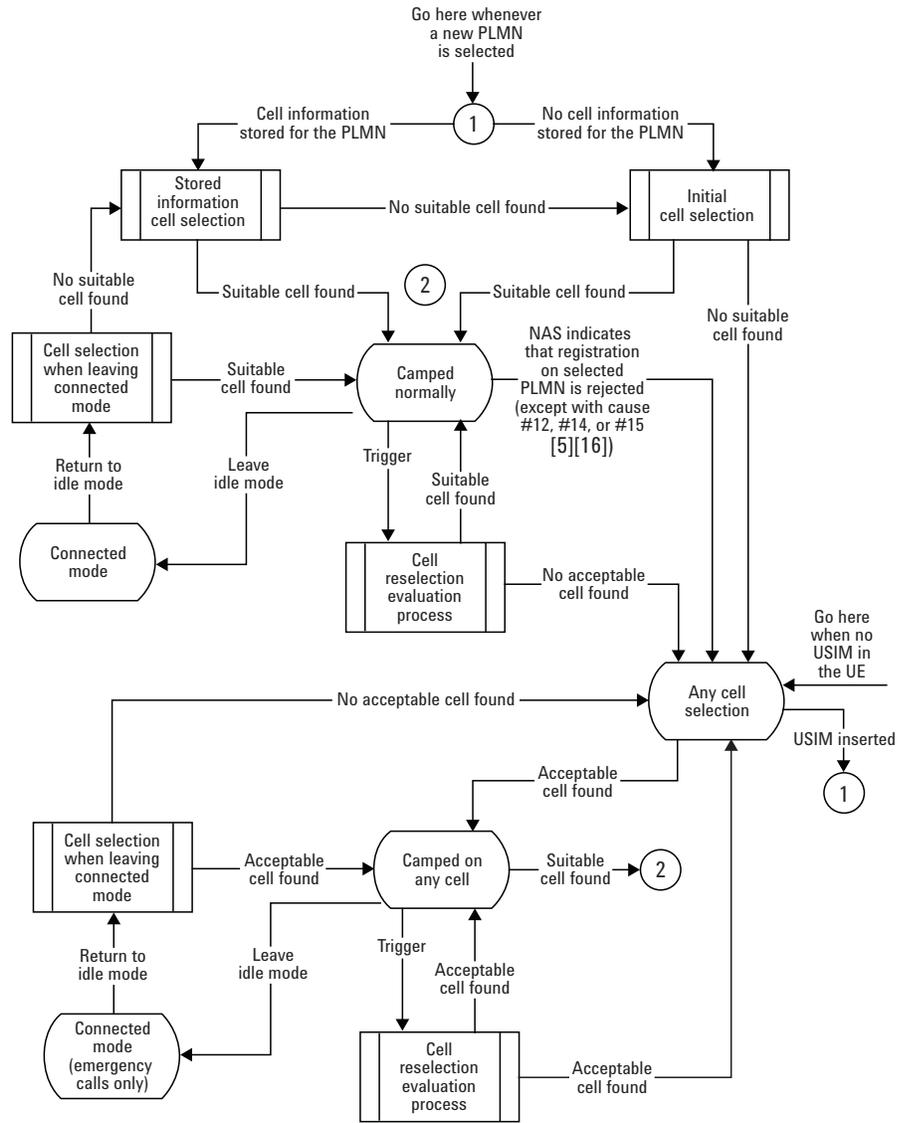


Figure 2. W-CDMA/HSDPA cell selection process

Cell Reselections

Cell reselection is the process by which an MS transitions to a more suitable cell. Cell reselection can be triggered for several reasons.

- **too much path loss** – The path loss depends on four parameters: average received signal level, the minimum signal the network requires when initially accessed (RXLEV_ACCESS_MIN), the maximum power that an MS uses when accessing the network, and the maximum power to the MS. The path loss of a different registration area must be lower by at least the value of the cell reselect hysteresis value before it is selected.
- **a downlink signaling failure** – This failure occurs when the too many messages are decoded unsuccessfully once the MS camps on a cell.
- **a failed authentication check** – If the upper layers have determined that the network has failed an authentication check (a failed authentication check occurs when there are three consecutive authentication failures), the MS treats the cell as though it is barred and reselects another cell.

Measurement reports from the MS play an important role in determining when the network should initiate cell reselections. The 8960 test set running a GSM/GPRS/EGPRS lab application can report up to 16 GSM/GPRS/EGPRS and 13 W-CDMA/HSDPA neighbor cells in its broadcast list of neighbors. The 8960 test set running a W-CDMA/HSDPA lab application can report up to 8 GSM neighbor cells (or 8 inter-frequency neighbor cells) and 8 intra-frequency W-CDMA/HSDPA neighbor cells in its broadcast list of neighbors.

The network control order in the GSM/GPRS/EGPRS application determines how the MS should perform cell reselections. If the network control order has been set to NC0 or NC1 at the 8960 to which the MS is currently GPRS-attached, it may not respond to network-initiated attempts at cell reselection. Further, if the 8960 to which the MS is GPRS-attached has the network control order set to NC2, autonomous cell reselection may not be performed by the MS as a result of invalid, user-set configurations of the 8960s' broadcast channels (BCH).

Cell reselections can be initiated by the mobile or network. When the network initiates a cell reselection, it sends a packet cell change order (if the current serving cell is GPRS/EGPRS) or a cell change order (if the current serving cell is W-CDMA/HSDPA), which provides the parameters necessary for the mobile to find and synchronize to the destination cell. If the mobile was actively transferring data at the time of the cell reselection, any subsequent allocation of traffic channel resources to continue the packet data transfer are handled by signaling between the mobile and destination cell, and does not involve the origination cell.

The 8960 allows two types of cell reselections: idle mode cell reselection and packet data transfer mode cell reselection.

Idle mode cell reselection

Idle mode cell reselection refers to cell transitions that occur when the mobile is in idle mode or the MS is PDP active but not actively transferring packet data.

In mobile-initiated idle mode cell reselection, the mobile decides on the basis of its own measurements to move from one cell to another to achieve improved RF quality. The network is not aware of the reselection until the mobile appears on the destination cell. The alternate cells a mobile may search for and transition to are determined by the serving cell's broadcast list of neighbors.

In network-initiated idle mode cell reselection, the network orders the mobile to transition to a new cell while in idle mode, using a packet cell change order (PCCO) or a cell change order (CCO).

Table 1. Idle mode cell reselection available in the two-cell test system

	<i>Mobile state</i>	Destination cell: GSM/GPRS/EGPRS		Destination cell: W-CDMA/HSDPA	
		Network-initiated	Mobile-initiated	Network-initiated	Mobile-initiated
Originating cell: GSM/GPRS/EGPRS	Camped but not attached	N/A ¹	Yes	N/A ¹	Yes
	Attached	Yes	Yes	Yes	Yes
	PDP active	Yes	Yes	Yes	Yes
Originating cell: W-CDMA/HSDPA	Camped but not attached	N/A ²	Yes	N/A ²	Yes
	Attached	N/A ²	Yes	N/A ²	Yes
	PDP active (but not actively transferring data)	Yes	N/A ³	No	N/A ³

1. In a GSM/GPRS/EGPRS cell, network-initiated cell reselection is only possible when the mobile is attached or PDP active.
2. In a W-CDMA/HSDPA cell, for Release 99 mobiles, network-initiated cell reselection is only possible when the mobile is PDP active.
3. Mobile-initiated cell reselection is not possible from a W-CDMA/HSDPA cell when the mobile is PDP active in CELL_DCH. Note that if you turn off the serving W-CDMA/HSDPA test set's cell power, the mobile will find the other test set and establish radio resources with it to continue data transfer on the existing PDP context; however, this is not the same as a mobile-initiated reselection to the other test set.

Packet data transfer mode cell reselection

Packet data transfer mode cell reselection refers to cell transitions that occur when the mobile is PDP active and actively transferring packet data (such as GPRS, HSDPA, or W-CDMA packet data). Whether the cell reselection is initiated by the mobile or by the network, the mobile is responsible for aborting the current data flow and restarting it upon arrival in the new cell. Any data packets routed to the old cell are lost and it is assumed that the higher layer protocol that was generating packets manages retransmission of any lost data to the mobile once it complete its transition to the new cell. A cell update procedure is performed by the mobile upon arrival to the new cell. The new cell is not responsible for re-establishing the PDP context, but rather the mobile or the network entity it was communicating with (for example, FTP server).

In network-initiated packet data transfer mode cell reselections, the current serving cell sends the mobile a PCCO or CCO to command it to change cells.

Mobile-initiated cell reselections made during GPRS/EGPRS packet data transfer mode may result in a temporary block flow (TBF) being aborted by the mobile with no indication provided to the 8960 as to why the abort is occurring. In this circumstance, a warning appears at the 8960 from which the MS is moving.

Table 2. Packet data transfer mode cell reselections available in the two-cell test system

		Destination cell: GSM/GPRS/EGPRS		Destination cell: W-CDMA/HSDPA	
		Network-initiated	Mobile-initiated	Network-initiated	Mobile-initiated
Originating cell: GSM/GPRS/EGPRS	Actively transferring packet data	Yes	Yes	Yes	Yes
Originating cell: W-CDMA/HSDPA	Actively transferring packet data	Yes	N/A ¹	No	N/A ¹

1. Mobile-initiated cell reselection is not possible from a W-CDMA/HSDPA cell when the mobile is PDP active in CELL_DCH. Note that if you turn off the serving W-CDMA/HSDPA test set's cell power, the mobile will find the other test set and establish radio resources with it to continue data transfer on the existing PDP context; however, this is not the same as a mobile-initiated reselection to the other test set.

Handovers

Handover refers to a cell transition that occurs when a circuit-switched (CS) connection is in place (such as CS voice, CS data, or dual transfer mode). Handovers can only be initiated by the network; no MS-initiated equivalent of such a procedure is defined. Through analysis of measurement reports of the serving cell and neighbor cells returned by the MS during the voice call, the network may determine that a more appropriate cell should be used by the MS and instruct the MS to handover to another cell. The most likely cause of a handover is the degradation of quality and power levels due to the physical movement of the MS moving between cell boundaries.

During a handover, the network sends the mobile a handover command, which provides information about the destination cell, including the traffic channel configuration (in the two-cell test system, this information is determined by the destination test set's current configuration; the originating test set retrieves this information from the destination test set before ordering the handover).

The 8960 allows two types of handovers:

- **8960 CS voice handovers** – A CS voice handover can be made with and 8960 to a non-synchronized, destination cell. A non-synchronized destination cell is not synchronized to the serving cell.
- **8960 dual transfer mode (DTM) handovers** – While similar to CS handovers, for a GSM/GPRS/EGPRS DTM connection (wherein the mobile simultaneously has a CS voice call and a packet-switched data connection), the network sends a handover command to transition the CS connection, but the mobile is responsible to abort the PS (packet-switched) connection and re-establish the packet data flow after arriving at the new cell. If DTM is not supported in the new cell, the mobile performs the cell change and drops the packet data connection.

Table 3. Handovers available in the two-cell test system

	<i>Mobile state</i>	Destination cell: GSM/GPRS/EGPRS		Destination cell: W-CDMA/HSDPA	
		Network-initiated	Mobile-initiated	Network-initiated	Mobile-initiated
Originating cell: GSM/GPRS/EGPRS	CS voice	Yes	N/A ¹	Yes	N/A ¹
	CS data	No		No	
	Dual transfer mode	Yes		Partial ²	
Originating cell: W-CDMA/HSDPA	CS voice	Yes	N/A ¹	No	N/A ¹
	CS data	No		No	
	Simultaneous services	No		No	

1. Handovers can only be initiated by the network.
2. Because simultaneous services are not supported in the W-CDMA/HSDPA application, when you handover a GSM/GPRS/EGPRS DTM connection to a W-CDMA/HSDPA cell, the voice portion of the connection is handed over and the data portion should be suspended by the mobile.

DTM Operation

In GPRS/EGPRS DTM, the mobile station is allocated resources providing an radio resource (RR) management connection and a temporary block flow on one or more physical channels. DTM is optional for the mobile station and the network, and is only applicable for an MS supporting GPRS or EGPRS.

When the MS and/or network is unable to communicate on a GPRS channel, the MS requests for suspension of GPRS services. This can occur when a GPRS-attached mobile station is in a cell that does not support DTM and a circuit-switched connection is initiated, or when Class A mode of operation is supported in the serving cell, but is not supported in the cell to which it is subsequently handed.

The following figure shows an intra-serving GPRS support node (intra-SGSN) suspend and resume procedure as defined in the 3GPP TS 23.060 V 3.11 Section 16.2.1.1.1.

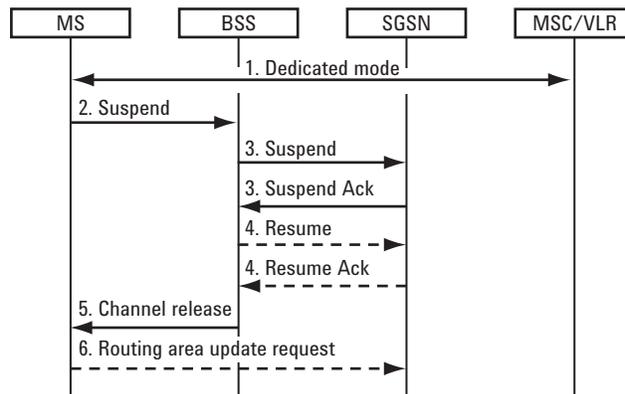


Figure 3. Suspend and resume procedure for intra-SGSN.

During the suspend and resume procedure, the following events occur:

- Step 1: The MS enters dedicated mode in a serving cell that does not support Class A mode of operation or handed over to a cell that does not support Class A.
- Step 2: The MS sends an RR suspend message to the base station subsystem (BSS).
- Step 3: The BSS sends a suspend message to the serving GPRS support node (SGSN). The SGSN acknowledges the suspend message by sending a send Ack message back to the BSS.
- Step 4: When the DSS detects that Class A mode of operation is supported, the BSS sends a resume message to the SGSN. If successful, the SGSN sends a resume Ack message back to the BSS.
- Step 5: The CS radio channel is released when the BSS send a channel release message to the MS. This indicates that the BSS has successfully requested the SGSN to resume GPRS services for the MS.
- Step 6: GPRS services are resumed by when the MS sends a routing area update request message to the SGSN.

Procedure to Set Up the Two-Cell Test System

The following list contains the required components of the two-cell test system needed to set up and test cell selection/reselection and cell handovers.

Two 8960s – The two-cell test system requires two test sets which emulate the two cells for the mobile to transition between. The inter-RAT two cell test system scenarios assume that one test set is running a GSM/GPRS/EGPRS application/format while the other is running a W-CDMA/HSDPA application/format.

LAN connection – The two-cell test system relies on an Ethernet connection (external device connection) between the two test sets to allow them to exchange control messages during cell reselections and handovers.

RF interface – The MS must be able to communicate with both test sets. To accomplish this, it is recommended that you use an RF splitter to connect the mobile station to both test sets simultaneously.

GPIB connection – GPIB connection between both test sets and a controlling PC are necessary if remote control of the instruments in the system is required.

Ethernet switch or hub – An Ethernet switch or hub is needed in order for the mobile to connect to external servers as well as for connecting the PC running WPA to the test sets.

This procedure details how to set up the two-cell test system. Refer to Figure 4: Two-cell test system setup diagram for the recommended layout of the two-cell test system.

1. If remote control of the 8960s in the two-cell test system is required, connect each 8960's GPIB port to the controlling PC.
2. Connect the two 8960s together. It is recommended that an Ethernet switch or hub be used when connecting the two 8960s via LAN. This helps minimize the risk of lost data due to delayed packets, and allows connection to external servers at the same time as connection to a PC for protocol logging. Alternatively, the two 8960s can be directly connected together via a crossover LAN cable (non-crossover cables do not work). Also note that the use of crossover cables does not allow logging and connection to external servers.
3. Connect the MS's RF port to both 8960s in the two-cell test system via a power splitter. Compensate for the losses through the splitter by setting the Amplitude Offset for each test set.
4. Set DUT IP address to a different value in each test set. In the GSM/GPRS/EGPRS application, DUT IP address is accessible from DUT PDP Setup (F2). In the W-CDMA/HSDPA application, DUT IP address is accessible from DUT IP Setup (F2).
5. Configure each 8960 to simulate realistic cells that the MS can transition to and/or from. It is recommended to configure the neighbor cell list in each test set to contain the other test set's information (using the SIB 11 Cell Info List in W-CDMA/HSDPA or the Cell Lists in GSM/GPRS/EGPRS). This enables the mobile to measure the other test set before transitioning to it (some mobiles will not perform a "blind" handover) and allows you to view the mobile's measurement reports for the test set. Ensure that you have properly configured the mobile measurement reports to match the destination test set's configuration (using the Compressed Mode settings in W-CDMA/HSDPA or the Measurement Reports settings in GSM/GPRS/EGPRS).

- To emulate a GSM/GPRS/EGPRS cell in one or both test sets, if the external 8960 is emulating a GSM/GPRS/EGPRS cell, the BA table must be configured to contain an entry for the broadcast channel absolute radio frequency channel number (ARFCN), NCC, and BCC the external 8960 is using in order for cell reselections and handovers to work. It is recommended the BCH ARFCNs, traffic channel ARFCNs, and cell identities or location area codes (LACs) are set to unique values. If the external 8960 is emulating a W-CDMA/HSDPA cell, the 3G FDD neighbors must be configured to contain an entry for the UARFCN and scrambling code the external 8960 is using. Additionally, the cell power should be configured at each 8960 to transmit stronger or weaker power levels.
- To emulate a W-CDMA/HSDPA cell in one of the test sets, the SIB11 Cell Info List must be configured to contain an entry for the BCH ARFCN, NCC, and BCC the external 8960 is using in order for cell reselections and handovers to work. Also, the cell power should be configured at each 8960 to transmit stronger or weaker power levels.

6. If desired, connect the PC that has the WPA application to both 8960s through the Ethernet switch or hub.

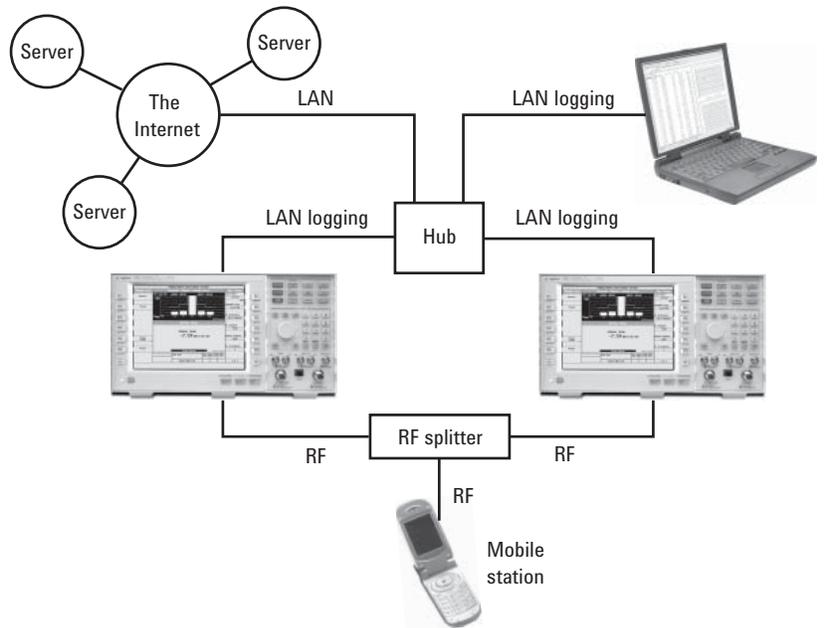


Figure 4. Two-cell test system setup diagram.

When the MS that is connected to the two-cell test system is powered on, it selects the 8960 that has more favorable RF conditions. After the MS is attached to an 8960, the MS's cell transition procedures are ready to be tested. When the MS transitions between the 8960s in the system, it is forced to move from the current channel configuration to the channel configuration of the 8960 in the system to which it is changing.

To emulate a GSM/GPRS/EGPRS cell in both test sets, before performing any inter-cell handover or cell reselection tests, you must configure each test set to have independent ARFCNs and neighbor cell lists must be set to use these ARFCNs to point to each other. Changes to the TCH or PDTCH parameters on the test set that the MS is not in communication with have no immediate effect, however they are stored and used when the MS moves to the test set in which the changes were made. Each test set in the system must be configured through its own front panel or by sending commands to its unique GPIB address.

Cell transition procedures are tested by using the test set to force a network-initiated handover or cell reselection, or by changing either of the test set's cell configuration to force cell reselection. Cell transitions can occur as long as the two-cell test system is connected.

Measurements for cell reselection, such as monitoring the received signal level and BCCH data, can be made when the MS initiates the cell transition process. GSM/GPRS/EGPRS mobile measurements for cell reselection, the criteria for cell selection and reselection, and cell reselection algorithms that determine when to initiate the cell transition process are defined in 3GPP TS 05.08 version 8.16.0. W-CDMA/HSDPA cell reselection information is available in 3GPP TS 25.304 version 3.e.0. The two-cell test system facilitates cell selections and reselections initiated by the MS based only on RF characteristics set the user. Additionally, network-initiated MS procedures are always instructed by the user and never occur automatically.

Table 4 shows the settings relevant to the two-cell test system in a GSM/GPRS/EGPRS cell. Table 5 shows the settings relevant to the two-cell test system in a W-CDMA/HSDPA cell.

Table 4: Two-cell test system control settings

Parameter	Range	Default	Description
Cell bar access	0 to 1	0	This parameter, as well as the cell bar quality parameter, affects the cell priority for cell selection parameters
Cell bar quality	0 to 1	0	This parameter, as well as cell bar access parameter, affects the cell priority for cell selection parameters
Cell identity	0 to 65535	0	Sets the cell's identity code
Cell reselect hysteresis	0 to 7	3	Sets the received signal level hysteresis required for cell reselection
Cell reselect offset	0 to 63	3	Applies an offset to the Cell 2 (C2) reselection criterion
C2 penalty time	0 to 31	0	Sets the duration that the C2 temporary offset is applied
C2 temporary offset	0 to 7	0	Sets the offset applied to C2 for the duration of C2 penalty time
NCC permitted	0 to 255	255	Sets the network color codes (NCCs) that the mobile station is permitted to report
Network control order	0 to 2	0	Sets the level of control that the network has to control measurement reporting and cell reselection <ul style="list-style-type: none"> • NC0 – Normal MS control. The MS shall perform autonomous cell re-selection • NC1 – MS control with measurement reports. The MS shall send measurement reports to the network. The MS shall perform autonomous cell reselection • NC2 – Network control. The MS shall send measurement reports to the network. The MS shall only perform autonomous cell reselection when the reselection is triggered by a downlink signaling failure or a random access failure
Rx lev access min	0 to 63	0	Sets the minimum received signal level at the mobile station required for the mobile station to access the cell

Table 5. Two-cell test system control settings (W-CDMA/HSDPA cell)

Parameter	Range	Default	Description
Cell barred state	0 to 1	0	When this parameter is set to ON, a UE is not allowed to camp on a barred cell, not even for emergency calls
Cell barred timer	10, 20, 40, 80, 160, 320, 640, 1280 s	40 s	This parameter specifies the time the UE must wait before considering a barred cell for reselection
Cell identity	0 to 268435455	1	Sets the cell's identity code
$S_{\text{intersearch}}$	-32 to 20 dB	0 dB	$S_{\text{intersearch}}$ controls whether the UE must make measurements of inter-frequency cells while camped. If the quality of the serving cell is above $S_{\text{intersearch}}$, then the UE will not measure other inter-frequency cells while camped. If $S_{\text{intersearch}}$ is not present, the UE must make inter-frequency measurements while camped. Note that if the UE does not make measurements on other cells, it will not reselect away from the current cell, even if there is another cell at a higher signal level
Quality measure	RSCP, E_c/N_0	E_c/N_0	This parameter specifies whether the UE should use CPICH E_c/N_0 or CPICH RSCP as the quality measure for determining which cell to choose when performing a cell selection or mobile-initiated cell reselection
Hysteresis 1	0 to +40 dB	0 dB	This parameter specifies the hysteresis value to be used by the UE if quality measure is CPICH RSCP
Hysteresis 2	0 to +40 dB	0 dB	This parameter specifies the hysteresis value to be used by the UE if quality measure is CPICH E_c/N_0
Minimum required quality level (Qqualmin)	-24 to 0 dB	1 dB	This parameter specifies the "minimum required quality level in the cell (dB)". If quality measure is set to CPICH E_c/N_0 , the UE compares the CPICH E_c/N_0 it measures for the cell with Qqualmin to determine if it may select/reselect to the cell
Minimum required Rx level (Qrxlevmin)	-115 to -25 dBm	-115 dBm	This parameter specifies the "minimum required Rx level in the cell (dBm)". If quality measure is set to CPICH RSCP, the UE compares the CPICH RSCP it measures for the cell with Qrxlevmin to determine if it may select/reselect to the cell
Timer ($T_{\text{reselection}}$)	0 to 31 s	0 s	The UE shall only reselect to a cell if it is better ranked than the serving cell during a time interval $T_{\text{reselection}}$

When the MS has selected and is connected to one 8960 in the two-cell test system, the other 8960 in the system does not report any measurement results. Moreover, if the MS transitions to the other 8960 in the two-cell test system while on a measurement, the original 8960 terminates the measurement in progress and the other 8960 begins reporting measurement results when the MS starts communicating with it. Measurement reports from the MS are not used by the 8960 to automatically determine when network-initiated cell transitions occur since the timing of these transitions is controlled by the user.

Testing Cell Selections/ Reselections and Handovers

The cell selection procedure is performed when the MS is powered on, and it must determine which cell is the most appropriate to camp on. Cell reselection takes place when a neighbor cell is found to have more favorable RF conditions based on the measurements performed at the MS. Cell reselections may be initiated by the MS or the network, and can be made when the MS's connection status is in idle mode or in packet transfer mode.

Handover procedures are performed when a MS needs to transition to a new cell due to poor signal strength while on a CS voice call. Handovers are always network initiated. The two-cell test system supports CS voice handovers and DTM handovers. There are, therefore, five test procedures explained here:

- mobile-initiated cell selection
- mobile-initiated cell reselection (idle mode)
- mobile-initiated cell reselection (packet data transfer mode)
- network initiated cell reselection (idle mode and packet data transfer mode)
- handovers (CS voice and DTM)

Mobile-initiated cell selection

This procedure allows you to observe which cell the MS selects from the two-cell test system once it has completed its power up sequence.

1. If desired, initiate logging in the WPA to capture the protocol messages of this procedure.
2. Set up the two-cell system as described in the previous section.
3. Connect the 8960s in the two-cell test system together:
 - a) Press **System Config**.
 - b) Press the **More** key until the second control screen appears.
 - c) Press **External Device Connection** (F4). This brings up the Ext 8960 Ctrl menu.
 - d) Enter the IP address of the external 8960 in the **Ext 8960 IP Addr** field (F1).
 - e) Press **Connect to External 8960** (F3). Ensure that the External Device Conn Status is "Connected" and the IP addresses in the LAN Connection Information menu are correct.
4. Set up each cell's parameters, for example the cell band, broadcast channel, and traffic channel.
5. Turn on the MS's power.
6. Let the MS perform its cell selection algorithms and camp on one of the 8960s in the two-cell test system.
7. Check to see which 8960 the MS selected.

If the MS does not attempt to automatically attach/register when powered on, the connection status at both 8960s in the two-cell test system remains "Idle" during and after cell selection. You can determine which 8960 the MS selected by comparing the color codes reported by the MS (for example, the MNC and MCC) and comparing them to see which 8960 in the two-cell test system it matches. If the MS attempts to register/attach to one of the 8960s when powered on, the connection status of that 8960 changes from "registered" to "attached", while the other 8960's connection status remains "Idle". The 8960 that is selected can therefore easily be determined by analyzing the connection status on the screen both 8960s in the system. Alternatively, start a voice call from the MS or from both the 8960s and observe on which 8960 the call takes place. Terminate the voice call before continuing to the procedures below.

Mobile-initiated cell reselection (idle mode)

This procedure lists the steps to test a mobile-initiated cell reselection when the MS is idle.

1. Follow steps 1 through 7 of the mobile-initiated cell selection (idle mode) procedure.
2. Change the cell characteristics of one or both of the 8960s in the two-cell test system such that the 8960, which the MS is not currently camped on, has more desirable characteristics than the one it is camped on.
3. For example, change the Cell Power of one or both of the 8960s so that the 8960 that was not initially selected has a much stronger signal, or simply turn the cell power off in the test set the mobile is currently camped on.
4. Verify that the MS did in fact reselect the more appropriate cell. If the MS automatically GPRS attaches, it is easy to see which cell the MS is camped on by observing the connection status window. If the MS displays "Idle" in the connection status window, start a voice call or check the color codes as described earlier to determine which cell the MS selects.
5. Repeat Steps 1 and 2 if you want to force the MS to return to the other 8960 in the two-cell test system.

Mobile-initiated cell reselection (packet data transfer mode)

This procedure lists the steps required to test the cell reselection procedure when the MS is transferring data.

1. Follow steps 1 through 7 of the mobile-initiated cell selection (idle mode) procedure.
2. Start a GPRS/EGPRS data connection between the mobile and the external server and configure the other test set for the type of data connection you wish to transfer to (by selecting the **Operating Mode** and **Coding Scheme** for GPRS/EGPRS or the **GPRS Radio Access Bearer** and **CQI Value** for W-CDMA/HSDPA).
3. Press the **Instrument Selection** key and select **Data Throughput Monitor** on both test sets. Observe the transfer of data on the current serving cell. You can also observe the DUT IP counters present on the Call Setup screen in GPRS/EGPRS or on the Data Channels screen in W-CDMA/HSDPA.
4. Change the cell characteristics of one or both of the 8960s in the two-cell test system such that the 8960, which the MS is not currently camped on, has more desirable characteristics than the one it is currently camped on.

For example, change the Cell Power of one or both of the 8960 so that the 8960 that was not initially selected has much stronger signal.
5. Verify that the MS did in fact reselect the more appropriate cell by observing the Data Throughput Monitor display and IP counters on both test sets.
6. Check the MS and/or external server software to ensure the data connection is still active after the cell reselection is complete.
7. Monitor the data throughput or perform other measurements at both 8960s during the cell transitions.
8. Repeat Steps 2 through 5 if you want to force the MS to return to the other 8960 in the two-cell test system.

Network-initiated cell reselection (idle mode and packet data transfer mode)

This procedure explains how to test both idle mode and packet transfer mode cell reselections.

1. Follow steps 1 through 7 of the mobile-initiated cell selection (idle mode) procedure.
2. For idle mode cell reselections from a GSM/GPRS/EGPRS cell, ensure that the MS is attached or PDP active. For idle mode cell reselection from a W-CDMA/HSDPA cell, ensure that the mobile is PDP active. For packet data transfer mode cell reselection, ensure that there is an active GSM/GPRS/EGPRS or W-CDMA/HSDPA data connection between the mobile and test set by observing the Data Throughput Monitor.
3. If the current serving cell is GSM/GPRS/EGPRS, select **Handover Parameters** (F10), **Ext Handover Setup** (F9). If the current serving cell is W-CDMA/HSDPA, select **Handovers** (F5), **1 of 2** (MORE), **External 8960 Handover** (F1). Note: This is only available if the two 8960s are connected. This can be verified by observing the External Device Connection Setup screen. (Refer to Step 3 of the mobile-initiated cell selection procedure on page 14.)
4. Press **Ext Handover Execute** (F5). This instructs the network to send a PCCO message if the current serving cell is GPRS/EGPRS or a CCO message if the current serving cell is W-CDMA/HSDPA.
5. Ensure that the (packet) cell change order was successful by viewing connection status on both test sets (for idle mode cell reselection) or the Data Throughput Monitor display and IP counters on both test sets (for packet data transfer mode cell reselection).
6. Repeat steps 2 through 5 if you want to force the mobile station to return to the other 8960 in the two-cell test system.

Handovers (CS voice and DTM)

This procedure lists the steps required to perform CS voice handovers and DTM handovers.

1. Follow steps 1 through 7 of the mobile-initiated cell selection (idle mode) procedure.
2. Establish a mobile originated or mobile terminated CS voice call with one of the test sets, (or a DTM connection if the GSM/GPRS/EGPRS mobile supports it and the two-cell test system is emulating two GSM/GPRS/EGPRS cells). The voice connection status should display "Connected" (for a DTM connection, the connection status window displays the voice and data connection status in the form: voice/data). The voice connection status should display "Connected". The data connection will depend on the data connection status prior to starting a voice call and if the MS supports DTM.
3. If the current serving cell is GSM/GPRS/EGPRS, select **Handover Parameters** (F10), **Ext Handover Setup** (F9). If the current serving cell is W-CDMA/HSDPA, select **Handovers** (F5), **1 of 2** (MORE), **External 8960 Handover** (F1). Note: This is only available if the two 8960s are connected. This can be verified by observing the External Device Connection Setup screen. (Refer to Step 3 of the mobile-initiated cell selection procedure on page 14.)
4. Press **Ext Handover Execute** or **Execute Ext 8960 Handover**. This instructs the network to begin its handover procedure.
5. Ensure that the handover was successful by viewing the connection status window. During the handover, both test sets display "Handover". The destination test set then transitions to "Connected", while the originating test set transitions to "Idle".
6. Repeat steps 2 through 5 if you want to force the mobile to return to the other test set in the two-cell test system.

Conclusion

Performing the tests described in this paper using two 8960s running the E6701E GSM/GPRS/EGPRS or E6703E W-CDMA/HSDPA Lab Application is a quick and easy way to test a MS's ability to perform cell selections/reselections and handovers. Handovers are the major cause of dropped calls and are vital to the functionality of a MS. While the two-cell test system's design is to emulate a real network, the user has total control of the parameters that are used to influence the MS's cell selection and reselection procedures as well as control of when the network initiates a handover. Each test described in this paper can be further analyzed by using Agilent's WPA to log the protocol messages.



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Revised: May 7, 2007

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Printed in USA, May 23, 2007
5989-3949EN

