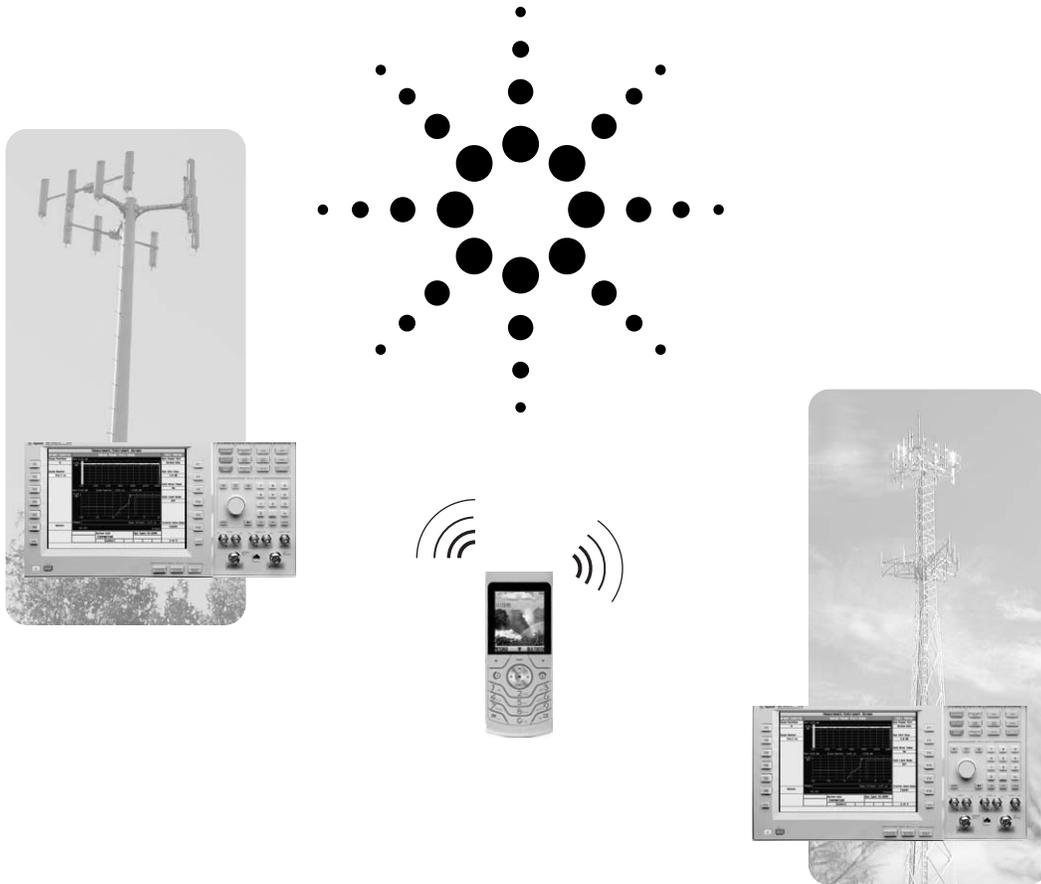


# Testing Hybrid Mode UE: Agilent's DO-cdma2000 Test Solution

Application Note



# Table of Contents

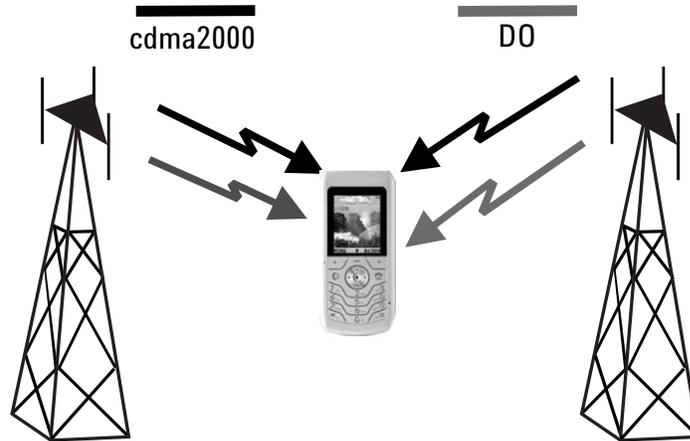
<b>Introduction</b> .....	3
<b>DO Operations</b> .....	4
<b>Hybrid Mobile Operations</b> .....	5
Turn on .....	5
Dual idle state .....	5
Voice call handling .....	5
Data call handling .....	6
Hybrid data session handoffs .....	6
<b>Configuring the 8960 Test Set to Test Hybrid MSs</b> .....	7
<b>Hybrid Mode Tests</b> .....	9
Assignment to a traffic channel .....	9
Transfer of the data carrying network from DO to cdma2000 .....	10
Sending SMS .....	10
<b>Conclusion</b> .....	11

## Introduction

The introduction of 1xEV-DO services in 2005 was the first time that higher data connection rates became available to the broad area coverage of cellular systems. Released as specification C.S0024 from 3GPP2, the official name is High Rate Packet Data (HRPD), but it is better known simply as DO, which stands for data only, not data optimized as the marketing folks will tell you. The deployment of DO requires a dedicated CDMA channel for the high speed data, while keeping the cdma2000 voice and other services available on the original channels. The interaction of the DO and cdma2000 systems, the mobile station (MS), and the services split between two frequencies is called hybrid mode.

This paper explains how mobile stations operate in hybrid mode and identifies hybrid mode functions that have added complexity to testing MSs. The later part of this document details how Agilent solutions can be used to ensure conformance of hybrid mode devices.

## Do Operation Overview



**Figure 1: Communication concept of hybrid mode devices.**

As Figure 1 illustrates, a hybrid mode device monitors cdma2000 and DO data channels separately. For DO, typical data speeds run at several hundred kilobits per second, with a peak rate of 2.5 Mb/s. While Figure 1 shows two cells, hybrid mode really only requires one cell operating with at least two frequencies.

When the MS is receiving data on the DO link, it is in constant communication with the serving cell. Every slot (1.67 ms), the MS sends a data rate control message (DRC) to the cell with a request of one of the available data rates. If the cell initiates a new packet to that MS, it must be at that rate. If no DRC is received at the cell for a particular MS, no new data will be sent to that MS. This forms the basis of hybrid mode operation, which is done without any unique signaling.

While in a DO data link, the MS is still required to obey all connectivity rules on the cdma2000 system. It must listen to the paging channel at its assigned paging slot to see if there is a page on the cdma2000 system. Typical contents of a page message would be the delivery of a short message service (SMS) or starting the process that would assign a voice channel.

While in a DO data session, there are numerous variations on hybrid mode such as SMS, assignment to a traffic channel, and transfer of the data carrying network from DO to cdma2000. All of these involve services available on the cdma2000 network, which will either stall the data transfer on DO or move the data transfer itself to the cdma2000 network. These types of variations add complexity to testing hybrid functionality on MSs.

# Hybrid Mobile Operations

The MS must be programmed for hybrid operation. It must have correct channels and SID in its preferred roaming list (PRL) for both systems. Also, it must be set to operate with mobile IP if it is desirable to test the transfer of the data link from DO to cdma2000.

## Turn on

When first turned on, the MS cycles through the following steps:

- It searches for cdma2000 service according to its PRL and will register on the strongest serving cell.
- It searches for a DO system consistent with its PRL and opens a session on the cell with the strongest signal.
- It enters dual idle state where it is available for either system, but active on neither.

There is no unique signaling that identifies that a hybrid device is talking to either network.

It should be mentioned that the normal system synchronization of system time of all cdma2000 services – including DO – is a requirement for hybrid operation. Once the MS has found either cdma2000 or DO service, it will only look for the other system within a tight time window of system time. This places a requirement on the test equipment that will be used to emulate hybrid mode: both must have the same system time within tight limits, typically a few microseconds.

There is the possibility that the normally assigned timing for cdma2000 paging slots and DO control channel cycle could occur at the same time, which is a conflict. To prevent this, the DO network must allow the MS to negotiate its control channel cycle, as only the MS knows that the timing conflict may exist.

## Dual idle state

While in the dual idle state, the MS

- Monitors the DO network for packet data connections on its negotiated control channel cycle
- Monitors the cdma2000 network for voice/SMS calls on its assigned slot cycle

## Voice call handling

To initiate a voice call, the MS will make a normal access to the cdma2000 system. Once assigned to a traffic channel, the MS will not read any data on the DO channel, and it cannot start any services on the DO channel until the cdma2000 traffic channel is released. Because of this structure, the DO link is subservient to the cdma2000 link.

## **Data call handling**

To initiate a data call from the dual idle state, the MS will open a connection on the DO system. It must still monitor the cdma2000 system on its programmed paging slots.

The MS will still monitor the paging channel on the cdma2000 system. If there is no MS directed page, the MS will return to DO and continue its packet data session. If there is a page, the MS will accept the cdma2000 service and stay connected to the cdma2000 system until the end of that call. Then it will return to the DO network and continue its packet session.

If service from the DO system is lost or is not available, the MS will initiate a packet data call on the cdma2000 system when a data connection is needed.

## **Hybrid data session handoffs**

There is no such thing as a hybrid mode handoff. A handoff is always system directed, and since no such structure exists, all activity is directed from the MS when in hybrid mode. The loss or degradation of a system will be the trigger that causes the MS to move its data session connection. When the MS loses a system while in an active packet data call, the following steps happen:

- The MS initiates a packet data call on the other system.
- The MS tries to re-connect the existing packet data connection.
- The PDSN routes its data connection to the new network with maintains the data connection to the MS.

This last step is the source of some complexity in hybrid emulation using test equipment. In a real network, the PDSN is higher up the network than the cells, and a common PDSN can support both cdma2000 and DO packet data calls. In test equipment, the entire network is emulated without external connection. So, each test set has its own PDSN, and the upper layer data links are not normally shared by two test sets. To get around this and allow continued data flow, it is necessary to structure the two test sets with an external PDSN. This is provided by the Mob-IP-Sim from Software Concepts, Inc.

## Configuring the 8960 Test Set to Test Hybrid MS

To test hybrid MSs, two separate E5515C test sets are required

- One unit running E6702B cdma2000 Lab Application revision B.03.05 or higher
- One unit running E6706A revision A.02.06 or higher

Combine the RF In/Out of the two test sets with a power splitter/combiner as shown in Figure 2 and Figure 3. Use either a resistive combiner or a transformer combiner.

Connect the network ports of two units either to a live network, or to a local hub (recommended).

Time synchronization:

- Define one of the test sets (either one) as the server, and the other is the client.
- Connect 10 MHz out of the server to 10 MHz in on the client.
- Connect trigger out of the server to trigger in on the client. This signal is the even second clock.

On the client, select **CDMA System Time/Sync Info**, then enter the IP address of the server, and press **Sync to External Server**. The Agilent star will flash in the lower right corner of the screen for a few seconds, and the Operation Complete message will appear. In the lower annunciator fields, the server will show S OPC, for server operation complete. The client will show C OPC, for client operation complete.

The location of the **CDMA System Time/Sync Info** key is slightly different on the cdma2000 application than the DO application. If the client is cdma2000, press **Call Control, Cell Info**, then **CDMA System Time/Sync**. If the client is DO, press **Call Control**, go to the second set of soft buttons on the left of the display, select **AN Info**. Go to the second set of buttons on the left, and choose **CDMA System Time/Sync**.

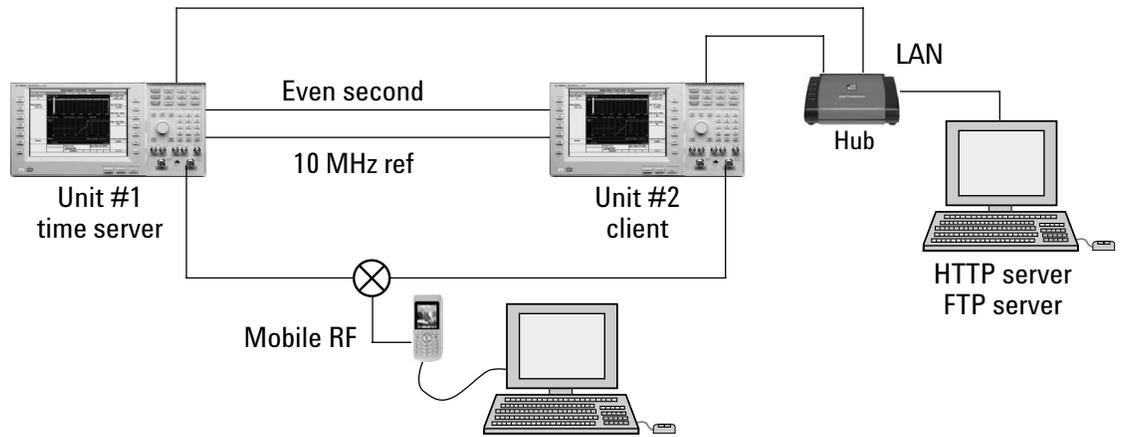


Figure 2. Setup for HTTP IP server, no external PDSN

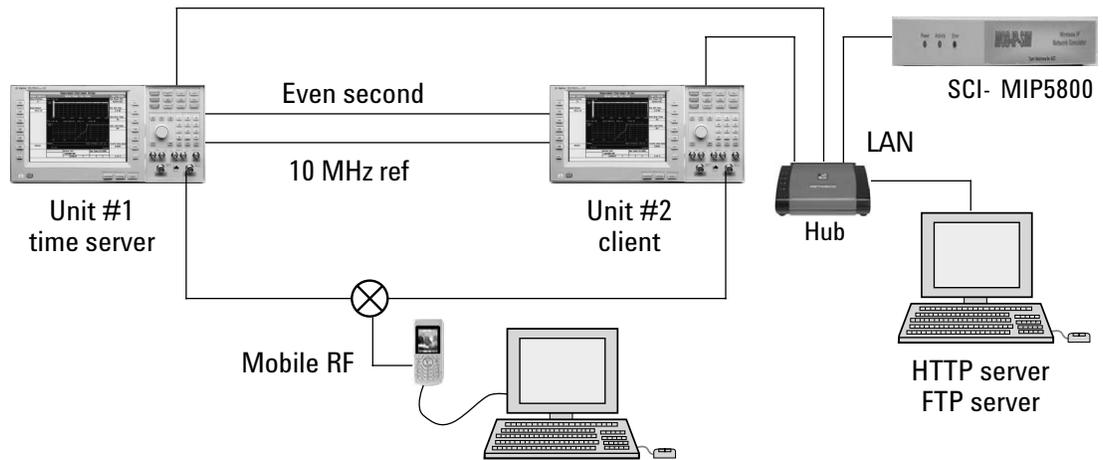


Figure 3. Setup with mobile IP simulator to provide external PDSN

## Hybrid Mode Tests

Three hybrid mode variations can be simulated with the use of two 8960s: assignment to a traffic channel, transfer of the data carrying network from DO to cdma2000, and SMS.

### Assignment to a traffic channel

The traffic channel assignment may be any service that the 8960 supports, which includes voice, loopback, and SMS (on the traffic channel or the control channel). To test channel assignment functionality of a MSs, set the level of both test sets (which are emulating cells) equal and at high power, such as -45 dBm. Turn on the MS, and give it time to see both systems. After about 20 seconds, it should register on the cdma2000 test set and create a session with the DO test set. The MS needs to be prompted to connect to DO. If this is a modem card for a PC, there will be a connection manager as part of the PC software that is used for this. On the server PC, start the FTP server or the HTTP server, or both. On the browser PC, connected to the MS, open a Web page or start a FTP file transfer. If using the browser, enter the IP address of the server to find the home page of the HTTP server. Initiate file transfer of a large file.

Watch the throughput monitor of the DO test set. It will show the data transfer. If the MS is in hybrid mode, you will see the dropouts in the flow of data that occur each time the MS leaves the DO channel to switch to the cdma2000 channel to monitor its paging slot. These dropouts will typically occur every 5.12 ms, which is the cdma2000 slot cycle. If you set the X-axis (time) of the throughput monitor to 61 seconds, the dropouts will occur approximately with the interval of one division.

While data is being sent over the DO link, initiate a S055 call (loopback) from the cdma2000 test set. The DO data will stall, and a cdma2000 link will be made. End this call quickly, and the DO data will pick up quickly. Do this again, but let the DO system time out, displaying an error message. When the cdma2000 call is ended, the DO session will re-start, but with a modest delay. There is some inconsistency on this restart; sometimes the same phone works, and sometimes it won't. If the data transfer doesn't restart after 10 to 20 seconds, refresh the browser window. This is application dependent.

## **Transfer of the data carrying network from DO to cdma2000**

The transfer of the data channel is initiated by the MS if the DO link becomes impaired while the cdma2000 link remains good. This can happen in real systems when a mobile MS is leaving a DO coverage region. It is highly desirable for the system to continue with data delivery without any action from the user.

To see the device switch from sending DO data to cdma2000 data if the DO link is impaired, set the cdma2000 test set to S033, so that it will accept the incoming data request. While data is transferring from the DO test set to the MS, turn off the DO link cell power. In a few seconds, there will be an access probe on the cdma2000 test set, and a data link will be established. If this is done with simple IP, the data will not transfer as the PDSN in the cdma2000 test set is different from the one that was serving data on the DO test set. If the mobile IP simulator is included in the setup, the data transfer will continue using the cdma2000 link. We generally turn off the DO cell, but the conditions where the DO device will initiate the cdma2000 data call are specifically programmed into the MS, and the level where the switch occurs can be precisely determined by raising the AWGN level relative to the cell and seeing where the MS transitions to cdma2000.

## **Sending SMS**

Another demonstration of hybrid mode is to send SMS to the MS. Most of our DO devices don't actually show the SMS, but we can see that the message was acknowledged by the MS. On the SMS screen on the cdma2000 test set, press the Clear SMS Info/Status key. Then send the SMS. The words "MS Ack" will show that the message was received by the MS from the cdma2000 cell. There will be a slight gap in the DO throughput as you send the SMS.

## **Conclusion**

Hybrid mode allows end-users to do more with their MS. To ensure these devices can efficiently use cdma2000 and 1xEV-DO technologies, and timely transition between the two platforms, it is essential that hybrid mode user equipment be tested. Agilent provides industry-standard solutions for performing this type of verification.

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