The CDMA2000® 1xEV-DO mobile radio standard is gaining in importance worldwide; the first networks using the enhanced CDMA2000® 1xEV-DO Rev. A variant were already put into commercial use in the second half of 2006. With a new signaling option, the R&S® CMU200 covers all test scenarios relevant in the development and production of 1xEV-DO access terminals, thus presenting an all-in-one test solution for both CDMA2000® 1x and 1xEV-DO. It is already preconfigured to handle 1xEV-DO Rev. A.

CDMA2000® widely in use

The CDMA2000® 1xEV-DO standard has evolved from the well-known CDMA2000® 1x 3G mobile radio standard, which is not only widely used in North and South America and Asia but is also becoming increasingly important in Eastern Europe in the 450 MHz band. There are over 275 million subscribers using CDMA2000® (1x and 1xEV-DO) worldwide.

1xEV-DO Rel. 0 supports data rates up to 153.6 kbit/s in the reverse link (from the mobile station to the base station). Unlike CDMA2000® 1x, EV-DO uses a time division multiple access method.

Attractive upgrade path for network operators

The spectral characteristics have not changed with respect to CDMA2000® 1x, which enables in-band migration. The protocol stack, however, is completely different from that of CDMA2000®.

This makes the upgrade path very attractive for network operators, since the measures necessary to modify the radio access network (RAN) are more or less reduced to exchanging a channel card. Network operators, therefore, are installing hybrid mobile radio networks that support both CDMA2000® 1x and CDMA2000® 1x EV-DO, which allows them to optimize the capacity for voice connections while at the same time offering modern, profitable data services.

EV-DO Rel. 0 supports data rates up to 2.4 Mbit/s in the forward link (from the base station to the mobile station) and 153.6 kbit/s in the reverse link (from the mobile station to the base station). Unlike CDMA2000® 1x, EV-DO uses a time division multiple access method.

EV-DO Rev. A supports data rates up to 4.1 Mbit/s in the forward link (from the base station to the mobile station) and 1.8 Mbit/s in the reverse link (from the mobile station to the base station). Downward-compatible with Rel. 0 QoS, VoIP, Multicast. Commercial introduction in 2nd half of 2006.

EV-DO Rev. B supports data rates up to 46.5 Mbit/s in the forward link (from the base station to the mobile station) and 27 Mbit/s at 20 MHz bandwidth. Downward-compatible with Rel. 0 and Rev. A. With 64QAM, up to 73.5 Mbit/s in forward link at 20 MHz bandwidth.
Similar to HSDPA, EV-DO employs hybrid ARQ (automatic repeat request), higher-order modulation modes (up to 16QAM), adaptive modulation and coding as well as receiver diversity.

EV-DO Revision A (TIA-856-A) is the first stage in a series of planned upgrades of the EV-DO standard (FIG 1). Revision A increases capacity in the forward link, supports realtime applications and quality of service (QoS), and provides substantial improvements for the reverse link (FIG 2). The main differences between EV-DO Release 0 and the new Revision A are:

- Improvements to reverse link (regarding peak data rate and sector throughput)
- Improved QoS mechanisms
- Expanded broadcast / multicast applications

Improved adaptation of the data packet size to the data rate as well as the introduction of new packet types have boosted the peak data rate in the forward link from 2.4 Mbit/s (Release 0) to 3.1 Mbit/s and in the reverse link from 153 kbit/s (Release 0) to 1.8 Mbit/s. With these characteristics, EV-DO Rev. A offers performance comparable to that of the HSUPA (high speed uplink packet access) technology, which is an expansion of the WCDMA standard. The first EV-DO Rev. A networks were put into commercial use in the second half of 2006. With the introduction of EV-DO Rev. A and a number of improvements to the core network, operators can now offer voice over Internet protocol (VoIP) services as well as videotelephony and video conferences with several subscribers.

<table>
<thead>
<tr>
<th>Forward link</th>
<th>Reverse link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shorter data packets for applications with lower data rates and short latency (e.g. VoIP, gaming)</td>
<td>Higher-order modulation modes (QPSK, 8PSK) for higher data rates</td>
</tr>
<tr>
<td>Larger data packets for data rates up to 3.072 Mbit/s</td>
<td>Multicode reverse transmission – a 1xEV-DO mobile station (access terminal) can transmit on multiple code channels</td>
</tr>
<tr>
<td>Nearly twice as many active subscribers</td>
<td>Optional reverse auxiliary pilot – additional pilot channel for high data rates and multicode transmission</td>
</tr>
<tr>
<td>Additional data packet types and rates for the control channel</td>
<td>Reverse hybrid ARQ for more efficient use of available capacity and transmission link</td>
</tr>
<tr>
<td>Additional MAC channel (ARQ) to support reverse hybrid ARQ</td>
<td>Enhanced access channel</td>
</tr>
<tr>
<td>Multicast data packets – sub packets for various subscribers are included in a larger data packet</td>
<td>MAC layer ARQ – handles the detection of missing data packets and retransmission</td>
</tr>
<tr>
<td>Broadcast channel</td>
<td></td>
</tr>
</tbody>
</table>

**FIG 2  New features in the physical / MAC layer for CDMA2000® 1xEV-DO Rev. A.**

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**Options for the R&S®CMU200 for CDMA2000® 1xEV-DO signaling**

1xEV-DO signaling for the R&S®CMU200 is based on the optional R&S®CMU-B83 (Var. 22) CDMA2000® signaling unit. To upgrade the mobile radio tester to include full 1xEV-DO functionality, the following options are required:

- **R&S®CMU-B83 (Var. 22)**
- **R&S®CMU-B89**
- **R&S®CMU-B87**
- **R&S®CMU-K839**
- **R&S®CMU-K849**
- **R&S®CMU-K859**
- **R&S®CMU-K869**

The **R&S®CMU-U83 (Var. 22) option** is a favorably priced upgrade for instruments already equipped with the previous version, i.e. Var. 12, of the R&S®CMU-B83 CDMA2000® signaling unit. The R&S®CMU-U83 (Var. 22) is required for the R&S®CMU-B89 1xEV-DO signaling module.

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Rohde & Schwarz has therefore systematically expanded its R&S®CMU200 product portfolio to offer complete EV-DO signaling in addition to the well-established test solution optimized for production applications. The EV-DO functionality will be expanded step by step to include EV DO Rev. A functionality. The R&S®CMU200 supports all currently defined band classes, including the extended IMT 2000 band classes and the various expansions and modifications of the 450 MHz band. The comprehensive set of parameters is easy to configure, and the setup menu is organized in accordance with the layer structuring of the EV-DO protocol stack (FIG 3). The R&S®CMU200 supports several connection types, e.g. forward / reverse test application protocol (FTAP / RTAP), default signaling application, and default packet application. The EV-DO option for the R&S®CMU200 not only offers all required transmitter measurements, including modulation, fast spectrum measurement, code domain power, and various types of power measurements (FIG 4), but also comprehensive receiver measurements based on FTAP / RTAP connections (FIG 5), including the following:

- Statistical overview – all FTAP / RTAP-based measurements at a glance
- Control channel PER, forward / reverse link PER
- Reverse link quality
- Forward / reverse link performance

Separate receiver and transmitter measurements

Using FTAP- and RTAP-based measurements, the quality of the receiver and the transmitter of a DUT can be tested separately, i.e. without the receiver and transmitter mutually influencing each other.
Wide variety of applications

The EV-DO option provides the basis for extensive end-to-end data test applications (support of simple / mobile IP). Using the default packet application, the R&S®CMU200 can operate as a host for an incoming dial-up IP connection. If the R&S®CMU-B87 option is installed, an external server can be used as a data source for end-to-end tests.

In conjunction with a baseband fading simulator from Rohde & Schwarz, more accurate and cost-effective solutions can be implemented than by using an RF fader.

Summary

With the CDMA2000® 1xEV-DO option, the R&S®CMU200 hardware and software concept proves its flexibility now also for the 3GPP2 technologies. The R&S®CMU200 is thus optimally prepared to handle the new 1xEV-DO Rev. A evolution of the CDMA2000® family of standards.

Robert Macketanz; Thomas Rösner

R&S®CMU200 Universal Radio Communication Tester

Blazing trails with voice codecs:
GSM-8PSK-AMR and WB-AMR

GSM-8PSK-AMR

The adaptive multirate (AMR) voice codec has established itself as a standard, since it allows data rate and error protection to be dynamically adapted to connection quality. The R&S®CMU200 provided the necessary measurement equipment for this right from the start[1]. Currently eight full-rate and six half-rate voice codecs are specified for GSM-AMR. Half rate is used to reduce network load in the short term, for example during large-scale events such as the Soccer World Cup, when many subscribers within one cell want to make calls at the same time.

A major disadvantage of the AMR half-rate voice codec is that up to now only the data rates from 4.75 kbit/s to 7.95 kbit/s can be used with it (FIG 1); however, the best voice quality is achieved at 12.2 kbit/s. This disadvan-