Universal Radio Communication Tester R&S CMU 200

CDMA2000 – a new challenge for 3G mobile radio testers

The CDMA world is facing its next decisive step: the introduction of CDMA2000 1X, handling packet data rates of up to 307.2 kbit/s. The future-oriented measurement platform Universal Radio Communication Tester R&S CMU 200 also supports this third-generation mobile radio standard.

The CDMA2000 market

Since the launch of the first commercial cdmaOne network in Hong Kong in September 1995, CDMA has established itself worldwide as a mobile radio standard. It has advanced triumphantly far beyond the USA, its country of origin, Korea and Japan. With rocketing growth rates, CDMA ranks besides GSM as a major digital standard of the second generation. Now the CDMA world is entering a new and decisive phase, the introduction of CDMA2000 1X, which is capable of working with packet data rates of up to 307.2 kbit/s.

In recent years, cdmaOne has expanded tremendously fast. In April 1998, there were around ten million subscribers worldwide, but now more than 100 million customers make their calls through CDMA networks (FIG 1). This development is remarkable in as much as GSM had already established itself worldwide as the de facto standard.

Asia paved the way for this enormous growth, headed by South Korea, which placed all its bets on cdmaOne. Japan also became an important CDMA bastion. KDDI, the only cdmaOne network operator in Japan, can boast more than ten million subscribers and a market share of about 20 %, making it serious competition for the market leader NTT DoCoMo. While the market in Korea and Japan is almost saturated, the highest growth rates have lately come from North and South America, and a large market is emerging in China. The network operator China Unicom is presently setting up a cdmaOne / CDMA2000 network, with capacity expected to serve some 50 million subscribers by the year 2005.

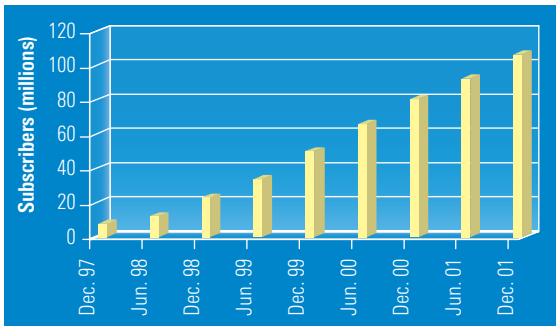
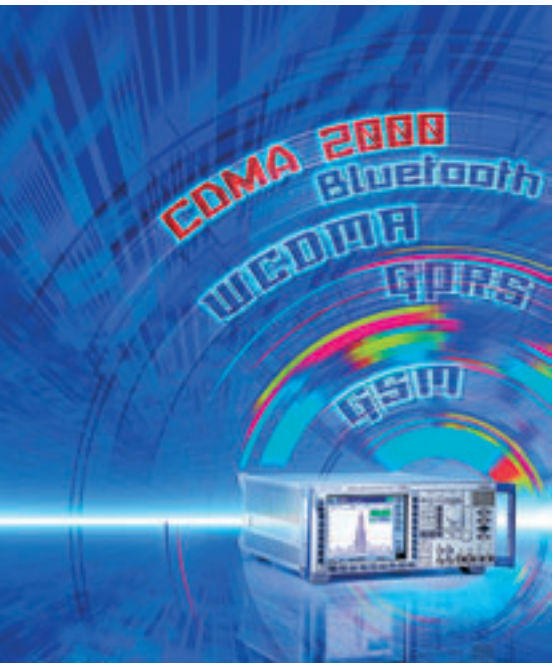


FIG 1 Development of cdmaOne / CDMA2000 subscriber figures

CDMA2000 is the logical successor to cdmaOne. Since cdmaOne is a subset of the IS 2000 standard, operators can easily upgrade their networks without losing functionality. CDMA2000 base stations are capable of communicating with cdmaOne phones and CDMA2000 phones can do the same with a cdmaOne base station. It is understandable that almost all cdmaOne network operators plan to offer additional services based on CDMA2000.

Photo 43 238/16



Further articles on the R&S CMU 200 can be found on pages 9 and 12 of this edition.

As was the case with cdmaOne, Korea again led the way and SK Telecom was the first to put a CDMA2000 network into operation in October 2000. Most cdmaOne network operators plan to put their CDMA2000 networks on the air by the beginning of 2002 (FIG 2). First networks are also planned in Eastern Europe (Romania, Moscow, Saint Petersburg) in the 450 MHz band, which became vacant a short time ago.

Producers of CDMA mobile radio equipment need a platform that offers high accuracy and speed as well as multimode capabilities. Just in time for the introduction of CDMA2000 in North America, the future-oriented measurement platform R&S CMU 200 is now also able to support this third-generation mobile radio standard.

Characteristics of forward link

The individual physical channels are distinguished by means of orthogonal Walsh codes (FIG 3). Codes of different length are used to obtain different data rates from a constant chip rate for the actual information bits. Convolutional coders are used for conventional voice and data services, and turbo coders for the high data rates of the supplemental channels.

If the number of Walsh codes is no longer sufficient because the orthogonal vector space is exhausted, channel separation can be continued with the aid of non-orthogonal functions. Quasi-orthogonal functions (QOFs) are created by masking existing Walsh codes. The frame lengths for signalling and user informa- ▶

FIG 2 Most CDMA2000 networks will go into operation by early 2002.

Country	Operator	Test / start
Australia	Telstra	Test 3rd quarter/2000
Brazil	Global Telecom	Start 4th quarter/2001
Brazil	Telesp Celular	Start 4th quarter/2001
Brazil	Vesper	Start 4th quarter/2001
Canada	Bell Mobility	Start 4th quarter/2001
Canada	Telus Mobility	Test 3rd quarter/2000
Chile	SmartCom PCS	Start 1st half/2002
Japan	KDDI	Start 1st half/2002
Korea	KT Freetel	In operation
Korea	LG Telecom	In operation
Korea	SK Telecom	In operation
Mexico	Pegaso PCS	Start 4th quarter/2001
New Zealand	Telecom Mobile Limited	Start 4th quarter/2001
Ukraine	CST Invest Limited	Start 1st quarter/2002
USA	AirGate PCS	Start 1st quarter/2002
USA	Alamosa PCS	Start 1st quarter/2002
USA	ALLTEL Communications	Start 2nd half/2001
USA	Horizon PCS	Start 3rd quarter/2002
USA	Sprint PCS	Start 4th quarter/2001
USA	Verizon Wireless	Start 2nd half/2001
Venezuela	Telcel	Test 1st half/2001
Vietnam	Saigon Postel	Start 2nd half/2001

CDMA2000 overview

CDMA2000 is a follow-on development of the established TIA/EIA 95 A/B standard for second-generation mobile radio. The extensive backward compatibility of signalling and network characteristics considerably simplifies introduction. For instance, CDMA2000 islands can be implemented in the overlay of an existing cdmaOne network during a transition period. Basically, two introductory phases are distinguished for CDMA2000.

In the first step, CDMA2000 1X (1xRTT*) is implemented with a signal bandwidth of 1.25 MHz and a spreading rate (SR) of 1 (i.e. 1.2288 Mchip/s). This corresponds to the physical characteristics of cdmaOne. CDMA2000 1X offers more code channels (128 Walsh codes) on the forward link, the connection from the base station to the mobile station. In addition, fast power control is introduced also on the forward link. Packet data rates of up to 307.2 kbit/s for stationary and mobile applications can be handled; voice quality and capacity are almost doubled. CDMA2000 1X supports new antenna techniques such as spot beams for covering limited areas with high traffic volume for short periods.

In the subsequent phase, CDMA2000 3X (3xRTT) with an SR of 3 (3.6864 Mchip/s) offers three times the bandwidth of cdmaOne. Peak data rates of up to 2 Mbit/s allow true multimedia applications. A precise time schedule for the introduction of 3X is not yet available. Presently, the CDMA2000 1xEV-DO system is being promoted – a CDMA method developed by Qualcomm and optimized for data transmission.

* RTT: radio transmission technology

tion vary between 5 ms, 20 ms, 40 ms and 80 ms. Another specified possibility is that under certain conditions system capacity can be increased by splitting up the forward link signal to several transmit antennas (transmit diversity).

Characteristics of reverse link

In contrast to cdmaOne, the channels of a true CDMA2000 link are distinguished by different Walsh codes and split up in the complex baseband into the inphase (I) and the quadrature (Q) path. Different channels can be used depending on the quality of service (QoS) and physical channel characteristics (FIG 4). On the reverse link, a continuous pilot simplifies synchronization to the base station. Traffic data is transmitted in an independent fundamental channel (FCH) and in supplemental channels (SCHs) with separate power and targets for frame error rate (FER).

As on the forward link, convolutional coders are used for low-rate voice and data transmissions and turbo coders for the new, high data rates of the supplemental channels. A new feature is fast control of base station power by the mobile station (forward link power control).

Nine different radio configurations (RCs) on the forward link and six on the reverse link determine the different connection modes defined by the IS 2000 standard:

- RC1 and RC2 define cdmaOne connections for rate sets 1 and 2
- RC3 to RC5 on the forward link (RC3 and RC4 on the reverse link) define CDMA2000 connections for spreading rate 1 (CDMA2000 1X)
- RC6 to RC9 on the forward link (RC5 and RC6 on the reverse link) are reserved for CDMA2000 connections for spreading rate 3 (CDMA2000 3X)

Service options define possible connection modes and their parameters, e.g. the different speech modes (depending on the voice coder used), SMS, fax and other data links, or especially test loopbacks.

CDMA2000 operates worldwide in different frequency bands. Presently, the standard defines eleven different band classes, all of which are of course covered by the R&S CMU 200.

FIG 3 New physical channels on the forward link of CDMA2000

New forward link common channels for CDMA2000 mobile phones	
Pilot channels (PICH)	Permit transmit diversity (F-TDPICH, F-ATDPICH); support smart antenna applications (F-APICH)
Quick paging channel (QPCH)	Improved slotted mode, longer battery lifetime; Walsh codes W_{80}^{128}, W_{48}^{128}, W_{112}^{128}, reserved for F-QPCH
Common control channel (CCCH)	F-CCCH transmits mobile directed messages for CDMA2000 mobile phones
Broadcast channel (BCCH)	F-BCCH transmits broadcast and overhead messages (e.g. SMS)
Common power control channel (CPCCH), common assignment channel (CACH)	Used together with enhanced access channel procedures

New forward link dedicated channels for CDMA2000 mobile phones	
Forward fundamental channel (F-FCH)	Transmits signalling/user information for a specific mobile phone; each traffic channel may contain an F-FCH
Forward dedicated control channel (F-DCCH)	Transmits signalling information for a specific mobile phone; each traffic channel may contain an F-DCCH
Forward supplemental channel (F-SCH)	Transmits user information for a specific mobile phone; used for high data rates; each traffic channel may contain two F-SCHs
Power control subchannel	Used together with F-FCH or F-DCCH

CDMA2000 in R&S CMU 200

Implementation of the CDMA2000 1X standard in the R&S CMU 200 is based on the TIA/EIA specification IS 2000 Rev. 0. Like in all mobile radio networks supported by the R&S CMU 200, there is a distinction between signalling and non-signalling mode. All major network, base station and link parameters are clearly organized and configurable (FIG 5). The implementation of CDMA2000 in the R&S CMU 200 particularly takes into account all innovations of the IS 2000 standard.

For instance, the R&S CMU 200 also supports the quick paging channel (QPCH) used to extend battery lifetime. In addition to the normal configuration, it is possible to define in the test system whether or not the QPCH addresses the DUT. This ensures that the mobile phone observes the QPCH and not the normal pilot channel or the common control channel F-CCCH.

CDMA2000 measurements

The R&S CMU 200 supports common cdmaOne measurements such as standby/access probe power, sideband suppression, gated output power, open-loop time response, min./max. output power and receiver quality (frame error rate). In contrast to cdmaOne, a CDMA2000 mobile phone sends on different code channels, possibly with different data rates and levels. A signal of this complexity typically has a higher peak/average power ratio than a signal with only one channel as in cdmaOne. This calls for power amplifiers with a wider dynamic range. CDMA2000 alleviates this problem through the use of QPSK modulation with a peak-limited spreading function. The result is the hybrid phase shift keying (HPSK) modulation mode (FIG 6). Consequently, completely new modulation measurements and – new on the CDMA reverse link – a code domain power measurement are required (FIG 7).

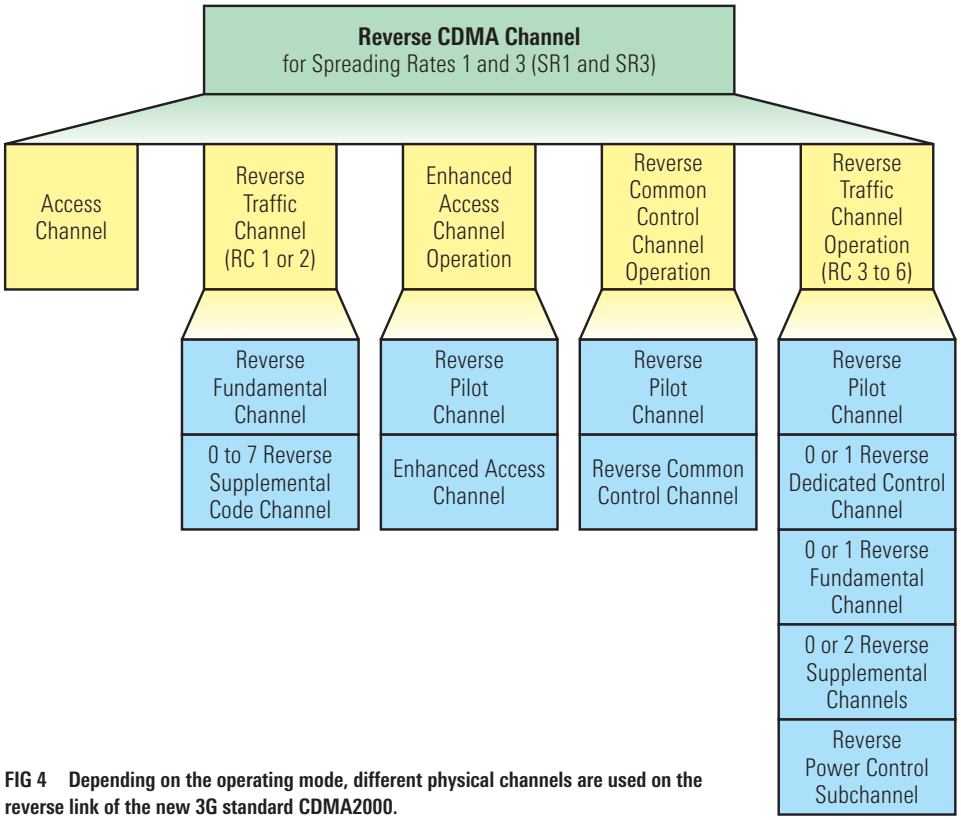


FIG 4 Depending on the operating mode, different physical channels are used on the reverse link of the new 3G standard CDMA2000.

FIG 5 All relevant base station, network and link parameters are clearly organized on the R&S CMU 200.

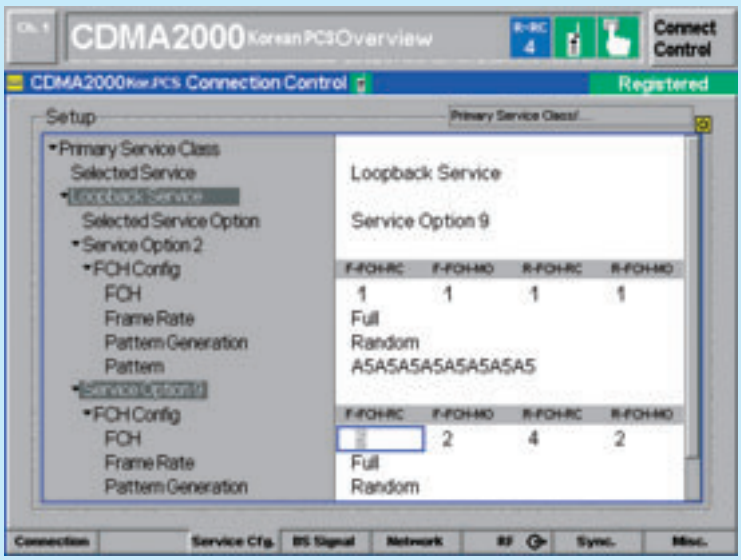
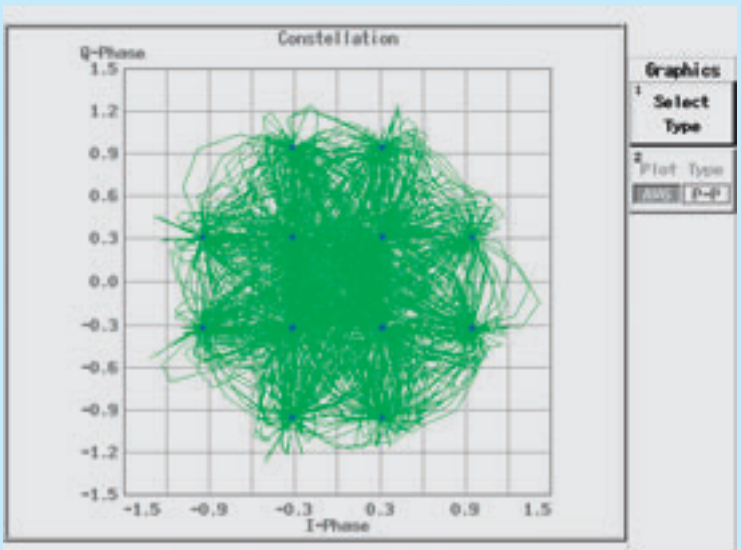


FIG 6 Constellation diagram of a CDMA2000 reverse link signal with F-PICH, F-FCH and one active F-SCH.



Another innovation, forward power control, enables the mobile station to control the output power of the base station in the dedicated channels. The R&S CMU 200 performs a comprehensive function check of this new CDMA2000 feature (FIG 8).

AMPS measurements

Especially in North America, mostly dual-mode CDMA mobile phones using AMPS (advanced mobile phone system) are sold. For this reason, the R&S CMU 200 also supports this analog standard of the first network generation. Its AMPS functionality boasts innovative concepts such as multitone measurement to check AF frequency response in the transmitter and receiver of the mobile phone.

R&S CMU 200 rises to the occasion

In terms of CDMA2000, the hardware and software concept of the R&S CMU 200 has again proven its great flexibility. The test system is now all set to go for measurements on future CDMA generations such as CDMA2000 1xEV-DO, etc.

Michael Altmann; Thomas Rösner

More information and data sheet at www.rohde-schwarz.com (search term: CMU 200)

Data sheet R&S CMU 200

REFERENCES

The Universal Radio Communication Tester R&S CMU 200 has continually been upgraded to keep pace with technical developments. There have been reports on the measurement capabilities and innovations of this state-of-the-art communication tester in almost every edition of this journal since the instrument was first introduced in News from Rohde&Schwarz No. 165 (1999). See REFERENCES on page 14.

FIG 7 The code domain power measurement verifies the correct level of the physical channels on the reverse link.

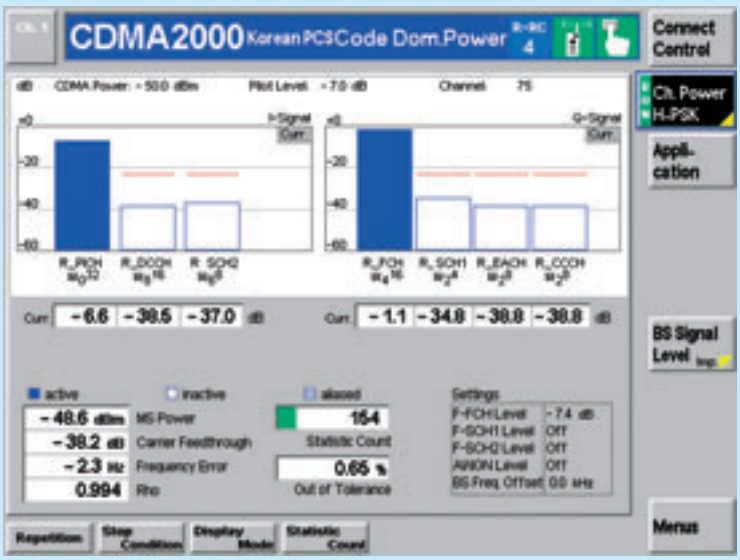


FIG 8 Forward power control measurement.