Test signals for the new CMMB and DVB-SH mobile TV systems

With the arrival of the new CMMB and DVB-SH standards, the next generation of mobile TV systems is just around the corner: hybrid terrestrial / satellite-based networks. To develop receivers for these standards, manufacturers of consumer electronics require appropriate test signals. Two new realtime coder options for the R&S®SFU broadcast test system from Rohde&Schwarz (FIG 1) now meet these requirements – as always, in high quality.

Hybrid terrestrial / satellite-based mobile TV

How many TV transmitters are needed to cover an entire country? The answer, of course, depends on a large number of factors, both technical and geographical. Only one thing is certain – there are many. And they cost a lot of money. An alternative is offered by satellite TV, which can illuminate a number of countries with a single transponder. However, there is also a drawback: The same programs will be broadcast in the entire coverage area, i.e. regional programs are not possible. Furthermore, satellite reception in the Ku band requires a directional antenna and a direct line-of-sight link to the satellite, which is hardly possible with mobile TV. What is required, therefore, is a technology for a mobile TV system that can cover an entire country at a reasonable cost and whose signals can be received by small antennas also

FIG 1 The R&S®SFU broadcast test system, the reference signal source for all major broadcast standards, also generates signals for the new CMMB and DVB-SH standards.

indoors. The solution is a hybrid terrestrial / satellite-based network like the one shown in FIG 2. A satellite transponder provides the umbrella cell and ensures nationwide coverage. In thinly populated rural areas, it is the only signal source. In cities and areas with poor satellite reception, terrestrial repeaters are used in addition to retransmit the satellite signal, which in particular improves indoor reception. The repeaters also make it possible to feed in regional programs. This principle is already being commercially utilized today in the USA's XM Radio™ and Sirius™ digital radio systems. Two new standards were recently developed for mobile TV: The Chinese CMMB (China mobile multimedia broadcasting) and the European DVB-SH (digital video broadcasting for satellite services to handheld devices).

CMMB in the UHF and S bands

The Chinese CMMB standard uses different frequency bands for the two transmission channels. The satellite downlink operates in the S band, the terrestrial repeaters in the UHF band. Since the range is larger in the UHF band, fewer transmitters are required than with a network in the S band. Receivers, however, become more complex, for with this concept they need a dual-band tuner. Program contents are coded into a multiplex and transmitted as a multiplex-frame transport stream, where three elementary streams (one each for video, audio and data) form a program. Depending on the data rate, multiple programs can be combined into a service. A CMMB multiplex can theoretically contain up to 39 services. Each service is assigned to a logical channel. The individual logical channels can be coded differently, giving each service individual error protection (FIG 3). For example, SDTV programs for basic coverage can be broadcast with strong error protection. In addition, an HDTV program can be transmitted in the same multiplex with high data rate and proportionately lower error protection. The error protection in the CMMB standard takes place in two stages: outer Reed-Solomon coding with four different code rates, and inner low-density parity check (LDPC) coding with two different code rates. At the RF, OFDM is used as the modulation type, with a 4K mode for 8 MHz channels and a 1K mode for 2 MHz channels (FIG 4).

CMMB trial operation during the Olympic Games

CMMB was tested in six cities in a pilot project during the Olympic Games in China. Seven TV and two audio programs were broadcast. According to the plans of the Chinese State Administration of Radio, Film and Television (SARFT), CMMB

Principle of a hybrid mobile TV system

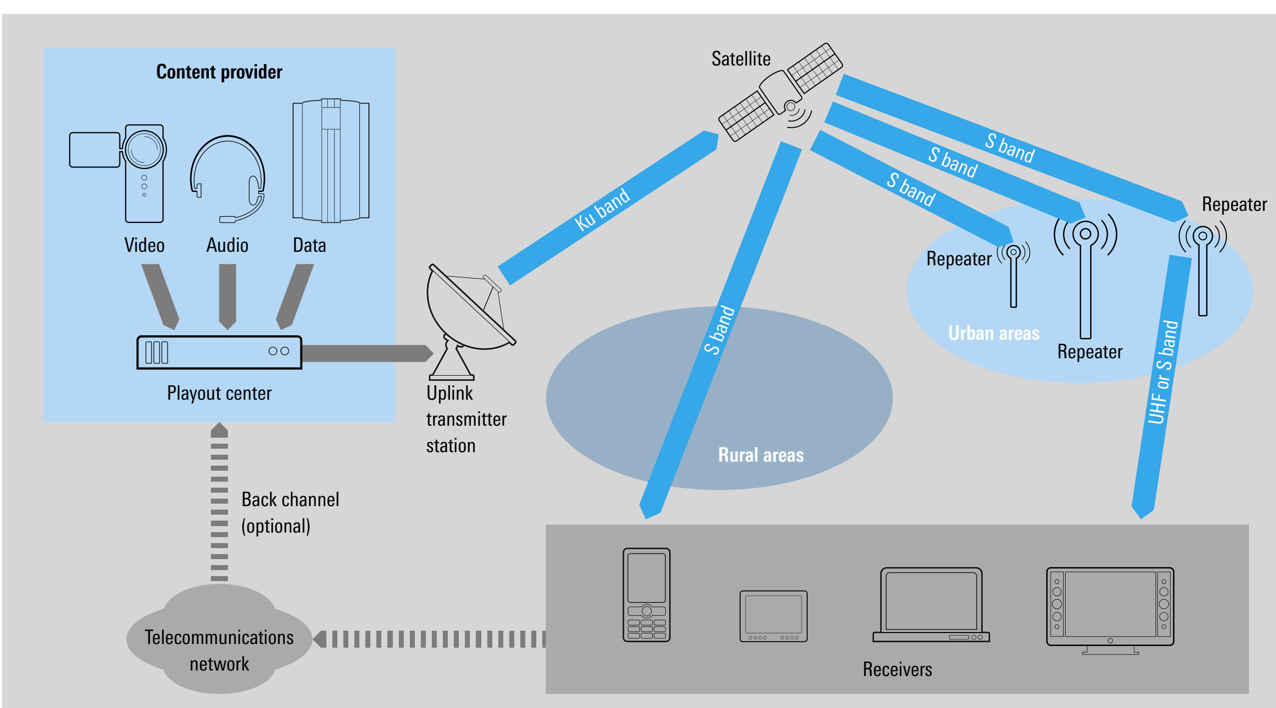

FIG 2 System architecture of a hybrid terrestrial / satellite-based network.

CMMB Physical Layer

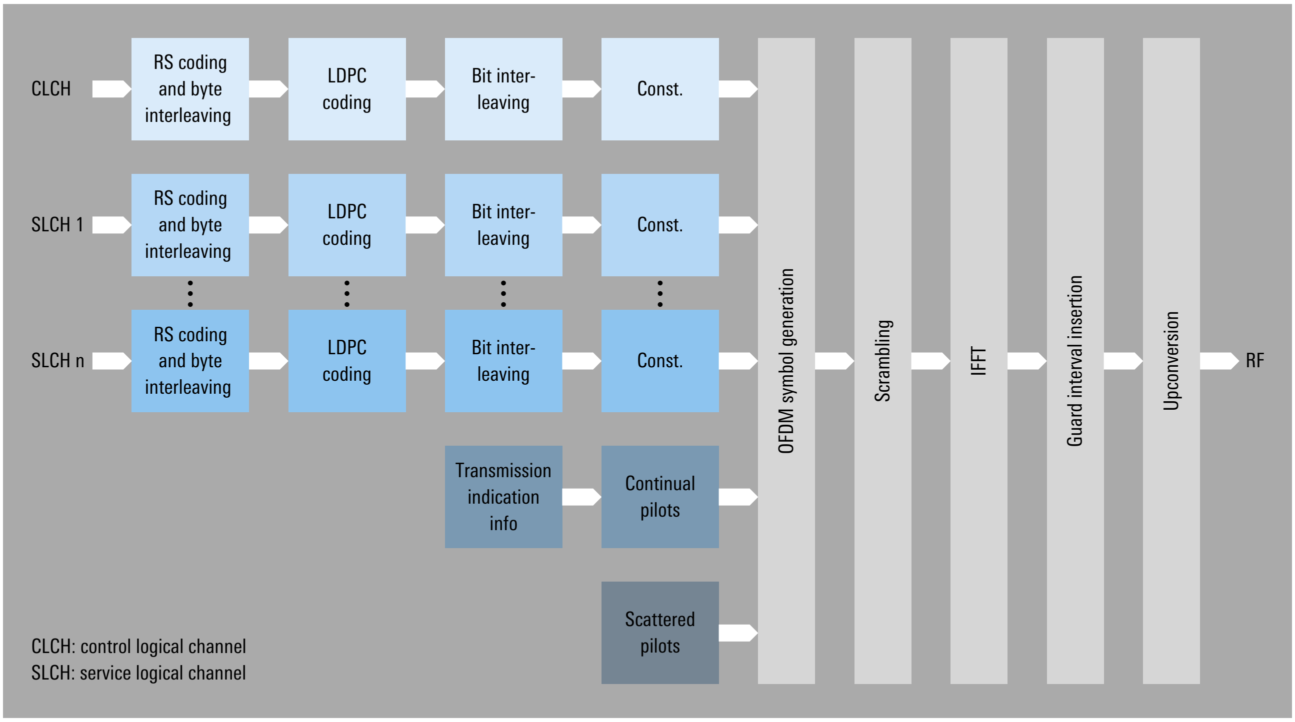

FIG 3 CMMB physical layer with logical channels.

is scheduled to be available in 200 cities by the end of 2008. Pilot operation is limited to only the terrestrial part of the network in the UHF band; a satellite is expected to be launched in the first quarter of 2009.

Similar yet different – the European DVB-SH standard

Although the concept is similar, the European DVB-SH standard differs from CMMB in several major aspects. In the case of DVB-SH, the network also consists of a satellite component (SC) and a complementary ground component (CGC). Unlike CMMB, however, the satellite component is the main component in DVB-SH and must be present in every network. In this way, DVB-SH ensures full coverage starting on day one. Both network components transmit in the S band, between 2170 MHz and 2200 MHz – a frequency range that the European Commission has allocated for operating mobile satellite systems (MSS).

Use of tried-and-tested technologies

The DVB-SH standard specifies two different operating modes. In the SH-A mode, both the satellite and the terrestrial repeaters transmit OFDM signals and can be operated as a single-frequency network. In the SH-B mode, the satellite transmits a time division multiplex (TDM) signal with single-carrier modulation. Using this type of modulation, the satellite transponder achieves higher efficiency. The terrestrial network uses OFDM also in the SH-B mode. DVB-SH specifies three types of terrestrial transmitters. *Simple repeaters* receive, amplify and retransmit the satellite signal, and serve primarily to improve reception indoors. *Transposers*, in contrast, decode

IFFT mode	4K	1K
Channel bandwidth	8 MHz	2 MHz
Signal bandwidth	7.512 MHz	1.536 MHz
OFDM carriers	4096	1024
Number of useful carriers	3076	628
Guard interval	1/8	
Constellation	BPSK, QPSK, 16QAM	

FIG 4 CMMB modulation parameters.

the receive signal and remodulate it before retransmitting it. *Mobile repeaters*, finally, are used to supply trains and buses with DVB-SH signals. Transposers and mobile repeaters can insert local content (e.g. regional programs, or advertisements and announcements in public transit vehicles) into the program. This is done either by replacing part of the received content or by superimposing local content onto the original signal by means of hierarchical modulation.

DVB-SH relies to a large extent on technologies that have already been tried and tested. For example, OFDM modulation is identical to that of DVB-H, except that a new 1K mode for 1.7 MHz channels has been added (FIG 5). The TDM technology is similar to that of DVB-S2 satellite TV. Baseband signal processing is largely the same as with DVB-H, allowing much of the DVB-H infrastructure to be taken over. However, DVB-SH adds an optional extended MPE FEC (multiprotocol encapsulation – forward error correction) with interleaving lengths of several seconds. This makes it possible to compensate slow fading effects occurring on the satellite downlink. And as with UMTS, turbo coding is used as error protection.

Pilot projects in Europe and the USA

The DVB-SH technology was successfully tested last year in an initial pilot project in southern France, where a helicopter hovering at a high altitude simulated the satellite. A pilot project in northern Italy is currently underway. Interest in DVB-SH is also growing outside of Europe. In April 2008, a private operator in the USA launched a satellite with which a pilot project is being run initially in the cities of Las Vegas and Raleigh. Later the service is to be offered nationwide.

Peter Lampel

	OFDM (SH-A and SH-B)				TDM (SH-B)
IFFT mode	8K	4K	2K	1K	–
Channel bandwidth	8 / 7 / 6 / 5 MHz			1.7 MHz	8 / 7 / 6 / 5 / 1.7 MHz
Signal bandwidth	7.61 / 6.65 / 5.70 / 4.75 MHz			1.52 MHz	roll-off 0.15 / 0.25 / 0.35
OFDM carriers	8192	4096	2048	1024	–
Number of useful carriers	6817	3409	1705	853	–
Guard interval	1/4, 1/8, 1/16, 1/32				–
Constellation	QPSK, 16QAM (α = 1), 16QAM (α ≠ 1)				QPSK, 8PSK, 16APSK

FIG 5 DVB-SH modulation parameters.

Realtime signal generation with the R&S®SFU

Since its market launch, the R&S®SFU broadcast test system (FIG 1) has firmly established itself in the consumer electronics industry as the reference signal source for digital and analog broadcast standards. Rohde&Schwarz is now expanding the package of transmission standards for the R&S®SFU by adding two new coder options for realtime signal generation for the CMMB and DVB-SH standards. The realtime coders accept video and audio data in the form of a transport stream, code the data and modulate the RF signal in accordance with the respective standard (FIG 6). In the case of CMMB, the coder detects the control information transmitted in the transport stream's MF0 frame and sets the coding for the individual services accordingly (FIG 7). This automatic setting is the main advantage of realtime coding as implemented in the broadcast signal generators from Rohde&Schwarz. Vector signal generators with arbitrary waveform functionality are unable to do this.

Simulating transmission channels realistically

In the development of CMMB and DVB-SH receivers, it is especially important to realistically simulate interference in the transmission channels. In hybrid terrestrial/satellite-based systems, the specific characteristics of both channels must be taken into account. During terrestrial transmission, interference is primarily due to multipath propagation; in the satellite channel, the greatest problem is the enormous attenuation. The R&S®SFU simulates these effects using a fading simulator and a wideband noise source. In addition, impulsive noise caused by electric appliances disturbs reception indoors. Plus, the phase noise of the satellite transponder diminishes the signal quality, especially that of TDM signals. Equipped with the impulsive noise option and the phase noise option, the R&S®SFU can simulate these effects, too. Last but not least, especially in the S band, reception may be disturbed by UMTS signals originating either from base stations or, in the case of 3G mobile TV phones, from the phone's own transceiver. Here, too, the R&S®SFU provides a solution: With its unique interferer management option, it simulates adjacent channel occupation without additional external equipment (FIG 8). The R&S®SFU broadcast test system therefore has what it takes to become, for the new CMMB and DVB-SH mobile TV standards, what it already is for today's broadcast standards: the reference signal source.

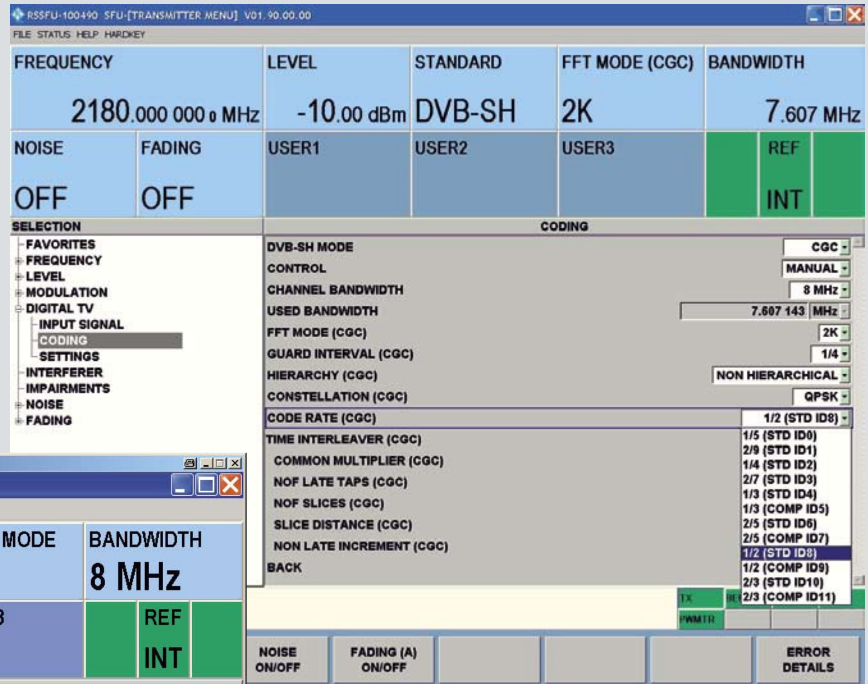

FIG 6 DVB-SH realtime coding with the R&S®SFU.

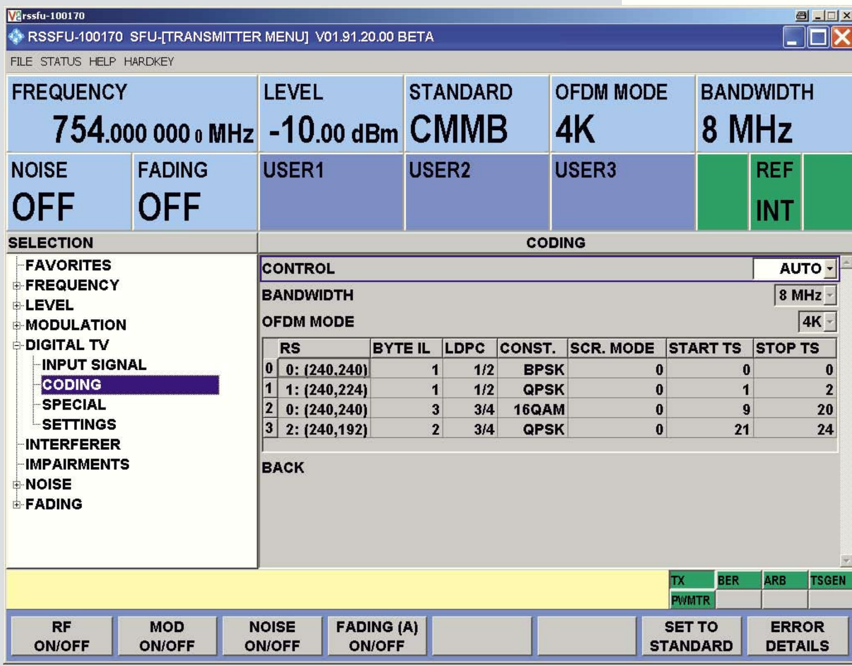

FIG 7 Automatic setting of coding parameters with CMMB.

FIG 8 Signal-generation and channel-simulation principle of the R&S®SFU.