Digital broadcasting and multimedia communication

In the past decades, classic broadcasting, namely sound and TV broadcasting, used to be a field of its own with specific developments, largely independent of the world of telecommunications and computers.

Sound broadcasting

Analog sound broadcasting, using amplitude modulation for longwave, shortwave and mediumwave and frequency modulation for VHF, more or less retained its principle of sound transmission over the past decades. The only innovation was the radio data system (RDS), which was specified in 1984 and then launched in Europe with differences in the information services provided from country to country. With its introduction in the United States as from 1994 and in many other non-European countries RDS became worldwide standard.

The compact disc, launched by Sony and Philips in 1985, was one of the events triggering off the revolution in sound broadcasting towards digital techniques. The CD created quality very close to that of a concert hall and added a further benefit in terms of simple and robust handling. The CD was of course a challenge to sound broadcasting to provide the same quality and performance features. This is when the demand for terrestrial propagation of digital audio broadcasts for mobile reception came up. From 1988 to 1992 the specification committee EUREKA 147 defined digital sound transmission with DAB (digital audio broadcasting) as a pure audio transmission system for mobile reception up to a vehicle speed of 160 km/h. Further applications covered by keywords such as “value-added service” and “data service” were added. The DAB channel can be considered as transparent point-to-area coverage for mobile reception and with an effective data capacity of about 1.2 Mbit/s. The introduction of DAB in Europe and many countries outside Europe should be completed by the turn of the millennium.

Television

The international TV standards PAL, SECAM and NTSC have practically been untouched up to the present day as far as the picture information is concerned. The developments made mainly had a program-supplementary character. Over the past ten years innovations were achieved on the basis of the given redundancy in the time- and frequency-related representation of the signal. In the mid-70s, for example, the teletext system was launched in different versions throughout Europe. Another digital TV service was added in the early 80s: the video program system (VPS) based on the TV data line ensuring program-synchronous recording by video recorders even in the event of program delays.

The change in TV picture transmission came about in the mid-80s in Europe with the compatible MAC (multiplex analog component) line. D2MAC is a combination of separately transmitted, compressed luminance and chrominance signals and a digital sound and data burst. An intermediate stage in the overall development is the analog PALplus method, which is compatible with PAL but specified for the new aspect ratio 16:9. Digitization in the picture area began in the TV studio with the specification of the 4:2:2 component standard (CCIR Rec. 601). As for transmission from the studio to the viewer, the future lies no doubt in digital video broadcasting (DVB), which is ready to be implemented in the media of satellite, cable and terrestrial transmissions. Toward the end of 1995, the European DVB project concluded the specification of channel coding and modulation for broadband digital TV channels.

With DVB the digital baseband signal is sent in compressed form according to the MPEG2 standard (Moving Picture Experts Group). Depending on the compression factor there are different quality levels and data rates: LDTV (limited definition TV with 1 to 1.5 Mbit/s), SDTV (standard definition with 4 to 6 Mbit/s), EDTV (enhanced definition with 11 Mbit/s), HDTV (high definition with 30 Mbit/s). The net data capacity of one or more video and/or audio sources is transmitted within a multiplex signal (transport stream, TS). DVB thus follows the container principle with
transparent transmission channels. Error protection for the transport stream is adapted to the physical medium by means of channel coding. The stipulated modulation modes are QPSK (quadrature phase shift keying) for satellite transmissions, 64QAM (quadrature amplitude modulation) for cable and OFDM (orthogonal frequency division and multiplexing) for terrestrial broadcasting. For the latter, the modulator in the terrestrial transmitter is followed by high-power amplifiers for the OFDM modulation signal. These amplifiers are preferably of solid-state design and feature high linearity.

### Multimedia

Parallel to the revolutionary developments in the field of broadcasting, a union of the worlds of audio/video, telecommunication and computer was started up last year for the consumer sector (FIG 1). “Multimedia” is synonymous for the convergence of the applications.

In this context the foremost feature is the **combination of devices in the home** such as desktop workstations, CD video, digital video cassettes, CD players and/or video cameras to form a kind of local area network (LAN). The second feature, which is **interactivity via a data channel**, can nowadays already be implemented via digital telecommunication media such as GSM/PCN (global system for mobile communications/personal communication network), ISDN (integrated services digital network) or Internet. Multimedia also implies a third feature, ie the broadband transmission of moving pictures, sound signals and data services. The classic broadcasting media using terrestrial, satellite and cable transmissions with SMATV (satellite master antenna TV) are utilized in the introductory phase. Further broadcasting media such as MMDS (multichannel microwave distribution system), BISDN (broadband ISDN) or IBCN (integrated broadband communications network) or ADSL (asymmetrical digital subscriber line) are being developed and made accessible for multimedia transmission. The interactivity potential is taken account of by an initially narrow-band back channel in the transmission medium.

The new multimedia world needs acceptance by the consumers of course. Therefore it must be introduced step by step. In the first step compatibility between the existing TV receiver and the new digital transmission technology will be established with the aid of the set-top box or the integrated receiver decoder (IRD). The set-top box has functions similar to a computer to establish the connections between the digital broadcasting medium and the conventional TV receiver, the PC and the telecommunications network, ie it is a multimedia switching center. Broadband transmission channels for multimedia are specified in the form of DAB and DVB-S (satellite), DVB-C (cable) and DVB-T (terrestrial) and their imple-
mentation is already in progress in some European countries.

The new digital transmission technologies bring decisive benefits for the consumer:

- low-cost receivers in a multimedia environment,
- good picture quality (SDTV) to high definition TV,
- large number of programs,
- portable reception of terrestrial TV programs,

as well as for the network operator:

- economical utilization of the resource frequency,
- flexible use of the transmission channel,
- reduction of investment, energy and service costs.

Therefore the implementation of the DAB and DVB standards is being strongly pushed ahead as shown by the following examples.

Implementation of DAB began in 1995 with the Bavarian pilot project as the first project worldwide using single-frequency operation on this scale. In addition to the channel-12 transmitters including DAB coder/decoder, Rohde & Schwarz supplied the complete infrastructure with audio baseband coding (MUSIC) and DAB multiplexer as well as program distribution via satellite. German Telekom recently started commissioning 60 DAB L-band transmitters for a national coverage network with Rohde & Schwarz as the main supplier.

Digital video broadcasting was started in mid-1996 via the SES-ASTRA satellite 1F, which was launched to its orbital position 19.2° east from the Baikonur (Kazakhstan) cosmodrome in April 1996. Another two ASTRA digital satellites are planned for 1997. Eutelsat, too, will take up digital television in 1997 via the Hot Bird satellites 4 and 5.

Broadband cable technology is optimally prepared for digital television with interactive communication: the hyperband originally intended for D2MAC transmission is now available. In addition, interactive capability in the form of the back channel is given in the range from 5 to 20 MHz. German Telekom has equipped its cable headends with modern digital systems for 64QAM modulation, frequency conversion and distribution by the end of 1996 and relies on well-proven Rohde & Schwarz technology [Fig. 2].

The next step will be the implementation of intelligent interactive headends with servers, billing and network monitoring as well as connection to public data networks.

Terrestrial digital video broadcasting will be started in the UK in 1997 with the programs of NTL and BBC. In Germany, DVB-T pilot projects in Berlin, Cologne and Munich are now in the planning stage. Since 1995, a DVB-T transmitter from Rohde & Schwarz has been tested by the Swiss PTT. This transmitter can be switched over to the emission of PAL signals for coverage comparisons.

The particular strength of Rohde & Schwarz in analog broadcasting will be continued in the new digital technology. We offer solutions in the form of units, systems, turnkey single-frequency networks, broadband communication systems as well as remotely controlled test and monitoring equipment for network operators. With its key products for digital broadcasting system and test equipment [Fig. 3 and 4], Rohde & Schwarz is right now best prepared to live up to its reputation as one of the world’s leading DAB/DVB suppliers and to master the quantum leap into the digital future of broadcasting and multimedia communication.

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REFERENCES


FIG 4 TV Test Receiver EFA with QAM measurement functions for DVB-C [4]