DVB with return channel via satellite

V. Paxal
Telenor R&D

For interactive purposes, the provision of a return channel via satellite is an attractive option. The DVB project has now drawn up the specification of such a return channel which is briefly outlined here.

Introduction

Telecommunication and broadcasting services today are showing an increasing tendency to provide for interactivity. Customers want to choose, sort, order, store and manipulate what they receive on their terminals and, ideally, they also want to interact from the same terminal. The distribution network is becoming an asymmetric interactive network, with a possible evolution towards fully-symmetric communication. This convergence between communication and broadcasting is leading to an evolution from broadcasting to multicasting or point-to-multipoint communication, where the difference lies in the possibility of offering content / services which are designed for individuals or groups of people with restricted access and billing. This evolution will also have consequences for satellite communications, which is certainly the most broadcast-oriented medium of all.

There are several ways of designing a return channel for satellite multicast services, and many people believe that terrestrial return channels are the most cost-effective and practical. Commonly-proposed terrestrial return channels include PSTN, ISDN and GSM. However, there is huge worldwide interest in defining a return channel via satellite, and there are several reasons for this. Firstly, as mentioned above, the "ordinary" consumer does not want to be bothered by technical set-ups which require interconnections between the TV, PC and telephone. A solution where all the technical equipment is concentrated within one box, and without having to worry about blocked telephone lines etc., will certainly be appealing to many people. Another reason for choosing satellite services to provide interactivity is the increasing traffic on the terrestrial networks, which often results in blocking or reduced quality of service. With efficient resource allocation for example, the instantly-available capacity on a satellite link can be set as high as

2 Mbit/s. At this bit-rate, a 100 Mbyte file will need just 7 minutes to transfer over a satellite circuit, whereas the time required over a 64 kbit/s terrestrial line will be about 3½ hours. Finally, there is an advantage, both for the users and the operators, that the forward and return channels are carried on the same medium. This enables better control of the QoS and the network management: terrestrial infrastructures are not always controlled by the same operator as for satellite, particularly when national borders are crossed.

The DVB-RCS specification

Due to the recognized need for a specification in this area, the DVB Technical Module (DVB-TM) created an ad hoc group in early 1999, called DVB-RCS (DVB – Return Channel via Satellite).

As with all other projects within DVB, the work in DVB-RCS is based on the Commercial Requirements (CR) issued by DVB-CM. Three user profiles were identified by the CM – the **prosumer**, the **corporate** and the **consumer**.

The early target will be the *prosumer* (the "professional consumer"), which is the name that has been fabricated for a user:

⇨ who requires broadband, high-quality services;

⇨ who has the financial capacity to invest in relatively costly niche-market equipment.

Typical prosumers are home offices, small media or graphical design offices, medical or educational centres.

The *corporate user* represents a larger group of users behind a single terminal, typically with a LAN connected to the RCST (RCS Terminal). The usage of the channel will tend towards more symmetrical behaviour, with the meshed network as the ultimate architecture.

The *consumer* will probably be the last profile to feel the need for, and be able to afford, this kind of equipment – but fast developments in technology, together with increased needs for capacity and enhanced services, make the consumer a realistic user of DVB-RCS in the future.

In addition to defining the three user profiles, the CR also gives the reference model and many specific requirements for the system. One of the requirements is that the DVB-RCS specification [2] shall resemble the other specifications as far as possible, in particular the DVB-S specification. The reason for this is the wish to provide a quick understanding of the specifications, to enable re-use of the technology and hence to reduce the time to market. The specification shall be frequency-independent. It shall enable reliable network- and user-security mechanisms, and will incorporate an efficient transport

layer. Interfaces with other infrastructures, such as PSTN, ISDN etc., shall be possible, and flexible terminals shall permit dynamic frequency allocation. The CR also describes the target bit-rates, services, bit error rates, prices and availability for each type of terminal. The DVB-RCS specification only aims at defining the network-independent layers – network management and the services offered are left for the network operators and service providers to define.

Fig. 1 gives the general DVB return-channel reference model. In this model, the interactive network is depicted as independent from the forward channel. Very often, however, the forward interaction channel, or forward signalling channel, is integrated in the forward transport stream (TS). This is also the case in the DVB-RCS specification, where the forward signalling is part of the DVB-S TS.

Fig. 2 shows a simplified diagram of a network architecture. Actually, the DVB-RCS reference model is far more complex than this, but the wish to indicate all possible network realisations may obscure the simplicity of the concept. Usually, several RCSTs will be connected to the interactive satellite network, consisting also of the satellite, an earthstation and a network control centre (NCC). In *Fig. 2*, the earthstation antenna acts both as a feeder for the forward path and as a gateway for the return path. The NCC shall handle the synchronization, give correction messages to the terminals and allocate resources.

One of the main challenges for the DVB-RCS group has been to specify inexpensive terminals. The CR indicates ex-factory prices of the order of €1000, €3000 and €50,000 for consumer, prosumer and corporate terminals, respectively. Cost limitations will also
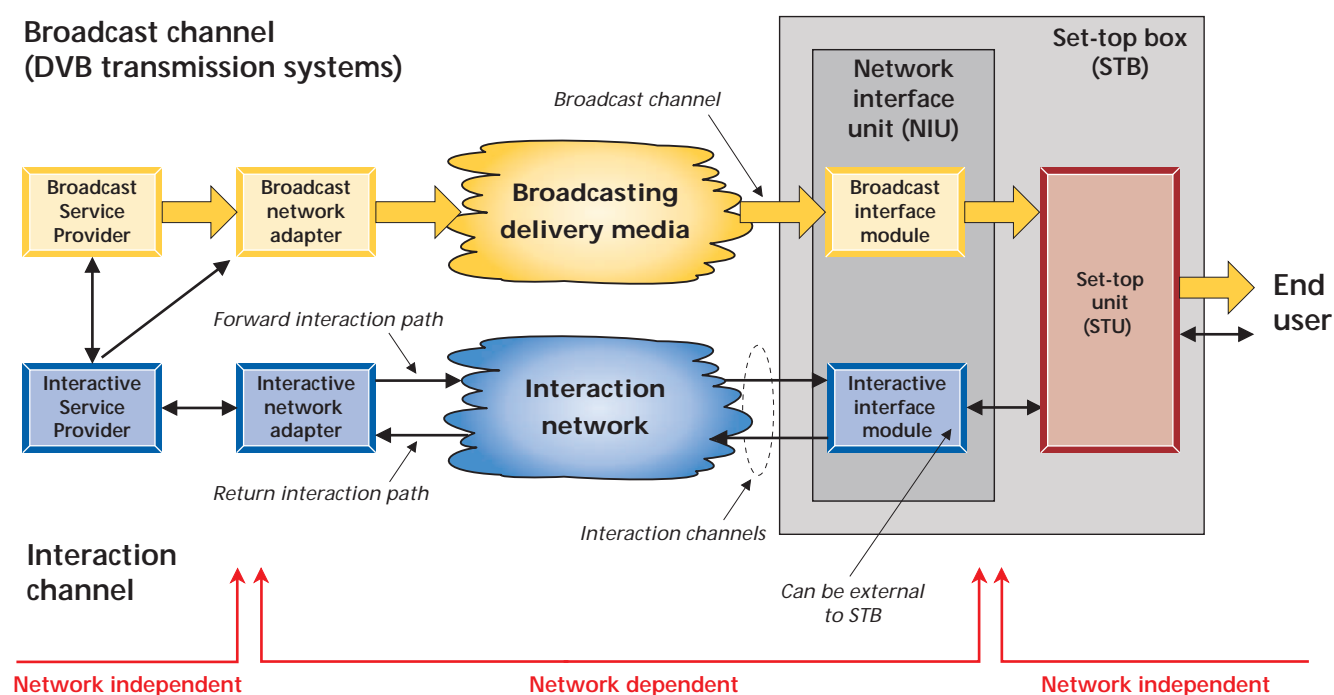

Figure 1
DVB's general reference model for interactive networks.

imply EIRP limitations and the possible use of suboptimal components such as nonlinear amplifiers. Of course, cost is not the only limiting factor for the EIRP; regulatory rules have to be respected as well. In addition, the satellite channel is noisy, and the use of a Ka-band transmission for the return channel may cause lesser-known effects of multipath fading. As soon as interactive services are considered, signal delays becomes a matter of concern with implications at several levels – ranging from synchronization and log-on algorithms to the delay perceived by the user after having made a request. This aspect highlights the need for efficient transport mechanisms, a need which has to be balanced against the contradicting need for flexibility. The NCC is in charge of the network control, which will include several RCSTs, but perhaps also several satellites, feeders, gateways and even several networks. The RCST network to be managed is a multipoint-to-point structure, far more complex to administrate than the opposite, the point-to-multipoint structure.

The NCC is thus in charge of the control of every RCST in the network, as well as the network as a whole. A terminal will log on after having received general information by "listening" to the forward link. The information given here is on the status of the net-
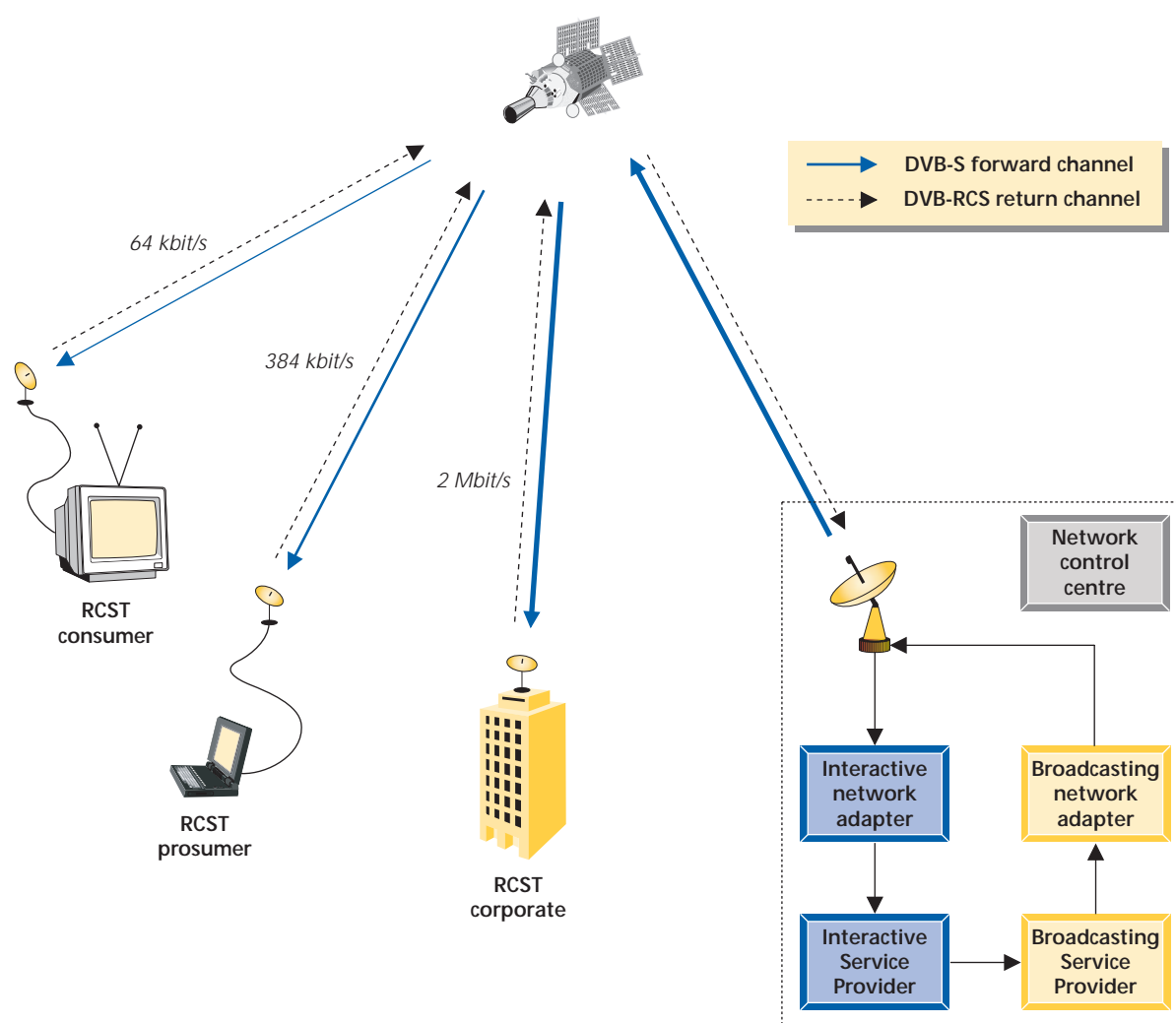

Figure 2
Simplified diagram of a network architecture for DVB-RCS systems.

work but, most importantly, the forward link provides the Network Clock Reference (NCR). When the RCST has obtained synchronization with the NCR, it will use one of the designated slots (indicated in the forward channel) to issue a log-on request, in a slotted-aloha manner. If the terminal is successful with this request, the NCC will forward various tables containing general network and terminal-specific information. The specific information is about the necessary frequency, timing and power-level corrections to be performed by the terminal before the transmission starts. These tables will also indicate the resources allocated for the terminal, and it is possible to ask for different services or increased capacity during transmission. The NCC has the possibility, with certain intervals, to correct the transmission parameters of the RCST and, if something goes wrong during transmission, the NCC shall also have the possibility of forcing log-off from the RCST. The continuous signalling from the NCC is provided according to MPEG-2 SI [3].

The DVB-RCS specification is restricted to the indoor unit, i.e. the signal processing between the source encoder and the IF conversion. The outdoor unit (the radio frequency part) will be specified by ETSI in [4]. The DVB-RCS physical layer contains the specification of timeslots and frames, organized in super-frames. The sequencing is controlled by means of the NCR, and the access method is MF-TDMA. Otherwise, the specification contains energy dispersion, two types of channel codes (concatenated Reed Solomon / convolutional coding and Turbo-codes), prefix emplacement, Nyquist filtering and QPSK modulation, most of which are well known from the DVB-S specification.

Abbreviations

CR	Commercial requirements
DVB	Digital Video Broadcasting
DVB-CM	DVB - Commercial Module
DVB-RCS	DVB - Return Channel via Satellite
DVB-S	DVB - Satellite
DVB-TM	DVB - Technical Module
DVB-TS	DVB - Transport Stream
EIRP	Effective isotropic radiated power
ETSI	European Telecommunication Standards Institute
GSM	Global system for mobile communications
ISDN	Integrated services digital network
ITU	International Telecommunication Union
LAN	Local area network
MF-TDMA	Multiple-frequency time-division multiple access
MPEG	Moving Picture Experts Group
NCC	Network control centre
NCR	Network clock reference
NIU	Network interface unit
PSTN	Public switched telephone network
QoS	Quality of service
QPSK	Quadrature (quaternary) phase-shift keying
RCST	Return-channel-via-satellite terminal
SI	(MPEG / DVB) Service Information
STB	Set-top box
STU	Set-top unit
TS	(MPEG / DVB) Transport Stream

Vendela Paxal received her *Maîtrise es Sciences* degree in physics from the Université d'Aix-Marseille III, Marseille, in 1988, her *Dipl. Eng.* degree in tele-communications engineering from the Ecole Nationale Supérieure de Télé-communications, Paris, in 1990 and ,finally, her *Dr Techn.* degree from the Norwegian University for Technical and Natural Sciences, Trondheim, in 1998.

From 1990 to 1995 Ms Paxal worked with the digital signal processing group in SAT/SAGEM, Paris, where her main interests were advanced mod-ulation and coding techniques. She designed ASICs for satellite and cable television receivers according to the DVB standards. In 1995, she joined the satellite and radio group at Telenor R&D, Oslo, where she has been involved in various system studies, mostly within European projects. In addition, she has been working in the DVB Ad-hoc group for standardization of the Return Channel via Satellite (DVB-RCS).

Conclusions

Many satellite operators have shown interest in the return-channel-via-satellite technology, and concrete plans now exist for operation of such services in the near future. The prosumer market has been evaluated to comprise several million users in Europe alone and, as soon as higher volumes of terminals are produced, reasonable prices for the consumer market can be expected.

The DVB-RCS specification has been treated and approved in the TM, the CM and the Steering Board of DVB, and was forwarded to ETSI for standardization in March 2000.

Bibliography

[1]   http://www.dvb.org/

[2]   DVB Blue Book A54, rev. 1.

[3]   ETS 300 421: **Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services**
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[4]   EN 301 459 V1.1.1 (1999-12) Draft: **Satellite Earth Stations and Systems (SES); Harmonised EN for Satellite Interactive Terminals (SIT) and Satellite User Terminals (SUT) transmitting towards satellites in geostationary orbit in the 29.5 to 30.0 GHz frequency bands covering essential requirements under article 3.2 of the R&TTE Directive**
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