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Abstract

This document describes some of the uses of hierarchical modulation in DVB-T. There is also a brief explanation of hierarchical modulation.

Key words: hierarchical, DVB-T

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Introduction

This document lists some possible uses of hierarchical modulation in both the changeover period and the digital-only world. It also explains briefly the modulation mode itself.

Explanation

The hierarchical modes of the DVB-T specification provide a means by which the MPEG-2 bitstream can be divided into two parts. One stream, the high priority (HP) stream, is heavily protected against noise and interference, whereas the second, low priority (LP), stream is much less well protected. The HP stream often carries data at a lower bit-rate than the LP stream.

The hierarchical modulation options are most easily illustrated by reference to constellation diagrams. Figure 1a shows the constellation of the data carriers of the DVB-T signal in the 64QAM mode. The pilot carriers have been omitted for clarity. Figure 1b shows the constellation for one of the hierarchical modes.

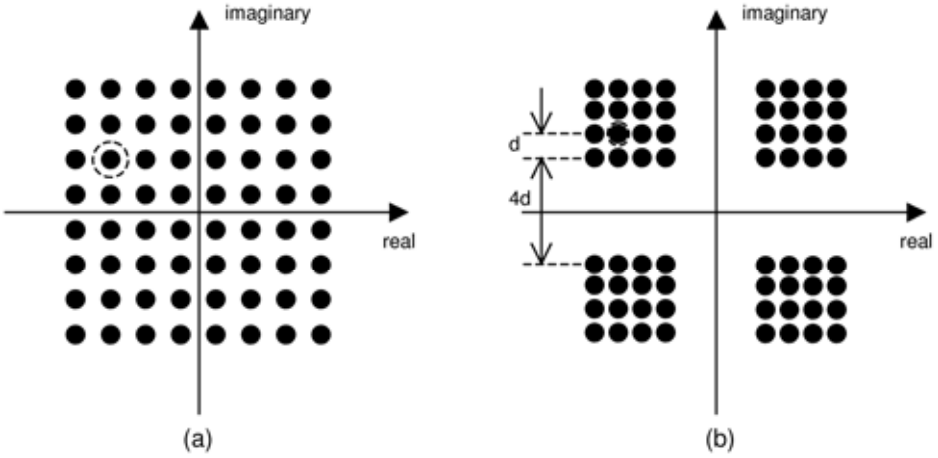

Figure 1 Constellations of 64-QAM DVB-T signals (see text for description of circled points) a) non-hierarchical; b) hierarchical with α=4

The constellation ratio α is used to determine the spacing between the groups of constellation points. α is the ratio of the spacing between the groups to the spacing between the individual points within a group. Permitted values of α are 1, 2 and 4. The above figure is for 64QAM but it is also possible to use a 16QAM variant.

While using a constellation ratio of 4 reduces the C/N requirement for the high priority (HP) stream, it increases it for the low priority (LP) stream. For example, normal QPSK and 64QAM (both rate 2/3) have C/N requirements of 8.4 dB and 19.3 dB respectively. But in a hierarchical mode with an

α of 4, these are approximately 9 dB and 25 dB respectively. Thus the HP stream is still not quite as rugged as normal QPSK, and the LP stream is significantly worse than normal 64QAM. The trade-off between the HP and LP streams needs careful consideration.

Data Capacities and C/N requirements

The tables below show the data capacities of the most useful hierarchical modes with the basic modes for comparison.

Mode	Code Rate	C/N (dB)	Net Data rate (Mbit/s)
QPSK	1/2	5	6
	2/3	8	8
16QAM	1/2	11	12
	2/3	14	16
64QAM	1/2	16	18
	2/3	19	24

Non-Hierarchical Modes

		QPSK		16QAM		
α	Code Rate	C/N (dB)	Net Data rate (Mbit/s)	C/N (dB)	Net Data rate (Mbit/s)	Total Net Data Rate
2	1/2	7	6	15	6	12
	2/3	10	8	18	8	16
4	1/2	6	6	20	6	12
	2/3	9	8	22	8	16

QPSK in 16QAM

		QPSK		64QAM		
α	Code Rate	C/N (dB)	Net Data rate (Mbit/s)	C/N (dB)	Net Data rate (Mbit/s)	Total Net Data Rate
1	1/2	11	6	16	12	18
	2/3	15	8	19	16	24
2	1/2	9	6	18	12	18
	2/3	12	8	22	16	24

QPSK in 64QAM

The C/N figures are for a Rayleigh channel and the data rate for a 1/32 guard interval.

Some Possible Uses

1 Two types of service

The LP stream could be used for fixed reception of an HDTV service while the HP stream would provide a portable/mobile SDTV service. The service areas may be similar, depending on the mode chosen. The HP stream would also provide a service to 'difficult' reception areas – for example, in city centres where normal housing is screened by tall office blocks.

2 Multiple programmes

The HP stream could provide a rugged service carrying a main (national) programme with the LP stream providing two or more additional (local?) programmes. Most viewers should be able to receive the HP stream without having to upgrade their aerial systems from those used to receive the analogue broadcasts. The LP stream could well require aerial system improvements but there would be the incentive of extra (free?) programmes.

3 Migration

In countries where there are no channels available for high power digital transmissions (7 dB below analogue), e.g. UK, but transmissions at lower powers (-17 dB or more) are possible, a scheme similar to 2 above may aid the transition to all digital broadcasting. The HP stream would carry one of the national programmes while the LP stream would carry the other (2 or 3) national programmes. This could allow virtually all those served by the analogue transmitter to receive at least the HP digital programme while a large proportion could receive the other programmes (the ERP of this multiplex could be as much as 20 dB below the analogue power and still provide similar coverage with the HP stream). When all those in the service area have digital equipment, the analogue channel broadcasting the same programme as the HP stream could then be converted to digital transmission with an ERP of 7 dB down, thus giving good coverage of all national programmes in a 'conventional' 64QAM mode. The other 2 or 3 analogue channels could then be converted.

4 Increased capacity

Instead of using the "standard" code rate of 2/3 for the HP stream, a higher code rate of 3/4 could be used. This gives an extra 1 Mbit/s but this could be lost by the necessity of duplicating the SI and EPG data, which may be needed in both streams.

Final thoughts

While hierarchical modulation may be useful in some countries to implement the changeover to digital television broadcasting, care should be taken in the way it is used. Also, equipment already in use may not be capable of decoding this mode, being built to only a subset of the DVB-T specification.

In the analogue world, the national networks are normally receivable at a similar quality. The use of hierarchical modulation in the digital world may mean that some areas will be only able to receive some of them, leading to dissatisfaction.