



DVB-H Receiver Quality and its effect on Network Cost

Executive Summary

When a number of products are quoted as being “compliant” to some particular standard, many people assume that this means that all of them are “the same”. Nothing could be further from the truth. Communication standards lay down a *minimum* set of conditions under which products can communicate (interoperate) with each other. There can be vast differences in product quality between devices even though all are “compliant” to the same set of standards. Furthermore, differences in product quality can have a major effect on the overall cost and performance of systems that use these products.

In the case of the DVB-H standard, receiver quality is seen to be a major factor in overall system cost and capability. Receivers that meet – or exceed – the higher “Proven Performance” rather than the required “Typical Reference” standard offer a far more satisfying experience for end users (particularly when mobile), and at the same time give network operators the opportunity to offer enhanced services and increased coverage at reduced cost.

Introduction

In common with the vast majority of communications standards, the digital video broadcasting” (DVB) standards specify the *interface* between a sender and a receiver. In the case of DVB the interface is the radio frequency (RF) signal passed between sender and receiver. The DVB standards specify the contents and the structure of the signal and especially its RF characteristics. In addition, the standards provide extensive guidelines that show how equipment implementing them could be built. *Of key importance is the fact that the standard does NOT mandate how compliant equipment shall be designed or how it should operate.* It was the intention of the standards authority to allow the maximum freedom for developers to use their skills and creativity to build the best possible products.

In the case of the DVB-H (handheld) standards, a transmitter is required to provide a stated minimum signal quality. Receivers are expected to be able to decode that signal under certain stated environmental conditions. Both of these requirements are minima. Developers are encouraged to build the best quality equipment that they can, consistent with the standardized signal characteristics.

In the case of receivers, the DVB-H Implementation Guidelines (ETSI TR102377 v1.2.1) describes two types:

1. A “Typical Reference Receiver” (Table 10.3). This is regarded as perhaps a performance benchmark for a basic receiver.
2. A “Proven Performance” receiver also known as the “Possible Reference Receiver” (Table 10.4). This specification is a reflection of what the standards developers believed was a target to which developers should aspire.

Implicit in these specifications is the fact that different pieces of equipment, all of which are fully compliant to the DVB-H standard, can have a very wide disparity in service quality. ***The critical point is that seemingly small differences in equipment quality can have enormous consequences when it comes to network quality (especially coverage) and cost!***

A good example is seen in the DiBcom "DiB7000-H" demodulator chip and the "DiB7070-H" integrated Front-End. Both of these chips fully comply with the "Proven Performance" receiver specification, and in fact have been designed to go well beyond it, offering an additional 1.5 dB carrier to noise (C/N) margin. These DiBcom chips exceed the lower "Typical Reference Receiver" C/N performance by a full 3 dB. That may not sound much, but 3 dB means double. A receiver that is 3 dB better offers comparable performance to a reference receiver that is operating in an environment with twice the signal (or half the noise). Another way of looking at it is to say that a receiver with 3 dB better performance can achieve (at least) a given quality level in a coverage area around 50% greater than the reference!

An equipment or network designer can take advantage of the benefits of a better receiver in a number of ways:

1. To reduce the number of base stations in a Single Frequency Network (SFN) to significantly lower overall infrastructure cost.
2. Alternatively, to improve (extend) the coverage area without increasing the cost of infrastructure.
3. To enhance services by increasing available bit rates.

A further benefit of a better receiver (such as the DiBcom chipset previously mentioned) is significantly improved performance for users who are in motion (such as in a car or train).

Reducing the Number of Base Stations

By reducing the number of base stations we can significantly reduce the total cost of the network.

The C/N of the DiBcom receiver, 1.5 dB better than the proven performance receiver and 3dB better than the "Typical Receiver" C/N, widens the coverage area of each DVB-H transmitter by approximately 50%.

This is a key feature for network operators since it reduces their capital expenditure dramatically. For example an 80% indoor coverage simulation over Paris Indoor in UHF bandwidth with a cellular topography (several medium cells transmitting at 5kW EIRP each) implies a minimum of 17 cells with a "Typical Receiver", but only 12 cells with the DiBcom receiver, i.e. a 40% improvement.

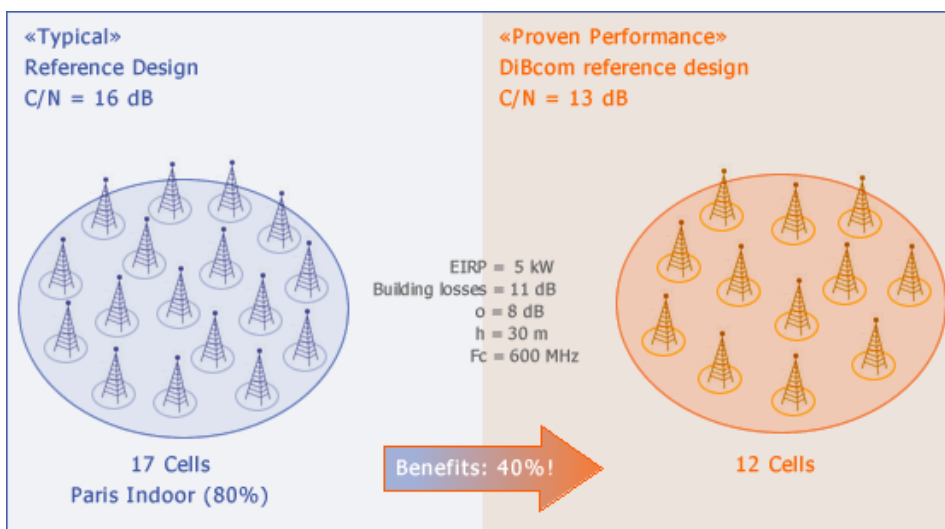


Figure 1: DVB-H "Proven Performance" benefit in UHF (Cellular topography over Paris with Medium Cells)

As an example, the estimated investment to cover all major cities in a European country like France would be about 200M Euros if receivers implement the "Proven Performance", and 300M Euros otherwise.

Coverage improvement

Another way to evaluate the benefit of the 3dB gain is, for a given transmitted EIRP, to consider the related increase in covered population. A simulation with a single transmitter over Berlin (EIRP 100 kW) results in 940,000 people able to watch TV using a "Reference Receiver" instead of only 600,000 people covered on a basic "Typical Receiver", i.e. a potential end user gain of 56%.

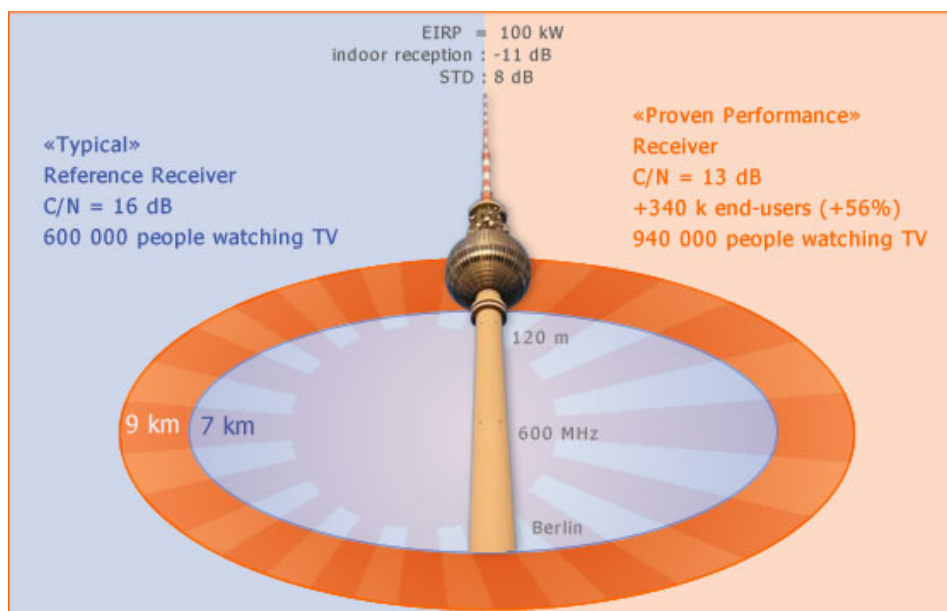


Figure 2: DVB-H "Proven Performance" benefit on covered population in UHF (Broadcast approach)

Bit Rate increase

The 3 dB improvement on C/N can be used offer much greater breadth of content by increasing the available bit rate. For example, instead of transmitting in an MUX only 6.65 Mbit/s using QPSK, CR2/3, GI1/4 modulation, the DiBcom "Proven Performance" receiver enables an increase in the bit rate up to 9.95 Mbit/s through the use of 16QAM, CR1/2, GI1/4 modulation. This 3.35 Mbit/s gain allows service providers to transmit approximately 10 more video services.

Enhanced Doppler Compensation

Better receiver technology offers end-users not just greater variety but also improved consistency of service. That naturally means increased service uptake. Key to this is the level of Doppler compensation offered.

The Doppler effect changes the frequency of the received signal when a receiver moves in relation to the transmitter. In DVB transmission sub-channels are packed very close together (without "guard bands"). The receiver cannot reliably track frequency change due to Doppler because the change can occur over the duration of a single symbol period. What happens is that each sub-channel starts to "overlap" (interfere with) an adjacent sub-channel. You get to a point where noise caused by Inter Carrier Interference will destroy the received signal.

Here, the quality of a receiver can make the difference between satisfaction and frustration for end users. When used at high speed, the DiBcom receiver is able to compensate a Doppler frequency up to 130 Hz compared to only 80 Hz for "Typical Receivers". When commuting (car, public transport) it is possible, thanks to the "Proven Performance" receiver, to watch DVB-H services at speeds up to:

- 185 km/h [114 km/h for "Typical Receiver] in UHF in Europe (750 MHz, 8MHz, 8k)
- 130 mph [80 mph for "Typical Receiver] in L-band in US (1.67 GHz, 5MHz, 2k)

When travelling in high-speed trains in Europe, the maximum speed of reception can reach 370 km/h [228 km/h for "Typical Receiver"] in UHF (750 MHz, 8 MHz, 4k).

In some countries that will launch DVB-H in 2006, the 8k mode will be used, so mobile broadcasts that can be enjoyed throughout inter-city journeys will be more or less restricted to passengers using "Proven Performance" technology.

Another important effect here is that a better receiver allows a network designer significantly more flexibility in the siting of transmitters. The Doppler effect is at its maximum when the receiver is moving directly towards or away from the transmitter. It is significantly reduced when the receiver is moving at an angle to the direct line of the transmitter. Thus supporting a network of "Typical Receivers" (operating in rapidly moving vehicles) could mean that transmitters need to be located well away from major roads or railway lines. With a "Proven Performance" receiver these considerations are far less important.

Commercial Considerations

Network operators who build the infrastructure have different commercial motivations from the people who buy end-user devices. Operators will know that if they construct a network based on the assumption that all users will have a "Proven Performance" receiver then they will save significantly on infrastructure cost. Many network operators are able to introduce and enforce regulations that demand "homologation" of end-user devices before connection to the network is allowed. This even applies to television networks and equipment. It may not be very long before the "Proven Performance" criterion is stated as a requirement for every network in Europe!