Digital radio by satellite
– new risks, new opportunities and a possible new gateway

D. Wood
EBU Technical Department

The future of digital radio by satellite (DRS) is exciting but uncertain, with a number of current and proposed systems all hoping for success.

In this article, the Author discusses the shortcomings of the current radio-by-satellite systems (DSR and ADR) – mainly their inability to provide for the mobile listener – and looks ahead to the difficulties that will be encountered if and when the rival WorldSpace and MediaStar systems take to the skies. The solution to this situation, he argues, is to work towards a minimum number of standards for DRS and to maximize the number of common elements between them.

1. Introduction

A selection of early DAB receivers from Bosch.

1998 may be a landmark year for digital radio by satellite (DRS). Although it has been available in some form for several years in Europe via the DSR and ADR systems, a new satellite digital radio system with a new objective, *WorldSpace*, is to be launched this year. Another system, *MediaStar*, may come in three years' time or more. These new systems may have major consequences for radio broadcasting.

The current situation – including why the Eureka-147 DAB system is *not* being used for WorldSpace – can be understood by drawing some historical threads. All radio broadcasters need to follow this development.

Original language: English
Manuscript received: 1/7/98.

2. The Eureka DAB terrestrial services

The European Eureka DAB system was developed technically almost a decade ago to provide near-CD sound quality to the listener, at home or on the move. Frequency space for DAB broadcasts across Europe was agreed at a conference in 1995. DAB services, some with new

programme content and data services, are now on-air from terrestrial transmitters in several European countries, Canada, Australia, China, India and other parts of the world.

Some public broadcasters have invested substantially in DAB transmitter networks. The latest survey shows that more than 120 million people in Europe are potentially served by DAB signals. But as yet, there are no mass-produced consumer receivers in the shops to receive them, although we wish it were otherwise.

Manufacturers say that DAB receivers will be found in the shops in the second half of this year. However, there is evidence that large consumer manufacturers are currently giving more priority to making and selling digital television receivers than DAB. We must watch and wait.

The situation in Germany, which is the largest European market, may be one of the most important barometers. The Heads of the Länder Governments issued a statement in November 1997, stating that radio and television would switch to digital transmission technologies over a period of 10 years. However, although a simplification, it can be said that both the manufacturers and the broadcasters in Germany are still reluctant to be the first to break the DAB "chicken and egg" cycle – by providing new programme services and putting reasonably-priced receivers in the shops.

Technological progress always marches on, and one of the dangers of a slow roll-out is that the technology is overtaken. However, the DAB situation in Europe is stable and there is no serious alternative yet. The most likely future for DAB is that the roll-out will continue across Europe, although not as fast as the broadcasters wish, and also in other parts of the world.

A rule-of-thumb for a "fast-track" roll-out for a new media delivery system is 50% penetration in ten years, once the receivers have become available. The RDS system achieved a much slower roll-out, about 10 - 20% penetration in ten years. DAB has a lot to offer but we could speculate that it will be closer to the RDS roll-out than the fast-track roll-out rate, unless receiver manufacturers show more enthusiasm in spearheading the implementation process.

Consumer research surveys show that DAB has major technical, programming and commercial strengths, and could have a large following. Criticism about the roll-out rate should not deflect us from our search for more frequency spectrum space for terrestrial DAB. This will inevitably be needed.

Abbreviations

ADR	Astra Digital Radio
DAB	Digital Audio Broadcasting
DRM	Digital Radio Mondiale
DRS	Digital radio by satellite
DSR	Digital Satellite Radio
DVB	Digital Video Broadcasting
DVB-S	DVB - Satellite
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITU	International Telecommunication Union
MPEG	(ISO/IEC) Moving Picture Experts Group
RDS	Radio Data System
SES	*Société Européenne des Satellites*

DRS

In the economist's jargon, new digital terrestrial broadcasting technologies – including DAB – operate in a "horizontal" structure. Programme providers and operators, and receiver manufacturers, are separate from each other. They discuss how to launch digital services but they make no strong contractual arrangements with each other. They rely, as they always did with terrestrial analogue TV and radio, on the combined effects of independent actions to start and popularise the new system. The technical details of the transmission system are made available to any receiver manufacturer that wants them – they are "open" standards.

DAB introduction thus requires a complex and time-consuming co-ordination process at the international level, to encourage its introduction. Such measures are discussed by a voluntary grouping of about a hundred manufacturers, broadcasters and regulators – the World DAB Forum (WorldDAB).

The Eureka-147 DAB system is being used for terrestrial digital broadcasting today but, in principle, it has always been possible to use the same system for digital radio by satellite. Because satellites are able to serve large geographical areas, and because the domestic radio services of EBU Members are no more than country-wide (and probably less), the use of satellites for DAB has been seen until now as unnecessary for most national broadcasting requirements although, for very large countries such as Sweden, it may be useful.

A European grouping *MediaStar* is considering starting a digital radio by satellite system using the Eureka-147 DAB system for pan-national services, as explained later in this article.

3. DSR, ADR and DVB-S

Satellite radio is currently available in Europe via the DSR system and the SES ADR system. The former is likely to be closed down. The latter uses an analogue television signal to carry, piggy-back, a number of digital radio channels as well as the TV channels. In order to receive ADR, a relatively large fixed receiving dish (80 cm) is needed and there are suspicions that the system may not survive in the long term. It's lifespan will be linked to that of analogue television. ADR has not been the success expected, in spite of the large pay-radio offer that has been made available.

DVB-S, intended primarily for digital television, can provide satellite radio to smaller-sized dishes than ADR but they still need to be fixed, and to have a clear line of sight to the satellite.

All the digital radio-by-satellite systems used to-date (DSR, ADR and DVB-S) suffer from the same shortcoming – listeners on the move cannot receive them. DAB was developed to remedy this, and to provide better sound quality.

4. The WorldSpace concept

In the early 1990s, an American called Noah Samara had a dream. It was to provide the developing countries of Africa and the southern hemisphere with low-cost, but reliable, digital radio-by-satellite. The developing world would have reliable access to a vast number of crystal-clear radio channels, coming from throughout the world, on a low-cost receiver. The dream has been developed as *WorldSpace* and 1998 should see the launch of the first satellites to realize it. The first satellite, Afrispace, is scheduled to be launched in October 1998. World-

Space is almost upon us. Africa, it is said, will soon have the four "Rs" – **R**eading, W**r**iting, A**r**ithmetic and **R**adio.

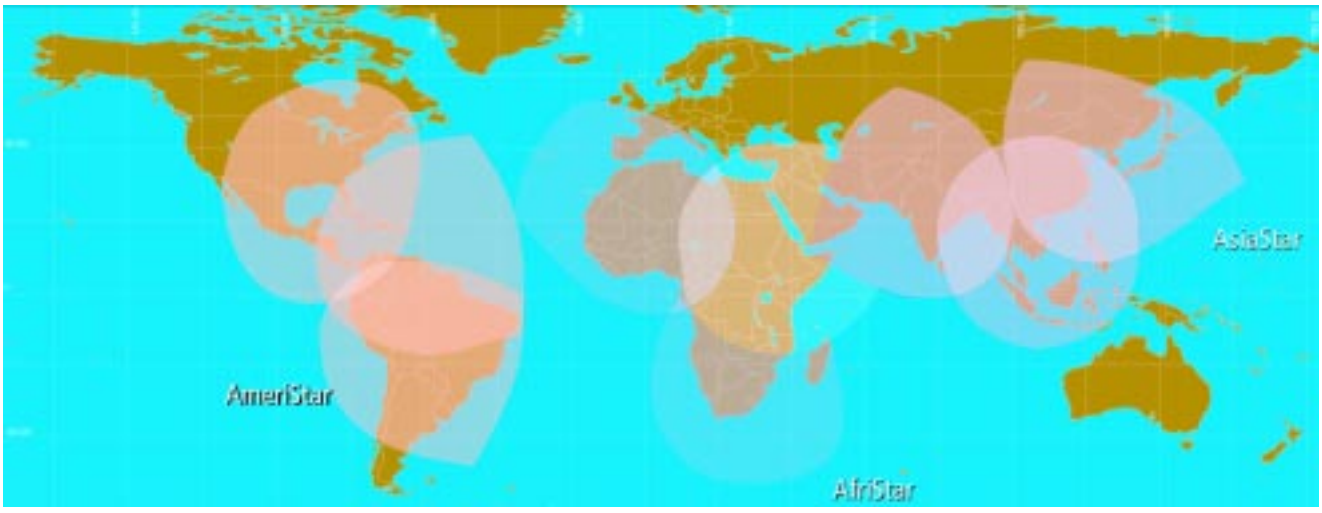
Mr Samara has worked in a different way to the international consensus approach that is characteristic for DAB. He has tried to bind together organizations, principally a small number of manufacturers, in firm contractual arrangements to roll out the system in a planned way. This, in economists' terms, is a "vertical" structure. WorldSpace claim that the horizontal structure approach – the terrestrial DAB route – is not workable for them. They point to the difficulty of getting a large number of organizations, some of which are competitors, to agree voluntarily to act rapidly and together.

In its early years, WorldSpace set about choosing a technical system. They initially considered the Eureka-147 DAB system but preferred to design and develop their own system. They said they needed a simple system that would lead to very cheap receivers, because this is all the developing countries can afford. They thought that DAB had features they did not really need. Their view was that the developing world does not need receivers capable of CD-quality audio – it only needs adequate sound quality and does not need failure-free reception in cars moving about in highly built-up areas. WorldSpace said they wanted a cheaper and simpler system than the one needed for the developed world of Europe. WorldSpace also argued that, for technical reasons, using a simpler system than DAB would allow a given satellite to deliver higher power, and thus enlarge the coverage areas.

Although the originator of WorldSpace comes from the United States, he has found his most important partners and allies in Europe. They include Alcatel, the Frauenhofer Institute, Thomson SGS, Intermetal, etc. Looked at globally, it can even be seen as a largely European consortium. Some of the organizations are also part of the roll-out of the European-devised Eureka-147 DAB system.

4.1. The performance of the WorldSpace system

Until recently, no-one outside the WorldSpace consortium could authoritatively comment on the system, judge how it will work, or test it – because they did not have full details on it. However, we do have some published information on it and from that we can draw some pro-



Footprints of the projected WorldSpace satellites.

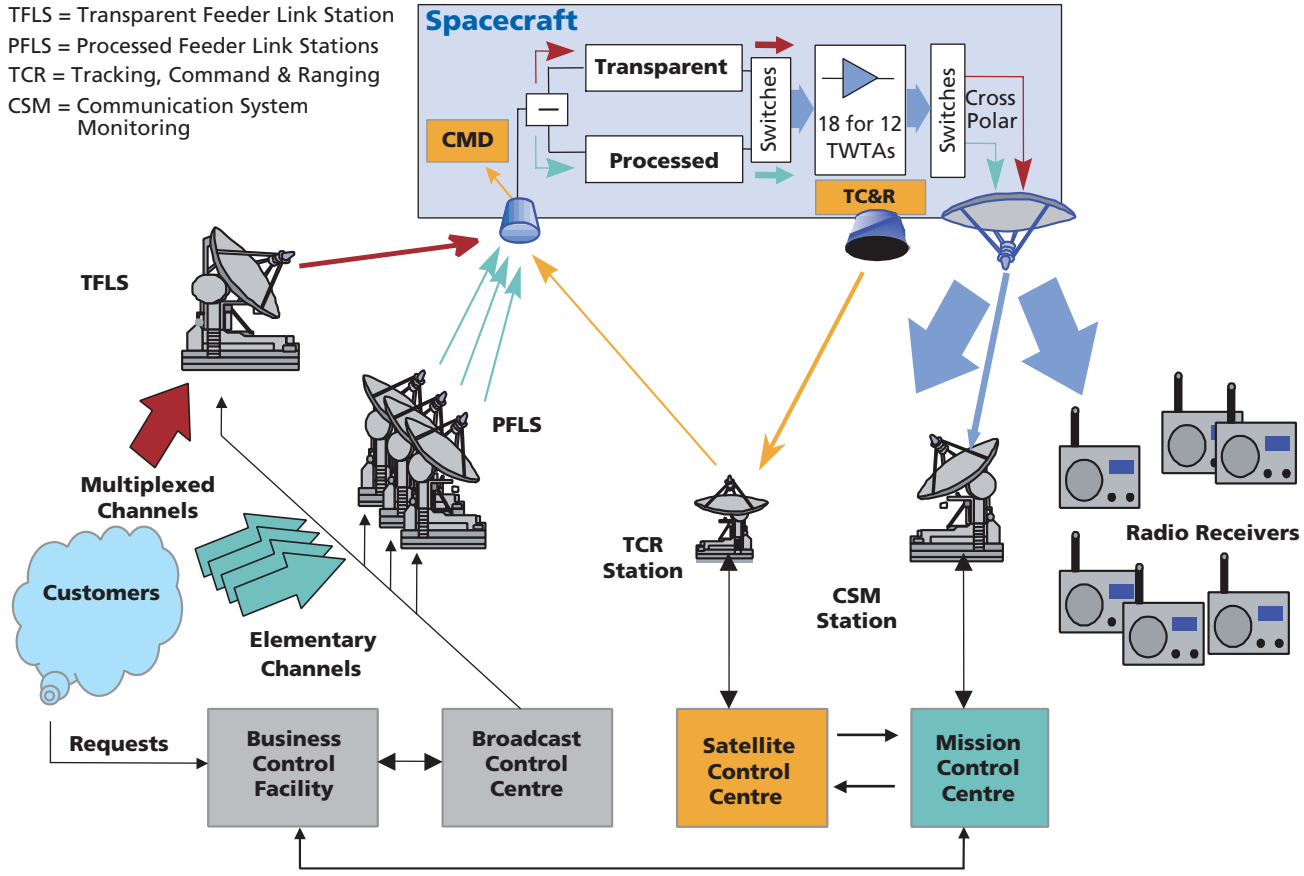
visional conclusions. Furthermore, in January 1998, WorldSpace submitted some information on the system to the ITU.

Broadcasts from all satellite systems will be difficult to receive in locations where the listener's receiver does not have access to an open sky. This situation may occur sometimes in rural areas but, in general, it is reception in cities and inside buildings that may not always be possible. The benefits of more satellite power that would come from using the simpler WorldSpace modulation system, compared to a DAB system, are now thought to be less significant than previously reckoned, essentially because the problems of obstructions cannot be overcome by higher power.

As far as we can judge, the projected cost for WorldSpace receivers in the shops has been progressively rising over the last two years. It is now about 250 US dollars for a portable receiver.

Some suspect that the proportion of locations where the listener will be able to receive the WorldSpace satellite services directly may well be modest. It may be far from complete outdoors and even less indoors (where there are solid objects such as walls between the listener's antenna and the satellite). The WorldSpace system is less able than the DAB system to make "fill-in" terrestrial transmitters in a cost-efficient manner, although fill-in transmitters will still be possible with WorldSpace and will increase their coverage.

There is insufficient evidence available yet to predict with certainty how well the system will work in practice, but noticing all the above and the fact that the WorldSpace cost projections for receivers have risen, can we reasonably conclude that the case for using a system which is different to DAB has diminished since the WorldSpace project began?



WorldSpace system architecture.

Digital radio uses compression to squeeze a sound channel into a narrow space. The World-Space group decided not to use the same sound compression system as used in DAB. They argued that time had marched on, and that a more efficient system is now possible. The system they have announced is similar to, but not exactly the same as, the world-standardized MPEG-1 Layer III method. The variant used by WorldSpace is called "MPEG-2.5" – although it is not formally documented in the MPEG standards group. According to one source, World-Space have not ruled out changing to the newer and even more efficient MPEG-4 compression system.

5. The problems of vertical structures

The use of vertical structures for any media delivery usually gives some cause for concern. The classic economist's objection to vertically-integrated structures has applied from the early days of movie distribution up to today's digital television delivery. Vertical integration can create a gateway. There is a single entity controlling access by the public to media content.

Wish as we might that it were otherwise, monopolies are sometimes exploited. The owner of the gateway can charge whatever he likes. The content provider and the user have only one choice – pay up, or move aside for someone else.

In a debate in 1997, the members of the EBU Technical Assembly were concerned not so much with the technical system itself adopted by WorldSpace, but rather with the potential gate-keeper consequences. *Will WorldSpace tie up most of Africa and the southern hemisphere with its own technical system, and with receivers that it alone can authorize to be made? Will the world, in any sense, have to ask permission of Noah Samara to broadcast there?* These are the concerns.

On the other hand, while it is possible to criticise WorldSpace, the alternative horizontal arrangement with an open-standards system has not made for a rapid start-up for terrestrial DAB.

6. The MediaStar project

The Eureka-147 DAB system has not been abandoned for satellite broadcasting. Another grouping is hoping to develop a digital radio-by-satellite system using the DAB system. This is called *MediaStar*. It is at an earlier stage of development than WorldSpace, and operation may begin in 2001 or later if investors can be found. A business plan is currently being developed, and funding may be sought from the European Community.

The MediaStar system would operate in the northern hemisphere, using a different and lower orbit height than the WorldSpace system. For technical reasons, this means that the satellite operator would be able to position the MediaStar satellite at a high angle in the sky, so that there is less risk of the listener being in the shadow of a building.

However, by using a lower orbit height, more that one satellite would be needed for 24-hour coverage. In fact, three satellites (plus spares) would be needed, each passing the baton of providing the service to the next satellite, every 8 hours. MediaStar will use a technical system based on DAB.

In principle, the receivers used for terrestrial DAB should also be able to receive the MediaStar services, provided they can tune to the right band (the 1.5 GHz band).

7. The users of WorldSpace and MediaStar

Digital radio by satellite will inevitably mean large coverage areas. It lends itself more to international broadcasting than to local, regional or national broadcasting. Of course, it can still be used for national broadcasting if the distribution costs are acceptable, and there are no issues of rights to restrain the coverage.

WorldSpace is hoping to include in its services to Africa and the southern hemisphere a mixture of local programmes and overseas broadcasts from other parts of the world. European overseas broadcasters such as Radio France International, BBC World Service, Deutsche Welle and Radio Nederlands are considering broadcasting via WorldSpace to Africa, but they are understood to have not yet taken a decision.

The WorldSpace satellites will offer a flexible system. On offer for programme providers will be slices of a digital broadcast cake that can be of a size to suit the user – provided there is enough of them left. In areas where reception will be possible, the basic slice will deliver a radio programme with about the quality of AM radio today, without fading or interference. Slices can be put together for stereo, or better sound quality.

MediaStar will operate in a similar way, with programme service providers being offered slices of the digital transponders for their radio broadcasts. The slice size will affect the price they have to pay. Because of the high public expectations, we could expect the minimum slice size for Europe to provide at least FM quality.

7.1. Financial viability

One of the unclear issues today is where the revenues will come from to sustain the WorldSpace and MediaStar services.

Both consortia must seek, in time, to make money to pay back the investments made in them by their principals. This money must come largely from the programme service providers. Costs to programme service providers are going to be proportional to the slice of the digital cake they take, but they are likely to be high because of the high satellite infrastructure costs. Creating the WorldSpace infrastructure must have been expensive, and the MediaStar infrastructure will also be expensive.

The situation may be the more difficult for WorldSpace, because of its target audience. Pay-radio seems unlikely to be viable in the developing world. Programme service providers will need income from advertising, or financing from other sources. Some advertising will be possible but, although very worthy recipients of these services, the developing world does not have the highest spending consumers. Although the cause is noble – in an environment where the resources of international broadcasters are not growing but shrinking, and where increasing attention is being paid to television as a means of international broadcasting – it is not entirely obvious where the long-term revenue for the WorldSpace services will come from.

8. Finding space in the frequency bands for digital radio

A frequency band not currently used for broadcasting (the 1.5 GHz band) is available in principle for digital radio in Europe, but the band is relatively small. It is split into two halves, one for terrestrial digital radio, and one for satellite digital radio. However, there is not much room for them both, and we need concerted action to enlarge the band available for broadcasting.

9. The digital short-wave option

It is impossible to protect satellite services from jamming. Any overseas broadcasting which is delivered by satellite will be vulnerable to jamming by the target country or region. Strange as it may seem, probably the only way to be relatively immune to jamming will be to use the short-wave bands – an old friend.

A digital system is being developed for the short-wave bands in a new collaborative project called DRM (Digital Radio Mondiale), chaired by Deutsche Welle. It may be possible by using digital technology to develop a new radio broadcasting system that is resilient to the fading which characterizes analogue short-wave broadcasting today. Thus, international broadcasters may need to use short-waves to ensure their services, although these may complement digital satellite services. Future months will probably see a heated debate about whether and how this digital short-wave system should be similar or different to the DAB system, possibly as a kind of cut-down version.

10. Summary

There are a large number of issues arising from digital radio by satellite. Some of them are as follows:

- The world would have been better off with a unique standard for digital radio by satellite, but this no longer seems possible. The best that can be done now is to work towards the minimum number of standards – no more than two – and with maximum common elements between them. This can happen if WorldSpace reveal information about their system and its performance, and if WorldSpace and Eureka-147 DAB work together.

David Wood *is the Head of New Technology at the EBU headquarters in Geneva, Switzerland. This division of the EBU Technical Department is responsible for the DVB Project Office and for co-ordinating the activities of the EBU Broadcast Systems Management Committee (BMC) and its various project groups.*

Mr Wood is Chairman of ITU Working Party 11A (Television Systems and Data Broadcasting) and Chairman of the EC ACTS Multimedia Domain project.

Formerly with the BBC and the IBA in the UK, David Wood is a graduate in Electronic Engineering of Southampton University in the UK.

- DRS will not provide the panacea for all problems. With all satellite systems, portable radio coverage in parts of cities or inside buildings can be low in the absence of local gap-fillers.
- Local co-operation will be needed when providing shadow-area fill-in transmitters, and these may be expensive. This local co-operation may also be difficult or impossible if the local authorities do not welcome the broadcasts.
- Europe is not one of the target areas for the first series of WorldSpace satellites. EBU Members could, in principle, just ignore it. This would be short-sighted. WorldSpace, and its technical system, will have an impact on broadcasting in Europe.