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DAB Eureka-147: The European Platform for Digital Radio

Abstract

Like its analogue counterpart, digital radio is one of the 'older' forms of new media. The technology of digital radio broadcasting has been under active development for at least 25 years and has produced a number of different technical solutions, the longest established of which is the so-called Eureka-147 or DAB (Digital Audio Broadcasting) system. This article explores the 'technological imaginary' of DAB and its distinctly European vision for new media and the future of broadcasting. DAB is traced to its origins in European R&D policy of the 1980s, and its affinity with the traditions of European public service broadcasting. Ironically, it was DAB's failure to capitalise on its 'Europeanness' that contributed to the fragmentary political support it later received, compromising its subsequent implementation. From a contemporary perspective, DAB's original mission to provide enhanced, interactive information and entertainment services through audio, text and visual content, while visionary, appears to have misread trends towards convergence and appears out of step with contemporary media consumption patterns.

Keywords: radio broadcasting; digital radio; DAB/Eureka-147; communication policies.

Introduction

The impact and future implications of digitalisation for radio have been the subject of much speculation, both in policy-based research (Given 2003; EBU-UER 2007; Lax, Ala-Fossi et al. 2008) and in technology studies (Berry 2006; Ala-Fossi, Lax et al. 2008). At the same time, researchers are now beginning to turn their attention to historical perspectives on digital radio (Rudin 2006; O'Neill 2007) asking questions about how the technology emerged and what purposes it was intended to serve. Digital radio has been in development for over 25 years and despite substantial investment and significant attention by both broadcasters and media regulators, there is less consensus now about radio's digital future than at any time in the past. What once may have appeared to have been a fairly straightforward proposition of updating the transmission system, much like the transition from AM to FM at an earlier stage in radio history, now seems much more complicated. Digital radio now represents a complex and thorny problem, complete with competing platforms, fragmentation in the market place and disagreement among radio broadcasters and regulators. Digital radio has been unfavourably characterised as the 'Betamax' of radio (Plunkett 2008) or likened to such failed technology implementations such as AM stereo (Leblibici, Salancik et al. 1991). As such, it may well be that the DAB platform, the subject of the current paper, will ultimately be an example of a technology that has failed.

Standing back from the current environment where digital radio is the subject of much debate, particularly given the competition from satellite and internet radio, this article explores the origins of digital radio at a time when its future seemed to be more certain. The principal sources for this discussion are a sample of the technical papers used to describe and promote the European solution, the so-called Eureka-147 Digital Audio Broadcasting system or DAB. This article examines the 'technological imaginary' of DAB and its distinctly European vision for the future of radio broadcasting. Eureka-147 is, of course, not the only technical solution for digital radio and, indeed, there is now a proliferation of different systems, posing different challenges to implementation within existing market structures (see Ala-Fossi, Jauert et al. 2008 for a survey). For instance, while Eureka-147 was initially positively received in the United States, it was ultimately rejected in favour of an alternative in-

band, on-channel approach developed by iBiquity, now labelled HD-Radio (Ala-Fossi and Stavitsky 2003). The two systems provide very different responses to the evolution of radio into the digital era though both derive from a model of broadcasting that is now under considerable pressure and undergoing substantial change itself.

Digital radio as symptomatic technology

The Eureka system, I argue in the following, offers a technological imaginary of digital radio (Lister, Kelly et al. 2003: 60), a vision of the potential and promise that this new technology could offer, though shaped ideologically by its roots in European broadcasting experience. Drawing on a social shaping of technologies (SST) approach (MacKenzie and Wajcman 1985), I suggest, Eureka-147 DAB may be read as a 'symptomatic technology' in the sense introduced by Raymond Williams (1974) when he described 'particular technologies, or a complex of technologies [that can be read] as *symptoms* of change of some other kind' (Williams 1974: 13). Williams' historical account of the development of broadcasting is, according to Mackay and Gillespie (1992), a pioneering example of SST. They argue though that, as it stands, SST studies have paid insufficient attention to the role of ideology either at a micro or a macro level in the development of technology. Indeed, ideology, they observe, is conspicuously absent in Williams' account of the social shaping of television (1992: 692). While due attention to technology as a social construct has been centrally important in extending our understanding of why technology is as it is, a wariness of determinism has led to insufficient attention being given to the ideologies underpinning technology development and to the central role played by designers and engineers in informing that ideology.

Relatedly, Patrice Flichy in his study of the *internet imaginaire* has called attention to the role of discourse and ideology in contributing to the collective vision of a technology (Flichy 2007). The creation of a social imagination around a particular technology and investing in it utopian dreams of what it might achieve is a constitutive part of its process of adoption and consolidation. In the case of the

internet, the information superhighway was a crucial metaphorical construction that articulated a technical utopia and informed a whole technological programme of development. Thus inspired by an imaginary digital society, software designers, managers, employees, politicians, and individuals, collectively supported one technology over another, at least in the public domain, and thereby shaped its future development.

This points to a second important dimension of Mackay and Gillespie's (1992) account of the SST approach, namely, the role of marketing or promotion in the shaping of the technology. The set of needs that a technology is designed to address is not created, Mackie and Gillespie argue, 'in the autonomous sphere of individual motivation…but heavily dependent on the productive system' (1992: 695). In this context, central to the R&D process is dissemination of research results, and promotion of the benefits of scientific findings through conferences, industry exhibitions, technical press and trade publications. In the case of digital radio, a crucial element of the effort involved in securing acceptance of the new standard was wide dissemination, promotion and marketing of the system's attributes and benefits for both radio professionals and for listeners. The combined efforts of organisations such as EuroDAB, later WorldDAB, the European Broadcasting Union (EBU) as well as individual broadcasters, sought to bring awareness of the new system to as wide an audience as possible and to promote a consistent and well-rehearsed message of the advantages that DAB offered. These technical and promotional discourses are an important source for the rationale underpinning the technology, what it was designed to do, and the problems it was intended to solve. This is not to privilege the 'expert' or 'technicist' point of view, but rather to relate it more symptomatically to the context in which the technology was developed.

Why digital radio?

Why, however, was it necessary to develop a digital technology for radio in the first place? In the technical literature, the conversion of sound processing and transmission

to digital form is often presented as an all-encompassing, inevitable and necessary vision of how broadcasting systems needed to develop in the future (World Broadcasting Unions 1998: 7). The extension of digitalization to radio was claimed to complete a process that had been well established in other parts of the audiovisual production chain and which included digital audio production, processing and recording techniques (Maddocks 1994). The prevalence of digital technology in professional radio production environments, replacing older analogue production techniques, as well as the wide penetration of digital consumer formats such as mp3 and the compact disc or CD format, had by the mid 1980s made the concept of digital audio and its associated benefits widely known in both everyday and professional contexts for radio and audio media.

At the mid point of the 1980s, given the momentum for digitalisation in areas such as telecommunications (ISDN) and storage media for audio (CD), it was widely argued in industry circles that radio sound broadcasting had a pressing need for improvement (Gandy 2003: 3). Satellite systems for digital transmission, including Digital Satellite Radio and Astra Digital Radio, had already been developed but, significantly, were as yet unsuited for reliable mobile reception where, it was claimed, analogue radio transmission suffered most (Hoeg and Lauterbach 2003).

The digitalisation of broadcast transmission systems had been an important and ongoing theme of engineering research for an extensive period of time. In the area of sound transmission, developments such as NICAM stereo sound for television in the early 1970s, and digital transmission technologies for satellite radio in the early 1980s generated significant momentum in the search for replacement technologies for conventional AM and FM broadcasting (Hoeg and Lauterbach 2003). The greater efficiency of transmission, resulting in lower costs for broadcasters and transmission networks, as well as greater frequency efficiency, allowing better utilisation of spectrum and the ability to provide more services, made the goal of digital broadcasting an important and attractive one for regulators and governments.

There was also and continues to be a strong commercial imperative for radio to become a digital medium and to become part of the trend towards full digital

convergence in the media market. Radio, as noted in a more recent European Commission study of the digital content industry, is often overlooked when thinking about convergence and interactive media (Screen Digest2006). Online music distribution, by contrast, has developed into a major new industry expected to be worth €1.1bn by 2010 and three times that in the United States (Screen Digest, 2006: 12). The same study estimated that there are currently 15 million listeners to online radio in Europe, expected to reach 32 million listeners or 7 per cent of Europeans by 2010, and a further 11 million listeners for podcasting also by 2010 (2006: 13). Against this, the total revenue anticipated by 2010 for all digital radio will be just 5 per cent of the overall advertising revenues for the radio sector and as a result there is major pressure on the industry to find ways to ensure it builds a higher profile in digital content distribution.

As it stands, radio is poised on the cusp of a rapidly expanding environment for digital media services where it can potentially contribute to diverse platforms including handheld mobile devices, online streaming and download services, and multimedia-rich cable and satellite services. This represents a considerable metamorphosis of radio as traditionally conceived in the one-to-many broadcasting model to stand-alone receivers. It is also, as analysed in the following discussion of its historical context, quite different to the original conception of broadcast digital radio as developed by the Eureka-147 consortium.

Brief Historical Overview of Eureka-147

DAB has its origins in the European high technology research environment of large equipment manufacturers, broadcasting and telecommunications organizations, and various public and private research institutes. Funded under the inter-governmental Eureka investment programme, it was part of a general effort through the 1980s to develop more efficient digital transmission systems. Rather than one single invention, DAB consists of a series of discrete, co-ordinated engineering innovations designed to solve specific research problems in the area of digital signals transmission. To date,

the history of its development has not been extensively documented, though several brief historical surveys are available (See for example: Kozamernik 1995; Gandy 2003; Hoeg and Lauterbach 2003; Lembke 2003; Kozamernik 2004; Rudin, Huff et al. 2004; Rudin 2006).

DAB is widely acknowledged to be a highly successful technical feat of engineering that provides an innovative approach to digital audio and multimedia broadcasting (Hoeg and Lauterbach 2003). It has been claimed to be the most significant development of radio since the introduction of FM stereo broadcasting (Bower 1998). It incorporates a range of advantages over conventional broadcast systems and was intended, at least originally, to be a replacement technology for AM and FM radio broadcasting (Hoeg and Lauterbach 2003).

The DAB project began as a collaboration between Institut für Rundfunktechnik (IRT), the research and development institute for a number of German broadcasters, and the Centre Commun détudes de Télédiffusion et Télécommunication (CCETT), the research institute of France Telecom and TDF. Two essential ingredients of the system were already in development prior to the formal organisation of the Eureka consortium: the audio compression or bit-rate reduction system, pioneered by IRT in Germany (MPEG Audio Layer II, originally called MUSICAM), and a new radio frequency modulation system (called COFDM) led by CCETT in France. The initial basis of the research was the development of an integrated services digital broadcasting system, not specifically dedicated to radio. The DAB bit-stream could in fact be used to transmit all kinds of data including images and slow scan television (Gandy 2003:3). However, with the crucial support of the European Broadcasting Union (EBU) and leading broadcasting organisations across Europe, including the BBC, a formal consortium of 19 organisations from France, Germany, The Netherlands and the United Kingdom was formed in 1986 to develop DAB as a successor for AM and FM radio broadcasting.

The Eureka Project 147 was established in 1987, with funding from the European Commission, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers (ETSI 2006). The first phase of the project consisted of

the development of the formal specification of the digital broadcasting system with a second phase up to 1994 comprising 'final system standardisation and design, system verification and investigation of implementation aspects'. At the outset, adoption as a worldwide standard by international bodies like the European Technical Standard Institute (ETSI) and the International Telecommunications Union (ITU) was considered essential. The technical development envisaged a digitalisation of broadcasting distribution, which would produce improved reception compared to FM, particularly mobile reception, and with the potential to offer additional services such as text and other data, conditional access, enhanced traffic services, and picture transmission (Eureka-147 n.d.: 4).

The DAB system was designed for terrestrial, satellite and for hybrid or mixed delivery. Following its adoption by ETSI in 1995 as the single European standard (ETS 300 401) and its recognition by the ITU as a terrestrial and satellite broadcasting system, DAB was widely promoted, and demonstrated with regular services being launched in many European countries. In 1995, the European DAB Forum (EuroDAB) was established to co-ordinate and promote the introduction of DAB services. It became the World DAB Forum (World DAB) in 1997 and launched a marketing campaign aimed at supporting a consumer launch from 1997 on (Witherow 1996). Following completion of the project in 2000, membership of the Eureka-147 consortium merged with World DAB. More recent developments have included the development of the related digital multimedia broadcasting system or DMB, and the adoption of an improved audio codec in a revised DAB+ specification. The current body, now known as the WorldDMB Forum, is exclusively dedicated to the commercial development and adoption of the DAB family of systems.

An important element of the overall promotional discourse for DAB was its claims to be the definitive future of radio, underpinned by the certainty that all media would in the future be digital. The dominant trope of mid 1990s technical discourse of audiovisual services was the conviction that all traditional media including radio, television and the press would adopt digitally-based delivery systems and that varying elements of convergence between different media would emerge (Kozamernik 1995: 3). Through various events and demonstrations, DAB was presented and believed to

herald a new revolutionary era in radio broadcasting (Nunn 1995; Witherow and Laven 1995). Allied to this was a further belief in the necessity for radio to rapidly embrace digital technology to survive in an increasingly competitive and complex market. DAB, it was claimed, provided the opportunity to keep 'radio not only alive but healthy in an increasingly competitive environment' (Witherow and Laven 1995: 61). Conversely, radio might be marginalised in a multimedia environment if it remained analogue (Kozamernik 1999).

The DAB architecture

The DAB system architecture offered a number of advantages over traditional analogue broadcasting that were intended to appeal to both broadcasters and listeners. Technical and operational advantages, of interest primarily to the professional radio industry, included its more efficient use of the spectrum and the ability to offer many more services. For listeners, DAB's advantages included better replication of sound, an enhanced listening experience and more choice (Hoeg and Lauterbach 2003: 456; Rudin, Huff et al. 2004). The extensive promotion for DAB drew on a combination of such attributes and included technical presentations and demonstrations which sought to convey the essential vision of the new system and to persuade different publics of the merits of the system.

The pre-eminent advantage of DAB for both consumers and the radio industry, it was claimed, was its proposed enhanced quality of transmission and interference-free reception. A BBC paper of the period claimed that the consistency of high quality transmission even in adverse conditions was the single most important reason for considering DAB as the future of radio (Gandy 2003: 2). The age-old problem of multi-path interference, or disruption to the radio signal caused by reflections and shadowing by high buildings particularly in dense urban areas, had been identified as one of the main problems associated with analogue broadcasting. For the listener, this resulted in poor quality reception, fading signals and noise interference (Maddocks 1994). This was especially the case for in-car reception and on portable receivers, and

was considered to be a real constraint to the further growth of radio as a medium (World Broadcasting Unions 1998). Stereo FM, when it was introduced in the 1950s, was, strictly speaking, designed for reception via a fixed, static receiver with a roof-top, directional antenna (Shelswell., C. Gandy et al. 1991; Lau and Williams 1992). Clearly, improvements in receiver design have created acceptable listening conditions for FM since, which include switching to mono when reception deteriorates. From an engineering point of view, however, FM was not originally designed for mobile or in-car reception. A key design parameter for DAB, therefore, was quality of reception in fast-moving vehicles, even in extreme conditions. DAB's innovative solution to the problems of reception was to use multiple signal reflections in a constructive way within a new modulation system called COFDM (coded orthogonal frequency division multiplex) which had the effect of successfully combating multi-path interference (Bower 1998).

Planning for digital transmission was conceived on the basis that nationally-based or regionally strong networks (for example, the BBC or a separate multiplex operator) would be primarily responsible for managing the network rather than individual local stations organizing their own transmission. The most cost-efficient coverage was achieved by a network of closely-spaced, relatively low powers transmitters, organised into a Single Frequency Network that allowed multiple transmitters to cover an extensive area without mutual interference (Lau and Williams 1992: 12). The greatest spectrum efficiency, therefore, was at the larger national or regional level, and more localized services were much less suited to the system. This bias in transmission was confirmed by the frequency allotments allocated for digital radio broadcasting following the ITU frequency planning meeting in Wiesbaden, Germany in 1995. Many smaller local and community services who had hoped that digital broadcasting would offer more secure access to the mass media market were sorely disappointed to discover that the transmission pattern and licensing structure would not favour their type of radio (Rudin, Huff et al. 2004: 461; Lax, Ala-Fossi et al. 2008).

A further innovation in the DAB transmission system, unfamiliar to broadcasters and the public at the time, was its organization into an ensemble of programme services or service multiplex, of typically up to six stereo channels (Riley 1994). The flexibility to dynamically vary the composition of the service according to need, such as splitting

a stereo programme into two separate mono channels, or to provide an additional language channel as required, offered the broadcaster greater control. The organisation of services into a multiplex would be invisible to the listener, as tuning would be automatic, and a menu function would list the services and programme content available.

The multiplex organisation of programming with potentially different providers contributing services represented a significant reorganisation of the transmission chain. From the relatively simple structure of broadcaster acting as programme provider and feeding final content into the broadcast chain for transmission and distribution, DAB introduced the distinct functions of programme provider, data service providers and multiplex or ensemble provider (Hoeg and Lauterbach 2003: 152). The DAB configuration thereby required effective co-ordination between each element of the service, and as such was optimally suited to the large broadcaster with the relevant technical and programming resources to serve all aspects of the DAB service. An idealised service provision model, therefore, mapped closely to the kind of programme services envisaged by DAB's main supporters, the large public broadcasting organisations such as BBC, Danmarks Radio or Bayerischer Rundfunk, who had the ability to produce suites of diverse programme material, associated programme data and other listener services under a common brand.

The DAB listener

Alongside its reconceptualisation of the broadcast production chain, the Eureka system also proposed a somewhat different mode of listener engagement with radio, with some significant changes in the way audiences would experience its service. The design of the user interface, for instance, posed a number of challenges for researchers given the different kinds of services the system could provide. In addition to the main audio service, for instance, DAB potentially offered additional information such as text and images; station identification, e.g. 'BBC RI Digital' and programme type labels, e.g. 'News', 'Sport', 'Classical Music'; time and date, for display or recorder control; as well as

traffic reports, news flashes or announcements on other services (Tuttlebee and Hawkins 1998: 266). DAB receiver design was based on a principle 'that service access should be *content based*, so that a listener can "forget" the technical delivery mechanism' (Marks 1998: 5) and projects such as the HuMIDAB project (WorldDAB, Clarion, Sony and Bosch, BBC, Radio France and Swedish Radio) proposed interfaces for in-car systems, utilising touch screen interfaces and electronic programme guide (EPG) menu systems as ways of accessing DAB audio and data information services (Riley 1994).

In early market research conducted by manufacturers and programme providers, three broad market segments and applications were identified as particularly important for new DAB services (Tuttlebee and Hawkins 1998: 268). Firstly, in-car listening, as mentioned above, was identified as a top priority for the DAB project. Eureka-147 was the first transmission system designed specifically with the motor vehicle in mind and had perfected a system to deliver near-CD quality with no signal loss or fading as a car traversed an entire country, even at high speed. The major defects of analogue radio, it was claimed, were most apparent in moving vehicles both in urban conditions and on cross national routes. Medium-wave reception, for instance, was beset by problems of low audio quality, often marred by interference from electrical equipment or distant stations. FM reception also fluctuated considerably as vehicles crossed tall buildings, or drove through the countryside. To the annoyance of listeners, radio receivers also had to be retuned as the car moved out of range of one transmitter and into range of another (Fox 1994). DAB was designed to address many of these problems and as a result offered a quality of service never previously attained through its robust reception and linkage to a single frequency network.

The promise of an all-digital audio entertainment system for the automobile, complete with high speed datacasting, GPS navigation systems, traffic management information and high quality images, was considered DAB's killer application and potentially its most lucrative market (Shelswell., C. Gandy et al. 1991; Yamauchi, Kakiuchi et al. 1995: 74; Müller-Römer 1997). DAB was conceived as an integrating technology, delivering the benefits of high quality digital audio and nascent, internet-delivered information services, into the world of in-car entertainment, thereby extending the sense of mobile privatisation (Bull 2000) and enlarging the frontiers of broadcasting beyond the

constraints of analogue broadcasting. An early description conveyed the promise of DAB as *radio sans frontières*:

> Imagine driving the length of Britain, over the Channel and across Europe, listening all the time to the same radio station. The sound is in digital stereo, which gives it the same quality as that from a compact disc. There is no interference, and none of the fading and fluttering that normally blemish reception as you drive past tall buildings, over hills and down valleys. There is no need to keep retuning the radio because the chosen station remains on the same frequency throughout Europe - although, of course, you could retune to alternative national, international or local stations if you wanted to. (Fox 1991)

A second market segment envisaged as important for early adoption of DAB radio was the audiophile market. Hi-fi audio enthusiasts were considered to be important opinion leaders in the consumer market for DAB fixed and portable receivers. An assumption of the period was that the advent of digital audio formats such as the compact disc had created a demand for uniform, high quality audio in radio (Maddocks 1994). A number of high-end audio receivers were developed by hi-fi manufacturers such as Arcam, building on the wide acceptance of compact disc as the benchmark audio standard (Josse 2002). This emphasis on DAB's audiophile credentials was and continues to be an important component of the marketing strategy for digital radio, and claims for a radio listening experience of unsurpassed quality were central appeals of the new radio format, despite ongoing controversy regarding its actual performance (Spikofski and Klar 2003). Again, a scenario envisioning the compelling features of the DAB listening experience is presented in this extract from an engineering publication dating from 1996:

> Returning home from a business trip, Doug Digital turns on his car radio and enters code 15 for classical music. After the radio selects an appropriate strong-signal digital audio broadcasting station, Doug hums along, adding his voice to the compact-disk

> quality sound of the selection, which is free of any interference or signal fading despite the hilly terrain. He likes the music, but cannot put his finger on what it is, so he glances down at the radio's liquid-crystal display and reads the name of the selection and the performing artists. As he travels farther away from the station's transmitting facility, the radio switches to a stronger station airing the same classical programming, without his noticing the changeover.
>
> …When Doug gets home, he and his wife have dinner and then decide to listen to a live concert of the New York Philharmonic orchestra. Doug requests the concert from the pay-per-listen digital audio radio service he subscribes to and the two settle back, listening to it in five-channel Dolby Surround on their stereo system. After the concert, Doug decides to add features to his digital audio radio system, including programming it with a "pick list" for advertising offers so that he will automatically be informed of products that interest him. (Jurgen 1996: 52)

This scenario underlines the elite nature of the envisaged early adoption market for digital radio. The proposed listening experience is a refined one at the top end of luxury electronic consumption, matched indeed by the prices for early DAB receivers.

Finally, one further segment identified as an important potential new market for DAB was that of personal computer users. Less-exploited features of DAB include its facility for data-casting in addition to digital audio delivery. PC-card DAB receiver applications targeted at internet users could, it was thought, better exploit the dynamic programme text capabilities of DAB and had the potential to integrate internet use with high quality audio reception (Tuttlebee and Hawkins 1998: 268). At a time when internet connectivity was still predominantly based on dial-up connections, DAB receivers as additional modules for PCs could enhance a multimedia experience and offer potential for greater interactivity and e-commerce applications. Computer peripheral devices such as the Psion Wavefinder were developed that would allow

easy access to digital audio broadcasts as well as to enhanced interactive text features, though in practice few such services were developed and the devices themselves proved unreliable and unpopular.

The European technology context

The development of DAB digital radio also needs to be set against the broader context of its origins in European technology development policy and the distinct socio-political concerns of the late 1980s and early 1990s which helped shape its 'Europeanness'. Strengthening the competitiveness of the European audiovisual industry has been a mainstay of European policy since the mid 1980s with an emphasis on the development of a single market, support for regulatory harmonisation and an enhanced, centralised role for the European Commission in the communications sector (Kaitatzi-Whitlock 1996; Levy 1999; Harcourt 2002). The consolidation of the single market in Europe following ratification of the Maastricht Treaty in 1993 led to a wide-ranging set of measures to capitalise on Europe's potential as a global player in communications technologies and in audiovisual services to rival those of the United States and Japan. The environment thereby created was one with both liberalising market tendencies, designed to encourage pan-European broadcasting, as well as interventionist measures to protect cultural diversity and European audiovisual heritage (Collins 1995). Measures such as the *Television without Frontiers Directive* established a thriving single European broadcasting market, particularly for trans-frontier satellite broadcasting, while the MEDIA programme sought to support and protect European audiovisual production and distribution from international competition. One such measure within the MEDIA 92 programme included the venture capital Media Investment Club to support European audiovisual high technology development.

The Eureka programme, of which DAB was a direct product, was established in 1985 as an inter-governmental initiative to enhance the competitiveness of European industries and to align them more closely with European Union research and

development policies. A particular concern of the period was the increasing dominance of the Japanese consumer electronics industry, threatening Philips and other European manufacturers, and support for European technological innovation became a priority (Lembke 2003: 212). A key objective of European investment in technologies like digital radio, mobile communications and in satellite navigation systems was to enable standardisation, firstly, at the European level and, subsequently, on global terms in order to create opportunities for world leadership in high technology systems. With regard to digital radio, it was assumed that with the establishment of a common European standard, significant opportunities would be available for the European entertainment electronics industry to develop a whole range of new products for the consumer electronics and automobile sectors. The development of DAB was frequently characterised as an attempt to emulate the success of GSM, the global standard for mobile phone communication, developed with strong European backing. According to a member of the European Commission:

> After the digitisation of communications, digital radio is probably, after digital TV, the last chance for Europe to enhance its competitiveness in the consumer electronics sector. […] Europeans who developed the system and invested most in DAB, have to put all their efforts to participate in the exploitation of the system. With such a joint European efforts DAB can and will repeat the success story of GSM.. (in Lembke 2003: 214)

Initial expectations for DAB as a consumer electronics item were high and market research suggested that Europeans could buy 50 million DAB sets in the first 10 years, with sales then rising to 35 million a year. This compared very favourably with the seemingly ubiquitous CD player, which took eight years to achieve annual sales of 5 million (Fox 1994).

Central to this strategic vision of developing a global standard for digital radio broadcasting was the requirement for public intervention at a pan-European level, necessitating a political commitment and institutional backing to include the development of a stable regulatory framework, co-ordination of frequency allocation

and a co-ordinated strategic approach to supporting market adoption of the system. The close association of DAB with the European Broadcasting Union (EBU) was particularly important in this regard and, as the representative European organisation for national public broadcasting organisations, it had been central to the development of digital radio broadcasting. The EBU initiated the first series of studies on satellite DAB in the mid 1980s and supported the formation of the consortium for Eureka-147. EBU members were the driving force behind the consortium and the EBU's Technical Department actively participated in its various working groups. Crucially, the EBU as an international organisation provided the essential logistical support in promoting DAB at the International Telecommunications Union and in the preparations prior to the adoption of DAB as an ETSI standard (Kozamernik 1995: 10). EBU members, the public radio broadcasters, were and continue to be at the forefront of European digital radio services and are its driving force 'from technical testing, to content provision, to marketing and promoting the platform' (EBU-UER 2007: 8). Most importantly, according to the EBU, public broadcasters have been to the fore in promoting the benefits of digitization to citizens and acting as the social force underpinning the provision of services that commercial broadcasters would be unable or unwilling to do. As such, digital radio in the European context has always been closely associated with and allied to the institutional visions and infrastructure of European public broadcasting in both form and content, and as argued above, articulated through the actual architecture of a system suited to its needs rather than to other forms of broadcasting.

While the focus of European policy has concentrated on the cinema and television sectors, a central aim of the participating partners in Eureka-147 was to lobby Brussels for an equivalent level of political support for the digital radio sector. From its inception, the ambition of the DAB consortium was to be the defining global standard for the digital system to replace analogue AM and FM broadcasting. Within European policy terms, Eureka-147 was the radio industry's vision of its role within communications convergence and the digital revolution. Its successful early development and adoption as the first digital broadcasting standard, before rival systems such as Digital Video Broadcasting (DVB), suggested that little public

intervention would be needed (Liikanen 2001). Its subsequent sluggish pace of adoption led to renewed calls for more direct European support. Michael McEwen, then chairperson of WorldDAB, argued to the European Commission in 1998 that the rest of the world was looking to Europe for a lead in the roll-out of DAB: 'If it is not led by Europe,' it was argued, 'then how can you expect the rest of the world to adopt a European technology?'(European Commission 1998)

However, the European policy commitment to removing regulatory barriers, market intervention and the principle of technological neutrality in liberalised communications markets, meant in European Commission terms that, success or failure was primarily the responsibility of market players (Liikanen 2001: 4). The radio industry and the EuroDAB lobby group for Eureka-147 attempted to argue that there was a European dimension to digital radio, i.e., an element of public policy that could only be satisfactorily addressed at a European rather than at a national level, and that diverging regulatory frameworks and implementation strategies in the Member States would lead to fragmentation of the European market. Manufacturers, for example, strenuously argued that the fragmented and disjointed roll-out of digital radio, with successful implementation in some countries and very little in others, was a serious impediment to the development of a new market for digital radio receivers. The prevailing understanding that radio was a local medium, and the primary responsibility of diverse national and regional authorities, however, worked against any further European co-ordinated action and as a consequence decisive European Commission support was always qualified.

Conclusion

The guiding assumptions underpinning the development of Eureka-147 DAB were that a robust and mature technology developed within Europe's highly regarded high technology research environment would provide an ideal replacement standard for the international radio broadcasting industry. DAB's version of digital radio built on the proud experience of its trusted and oldest broadcasting institutions, and looked

confidently to an imagined future in which the major broadcasting institutions would continue to provide more content of higher quality and in interactive and multimedia formats. It represented an exemplary model of co-operation between European member states and between public broadcasting organisation and private manufactures with the guiding and financial support of agencies such as Eureka and the EBU. Its early success in technology design and rapid development of a fully working system suggested that it would be a great success as GSM had been previously, and would contribute further to Europe's leading role in global technology development. DAB did achieve rapid early success in attaining international standardization, with adoption of the basic DAB standard by ETSI in 1993, followed by the ITU-R recommendation of DAB as the only digital radio standard in 1994. The allocation of spectrum for terrestrial digital radio broadcasting by the World Administrative Radio Conference (WARC) in 1992 provided a major boost to its international standing and launched its efforts towards implementation in Western Europe and beyond.

Despite these early, promising indicators, DAB deployment stalled and continues to languish in an extended period of early market deployment and adoption with both ongoing successes and reversals. Lacking the sense of urgency and political priority given to analogue switch-off for television, radio now contends with a multiplicity of delivery mechanisms, analogue and digital, and has deferred the question of whether AM and FM broadcasting needs to be replaced. Strategies for the introduction of digital radio are characterised by a liberal market approach where it has largely been left to market forces to decide the fate of particular technologies. As with previous technological developments in the sector, this resulted in long delays in new technology development, competing solutions, confusion for the radio industry and for audiences; and an uncertain environment for future planning. Ironically, it was the failure of the radio industry as a whole to convince the European Commission of the 'Europeanness' of Eureka-147, or that there was a European question that merited intervention, that led to a situation where it received only fragmentary support. The appeals by the sector that strong market intervention was needed to create an extended single market, with harmonised approaches to spectrum planning and regulation,

coincided with a shift in policy to content regulation rather than individual sectors media such as radio or television. As a consequence, responsibility for realising the potential of digital radio remained at a local and national level, and inextricably bound up with the cultural and political struggles for support and control of broadcasting in individual member states.

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