Frequency Economy — new convergence

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Frequency economy in terms of *economic efficiency* leads to quite different conclusions on how to use the broadcast spectrum than frequency economy in terms of *spectrum efficiency*. This article discusses some aspects of frequency economy and convergence, as seen from a radio broadcaster's perspective.

Broadcasters depend on two limited resources: ***radio frequencies*** and ***money***. The mobile telecommunications industry is becoming aware of similar constraints. The market for electronic distribution of information and entertainment is clearly large, but not unlimited. Many market players are concerned that it may not generate sufficient revenues to cover their large investments in new wireless infrastructures and technologies.

But the cost of transmitting a certain amount of data in a broadcast network is only a fraction of that in a mobile network. This creates a pressure on the broadcast sector – it may be much more efficient, in an economic sense, for mobile operators to use broadcast spectrum for non-broadcast types of services. But broadcasters may equally well take advantage of this opportunity.

The forthcoming ITU Regional Radio Conference RRC-04/05 will establish a digital Plan to govern the use of the broadcast bands for the foreseeable future. In doing so, the Conference will endeavour to satisfy the requirements of the participating Administrations by allocating frequencies as efficiently as possible. It is not unlikely that there will be several interpretations of what that means in practice.

Frequency Economy – New Convergence can be interpreted as understanding and exploiting a new cooperation between broadcast and mobile telecommunications networks and services, in order to expand markets and create new revenue sources.

Who should then pay the costs ... who should be able to profit from using broadcast spectrum ... and on which grounds should it be allocated to different systems, services and market players?

This article [1] presents some views and considerations from a Swedish perspective. It is however hoped that many of these will be relevant to other countries as well.

Political background

The first session of the Regional Radio Conference (RRC 04/05) will be held in May 2004. RRC 04/05 will establish a new digital plan for DAB and DVB-T broadcasting in Band III (VHF) and DVB-T in Bands IV

1. This article is based on a paper and presentation given at the 9th Meeting of the World DAB Forum General Assembly in Rome, 9 - 10 October 2003.

and V (UHF). The second session, to be held in 2006, will produce an Agreement that determines the use of the VHF and UHF bands for many years to come. The European Union is not a Member of the ITU and hence not a party to the Agreement. It nevertheless wishes to increase its control of the future use of the radio-frequency spectrum. In a Communication [2] from the Commission it is stated that:

> ***"... The Communication also proposes to launch a debate on spectrum aspects of switchover within the new Community spectrum policy framework. This would address possible approaches for greater transparency about the economic value of spectrum allocated to terrestrial broadcasting services. The top-level objective is to encourage efficient and flexible spectrum usage, while preserving the service mission of broadcasting."***

> ***"... Secondly, switch-off of analogue terrestrial TV could permit the release of several hundreds of megahertz (MHz) in the VHF and UHF frequency bands, which could be reallocated to various uses, for instance convergent services combining features of mobile telephony and terrestrial broadcasting, such as mobile "datacasting". But before such time, switchover may actually aggravate spectrum scarcity insofar as analogue and digital broadcasts are "simulcast" in parallel. So the duration of the switchover period is crucial, especially in areas where the spectrum space is over-crowded."***

The views of the Commission are not necessarily shared by the broadcast community. However, it is imperative that broadcasters understand: (i) the economic value of the spectrum allocated to broadcasting, (ii) which alternative spectrum usage may be beneficial to them, and (iii) whether non-broadcast usage represents threats or opportunities, and then use this knowledge.

Broadcast scene

Broadcasters today are experiencing increasing competition and fragmentation. For almost all radio and television channels, this means decreasing audiences. Many broadcasters try to meet the increasing competition with more programmes, new channels, new formats, interactivity and even personalised content. This causes fragmentation, which is further compounded by technical developments in terms of new distribution platforms and coding formats. They nevertheless regard presence on the new distribution platforms as instrumental for them to remain competitive and maybe even to survive. The possibility of offering more and diversified content, quality adaptation to suit the intended market, and various types of ancillary services has become increasingly important.

This is however often done without a corresponding growth in economic resources. Today, public service broadcasters (PSBs) get less rather than more funding from licence fees. Commercial broadcasters note that the advertising market has grown only marginally for several years. Other means of income are virtually non-existent. Digitalization has however created some scope for producing more radio and TV channels within existing budget limits. There are broadcasters who have managed to increase their total share of the audience in this way. But the transition period to digital broadcasting introduces significant increases in distribution costs, because there will be a long period of parallel analogue and digital transmissions.

When DAB transmissions commenced in Sweden in 1995, it was evident that the transition to digital radio would not be completely financed. Swedish Radio's new digital channels on DAB and on the Internet were not requested by politicians. There are still no special funds to cover parallel FM and DAB transmissions. It is generally anticipated that digital broadcast networks will eventually become more efficient and much cheaper per service than analogue ones. But this is no incentive for the audience to pay more for a particular service during the transition period. TV and radio programmes still have to be free-to-air to attract large audiences. It is only when the analogue networks have been turned off that the economic benefits of digital transmission technology can be harvested.

2. *Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions on the transition from analogue to digital broadcasting*, COM(2003) 541 final, 17 September 2003.

The situation for television might be slightly better than for radio. There is a strong EU political pressure to speed up the switchover to DVB-T. For radio, the transition period has not yet been determined.

Big and small markets

Radio is a small market compared to television and telecommunications. Radio in Sweden is a small market compared to radio in Great Britain. But a broadcast network in Sweden has to be much larger than a broadcast network in Great Britain. Unfortunately there has been a tendency in Europe to focus on problems in large markets to the detriment of the smaller ones. It is not always possible to apply conditions in one country to another – the radio markets differ surprisingly much between European countries. The successful model for introducing DAB in Great Britain may be difficult to apply in Sweden. It suggests that the extra distribution costs incurred by the technology shift must be covered by new financial resources or money that is made available in other ways. Especially, small commercial stations and non-commercial community radio stations need to find alternate funding and new sources of revenues to be able to take the step to DAB.

For radio broadcasters it may then seem natural to consider how DAB networks and technology may be used for other purposes than conventional audio broadcasting. "Datacasting" would exploit one of the most obvious advantages of digital broadcast networks: cost-effective distribution of identical information to many users, who do not need to be at any particular place.

Using part of the DAB multiplex for datacasting could create interesting business opportunities for third party service providers. As radio is such a small market compared to television and telecom, a rather tiny part of the market for "convergent" services would suffice to generate valuable contributions to the overall economy of radio broadcasting. In particular, services with high value per transmitted bit could generate significant revenue streams in DAB networks. On the other hand, if this becomes instrumental for digital radio to survive, even small shifts in customer habits and willingness to pay may have adverse effects on the total economy of radio broadcasting. DAB is the smallest and most vulnerable of the new digital platforms.

New roads to explore

Surprisingly few users are needed for a DAB network to become competitive with other wireless systems, especially mobile networks, for distributing one-to-many services. This is even valid for networks covering large areas with a limited population. SR has made some rough estimates based on typical GPRS tariffs and operational costs for broadcast networks in Sweden. Less than 100 users per day would suffice to make data downloading via a fully-deployed national DAB network cheaper for an individual user than via GPRS (assuming that each data file is retransmitted every five minutes in DAB). Comparing streaming services (e.g. radio) gives even more stunning results. Delivering radio programmes via GPRS would cost the average listener of SR's programmes almost 10 000 times more than via DAB, even if the effective audio bitrate is only half of that in DAB.

A great number of unorthodox services and applications of DAB technology have been proposed, which may attract new users and service providers, and widen the market for DAB. Most of these require that receivers are equipped with persistent memory to store data. They should also have a small screen if necessary. Many services could be significantly enhanced if the receiver is combined with a mobile phone to become a "convergent" terminal accessing both broadcast and mobile networks.

There has been some doubt about the market for such devices, due to the expected high retail prices. Nokia's firm plans to introduce IP datacasting services in handheld devices, as well as Microsoft's new portable MediaCenter, are likely to make these concerns obsolete. A novel idea is to include a broadcast receiver in the remote controls for TV sets. Games consoles equipped with DAB receivers may become another market driver.

The user experience would generally be similar to downloading services from the Internet, but the interaction can be done locally in the receiver using previously downloaded data. These services may therefore be desig-

nated “Internet-like”. They may equally be called “broadcast-like” because they are distributed to an indefinite number of users who can remain anonymous if they so wish. A few examples are:

- Downloading of data to “intelligent” systems (e.g. car navigation systems and pocket journey planners). This has probably been the most investigated of all the possible services. The return channel can be used for premium and personalised services.
- Electronic newspapers. This could be a hybrid service, where the bulk of the data is downloaded during night-time (possibly via a fixed Internet connection) and up-dates are broadcast during the day.
- On-line betting (or gaming). Current status of all races etc. are broadcast continually, and bets (or actions) placed via the mobile network.
- The “arena community”. This service could be described as closed-circuit broadcasting, for example local TV, radio, multimedia and data broadcasting during a sports event, including interaction with the public. Participants have to pay a small fee to access the service or send messages across the network.

None of these services would require particularly high data rates and would only occupy a minor part of the overall capacity. The distribution costs per user would be very small, which is a good starting point for interesting business models. Preliminary estimates show that a surprisingly low number of users paying a moderate sum for a service would suffice to cover the operational costs for the entire DAB network that carries the service. For example, 100 000 users paying € 0.5 a day would suffice to pay the costs for a national DAB network in Sweden.

It is important to note that any pay services should be designed to bring “fresh” money into the broadcast system, not as a way of re-distributing “existing” money among the actors. It is not necessarily the end user who should pay for a particular service. Distributing traffic data and other infrastructure or environmental information may generate significant savings for the society, which could be capitalised and result in economic subsidies to cover network operational costs. Similarly, if newspapers can save money by using wireless distribution, they should be prepared to pay for it.

Regulatory constraints and/or lack of frequencies may block the introduction of these new services. The regulatory aspects can only be solved at the political level. Some services, for example the arena community, could probably use DAB at L-band. But for the foreseeable future, wide-area coverage is likely to be economically viable only in the VHF or UHF bands. The national requirements put forward to RRC 04/05 should therefore not only reflect the need for adequate spectrum for traditional broadcast services, but also for additional services that may be needed to make the digital switchover economically viable for broadcasters.

Same ideas, other players

Radio broadcasters wishing to introduce digital services via DAB may obviously improve the economic conditions for doing so by granting third-party service providers the use of some capacity. But it is not sufficient to look at DAB only to predict the feasibility of introducing datacasting services via broadcast networks. As RRC-04/05 draws nearer, new and economically strong forces are joining the game.

“Infotainment services” were once expected to generate a substantial amount of revenues in 3G mobile networks. These services are similar to radio and television, but adapted for reception on small handheld devices in a mobile environment. Unfortunately, the cost for the individual user of these services seems to have been overlooked when market predictions were made. 3G networks may probably offer cheaper voice communication than GSM, but it is a straightforward exercise to show that the costs of transmitting sufficient amounts of data for streaming audio and video via UMTS will exclude mass distribution for the foreseeable future.

By contrast, digital broadcast networks are obviously designed for mass distribution of radio and television programmes at very low cost per individual user. In practice the cost of data transmission is negligible compared to mobile networks. For this reason the mobile industry is now looking at the broadcast bands and the possibilities of using them for datacasting to handheld devices. It may be assumed that the main concern is no longer the survival of radio broadcasters but safeguarding the interests of the mobile industry itself.

Datacasting to handhelds

The VHF and UHF bands are very suitable for mobile services. The VHF band is particularly favourable for mobile reception at high speeds. Parts of the UHF band also provide good mobile reception properties and, furthermore, allow smaller antennas than in the VHF band. These parts of the UHF band are therefore especially attractive for reception by small handheld devices such as mobile phones.

The mobile industry has claimed for years that conventional television should be evacuated from the UHF band, which should instead be allocated to mobile services. The telecom crisis in recent years has created some doubts about the real need for this. Now a more subtle approach is being adopted. The proposal from the mobile industry is for broadcast and mobile networks to be co-ordinated in such a way as to be attractive also for broadcasters.

The concept is called ***IP Datacasting*** (IPDC). For reasons that are not immediately obvious, DVB-T (Terrestrial) has been chosen as the distribution platform for IPDC, but in an adapted mode called ***DVB-H*** (Handheld). Technologies for enabling co-operation between UMTS and DVB networks and terminals based on IP data transport are being developed by EU-funded research.

Low battery consumption is a must in mobile telephones and other handheld devices. DVB was not designed with low power consumption in mind. "Power saving" is therefore an important aspect of IPDC and DVB-H and a key technology for the concept to work. A promising technology called "time slicing" has been developed where the receiver rests in stand-by mode most of the time. It switches on for short periods at regular intervals while the requested service is broadcast. This technology may reduce battery consumption by more than 90%. But it also restricts services to narrow bandwidth channels, typically a few hundred kbit/s, regardless of the bandwidth of the broadcast system itself.

IPDC via DVB-H is designed with mobile television and web-type services in mind. A DVB-H multiplex can typically carry more than 30 television channels coded at about 300 kbit/s. Higher bitrates cannot be used, and are not deemed necessary for the small screen sizes of mobile phones. Opinions on the resulting picture quality are likely to depend on what kind of interest the viewer has in the new technology.

IPDC in DAB

Systems for mobile television based on DAB have already been developed, but do not seem to attract the mobile industry in Europe. Bosch's Digital Multimedia Broadcasting (DMB) system has been used for broadcasting video services to trains. It uses the same MPEG transport stream as DVB. A new, similar, system for video broadcasting services in DAB is being developed in Korea by major broadcasters, network operators and industry, and is supported by Korea's Ministry of Commerce, Industry and Energy. Implementation of the network is already in progress and services will commence in 2004. The Korean system is based on H.264/MPEG-4 Advanced Video Coding and MPEG-4 ER-BSAC (Error Resilient – Bit Sliced Arithmetic Coding) for the audio. **It is likely to offer much higher picture quality than DVB-H will ever do.**

Samsung DMB terminal

The DMB systems do not use IP, but the concept of IPDC is equally applicable to DAB and DVB-H. Hence the choice of broadcast technology (DAB or DVB) is not a determining factor for IPDC as such. There are other underlying reasons for choosing DVB, as will be discussed below. But the firm interest in IPDC implies that the idea of using DAB for datacast types of services is not entirely imaginary.

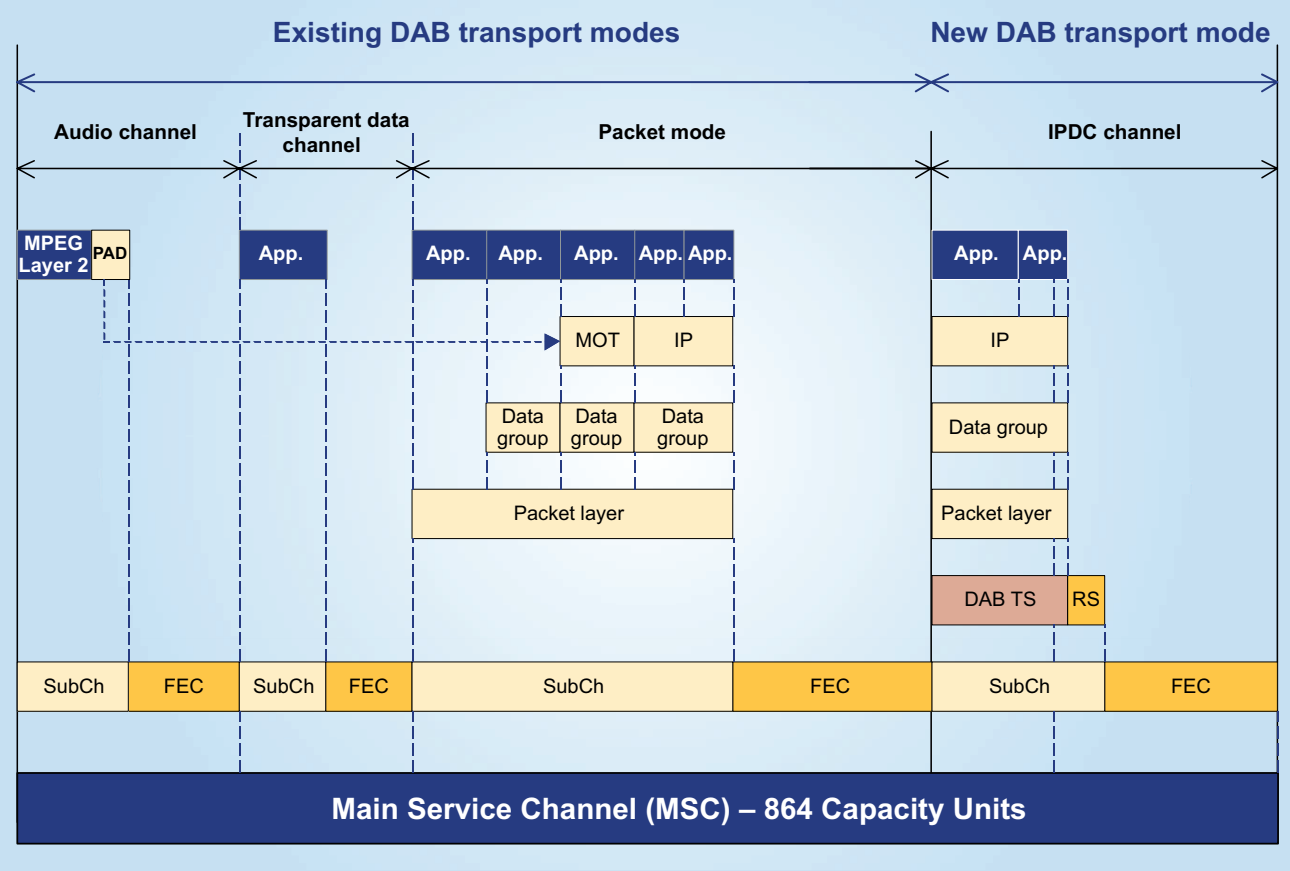

Figure 1
Proposed new modes of transporting data in DAB, including DMB and IPDC

There are two features of DVB-H that have to be matched by DAB in order to allow IPDC and video broadcasting to handhelds – low receiver power consumption to increase battery time, and improved resilience against transmission errors.

Without any change, the existing DAB standard permits implementing DAB receivers with low power consumption for narrow bandwidth channels. Power saving in DAB can be accomplished by processing only those RF carriers that convey the selected and decoded service. It is therefore equally applicable to both new IPDC and existing low bitrate services, but the saving would of course be lower for channels of higher bandwidth. The technology has not yet been fully exploited in existing chipsets. The power consumption of an optimized DAB receiver would be very low compared to that of a standard DVB-T receiver and would approach the savings made by a DVB-H receiver. In addition, specific power saving – using similar methods to DVB-H, notably time-slicing – can also be introduced [3]. Suitably designed DAB and DVB-H receivers should actually have similar power consumption for services of equal bandwidth – this is just a consequence of the laws of physics.

The unequal error protection (UEP) scheme used on audio channels in DAB permit satisfactory reception at BERs as high as 10^{-4}. Such high error rates would generate very high IP packet loss rates or unacceptable video decoding performance. Preliminary studies made in Sweden suggest that it would be a straightforward matter to define a new transport mode in DAB, which would include concatenated coding similar to that in DVB. This would guarantee the very low BER needed for robust data transport of video and IP packets (typically $< 10^{-8}$). This addition to the DAB standard would be perfectly backwards compatible and should not affect receivers that comply with the present standard.

A single DAB multiplex could carry a mix of existing and IPDC/video services. *Fig. 1* outlines the existing and proposed new modes of transporting data in DAB, including DMB and IPDC.

3. A specification for power saving in DAB is being developed by the WorldDAB Technical Committee.

Divergent scenarios

DVB-H must be regarded as a serious competitor to DAB for Internet-like and broadcast-like services. In addition there are reasons to assume that DVB-H networks will not be implemented to suit radio broadcasting, but to complement UMTS networks. However, DVB-T might become more affected by DVB-H than DAB. To understand this, other sectors of the consumer electronics market have to be observed. New distribution media such as mp3 music files and DVD have achieved a very large market penetration in a short time. The home cinema market, including multichannel audio, is growing faster than any comparable market in the past.

Nokia 7700 DVB-H terminal

It suggests that consumers appreciate very high technical quality for enhancing their viewing and listening experiences, but they may also accept low technical quality if needed to access content regardless of time and location.

The European Commission notes in a Commission Staff working paper [4]

> ***"A combination of new technologies – flat-screen displays, more powerful compression systems and new DVD technologies – and related market trends may alter European broadcasters' perceived incentives away from emphasizing the quantity of digital TV services, towards quality. This could culminate with HDTV services being offered to the European public. Given past experience, a policy-driven approach to HDTV would be counterproductive; however having prematurely over-estimated the role of HDTV in the past, the Union should not overlook its future potential."***

There is a great uncertainty about the future of HDTV, especially in terrestrial networks. In the future, a majority of television sets will be equipped with flat screens, which offer higher resolution than CRTs. Looking at the computer industry might give a clue to how this will be exploited. Microsoft's MediaCenter integrates virtually all electronic media and communication facilities into one box aimed at the consumer market. The user switches easily between television, radio, recorded media, Internet etc. When this (and similar) systems become abundant in our homes, the television viewer will note that some TV channels look worse than others without giving any regard to which way they entered the box. A long-term scenario therefore suggests that terrestrial television broadcasters may have to introduce HDTV in order to meet competition from satellite channels and other media such as DVD. This will require higher data rates for video coding, and hence increase the demand for more radio-frequency bandwidth. This may create a severe shortage of frequencies.

By contrast, the mobile industry seems to be convinced that the digitalization of broadcasting will free hundreds of MHz of broadcast spectrum. This view is also maintained at the political level, especially in the EU as quoted above. But if part of the UHF band is re-allocated to mobile services, the spectrum used for conventional multichannel television will be reduced. DVB-H might actually hamper the evolution of terrestrial digital television. Another long-term scenario therefore suggests that the resulting service offer could even become too small to constitute a viable market.

Both scenarios may create profound "overspill" onto the DAB market. Terrestrial HDTV would create a strong pressure on the VHF band, and compete with DAB for frequencies. Failure of DVB-T but success of DVB-H could literally free hundreds of MHz of spectrum, but probably marginalize datacasting in DAB.

4. *The contribution of wide-screen and high definition to the global roll-out of digital television*, SEC(2004) 46, 13 January 2004.

Market considerations

As we approach RRC-04/05 it would seem prudent to ask what use of the broadcast bands the consumers would prefer. Unfortunately no useful answers may be expected if the consumers are asked directly. The traditional planning process never asks what the end user market demands, although this is hopefully reflected in the different players' requirements. In practice we might end up with three, not two different systems that compete for broadcast spectrum in Europe. They may target different markets and customers and have very dissimilar requirements on network topology, coverage, etc.

It is therefore important for broadcasters to establish an overall view on how the markets may develop for all kinds of services in various versions and combinations of DAB, DVB, GSM and UMTS. The audience has a finite amount of money to spend on these services. A large portion of the market, in a wide sense, is already mortgaged by licence fees, network subscriptions and advertising. But there is an "open" market where users have more control. The new market players want to exploit this: for example, by asking customers to pay for interactive services, personalised content or mobile television.

A combined terminal for DAB and GSM and/or UMTS should be able to handle all types of services of a corresponding DVB-H/GSM/UMTS terminal. The pertinent question is: *What total transmission capacity is needed in a single broadcast multiplex when other factors are taken into account?* This question can be rephrased in an interesting way: *Will the capacity in DVB-H ever be needed for IPDC services? Does it represent a realistic assessment of the future IPDC market?*

Television is much bigger than radio in terms of capacity, revenues, market and the collective interest of all players. It suggests that any future datacasting system "should" be part of the DVB family. Nokia is a driving force behind DVB-H and IPDC. They believe that mobile television will become a significant driver on the mobile market.

DVB-H has sufficient bandwidth to transmit 30 - 40 low-resolution TV channels, depending on the video coding scheme used and the final specification of the system. IPDC is presently being conceived to convince users to pay for receiving existing television channels on their handhelds. But it remains to be seen what market demand there is for such services. Will users accept paying for Public Service or commercial channels that are normally free-to-air? How many video clips can be produced exclusively and profitably for the IPDC market, considering that it increases production and operational costs over simple transcoding to lower bitrates?

In this context it is essential to understand user expectations on different kinds of content and the cost of acquiring it. These are probably related to the platform used, and how services are paid for. The mobile telephone user is familiar with a device that has a small screen, and knows that it is possible to interact with the network to download content. It creates reasonable expectations about what the mobile phone can be used for or not. Micro-payment schemes are now being established in the mobile networks. Simply speaking, the user accepts to pay a small fee for rather simple content or services with limited technical quality. Micro-payments probably makes it easier to sell such content.

It may be more difficult to request money for live or streaming content than for a service that is perceived as unique or personal. There could even be an inverse relation between the data capacity required by a service and the willingness to pay for it. Broadband customers in Sweden have protested against special fees for

Abbreviations

CRT	Cathode Ray Tube	**IP**	Internet Protocol
DAB	Digital Audio Broadcasting (Eureka-147)	**IPDC**	IP DataCasting
DMB	Digital Multimedia Broadcasting	**ITU**	International Telecommunication Union
DVB	Digital Video Broadcasting	**MMS**	Multimedia Messaging Service
DVB-H	DVB - Handheld	**RRC**	(ITU) Regional Radiocommunication Conference
DVB-T	DVB - Terrestrial	**SMS**	Short Message Service
EU	European Union	**UEP**	Unequal Error Protection
FM	Frequency Modulation	**UHF**	Ultra High Frequency
GPRS	General Packet Radio Service	**UMTS**	Universal Mobile Telecommunication System
GSM	Global System for Mobile communications	**VHF**	Very High Frequency

watching SVT's channels, as they have already paid for the network access. The future user of the Media-Center expects to find virtually any kind of information or content – in large volumes and with high quality if needed. But he or she will not really be prepared to pay special fees for radio or television in addition to the network and Internet subscription fees. This is important knowledge for the broadcasters.

The transmission cost of a video clip in DVB-H or DAB is certainly low. However, bits that carry data services are normally much more valuable than bits that carry audio, which may be more valuable than bits that carry moving pictures. For example, TV4 viewers in Sweden are prepared to pay the equivalent of € 0.3 for sending an SMS message to the station – a tariff of € 0.4 is out of the question. An SMS amounts to a few hundred bits of data. It might be possible to ask viewers to pay more for an MMS message, especially if the sender can appear in person on a TV screen in this way but, in this case, thousands of bits have to be transmitted.

Video is unfortunately the most "diluted" form of information one might ask people to pay money for in a digital network. How much video is needed for a customer to pay 0.3 Euros? It is tempting to conclude that low bitrate services transporting high user value per bit represent a much more viable service proposition than mobile television to handhelds.

"Convergent" handheld terminals would be equipped to access both IPDC services and point-to-point mobile services. The combined system would be built on the assumption that the user downloads much more data than he or she generates. This is called asymmetric traffic. Content is therefore mainly assumed to be generated by third-party service providers. Recently, however, an interesting trend towards symmetric traffic has been observed. File sharing, whether legal or not, and interconnection of game consoles, is expected to generate the bulk of Internet traffic in the future. The mobile industry is following suit by encouraging customers to generate traffic themselves. MMS and video calls are typical examples. Activities are being undertaken to standardize a "walkie talkie" application. The mobile industry is already developing fourth-generation mobile technologies where data rates up to 100 Mbit/s are being discussed for both the uplink and downlink.

This trend does however create some problems when deciding the IPDC tariffs. It might be difficult to explain to customers that downloading a video clip may be very cheap in an IPDC network, but the cost increases by a factor of 1000 or more when the terminal cannot access an IPDC network and has to fall back on the 3G network, or if the user wants to upload a similar clip via the 3G network. Therefore the tariffs in a combined mobile/IPDC network may have to reflect the costs in the mobile network. If a flat rate is applied to even out the cost for the user, it is no longer possible to offer services as inexpensively as would have been possible in a stand-alone IPDC network. This is of course detrimental to any IPDC market. There are actually mobile operators who seem to have a more wait-and-see attitude towards DVB-H than Nokia and certain broadcast network operators.

Conclusions

Frequency economy in terms of ***economic efficiency*** leads to quite different conclusions on how to use the broadcast spectrum than frequency economy in terms of ***spectrum efficiency***. This article has discussed some aspects of frequency economy and convergence as seen from a radio broadcaster's perspective.

Kjell Engström graduated from the Royal Institute of Technology in Stockholm in 1972, where he worked with the Department of Telecommunication Theory for ten years. In 1980 he joined the Research and Development Department of the Swedish Broadcasting Corporation (SR) and was appointed Head of Research in 1988. The SR Group was reorganized in 1993 and he became Senior research engineer in the new (radio-only) company.

Mr Engström has worked on most new systems for radio and television broadcasting. For example, he defined the novel Nordic multiplex system for satellite broadcasting, proposed to the EBU in 1983, and the digital studio-quality transmission system for audio which is now ITU-R Rec. J.57. Today he is involved in strategic analyses of broadcast / telecom developments, media convergence and spectrum issues.

Kjell Engström has represented SR in a number of EBU groups in former Working Party V, including its Steering Committee, and in ITU-R Study Groups 10 and 11. He was chairman of EBU Project Groups B/DAC (DAB Characterization and Evaluation) and B/MM (Multimedia to Mobiles). Today he is a member of the EBU Broadcast Management Committee (BMC) and the WorldDAB Technical Committee.

DAB was developed for audio broadcasting, but is effectively a generic distribution platform for all kinds of audiovisual and data services. It is important that RRC-04/05 does not result in artificial constraints for the future use of DAB. Developments should be initiated to increase the competitiveness and applicability of DAB to new markets. In doing so, the radio sector should identify, analyse and describe the mutual dependence between overlapping "convergent" markets.

Asking users to re-direct existing money to pay for new services does not generate additional revenues. It must be possible to make market players from outside the broadcast sector interested in exploiting DAB to generate *new* revenue streams and make DAB networks profitable. DAB should be fully integrated in the new, convergent media landscape.

As discussed in this article, this is not mainly a technical problem but requires significant changes in attitudes in the telecom industry and at the political level.

The broadcast sector itself has to take full responsibility for this to happen.