An economic analysis of DAB & DVB-H

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Cost comparisons between DAB and DVB-H have sometimes been inconsistent in the past. Some have claimed that DAB networks are cheaper per multiplex, while others have claimed that DVB-H will be cheaper per radio or TV channel. The underlying and hidden assumption is that the networks will be filled with content.

These kinds of comparisons leave much for speculation – as one can claim that both DAB and DVB-H can be cheaper, depending on if you calculate the costs per multiplex or per channel. To know the costs of these technologies, we need to know the market size. And clearly, we need a common measurement system, to enable fair comparisons.

An intuitive analysis

Consider a family going on a holiday needing to rent a car. If the family is large they will want to rent a large car, perhaps a minibus, because it will be cheaper than renting several small cars. But if the family is small they can settle for a small car because it is cheaper than renting a large one. To tell the small family that the minibus is cheaper per seat is not truthful because they do not need the extra seats anyway. In the same way, telling the large family that the small car is cheaper, per car, is not completely correct as they would need to rent several cars to fit their needs.

Following this simple analogy, we can say that the overall relationship between DAB and DVB-H is that DAB is a small-scale system which is cost efficient when the total demand for broadcasting capacity is small. On the other hand, DVB-H is a large-scale system which will be more cost efficient when the demand for capacity is large. For any country, the central questions therefore are: *how large will the total capacity demand be, and what does it imply on the network costs?* The purpose of this article is to outline a framework, a method, for calculating capacity demand and network cost. This will be done by applying the method to the Swedish media market, from the perspective of Swedish Radio (SR). What we want to know is what the cost will be for broadcasting each of our radio channels to mobile devices using DAB and DVB-H.

In the rental car analogy above, one can also claim that it is better to have a large car for safety reasons, or a small car because it is easier to park. Furthermore, one can prefer either of the two cars for reasons such as the colour, brand name, technical features or even because we have stocks invested in one of the manufacturers. However, this analysis of DAB and DVB-H will leave out these kinds of considerations and focus only on the seating capacity and luggage space – i.e. how many media and other services will fit and what the cost will be for each one. The analysis will be applied to the Swedish media market from a long-run perspective, while ignoring the short run fluctuations and problems.

The general outline of our analysis is firstly to calculate the cost per channel at different market sizes and identify at what point, and by how much, each system is cheaper. Secondly, the costs and revenues for media services are calculated, essentially revealing the media-carrying capacity for different towns in Sweden. Thirdly, a calculation is made to establish what share of the population is covered more cost efficiently by each technology in different market scenarios. The population coverage is then transformed into area coverage and, finally, into network costs.

Step 1 – The cost per channel

Fig. 1 shows the distribution costs for DAB in comparison with DVB-H [1]. The calculations are based on the assumption that a typical radio channel is broadcast at 192 kbit/s. The blue graph shows what the cost (y-axis) is for each radio channel, depending on the capacity needed for the whole Swedish market (x-axis). The more players that want to use DAB, the cheaper it is per channel, as the fixed costs – masts, redundancy, security, etc. – can be shared by all.

The steps in the graph represent the need to add another multiplex, which leads to an increase in the costs. The red graph shows the costs per channel in the case of DVB-H, following the same reasoning. As depicted, DAB is cheaper when the demand for capacity is low, while DVB-H is cheaper when the demand for capacity is high.

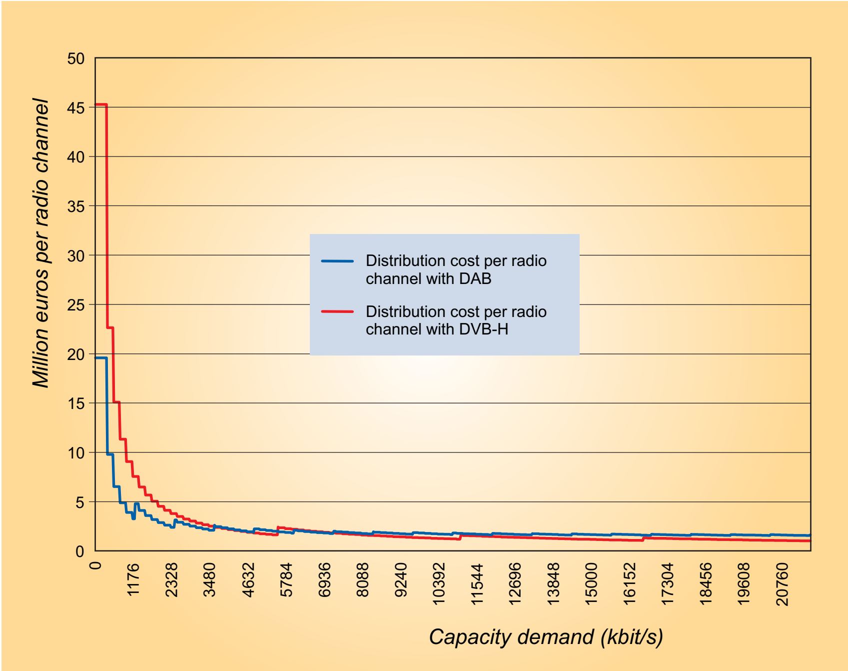

Figure 1
Relationship between DAB and DVB-H costs

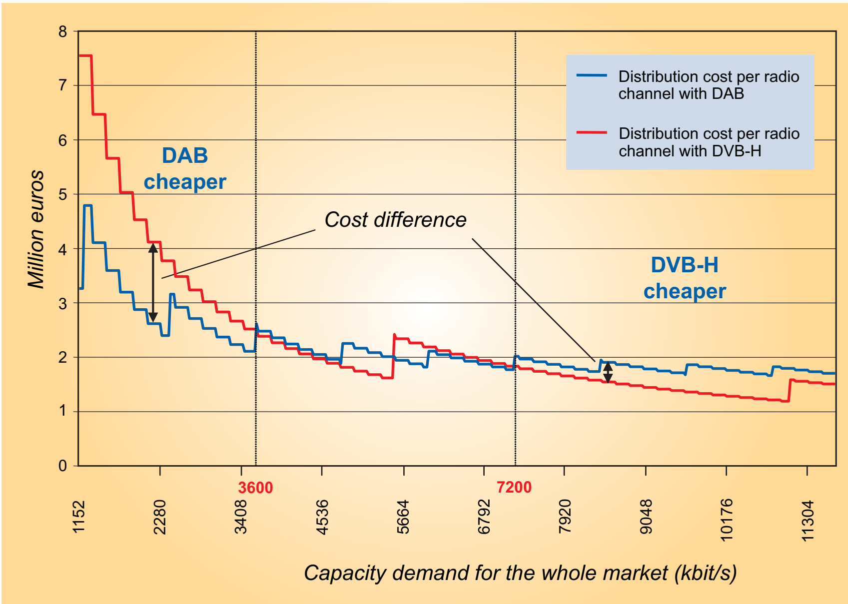

Figure 2
Distribution costs for national radio channels for DAB and DVB-H
(given that SR distributes at least 6 channels)

To make a reasonable analysis and cost comparison, we should concentrate on the parts of the graphs that portray what is likely to happen. If SR were to be alone in any of the networks, we would need a capacity corresponding to at least one DAB multiplex (typically 1152 kbit/s, as SR probably wishes to broadcast at least six radio channels). All values to the left of this point (1152 kbit/s) are therefore irrelevant. Moreover, capacity beyond approximately 11 000 kbit/s is unlikely to materialize, because the frequency allocations are limited.

Fig. 2 shows the distribution costs for national radio only, which are relevant to the first part of this analysis.

1. The costs per multiplex for national coverage were calculated by Progira Radio Communication, assuming DAB in the VHF band and DVB-H on UHF with 5.5 Mbit/s per multiplex.

As can be seen, the blue DAB cost graph is underneath the red DVB-H cost graph – where the demand is below 3600 kbit/s. If the demand for capacity is within this interval, DAB is preferable and will be 0.5 - 3 million euros cheaper per channel (which equals 3 - 18 million euros for SR's six channels). For capacity demand between 3600 and 7200 kbit/s, the cost comparison shows ambiguous results as the graphs are intertwined. Finally it can be noted that for capacity demand larger than 7200 kbit/s, DVB-H is preferable from a cost perspective. Here DVB-H is 0.2 - 0.5 million euros cheaper per channel (which equals 1.2 - 3 million euros for SR's six channels).

The first conclusion is thus that when DAB is cheaper it is ***much cheaper*** than DVB-H, while DVB-H is only ***marginally cheaper*** when it has a cost advantage.

However, to find out which of the systems will truly be cheaper, we need to understand the ***total demand*** for broadcasting capacity.

Step 2 – How to measure total demand

So what does this demand consist of? Both DAB and DVB-H technology can be used to distribute radio and TV programmes to mobile phones, along with websites or any other types of digital information. The total capacity demand therefore corresponds to the total amount of radio channels, TV channels, data services etc. that different companies want to distribute. To get a notion of this demand, one therefore needs to make a prognosis over how large the future markets for radio, mobile TV and other services will be. Such a forecast obviously contains a great deal of speculation but it can still be of value to be able to exclude some cases. Furthermore, if the speculations are made in a qualified way, they can be more valuable than plain guesswork.

Firstly, let us get the magnitudes right: 1152 kbit/s is assumed to correspond to six radio channels or three mobile TV channels.

A company that is considering whether or not to approach a market makes an assessment of the expected revenues in comparison to the expected costs. If the revenues surpass the costs, it will try to enter the market, otherwise it will not. If the market does not contain any considerable barriers to entry or exit, there will be exactly as many companies as the market can bear – perfect competition.

Another aspect to consider is that a radio or TV company can choose to enter only some local markets which are favourable enough. In other words, the above picture of distribution costs is too coarse as the companies do not necessarily need to broadcast over the whole of Sweden. It is therefore essential to analyse revenues and costs for local markets.

As SR's public service remit requires 99.8% population coverage, the relevant questions for us are:

1) Within which geographical areas must SR finance the whole network themselves?
2) Within which areas will there be other companies sharing our costs?
3) In the areas where we are not alone, how many more companies will share our costs?

We need all this information to finally be able to answer which network technology will be cheaper for us.

Step 3 – The future mobile TV market

Mobile TV is not a market that exists today and the accuracy of the following calculations are therefore unsure – the main purpose is to present the logic and a few possible scenarios. The following assumptions have been used:

- All TV companies have the same audience share and hence equal revenues.
- For the TV programmes to be watched on a mobile phone, a certain amount of formatting and transcoding is necessary. But costs for exclusively-produced channels are not included.

- The mobile TV channels do not need to be adapted to each local market (the same TV channel can be broadcast in all parts of the country). The formatting only needs to be done once and at the same location for all programmes.
- The Swedish TV market of today (excluding public service TV) has a turnover of 0.8 billion euros [2].
- No attention is paid to different business models; they are all assumed to generate the same revenues.

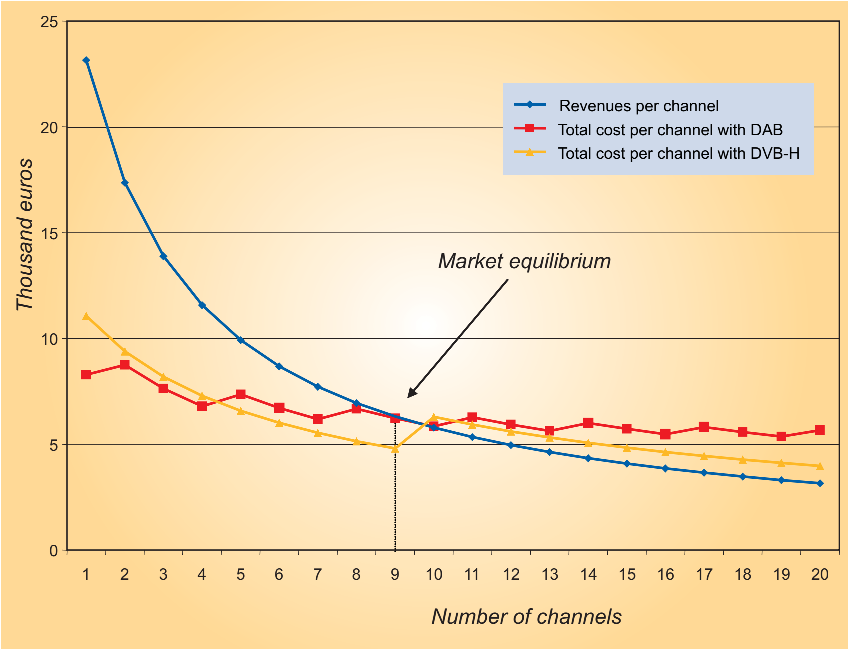

Figure 3
Mobile TV channels in a town with 15 000 residents
(Mobile TV represents 5% of today's TV market)

If one chooses a specific town and examines it closer, the following reasoning holds: the more TV channels there are, the smaller the revenues per channel as the competition increases. Furthermore, the distribution costs also fall with more channels, as more actors are sharing the fixed costs. *Fig. 3* shows costs and revenues for a town [3] with a population of 15 000 in a case where the revenues of mobile TV are 5% of the traditional TV market.

The blue graph shows how the revenues per channel decrease when more TV channels can be watched on a mobile phone. The red and yellow graphs show how the costs decrease for DAB and DVB-H respectively. The intersections between the blue graph and the other graphs show for how many channels the revenues equal the costs. If the revenues are larger than the costs, profits are made and more companies will therefore enter the market. If costs are larger than the revenues, companies will be knocked out. Market equilibrium thus lies at the intersection and a simple analysis yields that residents in this town will be able to watch nine TV channels on their mobile phone.

The more residents in a town, the more potential viewers. This implies that a large town will generate larger revenues than a small town (the blue graph is shifted to the right). However, a large town also has a larger coverage area, which increases the distribution costs (the red and yellow graphs shift to the right). From this reasoning we can construct an economic model with the principle that both the revenues and costs fall, the smaller the town is [4]. To answer question number 1 above, we therefore need to know how small a town must be for no single mobile TV channel to have commercial motivation to enter.

Central to this issue is how large will be the revenues that the future mobile TV market will generate. If, for example, we assume that revenues for mobile TV will equal 10% of today's TV market, the mobile market will have a significantly larger carrying capacity than if we assume 5%.

The answer to how small towns will be served by mobile TV is presented in *Table 1*.

From the table we can see that the mobile TV market will not serve towns smaller than 2 500 residents if revenues equal 10% of traditional TV. We can also see that the population coverage will be significantly affected by the size of the revenues that the mobile TV market may generate.

2. This includes revenues from commercials and for network operators.
3. The word "town" should be understood as a continuous coverage area.
4. With the constraint that the minimum cost is that of one transmitter.

Table 1
Limit for mobile TV coverage

The size of the mobile TV market as a percentage of the traditional TV market	The smallest town that will be served by mobile TV if DAB is chosen	The smallest town that will be served by mobile TV if DVB-H is chosen
10%	2 500	3 500
5%	5 000	7 000
1%	24 000	33 000

Apart from knowing the smallest size of town that will be served by mobile TV, it is also interesting to know how many channels there will be in larger towns. If we assume the case with 5% revenues and calculate the number of channels there will be in different towns, we get the following result:

Table 2
Mobile TV channels in a scenario of 5% of the traditional TV market

Size of town (population)	Number of mobile TV channels if DAB is chosen	Number of mobile TV channels if DVB-H is chosen
4 000	0	0
5 000	1 (384 kbit/s)	0
7 200	1 (384 kbit/s)	1 (384 kbit/s)
10 000	4 (1536 kbit/s)	5 (1920 kbit/s)
15 000	9 (3456 kbit/s)	9 (3456 kbit/s)
20 000	13 (4992kbit/s)	20 (7680 kbit/s)
30 000	20 (7680 kbit/s)	20 (7680 kbit/s)

We now know how many different mobile TV channels there will be in different towns for the 5% scenario. This gives us the capacity demand for the mobile TV market. The exercise can be repeated for the other market scenarios. From *Tables 1* and *2* we can also conclude that the choice of broadcasting technology affects the number of mobile TV channels that can be provided in towns of different sizes.

Step 4 – The radio market

A similar analysis as the one for mobile TV can be done for the commercial radio market. The accuracy of such an analysis is better, as the radio market already exists today and therefore a smaller amount of guessing needs to be done. The assumptions used for this analysis are:

- All commercial radio channels have the same listener share.
- Costs and revenues are 55 million euros per year (Swedish market).
- Commercial radio will get significantly lower licence fees when they switch to digital. (Today, the licence fees constitute about 25% of the total cost. It is likely that the fees will be lowered substantially in the future.).

The most prominent difference between the radio market and the mobile TV market is that commercial radio is associated with larger costs when entering a local market. This is due to production of local jingles, local advertising sales etc., although the programmes themselves are produced centrally and do not impose a cost on the local market. Distribution is therefore a smaller share of total costs.

The analysis yields that a town the size of Växjö (74 000 residents) would be served by 5 to 6 commercial radio channels. The smaller the town, the fewer the radio channels. If we follow the above assumptions, the limit for commercial radio coverage is at 15 000 residents. This is summarized in *Table 3*.

Table 3
Commercial radio channels

Size of town (population)	Number of commercial radio channels if DAB is chosen	Number of commercial radio channels if DVB-H is chosen
10 000	0	0
15 000	1 (192 kbit/s)	0
40 000	3 (576 kbit/s)	3 (576 kbit/s)
100 000	8 (1536 kbit/s)	7 (1344 kbit/s)
Larger than 150 000	10-13 (1920-2496 kbit/s)	10-13 (1920-2496 kbit/s)

The table shows how many commercial radio channels there will be depending on the size of the town and choice of technology. As can be seen, the choice of technology only affects the number of channels marginally. This is due to the distribution costs only being a small part of the total costs. At any rate, we now have a notion of the capacity demand for the commercial radio market in Sweden.

Step 5 – The total mobile media market

To get the aggregated demand for broadcasting capacity in Sweden, we must put together the demands for the different media. What we have not dealt with yet is how public service TV broadcasters will behave. This can be difficult to foresee as they will not make a decision on commercial grounds. It will most likely depend on the status of mobile TV in regard to ***must carry*** regulations and political demands for complete population coverage.

In the following aggregation, public service TV is assumed to have national coverage with two mobile TV channels. Furthermore, we have not discussed services other than radio and TV. This is mainly due to lack of information about costs and revenues. But also, as will be seen, because the effect on the results would probably be small. By aggregating the capacity demand for Swedish Radio, commercial radio, mobile commercial TV and mobile public service TV, we can now calculate how large the demand for broadcast capacity will be for towns of different sizes. This is depicted in *Fig. 4*.

The diagram presents how large the demand for broadcast capacity (y-axis) is in towns of different sizes (x-axis). The graphs represent capacity demand for DAB and DVB-H, given different sizes of the mobile TV market (1%, 5% and 10% of traditional TV). As can be seen from the graphs, the capacity demand will be significantly larger if the mobile TV market is successful (10%) compared to if it is not (1%). To be able to compare DAB and DVB-H, we need to recall *(from Fig. 2)* that DAB will

Abbreviations

DAB	Digital Audio Broadcasting (Eureka-147)	**SR**	Swedish Radio
DVB	Digital Video Broadcasting	**UHF**	Ultra High Frequency
DVB-H	DVB - Handheld	**VHF**	Very High Frequency

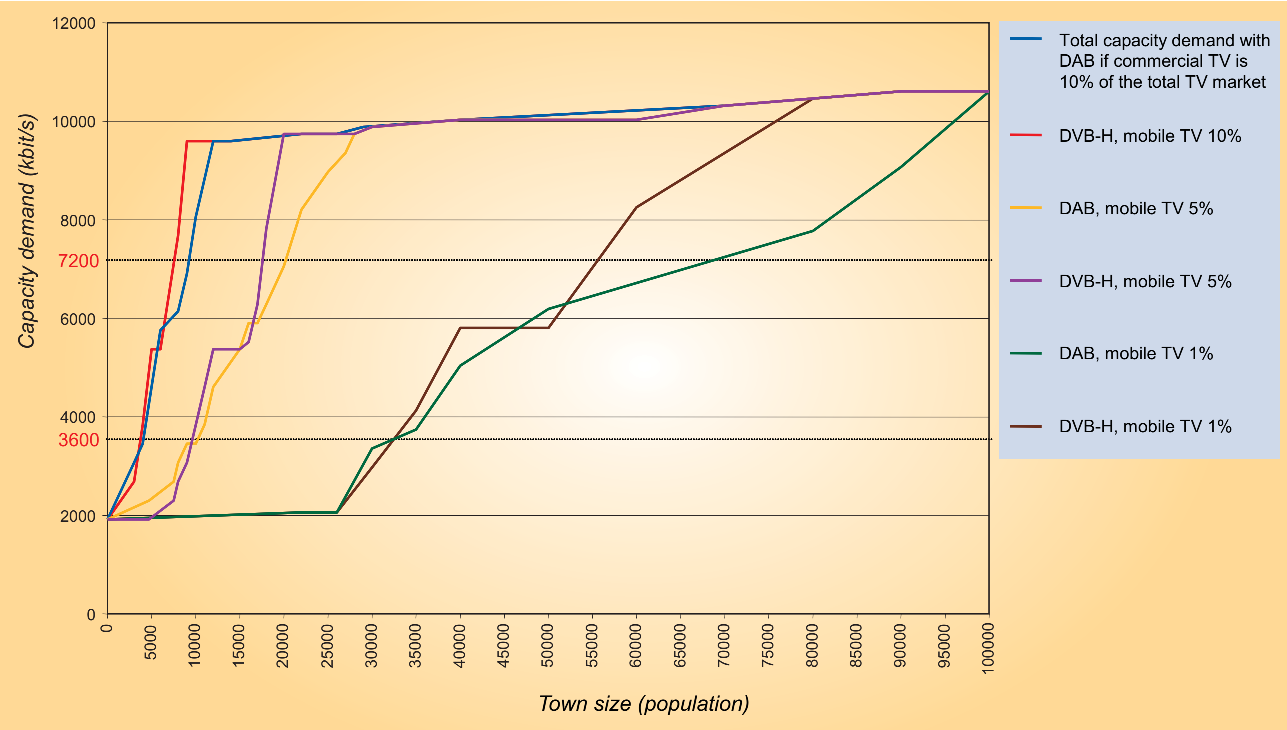

Figure 4
Total capacity demand for the mobile TV and radio markets

be more cost efficient for SR if total capacity demand is below 3600 kbit/s while DVB-H will be cheaper if the total demand is above 7200 kbit/s.

If we draw a horizontal line from 3600 kbit/s on the y-axis and examine where it intersects the capacity demand curves, we can establish for which town populations DAB will be cheaper. For example, the horizontal 3600 kbit/s line intersects the 5% DVB-H curve at town populations of approximately 10 000 residents. In Sweden, 8% of the population [5] live in towns of about this size (or smaller). This population share will be more efficiently covered by DAB. To know where DVB-H will be cheaper for SR, we need to do the same exercise for 7200 kbit/s. Intersecting this horizontal line with the 5% demand curve yields that for towns larger than approximately 18 000 inhabitants, DVB-H will be cheaper. This equals around 79% of the Swedish population. The total result is thus that the most densely-populated areas (79% of the Swedish population) are more economically served by DVB-H, the next 13% of the population are equally efficiently covered by both technologies while the remaining 8% (living in sparsely-populated areas) are more cost efficiently covered by DAB.

The results for where DAB and DVB-H respectively will be cheaper for the different mobile TV scenarios are presented in *Table 4*.

Table 4
The effect of population density on choice of technology

Mobile TV's share of the traditional TV market	Population share where DVB-H is more cost efficient	Population share where costs are ambiguous	Population share where DAB is more cost efficient
1%	49% most populously living	12%	39% least populously living
5%	79% most populous	13%	8% least populous
10%	94% most populous	3%	3% least populous

5. Data from Statistics Sweden (Sweden's government authority for official statistics, www.scb.se) were used for these calculations.

Step 6 – Area coverage

The previous step of the exercise might imply that DVB-H is preferable – as a very large portion of the population is more cost efficiently covered with that technology. But, as many broadcasters know, the costs in broadcast networks are not dependent on population but rather on area coverage. This brings us to the last step of the analysis. We need to translate population into area coverage and, essentially, into network costs. In Sweden the relationship presented in *Fig. 5* prevails [6].

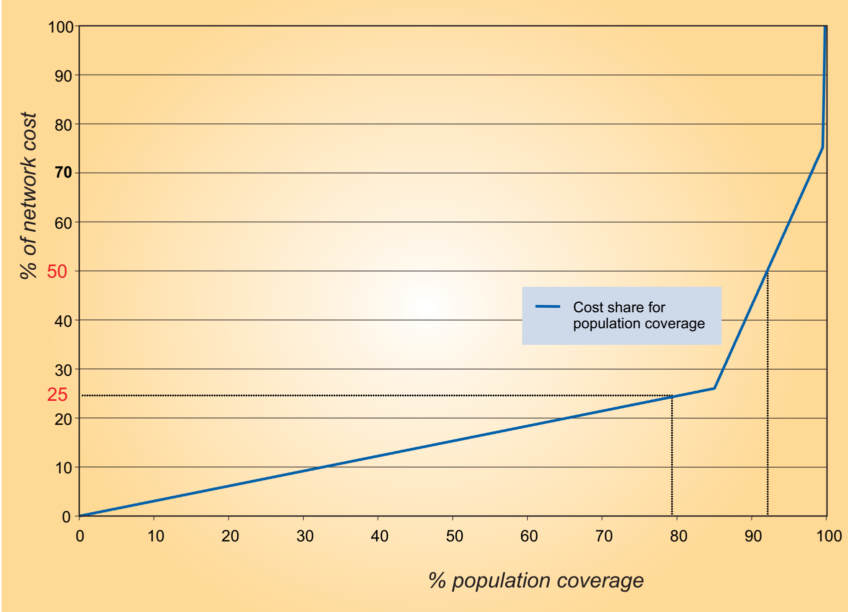

Figure 5
Relationship between population coverage and network cost

On the x-axis we have population coverage as a percentage of total population while the y-axis represents the percentage of total network costs. In a sense, the graph depicts how Swedes live geographically. We can see which part of the network costs a certain section of the population incurs: e.g. to cover the first 50% of the population corresponds to 15% of the costs.

This helps us finalize the analysis. Recall from *Fig. 2* that a national network with six channels in DAB would be around six million euros cheaper (compared to DVB-H) if capacity is below 3600 kbit/s. And, that a national DVB-H network is around two million euros cheaper (compared to DAB) if capacity demand is above 7200 kbit/s. Let's apply this to the 5% scenario. Here 79% of the population is more favourably covered with DVB-H. This corresponds to 25% of the area and would thus save Swedish Radio 0.25 * 2 million = 0.5 million euros. But the last 8% of the population, which equals about 50% of the area, are more cost efficiently covered by DAB. For these areas, by choosing DVB-H, we make a loss of 0.5 * 6 = 3 million euros. In this scenario, choosing DVB-H would mean a yearly loss for SR of 2.5 million euros (0.5 – 3.0 = –2.5 million euros), compared to choosing DAB. A similar exercise for the 10% scenario gives DAB a cost advantage of close to one million euros.

In fact, a reverse analysis reveals that only a very extensive supply of mobile TV channels covering more than 99% of the population can give DVB-H an advantage over DAB. This is a conclusion we could theoretically have derived without at all speculating about how successful the mobile TV market will be, owing to the geographic distribution of Swedish households and to the fact that while DVB-H can lower costs in some places, it does so only marginally compared to DAB.

Specific and general conclusions

A few conclusions can be drawn from this analysis. Some of them are general, i.e. no matter what scenarios we use, and a few are specific to what assumptions and values we use in the model.

The most general conclusion is that mobile TV will have a great impact on the costs of broadcast networks. This type of media demands large capacity and therefore implies extensive sharing of

6. Approximations by Teracom in "Digital Radio, Slutbetänkande av digitalradiokommitén, SOU2004:16" ("Final report of the Digital Radio Committee") published by the Swedish government.

fixed costs. Furthermore, in the case of two parallel broadcasting networks, i.e. coexistence of DAB and DVB-H, the one attracting the most content will be the cheapest – thus attracting even more content. Therefore, at the starting positions, if one has a preference in the choice of network (strategic, technical, economic), it is important to push the market towards the technology that one prefers. This can be compared to a snowball at the top of a snowy hill. Without interference it lies still. But if we push it, it will pick up size and speed as it rolls down the hill, making it harder and harder to push it back up again over the top to the other side. Pushing is easier at the outset than when the ball has started rolling.

Given DAB will be in the VHF band and DVB-H in the UHF band, some more conclusions can be drawn. For one, DAB is very much cheaper when capacity demand is low, while DVB-H is only marginally cheaper if capacity demand is large enough. This implies that DAB is a low-risk strategy as it is both more scalable and cheaper at the outset, when the market is small. This holds for any country. Specifically for the Swedish distribution of population, the broadcasting market needs to be very, perhaps unreasonably, extensive in terms of media supply and coverage if DVB-H is ever to have the edge.

Looking at a specific scenario, if mobile TV could generate 10% of TV's revenues today, the annual loss for SR would be almost a million euros if choosing DVB-H over DAB. The losses of choosing DVB-H would increase, the smaller the mobile TV market gets.

Obviously, the real world is not as perfect as the analysis assumes. Most companies do not conduct this kind of analysis research prior to making decisions. Generally this means that media coverage will be more coarsely defined and will not be fine-tuned as the demand curves imply.

It might be interesting to loosen some of the assumptions and see what the impact would be on the results. If public service TV coverage is reduced or only one channel is broadcast, the total capacity demand will decrease, favouring DAB. But reduced public service TV coverage means decreased competition for commercial TV companies, making it easier for them to enter smaller markets. This would generate an increase in capacity demand, favouring DVB-H. The total effect will however still be in favour of DAB as the first effect is more prominent than the second.

Another assumption is that mobile TV will broadcast existing channels, meaning no new productions. If regulation requires local content to be provided, the overall costs will increase, thus making the revenues not cover the expenditures. This would decrease the number of mobile TV channels and population coverage, decreasing capacity demand and essentially making DAB more favourable from SR's point of view. The same reasoning holds for any increase in costs for mobile TV or commercial radio. In the calculations, it is assumed that commercial actors do not make any profits (costs are equal to revenues). Practically, this is perhaps an unreasonable assumption as the commercial actors will not get any payoff for taking the risk. A profit requirement would decrease commercial media supply, forcing SR to pay larger parts by itself, thus favouring DAB. Graphically, any increase in cost or decrease in revenues would push the capacity demand curve in *Fig. 4* to the right. Vice versa would push the demand curve to the left, favouring DVB-H.

One may wonder why the capacity demand curve flattens out. This is due to practical reasons. For one, the access to frequencies may pose limitations. Secondly, the mobile TV market is assumed to re-broadcast existing content. This means that no more channels than the existing ones can enter the mobile TV market. Producing a completely new mobile TV channel is very costly, necessitating large revenues, making it very sensitive to a loss of audience to channels that already have all the content. Getting more access to frequencies would thus not change things in an essential way. This touches upon another issue. One assumption has been that all TV channels have the same audience share. This is hardly the case. In fact, viewing in Sweden is effectively dominated by five or six channels, of which two are public service. Viewing and revenues for the other channels is thus limited, making it hard for them to enter small towns. This favours DAB as capacity demand decreases. A limitation in frequency access would also favour DAB, as the places where demand should be large enough to benefit DVB-H, would not get the frequencies needed. This would work as an entry barrier for mobile TV and commercial radio.

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During his four years at Swedish Radio, Mr Skiöld has been working mainly on market analyses of media telecom, techno-economic analysis and corporate distribution strategies. He has also been involved in radio programme development and internal communications.

This analysis has focused on traditional media content. If we assume that some other services would use broadcasting technology, that would favour DVB-H as capacity demand would increase. For this to have more than a marginal effect, the other services would need to be of a high bandwidth type with a good revenue potential, even in sparsely populated areas.

If we were to apply the framework to a more densely populated country, everything else being equal, the capacity demand and profitability for broadcast services would be higher, thus favouring DVB-H.

Also, the calculations of the network costs have been based on DVB-H being in the UHF band. The reason for this is that the actors promoting DVB-H are themselves speaking of UHF. If instead, DVB-H were to be in the VHF band, that network would be approximately as costly as a DAB network, while supplying a greater capacity. This most probably means that DVB-H would win the match from a cost perspective.

If we were to use different parameters for the network planning, say DVB-H on UHF but with a larger bit capacity per multiplex, the result would change slightly. The right part of the DVB-H cost curve in *Fig. 2* would shift downwards, which would favour DVB-H. But, the left side of the diagram would not change, because DVB-H supplies a larger capacity than needed anyway. A more efficient coding in DVB-H yields the same effect.

Finally, a word or two on what the analysis might imply for commercial players. This analysis has been implemented from SR's point of view. A commercial player has different criteria. For example entry barriers could be positive, as they could increase profitability for the existing channels. A commercial player could furthermore be interested in the point before equilibrium in revenues and costs. Profit is the main goal on the open market, therefore the difference between costs and revenues is of interest for each local market, not the exact number of channels and the total capacity demand.

It is possible to do this analysis in our model, but modifications would be required to cover the different assumptions and aims of a commercial actor. Perhaps that can be the subject of a future article!