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TV DISTRIBUTION VIA CELLULAR NETWORKS PART 2: COST ASPECTS

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ABSTRACT

In a previous article [1], the spectrum consumption of LTE MBSFN and DVB-T2 with their associated different types of network topology for the distribution of linear TV content was investigated, and a comparison of High-Tower-High-Power (HTHP) and Low-Tower-Low-Power (LTLP) network topologies was performed. It was found that significant performance differences exist between these different types of networks. The results of this study form, therefore, an important aspect for the choice of a network topology, since spectrum is a scarce resource which has to be used in a careful and economic manner.

Apart from considerations of the spectrum consumption of a transmission system and the choice of a network topology, implementation and running costs of a particular approach are further relevant aspects for a decision on an appropriate terrestrial broadcast delivery system. This article evaluates the cost of an LTLP approach for the distribution of linear TV content, and discusses it in the light of the costs of a traditional HTHP approach. The calculation for the public broadcaster's TV offering in Germany is used as a practical example for this comparison.

The study is based on currently available cost information. It can be assumed that the trend of falling prices will lower these costs in the medium to long-term future for both LTLP and HTHP networks.

INTRODUCTION

In a previous article [1], the spectrum consumption for LTE MBSFN and DVB-T2 with their associated network topologies for the distribution of linear TV content was investigated, and a comparison of High-Tower-High-Power (HTHP) and Low-Power-Low-Tower (LTLP) network topologies was performed. It was found that there exist significant performance differences between these types of networks with regard to their spectrum consumption. This is a very relevant aspect for the choice of a network type, since spectrum is a scarce resource which has to be used in a careful and economic manner.

Apart from considerations of the spectrum consumption of a transmission system and on the choice of a network topology, implementation and running costs of a particular approach are further relevant aspects for a decision on an appropriate terrestrial broadcast delivery system. This article evaluates the cost of an LTLP approach for the distribution of linear TV content, and discusses it in the light of the costs of more traditional HTHP approaches. As in the previous article, the transmission systems LTE MBSFN for the LTLP approach and DVB-T2 for the HTHP approach are chosen.

It is not intended to give a detailed economic analysis; rather, a rough assessment of the order of magnitude of expenditures required to establish a cellular network for the delivery of linear broadcast content is presented. In particular, this study is not a dedicated forecast on future network costs in the medium or long term. The findings of the article are based on currently available information relating to today's situation. They can, however, give an idea of the relative costs of HTHP and LTLP networks in the future.

This article does not deal with regulatory or market aspects of the delivery of linear multimedia content, nor does it discuss the issue of competition between mobile platform operators and mobile network operators, such as: the aspects of free access to information; the obligation to subscribe to one of the current mobile network operators when using a mobile network; the vertical character of the current mobile market; and a lot more. Many of these aspects are still unclear and would need to be discussed in greater detail before a decision is taken on the future of the delivery of linear multimedia content.

In the following analysis, the results of [1] are frequently used and the reader is invited to refer back to this article for the understanding of the methodology and argumentation hereafter.

COST ASSESSMENT

NUMBER OF BASE STATIONS

As a basic unit for the cost evaluation the coverage area of a single HTHP transmitter with a typical coverage radius of 25 km is chosen. Firstly the required number of base stations in the cellular network to cover this area has to be determined. For this area, about 90 base stations with an inter-site distance (ISD) of 5 km are required; for an ISD of 2 km this number increases to 568. For an ISD of 10 km this number is 23. Here it is assumed that the coverage areas of the base stations are hexagonal. Table 1 gives the figures.

ISD [km]	Number of base stations	Data rate [Mbit/s]	
		Fixed reception	Mobile / Light indoor reception
2	568	30.0	30.0
5	91	15.0	10.0
10	23	5.0	2.0

TABLE 1: Equivalent number of base stations for one HTHP transmitter with coverage radius 25 km and data rate of one 10 MHz frequency block of LTE MBSFN as a function of ISD

Table 1 also gives the available data rates of the networks for a 10 MHz LTE frequency block. These figures are taken from [1]. Since the spectral efficiency varies with ISD, the data rate varies as well.

BASIC COSTS OF A BASE STATION

It is difficult to get detailed figures for the cost of an LTE base station or for a whole network, since mobile network operators regard this information as confidential. In the following consideration, figures are used that were published by the Technical University Vienna and Juconomy Consulting in a study commissioned by the German regulator (BNetzA) in 2011 [2]. They are given in Table 2.

The figures apply to a base station with three sectors and a bandwidth of 10 MHz and relate to an "average" base station. It should be noted that these data are 3 to 5 years old from the time of writing (March 2014), and that prices of equipment and backhaul may have dropped since to a certain extent.

Construction of a new base station	60000 €
Equipment per base station	40000 €
Annual operational costs per base station (urban)	28600 €
Annual operational costs per base station (suburban)	25100 €
Annual operational costs per base station (rural)	21600 €

TABLE 2: Assumptions for cost calculation (from [2])

CAPITAL AND OPERATIONAL COSTS

Firstly, the annual operational expense (OPEX) costs of the equivalent number of base stations to one HTHP transmitter with a coverage radius of 25 km as a function of the ISD of the cellular network are calculated. If the annual OPEX of one base station is assumed to have a median value of 25000 €, the resulting costs are given in Table 3. These figures refer to one 10 MHz frequency block.

ISD [km]	Annual operational costs [M€]
2	14.20
5	2.28
10	0.58

TABLE 3: Annual operational costs of one 10 MHz frequency block of the equivalent number of base stations of one HTHP transmitter with a coverage radius of 25 km

Secondly, the depreciation costs have to be considered. A simple linear depreciation over 7 years is applied. In Table 4, two cases are distinguished: one column gives the figures for the case where all base stations have to be newly established; the other column gives the figures for the case where all base station sites already exist, but have to be equipped additionally with LTE MBSFN. In practice, a mixture of the two cases will pertain.

	Annual depreciation costs [M€]	
ISD [km]	New base station sites	Existing base station sites
2	8.11	3.25
5	1.30	0.52
10	0.33	0.13

TABLE 4: Annual depreciation costs of one 10 MHz frequency block of the equivalent number of base stations of one HTHP transmitter with a coverage radius of 25 km

The cost figures of Tables 3 and 4 refer to corresponding MBSFN data rates as given in Table 1. If, for example, twice as much data rate is required, the annual costs will increase by a certain amount. From broadcasting experience with small gap-filler stations, it is assumed in the following that the cost for each additional frequency block amounts to 1/4 of the cost of the first frequency block, and it is assumed that this holds true for both CAPEX as well as OPEX costs even if in practice there will be a certain difference between the two. To what extent this consideration is affected by the possibility to choose a larger bandwidth, e.g. 20 MHz or more by means of carrier aggregation, still remains to be investigated in more detail with regard to its potential to lower the overall costs.

For a broadcaster or a broadcast network operator, the figures of Tables 3 and 4 have to be considered in light of the cost of the operation of one HTHP transmitter. In this context, it can be assumed that the total cost of one HTHP DVB-T2 transmitter carrying three multiplexes with 12 to 18 HDTV programmes (depending on the intended reception mode) amounts to about 1 million €.

To help with the considerations for the comparisons, therefore, the total annual costs have been depicted in Figure 1 for the case "existing base station sites" and the example of portable reception for (the capacity of) three DVB-T2 multiplexes.

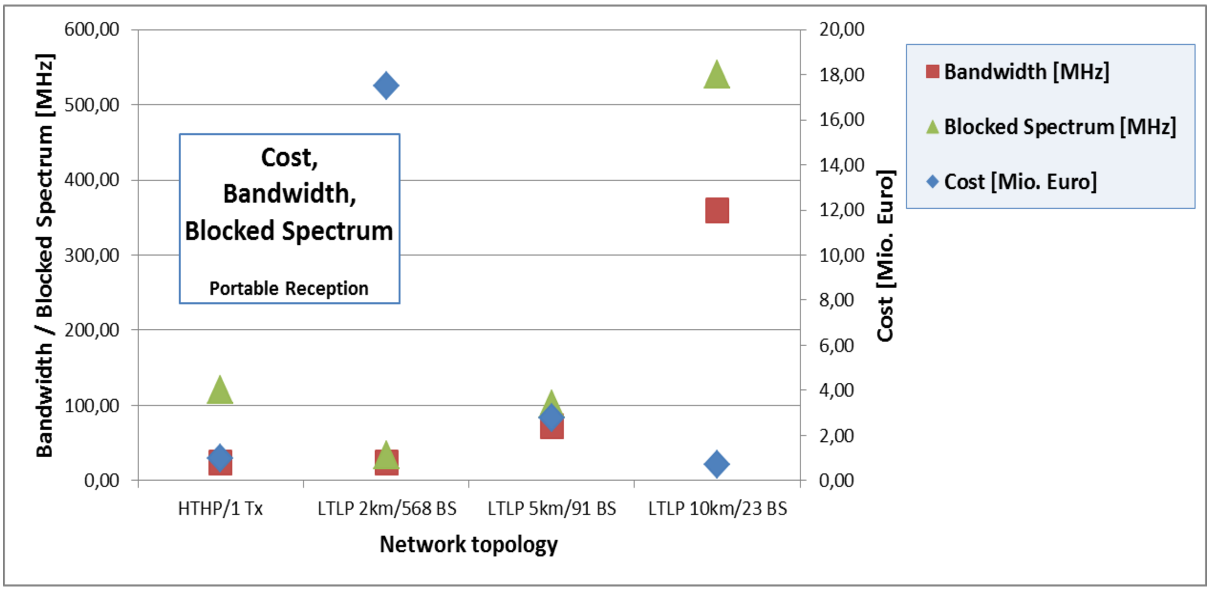

Figure 1: Comparison of Cost, Bandwidth and Blocked Spectrum for 1 HTHP transmitter and the equivalent LTLP networks and their associated number of base stations for three ISD values (2 km, 5 km, 10 km) for portable reception

This figure also contains results from [1] on the required bandwidth and the blocked spectrum. In particular, the comparison of cost and blocked spectrum makes the trade-off that exists between these two aspects very clear; the less spectrum that is blocked, the higher is the cost to realise the required network implementation (which confirms old wisdom: Nature doesn't make gifts).

This allows for a general conclusion already at this point: taking into account the required data capacity, all the cost figures for the LTLP scenarios are higher than the cost of an HTHP transmitter; some of them are much higher.

EXAMPLE: THE CASE OF GERMANY

To give a definitive example, the case of Germany is now investigated in more detail. Here, similar to the approach in our previous article, we do not distinguish between rural and urban areas, even if the density of existing base stations is different for rural and urban areas and the data rate requirements are different for rural and urban areas. For completeness, information which is required here from [1] of this investigation is repeated.

Germany has an area of 357000 km^2. To cover 98% of the population, which is the public broadcaster's requirement, coverage of an area of about 90% is required, which corresponds to an area of 321000 km^2. For this coverage, a certain number of base stations is required, depending on the size of a base station cell. These numbers are given in Table 5. At present there exist about 20000 base station sites per operator, several of them being jointly used by two or more operators.

ISD [km]	Number of base stations	Annual operational costs [M€]	Annual depreciation costs [M€]	
			New base station sites	Existing base station sites
2	92859	2321.5	1326.6	530.6
5	14877	371.9	212.5	85.0
10	3760	94.0	53.7	21.5

TABLE 5: Number of base stations for one layer (10 MHz) and their annual costs to cover 90% area of Germany with an LTLP approach

The table contains the expected cost associated with the implementation of one layer of the network. The data rate which is available at each location of the layer depends on the available spectral efficiency and is given in Table 1.

In Germany, public broadcasters operate three multiplexes for portable/mobile reception. With DVB-T2 these multiplexes will carry approximately 24 Mbit/s each, which amounts to a total data rate of about 72 Mbit/s. With the information of Table 1 the number of required MBSFN layers, each with 10 MHz bandwidth, to carry the data rate of 72 Mbit/s can be calculated. The result is given in Table 6 (see also Table 10 in [1]).

ISD [km]	Number of MBSFN LTLP layers Mobile / Light indoor reception
2	2.4
5	7.2
10	36.0

TABLE 6: Number of MBSFN LTLP layers with 10 MHz bandwidth to provide a data capacity of 72 Mbit/s

In order to calculate the total cost of the distribution of all public broadcast programmes via an MBSFN LTPT network these multiple layers have to be taken into account. Following the methodology as described in the previous section, the cost of the first layer is given in Tables 3 and 4; all additional layers are counted with a factor of 1/4 of this first amount. Here it is neglected that fractional layers do not exist and in reality only an integer number of layers can be implemented.

The calculation ends up with very high sums. Looking at the annual operational costs only, for:

- ISD of 2 km, OPEX is about 3.1 billion €;
- ISD of 5 km OPEX is about 0.95 billion €;
- ISD of 10 km OPEX is about 0.92 billion €.

In addition, the depreciation costs have to be considered. For simplicity, the same factor 1/4 is applied here to multiple layers, and the implementation of a new base station site is counted only once. Table 7 shows the results for the total annual costs to cover 90% area of Germany with all public broadcasting programmes (72 Mbit/s) with an MBSFN LTLP network.

ISD [km]	Annual operational costs [M€]	Annual depreciation costs [M€]	
		New base station sites	Existing base station sites
2	3134.0	1512.3	716.3
5	948.4	344.3	216.8
10	916.5	241.7	209.5

TABLE 7: Annual costs to cover 90% area of Germany with all public broadcasting programmes (in total, 72 Mbit/s) with an MBSFN LTLP network

The cost for ISD = 5 km and ISD = 10 km are very similar. The reason for this is that despite the fact that less base stations per layer are required for ISD = 10 km, more layers are required for this case in order to provide the required data rate. This trade-off results in similar cost figures.

The methodology of this approach to calculate cost and the application of a multiplication factor as given in Table 6 is still to be investigated in more detail. However, it can be expected that the order of magnitude of the cost is correctly determined. In this context also the issue of “long tail” TV programmes and their provision via a unicast mode are relevant. An example of such an investigation can be found in [3].

These findings have to be considered in the light of the cost of the current distribution of DTT. At present, the cost of one DVB-T multiplex layer of a public broadcaster in Germany is calculated to be 54 million € [4]. It can be expected that this will also hold for a DVB-T2 multiplex with a data rate of 24 Mbit/s. In Germany, there are three public broadcast layers (plus in fact an additional amount for metropolitan DTT coverage for commercial broadcasters). The total costs for providing the public broadcast TV offer by means of a DVB-T2 HTHP network are therefore about 160 million €.

These DTT networks, however, are implemented for portable outdoor / mobile reception and not for full area portable indoor reception. Although in metropolitan areas portable indoor coverage is provided as well, there is no full area coverage, and an upgrade to this coverage target would imply a higher density of HTHP sites which in turn would increase the costs to some extent.

CONCLUSIONS

This article has studied the economic aspects of the distribution of TV content via cellular networks. It is the second part of a broader investigation dealing with the delivery of linear mass multimedia content by means of cellular networks. The first part [1] dealt with the aspect of spectrum consumption.

It is shown in this article that the costs of very dense cellular networks which have significantly lower spectrum consumption are by a factor of 25 to 30 higher than the costs of present broadcast networks. Less dense LTE networks with a similar or slightly better spectrum consumption than broadcast networks are still about 7 to 8 times more expensive. These figures are reduced to some extent if, for DVB-T2/DTT, full area indoor coverage and not only metropolitan indoor coverage is assumed.

The study is based on currently available costing information. It can be assumed that the trend of falling prices will lower these costs for LTLP in the medium to long-term future. Similarly, however, it should be taken into account that prices for HTHP networks will decline as well.

The main conclusion of this article is that for economic reasons at this point in time, it is not reasonable to provide mass linear TV content via cellular networks, even with new state-of-the-art mobile technology (LTE MBSFN networks).

Nevertheless, it holds true for the cost aspects as well as the conclusions on spectral consumption stated in the previous article: a converged network that is capable of transmitting broadcast and unicast content would be a very attractive proposition.

Therefore it is recommended to investigate further the possibility of reducing the eMBMS/MBSFN network costs by, for example, adding HTHP components to LTLP networks while maintaining or even improving the efficient use of the spectrum.

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