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TECHNOLOGY
FACT SHEET

SFN -
MYTHS AND REALITY

Broadcasters are often asked why they do not make greater use of Single Frequency Networks (SFNs). After all, they are hugely more spectrum efficient, aren't they? Indeed, SFNs do have a number of advantages over Multiple Frequency Networks (MFNs). In particular they can improve the quality of coverage and give more flexibility to network implementation - and they have potentially higher spectrum efficiency, too. However, they are associated with a number of technical and non-technical constraints. This guide tells you why not all the advantages can be maximized at the same time.

WHAT IS A SINGLE FREQUENY NETWORK (SFN)

In Single Frequency Networks (SFN) the same frequency is assigned to all transmitters in a given service area. This is a different approach to the traditional Multiple Frequency Network (MFN) where each transmitter is assigned its own, separate frequency channel. The introduction of digital broadcast systems such as DVB-T/T2 and T-DAB gave the possibility of using SFNs which was not possible with analogue technologies.

THE ADVANTAGES OF SFNs

1. Improved spectrum efficiency

In principle, SFNs are more spectrally efficient than MFNs if service areas are large, of similar shape and size, and do not overlap. With an SFN it may be possible to provide coverage to large areas using only a single frequency channel, whereas an MFN would require multiple channels.

2. Network gain

SFNs can exhibit network gain where signals from more than one transmitter contribute towards a higher received signal level and lower variability from one location to another. These qualities can improve coverage compared to an MFN network. For portable or mobile reception, the network gain can be a useful contribution to overall coverage, improving the signal's reliability and potentially allowing lower transmitter powers. For roof-top antenna reception, this benefit may not be significant.

3. Increased flexibility

SFNs enable allotment planning which can simplify the technical aspects of the frequency coordination process as the detail of the transmission network does not need to be known in advance – the details can be determined later in the implementation phase. Overall there is no reduction in network planning effort because work is shifted from the coordination phase to the network implementation phase, but it may be more flexible.

THE LIMITATIONS OF SFNs

1. Regionality and service areas

In reality, service areas are not homogeneous because they are defined by editorial requirements and take into account topography, infrastructure and population distribution. Regional and local transmissions are one of the key advantages of terrestrial transmissions compared to other delivery platforms. In most countries, in order to realise important social and cultural benefits, both Public Service and Commercial Broadcasters have legal or constitutional requirements to provide regional and local content, as well as national services. Where there are

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many small service areas, differing significantly in shape and size, that are either adjacent or overlapping, there will be only a marginal difference in the spectrum efficiency between SFNs and MFNs, if any at all – as the same frequency cannot be used in adjacent service areas with different content.

2. Capacity constraints and increased network complexity and cost

In order to optimise coverage, the design of SFNs needs to take into account self-interference. There are three main ways of overcoming self-interference: adopting a more robust transmission mode, increasing the guard interval or by adding new transmission sites to increase the network density. The first two options reduce capacity while the third increases costs. SFNs therefore introduce an additional trade-off between the competing factors of cost, capacity and coverage.

In addition, as all transmitters in an SFN network use the same channel they cannot be operated independently. Consequently, to work correctly the transmitters require a high degree of timing synchronisation, which makes network design and operation more demanding compared to an MFN. This additional complexity entails some additional cost.

SPECTRUM CONSUMPTION OF SFNs

Although a national SFN may require a single frequency channel in a particular country, considerations of the wider planning area (covering immediate neighbours) imply that four to five channels may be required to avoid interference from one country into another.This is a similar number of channels as for regional SFNs, which may require four to six. This happens in particular in so-called ‘hotspot’ regions where specific geographical situations are found or many different cultural and linguistic communities within small geographical areas are to be served. Examples of such ‘hotspots’ in Europe are the areas around Luxembourg and the Baltic and Adriatic seas.

This factor, combined with the capacity limitations of a national SFN, has shown that in some cases (where coverage in the order of 98% may be sufficient) a national SFN may be some 25% more efficient than an MFN with regard to overall spectrum consumption, but only around 15% more efficient than regional SFNs. Given that national SFNs do not allow efficient delivery of regional content, regional SFNs are an attractive option for broadcasters with regional delivery requirements. EBU Technical Report 029 provides a comprehensive summary of this issue.

IN EUROPE SFNs ARE ALREADY HIGHLY USED

Current digital broadcasting networks in Europe make use of SFNs; they are now a mature and well established technique.

If a service area is already covered with an SFN the maximum spectrum efficiency in that area has already been reached. If the same service area was covered by MFNs or multiple 'small' SFNs, spectrum efficiency may be improved by using a single SFN if appropriate. However, the improvement in spectrum efficiency would be moderate over the entire planning area.

In those countries that already use SFNs extensively there is likely to be limited scope for further spectrum efficiency improvements, given broadcasters’ current and future requirements including regionality.

RELATED PUBLICATIONS

EBU Technical Report 16	Benefits & Limitations of SFNs for DTT
EBU Technical Report 24	SFN Planning and Implementation for T-DAB and DVB-T
EBU Technical Report 29	DVB-T2 – Single Frequency Networks and Spectrum Efficiency

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