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Title: **Principles of Frequency Allocation for HA Systems**

Agenda item: **HA PHY**

Document for:

Decision	**X**
Discussion	**X**
Information	**X**

Decision/action requested

This contribution should assist to specify the procedure of allocating frequency blocks to HA network operators. At least four combinations of frequency blocks and their channels are proposed to be adopted for HA systems.

Abstract

The principles of frequency allocation are introduced. Frequency blocks, channels within the blocks and guard bands between the blocks have to be defined and specified to guarantee interoperable HA networks. It is assumed that two network operators covering the same area and using adjacent frequencies should be able to perform their individual frequency planning independent of each other.

1. Principles of Frequency Allocation

A PMP architecture with TDM/TDMA and FDD is supposed.

We propose the allocation of a **frequency block** to a network operator. The frequency block is divided into a number of **channels**. One channel corresponds to a TDM/TDMA **carrier**. The relation between the **bandwidth** B of a carrier, the **symbol rate** (or Baudrate or total sector rate) r_s and the **roll-off factor** β is as follows:

$$B = r_s \cdot (1+\beta) .$$

The concept of allocating a frequency block including several channels is identical for the downlink and the uplink, given paired frequency bands of equal size for FDD operation. The number of channels per block should be large enough to allow a **full cellular coverage** for a single network operator. This corresponds to the **freqency re-use factor** which is defined as the ratio of total allocated bandwidth to the useable bandwidth per sector. A full cellular coverage is guaranteed for the most applications, if

2 channels in case of polarization or
4 channels without polarization

are available. The typical data rate requirements could be satisfied for channel sizes of 14 and 28 MHz. In summary, the frequency block allocation should at least support the following **four combinations**:

2 channels of 14 MHz form a frequency block of 28 MHz
4 channels of 14 MHz form a frequency block of 56 MHz
2 channels of 28 MHz form a frequency block of 56 MHz
4 channels of 28 MHz form a frequency block of 112 MHz

Figure 1 shows the principles of frequency allocation. Specifications on frequency masks and spurious emissions are required for the frequency block as an entirety, and in case of interoperability also for the single frequency channels. However, since the network operator has complete control on the frequency planning within his own block, the requirements on the TX filter and the frequency mask for the single channels could be relaxed. With suitable frequency planning, the network operator can avoid that a wanted carrier is received with considerable less power than an adjacent carrier.

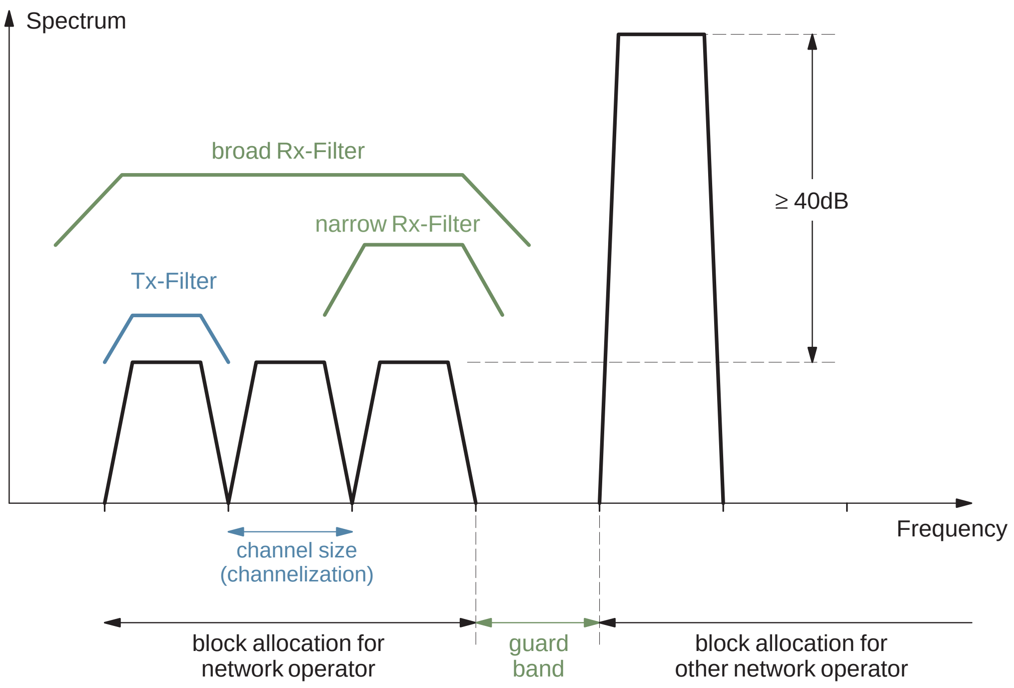

Figure 1: Frequency allocation for two adjacent network operators (with independent cell planning, assuming worst-case power ratio)

2. Guard Band Between Frequency Blocks

We suppose that two adjacent frequency blocks could be allocated to two network operators which cover the same area. As a further assumption the two network operators should be able to perform their individual frequency planning independent of each other, i.e. without any inter-arrangements.

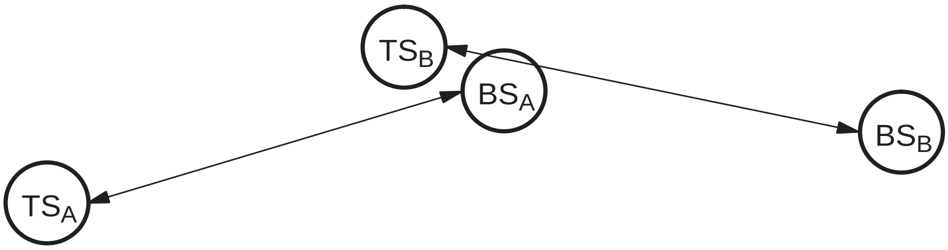

Figure 2: Worst-case constellation of two networks with independent cell and frequency planning

Therefore a geographic constellation as illustrated in Figure 2 seems to be a realistic scenario. Let TS_A and BS_A denote a terminal station and the base station of a network operator A, and let TS_B and BS_B be the same elements of another network B:

> BS_A receives TS_A with lower level than the adjacent carrier from TS_B (uplink), and
> TS_B receives BS_B with lower level than the adjacent carrier from BS_A (downlink).

The difference in the uplink between the wanted carrier from the own terminal and the unwanted carrier from the adjacent frequency block could be more than 40 dB, if the distance ratio between the two terminals and BS_A is more than a factor 100. The same applies for the downlink, if the distance ratio between the two base stations and TS_B is more than a factor of 100. Hence a power difference as indicated in Figure 1 seems to be a realistic case.
(Remark: it was already shown [1, case 3: overlapping cells] that this situation is critical for FDD as well as for TDD if the frequency separation between the carriers is not good enough.)

The upper limit for the power difference has to be specified for HA systems to provide a guideline for the specification of the guard band between two adjacent frequency blocks. The guard band must be broader if broad RX filtering is envisaged to allow receiver architectures with digital demodulation of the wanted carrier. Maybe the guard band could have the same width as a carrier, implying a continuous channelization. In this case, the guard band overhead is 33% for 2 carriers per block and 20% for 4 carriers per block.

Summary

After an agreement within BRAN Hiperaccess about the basic principles, the details of the frequency allocation have to be determined, depending on

- **frequency re-use factor**
- **filter technology**
- **assumptions on distance ratios**
- **receiver architecture.**

References

[1] B.Friedrichs: Comparison of FDD and TDD for Hiperaccess Including Cellular Aspects. BRAN document HA12bot1a, Jan. 1999.