OFDMA Modulation Technique in 4G LTE Mobile Networks

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Abstract

The last two decades have seen the technologies and needs in mobile communications evolve together. This report tries to explain how the principles of OFDMA (*Orthogonal Frequency Division Multiple Access*) in 4G LTE networks allow for answering the current needs both in high data rate and high user capacity.

1 | From OFDM to OFDMA

To be able to transmit a lot of data to many users, the physical resources, i.e. space, time and electromagnetic (frequency) spectrum, need to be used and shared in an optimal way.

1.1 Introduction to Modern Mobile Communications

When talking about mobile communications, the space resource is usually managed by using fixed base stations (BS) placed in a certain pattern similar to bee-hive cells. These BS are placed so that they can deliver information wirelessly to mobile stations within the range of their cell or seemlessly moving from a cell to another.

To achieve high data rates and multiple user services within a cell, it is however necessary to design techniques making smart use of time and frequency resources. ODFM is one of these techniques and is being used in several applications both in cable and wireless network such as ADSL, VDSL or WLAN and 4G LTE.

1.2 Description of OFDM

OFDM stands for *Orthogonal Frequency Division Multiplexing*. It relies on different principles used together to combine advantages.

The most basic of these principles is the *Frequency Division Multiplexing* and consists of the modulation of several (N) signals with sub-carriers that are regularly spaced by Δf, see *Figure 1.1*.

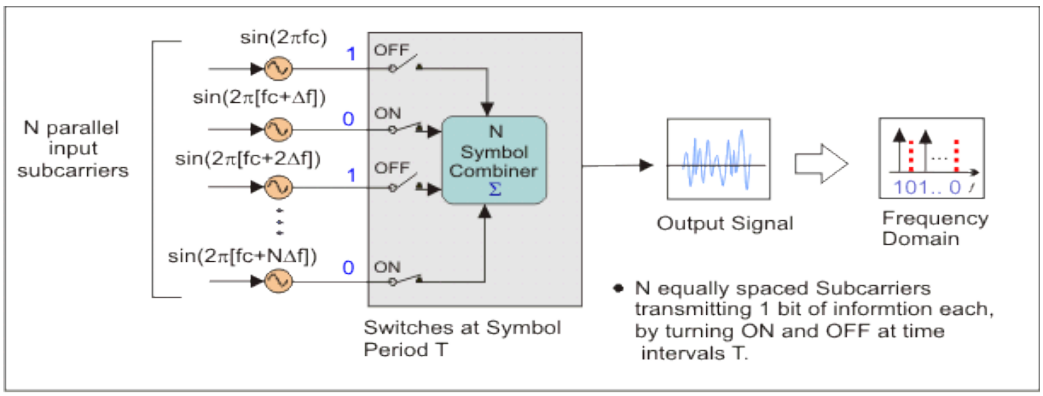

Figure 1.1: Modulation of signals using OFDM technique [**source: Keysight**]

All these modulated signals are then summed into a single signal which is updated periodicly according to the symbol period T and sent through the desired medium.

The second main concept is the orthogonality of the sub-carriers. When passing to the frequency domain, each sub-carrier will result in a sinc function. Therefore, the spacing, Δf, between each of them is chosen so that, in frequency domain, each sub-carrier overlap the others orthogonally, which means all the sinc functions have zero crossing and their side-loops cancel each other, while peaks remain distinguishable.

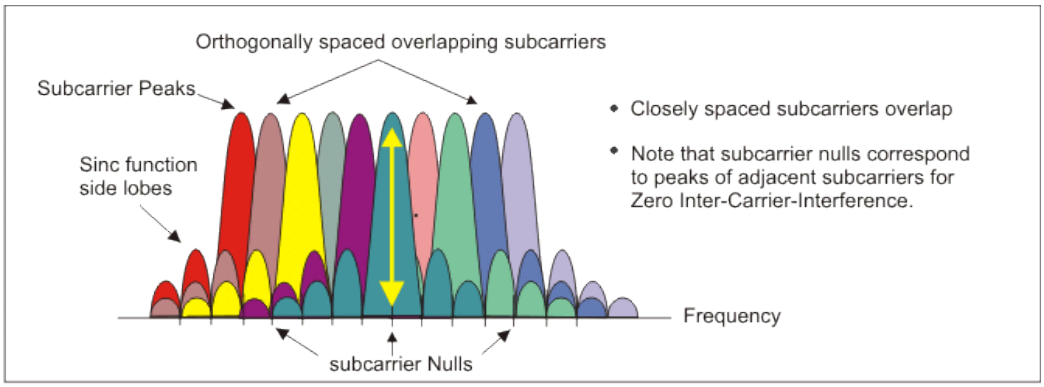

Figure 1.2: Modulation of signals using OFDM technique [**source: Keysight**]

Since, there is no undesirable interference, the spacing between each sub-carrier can be very short. To maintain the orthogonality, this spacing, Δf, actually has to be the inverse of a symbol period, T :

$$\Delta \mathrm{f} = 1/\mathrm{T} \tag{1.1}$$

Moreover, by sending information on parallel channels, it is possible to increase the overall data rate and therefore, the spectral efficiency.

1.3 What does OFDMA bring ?

2 | OFDM in 4G-LTE Mobile Networks

2.1 4G-LTE Overview