

LTE OFDM TECHNOLOGY

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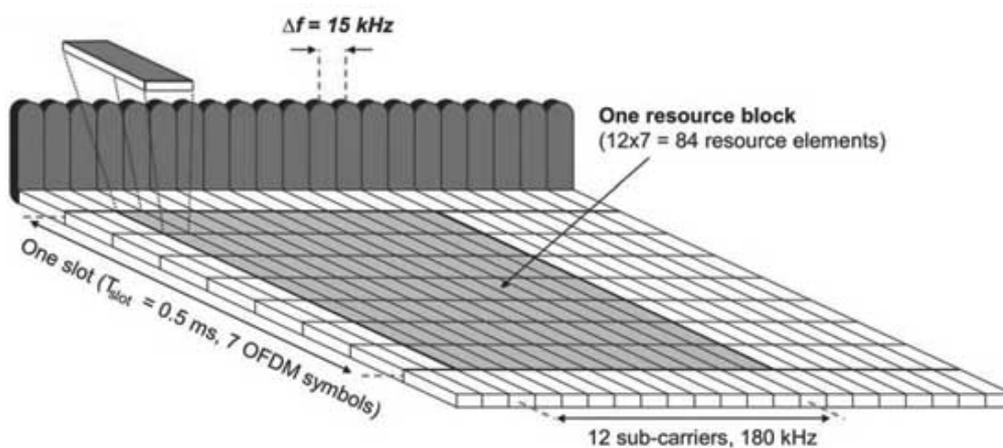
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To overcome the effect of multi path fading problem available in UMTS, LTE uses Orthogonal Frequency Division Multiplexing *OFDM* for the downlink - that is, from the base station to the terminal to transmit the data over many narrow band carriers of 180 KHz each instead of spreading one signal over the complete 5MHz carrier bandwidth ie. OFDM uses a large number of narrow sub-carriers for multi-carrier transmission to carry data.

Orthogonal frequency-division multiplexing *OFDM*, is a frequency-division multiplexing *FDM* scheme used as a digital multi-carrier modulation method.

OFDM meets the LTE requirement for spectrum flexibility and enables cost-efficient solutions for very wide carriers with high peak rates. The basic LTE downlink physical resource can be seen as a time-frequency grid, as illustrated in Figure below:

The OFDM symbols are grouped into resource blocks. The resource blocks have a total size of 180kHz in the frequency domain and 0.5ms in the time domain. Each 1ms Transmission Time Interval *TTI* consists of two slots *Tslot*.



Each user is allocated a number of so-called resource blocks in the time-frequency grid. The more resource blocks a user gets, and the higher the modulation used in the resource elements, the higher the bit-rate. Which resource blocks and how many the user gets at a given point in time depend on advanced scheduling mechanisms in the frequency and time dimensions.

The scheduling mechanisms in LTE are similar to those used in HSPA, and enable optimal performance for different services in different radio environments.

Advantages of OFDM

- The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions
forexample, attenuation of high frequencies in a long copper wire, narrow band interference and frequency-selective fading due to multipath without complex equalization filters.
- Channel equalization is simplified because OFDM may be viewed as using many slowly-modulated narrowband signals rather than one rapidly-modulated wideband signal.
- The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate inter symbol interference *ISI*.
- This mechanism also facilitates the design of single frequency networks *SFNs*, where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single-carrier system.

Drawbacks of OFDM

- High peak-to-average ratio
- Sensitive to frequency offset, hence to Doppler-shift as well

SC-FDMA Technology

LTE uses a pre-coded version of OFDM called Single Carrier Frequency Division Multiple Access *SC-FDMA* in the uplink. This is to compensate for a drawback with normal OFDM, which has a very high Peak to Average Power Ratio *PAPR*.

High *PAPR* requires expensive and inefficient power amplifiers with high requirements on linearity, which increases the cost of the terminal and drains the battery faster.

SC-FDMA solves this problem by grouping together the resource blocks in such a way that reduces the need for linearity, and so power consumption, in the power amplifier. A low *PAPR* also improves coverage and the cell-edge performance.

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