# Technical Report on 4G LTE

Yoonsung Ji

## I. Frame Structure of LTE system

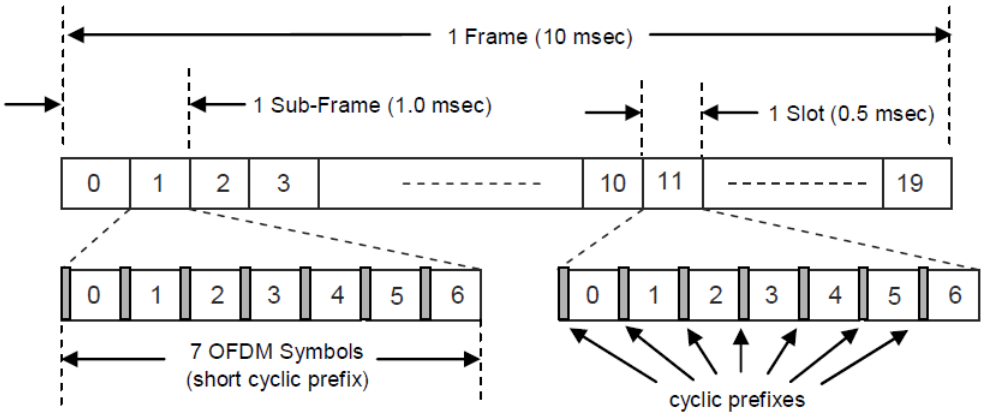


Fig. 1: Frame Structure of LTE system

LTE transmissions are segmented into frames, which are 10ms in duration. There are 10 subframes in one frame, and 2 slots in one subframe. This means that we have 20 slots within one frame. One slot is made up of 6 or 7 symbols. The number of symbols depends on the length of the cycle prefix.

### *A. Frequency Division Duplex Frame Structure*

LTE frame structure is divided into two system. The first is frequency division duplex (FDD) LTE. In FDD, both downlink and uplink transmission happens at the same time at different frequency domain. So each frame consists entirely of uplink subframe or downlink subframe. FDD enables continuous transmission through uplink and downlink. Interference between the frequency bands F1 and F2 may occur, so guard band is required.

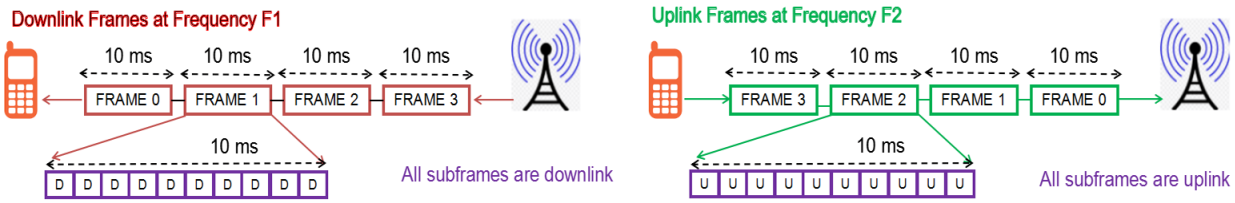


Fig. 2: Frequency Division Duplex Frame Structure

### B. Time Division Duplex Frame Structure

Second is time division duplex (TDD) LTE. In TDD, the transmission is divided into time domain, so each frame can be consisted by either downlink, uplink or special subframe. The sequence of these subframes has been defined by 3GPP with the name TDD Frame Configurations. There comes a special subframe which comes when there is transition from downlink subframe to uplink subframe. The special subframe is consist of three parts: downlink pilot, guard period, and uplink pilot.

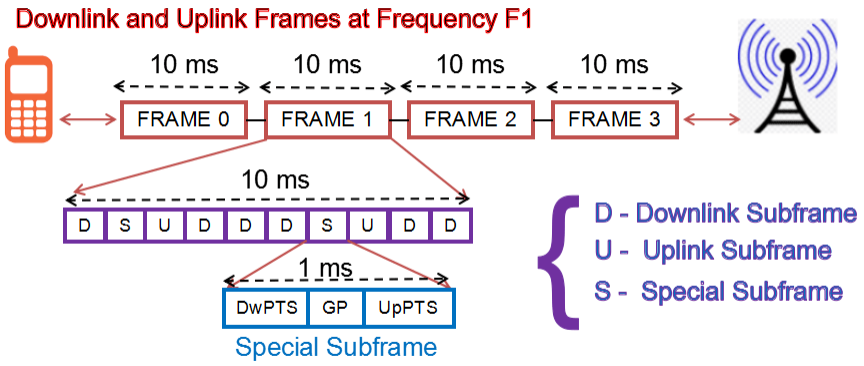


Fig. 3: Time Division Duplex Frame Structure

## II. Multiple Access Method for LTE system

### A. Orthogonal Frequency Division Multiple Access

In downlink LTE system we use Orthogonal Frequency Division Multiple Access (OFDMA), one of the multiple access method, to overcome the limitations of wireless communication. For high speed wireless communication, the high symbol rate is required. However, there is a problem that if the symbol rate increases, inter-carrier interference will occur greatly. Also there are multipath fading in the wireless communication system. So we need a multiple access method like OFDMA.

By using OFDMA, high spectral efficiency can be achieved. This is because in OFDMA the frequency domain is divided into orthogonal components so that guard-bands are not needed. Also OFDMA is computationally efficient, because the modulation and demodulation is based on FFT and IFFT.

In OFDMA, resource blocks are divided into different resource elements by frequency and time domain. Adding multiple parallel sub-carriers through IFFT results in a high peak-to-average-power-ratio (PAPR). High PAPR means high power consumption. High PAPR is not a big problem for base stations. However, the cell phone battery is not unlimited, the high power consumption is a big problem for UE.

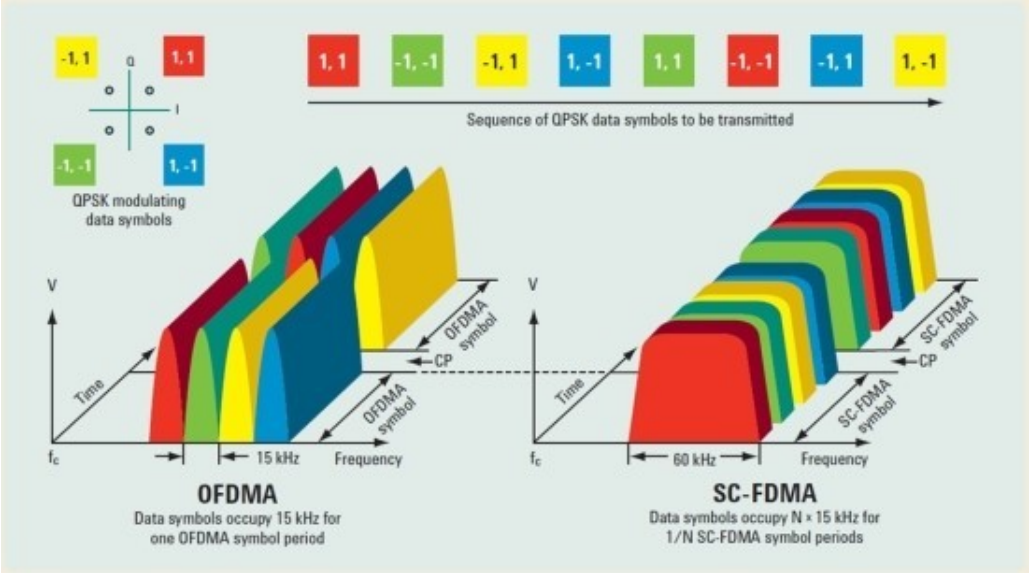


Fig. 4: Comparing OFDMA and SC-FDMA

### *B. Single Carrier-Frequency Division Multiple Access*

Single Carrier-Frequency Division Multiple Access (SC-FDMA) is another multiple access method. SC-FDMA have some difference between OFDMA. In SC-FDMA the frequency domain consist of only one single carrier. The high PAPR in OFDMA can reduced by combining multiple sub-carriers into a single carrier.

So as a way to address the high PAPR problems that occur in the UE when using OFDMA, the single carrier-frequency division multiple access (SC-FDMA) is used in uplink LTE system.