

## ANALYSIS OF DATA TRANSMISSION REQUIREMENTS USING LTE TECHNOLOGY

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**Abstract:** *In this article, the characteristics, main parameters and efficiency of LTE technology in the 4G generation, an overview of the LTE network, Uplink and Downlink data transmission, VoLTE voice data transmission technologies were studied. Data transmission requirements using LTE technology were also analyzed.*

**Keywords:** *spectrum efficiency , LTE technology, Latency reduction, SC-FDMA.*

Analysis of data transmission requirements using LTE technology includes determination of technical and economic requirements for mobile networks, data transmission mechanisms, spectrum efficiency, latency, and high-speed services. LTE (Long-Term Evolution) technology was created to provide services with high efficiency, speed and low latency in mobile networks, and the main purpose of this technology is to expand data transfer capabilities. Below is an analysis of data transfer requirements when using LTE technology.

**Improve spectrum efficiency.** Spectrum efficiency is the provision of maximum efficient use of the available radio frequency spectrum. Spectrum efficiency in LTE technology is provided by OFDMA and SC-FDMA technologies.

### **Requirements:**

OFDMA technology provides high spectrum efficiency in the downlink, allowing efficient distribution of data for multiple users in broadband networks.

SC-FDMA technology improves power efficiency in the uplink, helping to transmit signals with less power for user devices.

In order to improve spectrum efficiency, LTE supports channel widths from 1.4 MHz to 20 MHz, thus providing flexibility.

### **Technical requirements:**

- Support more users on less spectrum;
- Effective management of broadband frequencies for data transmission.

### **Achieving high data transfer rates**



High-speed data transmission is one of the main advantages of LTE technology. Users need services such as watching high-quality videos, using online services or uploading large files.

Requirements:

Support speed up to 100 Mbit/s in downlink.

Uplink data transmission up to 50 Mbit/s.

LTE uses multiplexing and coding technologies to provide these speeds. Multiple Input Multiple Output (MIMO ) technology transmits data simultaneously through several antennas, increasing the transmission speed.

Technical requirements:

Increasing the number of antennas to ensure high-speed data transmission (for example, 2x2, 4x4 MIMO).

Use of additional spectrum bands.

**Reduce latency.** Latency is the time it takes for a user to send a signal over the network and receive a response. Minimizing latency is important for real-time service applications.

Requirements:

LTE aims to reduce latency to 10ms. This ensures high-speed services, especially important for voice calls and video streaming services.

The low latency of small packet transmissions in LTE makes it convenient for real-time applications such as games and video conferencing.

Technical requirements:

Support Networks: EPC (Evolved Packet Core) to reduce latency by optimizing the network infrastructure.

Additional protocols: data optimization and latency reduction through RLC (Radio Link Control) and PDCP (Packet Data Convergence Protocol).

**Increase the number of supported users.** In LTE technology, each base station must be able to support many users at the same time. This is important in improving the user experience in public places (e.g. stadiums, conferences).

Requirements:

Each cell should have a capacity of 200 to 300 users.

To meet this requirement, LTE uses efficient spectrum allocation technologies, including OFDMA and SC-FDMA. Also, the network capacity is increased by expanding the bandwidth of the base stations.

Technical requirements:

Use of additional frequency bands and network expansion.

Enabling Technologies: Efficient use of spectrum through manual or automatic spectrum management.



**Increase the supported bandwidth.** LTE technology provides flexible bandwidth, which allows it to be used in different frequency bands.

**Requirements:**

LTE supports 1.4, 3, 5, 10, 15 and 20 MHz frequencies.

This flexibility allows operators to provide services depending on the available frequency bands.

Technical requirements:

Flexible bandwidth support.

Making it possible for operators to provide services that include different frequency bands.

**Types of supported services.** LTE technology should support voice, video, high-speed Internet services, as well as real-time gaming and video conferencing.

**Requirements:**

The LTE network must support voice calls (VoLTE) based on an architecture such as IMS (IP Multimedia Subsystem).

Ensuring continuous and high-quality delivery of video and data streams.

It is important that LTE supports not only data transmission, but also voice communication services in high quality.

Technical requirements:

Additional technologies: ensuring quality of service through IMS and QoS (Quality of Service) protocols.

In LTE (Long-Term Evolution) technology, data transmission is carried out at high speed and stability through a modern wireless communication network. LTE technology controls the data transfer process through several basic principles and technologies. Below I will explain how the data transfer is done:

**1. OFDM (Orthogonal Frequency Division Multiplexing)**

LTE network is based on **OFDM** technology. Using OFDM, data is transmitted in parallel in several small frequency bands (subcarriers). It splits the broadband signal into many smaller frequencies and allows you to send data on each frequency.

OFDM can make data transmission more powerful, especially in large bandwidth and complex radio frequency environments.

**2. MIMO (Multiple Input Multiple Output)**

**MIMO** technology supports the simultaneous transmission and reception of data through several antennas. This technology transmits signals through



different antennas at the same frequency at the same time, which increases the efficiency of the network and increases the speed of data transmission.

With MIMO, multiple data streams of the same frequency can be transmitted simultaneously.

### 3. TDD and FDD modes.

There are two main modes of data transmission in LTE technology: **TDD (Time Division Duplex)** and **FDD (Frequency Division Duplex)**.

**TDD** : Data is transmitted and received at the same frequency but at different time intervals.

**FDD** : Separate frequencies are used for data transmission and reception. This method allows data flow to be transmitted in two directions at the same time.

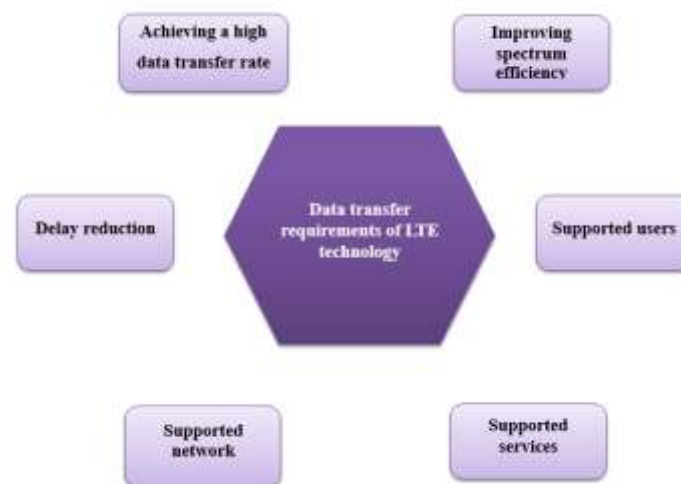
**Download and upload speeds** : LTE technology can provide a maximum speed of 100 Mbps for download (downlink) speed and 50 Mbps for upload (uplink) speed. This provides enough speed for multi-user applications, video streaming and real-time services.

In real-world conditions, these speeds may vary depending on factors such as frequency range, signal strength, and proximity to the base station.

### 5. Applied modulation technologies.

**QPSK (Quadrature Phase Shift Keying)** to ensure high-speed data transmission in LTE technology and **QAM (Quadrature Amplitude Modulation)** modulation methods are used:

**QPSK** : Used to increase the data rate and allows 2 bits to be transmitted simultaneously.



### 1 - picture. Data transmission requirements of LTE technology

The high efficiency and speed of data transmission in LTE technology is based on technologies such as OFDM and MIMO. These technologies help to



transmit multiple data streams at the same time, to use the network efficiently and to make the data transmission as fast as possible. LTE is an advanced form of mobile communication networks that provides users with high-quality Internet services. Spectrum efficiency, high speed, low latency and simultaneous support of many users play an important role in the analysis of data transfer requirements using LTE technology. LTE fulfills these requirements through OFDMA and SC-FDMA technologies, providing high-speed and quality services. Efficient use of spectrum, minimization of latency and broadband services are the main goals of LTE technology. Table 2.4 below analyzes the data transmission requirements of LTE technology.

### **CONCLUSION**

Thus, LTE technology provides high-speed, low-latency and wide-spectrum data transmission. By using advanced technologies such as OFDM, MIMO, TDD/FDD, network efficiency and user experience are improved. Also, LTE supports high-quality voice and video services, marking a new stage in mobile communication networks. This technology meets the requirements of speed and quality in mobile communication and Internet services, which makes it a necessary tool for modern networks.

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