KEY PERFORMANCE INDICATORS OF HANDOVER TECHNOLOGY IN LTE SYSTEMS

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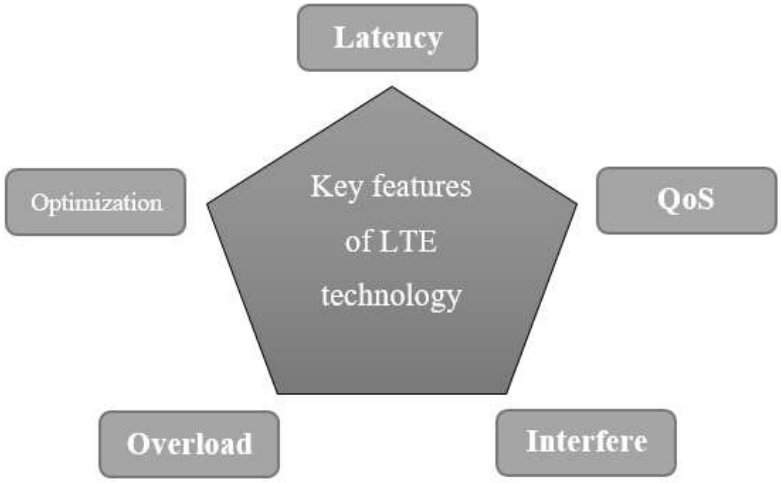
Abstract: *In this article, the key performance indicators of the handover process in 4G LTE networks, their impact on system efficiency, and the corresponding optimization mechanisms are analyzed, with each indicator examined in detail.*

Keywords: *LTE, Latency, QoS, Handover, Interference.*

Handover is one of the most complex procedures in mobile communications, consisting of numerous parameters configured within each base station (radio subsystem) and elements of the switching subsystem. The efficiency of the handover process is evaluated through indicators such as the probability of successful preparation, the probability of successful execution, and the duration of the procedure itself. For a long time, handover optimization—aimed at improving the above-mentioned key performance indicators (KPIs)—was performed manually by cellular network operator engineers. However, in fourth-generation networks, Self-Organizing Network (SON) algorithms for autonomous KPI optimization are being actively implemented. In this regard, the development of algorithms that optimize the handover procedure in LTE networks is becoming increasingly relevant.

When considering the key performance indicators of the handover process, they include the following:

Latency and Handover Success Rate. Latency is a metric that measures the time required by the network to respond and transmit data. During the handover process, latency includes the exchange of signaling and the establishment of connection between the base station and the mobile device. High latency introduces interruptions in user services, such as video call lags or delays in online gaming. Ensuring low latency guarantees better network performance and an improved user experience. Each packet arriving from the network must be received, redirected, and transferred to the new base station in minimal time.



1 – rasm. Key features of LTE technology

The handover success rate represents the proportion of handovers completed successfully. This indicator plays a crucial role in evaluating overall network performance. A high success rate reflects improved network management, optimal resource allocation, and uninterrupted service delivery to users. If failures occur during handover—due to insufficient signal strength or excessive network load, for instance—user experience deteriorates. Achieving a high success rate provides operators with essential insights for modifying and enhancing the network.

Quality of Service (QoS). QoS refers to maintaining service quality for users while ensuring optimal allocation of network resources. During handover, QoS is a critical factor that determines the operator's ability to sustain consistent service levels. Low QoS may result in service degradation or interruptions. For example, when network traffic is very high, the operator must redistribute resources and optimize the network to maintain QoS. Effective QoS management ensures balanced resource allocation, reduces network overload, and delivers stable and high-quality services to users.

Optimization of Handover Time. The speed of the handover process is directly linked to overall network efficiency. This indicator is essential for maintaining uninterrupted user connections. Reducing handover time improves the quality of user services. Optimizing handover time ensures low latency and high performance. For instance, when a user is moving, the variation in signal strength and the connection establishment with the new base station must occur very quickly, as long handover durations may negatively affect service continuity. In figure one we can see key performance indicators of handover technology in LTE systems.

Overload Level. Excessive load in the network, especially on base stations, can lead to low resource efficiency and high traffic. This situation, particularly during the handover process, can cause delays, errors, or failures in the network. Overload occurs when network base stations or other critical resources are so heavily burdened that they cannot perform handover successfully. An optimal load level ensures stable and efficient network operation while providing users with uninterrupted and high-quality services.

Interference Level. Interference can come from neighboring stations or other electromagnetic sources. The level of interference directly affects network performance. High interference reduces signal quality, can delay the handover process, and may result in user connection drops. Low interference ensures high-quality network connections and guarantees proper signal transmission. To minimize interference, correct channel and frequency allocation in the network is essential.

Handover Failure. The handover failure rate indicates problems during the handover process, such as connection drops or other network errors. Failures may occur due to insufficient signal strength, high interference, or network overload. A low failure rate ensures high network quality and uninterrupted user service. By reducing handover failures, operators can improve network efficiency.

Resource Allocation Efficiency. Proper allocation of resources ensures efficient network operation and provides users with high-quality services. Improving resource allocation efficiency simplifies traffic management and reduces network overload. Incorrect resource allocation can lead to handover failures. Therefore, efficient resource management is crucial for improving user experience and overall network performance.

CONCLUSION

In LTE technology, the handover process is one of the most critical mechanisms ensuring uninterrupted mobile network operation. Handover efficiency mainly depends on the correct assessment of signal metrics such as RSRP and RSRQ. The user device's movement speed and direction play a key role in timely handover execution. Low handover latency minimizes connection drops in the network. Coordination quality between base stations increases the stability of the process. Proper selection of neighboring cell parameters prevents additional load. Network congestion can reduce handover efficiency, so optimization is necessary. Synchronized resource allocation improves service quality during handover. Regular monitoring of each technical metric ensures high-quality mobile service. Overall, LTE handover technology plays a central

role in providing users with seamless, stable, and high-quality mobile connectivity.

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