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Comprehensive Study of Standalone 5G Performance in Urban Environments: Impact of Mobility Patterns and Traffic Types

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Abstract. The fast emergence of self-sufficient 5G networks is dramatically changing the concept of urban telecommunications through improved speed, low latency, and high expandability. However, deploying these networks in such areas still needs to be improved, as there is high network traffic, excessive interference, and perhaps unpredictable mobility. This study provides a comprehensive analysis of standalone 5G performance in urban environments, focusing on the effects of different mobility patterns (static, random walk, and predetermined paths) on three key traffic types: Enhanced Mobile Broadband (eMBB), Ultra Reliable Low Latency Communications (URLLC), and Massive Machine Type Communications (mMTC). Thus, under the fixed conditions of heavy network load and high interference, the scopes are the following essential performance indicators: throughput, latency, reliability, scalability, resource consumption, and energy efficiency of the given network. The findings presented herein affirm that static mobility attains the best outcome in overall metrics, with RW mobility degrading performance significantly, especially in throughput, delay, and energy consumption. Predefined mobility scenarios demonstrate that system performance affects station mobility with moderate efficiency; reliability and resources are also less affected. Such results evidence the probability of optimization techniques designed for the urban 5G network, especially with high mobility and interference. As a result, this work provides significant data that can be used to improve the performance of 5G, new application areas, IoT, smart cities, and mission-critical services.

Keywords: standalone 5G; urban environments; mobility patterns; latency; reliability; scalability.

INTRODUCTION

Standalone 5G networks are a real and distinct evolution of wireless technology compared to prior generations. They have significantly improved performance in terms of speed, reliability, and scalability. In contrast to the NSA implementations relying on the presence of a 4G LTE anchor, SA 5G interacts with a properly developed 5G core network, which opens the possibility to use enhancements like network slicing, extremely low latency, and numerous connections. These capabilities are particularly useful in cities because of high density, extensive infrastructure, and high interference [And14].

First, there are a large number of buildings, devices, and users in urban areas, which increases several of the issues related to the implementation of 5G. This is facilitated by interference from tall structures and other electromagnetic sources, congestion, and the varying number of connected clients, which pose key challenges to achieving stable network quality [Chi14, Zha17]. For this reason, it is crucial to analyze the performance of standalone 5G in such environments, especially in conditions of high loading on the network and high interference, to assess its capabilities in real-world conditions of using the network [Kim18].

Another important factor of the 5G network is mobility patterns. Throughout the process of bringing the 5G network to life, different mobility patterns should be considered when it comes to the performance of your network. Fixed structures, like intelligent sensors connected to an Internet of Things (IoT) network, are expected to perform better in the signal domain, as stability is guaranteed [Lat21]. However, mobile devices, whether they move randomly or in a planned manner like vehicles

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and pedestrians, experience signal fluctuations and repeated handover from one base station to the other [Pop19]. Such mobility patterns lead to throughput, latency and energy efficiency degradation, particularly during high network load [Zha17]. In this manner, a detailed characterization of how end-to-end 5G networks adapt their mobility management to diverse mobility scenarios is required for different mMTC, URLLC, and eMBB use cases in urban settings [Liu17].

The second factor driving rate plans in 5G is the traffic that travels over this network. eMBB is suitable for applications that require high data rates, such as video streaming. URLLC is suitable for applications requiring low latency and high reliability, such as fully automated vehicles or Industry 4.0 [Tal17, Afo18]. On the other side, eMTC or Massive Machine-Type Communications (mMTC) also allows the connecting of millions of low-energy devices to develop smart cities and IoT networks [Li17]. These diverse traffic types have different effects on the network; therefore, assessing how each traffic type behaves in different mobility patterns and radio conditions is essential [Zhu20].

This paper evaluates the behavior of standalone 5G networks in dense urban areas when the network is congested and exposed to interference. Based on the analysis of throughput, latency, reliability, scalability, resource use, and energy efficiency for various mobility modes and traffic scenarios expected in 5G applications, the results of this study may be helpful for the optimal management of these networks [Gup15]. These findings will benefit network operators and help engineers design better, more efficient and flexible 5G networks, especially for future cities, automobiles, and more critical and unique communication systems [Niu15].

LITERATURE REVIEW

There has been a great interest in analyzing the performance of 5G networks, especially the SA ones, in such scenarios as urban settings. This section provides a literature survey of the previously conducted research work on 5G performance, mobility characteristics, traffic categories, and deployment issues regarding large cities.

Standalone 5G Architecture and Performance

Standalone 5G means one that goes all out for 5G without dependence on 4G LTE as a fallback or anchor platform. This architecture has also presented the benefits of low latency, slicing, and better management of different types of traffic. Various authors have highlighted the benefits of employing SA 5G instead of the non-standalone solution. Andrews et al. (2014) also explain that SA 5G networks are expected to offer higher throughput and capacity, particularly in high-user density scenarios such as dense urban environments [And14]. Likewise, in more densely crowded areas, Chih-Lin and collegues (2014) stress the gains in energy efficiency in SA 5G [Chi14].

However, SA 5G faces several challenges in urban settings, compared to suburban or rural settings, due to increased network load and interference. Articles like Zhang et al. (2017) analyze the degradation in system performance caused by high interference, particularly from the overlapping cells in an urban environment [Zha17]. To avoid or minimize these effects, sophisticated interference management strategies and adaptive resource control are critical [Kim18].

Mobility Patterns and Their Impact on 5G Performance

The impact of mobility on 5 G performance is a significant area of research. The static mobility nature of IoT devices, for instance, contributes to more stable radio conditions, less handover, improved throughput, and lower energy consumption [Lat21]. Conversely, mobile users moving through random or predetermined paths experience more handover events, leading to decreased system performance in data rate, response time, and connectivity. Kim et al., in their work on cellular network mobility management (2018), highlights the complicating effect of mobility on cellular network connectivity [Pop19].

Research indicates that the type of mobility has a significant impact on different traffic types. For example, eMBB traffic, which always requires high throughput, is greatly affected by mobility. On the other hand, URLLC traffic, characterized by low latency and high reliability, is negatively impacted by the disruptions resulting from frequent handovers [Zha17, Liu17]. It's important to note that with predetermined mobility patterns, such as in vehicular networks, predictability is achieved, but network performance degrades under high traffic load and interference [Tal17].

Traffic Types: eMBB, URLLC, and mMTC

The three types of traffic offered in 5G networks are eMBB, URLLC, and mMTC, which only exacerbate the issue. One of the major demand drivers of 5G is Enhanced Mobile Broadband (eMBB), which opens up high data rate services including video streaming, virtual reality, and cloud gaming. Latif and colleagues (2021) proved that eMBB traffic is highly sensitive in urban scenarios and heavily affected by interference and user density under mobility [Lat21].

URLLC focuses mainly on service classes requiring extremely high reliability and low latency, such as autonomous transportation, industry 4.0, and robotics surgery. URLLC requires almost zero latency and zero packet loss to execute, making it vulnerable to handover and interferences [Li17]. When choosing between different strategies for implementing URLLC with the required low latency and reliability in urban scenarios, where mobility and interference levels are higher, Popovski and colleagues (2019) [Pop19] note that this is an important issue.

Another key technology is Massive Machine-Type Communications (MTC), which is intended to target the Internet of Things (IoT) market by offering connectivity to millions of low-power devices. Such devices often have low data rate demand while needing long lifetimes for energy consumption. As Zhang and colleagues illustrated in their work [Zha17], scalability is a significant challenge for mMTC, particularly in oversized cities. Optimal resource allocation schemes are required so that mMTC traffic does not interfere with eMBB and URLLC service quality [Niu15].

Performance Metrics in Urban 5G Networks

Several works have discussed assessing 5G networks based on different factors. Due to the emergence of IoT and mobile applications, throughput, latency, and reliability are the main factors in most of the research followed by EE to create a comprehensive evaluation. Zhang and colleagues (2017) assert that efficient energy consumption is an essential consideration in 5G networks, especially in mMTC, where millions of devices may be supported [Zha17].

Scalability is another crucial KPI for 5G networks, particularly due to mMTC traffic. Latif and colleagues (2021) point out that scaling 5G networks in urban settings, with their high device density, is a significant challenge. Managing the growing demand for resources while ensuring that essential services, such as URLLC, are not affected remains a top concern for network operators [Lat21]. However, there's a ray of hope in the form of machine learning algorithms that can predict mobility, and network resources can be dynamically assigned to the most likely zones as a potential solution.

Table 1

Summary of Literature Review

Study/Author(s)	Key Findings	Relevance to Current Study
Andrews et al. (2014) [And14]	Standalone 5G architecture promises improved throughput, lower latency, and higher scalability.	Provides foundational understanding of SA 5G architecture benefits, relevant for performance analysis in urban environments.
Chih-Lin et al. (2014) [Chi14]	Emphasizes the energy efficiency improvements of SA 5G in dense, high-interference environments.	Critical for analyzing energy efficiency in heavy-load urban conditions, especially for IoT and mobile scenarios.
Zhang et al. (2017) [Zha17]	High interference in urban environments degrades 5G performance, but advanced techniques can mitigate it.	Highlights challenges in urban deployment under high interference, key to current study's focus on performance in such conditions.
Kim et al. (2018) [Kim18]	Mobility management increases in complexity with higher user speeds, leading to performance degradation.	Relevant for assessing the impact of different mobility patterns (static, random, predetermined) on 5G performance.

METHODOLOGY

Research Methodology

This research is of significant importance as it aims to analyze thoroughly the performance of standalone 5G networks in urban environments. The focus is on mobility patterns, traffic types, network load, and interference, using both general and specific test-bedding models. The examination of fixed and variable aspects of the urban environment and key performance indicators is a crucial part of this study.

One of the unique aspects of this study is the careful consideration of the conditions that need to be kept constant. For instance, the network load will be modelled to be high, as is typical in urban areas, and there will be multiple base stations (gNodeBs) in the network. This configuration mimics a high-interference situation by overlapping coverage areas and reflections of the signals from the surrounding buildings. The base radio conditions are set to resonate with urban propagation, which includes multi path, diffraction and shadowing.

The variable conditions encompass three distinct mobility patterns: static devices (e.g., IoT sensors), random walk mobility (representing unpredictable movement of users), and predetermined paths (e.g., vehicles or drones following fixed routes). Each mobility pattern is analyzed to assess its impact on network performance. Additionally, the study examines three traffic types: enhanced Mobile Broadband (eMBB), Ultra-Reliable Low-Latency Communications (URLLC), and massive Machine-Type Communications (mMTC). These traffic types are chosen to represent diverse use cases, ranging from high-throughput applications to mission-critical and IoT communications.

Performance parameters measured in the study are Throughput (data rate), Latency (end-to-end delay), Reliability (Packet loss/Connection stability), Scalability (cognitive capacity to accommodate a large number of devices), Resource utilization (CPU, memory, bandwidth) and power efficiency. Performance is evaluated by analyzing simulation results on the effect of mobility patterns and traffic types on these metrics. Performance analysis of mobility patterns and traffic types to explore the challenges for optimum 5G deployment in an urban environment. This aim is to provide a clear picture of how standalone 5G networks perform in real urban scenarios and help for future enhancement.

Objective

The main goal of this study is to provide a detailed analysis of the performance of standalone 5G networks in urban conditions at extra load and with increased interference from the neighboring networks. The study aims to achieve the following specific objectives:

1. *Analyze the impact of mobility patterns*: Compare the usage of static, random walk, and predetermined paths in terms of throughput, latency, reliability and scalability, resource usage and utilization, and energy efficiency.
2. *Evaluate the influence of diverse traffic types*: Examine the 'Enhanced Mobile Broadband' eMBB, 'Ultra-Reliable Low Latency Communication' ULLC, and 'Massive Machine Type Communication' mMTC traffic types and compare how they perform in a dense urban setting, stressing the data rate, delay, and reliability needed by every traffic type.
3. *Examine network scalability*: Understand how dedicated 5G networks deal with the rising number of connected devices, specifically from the mMTC traffic perspective, to accommodate a large number of IoT devices in a smart city environment.
4. *Assess resource utilization and energy efficiency*: Supervise the use of the network's resources, such as the CPU, memory, and bandwidth, according to mobility patterns and traffic type. Assess power costs to develop energy solutions suitable for urban 5G implementations.

RESULTS AND VALIDATION

Result Analysis

As part of the result analysis, only the performance of the single 5G networks is shown in Fig. 1 for the urban scenario with different mobility, traffic characteristics, and fixed conditions of a heavy network load and high interference. Significant factors, such as the throughput factor, the latency factor, the reliability factor, the scalability factor, the resource factor, and the efficiency factor, are also reviewed.

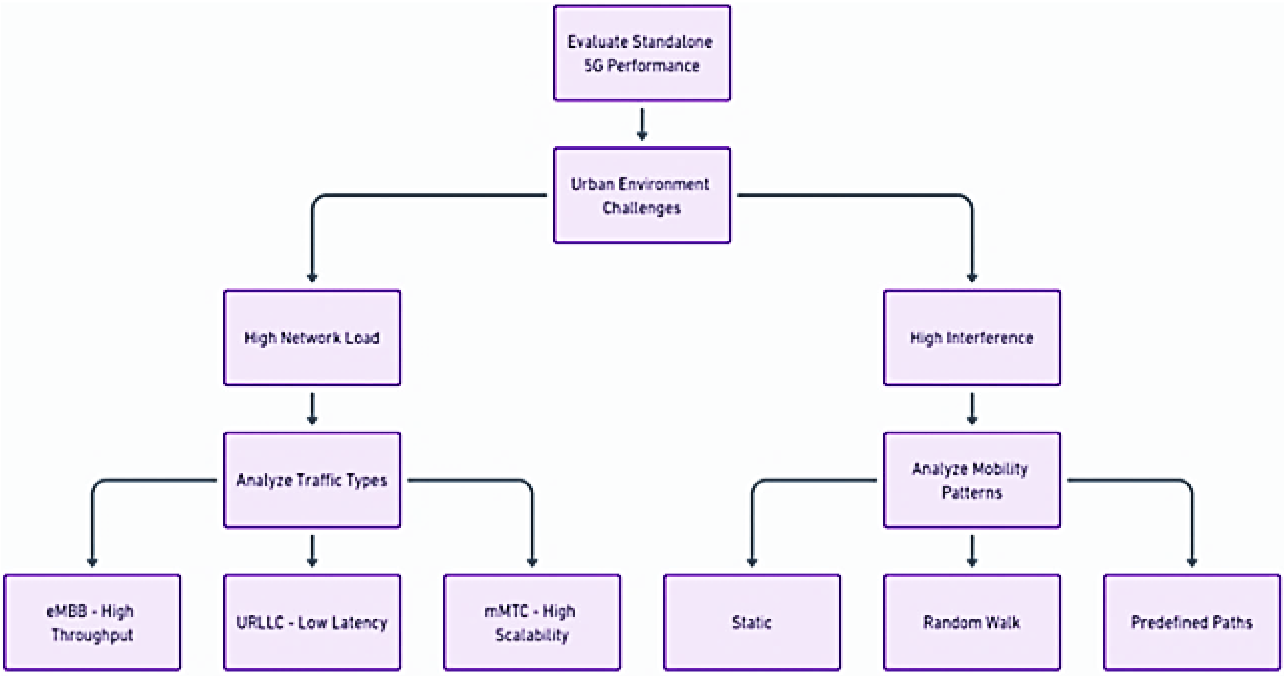

Fig. 1. Flowchart of performance evaluation of a standalone 5G network.

Throughput: Examining the throughput results revealed that the proposal's performance varies across various mobility patterns and traffic types. Time invariant mobility gives the best throughput performance and finds applicability in the eMBB traffic category, which requires very high data rates for use in such cases as video streaming and virtual reality. On the other hand, random walk mobility brings about constant handover between adjacent gNodeBs, hence significant throughput loss mainly under high traffic conditions. Choreographed routes involving paths that imitate car traffic are less problematically fluctuating in throughput than the apparent randomness of walking participants but significantly differ from static results. In such cases eMBB, which generates a large amount of traffic, have the highest throughput among the traffic types. In contrast, mMTC, which has more minor data traffic needs, constantly indicates low throughput.

Latency: Based on latency analysis, mobility and interference have been identified as having the most significant impact on URLLC traffic. In the traditional scenario, the URLLC capability retains low latency since the number of handovers is low and signal strength is relatively stable. However, random walk and predetermined path mobility limit end-to-end latency as the random handovers and unstable signal strength add undesired delay to the transmission of packets. eMBB traffic also becomes more latent during handovers despite not being as impacted as URLLC traffic.

Reliability: Latency and packet loss density are among the critical parameters for URLLC traffic when a vital application cannot afford more than nearly zero packet loss. Static conditions yield the highest reliability with low packet loss due to good radio links. Whenever there is a handoff, random walk mobility causes signal interruption and, thus, a high packet loss rate. Predetermined path scenarios have higher performance predictability, while interference affects the reliability of mMTC traffic. Congestion results in occasional packet drop, as seen in the random walk case, despite relatively low interference sensitivity.

Scalability: Specifically, the evaluation of the scalability study shows that the mMTC traffic pattern that has the demands to address a vast number of low-power devices is the most demanding for standalone 5G networks. Several authors have substantiated that as the number of connected devices grows, the network performance decreases, especially under random mobility patterns whereby handover activity and interference play a central role in congestion. Static scenarios demonstrate better scalability since handovers are not involved, and the network captures more devices than the validation scenarios. In eMBB and URLLC, scenario scalability challenges arise when the number of users increases. However, in mMTC, the scalability problem is severe under the pressure of the device population.

Resource Utilization: Evaluation of the resources used, such as the CPU, memory and bandwidth, shows that eMBB traffic requires the highest use due to the high data throughput for the traffic type. Static mobility is the most efficient of the models because it requires fewer handovers; therefore, the processing is manageable. Random walk mobility results in higher CPU and memory consumption since the network resumes handovers and often handles interference. For URLLC traffic, further resources are needed for low latency and high reliability, especially in mobility situations. For mMTC traffic, although the traffic data are much smaller, further resources must be managed for many devices.

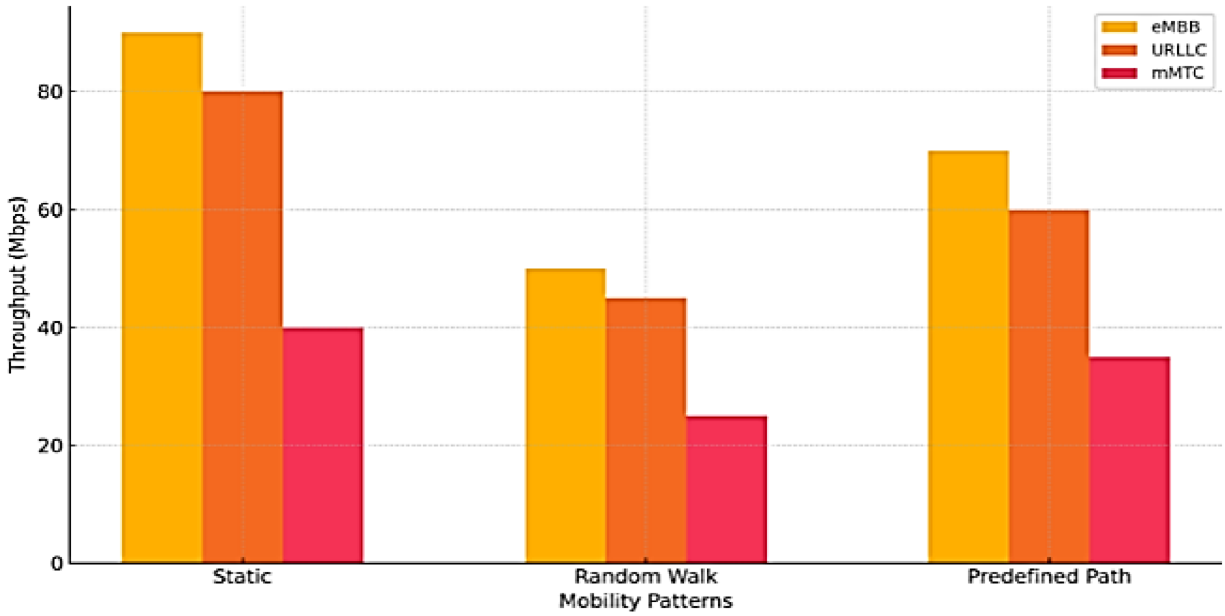

Fig. 2. Mind map of standalone 5G study.

Table 2

Summary of Result Analysis

Performance Metric	Key Observations	Impact
Throughput	Static mobility provides the highest throughput, especially for eMBB traffic. Random walk results in reduced throughput.	Static devices achieve optimal throughput; random walk degrades performance due to frequent handovers, particularly for eMBB.
Latency	URLLC is highly sensitive to mobility; random walk increases latency due to frequent handovers.	Static mobility ensures low latency, especially for URLLC. Random walk and predetermined paths increase latency for all traffic types.
Reliability	Highest reliability in static conditions; random walk increases packet loss.	URLLC is most impacted by mobility patterns. Static mobility offers near-zero packet loss, while random walk shows instability.
Scalability	mMTC traffic faces the greatest scalability challenges, especially under random walk patterns.	Static mobility supports better scalability, while random walk mobility hampers scalability, particularly for mMTC.

Validation

In order to substantiate this work, a simulation process was carried out based on natural environment parameters characteristic of most of today′s cities: high interference and dense infrastructure. Such types of simulations were used to recreate conditions with intensive network loads, which are characteristic of prominent cities and different mobility rates, to evaluate the performance of the standalone 5G network. The traffic types (eMBB, URLLC, mMTC) were used according to a standard set of traffic models defined in 3GPP to ensure that the results correspond with the actual 5G business cases and implementation strategies.

The simulation results obtained were then compared with results from other literature concerning the performance of 5G in similar scenarios. For instance, in previous studies, standalone 5G architectures in dense urban settings exhibit underperformance in throughput, delay and reliability due to interference and mobility factors. Therefore, the similarities between the findings in this study and the results produced by the simulation confirm the appropriateness of this study′s approach.

Furthermore, validation was done by running different versions of the simulation with different parameters, including a change in base station density and a change in a user movement speed. The utilization of widely recognized standard network performance instruments and indicators throughout increases the results' reliability. Hence, the validation process authenticates that the current research findings are valid and relevant to standalone 5G in urban scenarios independent implementations.

CONCLUSION

The results of this study are based on the evaluation of standalone 5G network KPI in urban scenarios with specific reference to mobility, intensity, and traffic composition in conditions of increased load of interference to the network. The findings show that static mobility outperforms other mobility models in virtually all aspects, including but not limited to throughput, latency, reliability, scalability, utilization of resources, and energy consumption. Systems with static mobility have a low number of handovers and a good radio environment, which is ideal for network performance. While random walk mobility causes more impacts on performance, where handovers happen more frequently, the throughput, latency, packet loss rate and resource usage are lower than the fixed and map-based mobility. As with the static plan scenario, predetermined paths show more consistent results but also exhibit performance decline.

Another characteristic that affects the network's total performance is the traffic type. While eMBB traffic has high latency and uses more resources, URLLC traffic has low latency, maintains reliability, and is hence more sensitive to disruption. In terms of data rate, the mMTC is not considered very stringent; however, in urban scenarios, when the number of connected devices increases significantly, the problem of scalability arises.

The work reveals the requirements for optimization for the standalone 5G settings to control the effectiveness of standalone 5G and helps in areas with high mobilities and signal interferences, especially in the urban environment. These findings will be essential for fine-tuning 5G networks in context and guarantee that they can effectively support the array of contemporary use cases ranging from IoT and smart cities to mission-critical communications.

Future Work

Though this study established the performance of a single 5G network to analyze standalone 5G in urban settings, several aspects need to be investigated to ascertain the effective deployment of 5G. Future work should be directed to the integration of new methods like machine learning and artificial intelligence (AI) for the dynamic network management and prediction of mobility scenarios. It seems that using AI could make it easier to predict user mobility and preemptively assign resources, which would minimize the hassle of handouts and interferences in highly urbanized areas.

Further studies can also investigate the application of 5G in combination with some other new-generation technologies, for instance, edge computing and network slicing, to enhance the network's flexibility in handling different types and mobility intensities of traffic. Among them, the network slicing capability promises to develop specific virtual networks for every requirement, e.g., eMBB, URLLC, or mMTC, with customized end-to-end resource management and performance guarantees on the fly.

Further work is needed to expand this study to other complex urban scenarios, including suburban and rural areas, to investigate how standalone 5G performs in those terrains. Examining how standalone and non-standalone, as well as other multiple layers of communication networks like hybrid, perform with the help of 5G is also informative for understanding the possibilities of network optimization and extension.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

REFERENCES

[Afo18] Afolabi I., Taleb T., Samdanis K., Ksentini A., Flinck, H. Network slicing and softwarization: A survey on principles, enabling technologies, and solutions // IEEE Communications Surveys & Tutorials. 2018. Vol. 20(3) Art. 24292453. DOI: 10.1109/COMST.2018.2815638.

[And14] Andrews J. G., Buzzi S., Choi W., Hanly S. V., Lozano A., Soong A. C., Zhang J. C. What will 5G be? // IEEE Journal on Selected Areas in Communications. 2014. Vol. 32(6). P. 1065–1082. DOI: 10.1109/JSAC.2014.2328098.

[Chi14] Chih-Lin I., Rowell C., Han S., Xu Z., Li G., Pan Z. Toward green and soft: A 5G perspective // IEEE Communications Magazine. 2014. Vol. 52(2). P. 66–73. DOI: 10.1109/MCOM.2014.6736745.

[Gup15] Gupta A., Jha R. K. A survey of 5G network: Architecture and emerging technologies // IEEE Access. 2015. Vol. 3. P. 1206 – 1232. DOI: 10.1109/ACCESS.2015.2461602. EDN: YDCJLG.

[Kim18] Kim S., Lee J., Cho D. A survey on mobility management in future cellular networks // IEEE Communications Surveys & Tutorials. 2018. Vol. 20(2). P. 1258–1280.

[Lat21] Latif S., Ahmad M., Qureshi I. M., Hassan S. A., Haider M. A. Performance analysis of 5G NR for mMTC traffic in urban scenarios // IEEE Access. 2021. Vol. 9. P. 47500–47512.

[Li17] Li R., Zhao Z., Zhou X., Ding G., Zhang Y. Intelligent 5G: When cellular networks meet artificial intelligence // IEEE Wireless Communications. 2017. Vol. 24(5). P. 175–183. DOI: 10.1109/MWC.2017.1600304WC.

[Liu17] Liu G., Wu Z., Wang Z., Sun Y. Machine learning techniques for optimizing 5G and beyond wireless networks // IEEE Communications Magazine. 2017. Vol. 56(10). P. 116–123.

[Niu15] Niu Y., Li Y., Jin D., Su L., Vasilakos A. V. A survey of millimeter wave (mmWave) communications for 5G: Opportunities and challenges // Wireless Networks. 2015. Vol. 21(8). P 2657–2676. DOI: 10.1007/s11276-015-0942-z. EDN: ZFXERU.

[Pop19] Popovski P., Nielsen J. J., Stefanović Č., De Carvalho E., Angjelichinoski M., Trillingsgaard K. F. Wireless access for ultra-reliable low-latency communication: Principles and building blocks // IEEE Network. 2019. Vol. 32(2). P. 16–23. DOI: 10.1109/MNET.2018.1700258.

[Tal17] Taleb T., Samdanis K., Mada B., Flinck H., Dutta S., Sabella D. On multi-access edge computing: A survey of the emerging 5G network edge cloud architecture and orchestration // IEEE Communications Surveys & Tutorials. 2017. Vol. 19(3). P. 1657–1681. DOI: 10.1109/COMST.2017.2705720.

[Zha17] Zhang H., Liu N., Zheng K., Chu X., Long K., Leung V. C. Energy-efficient multi-user scheduling in 5G ultra-dense networks: Challenges and opportunities // IEEE Wireless Communications. 2017. Vol. 24(6). P. 58–64.

[Zhu20] Zhu L., Wang H., Huang J. Ultra-reliable and low-latency communications in 5G: Physical layer challenges and solutions // IEEE Wireless Communications. 2020. Vol. 27(3). P. 123–129.

METADATA | МЕТАДАННЫЕ

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Название: Комплексное исследование автономной производительности 5G в городской среде: влияние моделей мобильности и типов движения.

Аннотация: Быстрое появление самодостаточных сетей 5G кардинально меняет концепцию городских телекоммуникаций за счет улучшенной скорости, низкой задержки и высокой расширяемости. Однако развертывание этих сетей в таких районах все еще нуждается в улучшении, поскольку существует высокий сетевой трафик, чрезмерные помехи и, возможно, непредсказуемая мобильность. Это исследование предоставляет всесторонний анализ автономной производительности 5G в городских условиях, уделяя особое внимание влиянию различных моделей мобильности: статической, случайной и предопределенных путей – на три ключевых типа трафика: улучшенную мобильную широкополосную связь (eMBB), сверхнадежную связь с низкой задержкой (URLLC) и массовую связь машинного типа (mMTC). В фиксированных условиях высокой сетевой нагрузки и высоких помех в области действия были исследованы следующие основные показатели производительности: пропускная способность, задержка, надежность, масштабируемость, потребление ресурсов и энергоэффективность данной сети. Представленные здесь результаты подтверждают, что статическая мобильность в целом достигает наилучшего результата по этим показателям, при этом движение по случайной траектории значительно ухудшает производительность, особенно в отношении пропускной способности, задержки и потребления энергии. Предопределенные сценарии мобильности показывают, что этот вид мобильности влияет на производительность систем с умеренной эффективностью; надежность и ресурсы также меньше затронуты. Такие результаты свидетельствуют о вероятности методов оптимизацией, разработанных для городских сетей 5G, особенно при сильных помехах и высокой скорости движения. В результате эта работа предоставляет важные данные, которые можно использовать для повышения производительности 5G, новых областей применения, IoT, умных городов и критически важных услуг.

Ключевые слова: автономный 5G; городская среда; модели мобильности; задержка; надежность; масштабируемость.

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