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REVIEW ARTICLE

Investigating Resource Allocation Techniques and Key Performance Indicators (KPIs) for 5G New Radio Networks: A Review

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Abstract – The demand for 5G networks is growing day by day, but there remain issues regarding resource allocation. Moreover, there is a need to focus on key performance indicators for the 5G network. This study looks at the assessment of 5G wireless communications as well as the minimal technical performance criteria for 5G network services according to the ITU-R, Next Generation Mobile, 3GPP, and Networks. 5G standards that have been created in the 3GPP, ITU-Telecommunication Standardization Sector, ITU-R Sector, Internet Engineering Task Force, and IEEE are covered. In 5G-based wireless communication systems, resource allocation is a key activity that must be done. It is essential for the new systems used in 5G wireless networks to be more dynamic and intelligent if they are going to be able to satisfy a range of network requirements at the same time. This may be accomplished via the use of new wireless technologies and methods. Key characteristics of 5G, such as waveform, dynamic slot-based frame structure, massive MIMO, and channel codecs, have been explained, along with emerging technologies in the 5G network. Previous research related to 5G networks that considered resource allocation in heterogeneous networks is elaborated, along with the requirement of KPIs for 5G networks. The functionality of 5G has been discussed, along with its common and technological challenges. The research paper has also focused on metrics, indicators, and parameters during resource allocation in 5G, along with machine learning. To move the massive amounts of data that may flow at speeds of up to 100 Gbps/km2, these devices need supplementary, well-organized, and widely deployed RATs. To accommodate the expected exponential growth in the data flow, 5G network RAN radio blocking and resource management solutions would need to be able to handle more than 1,000 times the present traffic level. In addition, all of the information that makes up this traffic must be available and shareable at any time, from any location, and using any device inside the 5G RAN and beyond 4G cellular coverage areas. The need for resource allocation is discussed, along with the existing algorithm and improvements made in technology for resource allocation.

Index Terms – 5G Networks, 5G Services, Resource Allocation, 5G Technologies, 5G KPIs, ITU-R.

1. INTRODUCTION

Considering the growing need for 5G, the present paper has focused on key performance indicators and resource allocation mechanisms. Initially, the evolution of wireless network systems is presented in this section. The evolutionary background started to take shape in the 1980s, with the introduction of a 1G analog cellular network [1]. In 1990, 1G of digital networks was replaced by a "global system for mobile communications" (GSM), which allowed for both voice & text messaging services. 3G, which offers comparably high-speed data rates, was introduced in 2001 as a result of the poor data rates [2]. The launch of the fourth generation of broadband services in 2009 was signaled by long-term evolution (LTE) networks. Multi-input, multi-output, and OFDM, two new technologies included in 4G, changed the status quo and significantly increased the number of users for numerous services, including the Internet. With

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the introduction of the fifth generation in 2019, the globe became a village, and mobile services were extended from people to objects in the industry [3]. There is no way that today's 4G & LTE networks can simultaneously provide a satisfactory user experience for mobile consumers while also enabling immediate cloud services, IoT, improved vehicle-to-everything connectivity, Haptic Internet, and communication with drones and robots. High-quality video streaming for a large number of users at once via LTE networks is currently not possible. [4].

A 5G wireless system is a marketing term for technologies that meet the requirements of ITU, IMT-2020, and the 3G Partnership Project's Release 15. Therefore, fast throughput, high spectrum efficiency, low latency (LL), high mobility (HM), and high connection density are likely to be some of the most crucial features of 5G networks [5]. Because it will have more available bandwidth and more advanced antenna technology, 5G will enable a significant increase in the amount of data that can be transmitted over wireless systems. Additionally, it will enable a dramatic increase in the variety of new services and applications that can be used. In preparation for the launch of 5G, several organizations, such as 3GPP, NGMN, & ITU-R, have conducted research into the infrastructure and services that are required to support 5G. Even though 5G is referred to as "IMT-2020" in the ITU-R WP 5D document, a vision paper proposes numerous services that would be possible with 5G. The terms "mMTC," "eMBB," and "URLLC" have been proposed as categories for use-case scenarios. In this context, examples of KPIs include technical requirements, peak data rate (PDR), area traffic capacity (ATC), latency, network energy efficiency (NEE), connection density (CD), SE, mobility, & user-experienced data rate. Other possible KPIs include spectrum efficiency, SU, and spectrum efficiency [6]. In the next section (1.1), you will find informational facts.

1.1. 5G Standards

3GPP, internet engineering task force (IETF), ITU-telecommunication standardization sector (TSS), ITU-R Sector, & IEEE all work on 5G standards. Activities within 3GPP and the ITU are the main emphasis here. Normal procedures for standardizing 5G technology for IMT-2020 include verification of these submissions. Independent assessment groups made up of academic and industry researchers must be registered with ITU before they may review the application [2]. One of the IEGs that looked into 3GPPNR for Nu-Front, EUHT-5G, and other proponents is the 5G India Forum. As part of the standardization process, all applicant technologies must submit self-evaluation reports to ITU-R. The ITU-R is responsible for standardizing radio aspects of all IMT systems, from IMT-2000 through IMT-Advanced to IMT for 2020 and beyond. Using the ITU-R-provided assessment process criteria, the IEGs evaluate the self-reported technology and SRITs. After a number of these sessions, the RITs and SRITs will likely be approved as IMT-2020 (5G) standards. The 5GIF IEG is an ITU-R-registered IEG that evaluates proposed radio technologies for the IMT-2020 standard. The purpose of this committee was to evaluate IMT-2020 hopefuls in India's network infrastructure [3, 6].

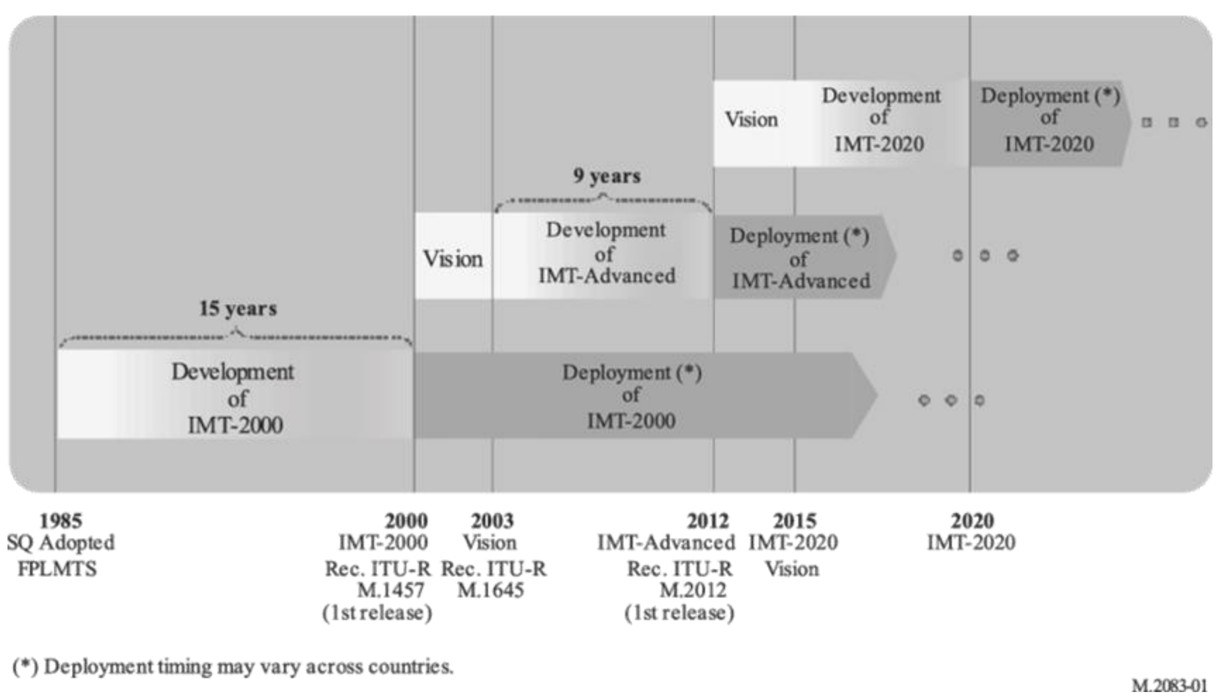

Figure 1 Timeline for IMT Development and Deployment [6]

Here, operators, OEMs, academic institutions, and individual experts collaborate to assess promising innovations for the IMT-2020 standard. This is a group effort where everyone has a say in the outcome, and choices are made via negotiation and compromise. Specifically for the Indian market, the 5GIF's technology and standards working group is creating use cases and requirements. Important achievements from 5G standardization groups like the 3GPP will be evaluated, along with integration ideas and migration strategies [7].

1.2. ITU IMT-2020

Systems beyond IMT-2020 & IMT-Advanced are supported by IMT-2020 systems, as described in Resolution ITU-R since they use new radio interfaces. To make IMT-2020 (figure 2) more flexible, reliable, and secure than previous IMT when providing a wide range of services across the aforementioned URLLC, eMBB, and mMTC scenarios, capabilities of IMT-2020 (figure 3) are outlined in Recommendation ITU-R "IMT Vision- Framework & overall objectives of future development of IMT for 2020 and beyond" [7].

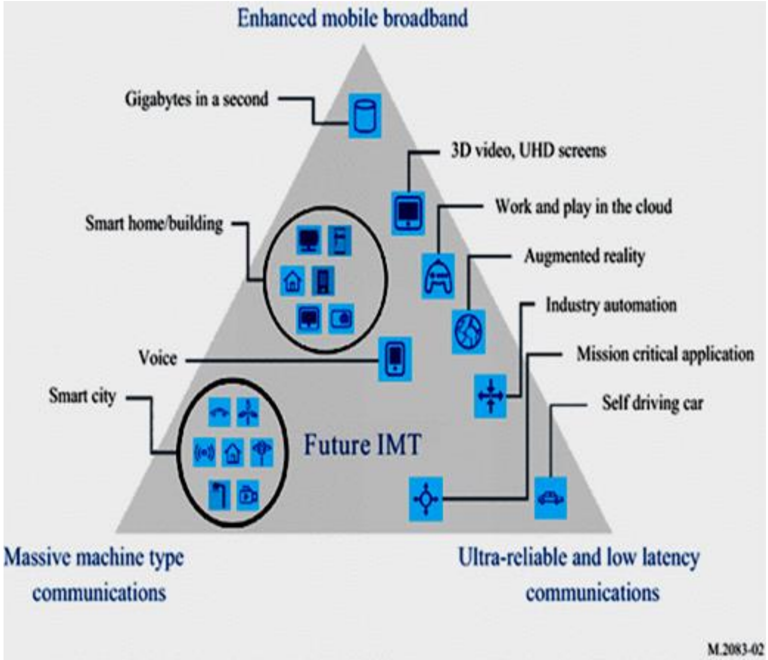

Figure 2 Usage Scenarios of IMT for 2020 & Beyond [7]

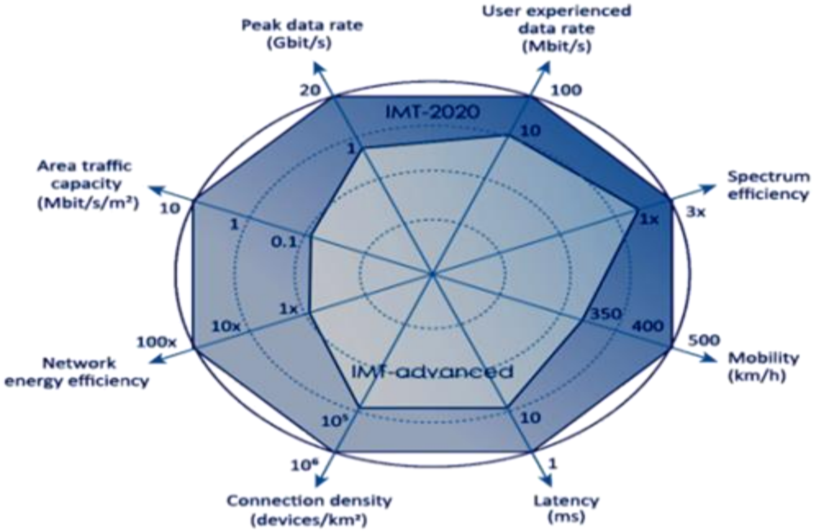

Figure 3 Enhancement of Key Capabilities from IMT-Advanced to IMT-2020[7]

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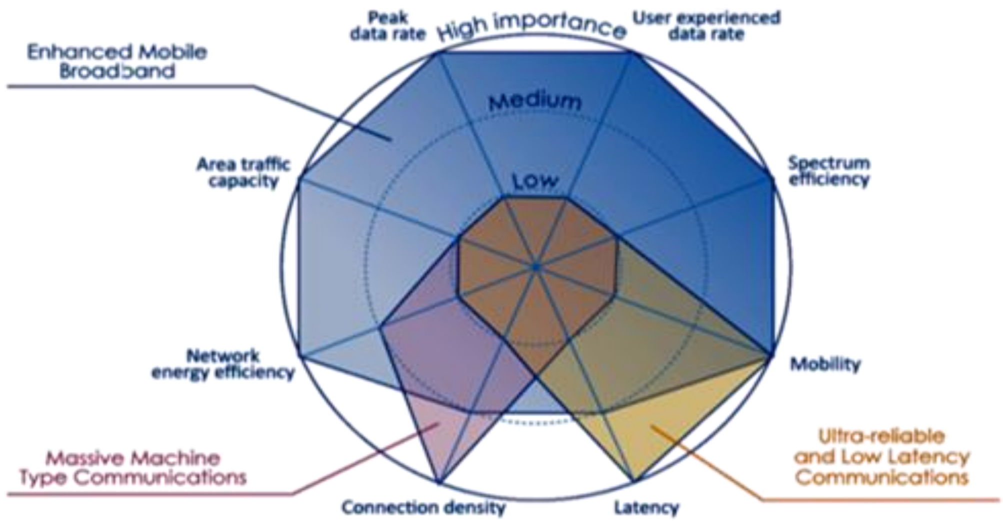

Figure 4 The Importance of Key Capabilities in Different Usage Scenarios [7]

1.3. 3GPP

3GPP is a collaboration between seven national standards bodies. Its purpose is to develop and manage international technical requirements for wireless communications [8] as shown in Figure 5.

Figure 5 Regional Standard-Setting Organizations [8]

A breakdown of the 3 technical standards groups and 16 working groups that make up 3GPP is shown in Figure 6.

Radio Access Network (RAN) Technical specification group	Service / System Aspects (SA) Technical specification group	Core network & Terminal (CT) Technical specification group
RAN WG1	SA WG1	CT WG1
RAN WG2	SA WG2	CT WG2
RAN WG3	SA WG3	CT WG3
RAN WG4	SA WG4	CT WG4
RAN WG5	SA WG5	

Figure 6 3GPP Technical Workgroups

1.3.1. 3GPP Releases

The 3GPP system operates on a series of concurrent "Releases," which provide programmers with a solid foundation on which to build their applications at any given time and make room for the inclusion of additional capabilities in later Releases [8].

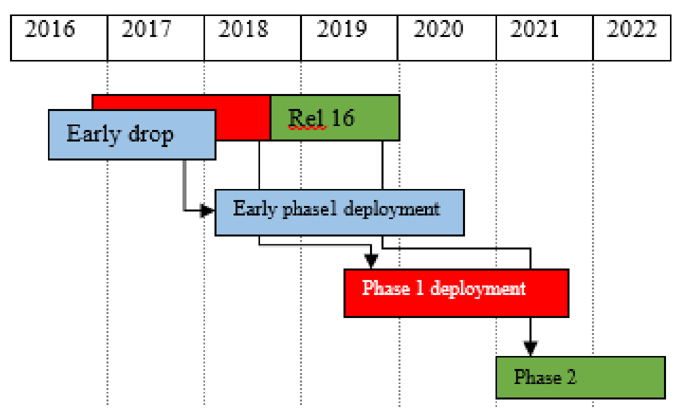

Figure 7 3GPP Timelines

1.3.2. 3GPP 5G

To fulfill the rising demand for mobile broadband, 3GPP is developing a new standard known as 5G that would both improve the efficiency and scalability of the LTE platform and allow for A new radio interface, 3GPP 5G is also a complete system that merges LTE & NR radio access technologies into a 5G Core Network [9]. LTE will initially satisfy some of the use cases, but NR's ultimate goal is to satisfy all of the needs. Release 15 of the 3GPP standards will be labeled as "5G," indicating an expansion of available services via the specialization of radio and network

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capabilities. Mobile Internet with Enhanced Speeds, Capacity, Reliability, and Latency for the IoT.

1.3.3. Recent 3GPP 5G Developments

The 5G development timeframe promise made in March 2017 was reaffirmed in the 3GPP RAN plenary in September 2017. Focus on LTE-anchored LTE-NR for the "early drop" (December/2017) Non-standalone (NS) / Dual Connectivity (DC) Network Router Different operations have continued through the end of 2017's December. Particulars on the whole Release 15 (June 2018): Since the air interface between NSA and SA uses the same 5G NR physical layer requirements, these issues were addressed in the December 2017 milestone for SA NR with the new 5G Core. Significant efforts are being put into standardizing NG core network architecture, which includes network slicing, and the SA's upper layers, which provide complete user and control plane capability [10].

1.3.4. 5G Phase 1: Release 15

Frequency bands between 450MHz and 52.6GHz are being prioritized to deliver improved mobile broadband (eMBB). Massive MIMO and adaptable RAN architecture are both supported by LTE-Anchored 5G (NSA) & Standalone (SA) 5G barebones URLLC.

1.3.5. Release 15 Timeline

There are two phases to Release 15, with the eMBB being the primary emphasis. Phase 1's first stage (Non-standalone) was finished in December 2017. In June of 2018, we'll have finished the second part of phase 1 (Standalone) [10, 11].

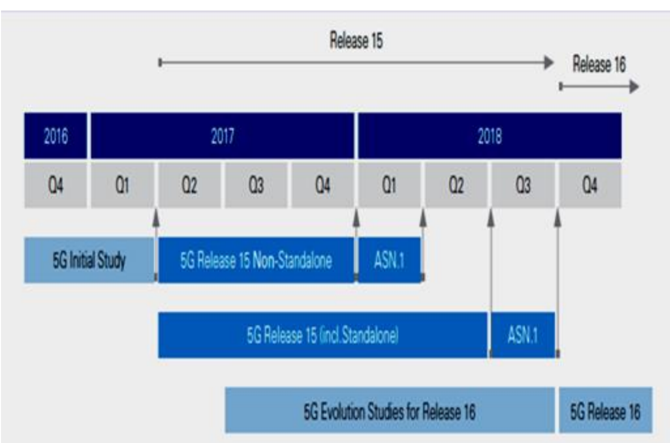

Figure 8 Release 15 Timelines [11]

1.3.6. Non-standalone vs Standalone

Non-standalone	Standalone
Uses LTE anchor, LTE core&LTE-NR DC	uses 5G radio & 5G core

Option 3 -LTE assisted

Option 3A -EPC connected

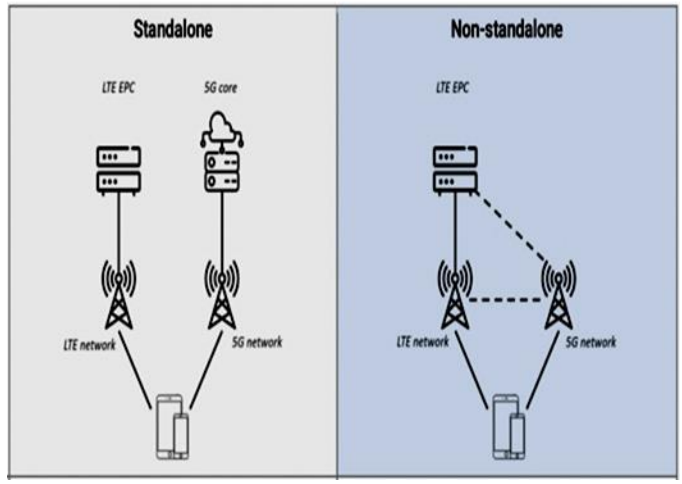

Figure 9 Non-Standalone vs Standalone [12]

1.3.7. 5G Phase 2: Release 16

Support for autonomous driving through URLLC and mMTC, as well as factory automation via V2X, are all new features [13]. New Unlicensed & Spectrum Sharing Paradigms and HBSMA, Non-Orthogonal.

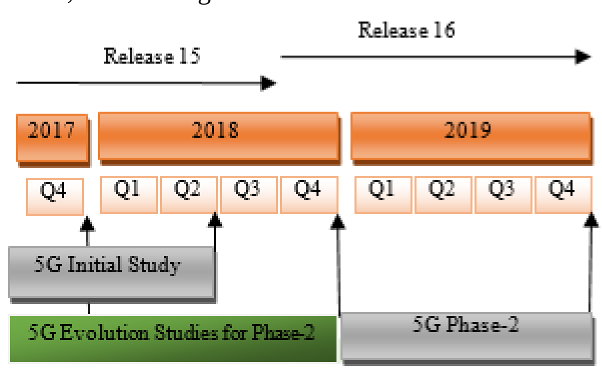

Figure 10 5G Phase 2 Timelines

1.3.8. 5G NR

The most potential next-generation alternative for meeting the demands of the increasingly demanding mobile market is 5G wireless technologies, whose air interface is known as "New Radio" [14]. 5G NR offers a wide variety of services that have specific requirements. The macro-categories of applications are defined by the International Telecommunication Union. Improved mobile broadband for high-throughput services; IoT-connected machines generating massive Machine Type Communications with stringent requirements for low cost, long battery life, &; LPC& Ultra-Reliable Low Latency Communications for seamless, low-delay bidirectional data exchange. Bandwidth from extremely

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low to very high is used. 0.45-100 GHz Incorporates use in unlicensed bands for standalone operation. A collection of numerologies optimized for use in certain frequency bands with built-in backward compatibility features the widest bandwidth available, up to 400 MHz above 6 GHz and 200 MHz below. Ultra-reliable low latency is supported natively, and there is brand new channel coding [15]. Split front-haul and C-U planes provide a versatile and adaptable RAN design. Support for network slicing that is native from end to end.

1.3.9. Key Characteristics of 5G NR

Waveform: Wideband operation and LL applications are possible with the scalable OFDM waveform n-technology for low-band, mid-band, and high-band spectrum allocations.

Dynamic: Slot-based frame structures provide a future-proof and ultra-lean architecture in addition to decoupled sub-frame structures, allowing them to successfully handle a broad range of use cases with requirements including LL, HPR, and high dependability [16].

Massive MIMO: Control & data channels for Massive MIMO's spectrum efficiency- and throughput-boosting Massive MIMO features.

Mobile mm-Wave: Adaptive beam forming& beam-tracking systems need control and data channels to be able to make use of the high-band millimeter Wave spectrum, which provides very high data rates and capacity.

Channel codecs: Polar codes for dependable control channels and state-of-the-art LDPC codes for supporting massive data blocks and bursty throughput.

1.3.10. Scalable OFDM

Using OFDM, NR can send data. Flexible numerology with subcarrier spacing from 15 kHz to 240 kHz and a corresponding change in the duration of guard interval allows NR to support a wide variety of deployment scenarios, from large cells with sub 1 GHz carrier frequency to mm-Wave deployments with very wide spectrum allocations. Radio specifications are specified for a subset of supported numerologies for each frequency band [16].

Table 1 Frequency Range of Scalable OFDM

Frequency Band	Subcarrier spacing	Max Bandwidth
0.45-6GHz	15/30/60 kHz	50/100/200 MHz
24-52.6 GHz	60/120 kHz	200/400 MHz

1.3.11. NR Release 15 Frequency Ranges

3GPP TS 38.104 provides the list of bands in which NR (New Radio) can operate. As per 3GPP release 15, these frequency bands are designated for different frequency ranges.

2. EMERGING TECHNOLOGIES IN 5G NETWORKS

Software-defined wireless networks and cloud radio access networks are two of the primary technology advances that have the potential to revive wireless cellular communication networks. 3G wireless networks; 4G millimeter wave spectrum; 5G heterogeneous multi-tier (6T) networks; 6T massive MIMO; 7G big data and cloud computing; 8G ultra-dense networks IoT, Ten) Highly mobile device-to-device connection; Eleven) Eco-friendly messaging; Thirteen) Cutting-edge radio access methods [17,18].

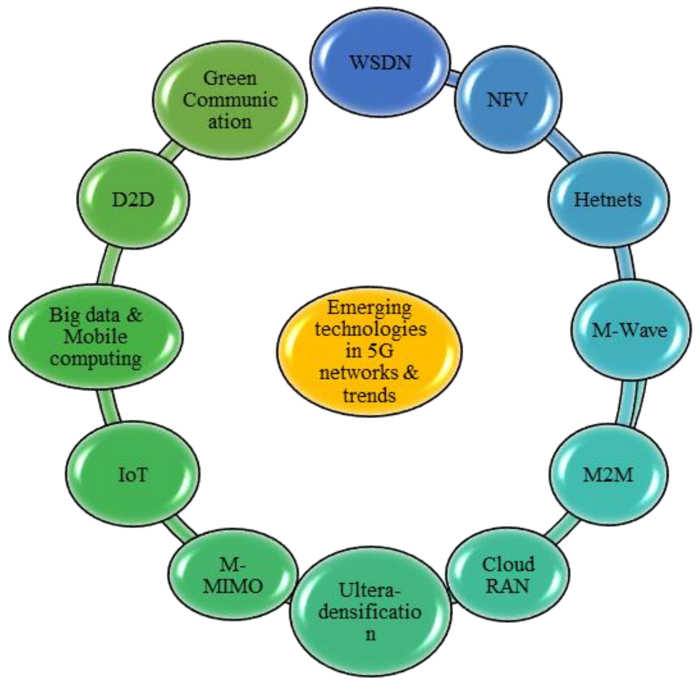

Figure 11 Emerging Technologies in 5G Networks and Trends

1. Cognitive Radio Access: The concept of "cognitive radio" hinges on the ability to detect and adapt to changes in the surrounding environment. Cognitive Radio Access networks' principal function is to detect nearby free airwaves, hence facilitating environmental adaptations by CRs networks. Upcoming technologies like 5G and Cognitive Radio will enhance capacity and network speeds to 10 Gbps, which will allow them to meet the need for heavy mobile DT in future wireless applications. However, CR networks may apply AI methods to improve their capabilities in real-time sensing and decision-making. With the help of cognitive radio powered by AI, the requirements for and effectiveness of 5G networks grow dramatically [4, 17, and 18].
2. Networks Function Virtualization: Network function virtualization, a complementary technology to software-

defined networks, lets whole network operations that were previously bounded to a hardware operate on cloud infrastructure [18]. Specific to traditional designs, operators buy and configure each network function with specialized hardware that is expensive and difficult to customize.

3. Millimeter-Wave: Present-day mobile systems are limited to operating in the microwave range between 300 MHz and 3 GHz. Millimeter-Wave frequencies, which span from 3 to 300 gigahertz, might be used instead of the relatively small amount of spectrum accessible at microwave frequencies. Over 24 GHz, the ITU has recommended a list of frequencies that meet specific criteria. The needs of the business. In December 2016, the Federal Communication Commission approved the ITU proposal. The Mm-Wave bands above 24 GHz now have official regulations according to the Federal Communications Commission [19]. Because they can provide enough frequency for Mobile applications, Mm-Waves will be in great demand over the next several decades. Mm-Waves are electromagnetic waves with wavelengths between 1 mm and 10 mm with a spatial resolution of more than.

4. Software Design Networks: Open Flow (2008) project at SU is widely regarded as the first implementation of software-defined networking, which involves physically dividing a network into a data plane and a control plane. When the network's control & data planes are split, administrators may streamline network operations & experiment with new service &setting combinations with more flexibility. Therefore, in the future network, dynamic adaptable topology control will be possible, allowing for the provision of For future communication networks to function, it will be necessary for programming to have the ability to process large amounts of data. Despite there being no consensus between the academic and industrial groups. Open Networking plans for SDN to be programmable &open source and extensible SDN and mm-wave deployment in mobile WCT may aid in simplifying network administration, according to the Open Networking Foundation [4, 17, 19, 20].

5. Heterogeneous - multitier Networks: With the increasing need for higher data speeds, one option available to operators is to reduce cell size. Through the size reduction, with this improvement, the cell's area spectral efficiency improves. By reusing transmission frequencies more often a power cut may be made so small that it results in zero power loss. The price of spreading the word will go down. The coverage of cells inside with poor reception may be improved by using smaller deployments, and traffic can be offloaded from large cells as needed. The advancement of technology in recent years is what made this option possible. Hardware miniaturization and the associated cost reduction measures [4, 17,18,20].

6. Massive MIMO: When it comes to creating 5G networks, massive MIMO will be crucial. Massive MIMO combines a high number of antennas at base stations to boost system throughput and capacity, as opposed to multi-user MIMO 4G systems, which employ just a handful of antenna components among user terminals & base stations [21].

7. Big Data & Mobile Edge Computing: With 5G's improved network speed comes new challenges for data storage. The traditional method of storing information will soon become inadequate due to the exponential growth of data. This is especially true when substantial volumes of data must be downloaded. Cloud computing has become more popular because of its convenient on-demand features, such as cloud storage. Users may back up their devices' local storage to the cloud. More importantly, mobile cloud computing is set to emerge as a leading method for processing massive amounts of data [22].

8. Network Ultra Densification: By using new technology, cell sizes have dropped throughout time as well. For increased bandwidth and capacity, 5G is projected to increase the density of the small cell deployment that began with 4G. Femto-cells increase the network's capacity & efficiency by making better use of the spectrum that is already accessible. In addition, it frees up the macro cells and cuts down on energy use. A smaller number of users in the offloading macro cells as a result of this deployment. The networks are becoming more and more diverse as we approach 5G, which calls for dense Multi-RAT in HetNet. There are a variety of operating systems and protocols that may be used on these networks [22].

9. IoT: IoT is the primary idea that has pushed the development of a 5G cellular network. In the Internet of Things, ordinary physical things such as cars, computers, and other gadgets are linked together in a network. Smart-watches, Microwave ovens, health monitors, and washing machines, are all examples of IoT devices [22, 23].

10. Device-to-Device Communications: It's a kind of innovation that lets gadgets talk to gadgets without using intermediary infrastructures like wireless routers. The most widely used D2D technologies today are Bluetooth & Wi-Fi Direct [23].

11. Green Communication: Data volumes & the number of linked devices are estimated to multiply by a factor of 100 in NG. Not only must we achieve these objectives, but we must do it in a way that is sustainable and economical [23].

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12. Radio Access Techniques: Offloading data to WLN may be convenient in many situations, but it may lead to a subpar performance in situations with a large number of concurrent users and devices. The throughput of WLANs is poorly designed. Managing a large number of customers clearly, this is a problem. With the realization that there would be situations when there is a high concentration of access points and a high concentration of user terminals, the IEEE 802.11 Working Group has established a task force on High-Efficiency WLANs [23].

13. Machine-to-Machine Communication: As the aforementioned enabling technologies continue to develop, expanding service coverage and capacity, new use cases and applications emerge. Applications are being discovered, and their appearance is imminent requiring much more from our worldwide networks. There are various obstacles unique to M2M communications, not the least of which is the autonomous and frequently limited operation. Power, size, and complexity s specifications. The normal M2M traffic is also pretty distinct: we 'have spent decades improving our networks, from the most powerful servers to the support of the lowest level PHY channel codes typical traffic fluxes associated with speech We are no longer limited to surfing and texting a distinct type of traffic: brief, periodic or bursts of telemetry and machine-generated updates. The distribution and character of these M2M traffic flows do not easily fit into expansions to conventional network architectures and changes are necessary [23].

2.1. Minimum Technical Performance Requirements for 5G Network Services

ITU-R, 3GPP, SMARTER, & NGMN are just a few of the groups that have worked on establishing technical standards for 5G networks and services. We talk about things like extra readings and group dynamics in addition to the main lecture. The ITU-R classifies three types of 5G service, and URLLC as shown in Figure 12. It demonstrates the connections between the service types proposed by the ITU-R, NGMN, and 3GPP and the 14 service categories and 24 use cases for 5G mobile services proposed by each organization. The gap between services with comparable technology requirements is thereby bridged. In Table 2 [2] and the following description, a wide variety of factors, user experience data rate, spectrum efficiency, including peak data rate, mobility, area traffic efficiency, user plane, mobility interruption time, bandwidth & control latency, mobility, network energy efficiency, reliability, and scalability, and 5th percentile user spectral efficiency, are shown to be important in different ITU-R eMBB service scenarios. In addition, certain URLLC service scenarios need low latency and mobility. 5G networks must reliably and smoothly handle a massive influx of devices broadcasting packets sporadically in mMTC service conditions [24].

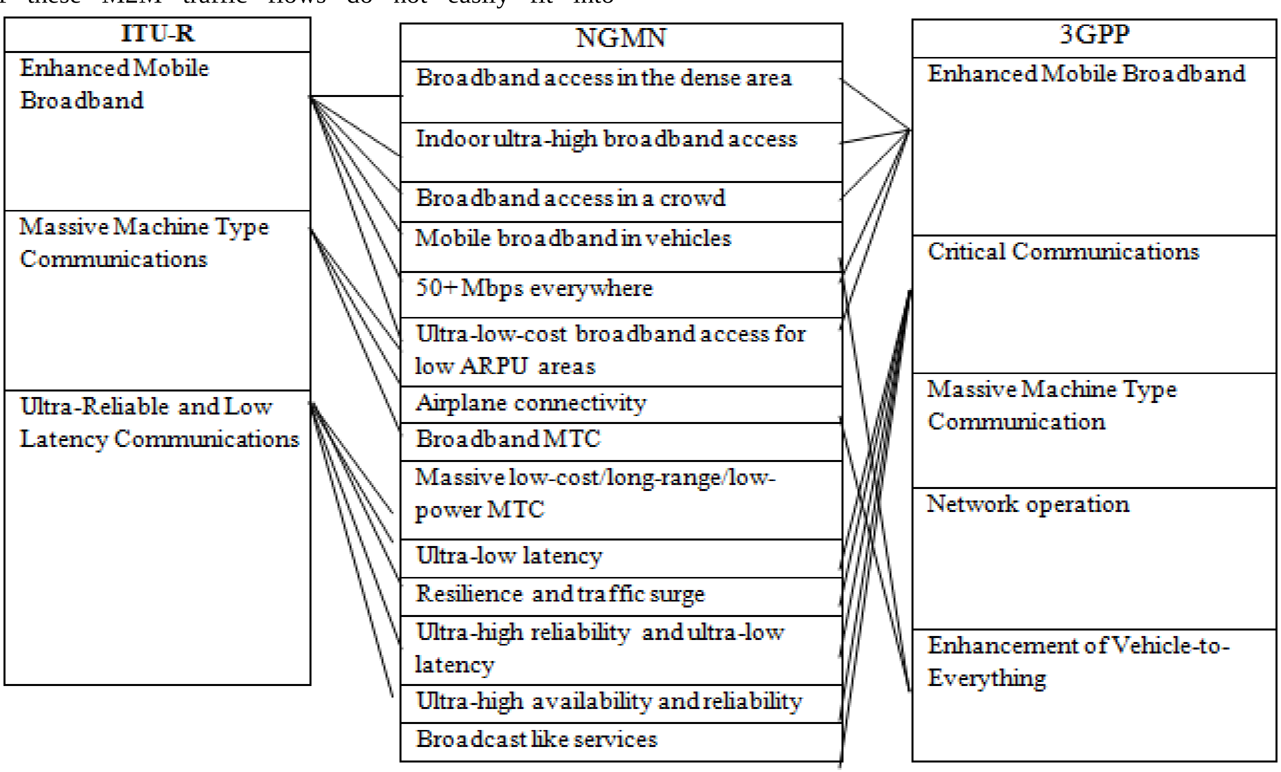

Figure 12 Comparisons of 5G Networks Services in ITU-R,3GPP&NG Mobile Networks

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Table 2 Technical Requirements for 5G Services in ITU-R [2, 3, 7, 24, 25]. eMBB, mMTC, URLLC Communications

<table>
<tr><th rowspan="2">Technical Requirement</th><th colspan="3">Usage Scenario Applicability</th><th rowspan="2">Required Value</th></tr>
<tr><th>eMBB</th><th>mMTC</th><th>URLLC</th></tr>
<tr><td>Peak data rate</td><td>High</td><td>Low</td><td>Low</td><td>DL: 20Gbps, Ul: 10Gbps</td></tr>
<tr><td>Peak spectral efficiency</td><td>High</td><td>Low</td><td>Low</td><td>DL:30bps/Hz, UL:15bps/Hz</td></tr>
<tr><td>User experienced data rate</td><td>High</td><td>Low</td><td>Low</td><td>DL:100Mbps, UL:50Mbps</td></tr>
<tr><td>5th percentile user spectral efficiency</td><td>High</td><td>Low</td><td>Low</td><td><table><tr><td>Test Environment(TE)</td><td>DL(bit/s/Hz)</td><td>UL(bit/s/Hz)</td></tr><tr><td>InH(Indoor hotspot)</td><td>0.3</td><td>0.21</td></tr><tr><td>DL(Dense Urban)</td><td>0.225</td><td>0.15</td></tr><tr><td>RL(Rural)</td><td>0.12</td><td>0.045</td></tr></table></td></tr>
<tr><td>Area traffic capacity</td><td>High</td><td>Low</td><td>Low</td><td>100 Mbit/s/m2</td></tr>
<tr><td>Connection density</td><td>Medium</td><td>High</td><td>Low</td><td>1000,000 devices/km2</td></tr>
<tr><td>Energy efficiency</td><td>high</td><td>medium</td><td>low</td><td>Capability to support a high sleep ratio and long sleep duration (eMBB) or Qualitative</td></tr>
<tr><td>Average spectral efficiency</td><td>High</td><td>Low</td><td>Low</td><td><table><tr><td>Test Environment(TE)</td><td>DL(bit/s/Hz)</td><td>UL(bit/s/Hz)</td></tr><tr><td>InH(Indoor hotspot)</td><td>9</td><td>6.75</td></tr><tr><td>DL(Dense Urban)</td><td>7.8</td><td>5.4</td></tr><tr><td>RL(Rural)</td><td>3.3</td><td>1.6</td></tr></table></td></tr>
<tr><td>Reliability</td><td>High</td><td>Low</td><td>High</td><td>1-10-5 success probability for a layer 2 PDU of size 32 bytes within 1ms in channel quality of coverage edge UL or DL</td></tr>
<tr><td>Mobility</td><td>High</td><td>Low</td><td>High</td><td>Stationary, pedestrian (UL)(indoor hotspot-eMBB test environment)</td></tr>
<tr><td>Mobility interpretation time</td><td>High</td><td>Low</td><td>High</td><td>0 ms (eMBB, URLLC)</td></tr>
<tr><td>Bandwidth and Scalability</td><td>Low</td><td>Low</td><td>Low</td><td>At least 100 MHz up to 1 GHz for higher frequency bands.</td></tr>
</table>

2.2. Key Technical Performance Requirements in Details

2.2.1. Peak Spectral Efficiency

The maximum feasible data rate is the number of bits per second of received data in error-free circumstances that can be assigned to a single mobile station while all available radio resources in the direction of the connection are being utilized. This number is determined by the number of bits per second of received data in error-free conditions [24, 25]. This criterion is defined for the purposes of testing based on the eMBB usage case. The minimal minimum requirements, as shown in Table 1, are necessary to ensure optimum spectrum efficiency.

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2.2.2. Peak Data Rate

The maximum theoretical data rate is the number of bits that may be received by a single mobile station under conditions in which there is no possibility of a mistake at the same time that all of the radio resources that are available in the intended connection direction are being used. This criterion is defined for the purposes of testing based on the eMBB usage case. Table 1 lays out the bare minimum requirements that must be met to reach a certain peak data rate [24, 25].

2.2.3. Area Traffic Capacity

This is the overall traffic throughput that is supplied across all locations, and it is measured in terabits per square meter. The term "throughput" refers to the average number of bps that are successfully received or the number of bits in the SDUs that are successfully sent to Layer 3 throughout a certain amount of time. As a result, this criterion has been created so that it may be used in the appropriate eMBB testing environment [22, 25]. You will require a downlink Area traffic capacity of 10 Mbit/s/m2 to succeed in the Indoor Hotspot - eMBB test.

2.2.4. User Plane Latency

The radio network is responsible for user plane latency, which is the delay that occurs between the transmission and receipt of a packet (in ms). The latency of a network may be defined as the amount of time it takes for a packet or message to travel from the ingress point of a mobile station to its outguess point at the application layer [22, 25].

This time is measured in milliseconds. This can take place in either the uplink or the downlink of the radio interface. The evaluation of eMBB & URLLC use cases is designated as appropriate applications for these criteria. The minimal minimum amount of delay that is considered acceptable for the user plane is shown in Table 2.

2.2.5. Control Plane Latency

Time to get from the "battery efficient" condition to the point where constant data transmission may begin is what this term describes (e.g. Active state). This criterion is specified for use in assessing the eMBB and URLLC use cases. Control plane latency must be no more than 20 milliseconds. Supporters are urged to think about the possibility of a control plane latency of 10 milliseconds or less [22, 25].

2.2.6. Mobility Interruption Time

This is the minimum duration that a user terminal must wait before it may begin exchanging User plane packets with any base station again after a transition [22, 25]. The mobility interruption time includes the time it takes for the mobile station and the radio access network to exchange messages, as well as the time it takes for any radio access network operation or radio resource control signaling protocol to be executed. The eMBB and URLLC use cases are intended to be evaluated using these criteria. All timeouts during movement must take place in under 1 millisecond.

2.2.7. 5th Percentile User Spectral Efficiency

To define normalized user throughput as a rate in bits per second per hertz, the channel bandwidth must be divided by the number of bits successfully received. The eMBB use scenario defines this criterion for testing purposes. Table 2 provides a summary of the minimal spectral efficiency requirements for the 5th percentile of users in a variety of test scenarios [25, 26].

2.2.8. Connection Density

It's the density at which devices meeting a certain QoS are packed into a given volume (per km2). These objectives must be satisfied given the limitations of available bandwidth & number of TRxPs. To achieve the required level of service, it is necessary to guarantee that a message of a particular size will be delivered within a specific time frame and with a certain success probability. This need has been defined in the setting of the mMTC assessment scenario. Connectivity density must be at least 1,000,000 devices per square kilometer [26].

2.2.9. Reliability

The probability is that a small data packet will travel from the ingress end of the radio interface to the egress end within the maximum time permitted for that channel quality. This testing criterion is defined by the URLLC use case. The minimal reliability criterion for the Urban Macro-URLLC test environment is a 1-10-5 success probability of sending a 32-byte layer 2 PDU within 1 millisecond in channel quality at the coverage edge, assuming modest application data [26]. Proponents are encouraged to consider a larger packet size, such as a layer 2 PDU of up to 100 bytes.

2.2.10. Mobility

It's the fastest speed at which a mobile station can still provide a specified quality of service [26]:

1. Stationary: 0km/h
2. Pedestrian:0km/hto10km/h
3. Vehicular:10km/hto120km/h
4. High-speedvehicular:120km/hto500km/h

For a mobility class to be enabled, the uplink traffic channel connection data rate must conform to the values in the table above, normalized by bandwidth. It is assumed here that the user is completing each test at the fastest possible pace for the given mobility class. The eMBB use scenario defines this criterion for testing purposes.

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2.2.11. Energy Efficiency

The EE of a network is measured by how well a radio access network uses its available traffic capacity to generate electricity. The efficiency of a device's use of energy depends on the RIT's or SRIT's capacity to optimize the device's power consumption in light of the traffic profile [27]. Both the network and the device's ability to save energy may be affected by the following factors:

1. Transmission of data under heavy load;
2. Reduced power usage when no data is being used.

The eMBB use scenario defines this criterion for testing purposes. Both a high sleep ratio and lengthy sleep duration need to be supported by the RIT/SRIT. Supporters of the RIT/SRIT are urged to detail any further methods that enhance the system's ability to facilitate network and device operations that are gentle on energy consumption [27].

2.2.12. Bandwidth

Bandwidth refers to the total amount of data that may be sent across a network at once. One or more it's possible that RF carriers might be employed to back up the bandwidth. Bandwidth requirements for RIT and SRIT testing in preparation for IMT-2020 are now known. There must be at least 100 MHz of bandwidth available. For usage in higher frequency bands, the RIT/SRIT needs to support bandwidths of up to 1 GHz. Recommenders are asked to consider growing to permit operation in wider bandwidths in light of the study objectives outlined in Recommendation ITU-R. Adaptable data rates must be supported by the RIT/SRIT. The capacity of a potential RIT/SRIT to function with varying bandwidths is the scalability of bandwidth [27].

2.3. Resource Allocation in 5G Network

In wireless communication systems, resource allocation is a crucial task that must be completed. New systems in 5G wireless networks need to be more dynamic and intelligent to concurrently serve a variety of network needs. This may be accomplished via the use of new wireless technologies and methods. In light of this, the process of resource distribution must contend with a great number of formidable obstacles, such as interference alignment, security threats, or environmentally friendly communication. On the other hand, the issue of energy is a serious problem in 5G networks, and it is directly affected by the resources that are allocated in the system (i.e., bandwidth allocation, power control, association allocation, and deployment strategies). This is one of the most significant problems with 5G networks. Therefore, in addition to the improvement of spectral efficiency performance, an emerging trend of 5G wireless networks is to approach green communication using energy efficiency (EE) (bits/Hz/Joule). This presents the most significant challenge because energy efficiency belongs to the fractional programming subfield of the optimization field, also known as non-convex programming. This leaves a lot of challenging problems in enhancing the performance of the network EE [28, 29].

2.4. Paper Organization

Section 1 has focused on the 5G network, its standards, key characteristics, and the KPI of 5G. Moreover, the section considers minimum technical performance Requirements for 5G Network Services along with the need for resource allocation in 5G networks.

Section 2 is presenting emerging technologies in 5g networks.

Section 3 is presenting existing research work in the area of 5G where different types of energy-efficient and resource allocation based 5G systems are presented.

Section 4 is presenting the requirement of KPIs for the 5G network along with common and technical challenges.

Section 5 is focused on allocating Resources in 5G. Different Metrics and indicators have been presented with influencing factors and parameters.

Section 6 is presenting the significance of resource allocation.

Section 7 is considering different issues and challenges faced during 5G implication.

Section 8 is evaluating previous algorithms and issues resolved using this algorithm. Moreover, improvements in the 5G network are also made considering its limitations.

Section 9 is the conclusion part that is justifying the impact of different factors on the efficiency & performance of the 5G network.

3. RELATED WORK

Many studies comparing 4G and 5G WCS are summarized and discussed [30], as are many forms of research from the area of 4th and 5th generation networks. Recently, there have been concerns with the performance of 4G networks, the foundation upon which 5G wireless technology is built. Researchers claim that with the introduction of the 4G system, specialists all around the globe started looking for next-generation wireless technologies to meet future internet demand. Consequently, studies on 5G wireless communication based on NR have intensified during the last several years. The review will primarily focus on the program provided by various prior researchers on NR-based 5G wireless communication systems and LTE-A and Resource allocation as well as machine learning in 5G which will be accomplished through an analysis of the literature produced by them in various areas of 5G. System performance may be improved by more efficient use of resources such as time, energy, & frequency. Resource allocation strategies used in 5G nowadays are analyzed and evaluated in this paper.

Sangmi *et al.* [31] presented a study on Cell Selection as well as Resource Allocation in the Case of Interference Management. Heterogeneous networks have been examined in this research using the Macro-Pico cell heterogeneous networks. Further, Y. Xu *et al.* [32] Did a study on the area of Multicell Heterogeneous Networks. To improve EE and reduce interference to macro users, they took into account the resilient resource allocation problem while maximizing user interference efficiency such as total rate/sum interference in heterogeneous networks.

5G Cellular Networks were described by Pratap *et al.* [33]. The goal of the 5G network is to increase transmission efficiency & service quality to accommodate the ever-increasing volumes of mobile traffic, and fairness and interference minimization was also outlined to help achieve this goal. At last, an overview of 5G resource allocation using CRAN was published by Ejaz W *et al.* [34], which means that several resource allocation methods are now available. However, the authors did not do much work on energy efficiency, instead focusing on other areas such as latency, security, throughput enhancement, interference control, and cost reduction.

EE Resource Allocation in NOMA Heterogeneous Networks with Energy Harvesting is a topic that was researched by H. Zhang *et al.* [35]. This study was unable to contribute to capacity enhancement in the 5G network; nonetheless, NOMA and heterogeneous networks are two probable candidate solutions in the scenario of coping with an exponential rise of mobile data. Further improvement M. Ghanbarisabagh *et al.* [36] suggested a study that improves capacity in 5G networks utilizing femtocells allocating resources between femtocells and macrocells is critical for mitigating the effects of interference in dense femtocells. The significant increase in the number of internet users, as well as the demand for greater data capacity per user, necessitates the development of complex systems but ignored spectral efficiency.

The connection between EE and SE in cognitive femtocell networks was studied by J. Ghosh [37] using resource allocation as an example. This research demonstrated the energy efficiency against spectrum efficiency trade-offs in both cooperative and non-cooperatively designed cognitive femtocell networks. The research did not even attempt to account for the efficient utilization of resources. Additionally, N. Jinaporn *et al.* [38] tackled this issue. Carrier aggregation in LTE cellular networks was analyzed, as was the efficacy of resource allocation. Multiple carrier aggregation methods and operating frequency bands were explored, without any optimization of the resource allocation process itself. This included the selection of component carriers and the scheduling of resource blocks. To address this issue, A. Pratap *et al.* [39] proposed a strategy to ensure that 5G networks distribute their limited resources fairly. Starting with the situation of maximum resource reuse in 5G Het Net ssmall cell networks, we first formalize IRA, IR, and user-level fairness as an NP-hard problem. More study was conducted by Y. Xu *et al.* [40] on resource allocation in 5G heterogeneous networks.

The author offered a thorough review of RA in HetNets in the case of 5G communications in their paper. But there was a need to consider a small-cell LTE-A-based heterogeneous network. Resource Allocation Techniques were reviewed by S. Kumar *et al* [41] and they worked on Small Cell LTE-A Heterogeneous networks (HetNet). In this work, a complete overview of current research difficulties was offered in a tabular format. Afterward, Amandeep *et al*[42] examined Resource Allocation in Heterogeneous LTE and this paper demonstrated how Small Cells solve Micro Cells issues and heterogeneous networks are important in managing device power along with performance. Further during those researches, the homogenous network was ignored so Small cell LTE-A networks with homogenous and heterogeneous small cells were studied by A. Noliya and others to check the performance of resource scheduling methods. This innovative design met the need as well in the case of high connectivity along with a variety of network types in next-generation mobile networks [43].

To improve UE throughput while keeping UE-specific SINRs to a minimum, Niu Chongyu *et al.* [44] of LTE-A HetNets have devised a multi-target resource allocation technique that makes use of the FC. The key to this technique is a novel approach to assessing interference in the downlink. It was necessary, however, to implement power optimization and energy-efficient sub-channels. Downlink NOMA heterogeneous network EE sub-channel and power optimization was studied by Fang *et al*. [45]. The author of these results uses sub-channel allocation and power allocation to guarantee that the whole system, including macro cells and microcells, is optimized for energy efficiency. When using 5G and HetNet for communication, the need for high-quality services has grown. In addition, the need for big data has grown, prompting Imran, A. *et al*. [46] to investigate 5G in light of optimistic QoS and new multifarious approaches to equipping SONs with big data to satisfy the needs of 5G.

Further, there was the need to make such a system smarter. To achieve this goal machine learning came into demand. M.U. Iqbal [47] presented Machine learning-based capacity improvement of femtocells. They worked on 5G heterogeneous networks research and always ensure minimal QoS requirements and conducted more studies on 5G-related problems and machine learning techniques. Eventually, 4G won't be able to provide the level of service that consumers

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expect because of the exponential growth of mobile data use and associated communication infrastructures. From a machine learning perspective, Morocho-Cayamcela *et al.* [48] also suggested possible 5G solutions. Before discussing how ML might improve mobile and wireless network communications & mobile traffic management, the author clarifies the fundamental principles of supervised, unsupervised, &reinforcement learning. RRM, mobility management, service provisioning management, etc. are just some of the areas Li, R. *et al.* [49] look at in their investigation of an intelligent 5G when Cellular Networks Meet AI.

HetNets, massive MIMO networks, mm-Wave scenarios, and energy harvesting networks were investigated by Liu, D. *et al.* [50], and all four were shown to be crucial enabling technologies for future 5G networks and demand for 5G NR. Parkvall, S. *et al.* [51] proposed a new 5G RI that can support a wide range of use cases while still meeting demanding performance goals. We require interconnection at high and low-frequency bands, adaptable numerology, and a latency-optimized frame structure to achieve these goals.

The aforementioned studies all focused on specific areas of 5G resource allocation such then RAN; HC-RAN, C-RAN, & CN, but the current investigation will examine the network as a whole. A comprehensive literature analysis was necessary to establish how to distribute resources in 5G networks. We address this requirement in our study by doing a thorough analysis of 5G resource allocation strategies. To emphasize the significance of resource allocation for 5G networks in this study and better take it into consideration in the future.

4. NEED OF KPIS FOR 5G NETWORKS

In this section, we have discussed the major KPIs for 5G networks, like the current problems addressed in 5G networks, what parameters as well as metrics are required for 5G networks when we allocate resources in 5G, how it properly allocates resources, and the last one is the existing algorithms as well as rules for 5G resource allocation. It is based on procedural guidelines and has a particular emphasis on the allocation of 5G resources. The major component of a comprehensive review is the formulation of research questions, combined with the variables of motivation that are discussed in this section. The current level of 5G RA was critically evaluated based on specified motives and research issues.

Challenges are a natural aspect of new developments, and 5G is no exception. It faces significant obstacles. The advancement of radio technology has grown quite quickly in the past. The journey only takes roughly 40 years to go from 1G to. The absence of infrastructure, the study technique, and the expense are the recurring problems we have seen along the way. However, dozens of nations are still utilizing 2G and 3G technologies and are unaware of 4G. Currently, the most pressing issues on everyone's attention are:

How long will 5G remain functional?

Will this only help part of the technologies in rich nations, or will it also aid underdeveloped nations?

To better address these concerns, there are classified 5G problems into two broad groups.

4.1. Common Challenges

4.1.1. Multiple Services: 5G would need to handle more networks, technologies, and devices in more places than current radio signal services. To meet people's high expectations for responsive, personable, omnipresent, and data-rich wireless services, widespread adoption of a common set of technical specifications is essential [52].

4.1.2. Infrastructure: Standardization & use of 5G services provide technological obstacles for researchers [52].

4.1.3. Communication, Navigation, And Sensing: The accessibility of the radio spectrum, which is utilized to transmit communications, is crucial to the operation of all three services. Though 5G technology's processing capacity is sufficient to analyze the massive amount of data coming from multiple sources, it does need a more robust supporting infrastructure [52].

4.1.4. Security and Privacy: Protecting users' personal data will be a major obstacle for the 5G network. To address evolving risks to global security, including those to trust, privacy, and cyber security, 5G will need to explain these ambiguities [52].

4.1.5. Legislation of Cyber-law: Some worry that cybercrime and other forms of fraud may increase as 5G rolls out rapidly and to more people. Therefore, cyber-law regulation is an extremely important topic that is essential of a political and governmental nature [52].

4.2. Technological Challenges

4.2.1. Inter-Cell Interference: Inter-cell interference is an important technical challenge that must be addressed. Because of their size disparity, traditional macro cells and modern microcells are bound to interfere with one another. [53].

4.2.2. Efficient Medium Access Control: Since a significant number of access points and user terminals must be located nearby for a hotspot to function, cellular technology cannot be relied upon to offer high throughput, resulting in limited throughput for users and excessive latency. A thorough investigation of the technology is required if its potential is to be realized [53].

4.2.3. Traffic Management: Overload and congestion in the radio access network might be caused by an abundance of M-2-M devices in a given cell. While human-to-human communication is the norm in cellular networks, this is a departure from the norm [53].

4.2.4. Mm-wave: Millimeter waves, on the other hand, are transmitted between 30 & 300 GHz, but frequencies often used for mobile devices are below 6 GHz. [4, 6, 11].To support the 5G technological revolution, millimeter wave exhibits several appealing properties, including a sizable quantity of accessible spectrum resources and acceptable propagation behavior in LOS environments. The current issues with millimeter wave communications and possible fixes such as 3D Channel Modeling, Dynamic Power Control, etc [53].

4.2.5. MIMO: Even while huge MIMO has great potential for the development of wireless networks, many concerns remain unanswered before it can be extensively utilized. In particular in the downlink [4], gathering the vast volumes of channel status data necessary for beam-intensive farming is challenging due to the information requirements of the operation. Massive MIMO may not function with FDD systems due to the channel's duality, but it could with TDD. As an alternative, you may implement a feedback restriction. Moreover, Massive MIMO suffers from thermal noise at low transmit powers and pilot contamination from neighboring cells at high powers. Last but not least, researchers are unable to adequately validate algorithms and procedures since there aren't enough channel models for Massive MIMO systems [53].

4.2.6. Mobility: Work must be done at speeds of up to 1000 km/h for 5G networks. To learn more about the problems with choosing the best beam and creating strategies that improve the transmitter response needed for CSI, a thorough examination is required. As a result, enormous MIMO performance is sensitive to speed since multiuser systems may become pricey due to the computational burden [53].

4.2.7. 5G User Equipment testing: The concerns that surfaced during the testing of 5G UE are similar to those that occurred in conventional systems that used measuring matrices for receiver sensitivity, excessive power output, and power regulation. New measurement methods are needed to conduct the essential tests for 5G systems based on LTE-A/LTE-B, which will need to provide instantaneous connections with energy provisioning capabilities, use SC-FDMA for uplink, and an OFDMA scheme for downlink. Trial equipment has to be configured to automatically account for operational signaling protocols to acquire correct RF measurements. There should be end-to-end throughput assessment, handover testing, and signaling protocol verification as part of the UEs' operational testing. Validating the solution's correctness is the main difficulty in testing 5G UE. The primary challenge in 5G UE testing is ensuring the requirements for responsive state changes are met. [53].

4.2.8. Network Slices: In allocating such slices, there will undoubtedly be competing needs, and providing a network effectively presents several difficulties. Network slicing has a dual effect on how users and traffic are prioritized since it requires managing both the priority between slices (inter-slice) and the priority amongst users inside a slice [53].

4.2.9. The Deployment and Maintenance Cost: The cost of setting up & running 5G is prohibitive. New applications won't be implemented until they can demonstrate long-term cost savings since the industry has tight standards for doing so [53].

5. METRICS/INDICATORS AND FACTORS/PARAMETERS USED

The KPIs discovered to be employed in this study's 5G resource allocation are listed in Figure 13. Scalability, throughput, overhead, fairness, system performance, power allocation, latency, energy efficiency, data sum rate, spectral efficiency, outage ratio, interference, low complexity, Delay, reliability, availability, the time required for RA, power consumption, feasibility, response time, end-to-end delay, etc. are some of the metrics considered in this paper's literature review. Measurements of this massive body of work are shown annually in Figure 13. The total number of papers published each year is shown here.

6. SIGNIFICANCE OF RESOURCE ALLOCATION IN 5G

Wireless network systems rely heavily on resource distribution. A 5G communication network must be smarter and more adaptable if it is to handle the wide range of demands placed upon it. The system divides up resources by predetermined criteria, such as power management, bandwidth distribution, deployment strategy, and group membership. Allocating resources is essential in any cellular network setting. It is essential to keep cellular-based apps accessible to consumers, business partners, and end users. Resource allocation is very helpful in cellular network environments. The efficiency of a network is influenced by how fairly its resources are allocated. "The degree of fairness and network performance are strongly correlated" Allocating resources fairly has four degrees of fairness: fair, perfect, unjust, and imbalanced. There are four performance levels for networks: good, and perfect, less good, poor.

An important challenge for 5G is how to balance the needs of high-performance, long-lasting battery-powered devices with

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those of high-quality application services. Effective resource management and allocation are required by users. Resource allocation is complicated and inefficient as a result of the ossified services and restricted architecture of current networks. Given the user-centric focus of modern WCN, especially 5G wireless networks, efficient resource allocation is required to get QoS. As a result, the increasing demand for 5G cellular networks is primarily hampered by the inefficiency with which resources are allocated. Power, spectrum, channel, etc., are all hard-and-fast parameters of a wireless communication network, and these resources must be allocated sensibly. A mobile network may run into spectrum resource constraints when the number of users and connected devices rapidly increases. Priority will be given to the distribution of 5G resources. The major component of reviews is the formulation of research questions, combined with the variables of motivation that are discussed in this part. To provide a critical evaluation of the current level of resource allocation in 5G, a set of motivations and research questions have been developed.

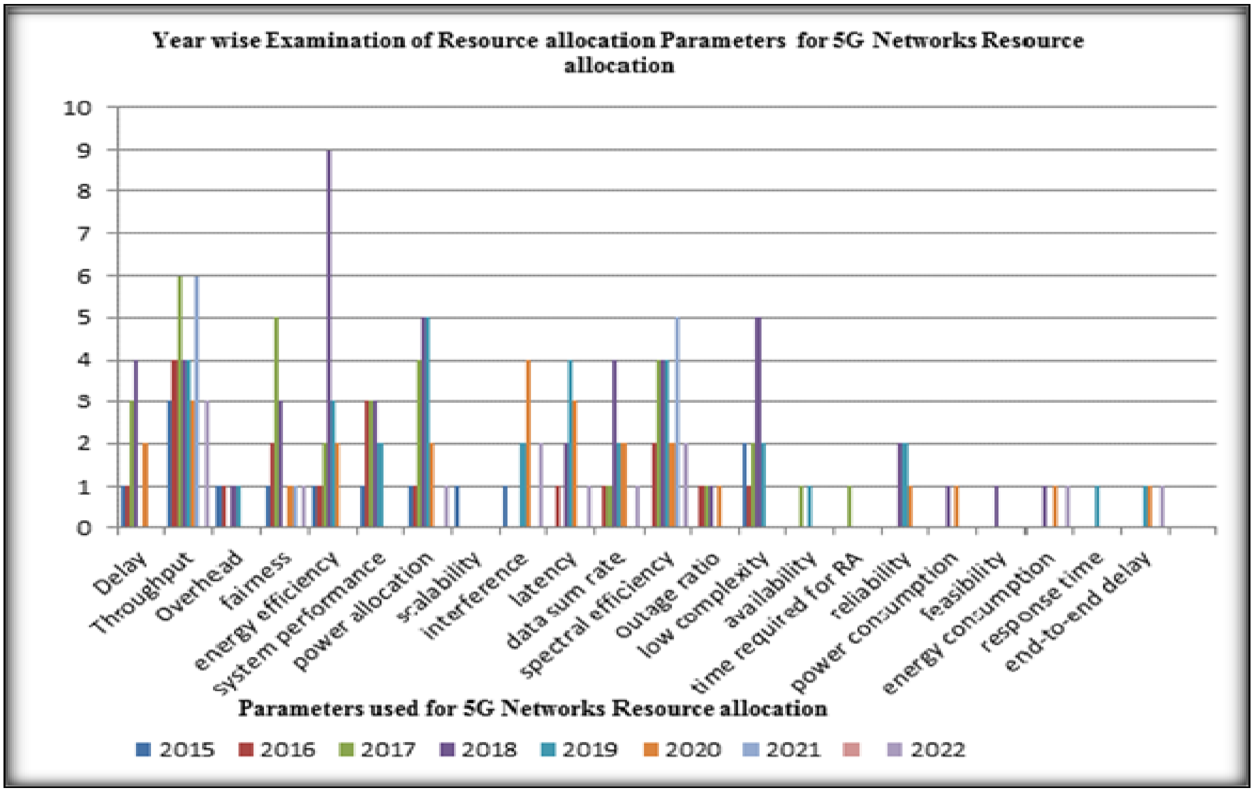

Figure 13 Year-Wise Examination of Resource Allocation Parameters for 5G Networks

7. ISSUES AND CHALLENGES IN THE 5G NETWORK

There have been several challenges in the implication of the 5g network. There is a need to provide an energy-efficient approach. Moreover, latency should be reduced to improve system throughput. Network scalability & mobility management is required for flexible 5G. Resource allocation techniques, Learning-based assisted optimization, and Network virtualization might play significant roles in resolving issues

7.1. Energy Efficiency

Because of this, measuring and analyzing the performance hit an app takes while switching to a power-saving mode that uses typical power allocation is crucial for mobile devices. There should be a greater focus on assessing the efficiency of beam-forming algorithms in a broad context. The energy efficiency of ultra-dense CRANs may be improved with the use of renewable energy sources [22, 27, 29, 54].

7.2. Reduced Latency

The performance of an application may suffer if the device's power is conserved by allocating power to it in a way that is not immediately recognizable to the user. More work is also needed to examine the efficiency of beam-generating algorithms at a systemic level. Energy efficiency is a key factor impact of ultra-dense CRANs, and harnessing energy from renewable resources may improve that efficiency. To further reduce energy usage from fewer traffic situations; hence it's vital to look into efficient methods of turning off RRH systems [22, 27, 29, 54].

7.3. Network Scalability

As the number of BSs grows, there is a possibility that the transmission latency would rise as well. Real-time processing capabilities of suggested methods may be greatly aided by understanding the effect of transmission and scheduling delays. More theoretical investigation on delay-sensitive traffic for hybrid CoMP in a CRAN is required. When encoding across large numbers of fading blocks, it is crucial to analyze the performance-delay trade-off that results. Offloading jobs and data to the network's edge utilizing appropriate edge computing and proactive caching technologies is an appealing approach for reducing network latency in a CRAN system. Collaborative edge-cloud processing has the potential to bring together the best of cloud- and edge-processing, allowing latency-sensitive applications to operate in real-time while still leaving the heavy lifting of processing large amounts of data in the cloud [22, 29, 54].

7.4. Mobility Management

It is crucial for moving vehicles to have a reliable and constant connection through a variety of wireless communication methods. Therefore, it is crucial to look into the potential for creating streamlined utility functions and optimized algorithms that are based on the needs or wants of network managers. Since mobile call patterns tend to become highly related to collocation patterns in the service area of the same BS at the same time, this information must be used in the optimization of CRAN if it is to boost its performance in the face of considerable user mobility. In addition, future studies might look at the best mobility models for various traffics, and create mobility-aware adaptive approaches for fine-tuning the CRAN's settings [22, 29, 54].

7.5. Joint Resource allocation techniques

The CRAN needs more processing power, which necessitates the deployment of complex resource allocation techniques. One of the challenges in designing a CRAN is developing efficient compression algorithms for the front haul lines that connect radio units to control units. Researching how front-haul latency affects higher-layer performance is, thus, vital. More study is required to determine how best to allocate resources in the context of front haul, which is now under great strain. Possible angles to explore include how packet loss is impacted by an unsatisfactory front haul connection. It is anticipated that the front haul network will be very heterogeneous, with varying connection capacities and latency, necessitating the requirement for a front haul that can be reconfigured to suit the specifics of the network architecture and the volume of traffic. Using adaptive after/before pre-coding strategies in a CRAN may increase the benefit of sum-rate performance. Thus, it is crucial to look at the issue of pre-coding that requires the least amount of backhaul. The accurate user profile is also a prerequisite for moving further with the design of a CRAN's reconfigurable backhaul. Further, the ideal backhaul should be determined by user profiles and traffic load, therefore well-designed algorithms should be developed. Exploring the effectiveness of BS collaboration with clustering and the function of reconfigurable backhaul in ultra-dense BS deployment are two more interesting directions to go in. Further work in this area should investigate effective resource optimization strategies that take into account the limitations of front- and back-haul networks and user requirements [22, 29, 54].

7.6. Learning-based assisted optimization

Keeping up with the ever-increasing amount of configuration options for cellular networks has proven difficult over the years. Additionally, it is often challenging to find optimum solutions with minimal complexity when using traditional optimization approaches to new ultra-dense networks [22]. Thus, new Machine Learning (ML) methods show promise for accelerating the optimization process and discovering heuristic solutions iteratively in cases when finding an optimum solution is difficult. It is therefore intriguing to speculate about how ML approaches may be employed for the effective management of CRAN-based Beyond 5G systems. Some of the more recent types of ML that are important here include SL, unsupervised learning, RL, DL, CL, AL, FL, hybrid ML, and Quantum ML [29, 54].

7.7. Network virtualization

To further understand how wireless network virtualization might enhance end-to-end performance, it is important to look at the topic. A method of communication that confines each user to a separate virtual cell is inappropriate. The closer you go to other users, the more interruption you'll experience. However, it is crucial to investigate dependable virtualization approaches to take advantage of multiuser cooperative transmissions to preserve the benefits of minimal interference. To provide 5G heterogeneous services including low-latency & UR communications, communications for huge machines, and improved mobile broadband, we may also explore developing network slicing technologies [22, 29, 54].

7.8. Service management

To improve the CRAN system's performance, it is crucial to compute network metrics like traffic circumstances and sparse network topology [22, 29, 54].

8. EXISTING ALGORITHMS, PROBLEM ADDRESSED, AND IMPROVEMENTS AS WELL AS LIMITATIONS FOR 5G NETWORKS RAS

This literature study organized methods used for 5G RA based on an analysis of available literature. Resource allocation algorithms and strategies used by multiple

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researchers were examined in this review, which categorized them according to the approaches used in each strategy. Table 3 displays the results of a critical evaluation of each article concerning the problem they address and the merits and limitations of the methods they use. Here, they provide the results of our in-depth evaluation of various approaches' ability to ensure efficient resource allocation in 5G. Diverse approaches, such as hybrid models, SI, GM, rule-based systems, and case-based reasoning, were used to address issues with 5G networks and provide viable solutions. As part of a mixed method for fixing the problem, AI-based resource allocation was used. The study's major objective was to provide the framework for picking and/or improving a future approach to dividing up 5G networks' resources.

Table 3 A Related Works "On Selected Resource Allocation Techniques" in 5G

Algorithm	Problem Addressed	Improvements	Limitations	References
The efficient resource allocation algorithm	Resource allocation issue	Support for Potential application	Need to do more work on my performance	[55]
Cooperative resource allocation and scheduling approach	Resource allocation and scheduling	Optimal multitier resource allocation	Lack of flexibility	[56]
The cooperative online learning scheme	Resource allocation in 5G systems	Cooperative resource allocation	Lack of technical feasibility	[57]
Online Learning Scheme for Resource Allocation	Resource Allocation	Sophisticated resource allocation	Dependency over internet	[58]
Two-Tier NOMA	Resource Allocation	Resource Allocation in Energy-Cooperation	Need to consider heterogeneous network	[59]
Random forests	Resource allocation	Performance and robustness enhancement	Need to provide an energy cooperation approach.	[60]
Orthogonal Spectrum Resource Allocation	Resource Allocation for Live Video Streaming	QoE-Driven Resource Allocation	Preprocessing is time-consuming.	[61]
RAA	Interference with 5G mobile phone users Related to QoS.	Increases the channel capacity for cellular subscribers.	Relevant parameters are considered.	[62]
A joint RA and Modulation and coding techniques	Needs for connection with UL latency and HR.	Low error rates are reached. Reduces resource use to a minimum.	Just traffic to URLLC makes resources available for the initial transmission.	[63]
"QoE-aware relay" allocation algorithm	Disregard timing criteria for the best performances.	Signal-to-noise ratio at its highest on average and improved efficiency for mean time to failure.	Working with various priorities.	[64]
5G centralized RA	Centralized multi-cell scheduling for the downlink.	URLLC latency improved as well as improvements gains of 99% & 90% URLLC latency.	Disregards cell-to-cell interference and takes URLLC traffic into	[65]

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			account.	
Learning-Based Resource Allocation Scheme	Resource allocation	Applicable in TDD-Based 5G CRAN System	Need to improve processing speed	[66]
Joint radio resource allocation	EE and MMW downlink lines for front-haul and access.	A 50% increase in the system total rate has been made.	Constrained and RAN-based only.	[67]
Hybrid modeling	Routing in MANET.	optimized multi-path routing	Need to do more work on the schedule	[68]
Improved RA MTC networks	Qos is needed to improve in MTC.	Performance gains in the success and outage probability.	A few parameters are taken into account.	[69]
Three-stage fairness plan	UDN's resource allocation issue includes caching and self-backhaul.	Improved resource allocation for backhaul links and flexible access.	Ignored Qos and uses of caching for a limited number of parameters.	[70]
SR and Power Allocation Schemes.	Ensure that resources are distributed fairly inside each cell.	Increasing system performance	Restricted to a single cell's usage interference also QoS was ignored.	[71]
Distributed Algorithm	Resource allocation	Suitable for HetNets	Need to improve performance	[72]
D2D centric RA technique	Decreasing network speed and increasing resource allocation delays.	Improved performance and up to 35% less weight at the BS.	Intelligent resource allocation has to be improved.	[73]
Deep Reinforcement Learning	Resource allocation	Uplink/Downlink Resource Allocation	Need to introduce a hybrid model to improve accuracy.	[74]

9. CONCLUSIONS

The marketing term "5G" refers to wireless networks that meet the standards of ITU, IMT-2020 standard, and the 3G Partnership Project's (15th) Release. Great speed, LL, HM, and high connection density are therefore some of 5G's most prominent characteristics. With 5G's increased capacity and cutting-edge antenna technology, the number and variety of new services and applications that may be delivered through wireless networks will explode. Several organizations, such as 3G Partnership Project (3GPP), NGMN, and ITU-R, have looked at the infrastructure and services required to make 5G a reality. Key technical performances include maximum spectral efficiency, maximum data rate, maximum area traffic capacity, minimum latency between user and control planes, the maximum time between mobility interruptions, maximum bandwidth, maximum connection density, minimum energy consumption, and maximum throughput. Furthermore, some of the technologies incorporated into the 5G network are IoT, SDN, D2D networking, vehicular networking, M2M, CRANs, MEC, cloud computing, etc. To maintain progress toward meeting this critical need, cutting-edge technology will be needed to enhance the massive cellular capacity anticipated in the heralded 5G cellular architectures. To combat these issues, numerous studies have been conducted in both academia and industry, with a particular emphasis on wireless structures that, by strategically placing multiple antenna components and reusing frequencies, offer superior spectral efficiency and wider bandwidth than existing cellular networks. This review analyzed many proposed approaches to allocating available resources. The issues, rules or procedures, and enhancements to the outcomes are also covered in our study. Managing network traffic and operations effectively has become a resource distribution problem owing to the rising demand for cellular service and stagnant supply. Reducing network congestion through improved quality of service is a pressing concern. Although a few survey pieces are covering the topic, no papers have been published that are dedicated only to the topic of 5G resource allocation. In light of these anticipated outcomes for consumers, we classify future 5G services as immersive, intelligent, autonomous, or public. Many different kinds of mobility—automobile, foot, HSV, and even stationary—are having an impact on the efficacy of the 5g network. Scalability of networks, reduced latency, mobility management, and shared resource allocation have all been issues with the prospective consequences of 5G. DL, CL, AL, FL, and hybrid learning-assisted optimization may all be used to automate the 5G system. So can SL, unsupervised learning, reinforcement learning, and more. The future of radio-based smart 5G technology depends on the success of the LTE-A network now being built.

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