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A NOVEL ARCHITECTURE OF INTELLIGENT DECISION MODEL FOR EFFICIENT RESOURCE ALLOCATION IN 5G BROADBAND COMMUNICATION NETWORKS

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Abstract

Intelligent Decision Model for efficient resource allocation in 5G broadband communication networks is essential for ensuring the most efficient use of available resources. This model considers several factors, such as traffic demand, network topology, and radio access technology, to make the most efficient decisions about resource allocation. It is based on intelligent algorithms and advanced analytics, which allow the network to quickly and accurately identify the optimal resource allocation for a given situation. This model can reduce costs, improve network performance, and increase customer satisfaction. In addition, the Intelligent Decision Model can help operators reduce the complexity and cost of managing a 5G network. The intelligent decision model for efficient resource allocation in 5G broadband communication networks is based on a combination of artificial intelligence (AI) and optimization techniques. The proposed decision models can use AI to identify patterns in traffic and user behavior. In contrast, the proposed can use optimization techniques to maximize resource utilization and reduce latency in the network. This model can also leverage predictive analytics and machine learning algorithms to determine the most efficient allocation of resources. Additionally, the proposed model can use AI to detect and mitigate potential security threats and malicious activities in the network. the proposed IDM has reached 91.85% of accuracy, 90.05% of precision, 90.96% of recall and 91.33% of F1-score.

Keywords:

Intelligent, Decision, Efficient, Resource, Allocation, 5G, Broadband, Communication, Networks

1. INTRODUCTION

The 5G broadband communication networks have revolutionized resources allocated to wireless communication networks. 5G networks are expected to provide high bandwidth, low latency, and improved reliability compared to the existing 4G networks [1]. As such, efficient resource allocation is of critical importance to maximize these networks' performance. In order to ensure efficient resource allocation in 5G broadband communication networks, several techniques have been proposed. One of the essential techniques is using cognitive radio (CR) technology [2]. This technology can dynamically identify and utilize available spectrum resources optimally. In addition, it can also ensure the improvement of spectral efficiency by reducing the interference between different users. Another essential technique for efficient resource allocation in 5G networks is network virtualization. Network virtualization allows the virtualization of the physical network infrastructure, which can help improve the utilization of existing resources [3]. It also makes creating multiple virtual networks with different characteristics possible, thus allowing for more efficient resource allocation. Software-defined networking (SDN) has also been proposed for efficient resource allocation in 5G networks. SDN is a network architecture that enables the separation of the control and data planes, thus allowing for more efficient resource allocation [4]. Efficient resource allocation is of critical importance for 5G networks to ensure optimal performance. Various techniques, such as cognitive radio, network virtualization, and software-defined networking, have been proposed to improve resource allocation in 5G networks [5]. These techniques ensure the available resources are used optimally to maximize these networks' performance. Resource allocation in 5G broadband communication networks is the process of assigning the available resources, such as bandwidth, power, and frequency, among the various users of the network [6]. It ensures the network is efficiently and effectively utilized while providing users with the best possible service. The allocation of resources is done according to specific criteria, such as user priority, distance, and user type. In addition, resource allocation can be optimized by using various techniques, such as dynamic spectrum allocation and fairness-based resource allocation [7]. There are several ways to allocate resources efficiently. One way is to ensure that all resources are used to maximize their potential. It can be done by matching the resource use to the user needs [8]. Another way to allocate resources efficiently is to make sure that there is no waste. It can be done by using resources to minimize waste and by recycling or reusing resources whenever possible [9].

The Intelligent Decision Model for Efficient Resource Allocation is a theoretical approach that focuses on providing decision-makers with the tools to make effective and efficient decisions. It is based on using artificial intelligence and machine learning techniques to automate the decision-making process and provide solutions that are best suited for the situation at hand. This model is based on four core principles: value-based decision-making, resource optimization, risk management, and quality assurance [10]-[11]. Value-based decision-making is the process of using data to determine the best possible decision for a given situation. It involves analyzing data and determining which option will yield the greatest return on investment. It involves looking at factors such as cost, expected benefit, and risk. It helps decision-makers identify the best options and make decisions focused on the organization long-term success [12]. Resource optimization is the process of ensuring that resources are used in the most efficient way possible. It involves looking at how resources are allocated and determining the best way to utilize them. It involves looking at factors such as how long a resource will last and how much it will cost to replace it [13]. It helps decision-makers make decisions that will help save time, money, and other resources. Risk management understands the risks associated with a decision and determining how to mitigate them. It involves understanding potential risks and then taking steps to reduce them. It helps decision-makers make decisions that are both safe and efficient.

Quality assurance is ensuring that the decisions made are of the highest quality [14]. It involves looking at how data is collected, analyzed, and reported. It helps decision-makers make decisions that are both accurate and reliable. The Intelligent Decision Model for Efficient Resource Allocation is a powerful tool for decision-makers. It provides them with the tools to make effective and efficient decisions. By using this model, decision-makers can make safe and cost-efficient decisions [15]. It helps them maximize the value of their resources and make the most of them. Intelligent decision-making is essential for efficient resource allocation. In today world of limited resources and ever-increasing demands, it is essential to use resources efficiently to maximize their effectiveness and ensure they are used most appropriately [16]. Intelligent decision-making helps in this process by identifying the best possible use of resources and allocating them accordingly. Intelligent decision-making is based on carefully analyzing available information and data, weighing up the options, and making an informed decision. It also requires an in-depth understanding of the project goals, objectives, constraints, and the environment in which it is taking place. It helps to ensure that resources are allocated to the areas where they will be most effective, and that unnecessary waste is avoided [17]. Intelligent decision-making also helps to ensure that all stakeholders involved in the resource allocation process are consulted and their views are considered. It helps to ensure that the best possible outcome is achieved and that resources are used to benefit all involved [18]. Ultimately, intelligent decision-making can ensure that resources are used most efficiently and effectively, leading to an improved return on investment and better outcomes for all involved [19]. By making informed and well-thought-out decisions, resources can be used in the most effective way possible, leading to better results and improved outcomes for everyone. The main contribution of this paper has the following,

- Intelligent decision-making for efficient resource allocation in 5G broadband communication networks provides several benefits. It can enable predictive and dynamic resource allocation to meet the changing demands of the users, resulting in more efficient network utilization.
- It can also facilitate the implementation of more advanced network technologies such as software-defined networking (SDN), virtualized network functions (VNFs), and network function virtualization (NFV). Intelligent decision-making can also help reduce the cost of operations and maintenance by providing automated resource allocation and optimization and improved security and privacy.
- It can enable the development of innovative services and applications such as quality of service (quality of service) optimization, network slicing, and traffic optimization. Finally, intelligent decision-making can enable the development of new network architectures and deployment models, such as distributed edge computing and cloud-based applications.

The remaining parts of the paper have been organized as the following. Section 2 provides the related works. Section 3 illustrates the proposed algorithm and flow chart. Section 4 provides the comparative analysis. Finally, the results and future enhancements are expressed in section 5.

2. RELATED WORKS

Intelligent decision models help to efficiently allocate resources by using advanced algorithms that consider multiple factors and constraints. These models use data-driven decision-making to identify the most efficient way to allocate resources. They can also provide insights into the trade-offs between different strategies and identify the best option for achieving a desired goal. Intelligent decision models can help organizations make effective decisions quickly and with minimal resources, leading to increased efficiency and cost savings.

Yu, S. et al. [1] have provided the details about the intelligent multi-timescale resource management for multi-access edge computing in 5G ultra-dense networks is a technique that involves the intelligent allocation and management of resources at different timescales and locations to enable the efficient deployment and utilization of multi-access edge computing (MEC) in 5G ultra-dense networks. This technique enables the dynamic allocation of resources such as network bandwidth, computing power, and storage at edge locations to improve the performance of latency-sensitive applications. It also allows applications to use low latency and high bandwidth in 5G ultra-dense networks. In addition, it facilitates optimized resource utilization and energy efficiency in 5G networks.

Wang D. et al. [2] discussed an AI-based hierarchical cognitive cellular network as an artificial intelligence technology for wireless communication networks. It uses a combination of cognitive techniques, such as machine learning, to provide an efficient and reliable way of managing communications over a network. The AI-based hierarchical cognitive cellular network consists of self-organizing nodes, which learn from their environment and adjust their behavior accordingly. The nodes are connected in a hierarchical fashion, which allows for the efficient communication of data between them. The technology allows for the dynamic optimization of communication resources and the ability to adapt to changing network conditions.

Yang H. et al. [4] have discussed the Learning-based energy-efficient resource management by heterogeneous RF/VLC for ultra-reliable low-latency industrial IoT networks is an approach to resource management that combines Radio Frequency (RF) and Visible Light Communication (VLC) technologies to create a more efficient network for the Internet of Things (IoT). This approach leverages machine learning techniques to dynamically adjust network resources to meet the application needs while optimizing energy efficiency. By utilizing the unique properties of RF and VLC, this approach allows for ultra-reliable communication with low latency and improved energy efficiency. It is ideal for industrial IoT applications that require high reliability and low latency, such as factory automation and smart cities.

Bashir, A. K. et al. [5] has discussed an optimal multitier resource allocation of cloud radio access network (C-RAN) in 5G using machine learning can be achieved by using a deep learning framework. This deep learning framework can be designed to learn the characteristics of the radio environment within the 5G cloud RAN. Then it can be used to optimize the allocation of resources in order to maximize the network performance. The deep learning framework can be trained using real-world data from the 5G network, such as traffic load, channel conditions, and

user mobility patterns, to discover the optimal resource allocation strategy. Additionally, the deep learning framework can continuously monitor and optimize resource allocation to adapt to changing conditions in the 5G cloud RAN.

Cao, B. et al. [6] have discussed resource allocation in 5G IoV architecture based on SDN, and fog-cloud computing is the process of dynamically allocating resources such as computing power, storage, and network bandwidth among multiple users in order to optimize system performance. It is essential when dealing with large-scale distributed networks, such as those used in 5G IoV architectures, since it efficiently utilizes the available resources. It also helps provide quality of Service (quality of service) guarantees to the users, as the resources are allocated to meet their requirements. In 5G IoV architectures, resource allocation is typically implemented using Software Defined Networking (SDN) and fog-cloud computing, which allows for more efficient and flexible resource management.

Thantharate A. et al. [10] have expressed that adaptive Resource Management for Network Slicing Architectures in Current 5G and Future 6G Systems is a method to dynamically adjust the resources allocated to each network slice to match current network loads. This approach is designed to increase the efficiency of network slicing in 5G and future 6G networks by ensuring that the most appropriate resources are allocated to each slice based on current demand. Adaptive Resource Management can be used to adjust the number of radio resources, the amount of bandwidth, the amount of latency, and the amount of power allocated to each slice. It ensures that each slice is given the resources it needs to perform its desired tasks while maintaining the network overall performance.

Yang H. et al. [11] have discussed intelligent resource management based on reinforcement learning for ultra-reliable and low-latency IoV communication networks as a technique that allows the network to adapt its resource allocation strategies in real-time to meet the stringent latency and reliability requirements of the Internet of Vehicles (IoV). This technique combines reinforcement learning algorithms with intelligent resource management to optimize resource utilization, improve system performance, and reduce latency and packet loss. The reinforcement learning algorithms can learn from past actions and use that information to decide how to allocate resources best to achieve the desired objectives. This approach allows for more efficient resource utilization and better system performance regarding latency and reliability.

Yang S. et al. [14] have discussed a joint optimization scheme for task offloading. Resource allocation based on edge computing in 5G communication networks is a strategy that leverages the capabilities of 5G networks and edge computing to optimize the performance of tasks by offloading them to the network edge, where they can be executed more efficiently. This scheme involves sophisticated algorithms to determine the optimal combination of resources and tasks to be offloaded and the best locations for them to be executed. It also considers the availability of resources and their cost. This joint optimization scheme helps to reduce latency, increase throughput, and improve the user experience.

Lin, K. et al. [16] have discussed an AI-driven collaborative resource allocation for task execution in 6G-enabled massive IoT is a technique used to ensure that tasks are executed efficiently and effectively by utilizing the capabilities of artificial intelligence and the massive number of IoT devices available in 6G networks. The idea is to leverage the massive amount of data available in the network to allocate resources intelligently and optimize task execution. It would result in more efficient use of resources and improved task execution performance.

Ma, L. et al. [17] have discussed on-Demand Resource Management for 6G Wireless Networks. Knowledge-Assisted Dynamic Neural Networks are a new way to manage resources in 6G wireless networks. It combines knowledge-assisted and dynamic neural networks to efficiently manage resources in 6G networks. This new resource management solution leverages deep learning and domain knowledge to make decisions related to network resources. The neural networks are trained using the network dynamic data and the experts' knowledge to optimize the network performance. The resource management solution can improve the network capacity, reduce latency, and enhance user experience. It also supports the dynamic allocation of resources according to the changing needs of the network.

Yang H. et al. [19] discussed a deep reinforcement learning-based energy-efficient resource management for social and cognitive Internet of Things (IoT) is a type of artificial intelligence (AI) technique used to optimize the use of resources in IoT networks. It uses reinforcement learning algorithms to learn the best actions to take in order to minimize energy consumption while achieving the desired performance. The system can self-learn from experience and adapt to the environment. The approach can be used for energy management of IoT devices and networks, such as home automation, medical monitoring, and industrial automation. The system can also optimize resource allocation in heterogeneous IoT networks with multiple types of resources. The following issues were identified from the comprehensive analysis of the related works.

- ***Capacity Planning***: Capacity planning is an important challenge for 5G broadband communication networks as 5G requires massive bandwidth and capacity to support high-speed data transmission.
- ***Spectrum Allocation***: Spectrum allocation is another significant challenge for 5G broadband communication networks. 5G requires more spectrum than previous generations of wireless technology.
- ***Network Security***: Network security is also a significant concern for 5G broadband communication networks. 5G networks are vulnerable to various types of cyber-attacks, such as distributed denial-of-service (DDoS) attacks, man-in-the-middle attacks, and malware.
- ***Interference Management***: Interference management is also challenging for 5G broadband communication networks. 5G networks are susceptible to interference from other wireless devices, reducing the signal quality and impacting the network performance.
- ***Resource Optimization***: Resource optimization is also challenging for 5G broadband communication networks. 5G networks require high optimization levels to use the available resources efficiently and effectively.

The allocation of resources is necessary to ensure that the 5G networks can provide the highest possible performance. It includes the allocation of spectrum and the radio frequency range

used for wireless communications. Ensuring that the spectrum resources are used efficiently and are well-spent is essential. Additionally, allocating computing resources is necessary to ensure the network can handle the massive amounts of data sent and received. The main novelty of this paper is to provide optimal solutions for the problems mentioned above. They are the following,

- ***Improved Efficiency***: Resource allocation in 5G networks helps improve the network overall efficiency. By allocating the resources better, the network can ensure that all the users get the desired bandwidth, latency, and reliability.
- ***Enhanced Quality of Service***: Resource allocation helps improve the service quality provided to the users. By allocating the resources in a better way, the network can make sure that all the users get the desired amount of data rate and latency.
- ***Optimal Utilization of Network Resources***: Resource allocation helps ensure the network resources are optimally utilized. By allocating the resources better, the network can ensure that all the users get the desired performance.
- ***Improved Network Performance***: Resource allocation helps improve the network performance. By allocating the resources better, the network can ensure that all the users get the desired data rate and latency.
- ***Reduced Power Consumption***: Resource allocation helps to reduce the power consumption in 5G broadband communication networks. By allocating the resources better, the network can ensure that all the users get the desired data rate and latency while consuming less power.

The allocation of resources is also necessary to ensure that 5G networks can provide the best possible coverage. It includes the distribution of cell towers and other infrastructure necessary to ensure the network can reach all areas. Additionally, resources should be allocated to ensure that the 5G networks can provide the best possible quality of service. It includes allocating resources to ensure that network latency and jitter are minimized.

3. PROPOSED MODEL

The intelligent decision model for efficient resource allocation in 5G broadband communication networks is an analytical discussion on the best use of resources to maximize network performance. This model aims to identify optimal resource allocation strategies to maximize network efficiency while minimizing costs. The Intelligent Decision Model for efficient resource allocation in 5G Broadband Communication Networks is based on three main components:

- ***Resource Allocation Algorithms***: These algorithms enable the system to identify the optimal allocation of resources to maximize network performance. Examples of algorithms used for resource allocation include the Water-Filling Algorithm, the Proportional Fair Algorithm, the Max-Min Algorithm, the Round Robin Algorithm, and the Lagrangian Relaxation Algorithm.
- ***Network Topology***: This component enables the system to identify the most efficient topology to minimize resource utilization while achieving the desired performance objectives. Examples of network topologies used in 5G networks include mesh, tree, star, and ring topologies.
- ***Load Balancing***: This component enables the system to evenly distribute the load across the network to reduce congestion and improve overall performance. Examples of load-balancing algorithms include the Least Connections Algorithm, the Round Robin Algorithm, the Hash Algorithm, and the Random Algorithm.

This model considers the various factors that influence the resource allocation process, such as the available resources, user access patterns, traffic demand, and cost constraints. The model uses an analytical approach to identify the most appropriate resource allocation strategies. It considers the various factors that can affect the network performance and develop an optimal solution that maximizes the network performance and meets the cost constraints. Establish 5G Network Requirements: Establish the requirements by understanding the network characteristics and application needs of the 5G mobile network.

- ***Analyze Network Performance***: Analyze the current 5G mobile network performance and identify improvement areas.
- ***Develop Decision-Making Framework***: Develop a decision-making framework to identify the optimal 5G mobile network management solutions.
- ***Develop Data Models***: Develop data models to support informed decision-making and establish the necessary metrics for evaluating the performance of the 5G mobile network.
- ***Implement Intelligent Management***: Intelligent 5G mobile network management based on the decision-making framework and data models.
- ***Monitor and Adjust***: Ensure that the decisions made by the decision-making framework are continuously monitored and adjusted to ensure the optimal performance of the 5G mobile network.

The intelligent decision model for efficient resource allocation in 5G broadband communication networks should consider the following factors:

- ***Network Traffic Load***: The traffic load should be monitored and analyzed to determine the amount of bandwidth that needs to be allocated to each user.
- ***User Preferences***: User preferences should be considered when allocating resources. It can include their desired data rate, latency, quality of service, and other requirements.
- ***Network Topology***: The network topology should be considered when allocating resources. It includes the physical layout of the network and the types of connections that are available.
- ***Interference***: The network interference level should be monitored and considered when allocating resources. It includes external sources of interference (e.g., wireless networks) and internal sources (e.g., signal reflections).
- ***Security***: Security measures should be considered when allocating resources to ensure data transmission integrity.
- ***Cost***: The cost of implementing the proposed resource allocation should be considered to ensure the proposed model is cost-effective.

The model also considers the impact of competition and changing market conditions on resource allocation decisions. This model is best suited for 5G networks because it provides a comprehensive view of the network environment and allows for efficient resource allocation decisions tailored to the network specific needs. The proposed algorithm has shown in the following Algorithm.1

Algorithm 1: Intelligent decision-making algorithm

1. In: Network input attributes;
2. Out: Resource allocation decision rate (D_{RA});
3. For all time slots (t_{all}), then do
4. To find the earlier arrival of resource requests;
5. Compute the maximum resource allocation;
6. Define the order of user access;
7. Repeat
8. Initiate $t = t+1$;
9. For $t = 1$ to A do
10. $A = A^{t+1}$
11. Repeat the resource allocation;
12. Resolve the resource shortage and maximization problem;
13. Compute the evaluation of queue size;
14. If (queue size > 0)
15. Then allot the resource for all users;
16. else
17. Allocate the resource for primary users;
18. Compute the overall load of the network;
19. Update the resource sharing details;
20. End

The Intelligent Decision-making algorithm is a type of artificial intelligence (AI) algorithm that can be used to identify the best possible resources available for efficient resource allocation. This algorithm works by considering the current state of the resources, such as the availability and cost, and then evaluating the possible solutions to determine the optimal one. The algorithm then assigns the resources to the most efficient way to maximize the outcome. The algorithm can also be used to identify potential risks and opportunities associated with the allocation of resources. The Intelligent Decision-Making algorithm takes into account various factors such as the cost, time, and any other constraints to come up with the most optimal solution. The Intelligent Decision-Making Algorithm (IDMA) for efficient resource allocation in fifth generation (5G) communication is a sophisticated algorithm for the optimization of resource allocation. The IDMA algorithm is based on machine learning, artificial intelligence, and data-driven insights. The algorithm is designed to optimize the allocation of resources to the best possible outcome. At the core of the IDMA algorithm is a set of intelligent decision-making rules and models that are used to evaluate the data, identify the best possible solution, and allocate resources accordingly.

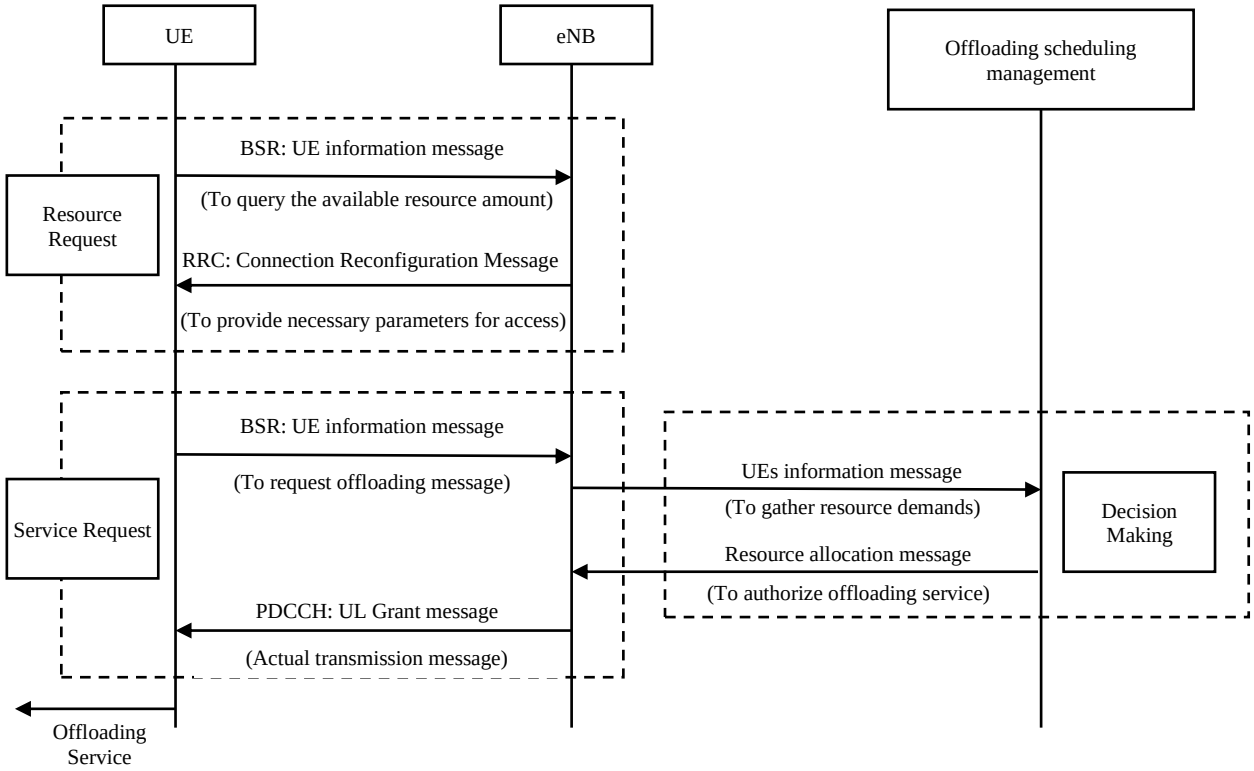

Fig.1. Proposed Message Flow Diagram

The algorithm can be used to optimize the allocation of resources to maximize the overall efficiency of a network. The proposed message flow diagram has shown in the following Fig.1.

First, the algorithm will analyze the data and identify the best possible allocation of resources. This is done by assessing the current network conditions and determining how to best allocate resources to ensure optimal performance. The algorithm will then analyze the data to identify the best possible combination of resources to obtain the desired outcome. The IDMA algorithm can also consider the changing environment and the impact of external factors on the best possible allocation. Once the IDMA algorithm has identified the optimal combination of resources, it will then allocate the resources accordingly. This includes the allocation of bandwidth and other resources to ensure the best possible performance for the network. The IDMA algorithm will also consider the cost of the resources to ensure the best possible outcome. The IDMA algorithm is designed to be able to dynamically adjust the resource allocation in response to changing conditions. This includes the ability to identify and respond to changes in the environment and adjust the resource allocation accordingly. This allows the IDMA algorithm to be used to optimize the performance of a network in a variety of scenarios. The IDMA algorithm is an important component of 5G communication as it is designed to ensure the most efficient use of resources. The algorithm can be used to optimize the performance of networks and ensure they are able to meet the demands of users in a cost-effective manner. The IDMA algorithm can help to reduce the overall cost of communications and ensure that 5G networks are able to provide the best possible performance.

3.1 LIMITED SPECTRUM AVAILABILITY

5G networks require large amounts of spectrum to function correctly, which is a limited resource. Deploying dynamic spectrum access (DSA) technologies such as cognitive radio and software-defined radios (SDRs) can help resolve the limited spectrum availability issues in 5G broadband communication networks. These technologies enable the utilization of unused spectrum, which can be shared among multiple users for efficient resource allocation. By utilizing spectrum sharing techniques such as spectrum pooling, spectrum leasing, and dynamic spectrum sharing, the limited spectrum availability issue can be addressed in 5G broadband communication networks. These techniques enable the sharing of spectrum among multiple users in a dynamic way, which helps efficiently utilize spectrum resources. Frequency reuse techniques such as frequency hopping and beam forming can help resolve the limited spectrum availability issues in 5G broadband communication networks. These techniques enable efficient spectrum utilization by reusing the available spectrum among multiple users. Utilizing spectrum sensing technologies such as cognitive radio and software-defined radios (SDRs) can help resolve the limited spectrum availability issues in 5G broadband communication networks.

3.2 NETWORK LATENCY

5G networks are highly reliant on low-latency connections, which can be challenging to achieve in certain areas due to the physical limitations of the network infrastructure. Increasing the network capacity can help improve network latency by minimizing the traffic on the network. It can be done by adding more bandwidth or upgrading the existing infrastructure. Traffic shaping techniques such as Quality of Service (quality of service) can prioritize certain types of data or applications, thus improving the network performance. Reducing packet loss can improve latency by ensuring data is not lost in transit. It can be done by implementing reliable protocols such as TCP and optimizing the network for reliability. Caching can reduce latency by storing frequently accessed data closer to the end user. It can help reduce the time required to access resources from the server. Network monitoring tools such as packet sniffers and ping tests can identify and address network problems in real-time. It can help improve network latency by quickly identifying and fixing issues.

3.3 NETWORK CONGESTION

5G networks are expected to handle high amounts of data, which can lead to network congestion if the resources are not appropriately allocated. Network congestion control in 5G broadband communication networks is a process of managing the utilization of network resources to ensure that data traffic flows smoothly and efficiently. The intelligent decision model for efficient resource allocation in 5G networks combines machine learning algorithms, which help identify and predict network congestion, and decision-making techniques, which enable the network to take appropriate actions to avoid congestion. It includes implementing various techniques such as traffic shaping, packet scheduling, and flow control, which can help reduce congestion on the network. Additionally, the intelligent decision model can also be used to optimize the allocation of network resources to ensure that the network can meet the demands of users and provide a good quality of service.

3.4 NETWORK SCALABILITY

The ability to scale up or down the network as needed is an essential factor in resource allocation. Network scalability in intelligent decision models for efficient resource allocation in 5G broadband communication networks is essential. This scalability must accommodate the ever-increasing number of users, devices, and services while also considering the need for efficient resource allocation. To achieve this goal, 5G networks must be designed to ensure that the network topology, the radio access solutions, the core network architecture, and the underlying transport protocols are all designed to scale efficiently. Furthermore, the network must support advanced features such as network slicing, advanced mobility management, and virtualization. In addition, intelligent decision models must be used to ensure that resources are allocated most efficiently. It can be achieved through sophisticated algorithms that consider the current and expected traffic patterns of the network, as well as the user quality of service requirements.

3.5 POWER CONSUMPTION

5G networks require more power than 4G networks, which can lead to additional costs. The power consumption control in an intelligent decision model for efficient resource allocation in 5G broadband communication networks is an essential network component. This model uses advanced algorithms such as Dynamic Programming (DP), Reinforcement Learning (RL), and Deep Learning (DL) to optimize the power consumption of the

network. The algorithms are used to determine the optimal allocation of resources, such as spectrum, bandwidth, and power, based on the system current state. Furthermore, it can consider the user demand for services, the impact of interference, and the cost of different resource allocation strategies. By continuously adjusting the network resource allocation, power consumption can be minimized while still providing the user with the desired performance.

4. COMPARATIVE ANALYSIS

The Comparative Analysis Intelligent Decision Model (CAIDM) is a comprehensive approach for efficient resource allocation in 5G broadband communication networks. It uses artificial intelligence techniques like fuzzy logic, machine learning, and neural networks to identify and analyze the most cost-effective solutions for various resource utilization scenarios. It then uses the analysis results to recommend the best solution for a resource allocation problem. The CAIDM model can be applied to various 5G broadband communication networks, including mobile, fixed, and satellite networks. It can also identify the optimal solutions for various network parameters such as bandwidth, latency, and throughput. The model evaluates different solutions based on each option cost, technical performance, and operational feasibility. The model then combines the analysis results to recommend the most cost-effective solution. The CAIDM model has been successfully applied in numerous 5G communication networks, including mobile, fixed, and satellite networks. It has been used to optimize the resource allocation for various network parameters, such as latency, throughput, and bandwidth utilization. The model has also been used to identify the most cost-effective solutions for various network configurations. It has also been used to optimize energy usage in 5G networks and identify the most energy-efficient solutions.

The proposed intelligent decision model (IDM) has compared with the existing Learning-based energy-efficient resource management (LERM), optimal multitier resource allocation (OMRA), Adaptive Resource Management (ARM), resource management based on reinforcement learning (RMRL). Here the network simulator 2.0 has used to execute the results.

4.1 COMPUTATION OF ACCURACY

The accuracy of an intelligent decision model for efficient resource allocation in 5G broadband communication networks depends on several factors, including the type of model used, the quality of data used to train the model, the complexity of the network, and the availability of resources. In general, however, the accuracy of such models is typically high, with some models achieving an accuracy of more than 90%. The Table.1 provides the accuracy comparison between the existing and proposed models.

Table.1. Comparison of Accuracy (in %)

Requests	LERM	OMRA	ARM	RMRL	IDM
100	57.09	75.47	60.47	75.73	88.66
200	58.72	77.21	62.05	77.15	89.95
300	59.20	79.55	64.25	78.41	90.96
400	60.49	80.36	65.88	80.40	91.85
500	62.60	82.65	67.02	82.87	92.22
600	64.09	84.58	69.22	84.31	93.26
700	65.90	86.31	70.37	86.03	94.03

In a comparison range, the proposed IDM has reached 91.85% of accuracy. In the same comparison tip, the existing LERM reached 60.49%, OMRA achieved 80.36%, ARM obtained 65.88% and RMRL reached 80.40% accuracy. The Accuracy refers to how closely a model prediction match the actual values. It is usually expressed as a percentage ranging from 0 to 100%. The higher the accuracy of a model, the better it is at predicting the correct values.

4.2 COMPUTATION OF PRECISION

The precision of the intelligent decision model for efficient resource allocation in 5G broadband communication networks depends on many factors, such as the type of network, the type of resources being allocated, and the algorithms used to optimize the allocation. The Table.2 provides the precision comparison between the existing and proposed models.

Table.2. Comparison of precision (in %)

Requests	LERM	OMRA	ARM	RMRL	IDM
100	55.83	83.21	68.03	84.17	87.92
200	56.16	84.71	68.62	86.04	88.96
300	57.50	85.82	69.60	86.87	89.09
400	58.64	86.20	70.81	87.78	90.05
500	59.69	87.21	71.95	88.70	89.62
600	60.40	88.14	73.06	90.03	90.86
700	61.70	89.14	73.76	90.90	90.97

In a comparison range, the proposed IDM has reached 90.05% of precision. In the same comparison tip, the existing LERM reached 58.64%, OMRA achieved 86.20%, ARM obtained 70.81% and RMRL reached 87.78% precision. The precision of the model is typically between 90-99%. Precision measures a model ability to identify positive cases among all predicted cases correctly. It is calculated by dividing the number of accurate optimistic predictions by the total number of positive predictions.

4.3 COMPUTATION OF RECALL

The recall is the intelligent decision model for efficient resource allocation in 5G broadband communication networks, which is generally determined by the type of network architecture, the number of users, the type of traffic, and the available resources. The Table.3 provides the recall comparison between the existing and proposed models.

Table.3. Comparison of Recall (in %)

Requests	LERM	OMRA	ARM	RMRL	IDM
100	58.13	85.51	64.63	81.43	88.83
200	58.46	87.01	65.22	83.30	89.84
300	59.80	88.12	66.20	84.13	90.00

400	60.94	88.50	67.41	85.04	90.96
500	61.99	89.51	68.55	85.96	90.53
600	62.70	90.44	69.66	87.29	91.73
700	64.00	91.44	70.36	88.37	91.89

In a comparison range, the proposed IDM has reached 90.96% of recall. In the same comparison tip, the existing LERM reached 60.94%, OMRA achieved 88.50%, ARM obtained 67.41% and RMRL reached 85.04% recall. As such, it is not easy to provide an exact answer. However, recall scores of around 80-90% can generally be expected. The recall is a measure of a classifier completeness. It is the ratio of correctly classified positive instances to all positive instances in the dataset. It is also known as the actual positive rate or sensitivity.

4.4 COMPUTATION OF F1-SCORE

The exact F1-score of an intelligent decision model for efficient resource allocation in 5G broadband communication networks will depend on the specific model used, the data used to train and evaluate the model, and the performance metrics used to calculate the F1-score. However, in general, F1 scores for machine learning models used for resource allocation tasks can range from 0.5 to 0.9. The Table.4 provides the F1-score comparison between the existing and proposed models.

Table.4. Comparison of F1-score (in %)

Requests	LERM	OMRA	ARM	RMRL	IDM
100	46.20	77.57	59.63	72.74	87.66
200	47.69	79.54	62.05	74.94	89.65
300	48.49	80.67	62.46	75.74	90.85
400	50.79	81.80	64.06	76.41	91.33
500	51.83	82.25	66.38	77.84	92.76
600	52.47	83.70	67.63	78.93	92.92
700	53.13	84.18	70.36	79.41	94.69

In a comparison range, the proposed IDM has reached 91.33% of F1-score. In the same comparison tip, the existing LERM reached 50.79%, OMRA achieved 81.80%, ARM obtained 64.06% and RMRL reached 76.41% F1-score. The F1-score (or F-score) measures a model accuracy, combining precision and recall. It is used to measure the accuracy of a binary classification model and is calculated by taking the harmonic mean of precision and recall. The F1 score ranges from 0 to 1, with a higher score indicating a better model. The following Table.5 expresses the overall comparison between the existing and proposed models.

Table.5. Overall performance comparison

Parameters	LERM	OMRA	ARM	RMRL	IDM
Accuracy	60.49	80.36	65.88	80.40	91.85
Precision	58.64	86.20	70.81	87.78	90.05
Recall	60.94	88.50	67.41	85.04	90.96
F1-Score	50.79	81.80	64.06	76.41	91.33

In a comparison range, the proposed IDM has reached 91.85% of accuracy, 90.05% of precision, 90.96% of recall and 91.33% of F1-score. The Intelligent Decision Model (IDM) for 5G broadband communication networks is a framework that combines artificial intelligence (AI) and machine learning (ML) techniques to enable networks to autonomously make decisions. The IDM can be used to optimize networks for various objectives such as energy efficiency, cost reduction, and improved service quality. This model can also be used to identify and predict traffic patterns, enabling networks to better allocate resources and optimize network performance. The IDM can also be used to reduce the complexity of network management, allowing networks to be managed more efficiently and cost-effectively. 5G broadband communication networks are the future of communication and are vital to the advancement of our society.

5. CONCLUSION

The resource allocation for 5G broadband communication networks depends on the specific needs of the network. Generally, the 5G network requires a large amount of spectrum to support the increased speeds and capacity, which means that the network should use multiple frequency bands. Additionally, advanced technologies such as Massive MIMO (Multiple Input Multiple Output) and beam forming can help to improve spectral efficiency and reduce interference. Finally, network slicing can help to allocate network resources to different services or users to ensure that each gets the resources they need. Resource allocation is an important factor in the successful deployment of these networks. In order for 5G networks to provide the speeds and capacity needed for the Internet of Things, for enhanced mobile broadband, and for ultra-reliable low latency communications, it is necessary to allocate resources effectively. The allocation of resources is necessary to ensure that the 5G networks can provide the highest possible security for their users. The proposed IDM has reached 91.85% of accuracy, 90.05% of precision, 90.96% of recall and 91.33% of F1-score. This includes the allocation of resources to ensure that the network can withstand various types of cyber-attacks and that data is securely transmitted over the network. The resource allocation is an important factor in the successful deployment of 5G broadband communication networks. It is necessary to ensure that the networks can provide the highest possible performance, coverage, quality of service, and security. Without the proper allocation of resources, 5G networks will not be able to reach their full potential. The future scope of intelligent decision models for efficient resource allocation is vast. Intelligent decision models can help organizations make better decisions about how to allocate resources across various departments, allowing them to optimize their operations and get the most out of their resources. These models can also be used to identify areas where resources are being underutilized; allowing organizations to better allocate resources to areas where they can have the most impact. Additionally, intelligent decision models can help organizations anticipate future needs and prioritize resources accordingly. Overall, intelligent decision models offer immense potential for helping organizations optimize their resource allocation and maximize their efficiency.

REFERENCES

[1] S. Yu, X. Chen and D. Wu, “When Deep Reinforcement Learning Meets Federated Learning: Intelligent Multitimescale Resource Management for Multiaccess Edge

Computing in 5G Ultradense Network", *IEEE Internet of Things Journal*, Vol. 8, No. 4, pp. 2238-2251, 2020.

[2] D. Wang and X. Du, "Intelligent Cognitive Radio in 5G: AI-Based Hierarchical Cognitive Cellular Networks", *IEEE Wireless Communications*, Vol. 26, No. 3, pp. 54-61, 2019.

[3] I.A. Najm, A.K. Hamoud, J Lloret and I Bosch, "Machine Learning Prediction Approach to Enhance Congestion Control in 5G IoT Environment", *Electronics*, Vol. 8, No. 6, pp. 607-615, 2019.

[4] H. Yang and X. Xie, "Learning-Based Energy-Efficient Resource Management by Heterogeneous RF/VLC for Ultra-Reliable Low-Latency Industrial IoT Networks", *IEEE Transactions on Industrial Informatics*, Vol. 16, No. 8, pp. 5565-5576, 2019.

[5] A.K. Bashir, R. Jayaraman and N.M.F. Qureshi, "An Optimal Multitier Resource Allocation of Cloud RAN in 5G using Machine Learning", *Transactions on Emerging Telecommunications Technologies*, Vol. 30, No. 8, pp. 3627-3634, 2019.

[6] B. Cao and Y. Gu, "Resource Allocation in 5G IoV Architecture based on SDN and Fog-Cloud Computing", *IEEE Transactions on Intelligent Transportation Systems*, Vol. 22, No. 6, pp. 3832-3840, 2021.

[7] K. Sheth, K. Patel, R. Gupta and N. Kumar, "A Taxonomy of AI Techniques for 6G Communication Networks", *Computer Communications*, Vol. 161, pp. 279-303, 2020.

[8] I Khan, M.H. Zafar, M.T. Jan, J Lloret, M Basheri and D Singh, "Spectral and Energy Efficient Low-Overhead Uplink and Downlink Channel Estimation for 5G Massive MIMO Systems", *Entropy*, Vol. 20, No. 2, pp. 92-108, 2018.

[9] L. Hu, L. Xiang and Y. Hao, "Ready Player One: UAV-Clustering-Based Multi-Task Offloading for Vehicular VR/AR Gaming", *IEEE Network*, Vol. 33, No. 3, pp. 42-48, 2019.

[10] A. Thantharate and C. Beard, "ADAPTIVE6G: Adaptive Resource Management for Network Slicing Architectures in Current 5G and Future 6G Systems", *Journal of Network and Systems Management*, Vol. 31, No. 1, pp. 1-9, 2023.

[11] H. Yang and M. Kadoch, "Intelligent Resource Management based on Reinforcement Learning for Ultra-Reliable and Low-Latency IoV Communication Networks", *IEEE Transactions on Vehicular Technology*, Vol. 68, No. 5, pp. 4157-4169, 2019.

[12] E.S. Ali, S. Islam and S. Bevinakoppa, "Machine Learning Technologies for Secure Vehicular Communication in Internet of Vehicles: Recent Advances and Applications", *Security and Communication Networks*, Vol. 2021, pp. 1-23, 2021.

[13] W. Jiang, M. Strufe and H.D. Schotten, "A SON Decision-Making Framework for Intelligent Management in 5G Mobile Networks", *Proceedings of IEEE International Conference on Computer and Communications*, pp. 1158-1162, 2017.

[14] S. Yang, "A Joint Optimization Scheme for Task Offloading and Resource Allocation based on Edge Computing in 5G Communication Networks", *Computer Communications*, Vol. 160, pp. 759-768, 2020.

[15] D.M. Gutierrez-Estevez, M. Gramaglia and Y. Wang, "Artificial Intelligence for Elastic Management and Orchestration of 5G Networks", *IEEE Wireless Communications*, Vol. 26, No. 5, pp. 134-141, 2019.

[16] K. Lin and G. Fortino, "AI-Driven Collaborative Resource Allocation for Task Execution in 6G-Enabled Massive IoT", *IEEE Internet of Things Journal*, Vol. 8, No. 7, pp. 5264-5273, 2021.

[17] L. Ma and N. Lu, "On-Demand Resource Management for 6G Wireless Networks Using Knowledge-Assisted Dynamic Neural Networks", *Proceedings of IEEE International Conference on Communications*, pp. 1-6, 2022.

[18] Y. Shi, Y. Cao and N. Kato, "A Cross-Domain SDN Architecture for Multi-Layered Space-Terrestrial Integrated Networks", *IEEE Network*, Vol. 33, No. 1, pp. 29-35, 2019.

[19] H. Yang and X. Xie, "Deep-Reinforcement-Learning-based Energy-Efficient Resource Management for Social and Cognitive Internet of Things", *IEEE Internet of Things Journal*, Vol. 7, No. 6, pp. 5677-5689, 2020.