Resource Allocation Technique among Mobile Virtual VCN operators

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Research Article

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Abstract: Resource allocation has been a guaranteed approach to provide users, spectrum from different network operators. In this research, we examine the use of Mobile virtual VCN operator (MVVO) to allow spectrum sharing. Specifically, we introduce a spectrum dividing framework between three VCN operators. We execute fairness by confirming that each VCN operators receive spectrum from another VCN operators for its user at reasonable charge. We formulate a Markov decision process to determine user scheduling between three VCN operators. Simulation result shows that virtual network operator takes 9 seconds for collecting information about user and network operator. Our numerical result validate that this scheme can achieve up to 90% improvement in terms of user satisfaction rate.

Index Terms: Spectrum Sharing, Mobile virtual VCN operator (MVVO), User scheduling, Resource allocation.

1. Introduction

Along with the advancement of wireless technology, the range of cellular gadgets has increased over the years. Different mobile network operator has different frequency range. So we have to use the concept of spectrum sharing. By allowing many user groups to safely utilize the same frequency bands, spectrum sharing makes the best use of the airwaves, or wireless communication channels. Superior coverage and capacity are offered by shared spectrum, which is a competitive differentiation to expand the customer. This will not only help current customers but also attract new customers as well. In the current research, we have to use the concept of spectrum sharing between different mobile virtual network operators. In this approach mobile network operators does not provide services only to their customers but also the customers of other network operators. This can be done with the help of mobile virtual network operator. Virtual network operator generate connection between different mobile network operators and users. Virtual network operator increase user satisfaction rate by user scheduling between mobile virtual VCN operators. Virtual network operators keep track of both users and network operators and support both in successful resource allocation. Spectrum sharing approach is beneficial for both users as well as network operators. Main benefit of this approach is optimum utilization of resources and offer resources to those users who need it most. The research organization is done as follows: Section II depict the related work. Section III represent methodology, simulation set up and algorithm used for proposed system. Section IV discuss about experimental results and comparative study. Section V conclude the work with summary and highlight the future scope of proposed system.

2. Literature Review

Several researcher has worked in the field of wireless communication. In 2021, Tejasvi Alladi present authentication based security scheme for vehicular Network. They analyze the role of various technologies such as SDN, Named data networking as well as AI etc. [1]. In 2021, Muddasar Ayyub reviewed about vehicular networks, They discuss about challenges, advantage and techniques for wireless technology. This review give right direction to the researcher for further research [2].In 2021, Vartika Agarwal reviewed about different kind of network scheduling technique. Such techniques are very effective and able to manage resource easily [3]. In 2021, Yuyang Zhang present skip network coding transmission scheme. They develop a vehicular communication-based simulation system. It is more reliable as compared to other transmission scheme [4].In 2022, Tianchen Wang present MIMO scheme to permit spectrum sharing. They develop technique to offer an efficient solution of this problem through functional method. Simulation result validate the 60% efficiency of this scheme [5]. In 2022, Yazhou Zhu works on resource utilization technique for enhancing the throughput of beamforming in satellite communication. Simulation result verify the effectiveness and efficiency of this scheme [6]. In 2022, Zheyuan Yang, formulate multi stage stochastic optimization problem for the development of mobile edge computing. They achieve great performance but has a higher computational complexity [7]. In 2022, Zhaoying Wang investigate reinforcement learning approach for solving the resource allocation problem. This scheme has been verified using MATLAB software and has a great performance over other traditional scheme [8]. In 2022, Ying he propose general framework for resource allocation in vehicular networks. They use the MHRL approach for resource management in vehicular environment. Simulation result verify the efficiency of this scheme [9]. In 2022, Xinran Zhang investigate reinforcement learning approach for fog based vehicular networks. This approach works well and has a less network drop rate

[10]. In 2022, Ahmad M. Hashanah propose heterogenous network model for vehicular communication. This model focus on vehicular cloud and heterogenous communication. It has a great performances as well as effective resource utilization [11]. In 2022, Lan Su propose vehicle to vehicle scheduling scheme for solving the resource utilization problem. This scheme has a great transmission efficiency and reduce transmission time upto 40% and increase network throughput upto 60% [12]. In 2022, Vartika Agarwal highlight deep learning technique for radio resource management. They use various machine learning tools for resource allocation [13]. In 2022, Vartika Agarwal introduce scheme which is based on radio resource management. This scheme is better for traffic management [14]. In 2022, Jamshid Tursunboev propose federated learning approach for the unmanned aerial vehicles. Simulation result shows that it has a better performance as compared to other technique [15]. In 2021, Vartika Agarwal discuss about network resource management technique in Vehicular network [16]. In 2022, Girish Kumar present resource allocation scheme for D2D communication. This scheme has various advantages such as increase no of D2D users as well as maximize the throughput [17]. In 2022, Vartika Agarwal discuss about vehicular communication schemes. Such schemes are able to use advanced technologies and make vehicular communication network more smart [18]. In 2022, Hongcheng Huang introduce temporal computing resource allocation scheme. Such schemes are able to improve efficiency of resources [19]. In 2022, Wenting Wei focus on resource allocation in vehicular cloud network. It has a great performance, better throughput as well as an effective output [20].

Main Contribution in this paper are as follows:

User scheduling between mobile virtual VCN operator

Virtual Network operator help operators to increase user satisfaction rate.

Virtual Network operator fulfill user requirement by offering best service at any location.

3. Methodology

We study the downlink of a multi-cell multiuser Mobile virtual VCN operator (MVVO) network consisting three VCN operators denoted as VO1, VO2 and Vo3 respectively. All operators have different spectrum range which can be divided into N1, N2 and N3 frequency slots. Each VCN operator has a base station to transmit signal to own users within the network. If any user comes to VO1 network but belongs to VO2 network. VO1 offer services to the user of VO2. But VO2 have to pay for it to VO1 or they can also provide services to those users who belongs to VO1. All operators can provide services to the user of another operator by paying money or exchange users.

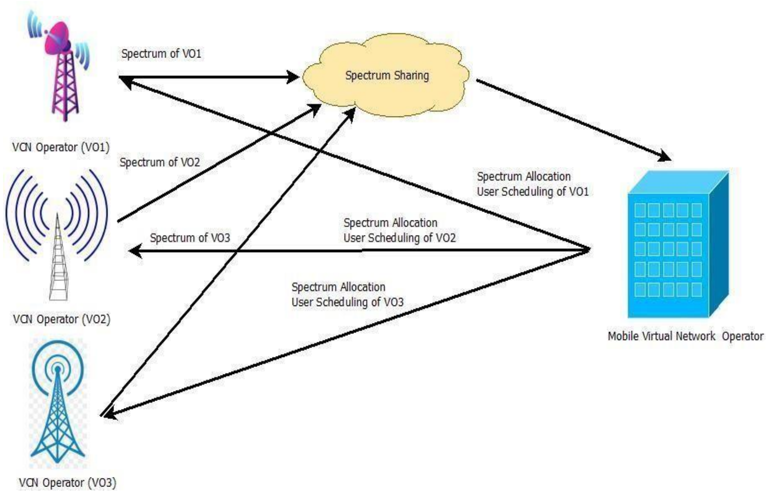

Fig 1. Implementation of Spectrum Sharing

From Fig 1, we can see that we have 3 VCN operators VO1, VO2 and VO3 which can take spectrum from MVNO. MVNO works for spectrum allocation as well as user scheduling. Such operator find out the how much users of VO1 belongs to V02 and VO3. How much users of VO2 belongs to VO1 and VO3.How much users of VO3 belongs to VO1 and VO2. After identifying users. MVNO shift user from one network to another network.

From Fig 2, we can see that Virtual Network Operator is responsible for spectrum sharing between users and network operators. Virtual Network operator maintain data of users as well as network operators and help both users as well as operator for successful resource allocation.

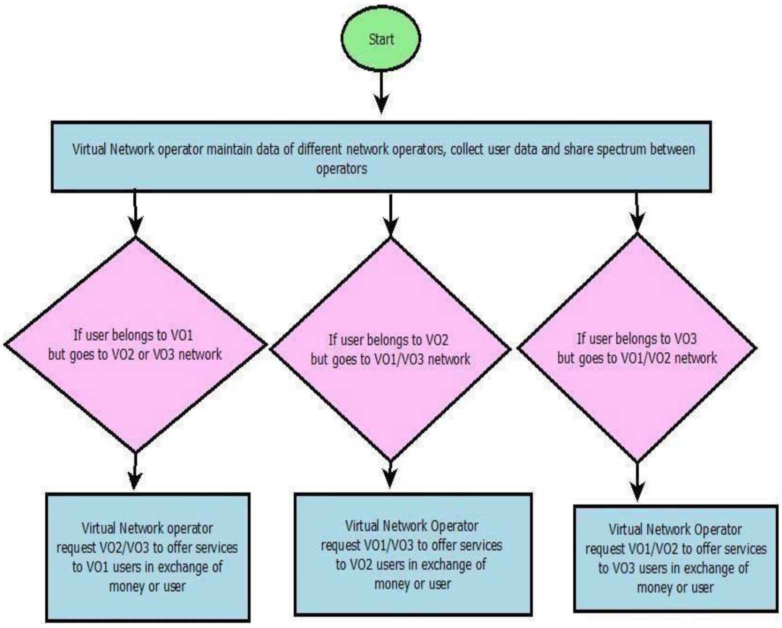

Fig 2. Working of Virtual Network Operator

A. *Simulation Set up*

Network Specification – It includes longitude and latitude generated by the system. System find out the network operator which is associated with the location.
System Configuration –Intel i6 processor with 16 GM RAM support this experiment. MATLAB 2018 have best features which are used for simulation of this research.

B. *Markov Decision Process*

Markov decision process is a mathematical structure to depict the situation. It contains states, models, actions and reward function. In this process, user have to plan the best action based on his existing state. When this phase is repeated, the problem is called as Markov decision process. Markov decision process can demonstrate sequential decision problems in which there is a decision node at each stage.

Table 1 includes the notation used for Markov decision process.

Notation	Description
F	VO1
S	VO2
T	VO3
#	Obstacles

Table 1 – Notation Used for Markov decision

Markov Decision	Process
States	VO1, VO2, VO3
Model	T(VO2, #, VO3)
Action	A(VO1, VO2, VO3)
Reward	R(VO2,-100), R(VO3,100)
Policy	∏ (S) -> VO3

Table 2 - Markov Decision Process

From Table 2, we have three network operators (States) such as VO1, VO2 and VO3. Model means effect of action in a state. In this case if user of VO1 select VO2, they found some obstacles so they select VO3. VO1 pay winning amount to VO3 for good service (+100) and VO2 have to face loss of 100 because user have to face obstacles.

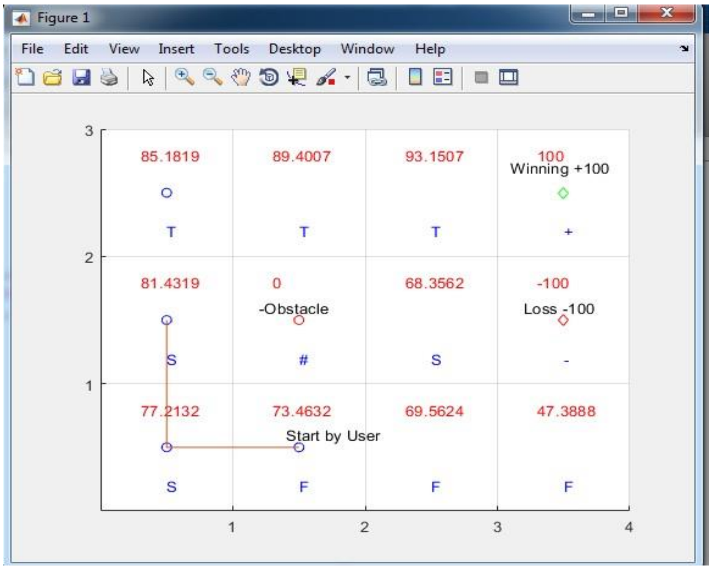

Fig 3. User move from VO1 to VO2

From Fig 3, we can see that we have three kind of network VO1(F), VO2(S), VO3(T). When user goes from one network to another network that is from VO1 to VO2. They found some obstacles that means improper signal. VO1 will not pay for this service to VO2. So VO2 have to face this loss (-100). From Fig 4, we can see that user will not found any obstacle in VO3. So Vo1 have to pay VO3 for this service (+100) which is winning amount.

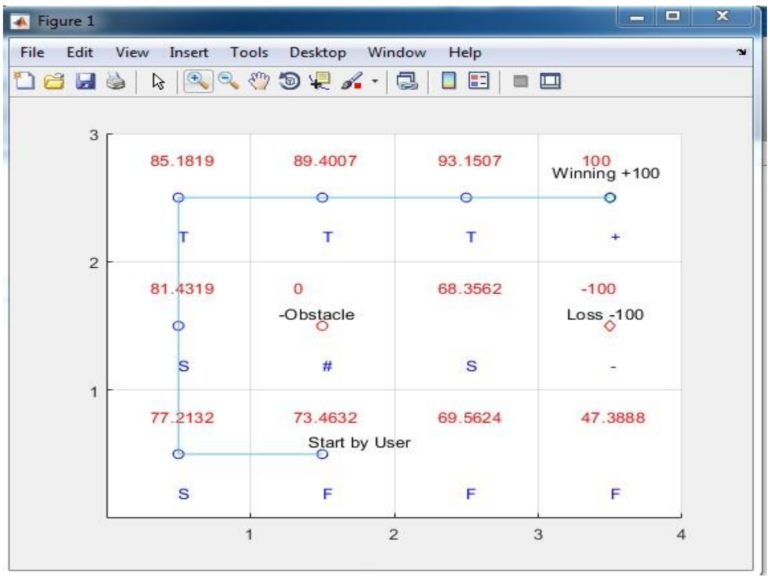

Fig 4 . User move from VO1 to VO3

4. Experimental Results

A. *Network drop rate* – In fig 3, when user comes in network 2, signals will break and when user enter the network of third operator, signal will work continuously. (Table 3)

NDR = (Ts-Tr)/Ts*100 = (20-15)/20 = 0.25 Sec

Ts = Time of Sending a message
Tr= Time of receiving a message
Network drop rate is calculated via difference between time of sending a message and time of receiving a message divide by time of sending a message.

Parameters	**VO1**	**VO2**	**VO3**	**Virtual Network Operator**
Network drop rate	0.25 sec	-	-	-
Processing time	-	-	-	9 Sec
Network throughput	-	-	Better	-
User satisfaction rate	90%	70%	90%	-

Table 3 – Experimental Result

B. *Processing Time* - Time taken by the Virtual Network Operator to supervise the service of operator . From the Fig 4, 9 sec will be calculated by the virtual network operator

C. *Throughput* - Network throughput means speed of network. From the fig 5, we can see that VO3 have better throughput as compared to VO2.

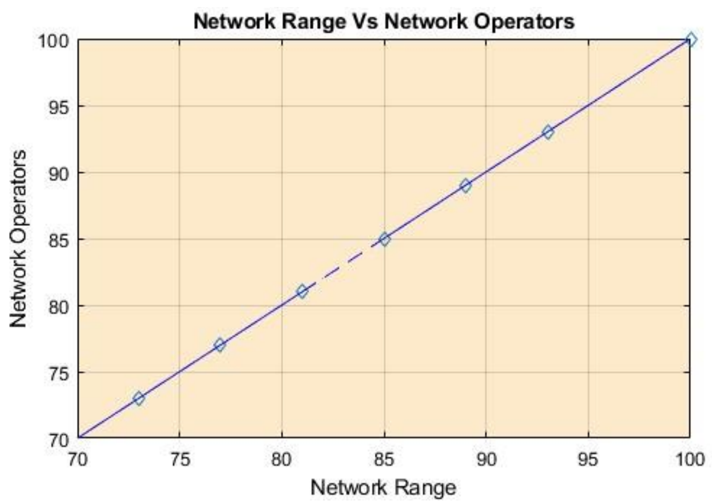

Fig .5 . Network Range Vs Network Operators

D. *User Satisfaction rate* – VO1 have 20 users, VO2 have 40 users and VO3 have 30 users before resource sharing (Fig 6)

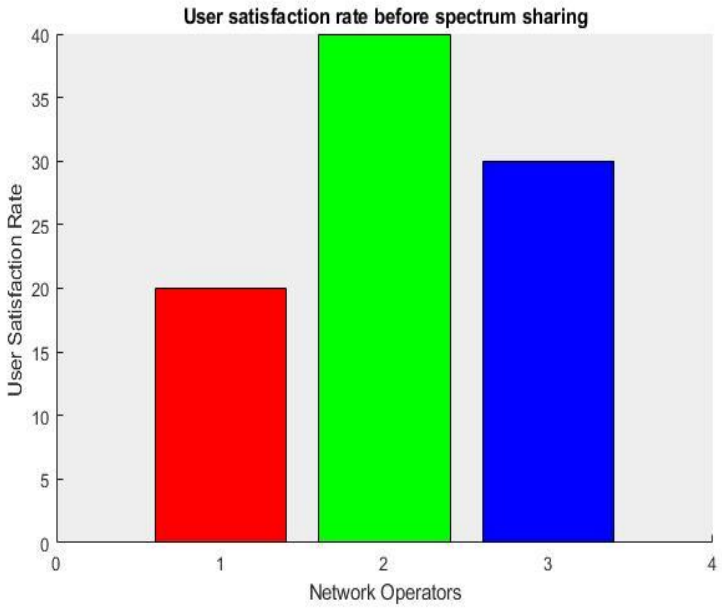

Fig. 6 – User Satisfaction rate before resource (Spectrum) sharing

Vo1 and Vo3 have 5 users who belongs to VO2 and Vo3 have 5 users who belongs to VO1. So the user satisfaction rate is almost 90% (Fig 7).

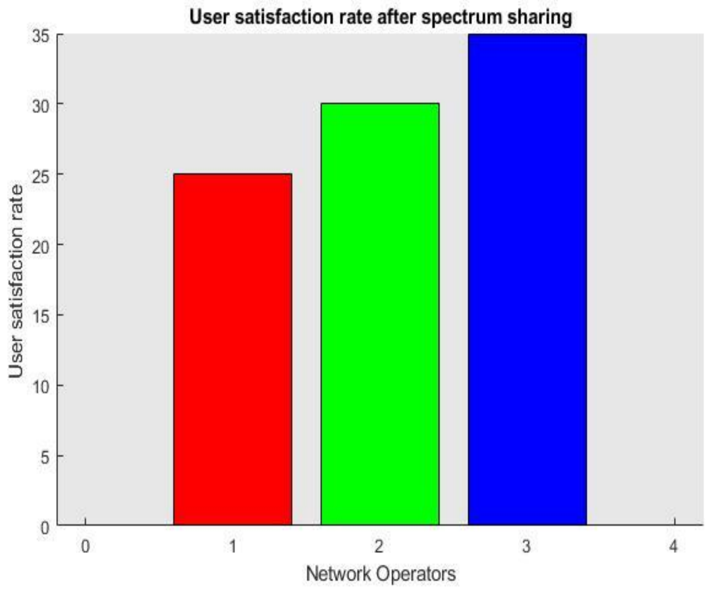

Fig. 7 – User Satisfaction rate after resource (Spectrum) sharing

Average User Rate -To evaluate the performance of resource allocation technique, we can find the average user rate of each operator accomplished through the following cases

No Spectrum Sharing - Each operator use its own spectrum. Each operator allocate resource to its own users. Allocation of resources for each operator are done through hungarian algorithm.

By using Hungarian algorithm, we have a 3 operators. Every operator provide service to its own users. Cost incurred in all operators is $2 (Table 4)

	User1(OP1)	User2(OP2)	User3(OP3)
OP1	$2	-	-
OP2	-	$2	-
OP3	-	-	$2

Table 4 – No spectrum sharing

Spectrum sharing - Table 5 shows how the operator takes benefit if they are ready to share spectrum. They get 3 users and $4 benefits and have to pay only $2.

	User1(OP1)	User2(OP2)	User3(OP3)	Benefit	Users
OP1	$2	-	-	$4	3
OP2	-	$2	-	$4	3
OP3	-	-	$2	$4	3

Table 5- Spectrum sharing

Fair Spectrum Sharing – Resource Allocation framework is proposed in Figure 4, where OP1 and op3 can transmit signals to overall frequency slots. While OP2 have some network issues so they are only able to allocate resources to its own users.

Full spectrum Sharing – Both OP1 and OP3 allocate resources to all users. In this case, they increase their average user rate.

From figure 8, we can see that no spectrum sharing means every operators have independent frequency slots and they do not want to share its users or spectrum. Fair spectrum sharing means OP1 and OP3 are ready to share spectrum and OP2 have some network issues. OP1 and OP3 increase their average user rate by sharing spectrum to its users.

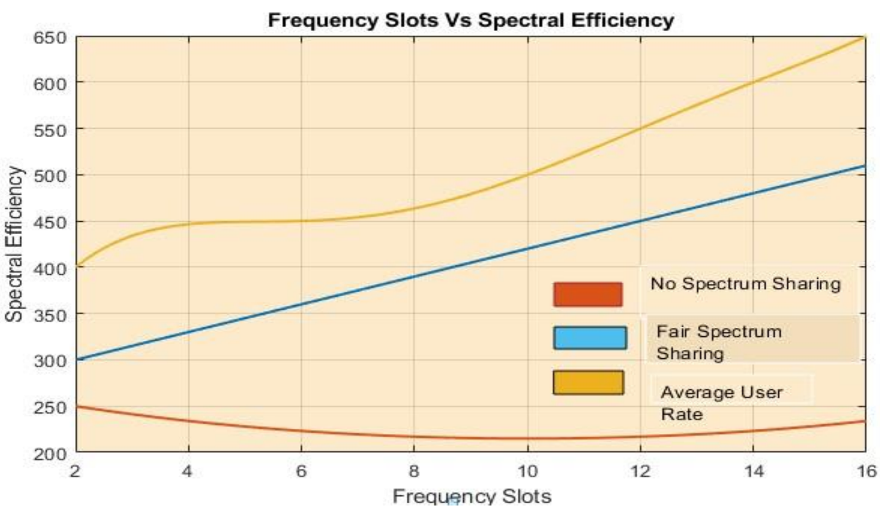

Fig. 8 – Frequency Slots vs Spectral efficiency

Author	Proposed Scheme	Advantage	Result	Limitation or Future Scope
[1]	Blockchain based Security Scheme for Vehicular Network	Use various technologies such as Named data networking, artificial intelligence and many more.	Make Vehicular communication more secured, faster and reliable.	Transportation as well as crowdsourcing are the areas for further research.
[2]	Clustering Schemes for Vehicular Network.	Reliability as well as Scalability etc.	Clustering help to improve resource optimization in vehicular network.	Modify this scheme for improving resource optimization.
[3]	Network Scheduling Technique	Know in advance about which obstacle occurred during vehicular Communication	Effective and Efficient communication between vehicles.	We can explore this scheme by analyzing performance about the resources.
[4]	Skip Network Coding Multipath Transmission scheme	Reduce packet loss as well as improve transmission performance.	Decrease the chances of packet loss as well as offer higher throughput.	Modify this scheme for high network utilization
[5]	Spectrum Sharing system between two MNO's.	Proposed scheme can achieve upto 60% performance as compared to other scheme.	Increase Average User Rate	Modify this approach for sharing spectrum between multiple MNO's.
[6]	Application of Non orthogonal Transmission in beamforming.	Better throughput as well as less transmission overhead.	Efficient user scheduling scheme is designed for better throughput.	In future, explore the resource optimization strategy for better output.
[7]	UAV enabled MAC Technology	Reduce Complexity as well as solving the resource allocation problem.	Significant performance gain through joint optimization method.	Modify this scheme for achieving better result
[8]	Deep Reinforcement learning approach	Solving the resource allocation problem through virtual network operator.	90% accuracy for solving the resource optimization problem through twin Actor DDPG algorithm.	It has some computational complexity, researcher have to work on this in future.
[9]	Reinforcement learning with meta learning.	Optimal resource allocation policy.	80% success rate and effectively able to allocate resources to every vehicle.	In future, we have to modify this scheme for better research.
[10]	RL approach for fog based vehicular network.	Reliable, Safe and Secure	Better throughput, minimize latency as well as less packet loss.	In future, we have to work on fulfill the latency requirement.
	Proposed Scheme	Better throughput and 90% user satisfaction rate.	User satisfaction as well as increase no of users for every network operator.	In future, Integrate resource sharing to acquire a more realistic network.

Table 6 – Comparative Study

From Table 6, [1] , author used blockchain based security scheme for vehicular network. They use various technologies which makes vehicular communication network more secured, faster and reliable. [2], author proposed clustering scheme for vehicular network. This scheme is more reliable and scalable. [3], author propose network scheduling technique which help us to plan about whole vehicular communication process. [4], author propose skip network coding multipath transmission scheme which reduce packet loss as well as improve transmission performance. [5], author propose spectrum sharing system between two mobile network operators. This scheme works well and achieve upto 60% performance in comparison of other schemes. [6], author propose application of Non orthogonal Transmission in beamforming. This scheme offer better throughput as well as less transmission overhead. [7], author propose UAV enabled MAC Technology which reduce complexity as well as solving the resource allocation problem easily. [8], author propose deep reinforcement learning approach for solving the resource allocation problem through virtual network operator. [9], author propose reinforcement learning with meta learning. It's success rate is about 80% and able to allocate resources to every vehicle. [10], author propose RL approach for fog based vehicular network. It is more reliable, safe and secure. After evaluation of previous research, Major research gap we found that any scheme would not work for more than two mobile virtual network operators. Proposed scheme work for more than three mobile virtual network operator and effectively allocate resources to both users as well as network operators.

4. Conclusion and Future Scope

This paper develop a spectrum sharing system between three mobile virtual VCN operators (MVVO).Each VCN operator has a base station to transmit signals to individual users inside the network. If any user comes from other network. VCN operator has to provide service at reasonable cost to another VCN operator or exchange users with other operators. Our goal is to understand how virtual network operator enhancing the benefit of successful resource allocation. In this concern, we demonstrate markov decision process to find out the successful resource allocation rate as well as average user rate.

Simulation result shows that virtual network operator takes 9 seconds for collecting information about user and network operator. This research offer VO1 and VO3 could reach up to 70% enhancement in terms of average user rate and 90% improvement in terms of user satisfaction rate.. VO2 have some network issues so they have to work on for overcoming this issue. Spectrum sharing help users as well as network operators to effectively allocate resources. In this paper, we focus on perfect resource sharing between network operators, which is unrealistic in real world. The next step would be to integrate resource sharing to acquire a more realistic network. However, our research offer an incentives to examine resource allocation for MVVO network.

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