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6G technology based advanced virtual multi-purpose embedding algorithm to solve far-reaching network effects

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ABSTRACT

At present, network virtualization is an essential technology that aims to resolve shortcomings including network ossification of the current design of the Internet. The Internet's tremendous success have adopted digital business growth and increased competition for bandwidth in communication. Ultra-high-definition videos and vehicle systems require rapid bandwidth rates and increase network connection capacity, respectively. The rapid advancement of network virtualization and 6G technologies is driven by high bandwidth and high speed parallel communication. This innovation often introduces new link allocation problems to existing substrate networks in a network virtualization environment. In order to solve this far-reaching network effects, this paper proposes an Advanced Virtual Multi-Purpose Network Embedding Algorithm (AVMPNEA) through the fuzzy C-mean clustering, which is a learning algorithm. The clustering integrally evaluates the topological node structure, the latency and the related bandwidth between the nodes. The Nodes that enhance the longevity are used for selected mapping. The experimental result shows that the proposed AVMPNEA is outperformed in comparison with other traditional methods with high throughput, low latency and reduced energy consumption. Hence, it improves the throughput and the long-term application support.

1. Introduction

The growing wireless service requirements and user density have lead to the evolution of sixth generation (6G) communication technology in the recent years. The advantage of 6G over the existing technologies is its high level support for heterogeneous applications and mobility support [1]. For being pervasive and seamless for the different application demands, artificial intelligence along with conventional communication standards is employed in this platform. It integrates blockchains, cloud and optical communications, backhaul networks, and machine type communications (MTC) for improving the heterogeneity support for diverse applications [2]. The design of 6G communication enhances the quality of service (QoS) requirements of the users through promising data rates and controlled latency [3]. This advantage is exploited in different application scenarios including smart healthcare, industry automation, smart homes and cities, intelligent transportation, etc. Integration of multi-level complex networks, information and communication technologies, computational methods, and distributed platform support through cloud ensures flexible and mobility supported access and allocation of resources to the 6G users [4].

Virtualization of resources is a QoS efficient measure for improving the service reliability in a distributed and ubiquitous communication environment [5,6]. Resource and network virtualization is a common procedure for replicating the available services to the user's edge. In a virtualization process, the available resources/network is ensured to be available within the range of the connected users with a limited time initiative. This is performed by placing a replica of the actual resources near to the service requiring environments [7,8]. Such process is eased through platform-as-a-service architectures such as cloud where optical and heterogeneous communication infrastructures and common in service request and access. This process requires a mutual abstraction between the physical hardware and resource allocation [9,10]. Resource allocation requires precise management strategies for which the computation of the service provider is inherited along with proper decision making and computation support [11,12]. Balanced resource allocation and management helps to improve the success of virtualization despite of the user demands and communication technologies [13,14].

Virtualization of resources results in outages due to prolonged access, user mobility, service overlapping and latency based access [15]. In order to address the problem of outage, latency and network features are to be identified and appropriate solutions needs to be administered [16]. In case of a service-concentric densely populated network such as 6G, outage issues need to be identified and addressed at its initiating stage to retain the success rate of the service disseminations [17]. For this purpose, the artificial intelligence and machine

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based computations are commonly used in the virtualization process to achieve the desired optimal solution. The optimal solution is to provide seamless and latency-less performance-centric virtualization for resources/network to meet the service demands of the users [18].

2. Related works

Wang et al. [19], presented a Markov Chain using Secrecy Outage Probability Analysis. In this study, the physical layer is used for the full-duplex relay network to increase the security presentation. It consists of inter-relay and residual self-interference for successful decoding relays by using the Markov matrix probability.

Virtual allocations of resources in 5G networks are using the Constrained Markov Decision Process (CMDP) for spectral efficiency is proposed by Tang et al. [20]. A slice-based method is used along with the NOMA for QoS enhancement. The CMDP is for increasing the user rate. Power granularity uncertain-approximate dynamic programming (PGU-ADP) algorithm is introduced that incorporates the fore mentioned CMDP for better resource virtualization.

A 5G network is used for the Edge-to-Cloud Multimedia Service Virtualized Platform (SVP) is designed by Alvarez et al. [21]. This study has three metrics first one is the immersive 3D-gaming application, the second one is a remote broadcast of user contents, the third one is adaptive content distribution.

Bagaa et al. [22], observed a Coalitional Game for efficient creation of virtual core in the 5G system. Two types of algorithms are used first is the optimal number of virtual instances for the specific traffic; the second is for the federated cloud.

Distributed optimization of resource allocation (RA) in a 5G virtualized network is proposed by Halabian et al. [23]. The system consists of a collaborative slice (CS) for the allocation of resources for the maximum utility function. Then the distribution solution is done between the slices and the data centres.

Jin et al. [24], observed an Information-Centric Network (IVCN) Slicing Optimization in Fog-enabled Radio Access Network (RAN). The Virtual Network Function is used for the service provision forwarding. The IVCN examines both the data and the control plane.

Gu et al. [25], introduced a network topology reconfiguration for Free Space Optics (FSO) in the 5G+ network using greedy matching based (GMB) method for reactive reconfiguration for traffic event (RTRTE). The optimization of the proactive is used for the FSO based on front haul/backhaul networks. The reconfiguration is used when there is a demand for traffic.

A Mobile Edge Cloud of Scalable Service Chaining is implemented by Anastasopoulos et al. [26]. A relaxation framework is used to reduce complexity during computation. It uses the Hierarchical Random Graph (HRG) theory for the tree topology approach.

Betzler et al. [27], introduced a Software Defined Networking (SDN), for dense 4G and 5G cell network. It is designed for the wireless backhaul network, a SODALITE is proposed using the LTE network. It is reliable for reconfiguration of data plane when there is a failure in the link.

Alsaba et al. [28], presented a wireless network having the bigger number of clusters that are in the decode-and-forward (DF) relay network. When there is the deterministic of outage probability in the closed-form means the distance of the random variable is in the distances. The Stochastic Geometry (SG) is derived for this probability case.

The performance of outage is developed by Xu et al. [29], for Incremental decode-and-forward (IDF) for mobile cooperative relaying networks. It is used to transmit antenna selection (TAS) for extracting the closed-form outage probability (OP).

Figueiredo et al. [30], designed a Radio hardware Virtualization for Software-Defined Networks. Software-Defined Radio (SDR) systems are developed for the Software-Defined Wireless Network (SDWN) which is used for the wired and wireless channels for end-to-end transmission.

Dai et al. [31], observed the allocation of resources for outage performance in heterogeneous cellular networks (HCN). It uses the downlink outage performance of HCN; it also includes the closed-form of system probability for achieving the matching game.

3. Advanced virtual multi-purpose network embedding algorithm

The Network Function Virtualization (NFV) in 6G is used as the multi virtual network on network infrastructure. The proposed method Advanced Virtual Multi-Purpose Network Embedding Algorithm (AVMPNEA) is used to resolve the far-reaching network effects which use terahertz communication. Consider the virtual system that has a K number of NFVs that is denoted by $= K = \{K_1, K_2, \ldots .K_M\}M$ is the number of resources in the network and $U = \{1, 2, \ldots, U\}U$ represents the number of users these are processed by the use of clustering.

The network virtualization is done using clustering because to determine the same standard that reflects the similar data points are clapped together within the cluster. In this work to address high bandwidth, low latency, and energy consumption requirements in 6G networks the Fuzzy C-means clustering is used as the unsupervised learning algorithm. Here, multi-virtualized resources are in the network and intermediate resources.

It is said to be the substrate network that acts as the temporary virtual network which is denoted as which is used to obtain the services for virtualized resources from K number of NFV. Initially, the distance between the virtualized resources and intermediate resources is calculated for a number of users. The objective of this paper is to obtain the optimal clustering algorithm for the virtualized network in 6G, the objective function of clustering is derived under Eq. (1).

$$O_J = \sum_{(D,E)=1}^{V_R,I} X\left(\left[M_U\right]_D^E\right) * (D) \tag{1}$$

In the above equation O_J is the objective function, D represented as Datapoint and M_U indicates the degree of membership function, E denotes the centroid of the cluster, X is used to measure the similarity of the data points and it is the membership function which is denoted in the matrix format such as $[M_U]_{D,L}$. The base station calculates and assigns the virtualized resources into the cluster, which is done based on the location information.

The resources are distributed in H * H region, these resources send a message to the Base station that contains the data about the geographical locations. The receiver resources get the information and compute the cluster centres and allocate the resources to the cluster by using Fuzzy C-mean clustering. Here, all the resources are having a specific membership to the cluster.

3.1. Fuzzy C-mean clustering

The Fuzzy algorithm for virtual resource allocation and access is processed using the following steps:

Step 1: First the data points and the clusters are set, $D = \{D_1, D_2, \ldots, D_n\}$ are the data points for the virtual network, and $L = \{L_1, L_2, \ldots .L_n\}$ are the set of clusters.

Step 2:Cluster centres are selected by using Eq. (2), which is derived from Eq. (1) objective function, where, L is the Cluster centre, S is the function of the cluster, m is fuzzier for the virtual resources, D_f indicate the function of the data points.

$$L_S = \frac{D_f * \left[\sum_{D=1}^{D,m} * \left(V_R\right)\right]}{\sum_{D=1}^{m}\left[M_U\right]} \tag{2}$$

Step 3: From Eq. (2), the fuzzy partition matrix are computed using the following Eq. (3); in this D_f is the data function, j indicates the initial cluster, L_i is the cluster iteration process, i denotes the number of iteration.

$$[M_U]_{D,L} = \frac{1}{\sum_{L}^{i=1}\left[\frac{(D_f - L_j)}{(D_f - L_i)}\right]^{\frac{m}{2}}} \tag{3}$$

Step 4: From the partition matrix the fuzzy centre are been calculated as follows in Eq. (4)

$$L_j = \frac{\sum_L^m (\mu_{D,L}) * D}{\sum_{L=1}^m (\mu_{D,L})}, \forall_j = 1, 2, \ldots L \tag{4}$$

Step 5: Repeat the step (3) and (4) to minimize the objective function to achieve the condition as $[M_U]_{i+1} - [M_U]_i < \delta$, where δ is the termination criterion that lies between [0, 1]. The objective function for minimizing during each iteration is calculated by using the following Eq. (5).

$$O_J = \sum_{D=1}^{L} \sum_{L=1}^{V_R} \left[(G, T)_{D,L}\right]^{\frac{m}{2}} \tag{5}$$

In this above Eq. (5) is obtained to minimize the objective function by using Eq. (1), where, G is the resource degree to the cluster, T is the distance between the resources and the cluster. By minimizing the objective function the accurate data points are been found out. From the processing step, it is discussed that the value of the fuzzier is either 0 or 1, by doing the fuzzy clustering. If the value is lower than the fix values means it is assigned as 0 or 1 and it is represented in Eq. (6). B, A, Y, denoted as Bandwidth, Latency, and Energy consumption, and γ is the fixed value, FO_J is the fuzzier objective function. From this equation it satisfies the user fuzzier objective lesser then the fixed value.

$$FO_J = L_S \begin{cases} [B, A, Y] > \gamma, & 0 \\ \quad else & \\ [B, A, Y] < \gamma, & 1 \end{cases} \tag{6}$$

From clustering, they form the matrix representation of rows and columns, rows indicate the data, and columns are denoted as clusters here two clusters are taken into consideration. The user accesses the resources, in this case, there is an issue regarding the bandwidth, latency, and consumption of energy to resolve these issues in the network the following Eq. (7) is used. The computed modelled in the queue, the links which are links the resources in the network are in the large buffers which are in terahertz. From Eq. (6) the fuzzier objective are used to find the data is either 0 or 1 from that the delay in the data is given in Eq. (7).Where the arrival and process data are calculated.

$$P = \frac{1}{2} (\mu_{D,L}) * \frac{2 - \frac{W_{D,L}}{\alpha_{D,L}}}{1 - \frac{W_{D,L}}{\alpha_{D,L}}} \tag{7}$$

From the above Eq. (7), P is used to find the delay, W is the arrival data and α indicates the processing rate of the data on the network. This is used to reduce the data delay in the network. If the delay is controlled, they are having the longer connectivity in the network. In this processing the energy consumption in the virtual resources is formulated. From Eq. (7) the delay of the resources are improved and the consumption of energy is done by using Eq. (8) in which the percentage of the energy is calculated.

$$Eng(V_R) = \begin{cases} \frac{P_r}{\left[\left|L_r\right| * \frac{1}{P_r}\right] - 1} * \frac{\left[Eng_{avg}\right]^{L_r}}{\left[Eng_{avg}\right]}, & if\ L \in r \\ 0, & Otherwise \end{cases} \tag{8}$$

The above equation is used to find the percentage of the energy for the virtual resources, and P_r, represents the percentage, Eng is the energy required for the data, whereas, r indicates the region in the cluster. In this equation, avg is the average energy along with the percentage is been calculated. The latency is calculated by taking the propagation delay and serialization delay and it is formulated in the below Eq. (9).

$$N_A = \begin{cases} A = (P_d - S_d) * S_s \\ S_s = \frac{Avg(\tau, S_a) + t_b}{N * \tau} \\ \tau = \left[\frac{S_a}{TA}\right]^2 \\ S_a = t_b \\ TA = \frac{S_s}{R_T} \\ \tau > 1 \end{cases} \tag{9}$$

From the above Eq. (8) the percentage of the energy are obtained among the average energy for the resources. By considering Eq. (8), the following Eq. (9), is used to reduce the latency A represents the latency, N is the network, P_d is the propagation delay, S_d is denoted as the serialization delay. τ is the length of the network, S_a is the data sent to the network, t_b is the memory based conflicts, where, TA is the required time to transmit the data from one resource to the other in the specific time. $\tau > 1$, R_T denoted as the response time for the initial data that are been transmitted through the network. This states that the network length is greater than 1. By using this equation the latency are been reduced. In Figs. 1(a)–1(c), the membership functions and its normalized fuzzy solutions are represented for latency, energy, and delay respectively.

By taking the above three equations, such as (7)–(9), for the normalization as in the above figures, it states an efficient way for reducing the bandwidth, energy consumption, and latency. The three equations are considered and rewritten as the following format which is shown in Eq. (10).

$$\begin{cases} P = \alpha_{D,L} > \gamma; & Bandwidth \\ Eng = \left[Eng_{avg}\right] * P_r; & EnergyConsumption \\ N_A = T_A * S_s; & Latency \end{cases} \tag{10}$$

By using the above Eq. (10), it overcomes the bandwidth, latency, and energy consumption issues and in the virtual resources when an on-demand user first sent the request to the virtual network, the virtual network search for the resource allocation by seeing the nearer value for the requested query which is either 0 or 1. The 0 value corresponds to the lesser amount of the user request cluster so it allocates the space for the user in this cluster 1.

Cluster 2 is having the value related to the 1, so the objective of this work is to increases the longer connectivity in the network. By doing this process the substrate network has some resource loss. Where the request is given to the virtual network, the reply is not obtained in this case the outage appears in the network. So, the objective is to reduce the outage in the network is done by using the service scheduling method. It makes the user access the resource without any waiting time.

4. Service scheduling

The outage probability is having the lesser data rate from the fixed data rate and the probability of the outage happens in a particular time period. The formula for calculating the total outage probability is expressed in the below Eq. (11). From Eq. (10) the connection longer is obtained and from Eq. (11) the outage are processed for the data. When the virtual resources are far away from the substrate network means the longer connection is not reliable in this case the outage probability is calculated as follows.

$$O_P = \alpha[E_R < \gamma] \tag{11}$$

From the above Eq. (11), it states the probability outage with respect to the error data rate is lesser than the fixed value, in this O_P is denoted as the outage probability, α is the probability, E_R is the error rate for the data. By computing the above equation the longer connectivity and higher data transfer are done through the network. Here, by considering two sets of the virtual network as subordinate sender, receiver, network, and relay. If the subordinate sender and

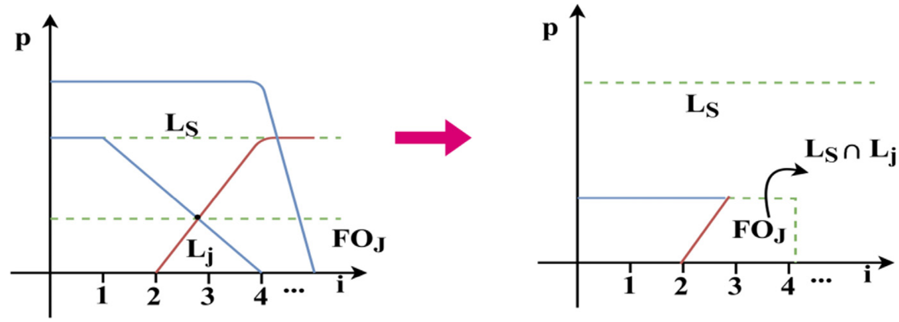

Fig. 1(a). Latency membership and normalization.

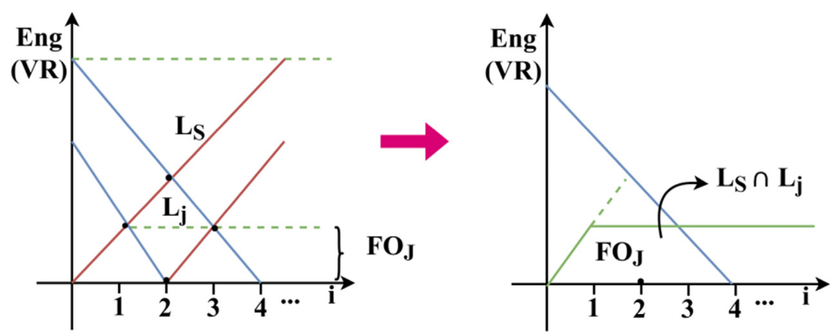

Fig. 1(b). Energy membership and normalization.

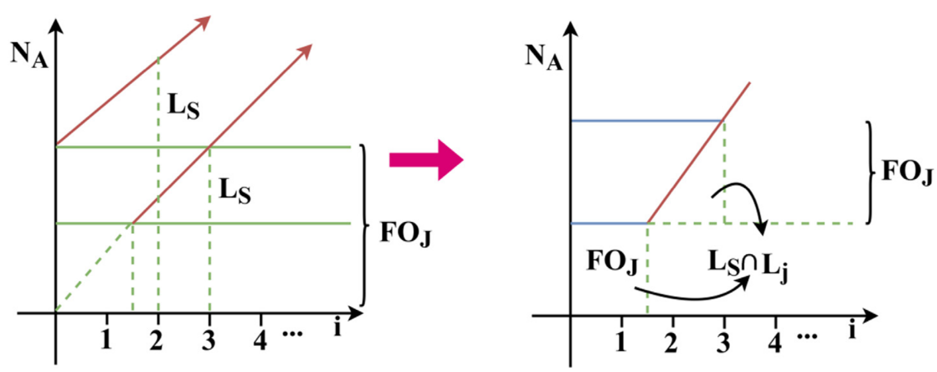

Fig. 1(c). Delay membership and normalization.

relay, subordinate relay and receiver is having a poor connection, then the total output probability is computed in the below Eq. (12).

$$TO_P = \beta\,|\alpha| * \left[\sum_{D=1}^{E_R} V_R\right] * \frac{D_S}{T_S} \tag{12}$$

From Eq. (11), the probability of outage is calculated for the error rate in the data from that it finds the data which are greater or lesser in the error rate. By doing this the final data are carried out for the total outage calculation for that Eq. (12) is used. In this Eq. (12), TO_P Represents the total outage probability, β is denoted as efficiency of the data transmission, D_S is denotes as the distance between the virtual resources. T_S is the total distance between the sender and the receiver network which is computed from Eq. (11). The initial step is when the first virtual network is far from the subordinate network means the receiver and the source and relay network are expressed in the following Eq. (13).

$$D_S = \left(\alpha * \left[D + E_R\right] < \gamma\right) = \frac{\gamma}{\beta} \tag{13}$$

From Eq. (12), the total probability is calculated in such a way the distance between the virtual networks is determined and then the far network are having the outage problem so by using Eq. (13) it finds the distance between the substrate network to reduce the outage. Eq. (13) is updated for every displacement of the network which is used to find the distance. After the distance is determined the scheduling is performed for the user without waiting.

The service scheduling is done by allocating the required service to the user request for the data in the virtual network. When the user request for the minimum data means it first accessed which is carried out in the queue format. So the data rate should be minimized by using the following Eq. (14).

$$M_{E_R} = \begin{cases} V_R * \sum_{D=1}^{D_S} \log_2\left(\frac{\gamma}{K}\right) > U \\ V_R + K \end{cases} \tag{14}$$

From Eq. (13), the near virtual network are find out along with the error data after this the virtual network are opt to reduce the error data so it is obtained by using Eq. (14), $M_{E_R}$is the Maximum error data, when the error data is maximum means the above equation is used in this when the requesting user is having a higher error means the first condition is used or else the second condition is used for the satisfaction of the results. The scheduling is carried out in such a way when the user who first requests for the virtual channel sent the request message to

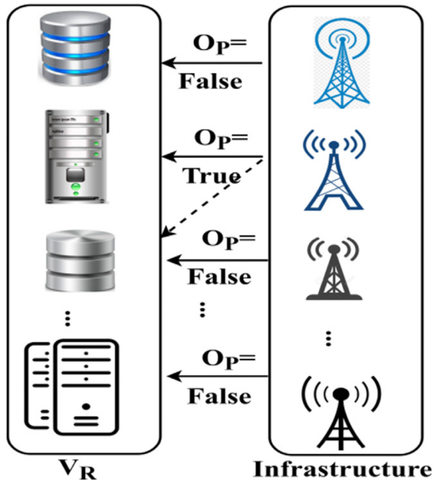

Fig. 2(a). Outage analysis.

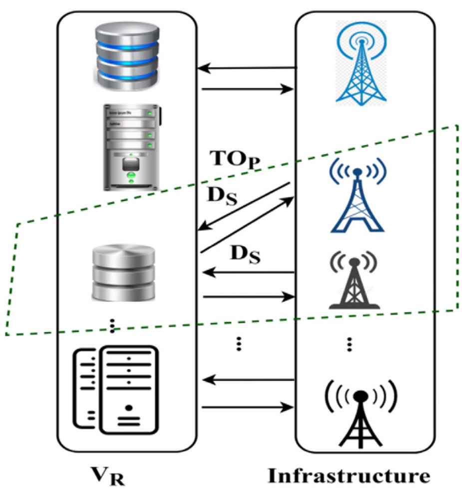

Fig. 2(b). Resource allocation between V_R and infrastructure.

the network. When the network is free to accept the request it allocates the space for the first requested user in the network.

The virtual network sends the acknowledgement to the first user and then the user is granted the required data. All these are done on the specific time interval and the buffering is used to store the data. If there is a U user in the network the first user sends the request and gets the reply are done on a particular time. For the rest of the upcoming users, the first user is set in the queue and processed one by one in the allotted time. The following Eq. (15) is used for this service scheduling.

$$S_H(V_R) = \begin{cases} \left[\left(D_S + FO_J\right) * \left(M_{E_R} + O_P\right)\right], & User1 \\ \left[D_S * O_P\right] + B_F, & User2 \\ \vdots & \\ (O_P + D) + B_F, & UserU \end{cases} \tag{15}$$

From the above Eq. (14), the maximum rate of data is computed and from that computed data the scheduling is done by using Eq. (15). In Figs. 2(a)–2(c) the scheduling process is illustrated.

It works when the first user request for the service in the network means the first condition is used. Then, the second user request for the service is stored in the buffer which is denoted as B_F. For all the U users the service is been scheduled in such a way. The buffer is associated with a certain time period.

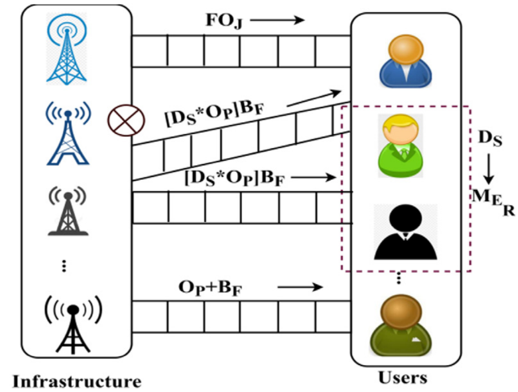

Fig. 2(c). Scheduling resources between infrastructure and users.

Table 1
Simulation parameter and table value.

Simulation parameter	Value
Operating frequency	6–8 GHz
Nodes	200
Resource server	8
Server rate	20 responses/unit time
Transmission power	40 W (max)
Resource size	8 × 2 TB
Maximum failure time	480 ms

By evaluating the above Eq. (15), the U number of a user is accessing the data based on the service schedule. By doing this the present user and upcoming user accessing the resources in the network does not require additional waiting time. If the waiting time is reduced then the outage is also reduced and they are having the longer connectivity and high data transfer.

5. Results and discussion

This section discusses the performance assessment of the proposed AVMPNEA with the existing methods namely PGU-ADP [20], RTRLF + GMB [25], and RA-CS [23]. This assessment is performed as a comparative study by considering the metrics throughput, outage, energy efficiency and latency for the varying nodes and resource utilization. For the above assessment, the simulations are modelled using MATLB simulator. The network consists of 200 nodes connected through 6–8 GHz wireless links. The resources of size 2 TB each is distributed through 14 infrastructure units. The resources are held with 8 serves out of which 5 is replicated. In Table 1, simulation environment and its related parameters are presented.

6. Throughput analysis

In Figs. 3(a) and 3(b), the comparison of throughput with respect to the users and resource utilization is presented. The allocation of high network resources helps to achieve better resource utilization. The fuzzy C-means clustering operates between the initial objective and optimized objective of varying data rates.

This is achieved by assigning appropriate scheduling slots for resource exchange between the users/nodes and service providers. The specific identification of L_j from L_S helps to achieve better solutions for resource virtualization, and longevity. This is retained simultaneously for the growing users and resource utilization rate, achieving high throughput. The partition matrix is used for generating appropriate D_f for the clusters formed, for augmenting shared data flows between the resource and users, increasing the throughput.

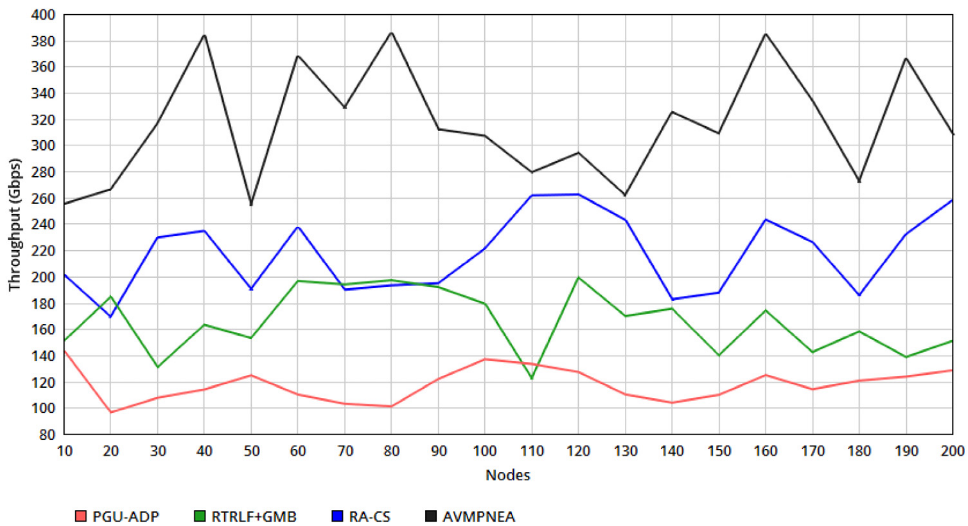

Fig. 3(a). Throughput versus nodes.

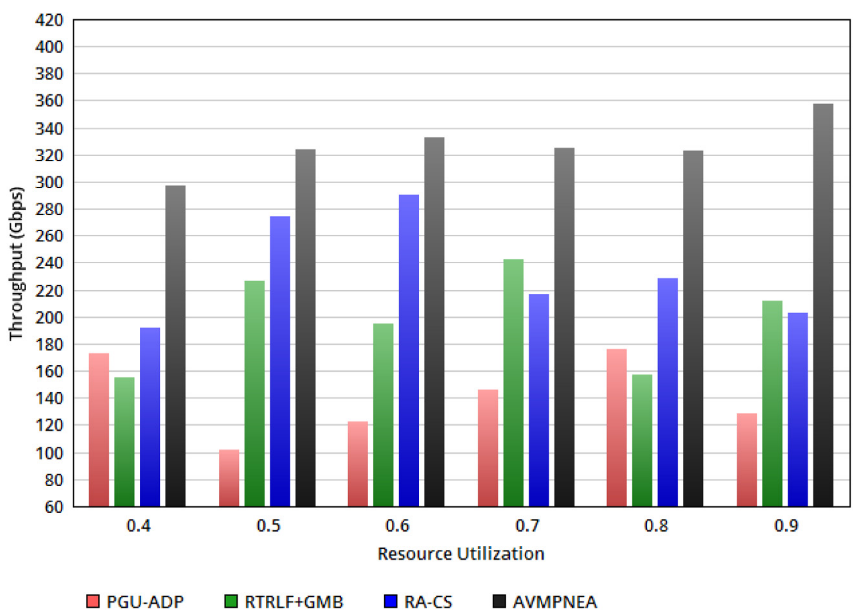

Fig. 3(b). Throughput versus resource utilization.

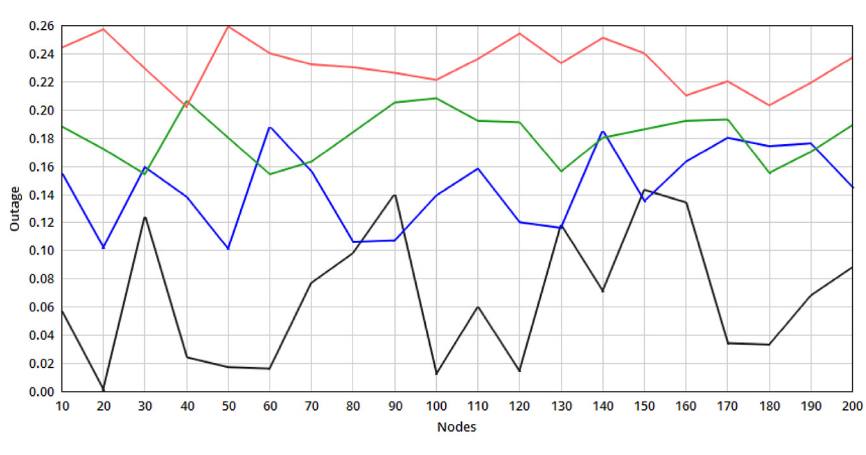

Fig. 4(a). Outage versus nodes.

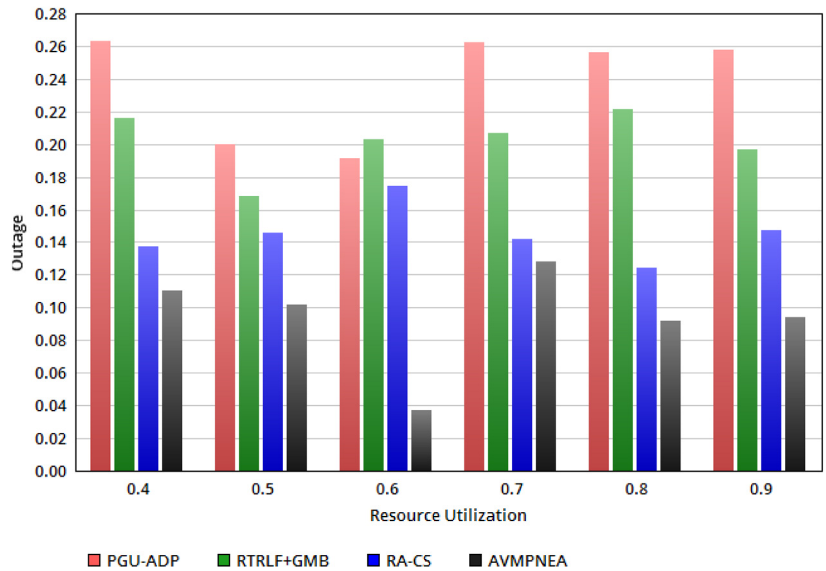

Fig. 4(b). Outage versus resource utilization.

7. Outage analysis

The objective of the proposed method is to maximize the data membership function by reducing the outage. Outage is reduced in two ways namely, through precise selection of mapping infrastructures on the basis of $[M_U]_{D,L}$ and scheduling V_R. In the first process, the data point and other constraints such as energy and latency are accounted for maximizing resource replications such that access is provided for all nodes within its maximum active time period. Secondly, the scheduling of the resources increases the longevity irrespective of the outage resources, reducing its impact over the network performance. Above all these, energy efficiency in data sharing and time-dependent resource allocations and frequent validity check helps to reduce the outage, as obtained through L_J and L_S of the fuzzy process [Refer Figs. 4(a) and 4(b)]. This process of scheduling is some for any number of users and service utilization.

8. Energy efficiency

The rate of energy efficiency per resource allocation over the varying user density and resource utilization is not even. This is due to the impact of availability and allocation of resources. In the proposed method, Eng is modelled independently based on bandwidth and latency based allocations as in Eq. (10). The allocated resource experiences an energy utilization for the users as in Eq. (8) for which the required FO_J for D_f is estimated. Depending on the D_f, the allocation and scheduling process is defined wherein D_s is divided between the nodes as in Eq. (14). As the rate of data dissemination flow is retained (without Outage) and the number of iterations help to identify the more optimal D_f. These two constructive features improve the energy efficiency by conserving the rate of utilization in $P > N_A$ conditions. For both varying users (as per latency), and resource utilization (as per bandwidth), D_f is estimated using the fuzzy membership process [Refer Figs. 5(a) and 5(b)].

9. Latency analysis

Figs. 6(a) and 6(b) presents the latency comparison for the varying nodes and resource utilization. The initial latency is as computed using Eq. (7) whereas based on FO_J, the latency is concealed with propagation and serialization as in Eq. (9). This normalization follows the constraints such as $\tau > 1$, where $\tau = \left[\frac{S_a}{TA}\right]^2$ is the maximum applicable range for latency estimation. This range is selected as the maximum resource utilization for the virtualized V_R by conceding all the considered parameters of bandwidth, energy and latency. Besides the slots allocation of resources to the nodes follows both shared and individual slots as in Eqs. (14) and (15) depending on the range of nodes/users. Therefore, overlapping of resources/scheduled slots due to high availability/outage is suppressed for $\tau \in \left[1, \left(\frac{S_a}{TA}\right)^2\right]$. This helps to retain the propagation delay with respect to the resource availability, achieving less latency.

Table 2
Comparison with respect to varying nodes.

Metrics	PGU-ADP	RTRLF-GMB	RA-CS	AVMPINEA
Throughput (Gbps)	128.44	150.93	258.25	308.54
Outage	0.237	0.189	0.145	0.088
Resource utilization	0.786	0.812	0.87	0.902
Energy efficiency	0.104	0.145	0.277	0.337
Latency (ms)	283.509	221.776	221.862	130.634

10. Resource utilization

In the proposed method, service related parameters such as bandwidth, energy and latency are defined on the basis of objective function. With the help of individual membership function and its normalization [32], appropriate factor (i.e.) latency and energy for concurrent access, latency and bandwidth for varying user density are accounted. This now forms as a normalized optimization using the membership functions of C-means Clustering. The objective defines L_S based on either of the above mentioned parameters, from which L_J for the different D_f is obtained as joint $L_J \cap L_S$ process [33]. Instead, the slot allocation for resource utilization is prompted without overlapping or latency concentric backlogs aiding better resource utilization [Fig. 7]. In Tables 2 and 3, the above discussions are compared with respect to the varying nodes and resource utilization factor.

From the above tables it is clear that the proposed method achieves fair performance with respect to the varying nodes and resource utilization rate [34]. In the proposed method, resource utilization is significantly increased using optimal allocation of scheduled slots and outage mitigation.

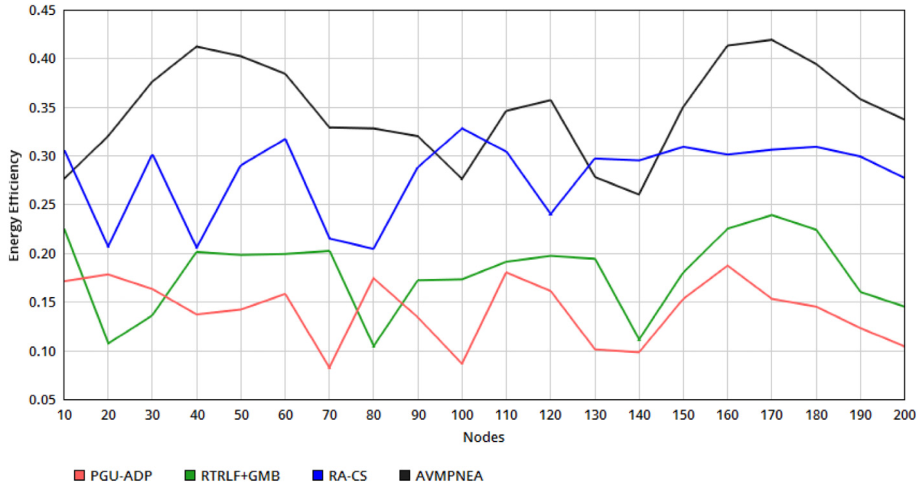

Fig. 5(a). Energy efficiency versus nodes.

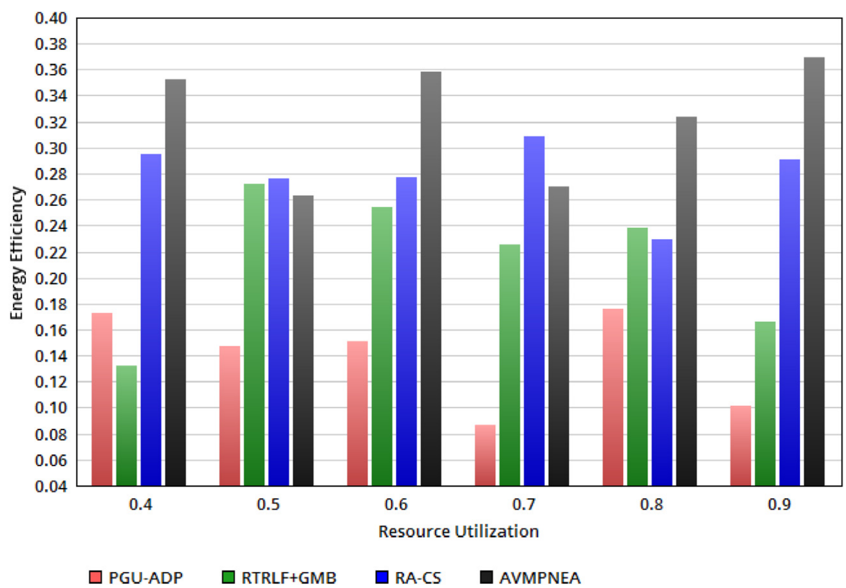

Fig. 5(b). Energy efficiency versus resource utilization.

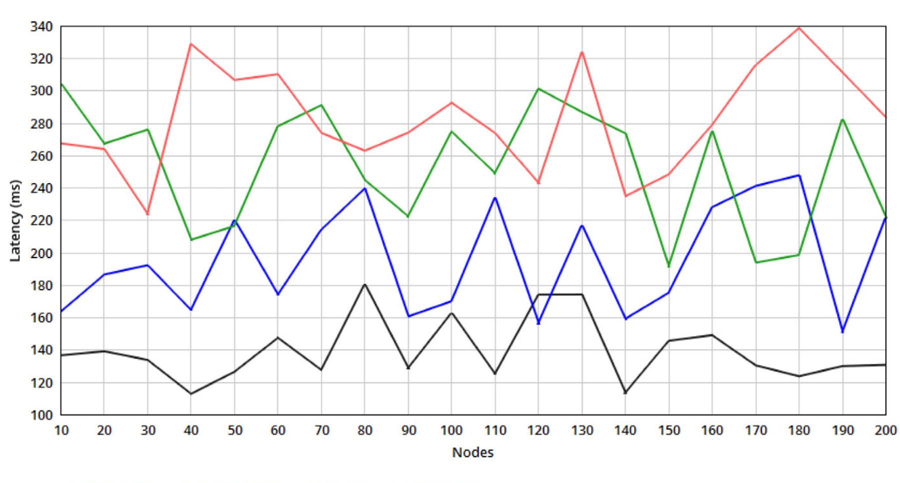

Fig. 6(a). Latency versus nodes.

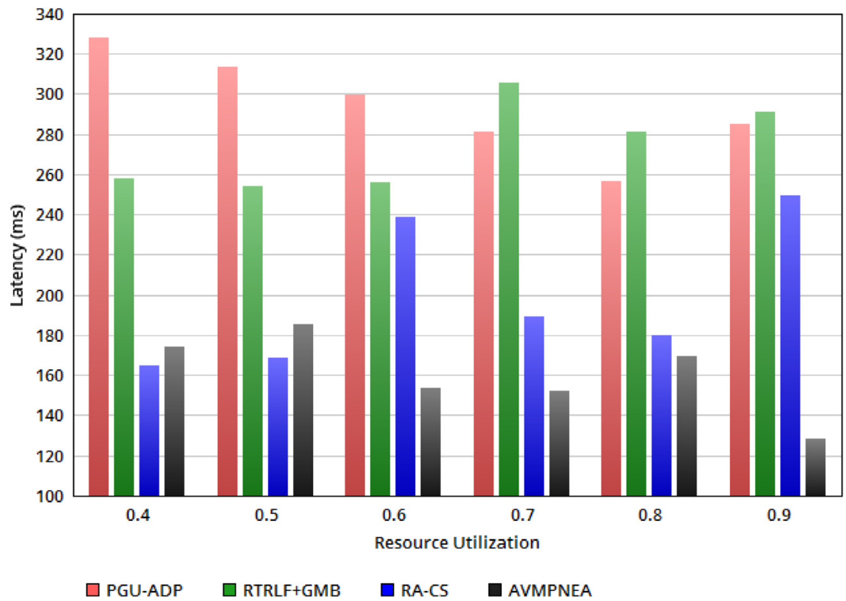

Fig. 6(b). Latency versus resource allocation.

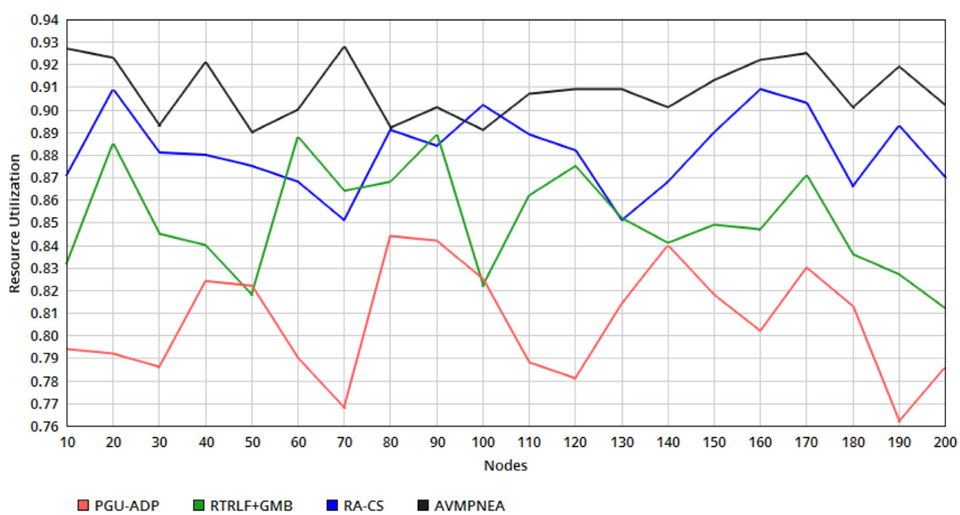

Fig. 7. Resource utilization versus nodes.

Table 3
Comparison with respect to resource utilization.

Metrics	PGU-ADP	RTRLF-GMB	RA-CS	AVMPINEA
Throughput (Gbps)	128.187	211.454	202.994	357.446
Outage	0.258	0.197	0.147	0.094
Energy efficiency	0.101	0.166	0.291	0.369
Latency (ms)	284.849	290.979	249.578	128.139

11. Conclusion

This paper presents advanced virtual multi-purpose network embedding algorithm for improving the service related performance of 6G users. In particular, the problem of outage in the virtualized resource access is addressed based on the independent parameters such as bandwidth, latency, and energy of the embedding network. The appropriate embedding is performed using fuzzy c-means clustering by defining independent membership functions for the considered parameters. Based on this embedding process, longevity of the resources is achieved through appropriate scheduling and node assignment to the resources. The proposed algorithm is effective in achieving better throughput, less outage and latency, and better energy efficiency for the varying nodes and resource utilization rate.

CRediT authorship contribution statement

Aldosary Saad: Conceptualization, Data curation, Formal analysis. **Mohammed Al-Ma'aitah:** Writing - original draft, Writing - review & editing. **Ayed Alwadain:** Investigation, Methodology, Validation, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] T. Huang, W. Yang, J. Wu, J. Ma, X. Zhang, D. Zhang, A survey on green 6G network: Architecture and technologies, IEEE Access 7 (2019) 175758–175768.

[2] T.S. Rappaport, Y. Xing, O. Kanhere, S. Ju, A. Madanayake, S. Mandal, A. Alkhateeb, G.C. Trichopoulos, Wireless communications and applications above 100 GHz: Opportunities and challenges for 6G and beyond, IEEE Access 7 (2019) 78729–78757.

[3] W.U. Khan, F. Jameel, M.A. Jamshed, H. Pervaiz, S. Khan, J. Liu, Efficient power allocation for NOMA-enabled IoT networks in 6G era, Phys. Commun. 39 (2020) 101043.

[4] J.-H. Zhang, P. Tang, L. Yu, T. Jiang, L. Tian, Channel measurements and models for 6G: current status and future outlook, Front. Inf. Technol. Electron. Eng. 21 (1) (2020) 39–61.

[5] S. Baskar, P.M. Shakeel, R. Kumar, M.A. Burhanuddin, R. Sampath, A dynamic and interoperable communication framework for controlling the operations of wearable sensors in smart healthcare applications, Comput. Commun. 149 (2020) 17–26.

[6] A. Rahim, K. Ma, W. Zhao, A. Tolba, Z. Al-Makhadmeh, F. Xia, Cooperative data forwarding based on crowdsourcing in vehicular social networks, Pervasive Mobile Comput. 51 (2018) 43–55.

[7] H. Fouad, M.N. Mahmoud, M.S. El Issawi, H. Al-Feel, Distributed and scalable computing framework for improving request processing of wearable IoT assisted medical sensors on pervasive computing system, Comput. Commun. (2020).

[8] J. Lai, J. Tian, R. Liu, Z. Yang, D. Jiang, A hybrid virtualization approach to emulate network nodes of heterogeneous architectures, Mob. Netw. Appl. (2020).

[9] X. Bai, I. Lee, Z. Ning, A. Tolba, F. Xia, The role of positive and negative citations in scientific evaluation, IEEE Access 5 (2017) 17607–17617.

[10] H. Fouad, A.S. Hassanein, A.M. Soliman, H. Al-Feel, Analyzing patient health information based on IoT sensor with AI for improving patient assistance in the future direction, Measurement (2020) 107757.

[11] Y. Zong, Y. Ou, A. Hammad, K. Kondepu, R. Nejabati, D. Simeonidou, Y. Liu, L. Guo, Location-aware energy efficient virtual network embedding in software-defined optical data center networks, J. Opt. Commun. Netw. 10 (7) (2018).

[12] J. Zhang, B. Xu, J. Liu, A. Tolba, Z. Al-Makhadmeh, F. Xia, PePSI: Personalized prediction of scholars' impact in heterogeneous temporal academic networks, IEEE Access 6 (2018) 55661–55672.

[13] A. Abdulmonem, W. Awwad, K. Bakarman, H. Fouad, N.M. Mahmoud, Magnetic resonance imaging evaluation of vertebral tumor prediction using hierarchical hidden Markov random field model on Internet of Medical Things (IOMT) platform, Measurement (2020) 107772.

[14] A.R. Gularte, O.M. Mendizabal, R.M. Barbosa, D.F. Adamatti, Node and link allocation in network virtualization based on distributed constraint optimization, J. Netw. Syst. Manage. 26 (1) (2017) 127–146.

[15] D.-T. Do, M.-S.V. Nguyen, Outage probability and ergodic capacity analysis of uplink NOMA cellular network with and without interference from D2D pair, Phys. Commun. 37 (2019) 100898.

[16] A. Paul, S.P. Maity, On outage minimization in cognitive radio networks through routing and power control, Wirel. Pers. Commun. 98 (1) (2017) 251–269.

[17] P.S.F. Sheron, K.P. Sridhar, S. Baskar, P.M. Shakeel, A decentralized scalable security framework for end-to-end authentication of future IoT communication, Trans. Emerg. Telecommun. Technol. (2019) e3815, http://dx.doi.org/10.1002/ett.3815.

[18] M.M. Selim, M. Rihan, Y. Yang, L. Huang, Z. Quan, J. Ma, On the outage probability and power control of D2D underlaying NOMA UAV-assisted networks, IEEE Access 7 (2019) 16525–16536.

[19] T. Wang, J. Si, Z. Li, J. Cheng, A Markov chain-based secrecy outage probability analysis of a full-duplex relay network, IEEE Wirel. Commun. Lett. 8 (6) (2019) 1718–1721.

[20] L. Tang, Q. Tan, Y. Shi, C. Wang, Q. Chen, Adaptive virtual resource allocation in 5G network slicing using constrained Markov decision process, IEEE Access 6 (2018) 61184–61195.

[21] F. Alvarez, D. Breitgand, D. Griffin, P. Andriani, S. Rizou, N. Zioulis, F. Moscatelli, J. Serrano, M. Keltsch, P. Trakadas, T.K. Phan, A. Weit, U. Acar, O. Prieto, F. Iadanza, G. Carrozzo, H. Koumaras, D. Zarpalas, D. Jimenez, An edge-to-cloud virtualized multimedia service platform for 5G networks, IEEE Trans. Broadcast. 65 (2) (2019) 369–380.

[22] M. Bagaa, T. Taleb, A. Laghrissi, A. Ksentini, H. Flinck, Coalitional game for the creation of efficient virtual core network slices in 5G mobile systems, IEEE J. Sel. Areas Commun. 36 (3) (2018) 469–484.

[23] H. Halabian, Distributed resource allocation optimization in 5G virtualized networks, IEEE J. Sel. Areas Commun. 37 (3) (2019) 627–642.

[24] H. Jin, H. Lu, Y. Jin, C. Zhao, IVCN: Information-centric network slicing optimization based on NFV in fog-enabled RAN, IEEE Access 7 (2019) 69667–69686.

[25] Z. Gu, J. Zhang, Y. Ji, L. Bai, X. Sun, Network topology reconfiguration for FSO-based fronthaul/backhaul in 5G wireless networks, IEEE Access 6 (2018) 69426–69437.

[26] M.P. Anastasopoulos, A. Tzanakaki, D. Simeonidou, Scalable service chaining in MEC-assisted 5G networks, J. Lightwave Technol. 37 (16) (2019) 4115–4124.

[27] A. Betzler, D. Camps-Mur, E. Garcia-Villegas, I. Demirkol, J.J. Aleixendri, SODALITE: SDN wireless backhauling for dense 4G/5G small cell networks, IEEE Trans. Netw. Serv. Manag. 16 (4) (2019) 1709–1723.

[28] Y. Alsaba, S.K.A. Rahim, C.Y. Leow, M.B. Majed, On the outage probability of large scale decode-and-forward relay wireless networks, AEU-Int. J. Electron. Commun. 97 (2018) 120–129.

[29] L. Xu, J. Wang, Y. Liu, J. Yang, W. Shi, T.A. Gulliver, Outage performance for IDF relaying mobile cooperative networks, in: Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 5G for Future Wireless Networks, 2017, pp. 395–402.

[30] F.A.P.D. Figueiredo, X. Jiao, W. Liu, I. Moerman, Radio hardware virtualization for software-defined wireless networks, Wirel. Pers. Commun. 100 (1) (2018) 113–126.

[31] H. Dai, K. Song, C. Li, Y. Huang, L. Yang, Resource allocation for outage performance in heterogeneous networks: a matching game approach, Wirel. Netw. 24 (6) (2017) 1873–1883.

[32] N.L. Venkataraman, R. Kumar, P.M. Shakeel, Ant lion optimized bufferless routing in the design of low power application specific network on chip, Circuits Systems Signal Process. 39 (2) (2020) 961–976.

[33] P. Han, Y. Liu, L. Guo, QoS satisfaction aware and network reconfiguration enabled resource allocation for virtual network embedding in fiber-wireless access network, Comput. Netw. 143 (2018) 30–48.

[34] Q. Wen, B. Hu, L. Zheng, Outage-constrained device-to-device links reuse maximization and its application in platooning, IEEE Wirel. Commun. Lett. 8 (6) (2019) 1635–1638.