QoS Enhancement in Wireless Ad Hoc Networks Using Resource Commutable Clustering and Scheduling

S. Shitharth[1,2], Hariprasath Manoharan[3] , Rakan A. Alsowail[4] , Achyut Shankar[5] Saravanan Pandiaraj[6] , Carsten Maple[7]

[1*] Department of Computer Science, Kebri Dehar University, Kebri Dehar, Ethiopia

[2] School of Built Environment, Engineering and Computing, Leeds Beckett University, LS1 3HE Leeds, U.K.

[3]Department of Electronics and Communication Engineering, Panimalar Engineering College, Poonamallee-600 123, Tamil Nadu, Chennai, India

[4] Computer Skills, Self-Development Skills Department, Deanship of Common First Year, King Saud University, 11362, Riyadh, Saudi Arabia

[5] WMG, University of Warwick, United Kingdom

[6] Computer Skills, Self-Development Skills Department, Deanship of Common First Year, King Saud University, 11362, Riyadh, Saudi Arabia

[7] Secure Cyber Systems Research Group (SCSRG), WMG, University of Warwick, Coventry, UK

[*]Corresponding author – shitharths@kdu.edu.et

Abstract

Effective management and control of large-scale networks can be challenging in the absence of appropriate resource allocation. This paper presents a framework for highlighting the significance of resource allocation in mobile, wireless, and ad hoc networks. The model has been designed to incorporate a clustering protocol and a schedule-based resource allocation algorithm, resulting in the establishment of a multi-objective framework. The proposed framework places a significant emphasis on the allocation of energy and distance, with a focus on minimizing these objectives. Each node is separated into several clusters where individual energy is allocated and the cluster head in each cluster allows the nodes to communication with shortest distance. For the transmitted information the speed of transmission is maximized thus more amount of time period is saved where stability factor is maximized. To test the allocated resources in the network the proposed method compares and evaluates the parametric outcomes with existing method based on five scenarios. In the comparative analysis it is observed that proposed method can able to maximize the life time and quality of service for all networks with optimized range of 84 percent.

Keywords: Resource allocation; Wireless and Ad hoc networks; Life time; Quality of service; Clusters

1. Introduction

The significance of mobile, wireless, and ad hoc networks has experienced a swift escalation in tandem with advancements in communication technologies. Consequently, there exists a pressing requirement to effectively allocate resources to ensure optimal network performance. Furthermore, it is imperative to raise awareness regarding ad hoc networks, which operate in a decentralized mode, necessitating regular monitoring of resource allocation. In wireless mode of operation, users are permitted to transmit information in a distributed manner, necessitating the maintenance of a distinct protocol for distributed networks. The proposed methodology involves the implementation of a clustering protocol, which entails the formulation of a set of rules for the allocation of resources to each cluster in an optimal manner. If a channel experiences instability, it is possible to allocate its resources to other transmitting channels during the designated time frame [1]. The aforementioned allocation of resources is only feasible in actuality when the nodes are situated within distinct clusters. The implementation of such allocations results in the clustered network's ability to sustain a consistent stability factor, which subsequently enhances the quality of service in mobile, wireless, and ad hoc networks. Given the self-organizing capabilities of nodes in ad hoc networks, it is imperative that resource deployment occurs in a uniform manner, free from any external factors that may cause disruption. The proposed method incorporates a schedule-based transmission, which effectively integrates the organization and maintenance of nodes, thereby preventing collisions among them.

The schematic diagram presented in Figure 1 illustrates the allocation of resources to different networks. The schematic representation in Figure 1 illustrates the correlation between time and speed factor as crucial parameters for resource allocation prior to clustering a specific network. During the initial phase, channels and sub-channels are allocated using a clustering procedure that relies on an individual weight mechanism. Upon clustering the nodes, in the event that the information is below the standard threshold value, resource optimization is implemented within the network. The outcome of the optimization process yields the distribution of lower energy sources among all clustered networks, thereby enabling the nodes to select the most efficient transmission route. After selecting the shortest path, the node establishes a connection with the task receiver to enhance operational efficiency within the designated time frame, ultimately optimizing the network's lifespan. The completion of tasks within a shorter time frame leads to the attainment of maximum stability factor at a reduced cost.

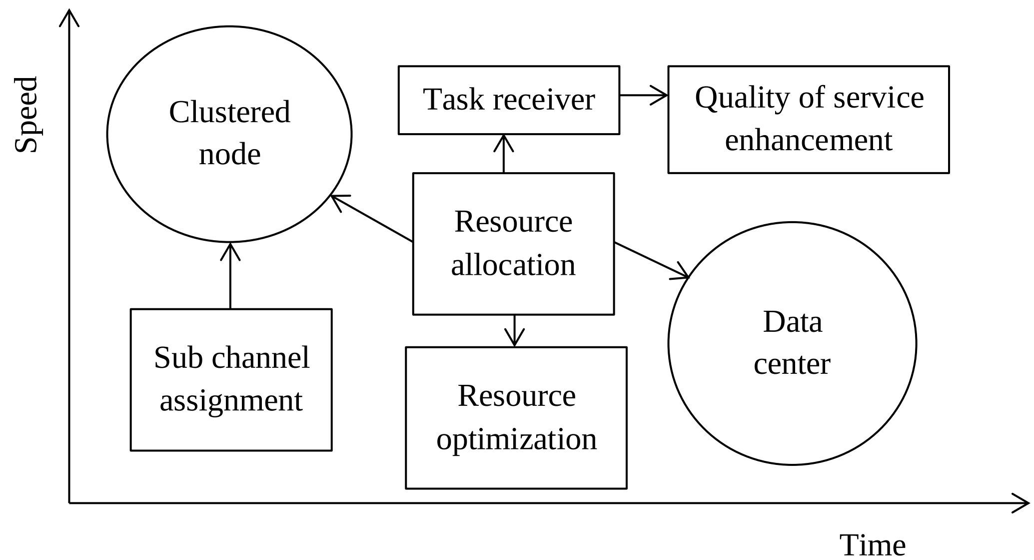

Figure 1 Schematic representation of resource allocation

1.1 Background and related works

This section presents a comparative analysis of prior works that elucidate the significance of resource allocation in wireless and ad hoc networks. The aim is to evaluate the quantum of resources allocated in earlier instances. The extant literature underscores the significance of optimizing the performance of wireless and ad hoc networks through the appropriate allocation of resources. The operation of low-cost mobile ad hoc networks is discussed in [1], wherein a two-tuple procedure is employed for resource allocation through a two-step process. In cases where resource allocation involves a two-step process, it is necessary to establish optimal settings and control procedures for each node involved. Consequently, each node functions autonomously without adequate configuration, and the architecture remains in a state of flux. Therefore, it is imperative to effectively manage all mobile terminals, even in dynamic environments [2]. Such management procedures are typically implemented in wireless ad hoc networks, as opposed to mobile ad hoc networks. In the course of managing multiple resource parameters, it has been noted that several communication fields associated with wireless mode of operation yield an average resource unit. However, a significant limitation arises from the fact that numerous nodes are required to function with restricted energy due to the average consumption of resources, resulting in a challenge to attain the anticipated packet delivery ratio. To attain the anticipated ratio for each assigned resource, a load distribution mechanism is implemented, wherein each node is organized based on its respective weight factor [3]. A time distribution mechanism is employed to allocate separate loads, involving multiple agents in the process and distributing resources to all agents. In the event of an unforeseen increase in the number of agents, it may be necessary to incorporate a network manager mode of operation utilizing deep reinforcement techniques, resulting in an associated increase in cost.

The introduction of heterogeneous mode of operation leads to the definition of routing protocols that result in highly reduced resources due to the transmission of shortest path, as stated in reference [4]. The determination of the shortest path is contingent upon the nature of the data and is typically restricted to ad hoc networks. It has been observed that wireless networks exhibit greater stability when shortest path transmissions involve clustering nodes. The aforementioned procedure involves the determination of the round trip time period, which serves to indicate the status of each node within the specified limits. Furthermore, external weight factors are evaluated in each clustered path, thereby enhancing the network's longevity. The aforementioned methodology is implemented and trials are carried out within cognitive settings wherein there is a heightened requirement for clustered networks [5]. The increase in demand has resulted in a need for high resource allocation in many nodes, necessitating the integration of an energy-aware protocol to prevent this. One of the primary challenges in cognitive radio networks pertains to the requirement for heterogeneity to be present in all radio resources, which can be a particularly arduous condition to fulfill. In addition to the discrete mobile and ad hoc operations, it is imperative to evaluate the collective impact of mobile ad hoc networks in a decentralized mode of operation, as stated in reference [6]. In decentralized mode, each sensor node necessitates a greater quantity of information to be transmitted, albeit with reduced security features. Insufficient security measures have led to a significant impact on the nodes, resulting in the loss of information for each node. Consequently, additional resources are required to allocate for the affected nodes. If resources are allocated for future use, it may not be optimal to configure each node with the same operating principle, as doing so could result in the loss of allocated resources. The allocation of resources in real-time environments for mobile, wireless, and ad hoc networks is a multifactorial process.

Moreover, a significant number of researchers have demonstrated enhanced performance through the integration of cognitive, mobile, and ad hoc networks [7], utilizing a dominant clustering principle. The dominant clustering principle entails a dynamic channel selection process whereby high resources are allocated exclusively to dominant nodes for transmission purposes. However, if resources are allocated in this manner, weak nodes may fail to establish adequate connections with other nodes, resulting in an insignificant cost factor. A stochastic model has been introduced to enhance the operational capabilities of the network, resulting in an increased network lifespan [8]. On the other hand, if the longevity of the network is optimized, there is a notable enhancement in the delivery ratio of packets. The aforementioned parameters of maximization facilitate the development of eco-friendly wireless networks that aim to minimize bit error rates. Furthermore, in cases where the path of wireless networks diverges, the issue of node failure is observed in each clustered network, as stated in reference [9]. As a result of an unexpected alteration in node paths, a multi-objective path planning algorithm has been chosen that incorporates dynamic energy consumption. The integration of a grid-based approach is implemented to enhance the performance of operating nodes in response to dynamic energy consumption. However, this dynamic configuration results in regeneration rates that are 2.5 percent higher than those observed under normal operating conditions. It has been observed that certain predetermined techniques employ a renewable energy model for clustered nodes, resulting in significantly faster operational speeds [10].

Table 1 Existing vs Proposed

Reference	**Type of Algorithm/ Method/ Protocol**	**Main Characteristics**	**A**	**B**	**C**	**D**
[11]	Vehicular ad hoc protocol	Verification of clustering properties		✓	✓	
[12]	Intelligent cluster based flying networks	Transmission of information using Euclidian distance	✓			✓
[13]	Energy efficient protocol with network coding	Network coding scheme for management procedures	✓	✓		
[14]	Stable clustering algorithm	Backup node scheme for mobile ad hoc networks	✓	✓	✓	
[15]	Multilayer clustering	Micro electrical mechanic systems with low energy consumption		✓		✓
[16]	Deep Q networks	Reduction of link breakages using flying ad hoc networks	✓		✓	
[17]	Adaptive resource allocation	Incorporation of multiple servers with steady state probabilities	✓	✓		
[18]	Yellow saddle goldfish algorithm	Maximization of stability period in ad hoc networks		✓		✓
Proposed	Clustering protocol and schedule based resource allocation algorithm	Enhanced quality of service with multiple reward functions in mobile, wireless and ad hoc networks	✓	✓	✓	✓

A: Distance and energy minimization; B: Maximization of stability; C: Clustered network life time; D: Quality of service

Nonetheless, the employment of the aforementioned renewable setup results in certain nodes experiencing failure. Specifically, when operating at a 70 percent duty cycle, these nodes persist in an irregular state that cannot be altered at any point in time. Table 1 presents supplementary details regarding pertinent literature on resource allocation in mobile, wireless, and ad hoc networks.

1.2 Research gap and motivation

Although the majority of researchers have focused on investigating the impact of resource allocation in mobile, wireless, and ad hoc networks, it has been observed that the effect of such allocation can vary depending on whether the data transmission process is stable or unstable. Furthermore, certain techniques [19,20] distribute resources to ad hoc networks according to priority, without adequately maintaining equal load conditions. The primary deficiency identified in current methodologies pertains to load conditions, wherein a distinct clustering technique is not consistently employed. The mathematical methodologies employed are not characterized by densely packed clusters, resulting in fluctuations in the energy of each packet occurring at irregular intervals.

Therefore, in order to address the deficiency observed in current methodologies, a novel approach has been introduced that employs a clustering protocol to allocate resources to mobile, wireless, and ad hoc networks. The energy constraint in all systems is addressed through the minimization of energy consumption of nodes and transmission distance. This is achieved by ensuring that every node transmits data without any wastage of allocated resources, while following the shortest path. The maximization of data transmission speed results in the attainment of stability factor for each clustered network within a reduced time frame. Furthermore, the clusters have been optimized through the implementation of equal space allocation. This allows for the transmission of each packet to occur according to a distinct schedule, which is facilitated by the use of the Schedule based Resource Allocation (SRA) algorithm.

1.3 Contributions of proposed work

The major contributions of proposed method is based on solving resource allocation problem for mobile, wireless and ad hoc networks by establishing the parametric conditions as follows,

- To minimize the energy of clustered networks where each node operates with equal load conditions.
- To maximize the stability factor of each node by establishing flexibility conditions.
- To maximize the life time of networks thereby increasing the quality of service at each cluster.

1.4 Structure

The rest of the paper is organized as follows, Section 2 describes the analytical model of proposed method where the parametric model is based on resource allocation conditions. Section 3 provides a rule based system with clustering protocol and schedule based algorithm. Section 4 provides real time simulation outcomes based on objective functions. Finally, Section 5 concludes the paper with directions on future work.

2. Proposed system model

Appropriate allocation of resources for mobile radio and ad hoc networks necessitates the definition of threshold levels in a suitable manner. Therefore, it is imperative to develop a distinct system model that pertains to energy, bandwidth, and other relevant parameters to uphold threshold values. Thus, this section presents a mathematical model for resource allocation that enables easier control of topology variations. Furthermore, the suggested parametric equivalences exhibit significant utility in the evaluation of allocated resources within mobile, wireless, and ad hoc networks. The proposed system model is founded on the utilisation of clustering technique, thereby enabling the construction of the system model for diverse nodes within the system. The aforementioned segregation is typically executed in order to mitigate the proliferation of redundant nodes that engender inefficient resource consumption. Equation (1) can be utilized to formulate the energy representation of clustered nodes in mobile, wireless, and ad hoc networks.

$$E_i = min \sum_{i,j=1}^{n} \frac{\vartheta_{ij}}{N_{pn} \times (P_{e1} + .. + P_{ei})} \quad (1)$$

Where,

ϑ_{ij} indicates enduring energy of allocated cluster nodes

N_{pn} denotes total energy of cluster

$P_{e1} + .. + P_{ei}$ describes individual packet energy

Equation (1) denotes the function of minimizing resources for each clustered packet. Hence, it is imperative that the amount of data contained within a clustered node is transmitted to the designated user in the shortest possible time frame, as denoted by Equation (2) below.

$$T_i = min \sum_{i,j=1}^{n} \frac{(B_{a1} + .. B_{an})}{nodes_{ij}} \quad (2)$$

Where,

$B_{a1} + .. B_{an}$ represents bandwidth of active nodes

$nodes_{ij}$ indicates total number of nodes including sleep and idle

The second objective function, represented by Equation (2), adopts a minimization criterion and serves to ensure that the resource allocation systems in the clustered network do not consume excessive amounts of energy. Specifically, this objective function mandates the removal of both sleep and idle nodes from the system. Equation (3) is utilized to denote the transmission distance for the assigned bandwidth.

$$distance_i = min \sum_{i=1}^{n} \frac{cluster_a}{T_A + T_i + T_s} \quad (3)$$

Where,

$cluster_a$ indicates distance of allocated bandwidth to a particular cluster

$T_i + T_s$ denotes summation of idle and sleep time periods

For the abovementioned distance measurement the cluster nodes must remain stable throughout the process. Hence the stability function can be formulated using Equation (4) as follows,

$$SF_i = max \sum_{i,j=1}^{n} \frac{mobility_j}{\tau_{in}} \quad (4)$$

Where,

$mobility_j$ represents the flexibility correlation of node *j*

τ_{in} denotes the adjoining nodes of *j*

Equation (4) delineates the maximized objective function, wherein stable conditions are attained for both the original and neighboring nodes. In practical scenarios, such as civil aviation and military operations, the determination of a stable state for resource allocation is contingent upon an assessment of gearbox velocity. The velocity at which data is transmitted through assigned resources can be denoted as follows.

$$speed_d = max \sum_{i,j=1}^{n} \frac{SN_j}{SN_1 + .. + SN_i} \quad (5)$$

Where,

SN_j indicates speed of selected nodes

$SN_1 + .. + SN_i$ denotes total speed of all nodes

The attainment of optimal stability in mobile, wireless, and ad hoc networks can be facilitated by appropriate allocation of resources, provided that the condition for separation as expressed in Equation (5) is met. If the distance between nodes is at its maximum, it can result in a decrease in the speed of data transfer. Therefore, in order to uphold a high-speed transfer allowance, tasks are implemented as denoted in Equation (6).

$$Task_i = \sum_{i=1}^{n} (\alpha_1 + .. + \alpha_i) \times speed_d \quad (6)$$

Where,

$\alpha_1 + .. + \alpha_i$ denotes task functions of clustered nodes

Upon completion of the task, the lifetime of the network is determined, assuming that resources at the receiving end remain unchanged. Therefore, the duration for which resources are allocated can be determined by utilizing Equation (7).

$$LT_i = max \sum_{i=1}^{n} \frac{U_r \times (c_t + E_i)}{G_d(i)} \quad (7)$$

Where,

U_r indicates utilization rate of resources

c_t represents total time for a node to remain at collision state

$G_d(i)$ denotes data generation values

The proposed method's overall objective function is expressed as a minimization of the maximum criteria. The allocation of resources to mobile, wireless, and ad hoc networks is contingent upon the fulfillment of the objective functions.

$$obj_1 = min \sum_{i=1}^{n} E_i , T_i, distance_i \quad (8)$$

$$obj_2 = max \sum_{i=1}^{n} SF_i, speed_d, LT_i \quad (9)$$

The aforementioned objective functions are constructed as a loop formation procedure that guarantees maximum quality of service for mobile, wireless, and ad hoc networks. Furthermore, it should be noted that the optimization of the performance of the aforementioned networks is not solely achieved through the direct allocation of resources. Consequently, a set of regulations is formulated utilizing the clustering protocol, as expounded in Section 3.

3. Clustering protocol

This section delves into the clustering-based hierarchy in relation to objective functions for wireless radio and ad hoc networks. A decentralized server is typically deployed in ad hoc networks to facilitate optimal resource allocation for a given cell. In the context of wireless networks, it is possible to carry out manual cluster operation to allocate resources during a specific time period [19-22]. The availability of resources within each clustered cell is contingent upon the number of users assigned to said cell. In ad hoc networks, resource allocation occurs automatically and resources are distributed promptly in response to demand. The clustering protocol can be categorized into proactive and reactive routing, wherein the cluster nodes follow distinct paths based on the shortest distance. The primary benefit of utilizing a clustering protocol in mobile, wireless, and ad hoc networks is the reduction of distance, making it the preferred method in the proposed approach. The mathematical formula for the minimized distance can be represented as follows.

$$distance_{cluster} = min \sum_{i,j=1}^{n} (s_{i1} - s_{j1}) \times (w_{in1} - w_{jn1}) \quad (10)$$

Where,

s_{i1}, s_{j1} denotes data of nodes *i* and *j*

w_{in1}, w_{jn1} represents the minimized distance of corresponding nodes

According to Equation (10), it is imperative to minimize the distance between data nodes within the allocated time frame while also reproducing new nodes. Furthermore, apart from minimizing the distance, the allocation of load to clustered nodes is evenly reserved, thereby enabling the creation of a virtual logic group in the system, as denoted by Equation (11).

$$space_{cluster} = min \sum_{i=1}^{n} \frac{distance_{cluster}}{n_{ij}} \tag{11}$$

Where,

n_{ij} denotes total number of nodes within the cluster

If uniform allocation of resources is implemented across all clustered nodes, it is possible to decrease the total space in relation to the dimensional area. Hence, in the context of wireless, radio, and ad hoc networks, exclusively optimized clusters are selected, as denoted by Equation (12).

$$Opt_{cluster} = min \sum_{i=1}^{n} \frac{HD_{cluster}}{\Delta t_i} \tag{12}$$

Where,

$HD_{cluster}$ indicates the cluster head

Δt_i denotes corresponding sub interval region in clusters

According to Equation (12), the selection of a cluster head within each cluster region necessitates the allocation of a time period to ensure appropriate resource allocation, while keeping the sub interval region constant. Equation (13) suggests that the provision of a reward factor may be necessary if resources in the sub interval region are not allocated appropriately.

$$\Delta t_i = min \sum_{i=1}^{n} \frac{reward_i}{II_t} \tag{13}$$

Where,

$reward_i$ denotes reward that is allocated to improper resource allocated cluster

II_t indicates inter-interval resource allocation rate

Protocol implementation- Cluster and cluster head

```
Begin PROCEDURE C1
    Feed the input data for nodes i and j
    for (i<j) do
        Allocate the weight of each node w_in1, w_jn1
        Measure distance of clustered nodes distance_cluster
    end
    else
    for all (i=j) do
        Optimized value with space_cluster, Opt_cluster
    end
end PROCEDURE
```

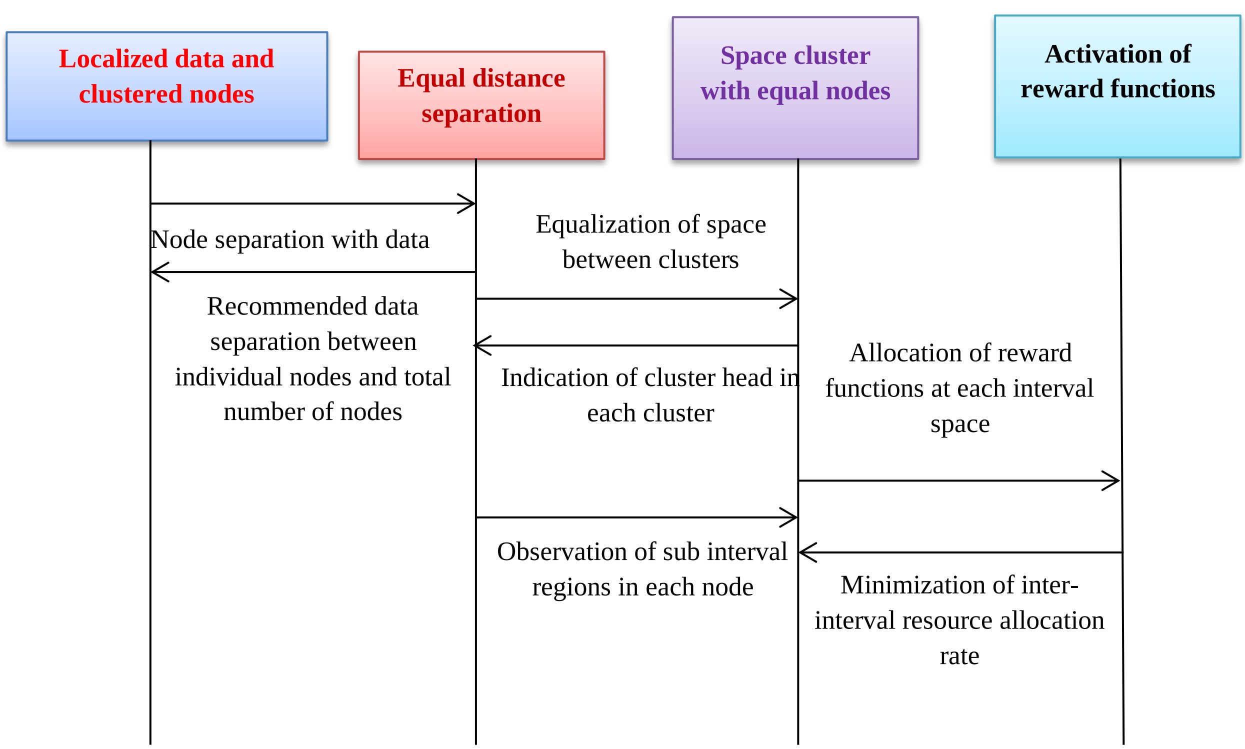

Figure 2 Block representation for clustering protocol

Figure 2 indicates the process of integration with clustering protocol where localized data is collected and nodes are clustered with required data. During this process only recommended nodes are clustered whereas other nodes remain in idle mode which is combined in distinct form. All the clustered nodes are separated with equal distance representations therefore every data is processed without any interruption therefore at this stage every cluster head is indicated for making individual decisions. Once the decisions are made then at every sub cluster point observations are made for each node regarding energy representations. Further the clusters are placed in space representations thus reward functions are allocated for each activity thus maintaining inter-interval resource for appropriate data transfer. The pseudo code for clustering protocol is implemented with two loop procedure and the corresponding block indications are indicated in Figure 2.

3.1 Optimization algorithm

An optimization algorithm is deemed necessary to effectively integrate the clustering protocol with the system model, despite the clustering of nodes and allocation of appropriate resources to each cluster. Therefore, the utilization of a Schedule-based Resource Allocation (SRA) algorithm is favored for the allocation of entire resources in accordance with a suitable schedule. The status of a node is evaluated in SRA through sample cases aimed at minimizing energy consumption during the initial state [23-26]. If the allocated nodes are determined to be in a normal state, data may be processed to the end nodes. In the event of detecting an abnormal status in a single node, it becomes necessary to deactivate interconnection with other nodes. Consequently, it becomes imperative to transition the nodes into an optimal mode wherein resource allocations are manually processed. During the process of Static Resource Allocation (SRA), the allocation of resources is contingent upon the speed factor, which is expressed mathematically as follows.

$$R_{SRA} = min \sum_{i=1}^{n} \frac{user_s + k_s}{LP_t + idle_i} \tag{14}$$

Where,

$user_s$, k_s indicates space allocated to each user and kernel

LP_t, $idle_i$ denotes time for low priority and idle periods

According to Equation (14), the scheduling process is carried out exclusively in relation to the allocated space of each node, with the requirement that the idle time period be completely minimized. To minimize the duration of idle time, Equation (15) is presented in the following manner.

$$idle_i = min \sum_{i=1}^{n} \frac{M_u + M_b}{M_{total}} \tag{15}$$

Algorithm 1: Schedule Resource Allocation

Given

M_b*:* Maximum buffer space

threshold: Limitation of buffer space

1. Begin
2. **PROCEDURE** SRA
3. Initialize maximum space for user and kernel
4. **for** i=1:*n* **do**
5. Generate LP_t, $idle_i$ for each clustered node
6. Provide M_u for each user
7. **end**
8. **else**
9. **for all** i=1:*n* **do**
10. Perceive RT_i, RT_j for each node
11. **if** $(buffer < threshold)$ **do**
12. Go to step 5
13. **end**
14. **end**
15. **end PROCEDURE**

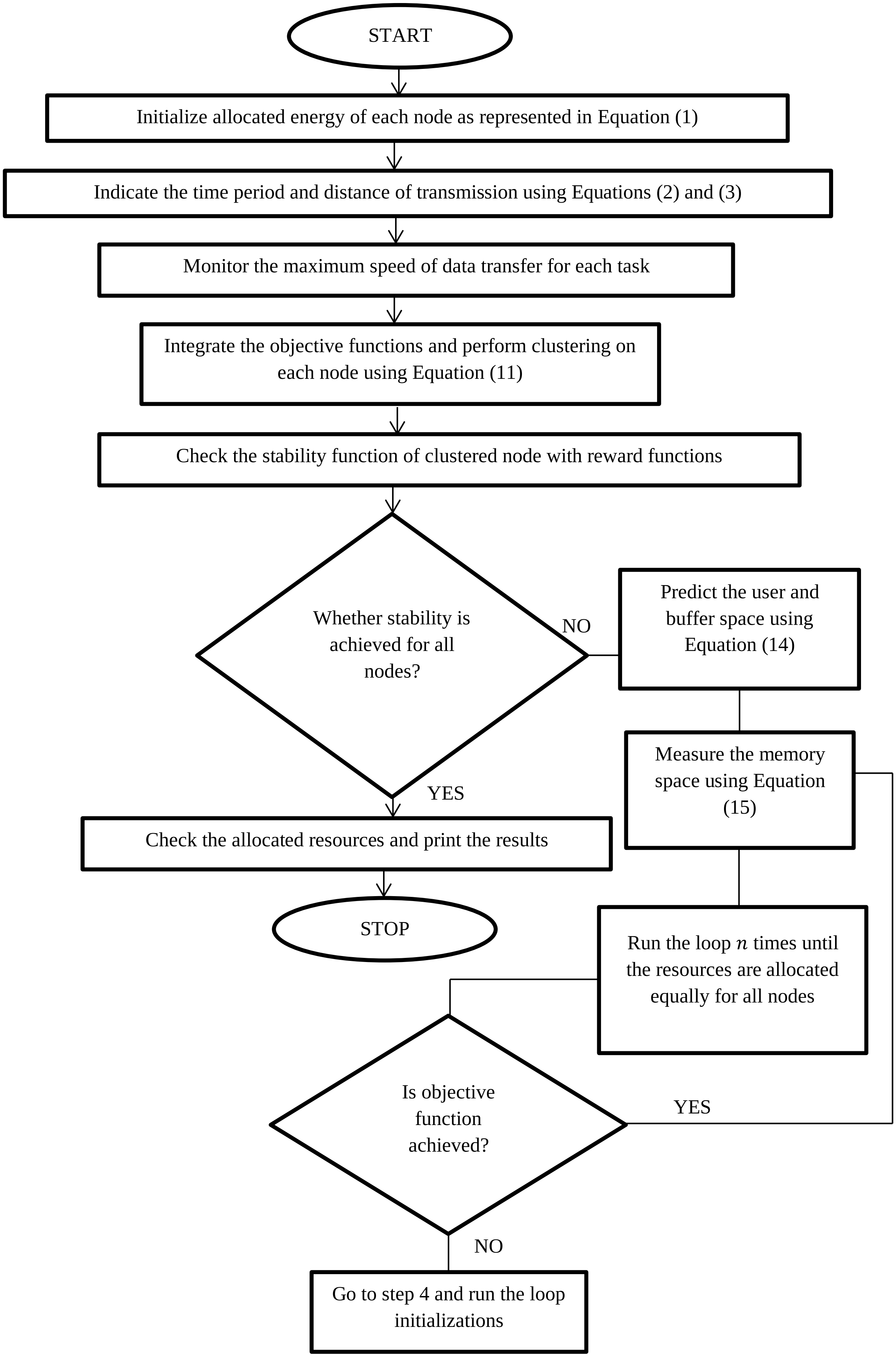

Figure 3 Step-by-step implementation of SRA with system model

Where,

M_u, M_b represents memory of user and buffer

According to Equation (15), a reduction in the idle time period of nodes where resources are allocated can be achieved by clearing the memory space that is occupied by the user and buffer, but remains unused. Equation (16) can be utilized to decrease the duration of low priority time in a comparable manner.

$$LP_t = min \sum_{i,j=1}^{n} RT_i + RT_j \tag{16}$$

Where,

RT_i, RT_j denotes the run time of i^{th} and j^{th} nodes

It is imperative to decrease the low priority time periods in resource allocation across all clustered nodes in order to minimise the allocation time for the entire system. However, in the mode of allocating schedules, it is imperative to ensure that the subsequent constraint is met.

$$SRA_i = \begin{cases} 1 \ if \ buffer < threshold \\ 0 \ if \ buffer > threshold \end{cases} \tag{17}$$

According to Equation (17), the allocation of resources is contingent upon the occupation of limited buffer space by clustered nodes. Insufficient allocation of resources occurs when a greater amount of buffer space is utilized. As the proposed system model is integrated with clustering protocol and schedule based resource allocation algorithm the objective functions that are represented in Equation (8) can be modified with reward functions and low priority representations as follows.

$$modfiedobj_1 = min \sum_{i=1}^{n} (E_i \, , T_i, distance_i) + (LP_t, \Delta t_i) \tag{18}$$

The modified objective in Equation (18) indicates that minimization of energy, time period and distance must be added with low priority time for allocating resources to several nodes that are present in the network and providing reward function for proper operation of networks. Figure 3 depicts the block representations for SRA, while the pseudo code for SRA is presented below and the variable representations for all Equations are provided in Table 2.

Table 2 Variable representations

Variables	Indications
ϑ_{ij}	Enduring energy of allocated cluster nodes
N_{pn}	Total energy of cluster
$P_{e1}+..+P_{ei}$	Individual packet energy
$B_{a1}+..B_{an}$	Bandwidth of active nodes
$nodes_{ij}$	Total number of nodes including sleep and idle
$cluster_a$	Distance of allocated bandwidth to a particular cluster
$T_i + T_s$	Summation of idle and sleep time periods
$mobility_j$	Flexibility correlation of node *j*
τ_{in}	Adjoining nodes of *j*
SN_j	Speed of selected nodes
$SN_1+..+SN_i$	Total speed of all nodes
$\alpha_1+..+\alpha_i$	Task functions of clustered nodes
U_r	Utilization rate of resources
c_t	Total time for a node to remain at collision state
$G_d(i)$	Data generation values
s_{i1}, s_{j1}	Data of nodes *i* and *j*
w_{in1}, w_{jn1}	Minimized distance of corresponding nodes
n_{ij}	Total number of nodes within the cluster
$HD_{cluster}$	Cluster head
Δt_i	Corresponding sub interval region in clusters
$reward_i$	Reward that is allocated to improper resource allocated cluster
II_t	Inter-interval resource allocation rate
$user_s, k_s$	Space allocated to each user and kernel
$LP_t, idle_i$	Time for low priority and idle periods
M_u, M_b	Memory of user and buffer
RT_i, RT_j	Run time of i^{th} and j^{th} nodes

4. Expected outcomes

This section presents an analysis of the outcomes resulting from a parametric system model. The model incorporates information pertaining to resource allocation problems, which are formulated as min-max problems with multi-objective functions. The analysis is conducted through a simulation study. The system model under consideration is instantiated through the creation of a distinct loop, wherein distinct rules are adhered to via the utilization of a clustering protocol. Upon clustering the nodes based on the predetermined set of criteria, the transmission state is subsequently determined through the utilization of SRA. To facilitate real-time outcome analysis, a representative network is selected and optimal allocation of essential resources, including energy, speed, time period, and space cluster, is performed. During the aforementioned allocation process, it has been observed that the network is capable of accommodating packets of up to 1028 bits without any loss. Thus, in the event that the packets within the network are increased, it becomes necessary to introduce additional energy for transmission within the newly clustered network. The proposed method is capable of efficiently managing up to 724 nodes with the allocated resources, while maintaining a high transmission speed. The nodes referred to above are segregated by a 12-tuple factor, thus providing ample space for the nodes within the system. In addition, the nodes within the system are authorized to function during a specific time frame based on the input signal's bandwidth. Therefore, if a node is transmitting a signal, the bandwidth constraint is verified during the initial phase, thereby minimizing the squandering of resources. The present study examines the outcomes of real-time simulations through the analysis of three distinct case studies pertaining to resource allocation.

Case study 1: Determination of energy and distance

Case study 2: Network life time

Case study 3: Quality of service

The MATLAB software was utilized to present the simulation outcomes and provide a detailed account of each case study. Furthermore, the performance evaluation of the clustering protocol and SRA is presented in all case studies, wherein the improvement factor is compared with existing approaches. Furthermore, the allocation of resources to nodes is achieved through the process of clustering, whereby the shortest path of transmission is exclusively taken into account. The aforementioned case studies each contain distinct objectives, as outlined in Table 3. A comprehensive account of the three case studies is provided below.

Table 3 scenarios and goals for Proposed and Existing methods

Scenario	**Goals**	
	Existing	**Proposed**
Determination of energy and distance	To utilize complete resource irrespective of route formation technique	To follow shortest path with allocated energies
Network life time	To function until complete resources are utilized thereby life time of networks are minimized	Maximize the working functionality of nodes in the clustered network
Quality of service	Minimize the energy of every allocated node to improve Quality of service	Improve the packet loss factor by allocating appropriate resources to mobile, radio and ad hoc networks

Case study 1: Determination of energy and distance

The primary significance of resource allocation lies in the selection of suitable energy for individual nodes and the overall energy allocation for each cluster. This case study examines the role of total energy as a secondary energy resource. In instances where a node experiences low energy levels, it can be supplemented from the overall available energy. When energy is provided to clustered networks, selecting the shortest distance results in greater energy conservation for each node. This conserved energy can be utilized for future purposes. The proposed methodology involves the allocation of energy to individual nodes through the exclusion of dormant and inactive nodes. This is achieved by enabling active nodes to share the bandwidth of both nodes. Therefore, during the designated time frame, a higher amount of bandwidth is utilized while maintaining a low energy signaling rate, resulting in a decrease in individual packet loss. The simulation results presented in Figure 4 pertain to the allocation of energy and distance within a clustered network comprising 203 active nodes.

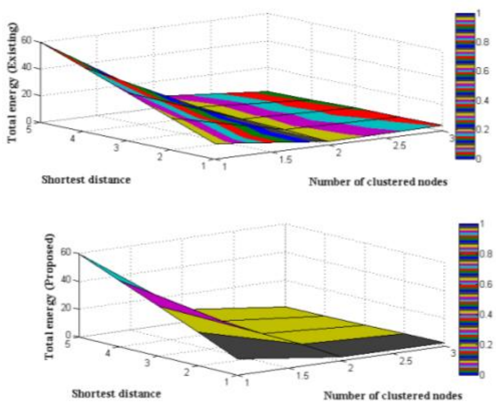

Figure 4 Allocated energies for clustered nodes

The proposed method appears to minimize energy and distance for mobile, wireless, and ad hoc networks, as compared to the existing approach [4], as evidenced by the results presented in Figure 4. The active nodes are capable of transmitting individual packets at a better signaling rate as a result of minimizing energy and distance. The performance of the clustering network is enhanced by increasing the number of active nodes, even when incorporating the distance of idle and sleep nodes. The present study examines the determination of energy and distance in a case study. The total number of clustered nodes under consideration are 12, 24, 36, 48, and 60. The shortest distance of transmission is achieved by crossing 3, 5, 6, 8, and 9 neighboring nodes. The total energy allocation for the distance and clustered nodes mentioned in the existing approach is significantly higher, with values of 4.13, 3.97, 3.52, 2.76, and 2.24, respectively. The proposed method involves an allocation of energy at values of 2.17, 1.94, 1.36, 0.89, and 0.42. This allocation enables the successful transmission of information in each packet to the receiver, even in cases where energy resources are limited and without incurring any loss.

Case study 2: Network life time

This case study determines the network lifetime of each cluster and notes that any collision between two nodes results in a reduction of the network lifetime. Moreover, if resources that have been allocated are utilized effectively, it is possible to optimize the network's lifespan for all data generated. The utilization rate is determined through the appropriate allocation of resources and is distinguished by the values of generated data. The proposed methodology ensures that all resources are allocated in an appropriate manner, thereby maximizing the network's lifespan to a certain degree. Achieving maximum transmission speed is possible if all allocated nodes are freed. During the remaining time period, the operational nodes can remain in a state of dormancy. The process of transitioning nodes from an active state to a sleep state, as described above, is a commonly employed technique in mobile, wireless, and ad hoc network data transmission applications. This technique is known to enhance the network's lifespan. The simulation outcome for network life time is presented in Figure 5.

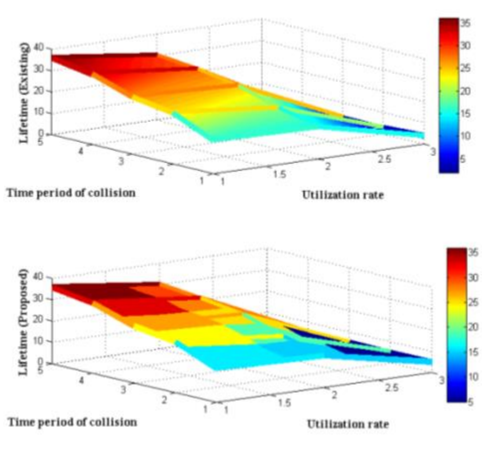

Figure 5 Life time of network with utilization rate

The findings depicted in Figure 5 demonstrate that the proposed method effectively optimizes resource allocation by relocating nodes within each cluster, resulting in a maximized network lifespan. The cumulative lifespan of clustered nodes is five cycles, and inadequate resource allocation may result in a decrease in lifespan. In order to assess the lifetime in comparison to the existing approach [4], the utilization rate at each node was recorded as 16, 24, 27, 33, and 36, respectively. The time period of collision was observed to be 15, 19, 25, 28, and 30. Reducing the collision rate of transmitted packets results in a 50% increase in the network's lifetime. The current methodology has demonstrated that a significant quantity of resources is allocated, yet not all packets utilize the allocated resources, resulting in a minimum level of loss. Therefore, the proposed method maintains a stable total lifetime over five periods, while the existing approach decreases the lifetime of the clustered network to two periods in the presence of a higher amount of collisions.

Case study 3: Quality of service

This case study investigates the quality of service pertaining to allocated resources, taking into account individual constraints such as time period and transmission speed in order to enhance the quality of service. The current methodology suggests that an increase in the speed of the assigned task corresponds to an improvement in the quality of the active nodes involved in data processing. The proposed methodology entails a thorough examination of the optimal allocation of resources to maximize service quality. To this end, the present case study integrates the impact of both SRA and clustering protocol with the proposed system model. An additional approach to evaluating the caliber of clustered nodes is through the analysis of low-priority and idle time intervals. Therefore, in the event that both of the aforementioned parameters are present, the transmission of data by individual nodes becomes a complicated process. Therefore, in order to mitigate complexity, low priority and idle time periods are minimized through the utilization of a well-defined spatial representation of a clustered network. Figure 6 illustrates the simulation results pertaining to the quality of service.

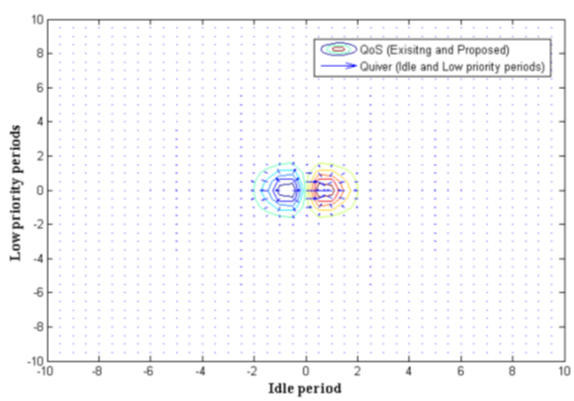

Figure 6 Quality of service for proposed and existing approach

The results depicted in Figure 6 indicate that the proposed method yields a higher quality of service in comparison to the existing approach as reported in reference [4]. This case study considers idle and low priority periods at intervals of 60, 120, 180, 240, and 300 seconds, during which active nodes are unable to transmit data to the receiver for 30, 60, 90, 120, and 150 seconds. The purpose of this is to verify the study. The present study suggests a method that facilitates the transfer of existing resources in various formats to other nodes within clustered networks under such circumstances. Furthermore, the network configuration has been expanded to facilitate the interconnection of nodes within the cluster, allowing for the sharing of resources subject to certain limitations. During periods of low activity and low priority as mentioned above, the current approach yields a quality of service of 43%, 47%, 54%, 58%, and 61%. However, the proposed method enhances the quality of resource allocation for clustered networks, resulting in a maximum quality of service of 73%, 79%, 82%, 85%, and 87%, respectively. Thus, by decreasing low priority periods, the level of service quality can be optimized to a certain degree.

4.1 Robustness analysis

In the process of allocating resources to several networks such as mobile, wireless and ad hoc it is observed that high robustness is present in the connected network. Hence the robust network must be checked and if extra resources are allocated then it must be removed during data transfer process. In addition in other case of allocated resources are reduced than the expected threshold values then proper allocation of resources must be made without any further delay. If the above mentioned two cases are solved then mobile, wireless and ad hoc networks are subject to minimized robustness where data transfer operation takes place in a precise way. Moreover the allocated networks also face robustness condition in case if the distance is minimized with more amount of allocated resources where most of the existing approaches are operated under the same conditions that needs to be prevented. However in proposed method due to proper allocation of energy, time period and speed of transmission the data is transmitted to maximized distance with equal load condition thus robustness is reduced as indicated in Figure 7.

From Figure 7 it is realistic that in comparison case of robustness the proposed method proves to be much better than existing approach [4]. To prove the robustness characteristics five iteration periods are considered in the step variations of 20 to 100. For all the iteration periods resource allocation is changed where robustness is increased to great extent at initial state whereas once the data transfer operation is started it is observed the system remains in low robust conditions. This condition can be clearly observed for iteration 60 where percentage of robustness is 24 in case of existing approach [4] whereas it remains at 11 percentage for proposed method. Also at high iteration state percentage of robustness is much low where it remains at 17 and 4 percentages in case of existing and proposed approach respectively. Therefore if resources are allocated in a proper way then it is possible to reduce the percentage of robustness for mobile, ad hoc and wireless networks.

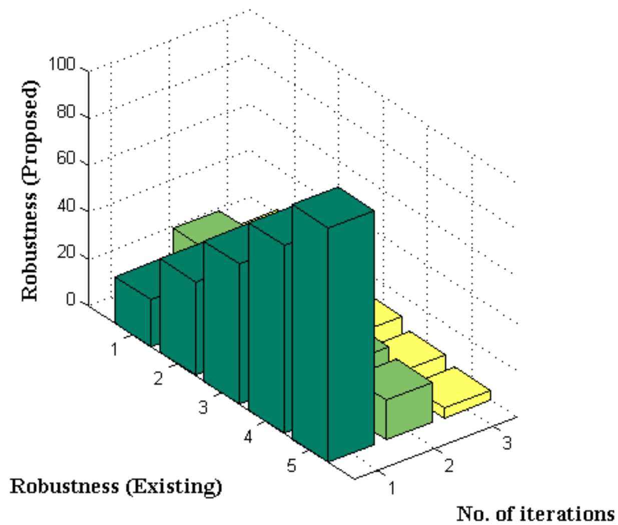

Figure 6 Comparison of robustness with number of iterations

5. Conclusions

The proposed method effectively addresses the challenges associated with resource allocation for maintaining optimal network performance. Initially, the requisite parameters for resource allocation are assessed, followed by the development of a system model that incorporates a distinct array of representations. The parametric representations encompass various factors, including the allocation of energy, time period for clustering and transmission, distance between nodes for transmission and separation, stability of both clusters and nodes, transmission speed, and network lifespan. The proposed method is integrated with a clustering protocol, wherein suitable guidelines are furnished for clustering in mobile, wireless, and ad hoc networks, based on the aforementioned parameters. The utilization of a clustering protocol has the potential to reduce transmission distance, as each individual node within the distinct cluster adheres to the shortest path of transmission. The utilization of the shortest path in projected systems results in a higher degree of energy conservation, leading to the emergence of spatial clusters. In addition, a cluster head is selected to oversee each cluster and delegate tasks, thus ensuring equitable resource allocation within the designated network. The proposed method not only incorporates distance separation and transmission, but also identifies idle and sleep nodes. Furthermore, it optimizes resource allocation by sharing resources from inactive nodes to active nodes, thereby eliminating the need for new resource allocation in the network. The resource sharing process operates on a schedule-based algorithm, whereby a greater amount of memory can be conserved in the clusters during the allocated time period.

To examine the efficiency of allocated resources in proposed method five case studies are considered and the real time simulated outputs are compared with existing approach. From the compared analysis in all five case studies it is observed that energy and distance is minimized with high stability factor in case of proposed method. Due to proper allocation of resources in mobile, wireless and ad hoc networks the life time and quality of service is maximized to an optimized percentage of 84 as compared to existing method.

5.1 Policy implications

The major advantage of implementing wireless, mobile and ad hoc networks in industrial applications is that a low cost interaction and data transfer process in two different modes are possible. The above mentioned two different modes consists of direct communication that represents two different clients by proper usage of allocated resources and the second represents indirect communication between a client and internet user where in both cases schedule based transmission is followed. Moreover in industrial applications it is possible to separate every user and client into individual cluster therefore the proposed method can able to use low amount of access points and routers which results in cost effective method for all industries.

Declaration:
Informed Consent Statement: “Not applicable.”
Conflicts of Interest: “The authors declare no conflict of interest.”
Data availability statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request.
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