A simplified optimization for resource management in cognitive radio network-based internet-of-things over 5G networks

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ABSTRACT

With increasing evolution of applications and services in internet-of-things (IoT), there is an increasing concern of offering superior quality of service to its ever-increasing user base. This demand can be fulfilled by harnessing the potential of cognitive radio network (CRN) where better accessibility of services and resources can be achieved. However, existing review of literature shows that there are still open-end issues in this regard and hence, the proposed system offers a solution to address this problem. This paper presents a model which is capable of performing an optimization of resources when CRN is integrated in IoT using five generation (5G) network. The implementation uses analytical modeling to frame up the process of topology construction for IoT and optimizing the resources by introducing a simplified data transmission mechanism in IoT environment. The study outcome shows proposed system to excel better performance with respect to throughput and response time in comparison to existing schemes.

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1. INTRODUCTION

With an increasing adoption of internet-of-things (IoT), the dependency towards fifth generation (5G) communication is increasing targeting towards facilitating computational resources by mobile edge computing (MEC) [1]. The idea is to enhance quality-of-service (QoS) and reduce latency along with an efficient traffic control system over backhaul networks [2]. At present, MEC is known to perform aggregation of idle resources e.g., processing and storage from the mobile user over similar applications. In IoT environment, the availability of cloud services, calculation of statistical processing, and other environmental monitoring is carried out by MEC [3]. In this perspective, the MEC resources can be harnessed for increasing the capabilities of certain mobile users using resources from other mobile users in IoT. However, there is a limitation associated with this process of MEC owing to their restricted capacity of resources to facilitate service delivery to the mobile user. Therefore, it is essential to develop an effective scheme of resource management while working over 5G in IoT in order to control these MEC resources. This will also result in reduction of unwanted resource allocation by user node. This problem can be sorted by resource management mechanism in IoT by using aggregation and allocation strategies. The MEC is actually constructed by the resource allocation steps which generates resource pool from one to another mobile device. The process of aggregation involves identifying with declaring the idle resources and increases the resource pool mainly [4], [5]. The process of resource allocation in IoT is all about provisioning services on the basis of available resources in MEC in order to cater up the demands of the user's request [6]. The performance of the services in an IoT significantly depends upon the selection of allocation of services with higher specifications. However, the problem arrives in an IoT environment in presence of dynamic users that result in potential resource variations with an increasing chance of intermittent connectivity from MEC. Presence of this problems give rise to various other adverse issues with respect to attended and allocated services in IoT. Irrespective of various work towards resource management in IoT and 5G, not much optimal solution is explored [7]–[9]. Majority of the existing studies have been carried out towards addressing specific problems of resource allocation and not much on aggregation. This results in significance less availability of criteria leading to unavailability of services owing to resource insufficiency. This could also result in blocking of services while attempting exploration of devices at the time of allocation of resources. It may also degrade the QoS performance owing to service relocation. IoT is also witnessed to improvise on operationalities while using cognitive radio network (CRN); however, one of the potential challenges in this regard is the degradation of quality of channel in case of more number of secondary users [10]. Apart from this, there is also a need to improve upon the optimization performance of the radio power so that better QoS performance can be delivered.

This section discusses about the various approaches being carried out towards resource allocation considering the case study of deployment in IoT. At present, there has been an investigation towards resource management concerning the narrowband IoT. The discussion of Migabo *et al.* [11] discussed the utilization of narrowband IoT that targets towards cost and energy efficiency in IoT. According to the study, there are still open-end issues in energy efficiencies due to the reasons viz: i) fluctuation of spatial and temporal factors associated with harvested energy, ii) latency issues, and iii) inclusion of iterative operation for offering reliable coverage. Such issues are addressed to some extent with usage of cognitive radio network (CRN) as discussed in work of Ejaz and Ibnkahla [12] where an optimization using cross layer is used for introducing a reconfigurable approach that is capable of allocation resources in dynamic order with an explicit quality of service. The study contributes toward formulation of a policy where a game logic is used for modelling the reconfiguration for supporting better allocation of resources. Study towards narrow band IoT was also carried out by Malik *et al.* [13] with a target of controlling overhead by formulating a data rate that is feasible to be achieved. The study also incorporates interference aware scheme where iterative scheme is formulated towards obtaining optimal solution for allocation of radio resources. Resource allocation has been studied with respect to Khan *et al.* [14] where mobility environment has been considered. The author has mechanized a policy where a software defined network (SDN) to leverage 5G technologies has been used for constructing framework for flow control in vehicular network. Apart from this, it is also seen that energy harvesting through radio frequencies also contributes towards resource management when IoT is integrated with cognitive networks. Study towards this direction is carried out by Alzahrani and Ejaz [15] with a core goal towards increasing the data transmission performance with better quality of service. The presented technique utilizes greedy approach and integer linear programming. The paper also increases the energy efficiency for all the IoT nodes. Adoption of machine learning scheme has also been witnessed towards improving resource management for nodes deployed in ultra-dense network of 5G. The study of Yu *et al.* [16] conjointly uses artificial intelligence along with blockchain for constructing this model. This technique utilizes less training time in order to ensure that there is reduced delay of cumulative offloading while optimizing the resources. Similar adoption of reinforcement learning is also found to be used in the work of Khumalo *et al.* [17] where fog computing is for testifying the architecture of radio access network. The study addresses the challenges associated with such architecture. The presented technique contributes towards allocation of the autonomous resources using Q-learning where the outcome is witness to exhibit reduced delay. Nassar and Yilmaz [18] have also implemented Reinforcement learning approach over fog computing where different types of Markov decision models are used for allocation of resources. Usage of artificial intelligence is also seen in work of Lu *et al.* [19] where a gated recurrent unit is used, the technique makes use of recurrent neural network and long short-term memory (LSTM) in order to carry out predictive operation for better form of resource management.

Apart from this, the study also uses federate learning in order to secure the privacy of the data. Li *et al.* [20] have discussed a model where game theory has been used for offering a unique power allocation approach along with reduction of computational complexity. A three-dimensional matching problem has been used for modelling the channel allocation while iterative Hungarian method is used to solve this problem over the virtual devices. Apart from this, bio-inspired algorithms are also witnessed towards improving resource allocation strategies in 5G network. The work carried out by Wu *et al.* [21] has used characteristics of slices for allocation of resources. The study also makes use of the evolutionary approach towards relationship and preference of personalized services using cellular automation for resource management. Lieria *et al.* [22] have also utilized bio-inspired approach for optimizing resource management. A unique study carried out by Sarrigiannis *et al.* [23] has discussed the connectivity of resource allocation with network function virtualization in 5G network. The study has presented an embedding mechanism on the basis of latency by allocating specific network virtualization factor followed by scaling and migration of it. The work carried out by Liu and

Zhang [24] have addressed the problems associated with allocation and power of IoT node in order to maximize the data transmission in 5G. The study implements Lagrange dual optimization scheme in order to solve issues associated with power reduction and data transmission increment. Abozariba *et al.* [25] have used a multiple access technology in order to perform resource management in IoT. The study has used non-orthogonal multiple access for this purpose to reduce the number of sub-carriers and thereby control better resource management. Song *et al.* [26] have developed a resource allocation scheme using virtualized network with cluster formation. Liu *et al.* [27] have developed a scheme that enhances the resource utilization over fiber wireless. The model also implements Q-Learning method for predicting traffic behavior and its dynamics using an embedding of virtual network in IoT. Miuccio *et al.* [28] have implemented a sparse code multiple access technology for allocation of resources in dynamic order. Kherraf *et al.* [29] have presented an assignment of workload as well as provisioning of resources. The study has addressed the problems associated with multi-access edge computing towards the computational burden. The study outcome shows better delay control. Study towards similar form of problem is also solved using resource provisioning scheme presented by Ugwuanyi *et al.* [30]. This study has presented deadlock avoidance scheme towards resource provisioning in order to offer maximized reliability. The study has also targeted towards controlling of communication overhead.

All the above-mentioned techniques significantly assist in accomplishing targeted resource utilization and still there are certain issues associated with existing literatures. The identified research problems are as follows: i) Less emphasis towards CRN: The dynamicity of the traffic management involved in IoT are better managed by CRN with respect to its cognitive ability and re-configurability. The facilitation of dynamic spectrum access is enabled by CRN along proper utilization/reconfiguration of it. However, there are also challenges in CRN which is related to fulfilling the demands for structured topology for handling smart city in an IoT. At present, there is no report of any standard model towards optimizing the data transmission performance over CRN based IoT use case scenario; ii) Non-inclusion of randomness in modelling: At present, existing studies in IoT has either considered mobile nodes or considered fully static IoT nodes. There is no much consideration of dynamic topology in smart city use case. Non-inclusion of this consideration will lead to impractical modelling in data transmission of IoT. An efficient modelling should have an inclusion of random number of users that are nearby to various forms of cells. Apart from this, there is also a need of considering interference in this process in order to ensure practical mapping of environment in IoT; iii) Lack of structured communication model: Existing studies on 5G in IoT mainly emphasized on using conventional access technologies in order to perform uplink and downlink transmission. The communication mainly involves either one or bidirectional transmission via macro and small cells in IoT environment where CRN is used. However, this will contradict for running distributed application in the user equipment while using 5G communication. There is a need of structured communication model which could perform a proper grouping and clustering of the IoT devices as well as various network devices (e.g., switches, and gateway) for better management of resources; iv) Adoption of sophisticated methodologies: Almost all the existing research work has used heavily iterative as well as complex algorithm formation in order to achieve better resource management. However, it should be noted that normal IoT devices (or smart appliances) are characterized by low processing capability as well as restricted resource availability. Hence, execution of complex and heavily iterative operation will result to drainage of excessive resources; and v) Low emphasis on optimization: Various machine learning and bio-inspired approaches were used for optimizing outcomes but not towards cumulative resource management in large scale. There is a need of cost-effective optimization approach which can balance computation and communication demands in IoT

Hence, there are various dedicated research attempts towards resource management scheme in IoT with claimed benefits. However, there are also explored issues reviewed from these literatures. The next section briefs about issues identified from existing approaches. Therefore, the proposed system presents a novel framework that introduces a unique process of implementing an optimization process with a target of better resource management when IoT is integrated with CRN. The proposed system implements an analytical research methodology in order to construct a model which is capable of performing optimization of the resources in IoT. The core idea of the study is to ensure development of cost-effective optimization process towards computational modelling harnessing CRN. According to the architecture exhibited in Figure 1, the first part of implementation is about IoT deployment where a use-case of smart city has been designed. The second stage of implementation is about developing a dual mode of connectivity i.e., inter and intra connectivity among the IoT nodes and base station within the deployed area of smart city. The deployed area will mainly consist of primary network of macro cell and small cell. The proposed study also considers availability of home access point user, core cell users, and random users in its deployment area of CRN. The architecture further has a block of operation for framing up the IoT ward considering mainly smart home, deployment area of smart home, and cumulative area of smart city. The proposed study will use intra connectivity for communication in deployment area within a smart phone while it will use inter-connectivity mode for cumulative area of smart city. The architecture of proposed system is shown in Figure 1.

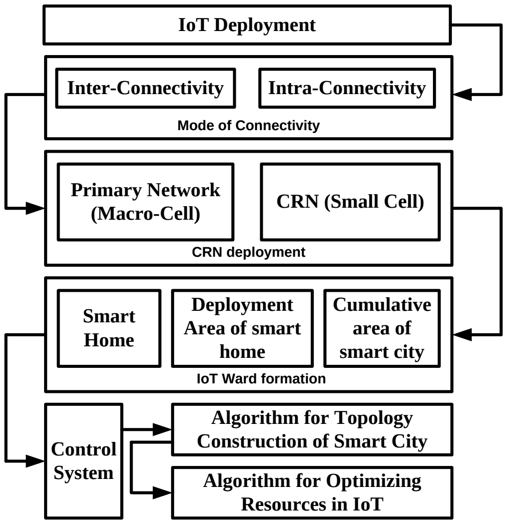

Figure 1. Proposed architecture

Further, the architecture offers a control of communication system by deploying two simplified algorithms. The algorithms are responsible for topology construction followed by optimization of resources. An extensive test environment is developed where various access control techniques are used over small cell base station for assessing its throughput performance. Signal quality over presence of interference is further assessed along with processing time of algorithmic operation in order to prove the optimization performance. The next section elaborates about the system design involved in proposed system.

2. METHOD

This section discusses about the complete system design of proposed study which aims for optimizing the process of resource management in IoT environment. The study assumes the deployment of 5G network as a media of communication where the case study of smart city is considered as an assessment environment. The complete implementation is carried out via two sequential algorithms where the first algorithm is associated with communication set up in IoT environment while the second algorithm is associated with the optimization of the resource management in IoT. In order to optimize management of resources within the devices involved in IoT environment, the proposed system hypothesizes that a better placement of the nodes with an efficient topology in IoT will significantly structure the process of resource-efficient data dissemination. The first part of this implement is associated with intra-connectivity among the IoT nodes. Basically, intra-connectivity communication refers to communication within a specific domain or location in a smart city. In a typical household in smart city, many devices or appliances need to communicate with each other in order to control it ubiquitously. In order to build such intra-device communication a setup of local IoT provides a cost-effective solution. In the local IoT setup, devices with unique-identity number get collaborated through a controller device with capacity of gateway as well as access point. The Figure 1 illustrates a scenario of such local IoT.

In order to construct a deployment scenario of all the IoT nodes with dedicated connection among them, the proposed system makes use of graph theory. The diagrammatic representation of the above scenario exhibited in Figure 2 is implemented using graph theory represented by $G(v, e)$, where the vertices v is further classified into v_1 representing a set of devices and v_2 representing the base station. The variable e will represent the connectivity link between the all the vertices as in the Figure 3.

It should be noted that above exhibited graph G is representation of one local IoT with specific number of vertices. In case of smart city, there are possibilities of various such graphs which could represent houses or a defined location with multiple IoT devices. The typical smart city possesses many locations (e.g., smart home) with smart appliances running (vertices) which are connected by certain access points. A pictorial representation of this is shown in Figure 4, where it can be seen that each smaller regions (local IoT) is arranged in structure of an array.

The next operation of the proposed study is to develop an inter-connectivity functionality. The local IoT requires connectivity to the global level to achieve many of the application goals; therefore, a global IoT system is formed. In simpler representation, global IoT is an interconnected system of available local IoT system to offer extensive coverage using 5G. The global IoT exploits the benefit of the CRN capacity of the respective base stations in both local IoT and global IoT to realize a connection between the base station of the small-cell and the large cell using CRN and 5G communication standard. The justification behind the usage of CRN in proposed system is to exploit the following capabilities viz. i) CRN offers the capabilities where the available frequencies, which is basically a spectrum that is under-utilized, is identified by sensing operation of an IoT devices. The decision towards selection a specific band, either occupied or idle, is carried out by CRN at given location and time and ii) CRN also facilitates dynamic programming capability of the radio for the purpose of enabling the communication system with another set of frequencies and access technologies specified by the underlying hardware. The typical processing blocks of the node with cognitive technology is as in Figure 5.

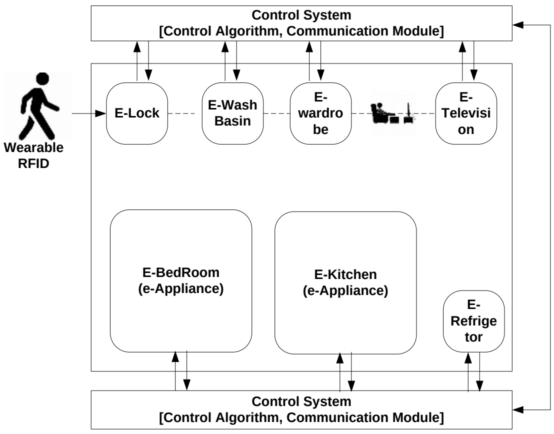

Figure 2. A context of local IoT in the smart home

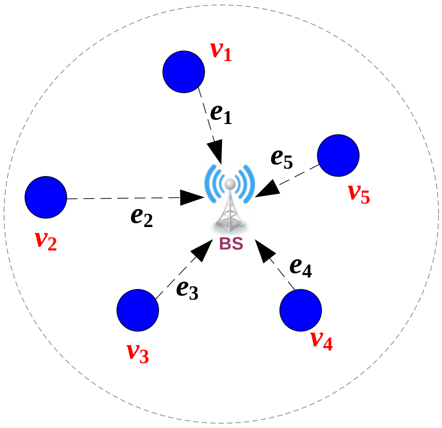

Figure 3. Graph modeling of local IoT as $G(v, e)$

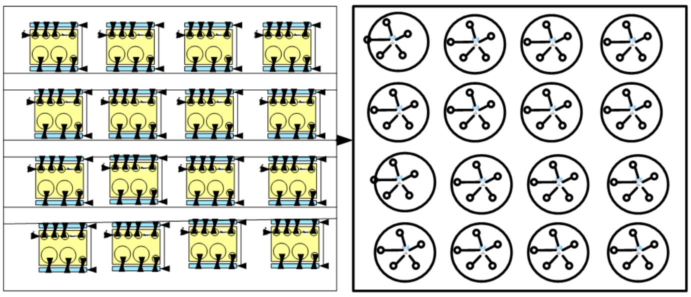

Figure 4. Array of smart homes in a smart city

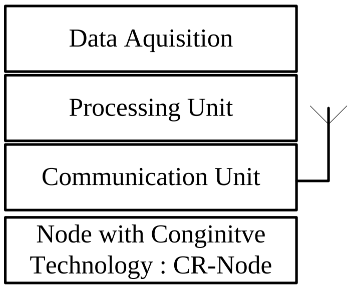

Figure 5. Processing units/blocks of the node with CR technology

The capacity of the CRN to share the spectrum resources comes from a spectrum sensing technology, where the user equipment (UE) in the small cell is popularly known as secondary or the cognitive user (SU/CU) and the UE of bigger cell is known primary user (PU). The Figure 6 shows a typical communication scenario of the 5G based CR enabled IoT system.

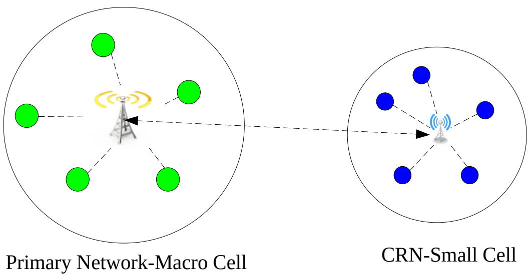

Figure 6. 5G based cognitive radio enabled IoT

The design of the algorithm is carried out in sequential approach where primary emphasis is given towards topology construction of smart city in IoT while the secondary approach is meant for optimizing the resource management while performing data dissemination process. The briefings of the inclusive algorithms are as in algorithm 1.

Algorithm 1. Topology construction of smart city

```
Input: λ1, da, ca
Output: (px, py)
Start
1. init λ1, da, ca
2. For i =1: h: ca
3.      For j=1: h: da
4.          ca=g1(i, j, λ1, da, ca)
5.          [px, py]=g2(π1, π2)
6.      End
7. End
End
```

The algorithm takes multiple input i.e., spatial distance λ between two local IoT (smart home), deployment area of smart home *da*, and cumulative area of smart city *ca*. The algorithm gives an outcome of effective coordinates of the IoT ward (p_x, p_y). The initial operation of this algorithm is to consider the spatial distance λ along with deployment area *da* of local IoT. The spatial distance λ_1 is summed up with deployment area *da* in order to obtain the area of smart city (Line-1). It should be noted that proposed system considers the distance between all individual IoT homes *h* to be uniform as exhibited in Line-2/3. An explicit function $g_1(x)$ is developed that can carry out an update operation with regular interval of time. The updating is carried out for the matrix considering all the input arguments λ_1, *da*, and *ca* (Line-4). The outcome of this operation is updated version of the topology with respect to the cumulative deployment area *ca* (Line-4). A unique function g_2(x) is deployed considering dual form of input arguments π_1 and π_2, where the former argument represents a structured memory with retention of information related to deployment area *da* maintained in the form of an array. It also retains information associated with (i+λ_1**da*). The latter argument (π_2) represents a structured memory with deployment area *da* maintained in the form of an array along with information associated with (j+λ_1**da*). This part of the matrix-operation results in generation of a better position information associated with the IoT ward i.e. (p_{xm}, p_{ym}). The advantage of using these algorithmic steps is that the model contributes towards better disposition of finding the better placement of the local IoT ward for a given smart city. This strategy of implementation will further contribute towards superior form of scope as well as extensive flexibility towards IoT node placement. This will also provide the user to consider the CRN in order to carry out data transmission. The primary idea of this algorithm thereby performs structured management of resources in presence of IoT nodes which is better position to perform cost effective data transmission in IoT environment. The next step of the algorithmic operation is to carry out an optimization of the resource management in dynamic form over 5G network. The briefing of the algorithmic steps is shown in algorithm 2.

Algorithm 2. Optimizing resources in IoT

```
Input: ca, rg
Output: dprop
Start
1. init rg
2. field=g3(ca, rg)
3. Mm=field(ψ);
4. Pward→g4(Mm)
5. Ahome→ ηward* θ
6. deploy → Mhome(nrand)
7. If node>Fr
8.     node→ha
9.     Assign δ →node
10.   Check γ
11.   If δ =unused
12.       assign δ →node
13.  End
14. Estimate Dm=Euc(N(Px, Py), δs)
15. initiate dprop nodei→nodej
End
```

This part of the algorithmic operation is basically a continuation of the prior algorithm where currently a novel strategy of optimization is carried out. In order to process this algorithm, the input arguments are cumulative deployment area *ca* associated with use case of smart city and range of transmission *rg*. The resultant of successful data propagation d_{prop} is formed after processing this algorithm. The computation of the positional information of the IoT ward is initiated by this algorithm considering the spatial distance between them along with their respective range of transmission *r* (Line-2). This process is carried out in order to evaluate the coverage region of the smart city. The study considers ψ number of masks obtained in Line-3 which is further continued by computing the positional information of the IoT ward P_{ward} by applying function of concatenation $g_4(x)$ as seen in Line-4. The next step of the operation is to deploy an access point in the local IoT A_{home} which is carried out on the basis of number of involved local IoT ward η_{ward} and density θ (Line-5). A specific matrix M_{home} is formulated in order to retain all the positional information of the access point of local IoT considering random IoT nodes n_{rand} (Line-6). The resource management is carried out in further steps of operation of this algorithm. A link of communication for all the user is set up by this algorithm on the basis of received power. This is further continued by computing the distance on the basis of both access point within local IoT and core cell. The access point of local IoT that is located in higher proximity is explored followed by assessing a logical condition if the user's position falls within the transmission range of the access point of the local IoT. If the user is positively found to reside the transmission range than the access point of local IoT is used by the user (Line-8). This operation is further continued by setting up assignment channel and communication link (Line-9).

On the other hand, if there is no IoT device within this range of transmission of access point of local IoT (Line-7), then core cell is communicated by that IoT node which is further followed by provisioning of channels in an arbitrary fashion. The received signal strength γ is computed by the algorithm (Line-10); further an assessment is carried out for unutilized communication channel δ. Therefore, if the condition finds the channel to be unutilized (Line-11) the user is assigned to this channel in next step (Line-12). The minimal spatial distance between the IoT node with allocated arbitrary channel as well as the other node is computed in next step (Line-14). Further, the algorithm assesses the proximity of the target node with the core cell followed by enabling the communication with the core cells. This operation is further continued by extraction of the information of the deployed region over the smart city. The signal to interference noise ratio is computed concerning all the nodes followed by obtaining the user channel as well as it also looks for another user who is also utilizing the similar channel of communication. Further, all the positional information of the source IoT nodes are obtained which results in interference along with interference power associated with all the IoT nodes. The algorithm obtains the Euclidean distance for all the IoT nodes from main source node that ultimately yields to confirmation of the communication path for transmitting the data packet. This operation finally ends up with the data transmission between the transmitting and destination node (Line-15).

On the basis of the complete operation, it can be said that proposed algorithm offers supportability of both centralized as well as decentralized management of resources. According to this algorithmic operation, the network centrality of the process is carried out by the core cell while the access point of local IoT controls the local network. The core cell in this model is established with the communication with the access point of local IoT using a backhaul connection. The determination of the relative position of the access point of the local IoT is carried out by the core cell. This process is further followed up by the synchronization of the significant radio signals by access point of local IoT for obtaining expected core signal. By assigning a particular capacity of the access point of local IoT that is directly proportional to the arbitrary number of users. A coefficient of the resource distribution is considered in proposed model that is computed by ratio of maximum capacity of the arbitrary user to the capacity of the access point of local IoT. A conditional logic is formulated which attempts to find the equivalency of infinity value associated with coefficient of resource distribution. In such case, all the arbitrary users will be provisioned with the resources from the access point of local IoT. On the other hand, if the coefficient of resource distribution is found to be zero then home access point will represent a closed access while if the value of coefficient of resource distribution is found to be 1 then the home access point will represent open access. The value of coefficient of resource distribution is resides between 0 and 1 when it is a case of hybrid access. The random users are permitted to use limited capacity allocated for all the type of user. The switching between the station can be done for any arbitrary user in order to obtain enhance service from core base station. A user is permitted to assess other user in case it is found to be active within the transmission range T_x as per the list of identity of owner of home access point. However, the identity of the subscriber will be different while the right to reserve the capacity of home access point is done by home access point itself while that of random users too.

Upon identifying the cumulative number of users in smart city deployed, the home access point chooses number of random users and estimates throughout of owner as well as arbitrary users. The availability of service for the arbitrary users is computed by core base station. In number of arbitrary users are minimized by home access point to one every time when it finds the reserved throughput for the arbitrary user in home access point is minimal compared to core base station. Hence, an effective resource management is carried out for the considered deployed scenario of smart city in IoT using 5G communication system. The next section discusses about outcome. A closer look at the proposed methodology and system design shows that proposed system is highly progressive and extremely less iterative which will offer more benefits towards faster data transmission along with optimizing resources. This will also justify the cost effectiveness of the model. The next section discusses out outcomes achieves.

3. RESULT

This section discusses about the outcomes obtained after implementing the proposed system discussed in prior section. The core idea of the proposed model is to offer resource optimization in an IoT environment. A specific testbed is constructed for this purpose with the simulation parameters exhibited in Table 1.

Table 1. Simulation parameters

	Parameters	Values
1	Number of base stations	1
2	No. of access point in local IoT	20 to 4,500
3	No. of active user	600
4	Interval of distributed time	500 s

3.1. Individual outcomes

The study introduces three different layers of communication introduce various kinds of noises as well interferences and the suitable medium access control techniques (MACT) used in the small cell base station or local IoT base station alleviates the challenges of such interferences. The effectiveness of the local IoT base station largely depends on the technique used for establishing connectivity between the IoT nodes as secondary user (SU) or cognitive user (CU) with a base station (BS) of a particular cell. The system model introduces three types of MACT namely: i) MACT-O, ii) MACT-C, and iii) MACT-H.

In MACT-O approach, it permits all the registered nodes to get communicated within the communication range of local IoT base station. In MACT-C approach, the local IoT base station does not permits the communication to the registered nodes from a specific group of the local IoT node even if a better signal quality is available. In MACT-H approach, the communication is granted for both registered and nonregistered node with a constrained resource of the local IoT base station. The Figure 7 illustrates the observations made for throughput by varying the number of local IoT base station respective to the methods of MACT-O, MACT-C, and MACT-H.

Table 2 highlights the SINR outcomes obtained from individual analysis of proposed model. The outcome shows that at the value of number of local IoT base station is 500 Figure 7, both MACT-O and MACT-H gives same throughput whereas the MACT-C provides much higher throughput. The pattern of throughput for MACT-O is nonlinear incremental, whereas MACT-C provides much higher throughput as compare to MACT-O and MACT-H.

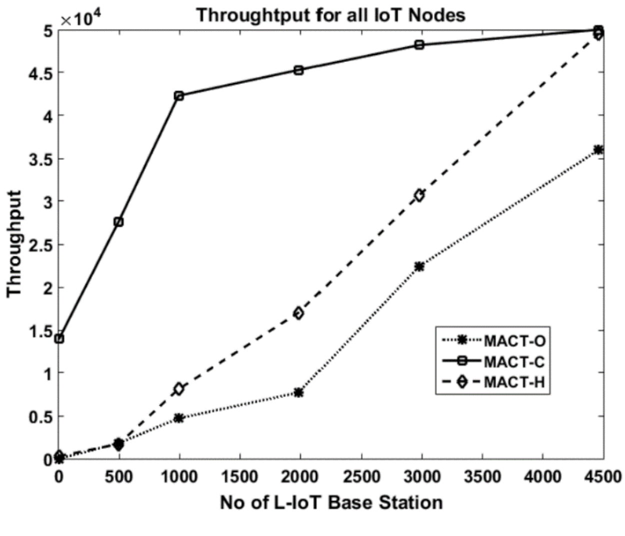

Figure 7. Evaluation of throughput for all IoT nodes based on resource allocation methods

Apart from this, Figure 8 highlights the throughput evaluation with respect to various node densities. It can be seen that higher throughput is achieved in proposed local IoT cell whereas increase of node density affects the throughput slowly. This outcome evidently shows that proposed system is not dependent on increment of node density to increase the throughput. Hence, a better optimization outcome can be exhibited here. However, the pattern of increment is highly nonlinear as compare to both MACT-O and MACT-H. The MACT-H provides linearly consistent increment in throughput with respect to increasing number of L-IoT base station, therefore MACT-H is a consistent medium access control technology to achieve optimal resource allocation in the context of 5G based CRN enabled-IoT ecosystem. This evaluation is further validated with respect to comparative analysis with existing system.

Table 2. Comprehensive SINR performance

Noise (dB)	SINR		
	0.1	0.4	0.9
-20	-0.1027	-0.098878	-0.09878
-15.6	-0.1027	-0.1027	-0.09488
-11.2	-0.09878	-0.09098	-0.09488
-6.8	-0.07929	-0.1027	-0.09488
-2.4	-0.04421	-0.07929	-0.09878
2	-0.07274	-0.01302	-0.09878
6.4	0.252	0.1351	-0.08708
10.8	0.4119	0.2598	-0.02082
15.2	0.5678	0.4275	0.1039
19.6	0.7081	0.5561	0.1936
24	0.8017	0.6574	0.3144
28.4	0.8446	0.7315	0.3651
32.8	0.8952	0.7705	0.4197
37.2	0.9264	0.7861	0.4625
41.6	0.9498	0.8134	0.4664
46	0.9615	0.8601	0.4742
50.4	0.9771	0.903	0.5171
54.8	0.9849	0.9576	0.5678
59.2	0.9693	0.9693	0.6419
63.6	0.9888	0.981	0.8718
68	0.9771	0.981	0.9888
72.4	0.9771	0.9849	0.9888
76.8	0.9771	0.981	0.9888
81.2	0.9732	0.981	0.9927
85.6	0.9849	0.981	0.9888
90	0.9849	0.9771	0.9849

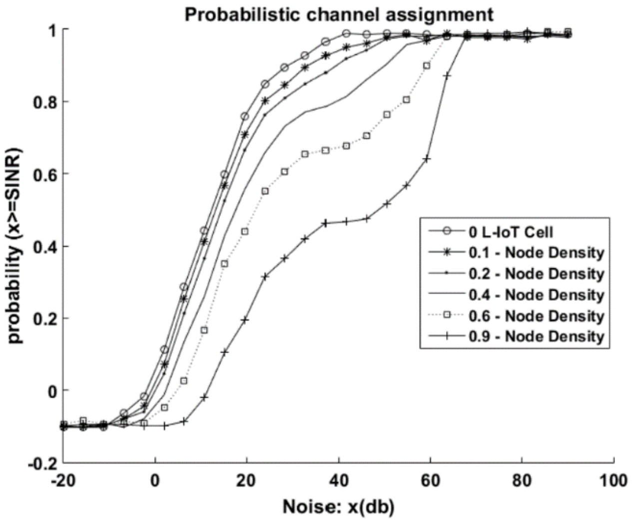

Figure 8. Evaluation of throughput for all IoT nodes based on resource allocation methods

3.2. Comparative analysis

The proposed system is scripted in MATLAB where the idea of implementation is to carry out assessment the outcome associated with resource management optimization. The assessment consists of two scenarios of channel assignment that is confirmed to be highly suitably working with IoT when integrated with CRN i.e. i) spectrum-based sharing and ii) spectrum-based allocation [31]. In order to evaluate the effectiveness of proposed study, a comparative analysis is carried out considering the recent approach implemented by i) Mansukhani and Ray [32] who has used spectrum-based sharing (SS) and ii) Tang *et al.* [33] who has used spectrum allocation approach (SA). The implementation of existing system considers similar simulation parameters in order to arrive at unbiased outcome of performance parameters with respect to throughput and processing time. The analysis is hypothetically carried out emphasizing over the above-mentioned channel assignment schemes from literatures.

Figure 9 highlights the outcome of throughput trend with respect to increasing number of home access point. A better form of resource management in CRN can be ensured if the data delivery services are found to be enhanced considering the larger dimension of IoT environment. The outcome shows that proposed system offers significantly better throughput in contrast to existing mechanism of channel assignment. The prime justification behind this is: The conventional mechanism of spectrum sharing scheme has used a complex mechanism in order to compute the amount of the spectrum resources in random fashion to be shared among the users. In this process, the system over utilizes the available channel capacity which degrades the throughput performance over long run with increase of home access point. Similarly, the mechanism of conventional spectrum allocation considers sharing of spectrum by primary users to cognitive users in order to enhance the throughput performance. However, with increasing usage of the home access point, there is only a slight improvement in obtaining optimal channel resulting in better mechanism compared to conventional spectral sharing method by reduced in contrast to the proposed system. This is because the proposed system ensures the controlling of the core cell controller to determine the relative position associated with home access point. This results in significant improvement of throughout with increasing home access points and thereby the effect of optimization is noted in this outcome. Apart from this, the proposed system offers a simplified binary logic for representing home access point to either open access point or closed access point as well as it also supports hybrid access mechanism. This operation of optimization carried out in proposed system also leads to faster algorithm processing time in contrast to existing system as shown in Figure 10.

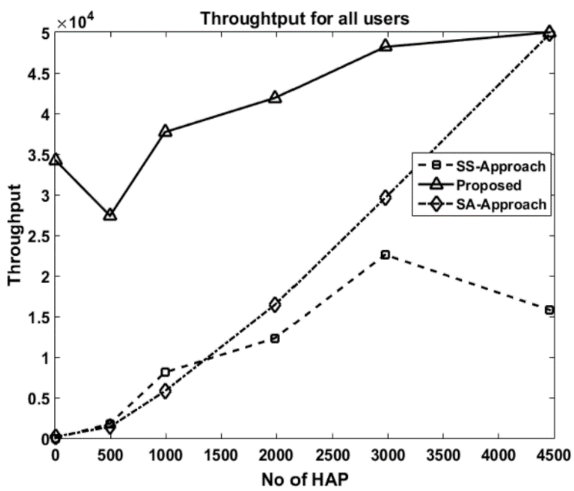

Figure 9. Comparative analysis of throughput

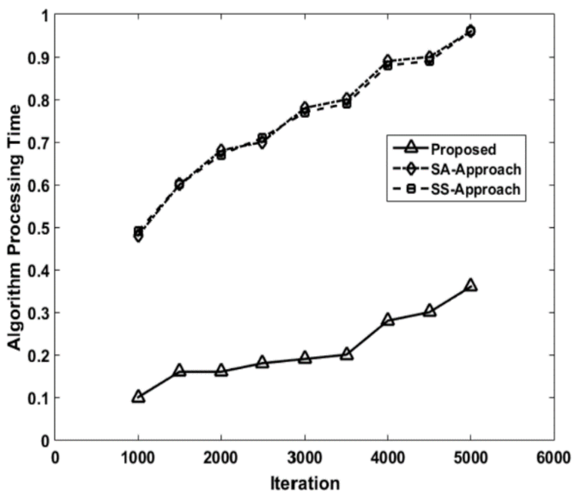

Figure 10. Comparative analysis of processing time

A closer look into Figure 10 highlights that performance of both conventional channel assignment scheme is nearly same as compared to that of proposed system. This reason behind this is that proposed system performs resource allocation in dynamic approach which offers faster decision making for switching the channel based on the current demand of the user (for both home user, hybrid users, and random user). Apart from this, the proposed system assumes the block of resources from standard 5G concept where same channel capacity is used for operation of home access point which are randomly deployed. Similar frequencies are also used by the home access point users. This will mean that proposed system is capable of offering better data delivery services over 5G standards with an effective power usage and without using any form of iterative and sophisticated method. This causes the proposed system to be in cost effective in its operation towards resource management in CRN deployed over IoT.

4. CONCLUSION

A closer look into the existing literature towards 5G implementation in IoT shows higher inclination towards achieving increases rate of data transmission and lower inclination towards computational cost involved in controlling resource consumption. Hence, the proposed study addresses this problem by presenting a simplified model where CRN is used over IoT for optimizing resources. The contribution of the proposed model are as follows: i) the proposed scheme deploys CRN over a use case of smart city management in IoT targeting towards achieving faster rate of data transmission along with resource conservation, ii) the proposed scheme facilitates equal emphasis towards random user as well as home user by identifying the idle resources available in network resulting in throughput improvement, and iii) the proposed system has a better control of the users connected with access point of local IoT by mitigating interference to offer higher quality signal transmission.

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