Load Balancing in 5G C-RAN using Swarm Intelligence (SI) Algorithms

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Abstract: - Cloud RAN(C-RAN) is also known as Centralized RAN is providing flexible for operators for capital expenditure and operational expenditure. The benefits of C-RAN minimize the Total Cost Ownership (TCO) and improve the network performance. It is providing benefit for low-latency network in 5G as Ultra-reliable Low-latency Communications (uRLLC). The 5G C-RAN providing the benefits of no need of rebuild the transport network. C-RAN architecture it is essential dynamically mapping of Remote Radio Heads (RRHs) and Baseband Units (BBUs). Otherwise, it will cause call blocking and network connections with less quality. The proposed paper optimization of reduce blocking calls as well as load process balance of BBUs by using Swarm Intelligence (SI) algorithms. In simulation results it's proved that SI algorithm reduce the blocked calls and maximize balance of processing load of BBUs.

Key-Words: - C-RAN, BBUs, RRH, Swarm Intelligence Algorithms, Total Cost Ownership.

1. Introduction

The tremendous growth of data traffic by mobile phones, smart phones, newly introduced IoT applications, IIoT applications 4G architecture unable to support to store, process such a huge data. The new 5G network to support the demands clients' needs to support to hand such a huge data and applications. To manage such a huge data C-RAN is introduced to handle low-latency network in 5G as ultra-reliable and low -latency communications (uRRLC). The centralized Cloud RAN architecture beneficial for reduce network consumption and increased network flexibility [1, 2].

In C-RAN architecture is made of three components i.e., Base Band Unit (BBU), a Remote Radio Unit (RRU) and a transport network called as Fronthaul [3]. BBU is a pool of centralized resources worked as a data center. RRU connect and communicate wireless devices. Fronthaul uses connectivity between BBU with RRU. The benefits of C-RAN include resource pooling, reusable infrastructure, simple network operations, lower energy consumption and lower capital expenditure(capex) as well as operational expenditure(opex).

In C-RAN architecture Remote Radio Head (RRH) are connected with Base Band Unit (BBU) through fronthaul. BBU are connect & communicate with a Host Manager is a server for verify the load for every BBU. The responsible of host manager is providing configure between BBU-RRH. Every BBU connect with Number of Sector and every sector possess with various RRHs. These RRHs are being connected to single sector for a time duration. The load of every BBU is depends on number of active users in BBU. The mapping and allotment of resources in C-RAN network will be managed by Self Organizing Network (SON).

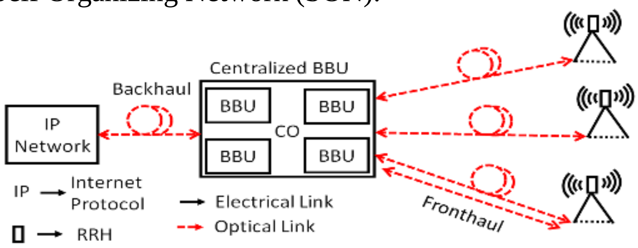


Fig. 1. C-RAN Architecture

2. Literature survey

As per traffic conditions C-RAN dynamically communications between BBU and RRH. The objective of this paper is capacity routing of C-RAN for balancing of load in 5g network. Optimization by Genetic algorithm to balance of network traffic and minimize blocked calls in network and also improve the Quality of Service in C-RAN. The QoS reached by KPI which inverse the blocked calls [4].

In [5] authors proposed resource allocation method for 5G C-RAN. The authors address to balance network load, minimize network cost and reach quality of services, proposed mapping between user equipment (UE) and remote radio head (RRH) and also mapping between Remote Radio Head (RRH) and Base Band Unit (BBU). This is NP hard problem. This should be optimized to decompose this into two resource allocation problems i.e., UE-RRH association and RRH-BBU applying.

Optimization of UE-RRH mapping (resource allocation) is done by Artificial Bee Colony (ABC) and RRH-BBU mapping (clustering) by Ant colony optimization (ACO). This way the proposed Bee-Ant-CRAN method minimize the resource wastage, improves spectral efficiency and throughput.

In [6] authors proposed Deep Reinforcement Learning (DRL) framework for C-RAN. The DRL agent is authorized on remote radio head (RRH) activates as per three phases like defined state, action, and reward function. And take decision for transmit beam forming at active RRHs in every period. The proposed framework achieves higher sum rate in time-varying network.

3. Base Band Unit (BBU)-Remote Radio Head (RRH) Mapping

To improve Quality of Service (QoS) used Number of Blocked Calls (KPI). Balancing the resources for BBUs the host manager mapping for BBU-RRH as per Key Performance Indicator (KPI). 19 RRHs randomly distributed to BBU pool contains 2 BBUs with 3 sectors [7]. The imbalance distribution may cause blocked calls. For reducing number of blocked calls, their better looks manage balance the distribution of users for every sector of every BBU. Distribution of number of users as per number of sectors in Base Band Unit (BBU) for balancing the network. The balancing of users Remote Radio Head (RRH) load in a sector indicates by following equation as follows...

4. $Users_{sector} = \sum_{j=0}^{N} Users\_RRH_j \;\; BV_s^{i+1}, S_{sectors} = 1,2,3..,Total_{sectors}$ (1)

Where

Userssector= users in sector, N=total number of RRHs, Totalsectors=total sectors, Users_RRHj=number of users connect to RRHj, BV=binary variable have value 1 whether RRHj allocate in sectors

The Userssector will vary as per no. of users in n/w for sectors automatically balance with BBUs.

Userssectors for Total_sectors will acquire lowest possible value (KPIminimize). For that it will minimize the blocked calls and maximize Quality of Service (QoS) by equation 2 as follows.

$Key\_Performance\_Indicator_{minimize} = \sum_{s=1}^{k} users_{sector} - hard_{capacity\_hc}),$
$\{0, \quad if\left(\left(users_{sector} - hard_{capacity\_hc}\right) <\right) < 0\} or\ if\left(\left(users_{sector} - hard_{capacity\_hc}\right) <\right)\ if\left(\left(users_{sector} - hard_{capacity\_hc}\right) <\right) > 0\}.$
(2)

$sector_j^{i+1} = sector_1^{i+1}\ , sector_2^{i+1}, sector_3^{i+1} \dots sector_N^{i+1}\}$de noted as sectors of BBUs $sector_j^{i+1}$ and RRH allocated to these sectors.

5. Proposed Particle Swarm Optimization (PSO) Algorithm

The proposed BBU-RRH mapping is implemented by Swarm Intelligence algorithm i.e., Particle Swarm Optimization (PSO). Swarm Intelligence (SI) algorithms are the one of the flavors of Nature Inspired Computing algorithms. The NIC algorithms are inspired from nature. These are model of solving computational problems of cloud computing with optimum results [8,9,13]. SI algorithms having features of self-organization, self-motivation and collective behavior to solve a particular problem [10].

PSO is a meta-heuristic technique to solve optimization problem, especially the problem the linear, non-linear or mixed integer or even our problem is a block optimization problem. The solution in optimization known as particular or bird in swarm intelligence. Each particle or bird has position and velocity associated. In real life particles keep change their positions by adjusting their velocity. Do this either to seek food or avoid predators or identify environmental parameters. There are many reasons particles change their positions.

Each particle keep track their best positions identify it. So, all particles communicate their own best location and from this best location. The individual particles modified flying experience of that particle. Velocity is modified flying experience of that particular particle position and velocity of particles. In 1st step is to initialize within the search space similar.

The PSO algorithms uses swarm of initial particles. Every particle similar to candidate solution. These solutions randomly have various speed and position. The swarm communicate to possible better positions among themselves and updating its own position as well as speed called as local best (Pbest) and which swam best among all particles for position and speed called as global (Gbest). The factor Pbest and Gbest are changed in every iteration [11,13]. In this proposed research Optimization of BBU-RRH mapping with load balancing in C-RAN by using Particle Swarm Optimization (PSO) algorithm [12, 13].

These following are the two equations that generation of new solution
Particle velocity(v) is determined as

$$Vi = wv + c_1 r_1 \left(P_{best} - X_i\right) + c_2 r_2 \left(G_{best} - X_i\right)$$

In above formula vi = velocity of ith particle
ω = inertia of particles, c1, c2 = acceleration coefficients, r1,r2 = random numbers ε[0,1] of size [1xD], Pbest,i = personnel best of ith particle, Gbest,i= global best of ith particle, Xi = position of ith particle
Position of particle modified as

$$Xi = Xi + vi$$

Algorithm: Particle Swarm Optimization (PSO)

$for\ i = 1 to |\Delta| do$

$Generate\ Particle\ i\ with\ random\ position\ and\ velocity$

end

$Initialiseall\ pbest_i\ and\ gbest$

$I = 0$

$While\ I < I_{max}\ do$

$\quad for\ i = 1 to |\Delta| do$

$\quad\quad if\ f(x_i) > pbest_i\ then$

$\quad\quad\quad p_i = x_i$

$\quad\quad\quad pbest_i = f(x_i)$

$\quad\quad end$

$\quad\quad if\ pbest_i > gbest\ then$

$\quad\quad\quad gbest = pbest$

$\quad\quad\quad s = p_i$

$\quad\quad end$

$\quad end$

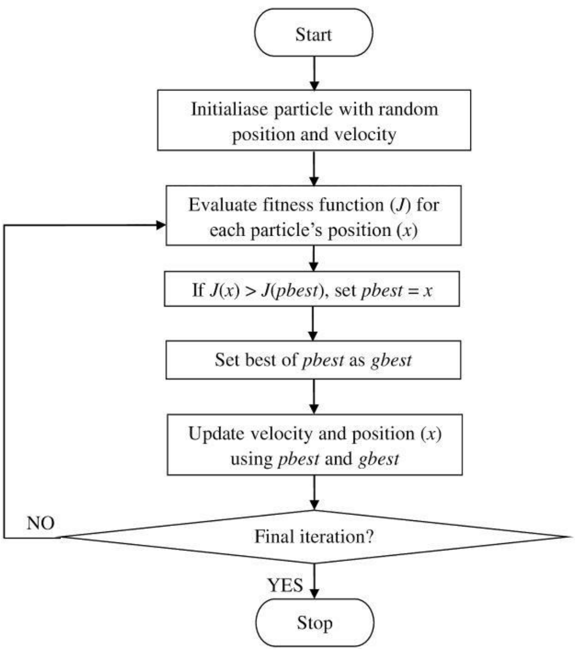


Fig. 2. Fig. 2. Flow Chart PSO

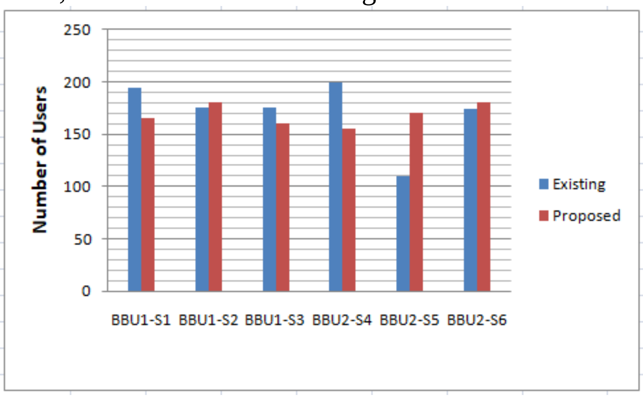
In proposed work 19 RRHs randomly distribute in geographical area manage by 2 BBUs with 3 sectors, Hardware Count (HC)=20 for every BBU. In this approach, without considering of distribution in RRHS, consider only divide users between BBU sectors.
The following table 1 showing the proposed method proved an efficient in providing balancing of equal sectors.

Table 1. Parameters Value

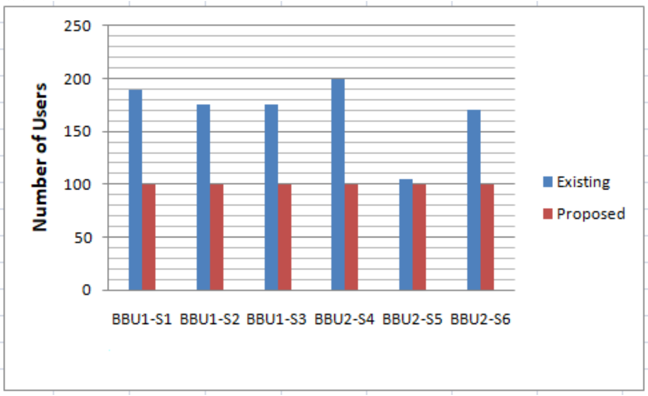
Parameter name	Value
Local acceleration factor	1.8
Global acceleration factor	1.8
Population size	220
Limit number of interactions	100

6. RESULTS and DISCUSSION

In figure 3(a) in existing work produce sectors no call blocking but dis-advantage is imbalance of users. The proposed work sectors are uniformly allocated with no call blocking. In figure 3(b) existing work no balancing load of BBUs, in proposed proper manage the balancing load in every BBU, this is evidence balancing load other BBUs.

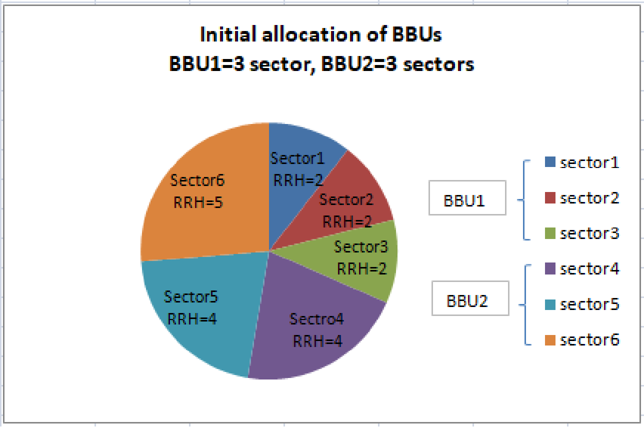


(a)

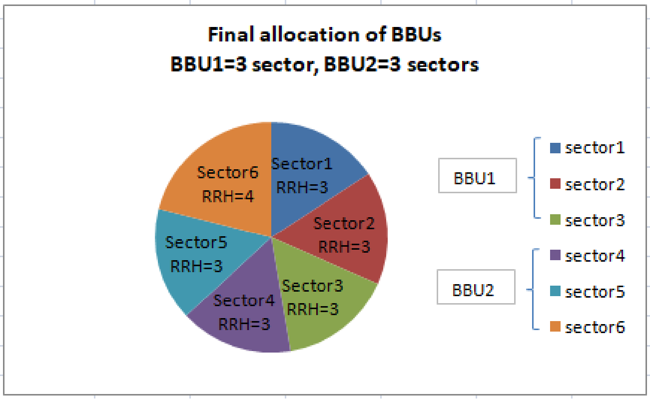


(b)
Fig. 3. Results of 1 and 2: number of users by sector (a); Equal number of users balancing load of BBU (b)

In Fig4 (a) and Fig4 (b) shows the distribution of BBU sector. In Fig4 (a) shows imbalance due to randomly distribution of sector. In proposed method, in Fig4 (b) results show the minimization of blocked calls and equally distributed load in BBU sectors.



(a)



(b)
Fig. 4. Results of 1 and 2: Starting allotment of BBU (a); Final allocation of BBU (b)

7. CONCLUSION

In this paper we are focusing the importance of Swarm Intelligence algorithms for solving computation al problems with optimum results. The SI algorithms are one of the categories of Nature inspired computing algorithms. The SI algorithms are solving computational problems efficiently. The features of SI algorithms are collective behavior, amativeness, co-coordinately work together for solving a particular problem efficiently and selecting optimum results From results available. All these are effective features of swarm intelligence algorithms. In this paper our proposed researches on mapping of resource allocation of BBU-RRH by applying swarm intelligence algorithms.

In Cloud Radio Access Network(C-RAN) mapping of resource allocation (RA) for BBU-RRH is a challenging task. In this paper reduce the blocked calls in every sector. For gain Quality of Service (QoS) the proposed algorithm Particle Swarm Optimization (PSO) is achieved equally balance the sectors in BBU-RRH. The results showed better performance than that of existing. In future work we plan to optimize the load balancing of sectors for RRH-BBU by applying recent hybrid nature inspired computing algorithms for better optimum results.

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