# Cross Layer Multi Metric Approach for Resource Estimation and Optimization for Cloud Radio Access Network

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**Abstract-** *Radio access technology is conventionally divided into cells with a base station at the centre of each cell servicing mobiles within the cell. A mobile can communicate with more than one base stations belonging to more than one cells in its proximity. In conventional networks, the decision to service a mobile is taken care by the base stations. As the number of mobiles and load increases, the communication and computation overhead at the base station increases exponentially. Due to limited processing capabilities of the edge base stations in comparison to core network, a significant amount of latency is induced in the network for the service decisions like handoff, uplink power management, bandwidth allocation and QOS provisioning. In order to solve this problem, various past works have proposed different techniques that can optimize the service and decision process. Few literature have proposed an end device base technique by means of which the nodes themselves decide upon the base station that they want to get connected with. However in a licensed frequency cellular network, such a decision is not practical due to immense computation overhead. In this work we have proposed a unique architecture for taking the service and provisioning decision to core of the network from the edge of the network. We have further introduced cross layer based technique, by means of which a BS collects the information of the bandwidth from the MAC layer and delay from the physical layer and then overall bandwidth is calculated by combining these two matrices. The Simulation results in OMNET++ environment shows that the proposed system improves the conventional edge base computing technique without cross layer significantly by offering high packet delivery ratio at significantly low latency and an improved throughput even at a very high load.*

***Key Words***: C-RAN, RRH, BBU, Cross layer, Cross layer resource allocation, Energy wasted, Throughput, Packet delivery ratio, Latency.

## 1. INTRODUCTION

The Radio Access Network (RAN) is the mainly essential part of a cellular network. They unable to manage new wireless improvement techniques to accomplish user data rates also not compatible with today's user data rate requirements [1]. Cloud Radio Access Network (C-RAN) is an innovative model for broadband wireless access that gives a higher degree of collaboration and communication among Base Stations (BSs), where all the computational resources of BS are collectively present in a central location. The C-RAN architecture consists of base band unit (BBU), radio remote head (RRH), and mobile nodes. Generally BBU's are at the core of the network that is which actually constructs the infrastructure of the network. RRH are at the edge of network. BBU is one from where the resources are allocated. All the BBU's are connected to the RRH by means of fiber links. All the RRH are connected with a several mobile nodes wirelessly. This architecture supports cooperative method like alleviating interference, joint scheduling, beam forming also flexible [5]. Additionally in C-RAN, by adjusting cluster size also by means of applying best resource it is easier to dynamically adjust the cluster size and apply best resource distribution approach improvement in the capacity and energy efficiency of system can be achieved [4]. Furthermore, reduction of Capital expenditure (CAPEX) and operational expenditure (OPEX) through virtualization technique constructing virtual base stations can be achieved [7].

Taking Service decision for mobile user at the core of the network has been proved that flexibility in upgrading network. Computing the resources at the core of the network reduces the delay as core consists of virtual base stations. In order to fully utilize the performance of cloud radio access network, cross layer design concept has been used and for monitoring the performance metrics like Throughput, packet delivery ratio, energy wasted and Latency.

## 2. SYSTEM MODEL

### 2.1 Brief about Proposed Mechanism

Centralized cloud radio access network is proposed. In this architecture we are taking the service provisioning decision to core of the network from the edge of the network [2]. In the proposed system link access and channel sharing will be resolved at the cloud in the core. By using the cloud computing infrastructure multiple clusters of servers can calculate the optimum topology with link management. This enables the network to compute the links and channel sharing based on much complex data like bandwidth and power and in a more efficient way, as the cloud has a large cluster of computers for computation. The frequent changes of link quality variations are observed at the edge and are sent to the cloud. The collaborative cluster computing at the cloud ensures a centralized optimization process and decision making. This enables easier upgrading the network. Less congestion and flexibility. In this we have adopted a cross layer scheme in order to monitor the performance metric such as packet delivery ratio, throughput, and latency.

## 2.2 Cross layer design

Cross layer design (CLD) is characterized as a different approach from the reference architecture model that does not permit direct correspondence involving non-adjacent layers also does not allow to share variables (e.g., TCP/IP or OSI) [3]. By Cross-layer design it is possible to underline the improvement in network performance by facilitating various layers of the Communication stack to distribute state information or to manage their activities so as to optimize network performance jointly.

## 2.3 Cross layer cloud based resource allocation

Implementation of a cross layer scheme at the RRH edges. Whenever a mobile generates a data it is handled by RRH, in the RRH physical layer computes the delay and MAC layer computes the bandwidth. The delay and bandwidth received by these lower layers then mitigated to the network layer of RRH. This information is sent to the BBU which then give it to the cloud for decision making.

At the RRH edges where nodes collect information from the observations from each layer and create a Multi-Metric cost. The cost is given as

$$\text{Cost}=(Bi)^{1/n} = \sum_{k=0}^{n} \binom{n}{k} P^k d^{n-k}$$

Where Bi is the bandwidth of the $i^{th}$ RRH, shared among n mobiles. $P^k$ The power loss for transmitting to all k nodes in a cell and d is the delay of transmitting to $k^{th}$ node. Bandwidth is calculated at the MAC and Network layer. MAC bandwidth is channel contention of a single RRH node, where as Network bandwidth is obtained through a series of probe exchange. Hence, Bandwidth B can be defined as

$$B=B_{(MAC)} + B_{(Network)}$$

$B_{(Network)}$ is further defined as the average factor of round trip time.

$$B_{(Network)} = 1/T \sum_{k=0}^{n}(1 - \text{Trtt})B$$

Where T is the round trip time of B bytes to mitigate to a RRH from a mobile and back.

# 3. PROPOSED METHODOLOGY

## 3.1 Simulation model and parameters

To simulate our proposed system we are using OMNET++. In our model of simulation, we are taking 8 nodes and all nodes have same transmission range of 100 meters. Each node is having a simulation time of 500s.

We use OMNET++ to simulate our network. OMNET++ is a network simulator and is designed for movement modeling of telecommunication network, set of rules modeling, modeling of queuing network etc. The basic architecture of the OMNET++ basically has got two parts one is GNED graphical network definition and the other one is a source file which is C++ file. The GNED defines the individual parts present in the simulation.

**Table-1:** Simulation Settings and Parameters

| Simulation parameters | Simulation values |
|---|---|
| Number of nodes | Min 8 |
| Channel type | Wireless channel |
| MAC | 802.11 |
| Packet size | 4096 |
| Simulation time | 500s |
| Transmission range | 100m |
| Mobility Model | Random WP |
| Protocol | DSR |
| Channel delay | 0.0001 |
| Channel data rate | 5.04858e+6 |
| Channel error rate | 1e-5 |

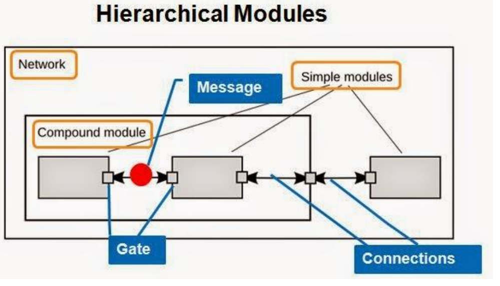


**Fig-1:** Basic architecture of OMNET+++

### 3.2 Performance parameters

We evaluate the performance of C-RAN based on the following parameters.

1) Throughput: The amount of data packets transferred from one node to another node in a specified amount of load. Typically throughput is measured in terms of Kbits per second.
2) Packet delivery ratio: this refers to the proportion of total amount of successfully data packets delivered to the total number of data packet transmitted from the source to the destination.
3) Energy consumed: This parameter indicates the amount of energy utilized for processing.
4) Latency: the amount of time taken by the data packet to travel from one node to another node.

## 4. SIMULATION RESULTS

Chart-1 shows the throughput as a function of load. The graphs illustrate that throughput of proposed system greater than present system at all load values. Thus proposed work gives good throughput.

Chart-2 shows packet delivery ratio as a function of load. Proposed system shows superior packet delivery ratio than that of present system because computation functionalities of cloud.

Chart-3 shows the energy wasted as a function of load. In the present system energy wasted will more than in the proposed system because RRH are low powered, and takes much time for processing. In the proposed system core network consists of virtual machines pool of BS.

Chart-4 shows the latency as a function of load. Latency of proposed system (cross layered) is less compared to latency of present system (non cross layered). This is because we taking the decision of computation at the core of the network rather than at the edges. It also reduces the congestion on RRH.

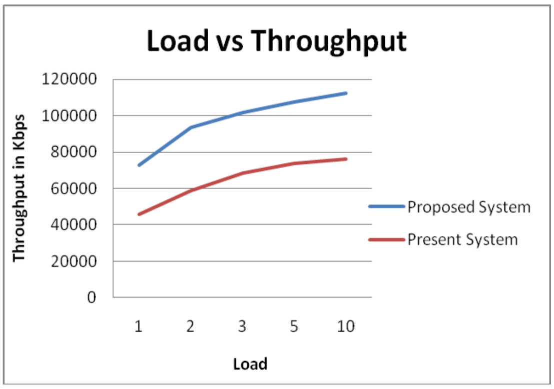


**Chart-1:** Load Vs Throughput

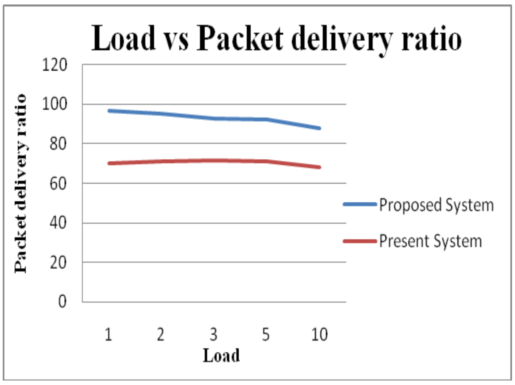


**Chart-2:** Load Vs Packet Delivery Ratio

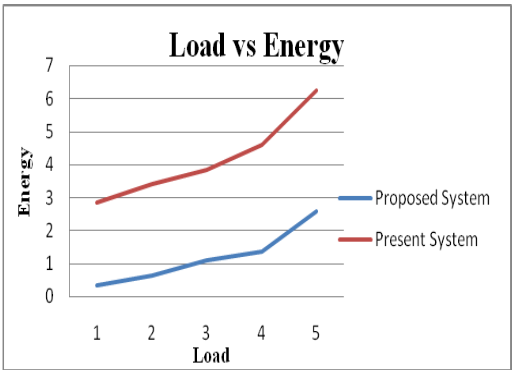


**Chart-3:** Load Vs Energy

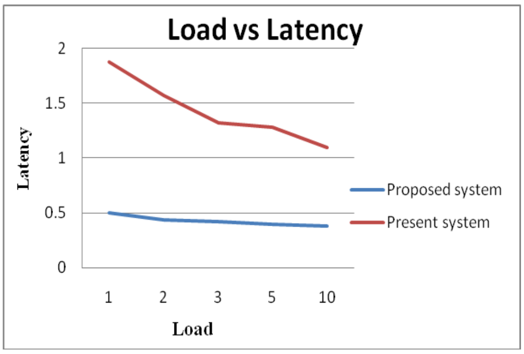


**Chart-4:** Load Vs Latency

## 5. CONCLUSION

As compared to the edge based resource allocation mechanism, the result of the core base computing and allocation of resources and the cross layered based BW calculation and resource allocation mechanism shows that it improves the current state of art of network layered based calculation at the edge significantly by improving the packet delivery ratio and throughput considerably under high load over the edge base system

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