Performance Improvement with Intra-site CoMP for C-RAN Networks

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Abstract
Coordinated multi-point (CoMP) transmission adopt the Base Stations (BS) cooperatively process User Equipment (UE) connected to multi-points to improve UEs spectral efficiency at the cell edge and eliminate the inter-cell interference (ICI). This technology is important for UEs at the cell edge. Considering the real environment, energy consumption and cost situation, we propose in a Local C-RAN architecture deployment of CoMP and observed its spectral efficiency and Signal-to-Interference and Noise Ratio (SINR) in intra-site CoMP scenarios. Simulation results show that this approach has significantly enhanced than Non-CoMP.

1. Introduction
OFDM and MIMO technology, through the high-rate data divided a number of low-rate data. Modulation onto the set of orthogonal subcarriers to transmitted, it can effectively eliminate the interference within the cell. However, in order to obtain higher spectral efficiency, the system uses the same frequency networking mode. So that UEs at the cell edge will receive the co-channel interference from the adjacent cell, severely limits the throughput and quality of service in edge, and OFDM technology cannot effectively eliminate inter-cell interference (ICI). Thus CoMP will be better solve these problems.

2. Related research
A. CoMP species
According to the relation between the nodes coordinated, CoMP can be divided into:
(1) Intra-site CoMP collaboration occurs within a site, at this time there is no return capacity constraints, so it can interact with a lot of information across multiple cells of the same site.
(2) Inter-site CoMP collaboration occur across multiple sites, thus for backhaul capacity and delay must be need high requirements.

B. Cloud radio-access
The Centralized, Co-operative and Cloud RAN (C-RAN) architecture [1] has many significant benefits. Energy efficiency: The power consumption of site support equipment can be largely reduced due to the consolidation of baseband unit (BBU) processing. Capital expenditure (CAPEX) and operational expenditure (OPEX): The pooling of BBUs allows centralized...
management and operation, leading to significant cost savings on site rental as well as operation and maintenance.

Capacity: More advanced transmit and receive wireless communications technologies can be implemented using the C-RAN infrastructure, leading to remarkable network capacity improvements.

Traffic offloading: BBU pooling can serve as a natural local breakout point to offload core network traffic to different network nodes as well as different radio access technologies if available.

3. System Models

While increasing the performance in cell edge is very important, but consider that in densely populated cities, the traditional C-RAN take up a lot of space is a problem. According to share different information, CoMP has many sharing scenarios. Many publications have shown how CoMP mitigates interference and improves both the data rate and the spectral efficiency in ideal networks.

In this paper we structure a local C-RAN, and the use of Coordinated Scheduling to improve the communication quality of UE’s in cell edge. It does not require very complex calculations, and adequate support Coordinated Scheduling. Finally we using the SINR to confirm whether to increase. SINR is one of the main aspects that should be optimized in any wireless communication system.

In the system model [4], we address some important parameters such as path-loss, antenna pattern and SINR. In the considered ideal network layout, each BS serves three hexagonal cells using three directive antennas. Each antenna covers one cell area, and the azimuth for each antenna is beaming 120 degrees out of phase from the neighboring antenna in the same BS. Serving cell selection criteria depends on UE downlink received power. Hence, the UE will be served from the sector which supports this UE with the highest Received Signal Level (RSL).

Considering a flat-plane path-loss, PL, model

$$PL = 120.5 + 27.6 \log_{10} \left( \frac{d}{\lambda} \right) \ [dB] \quad (1)$$

And $d$ refers to the distance between the UE and the BS. The path-loss exponent in equation (1) equals to 3.7 assuming shadowed urban areas.

The antenna pattern depends on the angle, $\phi$, between the antenna azimuth and UE, the front-to-back ratio of the antenna and the maximum possible attenuation ($Am$), and the 3dB main lobe beam-width, $\theta_{3dB}$. The antenna pattern equation can be defined as in:

$$AL(\phi) = \min \left( 12 \left( \frac{\theta_{3dB}}{\phi} \right)^2, Am \right) \ [dB] \quad (2)$$

The number of sectors per BS is affected by the values of $\theta_{3dB}$ and $Am$. In our case, each BS consists of 3 sectors with an antenna gain equals to 14 dB $\phi$ where $\theta_{3dB}$ and $Am$ are 70 degrees and 20 dB respectively. Each sector has directional antennas with 120-degree beam-width.

CoMP technique improves the UEs SINR values and reduces the interference at cell edge, where appropriate network optimization that care about choosing the coordinated sectors in CoMP systems can enhance the network efficiently. Considering J UEs and M cells. The experienced SINR by a UE $j$ from the serving cluster $M$ is formulated as:

$$SINR_{ij} = \frac{P_{\text{transmit}}}{P_{\text{interference}}} \quad (3)$$
4. Simulation & Results
In this section, the performance of the proposed BBU+RRU based CoMP system is evaluated by system level simulation.

<table>
<thead>
<tr>
<th>parameters</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout</td>
<td>20 sites with 3 cells</td>
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<tr>
<td>Inter-site distance</td>
<td>500 m</td>
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<td>Carrier Frequency</td>
<td>20 MHz</td>
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<td>Bandwidth</td>
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<td>UE Noise Figure</td>
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<td>Antenna Gain</td>
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<td>Resolution of</td>
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<td>Max Tx power</td>
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<td>BS antenna height</td>
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<td>FFT size</td>
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</table>

Table 1

SIMULATION PARAMETER

We simulated 20 BSs using one of the LTE frequencies which is 2.6 GHz and 20 MHz for bandwidth, and using hypothesis BSs locations. Each sector maximum transmitted power is 40 dBm which is a reasonable level of power that can be used in urban networks. Table 1 briefs the used parameters. These parameters are feed to the propagation modeling software.

5. CONCLUSIONS
In this paper, we propose a relatively uncomplicated and can save energy consumption- Local CRAN environment and using the coordinated scheduling. Simulation results show that this method has been improved in performance than not use.

Reference
[3] Huaning Niu; Clara Li; Apostolos Papathanassiou; Geng Wu “RAN architecture options and performance for 5G network evolution”, April, 2014, IEEE.

Figure 4 Network SINR CDF comparison between using CoMP and Non-CoMP approaches