Cell-free massive MIMO (mMIMO)

Introduction

Conventional mobile networks are based on cellular structure. In a cellular network, each user is served by one access point (AP) also called base station (BS). Thus, the whole geographical area where the network is deployed is divided by cells. One of the main challenges of a cellular communication network is variation in quality of service (QoS) resulting from distance from the AP (i.e. the center of cell). For example, the user located at the edge of the cell experiences lower QoS, compared to the user located near the BS. To enable a <u>uniform</u> high data rate for all users, a new concept known as cell-free mMIMO has been proposed.

In cell-free mMIMO, it is the APs that surround the users, rather than the conventional cellular that the users surround the AP. As shown in the following figure, in a cell-free network, APs are geographically distributed in the area of interest (can be an outdoor environment or an indoor e.g. inside of a factory). In contrast with the cellular networks, the number of APs is larger than the number of users and each user can be served by several APs. A set of APs are connected to a Central Processing Unit (CPU) using fronthaul connections and CPUs are connected using backhaul connections.
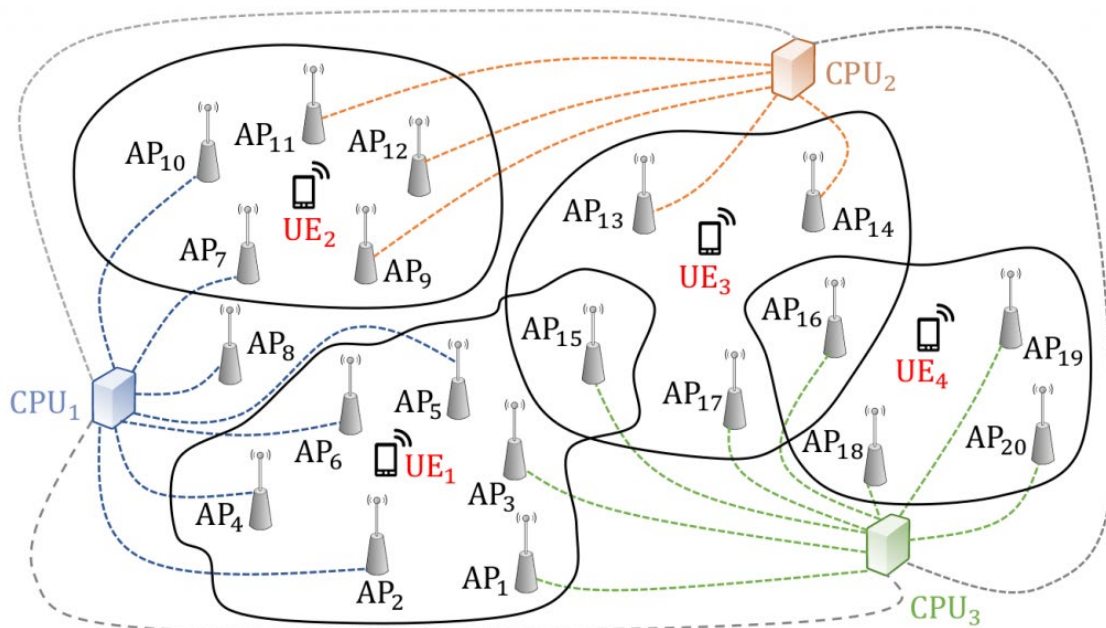

Figure 1. A cell-free structure with 4 users and 20 Aps. Blue, green and orange dashed lines are fronthaul connections and gray dashed lines are backhaul connections.

Description

It has been shown that cell-free mMIMO structure can provide high capacity communication evenly for all users. However, to achieve a realistic estimate of the achievable capacity, the non-idealities in the system should be investigated and practical challenges need to be addressed. In our previous work, we have shown in our analysis that the capacity can be improved by optimizing the position of APs while considering some of the HW non-ideal effects. To get closer to a practical solution different aspects still need to be investigated, including:

- Effect of HW nonlinearity on the achievable capacity?

- Difference of quality between APs hardware?
- Effect of limited backhaul/fronthaul communications
- Challenge of synchronization between Aps
- Effect of environment dynamics and AP deployment strategy on the user experiences
- Effect of AP-collaboration on focusing performance to users

To investigate cell-free mMIMO considering the abovementioned aspects, a few assignments are available in RS group. The assignment can be tuned to the student's interest and skills, and ranges from simulation to implementation. If this sounds interesting do not hesitate to contact us for more details.

Requirements:

You are familiar with MATLAB. You have a background/knowledge in wireless communication or willing to learn related skills.

Contact person:

If you are interested in this topic and similar assignments you can contact Yang Miao (y.miao@utwente.nl) or Siavash Safapour (s.safapourhajari@utwente.nl) from RS group.