3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Analysis of the switching threshold between unicast and broadcast modes in 5G cellular networks

Mohamad YOUNES [(1)], Yves LOUET [(1)]
(1) IETR/CentraleSupélec, Campus de Rennes, Av. de la Boulaie, 35557 Cesson-Sévigné, France
Email: mohamad.younes@centralesupelec.fr, Yves.Louet@centralesupelec.fr

Mobile networks have undergone major improvements in recent years in the delivery of popular content, notably with broadcast transmission (BC). BC transmission is known as an efficient method to optimize resource utilization when the same content is transmitted to a large number of users in the same cell. We consider BC transmission via the Multicast Broadcast Single Frequency Network (MBSFN) technique. In this paper, a threshold analysis to switch from unicast (UC) to BC mode is proposed in the framework of Covera5Ge[(1)] RAPID project. The idea to perform this switching is based on the calculation of the number of resource blocks allocated in UC and BC modes, in order to find the number of users from which the BC mode consumes less resources than the UC one.

A propagation model is considered with path loss, shadowing and fading effects with reference to the model proposed by the 3GPP [1]. The study considers a square area where the base stations are spread according to a PPP (Poisson Point Process) law with a density of 2 BS/km². We consider base stations with three sectors (with width of 120° each) with matched antennas capable of using UC beamforming (of which we use a certain number of antennas per sector - noted by M in the following). It is assumed that all base stations transmit OFDM signals at the same power (Ptx=0.5 W), use the same carrier frequency (f_c=2 GHz) and the same system bandwidth (B=5 MHz). These features are closer to real deployments than most assumptions in literature using the PPP model.

We present in Fig 1, the user threshold $Nb_{User\ sw}$ as a function of the targeted SINR γ_{target}, for different UC configurations: without beamforming (M=1) and with beamforming (M=2, 4, 8, 16). The evaluation of γ_{target} was performed over a range of γ_{target} from -5dB to 12dB, where γ_{target} is the minimum SINR to access the service. We note that when a service provider sets a γ_{target} of only -5dB, and the UC transmissions are performed using beamforming with 16 antennas per sector, the BC mode should therefore be preferred over the UC when there are at least 10 users per cell requesting the same content.

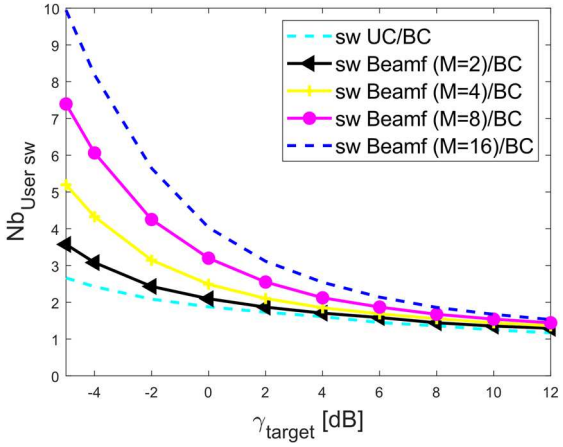

Fig 1. User threshold ($Nb_{User\ sw}$) as a function of the target SINR (γ_{target}), for different configurations of unicast mode.

Based on this study, we conclude that when a SFN covers a very large area, it still outperforms UC mode in terms of resource allocation, even when using beamforming with 16 antennas per sector, while still meeting the requirements of service providers. This information could be considered by the network planning tools in order to transmit with the most efficient transmission mode.

[1] 3GPP. Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios. TR 36.942. Version 15.0.0. June 2018.

[(1)]Covera5Ge is a French collaborative project supported by the DGA and whose partners are CentraleSupélec, ENENSYS Technologies and Siradel.