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Multiple Access Techniques for Beyond 5G Communications

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To meet the extremely challenging requirements of Beyond 5G Communications (B5G), such as, high spectral-energy efficiency, massive connectivity, low latency, and ultra-reliability, novel multiple access (MA) technologies have been proposed, in which the strategy of resource assignment to users is made from orthogonal to non-orthogonal [1].

Call K the number of active users and N the number of available resources; The system is called underloaded if $K < N$, while overloaded when $K > N$. In conventional MA strategies, users are allocated with orthogonal resources, that is, the system operates in an underloaded condition either in frequency (frequency-division multiple access FDMA), in time (time-division multiple access TDMA), or in code (synchronous code-division multiple access CDMA in underloaded regime) [2]. When the number of users exceeds the available physical resources, that is $K > N$, other degrees of freedom are used to suppress inter-user interference, such as, the power and code domains in Non Orthogonal Multiple Access (NOMA), or the spatial domain in massive MIMO. Note that, with spatial multiplexing, the number of available resources increases M-fold, where M is the number of base station antennas, making massive MIMO capable to achieve unprecedented spectral efficiency when $M \to \infty$. On the other hand, power and code domain NOMA techniques proved to significantly enhance spectral efficiency, with respect to traditional orthogonal access. Since massive MIMO will potentially become the norm in B5G, recent investigations addressed the application of power/code domain NOMA in massive MIMO networks. Power domain NOMA standalone was shown to outperform massive MIMO in the overloaded regime ($K > M$), but to also improve the sum rate performance in the underloaded case ($K \leq M$), in particular in line of sight (LoS) propagation by pairing users with similar channels [3]. Code domain NOMA, on the other hand, was shown to be beneficial even in the classical massive MIMO setup ($M \gg K$), particularly in non-LoS propagation, when users are geographically close to each other, for instance in public hubs like train station or offices in high rising building [4]. In the end, power and code domain NOMA may offer a far-sighted solution for future B5G massive MIMO networks, when spatial resolution is insufficient to separate close-by users.

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