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## On Device-to-Device (D2D) Communication



Nei Kato

In this editorial, I would like to highlight device-to-device (D2D) communication, which has emerged as a hot research area for next generation cellular networks. D2D communication typically aims to leverage the physical proximity of communicating devices to extend cellular coverage mostly in sparse deployment scenarios. D2D communication may have additional advantages such as offloading in cellular networks, improved spectrum reuse and system throughput, and so forth. However, it does pose new problems and challenges, some of which are mentioned as follows.

First, it is necessary to have a balanced yet dynamic sharing of resources such as spectrum and energy between cellular communication and ad hoc D2D communication. This is particularly important to accommodate large volumes of traffic as well as provide better service to users. However, the resource allocation challenge is specific to D2D design. For example, in D2D communication with operator controlled link establishment, the base station can partially manage the relay and channel selections. On the other hand, under the device-managed link setup, centralized relay selection or channel management are not possible. How to pinpoint a balanced mix from these various designs can be a basic but critical design factor for effective D2D communication.

Second, while designing D2D communication systems, careful attention must be given to interference management. Various methods for interference management can be found in the literature, such as D2D admission control, power control, relay selection, and even game theory. Nevertheless, for upcoming 5G deployments, interference management in D2D communication requires thorough research attention.

Third, cooperative communication is a big feature and also a big challenge of D2D communication. For example, a relay device's battery can quickly drain while relaying data for other users. If the relay device owner has no tangible benefit or incentive to relay, widespread user dissatisfaction is imminent. This will eventually lead to loss of customers and revenue for the network operator. Therefore, to realize the potential of D2D relaying in cellular networks, practical consideration for cooperation with adequate incentives must be given in the D2D system model.

Next, new and exciting applications of D2D need to be envisioned. Some researchers have considered D2D for relaying safety confirmation messages from disaster-affected people. Are there other ways to harness this technology? What part will it play in the 5G era? Could it facilitate a vibrant mobile social network platform? Addressing these questions could appeal to users/practitioners even more.

Finally, like so many other technologies, we should not forget the security aspect of D2D communication. The devices sending and receiving the data must be guaranteed that their data are not accessible to the relay, while the relay should also be assured that it is not handling any malicious data. Thus, trust management in D2D is an interesting but challenging area. In addition, other security issues on D2D such as routing, key management, privacy preservation, access control, attack identification and detection, need to be addressed with new approaches, that is, not only force-fitting existing solutions from the literature but also addressing these issues from the context of D2D communication.

The above is only a brief discussion of the major D2D topics. There are, of course, other open issues. Researchers and practitioners are cordially welcome to contribute their original and creative ideas on D2D in the context of our magazine.