Ilmenau University of Technology

Hierarchical Radio Resource Allocation for Device to Device (D2D) Communication in LTE and 5G

Problem Statement

Direct communication between user devices (D2D) offers the opportunity to introduce multiple new applications in mobile cellular networks. Examples are communication between vehicles, Vehicle-to-everything (V2X), which is required for e.g. autonomous driving or critical Machine-to-Machine (M2M) communication for direct communication between machines or robots in industrial environments.

These D2D applications are characterised by the demand for low latency and high reliability as well as small traffic payload, e.g. in the range of 10 to 300 bytes.

Cellular radio networks are, however, optimized for high traffic payload at modest reliability, required e.g. for streaming services and file download. Therefore, the granularity of the radio resources granted for data transmission is too coarse and not tailored to support the requirements of typical D2D applications.

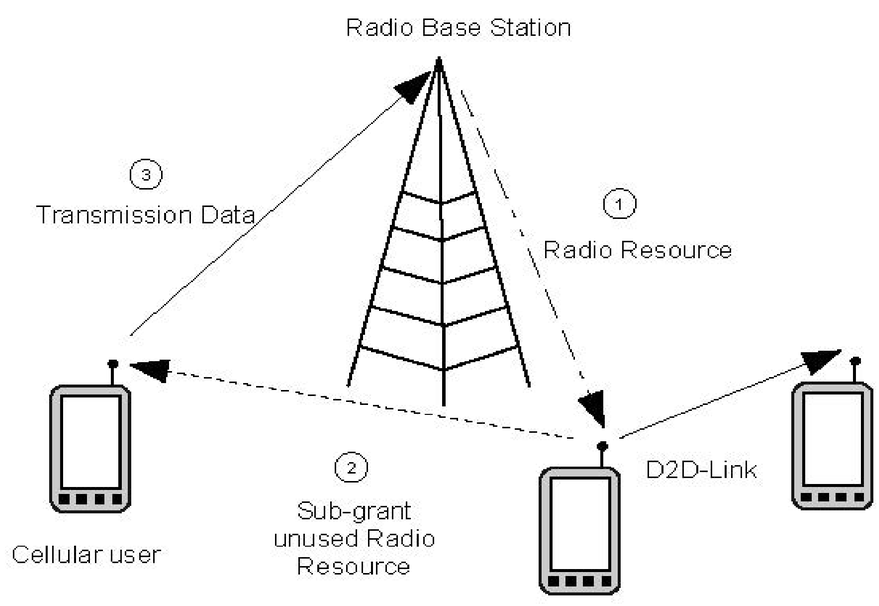

Fig. 1: Principle of Sub-granting for D2D Communication

Idea

- In order to provide low latencies at high reliability, a part of the radio resources need to be reserved for this traffic (semi-persistent scheduling). In case this traffic is event-based and sporadic, most of these reserved resources remain unused, resulting in a tremendous waste of resources which in turn decreases the overall network capacity.
- Our approach allows a second user in vicinity to benefit and allocate these reserved, but otherwise unused resources.
- In our hierarchical scheme, the base station grants resources to a highly latency and high reliability demanding communication semi-persistently (similar to the solution in LTE). In case this user does not need the granted resource, the resource is sub-granted to another user in its vicinity.
- The patent DE102016103027B3 of TU Ilmenau is granted in DE and describes the solution in detail.

Details

- The solution manages resources hierarchically at two levels. The first level is managed entirely by the radio base station (cf. label (1) in Fig. 1). The radio base station assigns the radio resources to the D2D users semi-persistently. In addition, the base station identifies a cellular user in vicinity of the D2D users.
- In the second level, the D2D user identifies the unused resources and "offers" the sub-grant to the selected cellular user in vicinity (cf. label (2) in Fig.1). For this purpose, the D2D user adds some additional information, which enables the cellular user to identify the sub-granted resource. The cellular user overhears the D2D user transmission and utilizes the sub-granted radio resource for its own data transmission (cf. label (3) in Fig.1).

Advantages

- The overall utilization rate in the cell increases by 15% to 55% in case 20% to 40% of the available radio resources are reserved for D2D communication
- An alternative approach is to reduce the transmission time of data by addressing the sub-frame length, i.e. shortening time transmission interval (sTTI).
- In LTE, the additional signalling information overhead for our sub-granting scheme is limited to 8% compared to the additional overhead for the sTTI scheme which results in 30% to 50% overhead depending on the sub-frame length.
- Our proposed scheme shows a 30% to 40% improvement in the utilization compared to the sTTI scheme, depending on the specific scenario.

Target Group and Applications

- Vehicle type communication (V2V) is a typical application for D2D communication, e.g. used for platooning and autonomous driving.
- Critical machine type communication (cMTC), e.g. machine to machine communication in industrial environments.

Development Status and Intellectual Property Rights

- German patent: DE102016103027, PCT application
- **Inventors:** Dariush M. Soleymani, Dr. Ing. Andre Puschmann, Dr. Ing. Elke Roth-Mandutz, Prof. Jens Mückenheim, Prof. Dr.-Ing. habil. Andreas Mitschele-Thiel
- **Applicant:** Ilmenau University of Technology

TECHNISCHE UNIVERSITÄT
ILMENAU

Contact
Thüringer Verwertungsverbund
c/o TU Ilmenau, PATON-PTH
PF 10 05 65
98684 Ilmenau

Tino Rhein
Tel. +49 3677 69 4556
Tino.rhein@tu-ilmenau.de
Unser Zeichen: PTH 01-214

www.paton.de
www.technologieallianz.de