Towards Ad-hoc Device-to-Device Routing in Cellular Networks

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Summary
The demand for bandwidth (BW) in cellular networks is expected to grow rapidly in the upcoming years. To prevent high investment costs to satisfy the expected demand, offloading traffic onto device-to-device (D2D) communication is a possible alternative.

Research Goals
- Enable multi-hop routing supported by incorporating existing infrastructure
- Relief cellular infrastructure by offloading traffic onto D2D communication

General Idea
- Split up communication traffic for transmitting payload and pure path finding messages (routing)
- User Equipment (UE) requests unknown route from infrastructure's Device-to-Device Routing Service (D2DRS)
- D2DRS maintains "global" view on ad-hoc network topology, regarding UEs in its service area, as graph (NTG)
- Payload is transmitted via D2D-communication (Ad-hoc)

Data Structures
- UE-level:
  - NHT: Neighbourhood Table: Maintains adjacent UEs in range
  - RC: Route Cache: Stores requested routes temporarily
- D2DRS-level:
  - NTG: Network Topology Graph: Concatenation of UE neighbourhoods

Message Types
- UE-to-UE:
  - HELLO: Broadcast Message between UEs for NHT setup
  - DAT: Message for data/payload transmission
- UE-to-D2DRS:
  - RREQ: Route request for unknown destination towards D2DRS
  - RREP: Route reply from D2DRS after shortest path calculation
  - NTU: Network Topology Update: Sent when new adjacent UE enters neighbourhood / radio range of sending UE

In situations where a large amount of data packages are passed through the network, the QoS can be increased by offloading data transmission onto D2D communication and keep the existing infrastructure responsible for routing tasks (i.e. proposed hybrid approach).

Utilisation of the limited bandwidth can be highly decreased by splitting-up means of handling pure routing- (UE-to-D2DRS) and payload transmission messages (UE-to-UE). The hybrid approach shows obvious improvements in comparison to pure centralised or rather decentralised methods.