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

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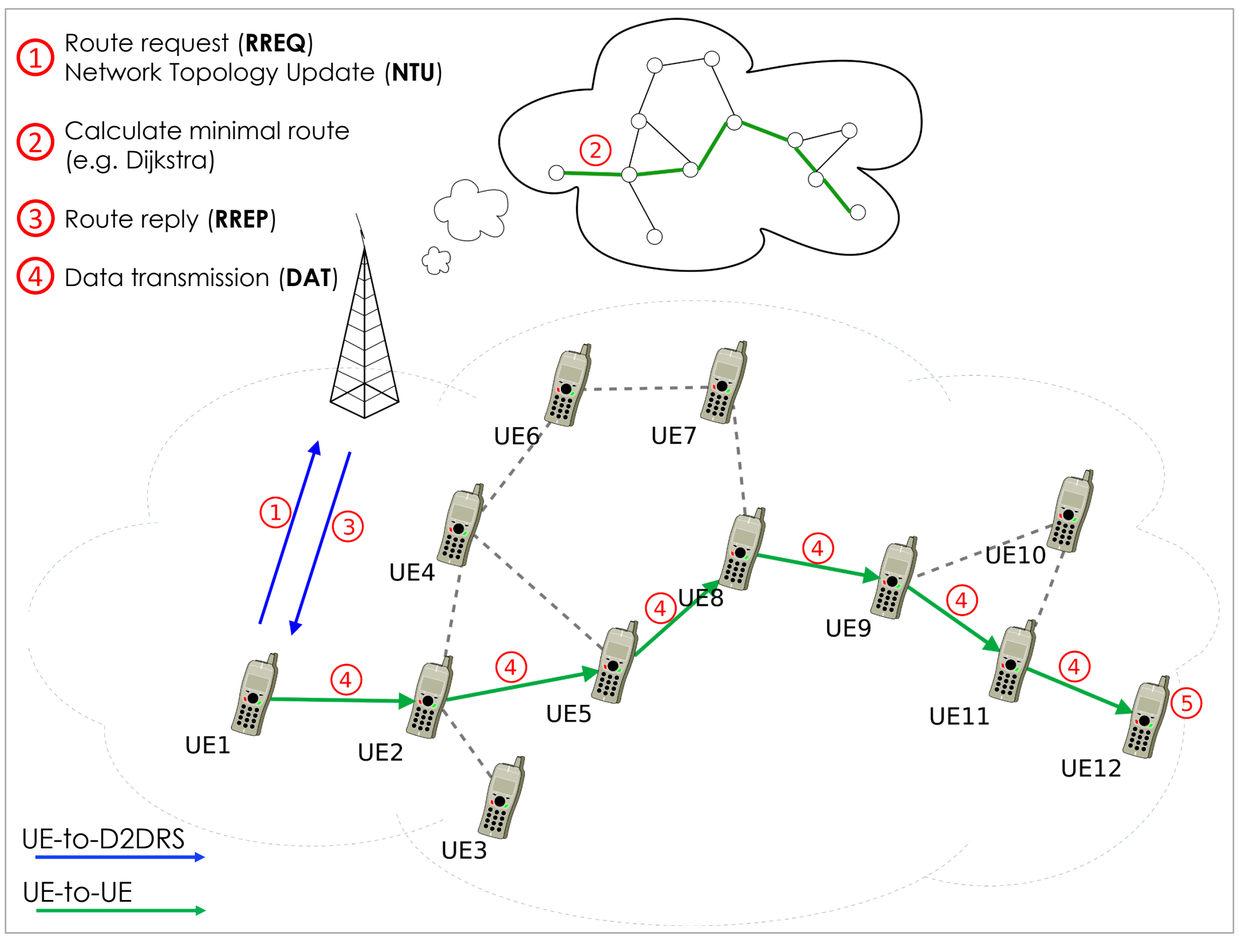
Summary

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

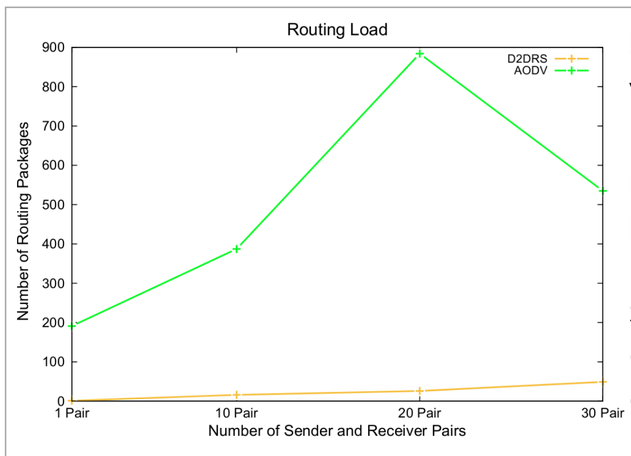
Message Types

UE-to-UE:

- **HELLO** Broadcast Message between UEs for NHT setup
- **DAT** Message for data/payload transmission

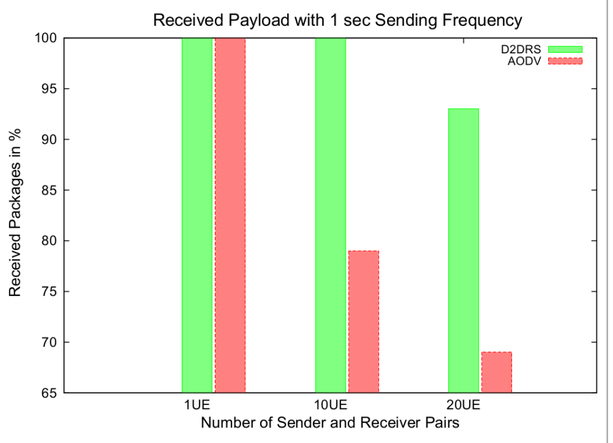
UE-to-D2DRS:

- **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



Utilisation of the limited band-width 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.

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).



Sim. duration: 900s
Package size: 512KB
Sim. area: 655x1055m
Total number of UEs: 650
WiFi-range: 250m
UE mobility: Random Waypoint (velocity 2-6 m/s)