Advanced VANET routing design

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Content

- VANET routing approaches
- Simulations
- Advanced VANET routing design
- VANET communications solutions
- Conclusion

VANET routing approaches

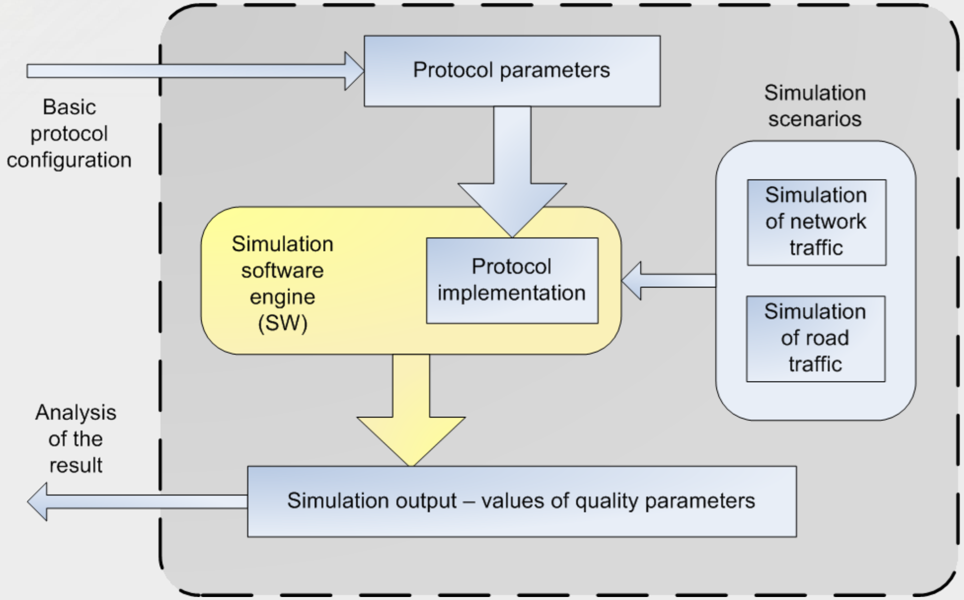
- Position based routing
  - Greedy Perimeter Stateless Routing (GPSR)
  - Geographic Source Routing (GSR)
  - Anchor-based Street and Traffic Routing (A-STAR)
- Cluster based routing
- Geocast based routing

VANET routing approaches

- Different approaches to routing issues
- Efforts to create more complex protocols
  - Improvement in the formation of clusters
  - More efficient use of vehicle position
  - Use of actual traffic information
  - New type of messages with information about throughput or content of messages
  - Use of fuzzy logic to determine suitability of individual wireless connections
- No universal approach which solve existing problems

Simulations

- Different software simulators
- Simulation scenarios
  - Simulation of network traffic
  - Simulation of road traffic
- Analysis of results



Advanced VANET routing design

- **Combination of Geocast based type routing with centrally managed clustering.**

- Reduction of collisions due to dominant centralized communication approach with dedicated bandwidth and application in cluster only event-based case.

- Limited available accuracy of vehicles localization based on GPS satellite services can be improved by processes based on digital road maps application.

Advanced VANET routing design

- Application of dynamic clustering based solution

- Specific rules for formation of clusters
  - The same direction of move and mutual distance
  - Speed difference between vehicles
  - Density of vehicles in area

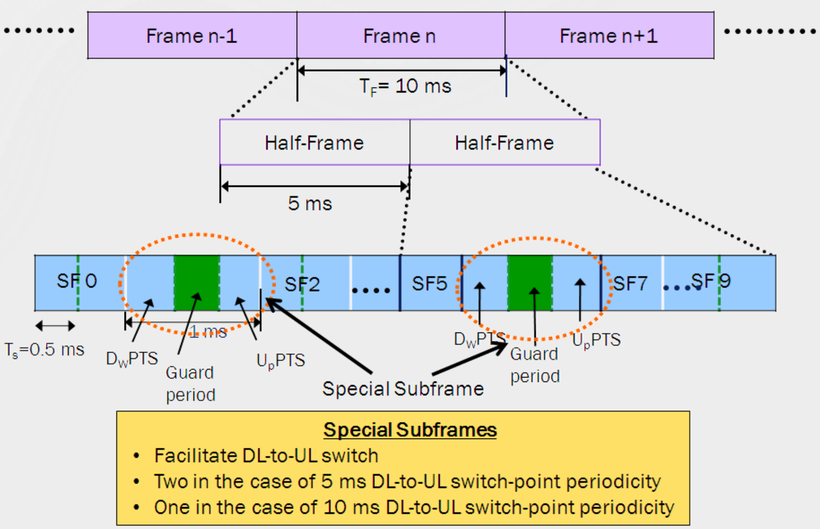
VANET communications technologies

- IEEE 1609 Vehicular Environments (WAVE)
  - Decentralized pinciples (based on 802.11-2012 principles) - limited for 100+ users per 2x10MHz bandwidth in 100ms service period
  - Centralized RSU based approach (1 RSU per 1km)
- 3GPP LTE
  - Infrastructure-based centralized architecture
  - Centrally operated traffic management
  - Potential of decentralized communication based on D2D principles as future option - Rel. 12 D2D and planned Rel. 14 C2C

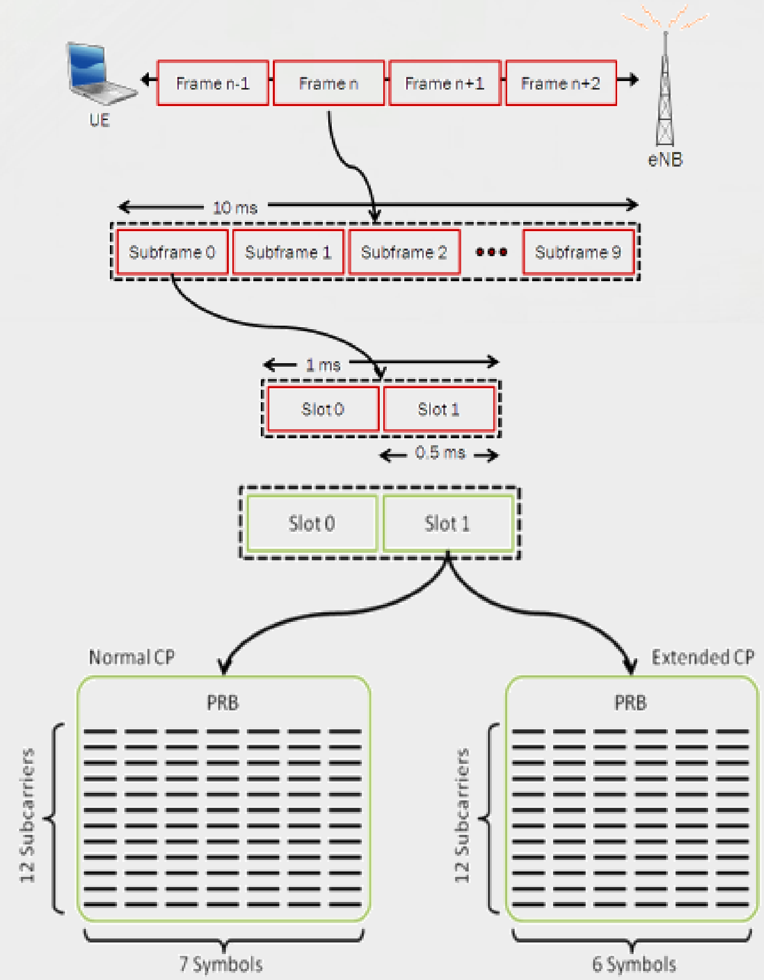
LTE TDD and FDD

Both FDD and TDD are supported. TDD frame structure is more complex, however, it can be much more effective if traffic is not balanced

Type 2 Frame Structure (TDD)

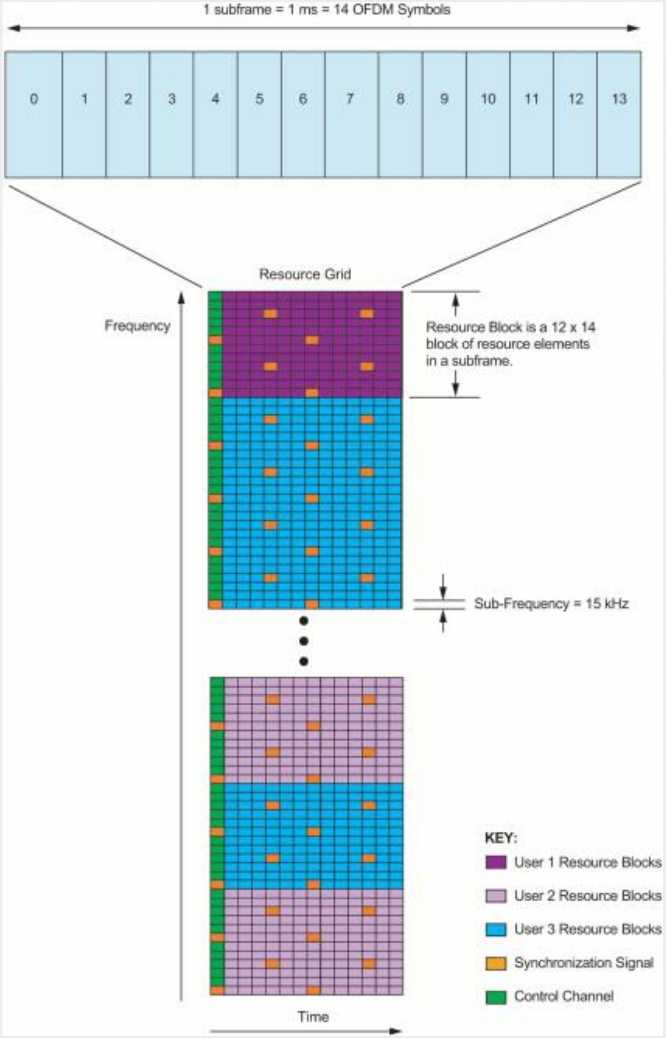


LTE Frame Structure



3GPP LTE – Resource grid

- One subframe represents 14 symbols (standard CP) and 12 frequencies.
- In case of 64QAM symbol represents 6bits and subframe represents 12*14*6bits = 1008bits including overhead.
- Typical LTE overhead is approx. 15%; however, it can in specific conditions reach up to 45%.
- In case of FDD 2x10Mhz – up to 5000 short beacons (<100B resp. 126B with overhead) can be transferred in each direction (FDD) in 100ms service period



3GPP LTE implementations frames

- Critical C-ITS applications (i.e. anti-collision systems, extended autonomous driving, …) generate strong expectations on guaranteed telecommunication service quality.
- Conflict between guaranteed service quality requirement and relatively low expectations of public services
- Legal issue of principally different requirements on one network - it should be revised and most probably also legislatively modified to enable such specific approach to share capacity for both public and “critical for society” applications with specific QoS provisioning dedicated for explicitly defined CUGs (Close User Groups).

Conclusion

- Most suitable option is to combine Geocast based routing type with centrally operated vehicles clusters based support

- It leads to combination of centralized mobile services on LTE basis used for periodical C2I communication and C2C non-periodical event based data exchange (either WAVE or D2D LTE).

Thank you for your attention.