A Token-Based MAC Protocol for Achieving High Reliability in VANET

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Goals

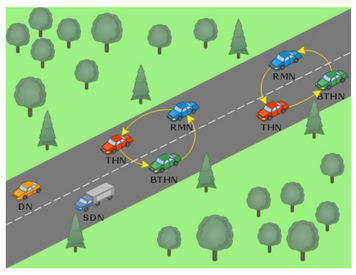
- **Address the short-comings of IEEE 802.11p**
- **Support the strict requirements on timing and reliability**
- **Using standardized 802.11-based hardwares**

Background

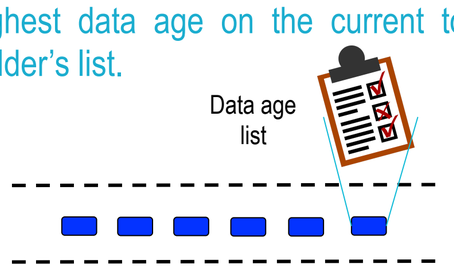
- CAM (Cooperative Awareness Messages) or beacon [1]
  - Short, periodic status messages (2-10 times per second)
  - Broadcasted by every car
  - No multi-hop intended (so far)
  - Include: position, speed, direction, other status information (e.g. blinker status)
- DENM (Decentralized Environmental Notification Message) [2]
  - Event-based warning message
  - Broadcasted only during specific event
  - Broadcast stops when event is over

Protocol Description

1 Ring establishment and maintenance

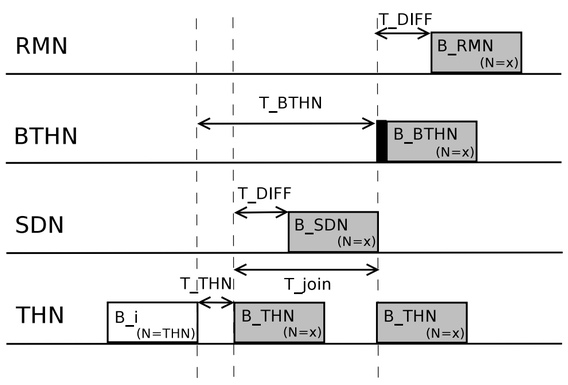


2 Data age list generation
- Each vehicle maintains a data age list logging the age of the latest successfully received beacon from individual nodes.
- Next token holder is the node with the highest data age on the current token holder's list.



3 Token Passing
- Token is circulated with beacon packets
- Whoever holds the token has unique right to access the channel
- Each token holder is responsible for the choice of the next token holder

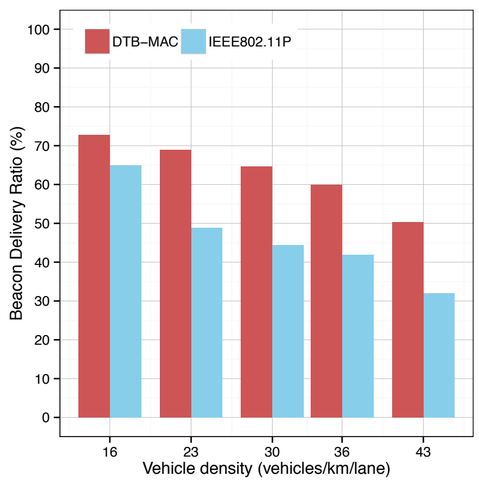
4 Transmission order



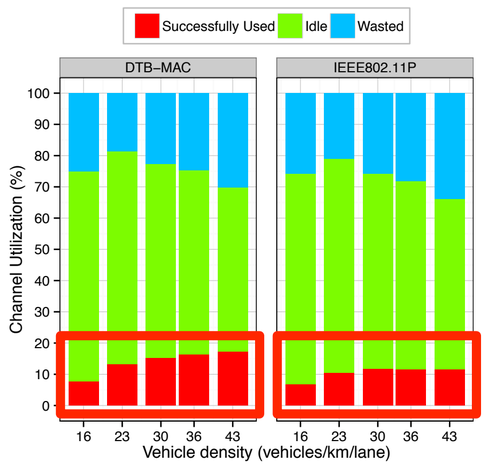
Highway Scenario

- Metrics
  - Channel utilization
  - Beacon Delivery Ratio (BDR)

Propose an alternative solution specially for high densities when IEEE 802.11p is not able to handle a high number of beacons.



The way DTB-MAC uses the token passing not only does not produce more delay, but also improve it for some network densities.

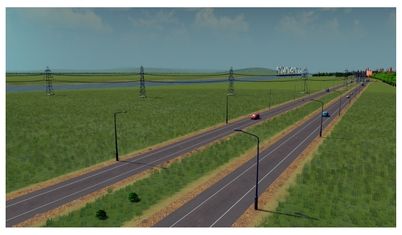


Simulation Settings

- Beacon Send Rate: 10 packet/s
- Beacon size: 500 Bytes
- Data Rate: 6 Mbps
- Transmission Range: 500 m
- Simulation time: 300 s
- Simulation package: Veins

Simulation Scenarios

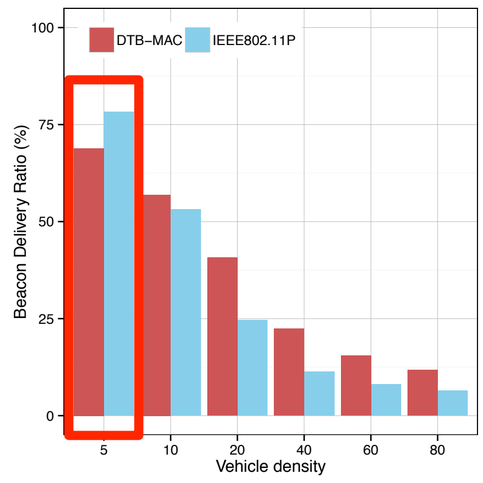
- Highway Scenario
  - 2.2 km highway with 2 lanes

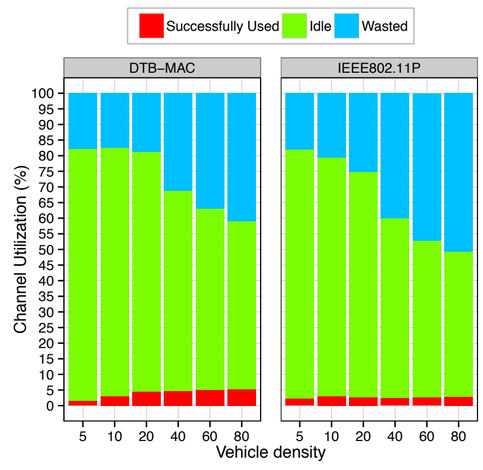


- Urban Scenario
  - Downtown of Milan
  - 2.6*2.6 km^2

Urban Scenario

- In low densities
  - difficulties for token circulation
  - low BDR





Conclusions

- Support for delay-sensitive data traffic through deterministic channel access is needed
  - In the current standard this support is compromised due to the properties of IEEE 802.11p MAC
- A distributed, token-based MAC method supports reliable beacon broadcast before a given deadline
  - Prioritizing vehicle that is in most need to communicate to keep its deadline.
  - Built-in retransmission opportunities (if bandwidth available)

Future Works

- To extend DTB-MAC protocol by adding support for event-driven messages for safety applications in highway and urban scenarios
- To extend our token-based protocols to handle Platooning Application challenges
  - Selecting a token manager when two tokens are detected
  - Merging two platoons of cars driving in close proximity

References

[1] "Its; vehicular communications; basic set of applications; part 2: Specification of cooperative awareness basic service," ETSI Std. EN 637-2, Tech. Rep., November 2014.
[2] "Its; vehicular communications; basic set of applications; part 2: Specification of decentralized environmental notification basic service," ETSI Std. EN 637-3, Tech. Rep., November 2014.

Acknowledgements

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