What is the Best Achievable QoS for Unicast Routing in VANET?

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OUTLINE

- Motivation
- Approach
- Simulation environment
- Results and discussion
- Conclusions

MOTIVATION

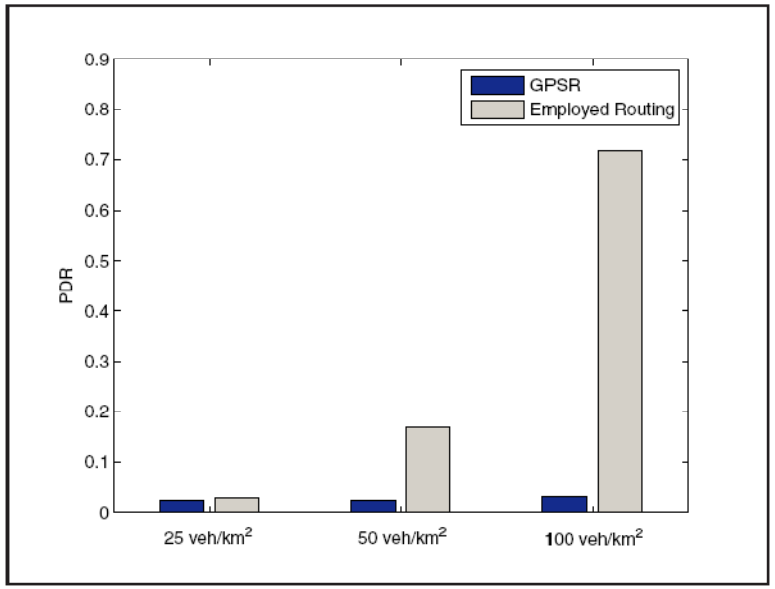
- A lot of research dealing with the design of VANET routing protocols:
  - How to increase the PDR/throughput?
  - How to decrease the delay?
- Questions:
  - Which unicast applications will be feasible over VANET?
  - What is physically achievable over DSRC-enabled, infrastructureless VANET with regards to delay, jitter, and PDR?
  - How long can a connection last?
- We analyzed the VANET QoS that will be available to applications using *any* unicast routing protocol

APPROACH

- Build a realistic simulation environment, but with optimum conditions regarding the unspecified VANET parameters
- Specified parameters: Road topology, mobility, signal propagation, vehicle densities, DSRC
- Unspecified parameters: routing protocol, transport protocol, interference

Routing

- Only one sender/receiver pair
- All paths between the S/R pair are analyzed
- Optimum path (defined by least delay) is utilized

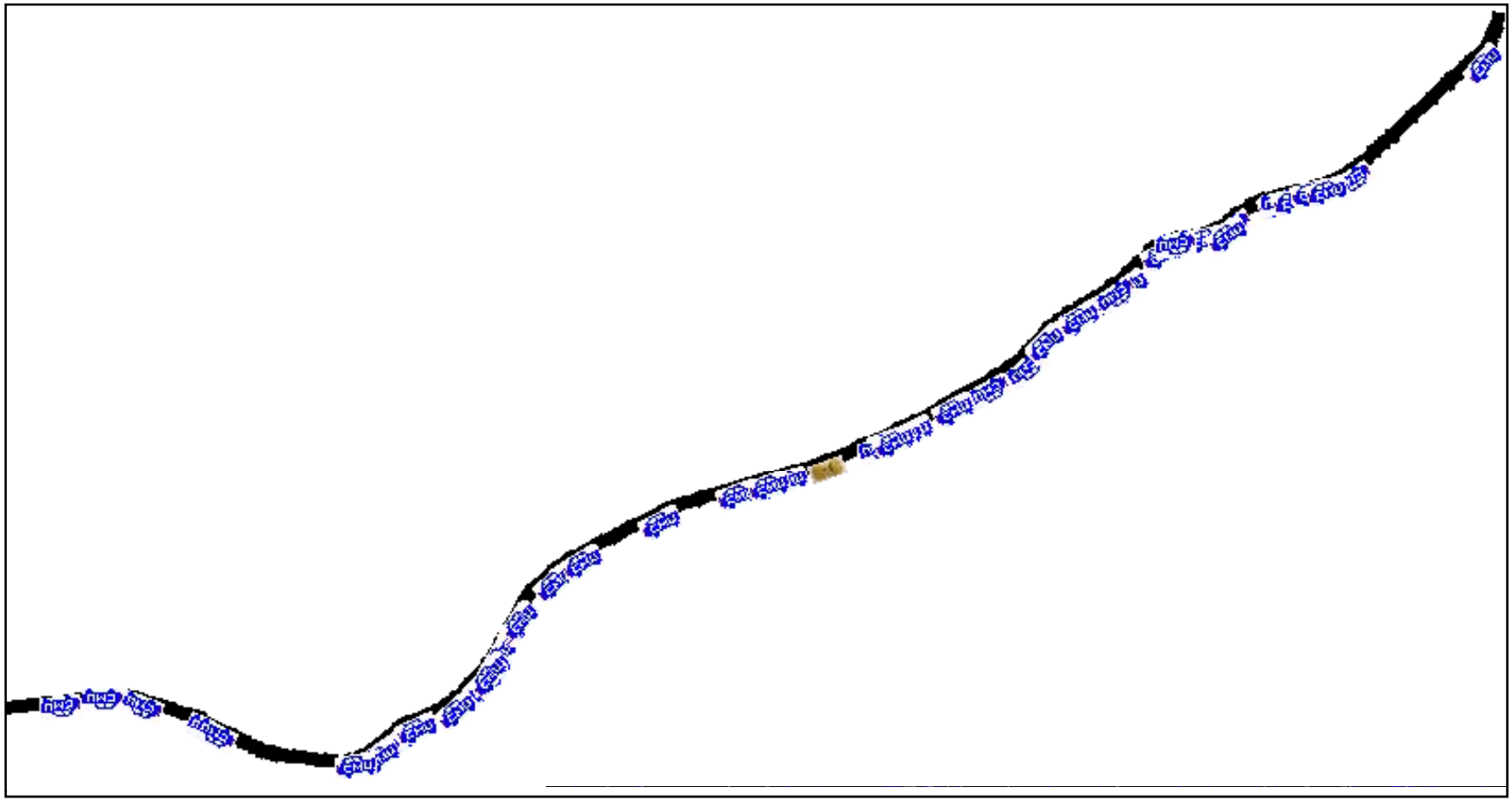


SIMULATION ENVIRONMENT

JiST/SWANS with STRAW mobility model

- Environment setup
  - Vehicular mobility: car following with intersection control and lane changing
  - Vehicle densities: 5, 10, 20 veh/km (hwy); 10, 25, 50, 100 veh/km^2 (urban)
  - Vehicle speeds: Normally distributed; mean ≈ 100 km/h, std. dev = 0.25*mean (hwy), mean ≈ 50 km/h, std.dev. = 0.35*mean (urban)
- Implemented PHY and MAC layers of DSRC
  - 20 MHz channel, 5.9 GHz frequency, connectionless LLC, 6 Mb/s
- Signal propagation model:
  - Highway: two-ray model, 550m
  - Urban: shadowing model; up to 50m with near 100% probability, progressively decreasing up to 400m (near 0% probability after 400m)
- Number of senders: two, sending 20 msg/sec to each other.
  - Message size: normally distributed, mean = 100B, std. dev = 15B

Highway

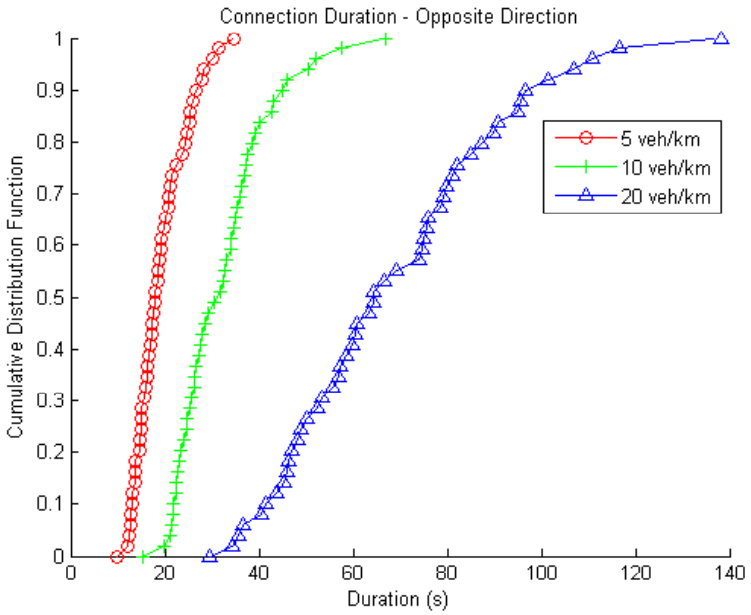


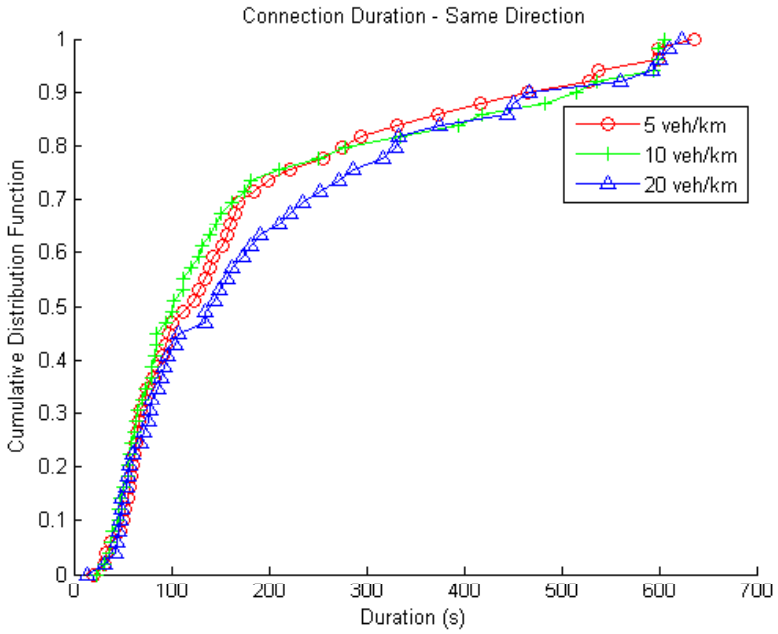
Urban area

RESULTS AND DISCUSSION

Connection Duration

- Highly dependent on vehicles' relative speed
- At higher relative speeds, additional vehicles increase connection duration significantly





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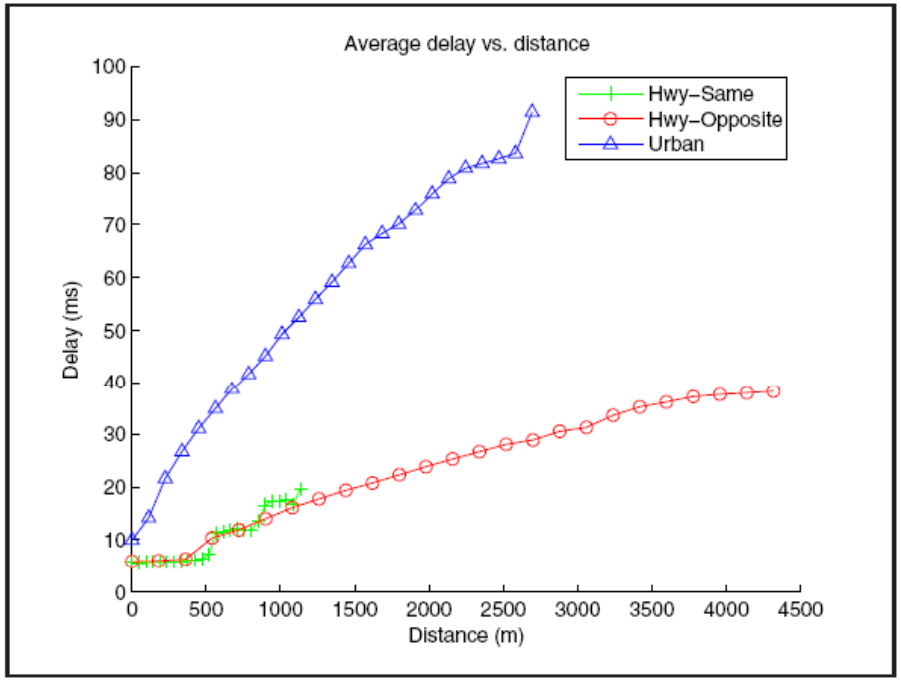
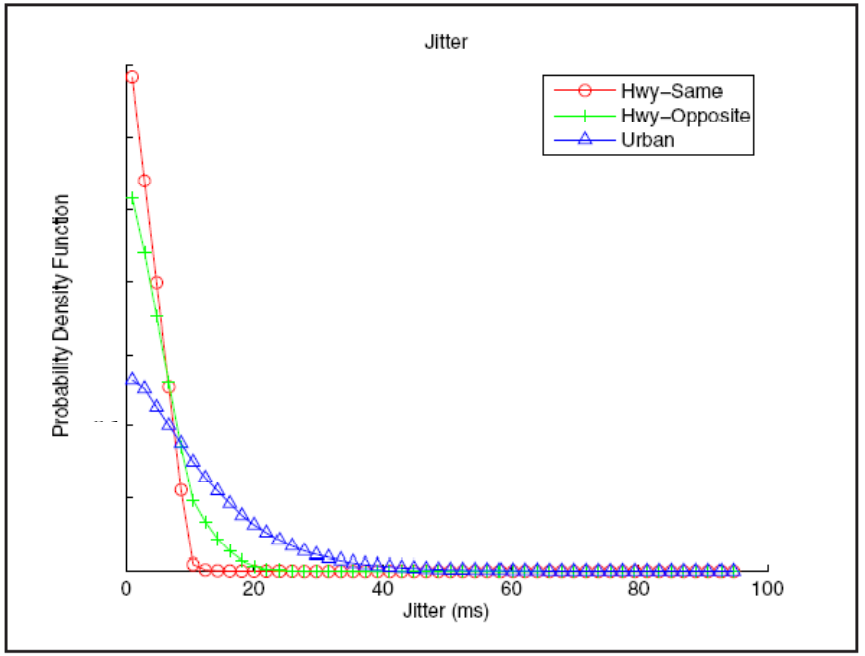
Delay

- Delay is highly dependent on the distance
- Increases linearly with different slopes for different environments



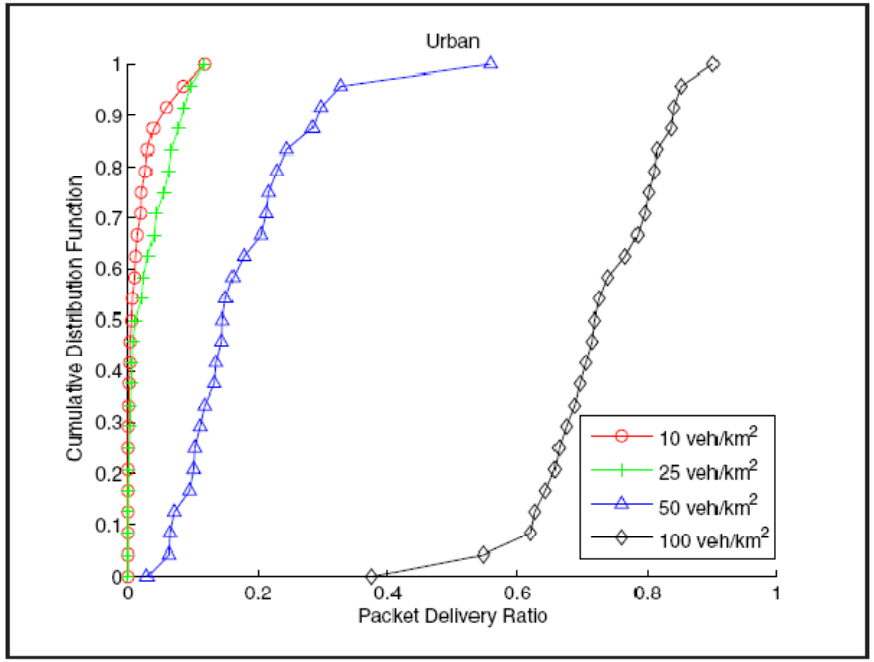
Jitter

- Largely confined to 0 - 30 *ms* on highway
- Longer tail in the distribution of jitter in urban environment
  - Due to decreased transmission range, which implies larger number of hops, thus producing larger variance



PDR

- Greatly affected by vehicle density
- Median values of PDR: 1%, 3.5%, 17%, and 72% for the analyzed vehicle densities



CONCLUSION

- VANET has the ability to provide the applications with:
  - Delay under 100 *ms*
  - Jitter largely under 40 *ms*
- Given a high enough vehicle density in urban environment or a small enough locale of interest in highway environment, PDR is satisfactory
- Connection duration is the biggest issue

Connection duration

- In urban environment, connection duration is low
  - it is limited physically by the shadowed environment and by the prohibitively shorter connection duration with the increase in the number of hops.
- In highway environment, connection can be prolonged significantly by relaying vehicles

Impact of VANET QoS on real-time applications

- Even with well connected network, applications have to be bound by the locale of interest:
  - in order to avoid high delay and/or flooding the network
  - in order to have a meaningful connection duration
- Data from positioning systems (location/direction/speed) could be used to great advantage to prolong the connection duration
- In urban areas, connection duration is insufficient for most applications (without the infrastructure support)

SUMMARY

- Upper bound for QoS
  - Detailed analysis of achievable QoS in both highway and urban VANET environment
    - Delay, jitter, PDR
    - Connection duration
- Feasibility of unicast, real-time applications
  - Insight into potential performance of unicast applications running on top of DSRC-enabled VANET.