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# Performance Evaluation of ADV with AODV for Real-time and Multimedia Applications in Vehicular Ad-hoc Networks (VANETs)

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**Abstract:** It is expected that wireless communication and access technologies will continue to evolve at a rapid speed. Different wireless networks such as IEEE 802.11, 3G/4G, WiMAX, multimedia networks and sensor networks, will integrate into the next-generation vehicular networks. This will result in several diverse real-time applications. Given the high mobility of vehicles, there are many outstanding issues to be resolved before real-time applications based on multimedia over VANETs become a reality. In multi-hop communications the vehicles are consistently in motion and real-time multimedia applications require more bandwidth; a number of factors need to be considered during communication e.g. Throughput, packet loss, time-to-live, delay and jitter etc. Therefore, selection of routing protocol is important in these real-time applications over VANETs. In this paper, a comparison of ADV with AODV routing protocols for real-time applications is presented. Simulation results show that ADV outperforms AODV in audio and video data communication.

**Keywords:** ADV, AODV, DSR, DSDV,VANET, RTP, RTCP, SDP

## I. Introduction

VANETs have an important role to play in the wireless world so as to provide multiple services to mobile users like traffic information, road safety and instant help for accidental casualties, entertainment, weather forecast and so on. Some other VANET applications include Vehicle collision warning, remote security warning, driver assistance, cooperative transmission, cooperative cruise control, distribution of the highway information, internet access, location map, automatic parking, and vehicles without drivers. Multi-hop communication is quite a tough job because of the continuously changing network topology. The packet loss and delay become more critical in real-time applications like multimedia and video streaming. The effect of the packet loss needs to be carefully assessed in these delay sensitive applications. Path selection is another acute aspect in distributing packets to the destination for smooth playing of video in multi-hop communications. In a particular communication between vehicle and the RSU or between vehicles, there could be a number of routes available to transmit data; so an intelligent choice of the route should be arranged to utilize the available bandwidth more efficiently.

Multi-hop communication is much like a peer-to-peer network. If a source node fails during communication then another path can be established using any other node so that the communication remains continuous. As the vehicles are generally in high speed at highways, handover occurs very frequently due to the limited range of the wireless adapters used for communication. Luckily, like other ad-hoc networks, low battery power is not a problem in VANETs. Larger buffers also tend to minimize the latency incurred by the multi-path and multi-hop communication.

## II. RELATED WORK

VANETs can be described as a subset of MANET in which the speed and direction of the nodes can be quite diverse. In recent years, several peer-to-peer systems have been proposed for Mobile Ad Hoc Networks (MANET) [1]. The VANET nodes pass through a number of static internet gateways and because of their high speed they get connected to a particular gateway, send a small amount of data and then disconnected as they get out of the wireless range. A link reliability model is presented to characterize the duration for which a link remains active in some previous work [2]. Link reliability model is a function that can guess the probability of future status of a wireless link. A Delay-reliability constrained QoS routing algorithm had been presented in [2] according to which reliable routes which have more estimated lifetime and less hop numbers should be chosen instead of the shortest paths that are probable of to be broken quickly. A comparison of different routing protocols used in VANETs is presented in [3]. The pros and cons of Topology based (Proactive & reactive) and position based protocols is described. In another work, a combination of a sensor network and VANET is suggested [4].

In terms of regulated bandwidth usage and startup delay, streaming video has better performance over downloading. However, it must be the size of the overlays which is under strict control in VANET to avoid a surge in the movement of the competition between the nodes of overlay, leading to increases in the rate of acceptable packet loss [5]. The output of VANET Routing protocols rest on numerous parameters such as the mobility model, driving environment etc. Routing is an important component of vehicle-to vehicle and vehicle-infrastructure communication. Designing an efficient routing protocol for all VANET applications is very difficult. The position-based protocols and cluster-based Geo-cast are more reliable for most applications in VANET [6].

A recent work addresses problems such as channel outage due to motion, congestion because of traffic jam and negative interaction between channel outage and congestion. Video stream should be smoothened because it is more bursty. This can be done by minimizing the amount of video compression with respect to the flow of overall traffic. It is imperative to have a congestion control algorithm and a simple traffic shaper so that the packet Average delay and losses experienced can be reduced and effectively cope with Congestion [7].

In another work, a scenario is presented where two vehicles are connected for a long time period but not continuously. These links arise between vehicles of identical mobility behavior, which urged the generally high reliability rating. This problem is addressed through a path stability protocol [8]. The purpose of this Protocol is to take benefit of the broadcast nature of communication in VANETs, for the use of in-between vehicles to automatically relay packets between the sender and the receiver out of the reach. PASTA is designed to work within the protocol layer to the current MAC. A quality driven routing protocol is suggested in [9] based on the optimization of video quality, in terms of improving the quality of the visual video frames transmitted and the smoothness of the sequences. To assess the quality of performance driven by the guidance system, the proposed model is compared with the traditional greed geo-routing protocol in erms of quality transmission (time delay and the number of freezing) and visual quality (PSNR of video frames delivery). Rise in the data speed results in less contribution to delay the start. In [17] a comparison of AODV, DSR and DSDV routing protocols is presented and simulation results show that AODV provides better performance than the other two protocols.

## III. DESCRIPTION OF AODV AND ADV

Routing protocol has a huge impact on the throughput obtained in wireless networks. There are a number of ad-hoc routing protocols in use today each with their own pros and cons. We will give a brief description of ADV and AODV and use each of them in VANET. The simulation results would be used to compare their performance metrics.

### a. ADV Routing Protocol

The Adaptive Distance Vector (ADV) is a Distance Vector Routing algorithm that uses sequence numbers to deter loops in the network. ADV is similar to other distance vector algorithms but it reduces the routing overhead by fluctuating the frequency and size of routing updates owing to variation in traffic and node mobility. It maintains routes to active receivers only so that the number or entries advertised is reduced. It triggers partial and full updates so that periodic full updates are avoided.

### b. AODV Routing Protocol

AODV is a distance vector routing protocol. Unlike proactive routing protocols like DSDV, AODV is reactive which means that it only requests a route when required and does not need nodes to maintain routes to destinations that are not currently active. When a node wants a route to a destination which is currently unidentified or the previous node has expired, it broadcasts a RREQ. The source node uses an escalating ring search technique to avoid unnecessary flooding of RREQs. This technique uses neighborhood to find the destinations. The TTL (Time-to-Live) field in the IP header of the RREQ packet is used to regulate this search.

## IV. Simulation

### a. NCTUns Simulator

We have used the NCTUns simulator for simulation purpose. NCTUns is a powerful and flexible simulation and emulation tool which can simulate large networks and various protocols used in both wired and wireless IP Networks with high precision. NCTUns directly uses real-life Linux TCP / IP stack to generate high-fidelity simulation results. By using the novel kernel reentering simulation methodology, a real-life UNIX (e.g., FreeBSD or Linux) kernel's protocol stack is directly used to generate high-fidelity simulation results.

### b. RTP, RTCP and SDP

Real-Time Transport Protocol (RTP) provides node-to-node network transport functions appropriate for transmission of applications which are delay-intolerant, such as audio, video, or simulation data on unicast or multicast network services. RTP does not provide resource reservation and does not assure quality-Of-service for real-time services. The data transport is governed by a control protocol (RTCP) to observe reliable delivery of data in large multicast networks, and to deliver marginal control and identification functionality. RTP and RTCP are so designed that they are independent of the underlying transport and network layers. The protocol supports the use of RTP-level translators and mixers [14]. SDP is envisioned to define multimedia sessions for session declaration, session invitation etc. It offers a layout for defining session information to session members. This information comprises the name of the session and media type and format.

### c. Simulation scenario

Nodes in the simulated VANET all have IEEE 802.11 PHY/MAC acquiescent network interfaces. Vehicular scenario is implemented using the CarAgent application. The default car agent program provided in the NCTUns package represents a proof-of-concept reference implementation showing that such a car agent program can drive a car on a road network with reasonable driving behavior. 18 nodes are moving along 4-lane road within an area of 1200m by 680m. Vehicle average speed is set between 8 to 50 m/s with maximum acceleration 1 to 10 and maximum deceleration 1 to 20 meter per second square in each scenario. Audio, video and data packets are applied to test the performance of our algorithm. Real-time audio and video data are sent by using real-time transport Protocol (RTP). Table 1 shows the physical layer and channel model parameters of simulation environment:

**Table 1.** Simulation Environment Parameters

| | |
|---|---|
| Frequency (MHz) | 2400 |
| fadingVar | 10.0 |
| RiceanK | 10.0 |
| TxAntennaHieght (m) | 1.5 |
| System Loss | 1.0 |
| Trans Power (dbm) | 3.0 |
| AverageBuilding Height (m) | 10 |
| Street Width (m) | 30 |
| Average Building Distance (m) | 80 |
| Path Loss exponent | 2.0 |
| Shadowing Standard Deviation | 4.0 |
| CloseInDistance (m) | 1.0 |
| RxAntenna Height (m) | 1.5 |

Figure 1 shows a snapshot of network topology during simulation.

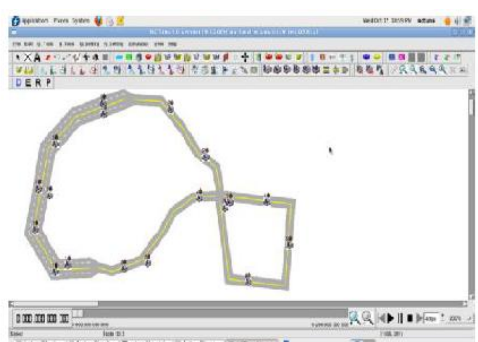

**Figure 1.** A snapshot of simulation using NCTUns 6.0

Table 2 shows the Video packet specification which is used to send video data over VANET.

**Table 2.** Specification of Video data

| | |
|---|---|
| Session bandwidth | 1600 Kbps |
| Media Type | Video |
| Payload Type | 34 |
| Encoding | H263 |
| Sampling Rate | 90 kHz |
| Bits per sample | 1 |
| Frame Rate (F/sec) | 30 |

Table 3 shows the Audio packet specification which is used to send audio data over VANET.

**Table 3.** Specification of Audio data

| | |
|---|---|
| Session bandwidth | 1600 Kbps |
| Media Type | Video |
| Payload Type | 127 |
| Encoding | GSM |
| Sampling Rate | 8 kHz |
| Bits per sample | 1.65 |
| Packet time | 20 ms |

We have done two simulations for each type of data (Audio and Video) i.e. one at slow speed which is between 8m/sec and 18 m/sec and the other at high speed which is from 36m/sec to 50 m/sec. The simulations have been running for 200 seconds. Then convention has been same throughout the simulations. Blue graph represents AODV and Red graph represents ADV. Audio and Video data represent the above defined specifications in the entire simulation. Throughput is represented as KBps (Kilo Bytes per second).

Packet-Loss Ratio= 1 – (Number of packets delivered / Number of packets sent)

## V. Simulation Results

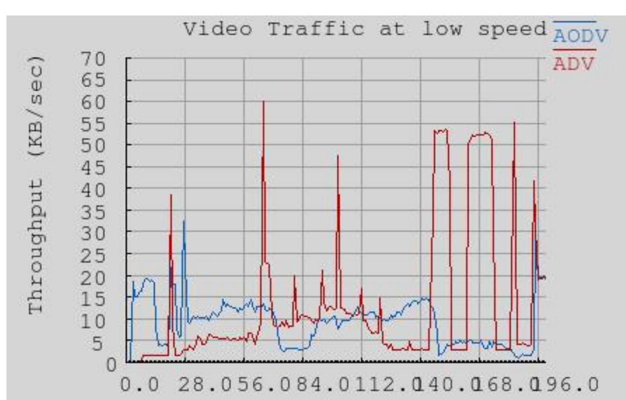


**Figure 2.** Throughput in Video Traffic at low speeds

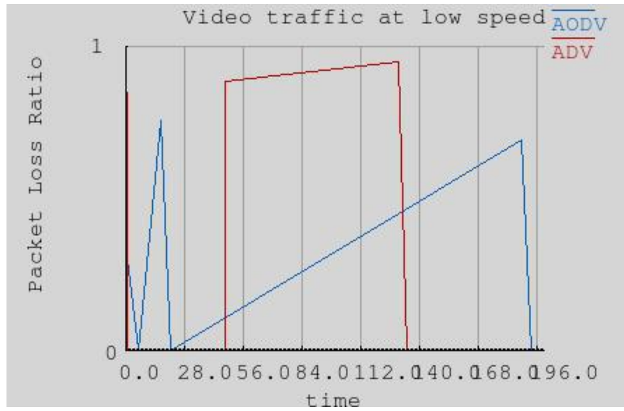


**Figure 3.** Packet-Loss Rate in Video Traffic at low speeds

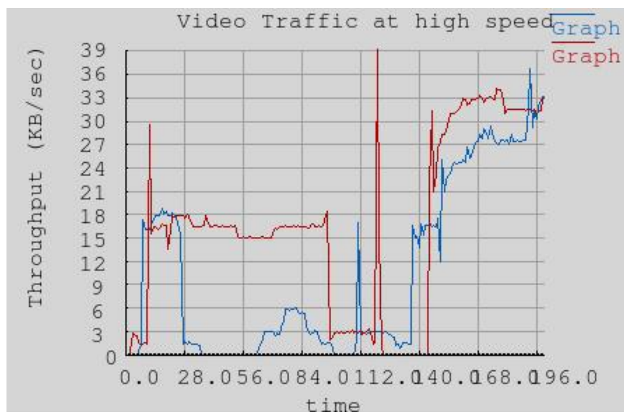


**Figure 4.** Throughput in Video Traffic at high speeds

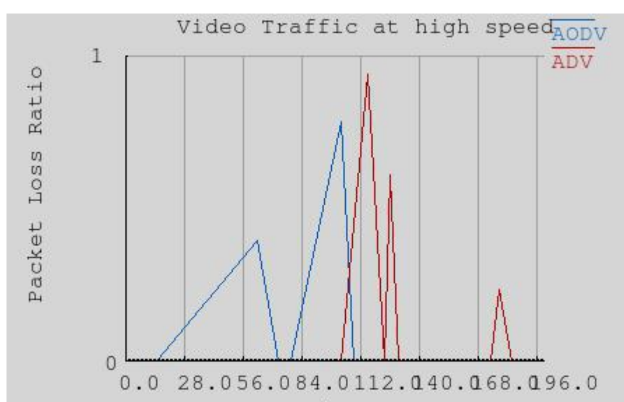


**Figure 5.** Packet-Loss Rate in Video Traffic at high speeds

Figures 2 and 4 show that throughputprovided by ADV protocol is higher thanthat of AODV. Figure 3 shows that overall packet-loss ratio of ADV is much lower than that of AODV.

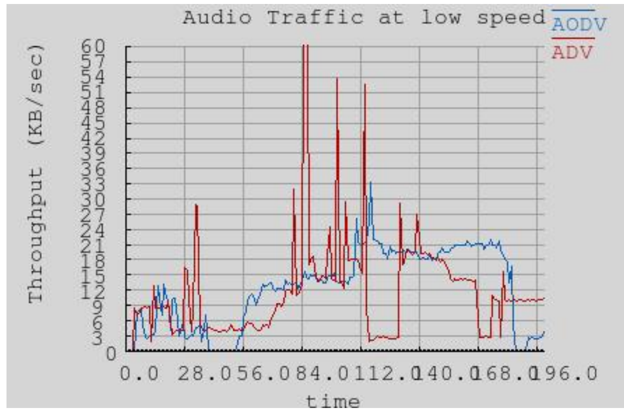


**Figure 6.** Throughput in Audio Traffic at low speeds

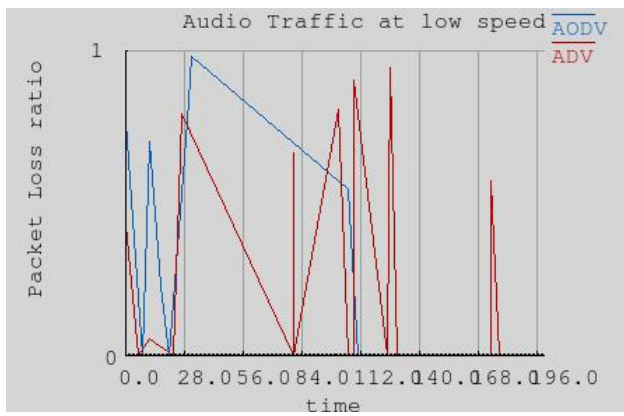


**Figure 7.** Packet-Loss Rate in Audio Traffic at low speeds

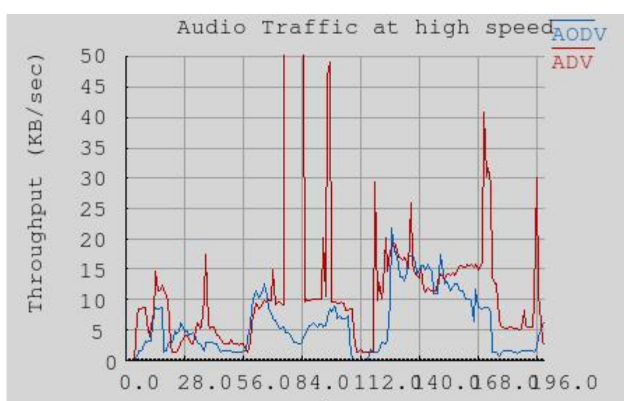


**Figure 8.** Packet-Loss Rate in Audio Traffic at low speeds

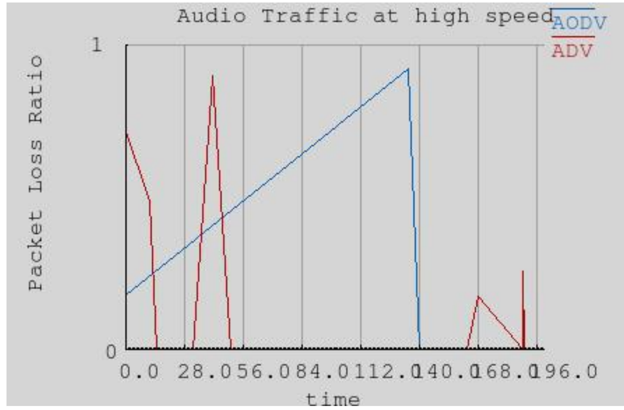


**Figure 9.** Packet-Loss Rate in Audio Traffic at high speeds

Figures 6 and 8 show that throughput of ADV is better than that of AODV. Figures 7 and 9 show that the packet-loss ratio of ADV is a little lesser than that of AODV. Less Packet-Loss Ratio means better performance because more number of packets are delivered to the destination and less number of packets are dropped. When network load increases and more data packets use the channel, number of collisions increase, and route discovery in AODV takes more time. This results in creating burden on the data-link and network layer queues which results in increased packet loss in these layers. On the other hand, ADV efficiently distributes routing information and minimizes the number of routing packets used thus leaving more bandwidth for data packets.

## VI. Conclusion and Future Work

In a network like VANET where topology changes very quickly; the timing and control of routing update is very important. Triggered partial updates are more efficient than full periodic updates. The routing overhead of ADV is lower than that of AODV which uses on-demand routing. ADV adjusts to sudden network load changes quickly so it is a solid contender for multimedia communications in ad-hoc wireless environment. Since ADV chains both proactive and on-demand techniques, it shows the best features of proactive algorithms and still quickly responds to network load changes. ADV is more efficient for real-time communications like audio and video where more throughput is required and data is more bursty. AODV is more robust for non-real-time delay-tolerant traffic which is proved in [17]. Hence, we need a supervisory algorithm which routing protocol to use depending on the data being transmitted for increased performance in VANETs.

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