



Server Based Dora in Vanets and its Applications

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Abstract— In this paper, we study Vehicle-to-vehicle (V2V) and Vehicle-to-roadside (V2R) communications for a vehicles that aims to upload a file when it is within the APs' coverage ranges, where both the channel contention level and transmission data rate vary over time. Dynamic optimal random access (DORA) algorithm scheme achieves an upload ratio 130% and 207% better than the heuristic schemes at low and high traffic densities, respectively. The problem with this DORA is that it provides communication to all nodes when one node request the service, this problem can be avoided by the same vehicle based algorithm with server based manner. We evaluate the performance of our system using the ns2 simulation platform and compare our scheme to existing solutions. The results shows the efficiency and feasibility of our scheme.

Keywords— medium access control, vehicular ad hoc networks, dynamic programming, Markov decision processes, Vehicle-2-Vehicle(V2V), Road Side Unit(RSU).

I. INTRODUCTION

The concepts of the paper says about VEHICULAR ad hoc networks (VANETs) enable autonomous data exchanges among vehicles and road side access points (APs). Going to implement the same vehicle communication with server based manner and are essential to various intelligent transportation system (ITS) applications. VANETs support various ITS applications through different types of communication mechanisms, including vehicle-to roadside (V2R) and vehicle-to-vehicle (V2V) communications [3]. V2R communications involve data transmissions between vehicular nodes and roadside APs. V2V communications only involve data exchanges among vehicular nodes. For both types, we can further classify the communications as either single hop or multi-hop. In this paper, we focus on analyzing V2R *single-hop uplink transmissions* from vehicles to APs. Due to the limited communication opportunities between vehicles and APs, efficient resource allocation (either centralized or distributed) is crucial for the successful deployment of V2R ITS applications. In the distributed setting, the vehicles contend for the channel for transmission based on the applications' QoS requirements. The scenario where the data packets are first distributed from the roadside units (RSUs) to the on board units (OBUs). The OBUs then bargain with each other for the missing data packets, and exchange them using Bit Torrent protocol. The medium access control (MAC) module collects information of local data traffic, and the routing module finds a path with the minimum delay. The optimal pricing and bandwidth reservation of a service provider is obtained using game theory, and the optimal download policy of an OBU is obtained using constrained Markov decision processes. We aim to design a uplink random access algorithm that is distributed in nature and also we aim at designing an optimal uplink resource allocation scheme in VANETs analytically in this paper.

Consider the drive-thru scenario, where vehicles pass by several APs located along a highway and obtain Internet access for only a limited amount of time. We assume that a vehicle wants to upload a file when it is within the coverage ranges of the APs, and needs to pay for the attempts to access the channel. As both the channel contention level and achievable data rate vary over time, the vehicle needs to decide when to transmit by taking into account the required payment, the application's QoS requirement, and the level of contention in current and future time slots. Because of the dynamic nature of the problem, we formulate it as a finite horizon sequential decision problem and solve it using the dynamic programming (DP).

- 1.1. **Optimal Access Policy Design:** In the case of a single AP with random vehicular traffic, we propose a general dynamic optimal random access (DORA) algorithm to compute the optimal access policy. We further extend the results to the case of multiple consecutive APs and propose a joint DORA (JDORA) algorithm to compute the optimal policy.
- 1.2. **Low Complexity Algorithm:** We consider a special yet practically important case of a single AP with constant data rate. We show that the optimal policy in this case has a threshold structure, which motivates us to propose a low complexity and efficient monotone DORA algorithm.

Superior Performance: Extensive simulation results show that our proposed algorithms achieve the minimal total cost and the highest upload ratio as compared with three other heuristic schemes. In the multi-AP scenario, the performance improvements in upload ratio of the JDORA scheme are 130% and 207% at low and high traffic densities, respectively.

II. PROPOSED FRAMEWORK

The proposed system model consider a drive-thru scenario on a highway as shown in Fig. 1, where multiple APs are installed and connected to a backbone network to provide Internet services to vehicles within their coverage ranges. We focus on a vehicle that wants to upload a *single* file of size S when it moves through a segment of this highway with a set of APs $J = \{1, \dots, J\}$, where the vehicles pass through the i th AP before the j th AP for $i < j$ with $i, j \in J$. We assume that the j th AP has a transmission radius R_j . We also assume that the vehicle is connected to at most one AP at a time. If the coverage areas of the APs are overlapping, then proper handover between the APs will be performed [6]. For the ease of exposition, we assume that the APs are set up in a way that any position in this segment of highway is covered by an AP. Our work can easily be extended to consider the settings where the coverage areas of adjacent APs are isolated from each other.

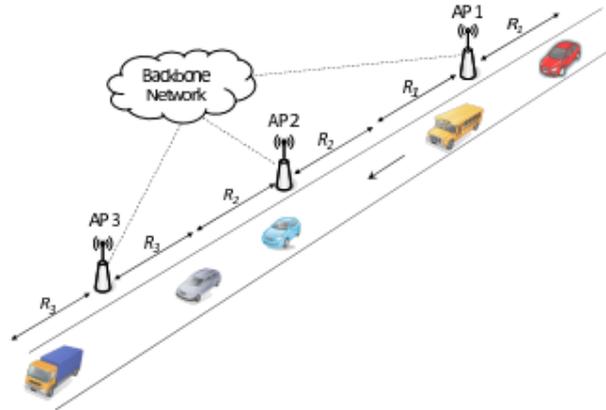


Fig. 1. Drive-thru vehicle-to-roadside (V2R) communications with multiple APs.

2.1 Traffic Model

Let λ denote the average number of vehicles passing by a fixed AP per unit time. We assume that the number of vehicles moving into this segment of the highway follows a Poisson process [7] with a mean arrival rate λ . Let ρ denote the vehicle density representing the number of vehicles per unit distance along the road segment, and v be the speed of the vehicles. From [8], we have

$$\lambda = \rho v. \quad (1)$$

The relation between the vehicle density ρ and speed v is given by the following equation [17]:

$$v = v_f(1 - \rho/\rho_{max}), \quad (2)$$

where v_f is the free-flow speed when the vehicle is moving on the road without any other vehicles, and ρ_{max} is the vehicle density during traffic jam. The maximum number of vehicles that can be accommodated within the coverage range of the j th AP is given by

$$N_{max,j} = \lfloor 2R_j \rho_{max} \rfloor, \quad \forall j \in J. \quad (3)$$

2.2 Channel Model

Wireless signal propagations suffer from path loss, shadowing, and fading. Since the distance between the vehicle and the AP varies in the drive-thru scenario, we focus on the dominant effect of channel attenuation due to path loss. The data rate at time slot t is given by

$$w_t = W \log_2 \left(1 + \frac{P}{N_0 W d_t^\gamma} \right), \quad (4)$$

where W is the channel bandwidth, P is the transmit power of the vehicle, d_t is the distance between the vehicle and the closest AP at time slot t , and γ is the path loss exponent. We assume that the additive white Gaussian noise has a zero mean and a power spectral density $N_0/2$.

2.3 Distributed Medium Access Control (MAC)

We consider a slotted MAC protocol, where time is divided into equal time slots of length Δt . We assume that there is perfect synchronization between the APs and the vehicles with the use of global positioning system (GPS) [9]. The total

number of time slots that the vehicle stays within the coverage range of the j th AP is $T_j = \left\lfloor \frac{2R_j}{v\Delta t} \right\rfloor$.

$$\zeta(j, \tau) = \sum_{i=0}^{j-1} T_i + \tau, \quad \forall \tau \in \{1, \dots, T_j\}, \quad (5)$$

When the vehicle first enters the coverage range of the j th AP, it declares the type of its application to the AP. In return, the j th AP informs the vehicle the channel contention in the coverage range, data rate in all the time slots in the j th coverage range, the price q_j , and the estimated number of vehicle departures from the coverage range.

III. PROBLEM FORMULATION

Here, we formulate the optimal transmission problem of a single vehicle as a finite-horizon sequential Decision problem [10]. After that, we describe how to obtain the optimal transmission policies in both single-AP and multiple-AP using finite-horizon sequential Dynamic Programming. When the traffic pattern can be estimated accurately, we consider a joint AP optimization.

3.1 Single AP Optimization with Random Vehicular Traffic.

Since we are considering one AP in this subsection, we drop the subscript j for simplicity. Although the exact traffic pattern (i.e., the exact number of vehicles in the coverage range of the AP in each time slot) is not known, the vehicles arrive according to a Poisson process with parameter λ . Now propose the general dynamic optimal random access (DORA) algorithm in Algorithm 1 to obtain the optimal policy Theorem 1: The policy π^* obtained from Algorithm 1 is the optimal solution of problem (15). The proposed DORA algorithm consists of two phases: Planning phase and transmission phase. The planning phase starts when the vehicle enters the coverage range. The vehicle then obtains information from the AP and computes the optimal policy π^* offline using dynamic programming. In the transmission phase, the transmission decision in each time slot is made according to the optimal policy π^* , and s is updated depending on whether the time slot is granted to the vehicle for transmission or not. Theorem 2: Here, we propose the monotone DORA algorithm with a lower computational complexity in Algorithm 2 using monotone backward induction [10]. Moreover, memory can be saved, because we do not need to store the complete optimal policy.

3.2 Joint AP Optimization with Deterministic Vehicular Traffic.

Now, consider the optimization problem in a single AP. So, we extend the result to the case of multiple APs, where we assume that the traffic pattern (i.e., the exact number of vehicles in the coverage ranges of the APs in each time slot) can be estimated accurately. The traffic pattern can be estimated in various ways, such as by installing a traffic monitor at a place before the first AP to observe the actual traffic pattern when the vehicles pass by (e.g., using computer vision [11] and pattern recognition [12]). If the traffic flow reaches the steady state the estimation of the number of vehicles at time can be accurate. The JDORA algorithm for joint AP optimization is given in Algorithm 3. In Algorithm 3, the vehicle first needs to obtain the values of $n_t, \forall t \in T$, from the traffic monitor. In the Planning phase, for each $s \in S$ and $t \in T$, the optimal decision rule $\delta^*(s, t)$ is the action that minimizes the expected total cost, where the expected total cost $v_t(s, t, a)$ for all possible actions is calculated based on v_{t+1} obtained in the previous iteration $t+1$. After the process is repeated for all $t \in T$ and $s \in S$, we obtain the optimal policy π^* . In the transmission phase, the transmission decision in each time slot is made according to the optimal policy π^* , and it follows the MAC protocol.

IV. FIGURES AND THE TABLES

In this section, the performance of Server Based DORA in VANET and its Applications is evaluated using Network Simulator. The performance of V2R and V2V is compared with the various parameters. This analysis can be obtained by varying the parameters such as throughput, drop performance, packet delay and packet delivery ratio with the simulation time.

TABLE I
SIMULATION PARAMETERS

PARAMETERS	VALUE
Number of APs J	1, 5
AP's transmission radius R	100 m
Free-flow speed v_f	110 km/h
Vehicle jam density ρ_{max}	100 veh/km
Duration of a time slot Δt	0.02 sec
Duration for data transmission in a time slot Δt_{data}	0.018 sec
Channel bandwidth W	20 MHz
Transmit signal-to-noise ratio P/N_0W	60 dB
Path loss exponent γ	3
Payment per time slot q	1
Contention window $cw \in [cw_{min}, cw_{max}]$	[1, 8]

MCBC parameter K (used in[11])	3
MCBC parameter [p1 p2 ,p3] (used in[11])	12, 0.77, 0
MCBC parameter F (used in[11])	15

Now, we first compare Algorithms 1 and 3 with three heuristic schemes using the traffic model for both the single-AP and multiple AP scenarios. The three heuristic schemes that we consider are as follows. The first heuristic scheme is a greedy algorithm, in which each vehicle sends transmission requests at all the time slots if its file upload is not complete. That is, the greedy algorithm aims to maximize the total uploaded file size. The second heuristic scheme is the exponential backoff algorithm that is similar to the one used in the IEEE 802.11. We have slightly modified it for the system that we consider as follows. Each vehicle has a counter, which randomly and uniformly chooses an initial integer value cnt from the interval $[0, cw)$, where cw is the contention window size. The value of cnt is decreased by one after each time slot. When $cnt = 0$, the vehicle will send a request. If the vehicle has sent a request in a time slot, the size of $cw \in [cw_{min}, cw_{max}]$ will change according to the response from the AP: If an ACK is received from the AP, cw is set to cw_{min} . Otherwise, cw is doubled until it reaches cw_{max} . For the DORA, JDORA, greedy, and exponential schemes, we assume that the APs allow the vehicles to share the channel with an equal probability. Therefore, $p_i^{succ} = 1/nt$. The third heuristic scheme is the MAC protocol in the multi-carrier burst contention (MCBC) scheme [13]. Similar to the greedy scheme, a vehicle will send a request if it has data to send in each time slot. However, the vehicles need to undergo K rounds of contention in each time slot. First, in round r , a vehicle survives the contention with probability pr . Each of these vehicles will choose a random integer in $\{1, \dots, F\}$. Vehicles that have chosen the largest number can proceed to round $r + 1$. The transmission is successful if there is only one vehicle left in round K . Otherwise, packet collision will occur. For the evaluations of all the schemes, we use the convex self-incurred penalty function.

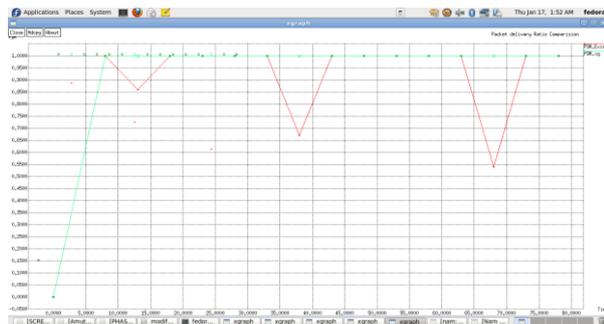


Fig 2: Packet delivery ratio

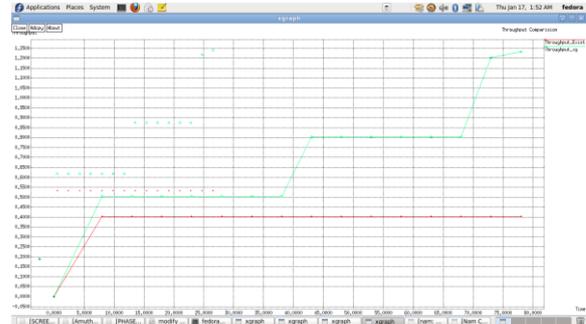


Fig 3 Throughput performance

The results are demonstrated using more nodes. Here Fig2 represents the Packet Delivery Ratio (PDR). Fig 2 says about both existing system and the proposed system. The red colour explain about the PDR of existing system and Green colour explain about the (PDR) proposed system. Here the proposed system says the constant level of delay performance. Next, we are going to see about throughput performance of V2R and V2V in DORA concepts. While Fig 3 says about the comparison of existing systems and proposed systems of throughput performance. While comparing the throughput, V2V has been increasing throughput. As a result, a larger file size is uploaded to reduce the penalty. Depending on the QoS requirements of different applications, different values should be chosen that trade off the total uploaded file size and total payment to the AP by a different degree.

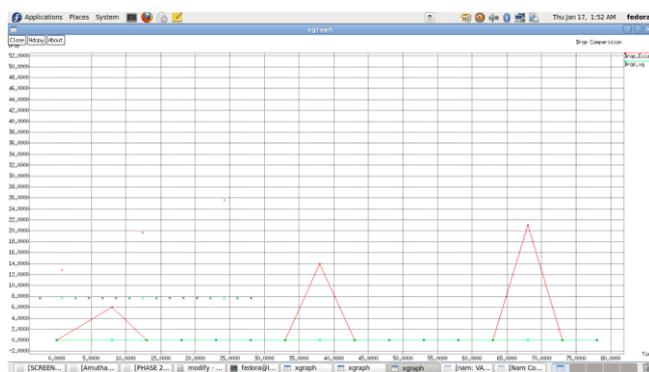


Fig 4 Drop performance

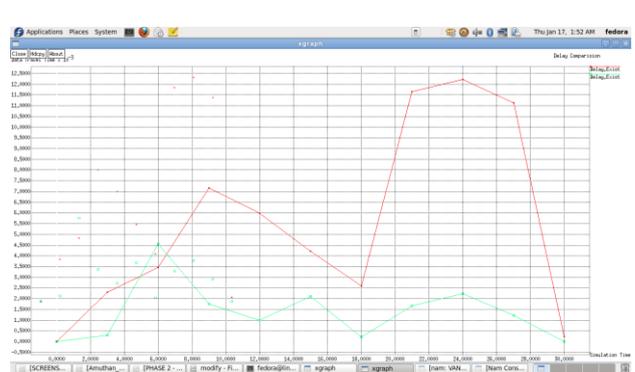


Fig.5 Delay performance

Next, we going to see the drop performance of proposed and existing systems. Since the DORA algorithm takes into account the varying channel contention level and data rate in determining the transmission policy, it is cost effective and achieves the highest upload ratio. In Fig. 8, we can see that the JDORA scheme with perfect estimation achieves the highest upload ratio. In particular, it achieves an upload ratio 130% and 207% better than the exponential backoff scheme

at low and high traffic density. Finally, we going to see about delay performance of existing and proposed systems. Here the delay has been decreased in V2V communication. Fig 5. Upload ratio versus traffic density ρ for file size $S = 500$ M bits with five APs. The JDORA scheme with perfect estimation to achieves the highest upload ratio as compared with three other heuristic schemes. Moreover, a lower upload ratio is achieved when the precision of the estimation reduces.

V. CONCLUSIONS

The paper has implemented by using same vehicle with server based manner in V2V and V2R communication. Vehicles to provides communication between requested nodes and Do not give a chance to data drop and Easy to manipulate data-base. Then, uplink transmission from a vehicle to the APs in a dynamic drive-thru scenario, where both the channel contention level and data rate vary over time. Depending on the applications' QoS requirements, the vehicle can achieve different levels of trade-off between the total uploaded file size and the total payment to the APs by tuning the self-incurred penalty and Path Traffic density will be enhanced. For a single AP with random vehicular traffic, we proposed a DORA algorithm based on DP to obtain the optimal transmission policy for the vehicle in a coverage range. A monotone DORA algorithm with a lower computational complexity was proposed for this special case. Next, for multiple APs with known vehicular patterns, we considered the transmission policy in multiple coverage ranges jointly and proposed an optimal JDORA algorithm. Simulation results showed that our schemes achieve the minimal total cost and the highest upload ratio with increasing throughput as compared with three other heuristic schemes. Also we provide communication between involved source and destination only.

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