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ON DEMAND DATA DISSEMINATION FOR DIFFERENTIATED LEVELS OF PRIORITIES IN VANETS

Ajay Guleria[1], Narottam Chand[2] and Lalit Kumar[2]

[1]Computer Centre
Panjab University
Chandigarh, India
ag@pu.ac.in

[2]Computer Science and Engineering
National Institute of Technology
Hamirpur, Himachal Pradesh, India
{ nar; lalit }@nith.ac.in

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Abstract. *The primary goal of deployment of vehicular networks is to increase road safety. For its commercial viability it does also support other comfort applications. However, the main objective of these networks still remains to reduce the number of accidents and saving of human lives. In this paper we propose a new data dissemination scheduling strategy for on demand broadcasting of information from a road side unit to support the differentiated levels of services in vehicular ad hoc networks. The major novelty of our work lies in dividing set of vehicles into different categories based on their active participation towards road safety and introducing the concept of new selection criteria, termed as importance factor for effectively scheduling items from a road side unit. The importance factor combines the vehicle's priority, deadline of the request, size of item requested, and number of outstanding requests for that particular item. The item having maximum importance factor is scheduled first by road side unit. Mathematical modeling and simulation results point out that the mean waiting time for the highest priority vehicles can be kept very low, while simultaneously achieving good service ratio.*
Keywords: Scheduling, Vehicular ad networks (VANETs), Road side unit (RSU), Quality of service (QoS)

1. **Introduction.** Vehicular ad hoc networks (VANETs) are a subgroup of mobile ad hoc networks (MANETs) with the distinguishing property that the nodes are vehicles like cars, trucks, buses, motorcycles and fixed infrastructure. Vehicles and infrastructure communicate by means of dedicated short range communication (DSRC) that employs the IEEE 802.11p standard for wireless communication. The fixed infrastructure generally referred as road side unit (RSU) is deployed at critical locations like access roads, service stations, dangerous intersections or places well-known for hazardous weather conditions. The primary goal of VANET is to increase road safety. To achieve this, the vehicles and RSU act as sensors and exchange warnings and telemetric information (like current speed, location or ESP activity) that enables the drivers to react early to abnormal and potentially dangerous situations like accidents, traffic jams and ice on road [1,2]. The information provided by other vehicles and stationary infrastructure might also be used for driver assistant systems like adaptive cruise control (ACC) or breaking assistants. In addition, authorized entities like police or fire-fighters should be able to send alarm signals and instructions, e.g., to clear their way or stop other road users. Besides that, the VANET should increase comfort by means of value-added services like location based services or

Internet on the road. So VANETs have been regarded useful in various applications, serving the interest of consumers, businesses, governments, and emergency services [1-5]. The major objective behind the deployment of vehicular networks is on improving the safety of motor vehicles. So the applications and vehicles which participate actively in road safety should be given priority over other categories of vehicles and applications. The roadside infrastructures play a very important role in disseminating information in VANET. Whenever vehicles enter wireless coverage area of an RSU they may have some urgent information on hazards to update like accident or damaged road segment for upward moving vehicles. Vehicles may request some information of their interest from RSU, so scheduling of information in an effective and productive manner from RSU is very challenging task.

A significant work has been done to address data dissemination issues from roadside unit in vehicular ad hoc networks (VANETs) [8-10]. Broadly there are two approaches: push based and pull based approach . In the push based approach [12-14], the roadside units push out the data to all vehicles in its range. This approach has its application in disseminating traffic alerts, weather alert, etc. The pull based approach [11,12,14] is based on a request response model as this is based on user specific data. Our work aims at separating the vehicles into different classes and introducing the concept of new selection criteria, which we call importance factor by combing the vehicle's priority based on type of request, vehicle's deadline, size of item and number of outstanding requests for that item for scheduling of the requests arriving at the server at RSU in vehicular adhoc network. Most existing information scheduling techniques have considered only parameters like data size, deadline, max-request involved in vehicle adhoc networks [15,16]. Their main focus is on specific elements involved in the communication, such as medium access, vehicle mobility, traffic flow, and routing. The challenges for VANETs raise the demand for a more perfect and effective data dissemination technique. Pull scheduling on RSU server is based on linear combination of number of vehicle requests accumulated and their priorities. It is observed that the items with pending requests from higher priority vehicles should be serviced faster than the items having requests from lower priority vehicles. However, this scheme might suffer from unfairness to the lower priority vehicles and also does not consider the number of vehicles' requests. A data item, requested by many vehicles having lower importance, might remain in the pull queue for a long time. Eventually, all the pending requests for that item might be blocked. Hence, a better option is to consider both the number of pending requests and the priorities of all vehicles requesting the particular data item. A close look into the system reveals that the service time required by an item is dependent on the size of that item. The larger the length of an item, the higher is its service time. A better option is to use a scheduling strategy that combines deadline, size of request, and number of outstanding requests for that particular item with the priority scheduling to select an item from the pull queue.

2. **Related Work.**

2.1. **Vehicular networks.** In VANET the main focus is to improve vehicular safety by taking into account the physiological and ecological based context-aware sensitive parameters as intelligence hence increasing driver convenience. The technology used to design vehicular networks should provide priority for time-critical safety messages and traffic information over other comfort applications [2-4,13]. While many communication scenarios exist for these networks, creating high-performance, highly scalable and secure VANET technologies presents an extraordinary challenge to the wireless research community. Most vehicular network researches have been focused on routing issues. In this paper we have developed a new service classification strategy in on demand scheduling scheme from an RSU to support differentiated quality of service based on priorities associated with the different set of vehicles.

2.2. **Basic information scheduling schemes.** Earlier a large amount of work related to CPU and job scheduling has been done in the literature [14,17]. Wong studied several scheduling algorithms such as first-come-first-served (FCFS), longest wait time (LWT), most requests first (MRF) in broadcasting environments [17]. Later, many broadcast scheduling algorithms have been proposed to reduce the waiting time and energy consumption [16]. Acharya and Muthukrishnan [12] addressed the broadcast scheduling problem in heterogeneous environments, where data items have different sizes. The solution is based on a new metric called stretch, defined as the ratio of the response time of a request to its service time. Based on stretch, they proposed a scheduling algorithm, called longest total stretch first (LTSF) to optimize the stretch and achieve a balance between the worst case and the average case. However, a straightforward implementation of LTSF is not practical for a large system, as at each broadcast time, the server has to recalculate the total stretch for every data item with pending requests in order to decide which data to broadcast next, and hence the scheduling algorithm becomes a bottleneck due to the high computation overhead.

2.3. **Level of services for data scheduling.** The work in [18] introduced the concept of Quality Contracts (QCs) which combines the two incomparable performance metrics: response time or Quality of Service (Level of Services), and staleness or Quality of Data (QoD). QCs allow individual users to express their preferences for the expected Level of Services and QoD of their queries by assigning "profit" values. They proposed an adaptive algorithm to maximize the total profit from submitted QCs. This work is also based on point-to-point communication and does not take advantage of broadcasting. All these works mainly focus on responsiveness such as average/worst-case waiting time or fairness without considering the time constraints of the user requests. However, in vehicular networks, time constraint of the request has to be considered. Jiang and Vaidya [19], Rajan et al. [20] and Xu et al. [18] studied the scheduling problem in real-time broadcasting environment and took time constraint into account.

2.4. **D*S/N scheduling.** The authors in [8] initially investigated online scheduling algorithms for the time critical on demand data broadcast. Their work took into account deadline for requests and found that the requests shall be dropped completely if vehicles move out from the RSU area. In this case if the request is urgent, it will not be served and dropped. The authors in [8] proposed a basic scheduling scheme called D*S to consider both deadline and data size when making scheduling decisions. To make use of wireless broadcasting, the authors gave another scheduling scheme called D*S/N to serve multiple requests with a single broadcast. The authors also identified the effects of upload requests on data quality, and proposed a two step scheduling scheme to provide a balance between serving download and upload requests. They have compared the three naive schemes: FCFS, FDF and SDF and showed their performance and limitations. We consider the problem of reducing the delay to those requests which needs to be served immediately. We build our strategy on previous work in this area [8,21]. We are proposing our scheme that shall consider priority of the vehicles' and D*S/N value of the request and schedules data based on new criteria called importance factor.

3. Problem Statement and Preliminaries.

3.1. On demand data access in VANET.

There are two different ways through which vehicles access data in vehicular ad hoc networks. In vehicle to vehicle (V2V) communications vehicles talk to each other directly on single hop or through other vehicles or base stations. In the second approach vehicle to infrastructure (V2I), vehicles enter in a road side unit (RSU) area and communicate directly with it. In vehicle to roadside access, roadside unit can be used to disseminate safety critical information, real-time traffic information, weather information or value added advertisements in a zone of relevance (ZOR) [3]. To make best use of RSU and to share information with as many vehicles as possible, roadside units are often set at roadway intersections or areas with traffic lights. In RSU area certain vehicles upload data and others download required information. As the number of requests from vehicles increases, deciding which request to serve at which time will be critical to system performance. Hence, it is important to design an efficient scheduling algorithm for vehicle roadside access.

3.2. Scheduling with service classification.

Priority based on demand scheduling in vehicle roadside access is based on a linear combination of the number of vehicles, requests accumulated and priorities. It should be noted that items with pending requests for higher priority vehicles should be serviced faster than the items having requests from lower priority vehicles. However, this scheme might suffer from un-fairness to the lower priority vehicles and also does not consider the number of vehicles' requests [11,21]. A data item, requested by many vehicles having lower importance, might remain in the pull queue for a long time. Eventually, all the pending requests for that item might be blocked. Hence, a better option is to consider both the number of pending requests and the priorities of all vehicles requesting the particular data item. In case of vehicular networks other parameters like deadline of the request, size of the item requested and number of pending requests does play a very important part for scheduling information from a roadside unit. To have an efficient and fair priority based on demand scheduling we introduce a new scheduling strategy that combines D*S/N scheduling [8] with the priority scheduling to select an item from the pull-queue. Vehicles are divided into different priority classes based on their participation and criticality for designing safety applications for vehicular networks. Vehicles that have acquired some critical information like accident or ice on the road need to be prioritised by the road side unit for uploading of information in its server and at the same time these RSUs need to disseminate this information immediately. In our scenario equipped vehicle with GPS when enters in the range of a road side unit calculates deadline, i.e., the time when it will leave the RSU coverage area and generates request for specific data item from the RSU server. The request contains four types of information in its header, i.e., deadline of request (deadline), identifier of the requested item (i-id), identifier of the vehicle (v-id), and priority class of vehicle (w). Based on work of authors in [8], we calculate DSN value of a request and represent it by S. DSN value combines deadline of request, size of requested item and number of outstanding requests for that particular item. D*S/N scheduling works on following principles:

- Given two requests with the same deadline, the one asking for a small size data should be served first.
- Given two requests asking for data with the same size, the one with earlier deadline should be served first.

DSN value is calculated as DSN = (Deadline − CurrentClock) ∗ DataSize/Number, where Deadline is deadline of request, DataSize is size of requested item and Number is number of outstanding requests for that particular item.

If S_i represents the DSN associated with item i and Q_i represents the total vehicles priority associated with item i, then the item selected from the pull queue by RSU server is determined by the following condition:

$$\eta_i = \max[\alpha S_i + (1-\alpha)Q_i] \tag{1}$$

where α is a fraction $0 \leq \alpha \leq 1$, that determines the relative weights between the priority and the DSN value. $\alpha = 0$ and $\alpha = 1$ make the schedule priority scheduling and D*S/N scheduling, respectively. When a vehicle enters in range of RSU and needs an item i, it requests the RSU server for item i and waits until it listens for i on the channel. The RSU server goes on accumulating the set of requests from the vehicles. RSU server inserts the request into the waiting queue with the arrival time, and updates its DSN value and total priority of all the vehicles' requesting that item. The server chooses the item having maximum importance factor η from the queue. The bandwidth required by the data item is assumed to follow Poisson's distribution. The server assigns the required bandwidth and transmits the item. Once the transmission is complete, the pending requests for that item in the queue are cleared and the bandwidth used is released to update the available bandwidth.

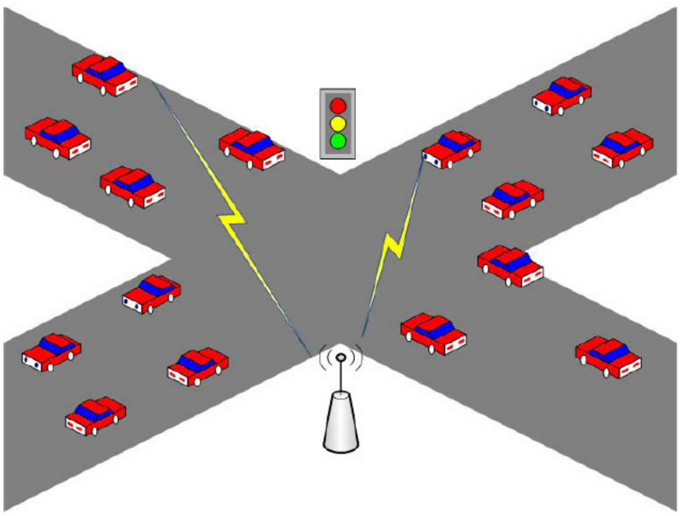

FIGURE 1. Scenario for vehicle-infrastructure communication

3.3. **System model.** As shown in Figure 1, all the equipped vehicles can send requests to the RSU if they want to access the data. Each request is characterized by a 5-tuple [10]: $\langle$*v-id*, *d-id*, *op*, *size*, *p-oc*$\rangle$, where *v-id* is the identifier of the vehicle, *d-id* is the identifier of the requested data item, *op* is the operation that the vehicle wants to do (upload or download), *size* is size of requested data item and *p-oc* is priority class of the vehicle. All the requests are queued at the RSU server upon arrival.

4. Mathematical Foundation and Proposed Scheduling.

4.1. Assumptions.

(1) We assume a scenario where a single RSU server and multiple vehicles are sending requests for update or download as soon as they enter in the area of RSU.
(2) The database at the RSU server is assumed to be composed of N distinct items. Every item has a different length randomly distributed between $1-L$, where L is maximum length.

(3) The arrival rate of vehicles in RSU area is assumed to obey the Poisson distribution with mean λ'. The RSU server serves the vehicles by on demand serving the items. The service times of system are exponentially distributed with mean μ.
(4) The access probability P_i of item i is a measure of its demand or popularity. To have a wide range of access probabilities, we assume that the access probabilities P_i follow the Zipf's distribution with access skew-coefficient θ, such that, $P_i = \frac{(\frac{1}{i})^\theta}{\sum_{j=1}^{n}(\frac{1}{j})^\theta}$.
(5) Thus, the arrival rate in the system is given by $\lambda = \sum_i^Z P_i$, where P_i denotes the access probability of item i.

4.2. **Priority based on demand scheduling.** We assume that the average number of instances of the particular item i present in the waiting queue is R_i. If the total number of items in queue at any instance are T_n, Then, $R_i = [T_n]P_i$. Let the size of the item i be L_i and deadline of the request be d_i. The DSN value S_i is given by $S_i = (d_i - currentClock)\frac{R_i}{L_i^2}$. Every vehicle j is associated with a certain priority q_j, that reveals the importance or class of that vehicle. If T_i represents the average length of the waiting queue at RSU server, then the average number of ith items present in the queue is given by $R_i = [T_n]P_i$. Hence, the average importance of the ith item requested by the jth vehicle is given by: $[T_n]P_iq_j$. Representing the cumulative priority of the set of vehicles ℓ requesting for item i by $\tau_i = \sum_{j=1}^{\ell} q_j$, substituting the values in Equation (1), the selection criteria are given by the following equation:

$$\rho_i = \left(\alpha(d_i - currentClock)\frac{[T_n]P_i}{L_i^2} + (1-\alpha)[T_n]P_i\tau_i\right) \tag{2}$$

while true **do**
    take out an item from the queue and broadcast it;
    consider the access/requests arriving from vehicles;
    append the requests for the item in the queue with its arrival time and importance factor;
    if pull queue is not empty **then**
        extract the item having maximum importance factor η from the queue;
        assign the required bandwidth of the item and update the available bandwidth;
        transmit that item;
        clear the number of pending requests for that item;
        free the amount of required bandwidth and update the amount of available bandwidth;
        go to step 2;
    end if
end while

FIGURE 2. Priority based on demand scheduling

This condition provides the position of every item in the priority queue. To distinguish this measure with the vehicle priority q_j, we term ρ_i as the importance factor of item i. The items are grouped based on these importance factors. Formally, we can say if G_i represents the group of d_j items, then $\rho d_i = \rho_j$. We analyze in the next section the system performance with vehicles belonging to different classes [21], having multiple importance factors.

4.3. **Effect of multiple importance classes.** Determination of stationary probabilities in a non preemptive Markovian system is an exceeding difficult task when the numbers of priorities are more than two. Thus, a better way is to follow a direct expected value approach [22]. Considering a non preemptive system with many importance factors. Let $\lambda_1, \lambda_2, \ldots, \lambda_n$ represent the average arrival rate of data items having importance factors $1, 2, \ldots, n$, i.e., $\lambda = \lambda_1 + \lambda_2 + \ldots + \lambda_n$. We also assume the data items with importance-factor ρ_j have an arrival rate and service time of λ_j and $\frac{1}{\mu_j}$, respectively. The occupancy arising due to this jth data item is represented by $\rho_j = \frac{\lambda_j}{\mu_j}$ $(1 \leq j \leq \max)$, where max represents maximum possible value of importance factor. Also let σ_j represent the sum of all occupancy factors ρ_i, i.e., $\sigma_j = \sum_{i=1}^{j} \rho_i$. In the boundary conditions we have $\sigma_0 = 0$ and $\sigma_{\max} = \rho$. If we assume that a data item of importance factor i arrives at time t_0 and is serviced at time t_1, then the wait time in queue is $T_i = t_1 - t_0$. Let us assume at t_0 there are n_j data items present having priorities j. Also let S_0 be the time required to finish the data item already in service, and S_j be the total time required to serve n_j. During the waiting time of any data item, n'_j, new items having a higher importance factors can arrive and go to service before the current item. If S_j is the total service time required to service all the n_j items, then the waiting time of item in queue is:

$$T_i = \sum_{j=1}^{i-1} [S'_j] + \sum_{j=1}^{i-1} [S_j] + [S_0] \tag{3}$$

By taking expected values on both sides of the above equation, expected waiting time for the ith item will be:

$$E[W_i] = \sum_{j=1}^{i-1} E[S'_j] + \sum_{j=1}^{i-1} E[S_j] + E[S_0] \tag{4}$$

In order to get a reasonable estimate of W_i, three components of Equation (3) need to be individually evaluated. The random variable remaining time of service S_0, has the value 0 if the system is idle. So $E[S_0]$ is computed as:

$$E[S_0] = P_r[system\, is\, busy] E[S_0 | system\, is\, busy]$$

$$E[S_0] = \rho \sum_{j=1}^{max} E[S_0 | serving\, queue\, item\, having\, importance\, factor = j]$$
$$P_r[item\, having\, importance\, factor = j] + (1 - \rho)$$

$$E[S_0] = \rho \sum_{j=1}^{max} \frac{\rho}{\rho \mu_j} \tag{5}$$

Since n_j and the service time $S_j^{(n)}$ are independent, so estimate of $E[S_j]$ can be obtained as follows:

$$E[S_j] = E\left[n_j S_j^{(n)}\right]$$
$$E[S_j] = E[n_j] E\left[S_j^{(n)}\right]$$
$$E[S_j] = \frac{E[n_j]}{\mu_j} \tag{6}$$

Similarly

$$E[S'_j] = \frac{E[n'_j]}{\mu_j} \tag{7}$$

The above equations can be solved by using the Cobham's iterative induction [22]. The expected waiting time of the ith item and the overall expected waiting time of the system are given as:

$$E[W^i] = \frac{\sum_{j=1}^{\max} \frac{\rho_j}{\mu_j}}{(1-\sigma_{i-1})(1-\sigma_i)} \tag{8}$$

$$E[W^q] = \sum_{j=1}^{\max} \frac{\lambda^i E[W^q]}{\lambda} \tag{9}$$

The RSU server here always tries to reduce the delay of the high priority vehicles, to ensure their active participation toward road safety.

5. **Evaluation.** In this section we validate the performance analysis of our prioritized on demand scheduling by performing simulation experiments. The framework is made for differentiated level of priorities in vehicular ad hoc networks; the primary objective is to reduce the cost associated in maintaining the different classes of vehicles, thereby increasing the participation of highly important vehicles towards road safety. In order to evaluate the above scheduling algorithms we developed a simulator based on sumo [7] for traffic simulation and ns-2 [6] for network simulation. We have performed experiments to evaluate performances of on demand priority based scheduling. The main objective of the whole scheme is to minimize the expected access time and improve service ratio for prioritized vehicles and at the same time be fair for less important vehicles.

5.1. **Performance metrics.** The prime goal of on demand data dissemination for differentiated levels of priorities in VANETs is to reduce the overall expected access time for each class of vehicles. In the case of vehicular networks a performance guarantee is required to be delivered, i.e., requests from vehicles need to be answered within a precise time frame, thereby ensuring a good delivery ratio with minimal average access time. We use the following metrics for performance evaluation.

(1) Minimum average access time: the definitive goal of the proposed algorithm is to reduce the expected access time.
(2) Service ratio: a better scheduling algorithm should serve as many requests as possible. Delivery ratio or service ratio is defined as the ratio of the number of requests served before deadlines to the total number of arriving requests from vehicles to server at RSU.

5.2. **Experimental setup.** The experiment is based on a $200 \times 200\text{m}^2$ street intersection of one horizontal road and one vertical road where each two-way road has two lanes. One RSU server is put at the center of the junction. To generate the vehicle traffic, we randomly deploy 10 vehicles in each lane, that makes a total of 40 vehicles. All vehicles move towards either end of the road. They are moving forward and backward during the simulation to have the continuous traffic flow in the intersection area. When one vehicle reaches the end of the road, which means the vehicle will move out of the RSU serving area, its request not serviced will be dropped. The entire set of vehicles is divided into three classes: Class A, having highest priority, Class B with medium priority, and Class C with lowest priority. The distribution of vehicles among different classes is assumed to obey Zipf's distribution, with the lowest number of highest priority (Class A) vehicles and the highest number of lowest priority vehicles. For the experiments the distribution among three classes priorities are taken in the ratio 1 :: 2 :: 4. The simulation parameters with their corresponding values are listed in Table 1.

TABLE 1. Simulation parameters

Parameter	Value
Simulation Time	1000s
RSU Coverage Area	200m
Vehicle Speed	20m/s
Vehicle-Vehicle Space	15-20m
Item Size	2M, max
Item Set Size, (N)	10
Skew Coefficient, (θ)	0.0-1.0
Dilation Factor, (α)	0.0-1.0
Arrival Rate, (λ)	6-20

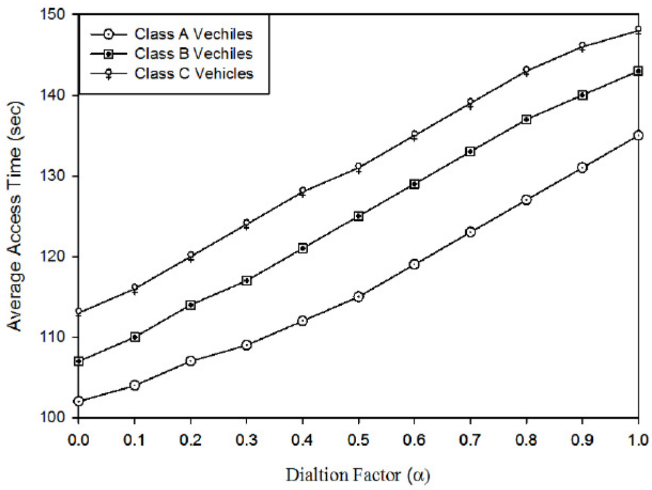

FIGURE 3. Effect of dilation factor (α) on mean waiting time

5.3. **Results.** (1) Effect of Dilation Factor: one major objective is to increase service ratio for vehicles having higher importance factor. The second set of experiments is looking into the service ratio of all class of vehicles with respect to different values of α. This is also again performed with different values of θ. Each vehicle sends requests with a probability p, $(0 < p \leq 1)$. Value of p closed to 1 generates a heavy workload for the RSU server. The arrival rates of requests from vehicles and service rates of these requests by the RSU server follow Poisson distribution. The average arrival rate (λ) is taken 10 and 20. The RSU server in the experiment serves, $N = 10$ items. In order to keep the access probabilities of items from very similar to very skewed, θ is varied between 0 and 1. The value of dilation factor α is varied between 0 and 1. The result in Figure 3 shows that as the dilation factor moves from 0 to 1, the waiting time of different class of vehicles increases and at value 1 it is similar to D*S/N scheduling scheme. Figure 4 shows that service ratio for different priorities classes of vehicles also decreases with the increase in value of dilation factor.

(2) Effect of Arrival Rate: the effect of the vehicles' request arrival rate with difference importance factors to overall wait time is shown in Figure 5. Effect of the vehicles' request arrival rate with different importance factors to service ratio is shown in Figure 6. Simulation experiments are performed for a total number of $N = 10$ items. Arrival rate is varied between 6 to 20. The value of skew coefficient θ is taken as 0.6 where items' access probabilities will be well balanced. Figure 8 demonstrates the effect of arrival rate on priority based on demand scheduling scheme.

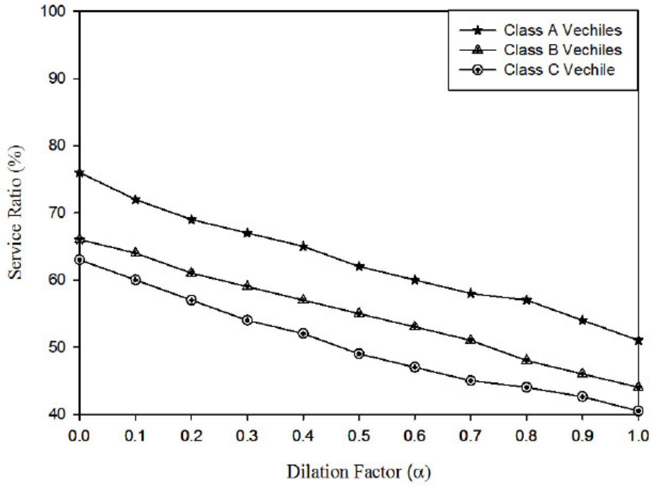

FIGURE 4. Effect of dilation factor (α) on service ratio for different classes

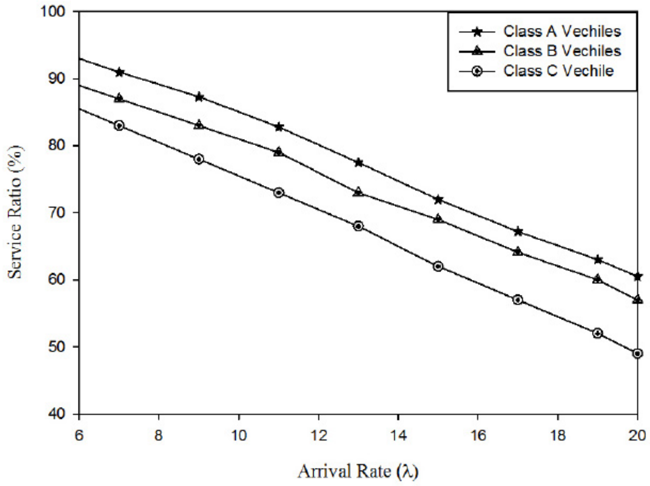

FIGURE 5. Effect of arrival rate (λ) on service ratio of different classes

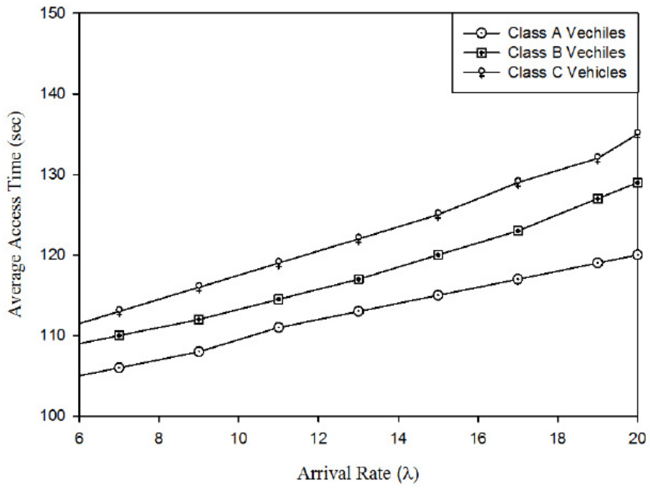

FIGURE 6. Effect of arrival rate (λ) on mean waiting time

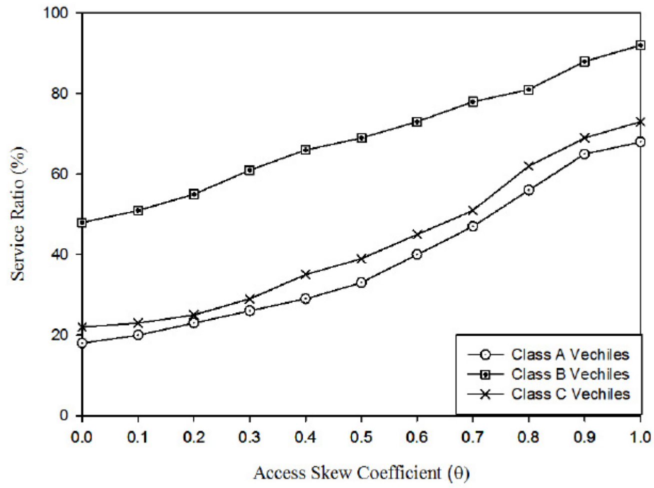

FIGURE 7. Effect of access skew coefficient (θ) on service ratio

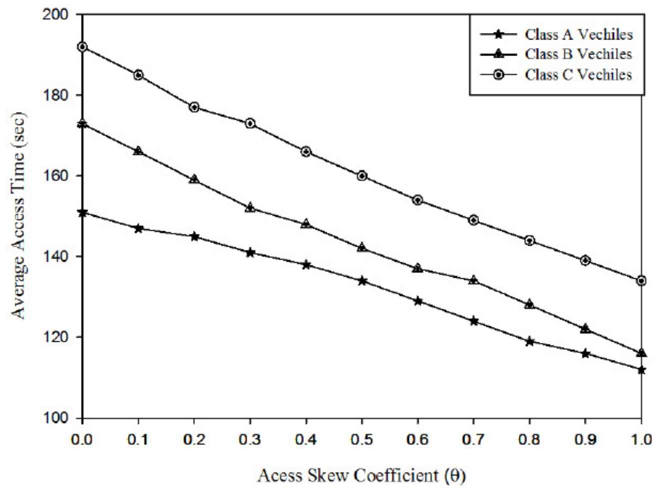

FIGURE 8. Effect of access skew coefficient (θ) on mean waiting time

When α is zero or close to zero, then the algorithm works as a pure priority scheduling algorithm and $\alpha = 1$ means a D*S/N optimal scheduling algorithm. For low values of α, the high priority class A vehicles have less waiting time as compared with other classes for different values of θ.

(3) Effect of Access Pattern: the goal of the first set of experiments is to investigate the overall delay experienced by each class of vehicles. Results demonstrate the dynamics of total delay of each class with different values of α. When θ is zero or close to zero, the access pattern is uniformly distributed, and different items have similar popularity. As its value increases the access pattern becomes more skewed. The simulation experiments are evaluated for $N = 10$ items. The average value of arrival rate λ is taken 10. In order to keep access probabilities of the items from similar to much skewed, θ is dynamically varied from 0 to 1. Figure 8 shows the variation of average access time with different values of θ. This is performed for different values of access skewness. The delay associated with the Class A (highest priority) vehicles is very low (within 5-10 broadcast units). The delay experienced by the Class B vehicles remain in the range 20-40 broadcast units. The highest delay (40-70 broadcast units) is experienced by the Class C vehicles. Figure 7

shows the service ratio of all class of vehicles for low values of θ, performs much better than for higher values of θ.

6. **Conclusions.** In this paper, we addressed some challenges in scheduling information in VANETs. We proposed a new framework for priority based on demand scheduling in VANET for disseminating information from an RSU server. The framework is suitable for supporting differentiated classes based on priority in VANETs. The scheme explores vehicles' priorities and items popularity for differential distribution of wireless resources. To the best of our knowledge, our work is first of its kind in VANETs which schedules items based on importance factor which combines vehicles' priority, deadline of request, size of requested data item, maximum outstanding requests for that data item. The nature of VANETs demands a flexible communication protocol supporting different communications needs and adapting to the network environment and to context elements specified by the application itself will motivate further research in this area.

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