ISSN: 2321-7782 (Online)
Volume 2, Issue 3, March 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Paper / Case Study
Available online at: www.ijarcsms.com

Platooning for adaptive traffic signal monitoring using a two phase approach

B. Priyadharshini[1]
Final year, Computer Science and Engineering
RVS Educational Trust Group of Institution
Dindigul – India

J. Dhivyadharini[2]
Final year, Computer Science and Engineering
RVS Educational Trust Group of Institution
Dindigul – India

Abstract: ***A vehicular ad hoc network (VANET) uses cars as mobile nodes in a MANET to create a mobile network and gathers information of vehicles such as real time speed and location to enhance traffic signal control at intersections. First, the vehicles that arrive towards traffic signal are grouped into the platoons which are assumed to be equal sized jobs. Then these jobs are scheduled using an online algorithm called Oldest Job First (OJF) algorithm to reduce the delay across the intersection. The traffic signal timing can be made dynamic by determining the vehicle density of the platoon and depending upon that the green times are calculated and vehicles are evacuated, thereby minimizing the waiting time. This is said to be the two phase approach, where division of the vehicular traffic into platoons is made first and next OJF algorithm is applied. Our simulation results show that under low and medium traffic conditions, OJF has less minimized delay as that of vehicle actuated method, Webster's method, pretimed signal control methods. Under heavy traffic conditions, OJF performs equal to that of vehicle actuated method, but still produce lower delays when compared to Webster's method and pretimed signal control methods.***

Keywords: ***Traffic signal control, online job scheduling, vehicular ad hoc networks (VANET) simulation, conflict graphs, vehicle-actuated traffic signal control, Webster's method, pretimed signal control method.***

I. INTRODUCTION

Vehicular Ad-Hoc Networks (VANETs) are a special class of Mobile Ad-Hoc Networks (MANETs) where nodes self-organize and self-manage information in a distributed fashion. They contain vehicles and/or roadside units that assist within the management of the network Security plays a very important role within the system style with the event of VANETs. Due to the unreliable communications in VANETs, security protocols would like a lot of concerns, like privacy, authentication, and consistency of messages. However, the efficiency was unnoticed before; as a result of previous ways incur important communication overhead. Several Intrusion Detection approaches for conveyance unintentional networks (VANETs) are projected. However, not moving pretend vehicles and vehicles with a plausible quality model aren't thought-about in different approaches. Vehicular Ad-hoc Network (VANET) can be envisaged as the network of moving vehicles act in asynchronous and autonomous fashion.

Economical and scalable data disseminated may be a major challenge because of the movement of vehicles that causes unpredictable changes in topology. For people living in developing countries the sheer volume of road traffic is also a daily nuisance. The road traffic conditions have an effect on the protection of the population since one point two million people worldwide are calculable to be killed once a year on the roads. For this reason, these days the motorcar motive business and governments invest several resources to extend road safety and traffic potency, in addition on cut back the impact of transportation on the setting. Two communication modes can be distinguished: the Vehicle-to-Infrastructure (V2I) and Vehicle to Vehicle (V2V) communications. The first mode requires the use of roadside sensors for vehicles to gather information such as traffic signal violation warning. In the second mode, vehicles can communicate directly with each other's without passing by the road infrastructure. The objective is to increase the vehicle safety by relaying required information from vehicle to vehicle. For example, a vehicle detecting an icy road could inform other vehicles like those traveling in the opposite direction and those traveling in the same lane. Road Side Units (RSUs) collect and analyze vehicles' real-time travel information. After that, the RSUs generate traffic information, which contains the average speed of vehicles, vehicle density, and events like a traffic jam. Finally, the RSUs broadcast it to the vehicles in a very comparatively distance. This is suitable for urban traffic environment. Compared with the existing traffic broadcasting systems, it uses RSU to collect, create and distribute traffic messages, and the traffic messages are propagated reliably with data verification mechanism. Therefore, it can capture the real-time traffic information accurately, and meets the requirements of reducing traffic jam and improving road safety. To allow V2V communication, vehicles must form some kind of network, called Vehicle Ad hoc Network (VANET). VANET is a Mobile Ad-hoc Network (MANET) that has vehicles as network nodes. A VANET is a decentralized and self-organizing network composed of high speed moving vehicles.

Driving is an indispensable part of the life of many people. The past years have witnessed substantial efforts on improving driving safety. Among them, the most prominent technological one might be the emerging vehicular ad hoc network (VANET) and the safe driving-targeted applications built atop the VANET. The VANET is composed of highly mobile vehicles and sparsely-deployed roadside stations, each equipped with wireless communication devices and optionally with sensing devices. Wireless communication can be conducted between vehicles and/or between vehicles and roadside stations. On top of the VANET, applications have been developed to collect, process, share and deliver real-time information about road conditions. These systems sometimes help in accident prevention, but they are not always effective since the underlying VANET does not provide guaranteed real-time detection of road conditions or communication connectivity. Firstly, the VANET only opportunistically monitors road conditions.

That is, only when there exists a vehicle or a roadside station detecting or being notified of some conditions, can the information be shared within the VANET. Secondly, the VANET can be disconnected due to high mobility and unpredictable movements of vehicles and the sparse deployment of roadside stations. If the VANET is disconnected, critical information about road conditions known by one partition of the VANET cannot be shared timely with vehicles that need to know it but are in other partitions.

The speed and location information on vehicles that can be disseminated to the traffic signal controller using VANETs are both spatially and temporally fine-grained. Such precise vehicle speed and location information can enable additional capabilities such as being able to predict the time instance when vehicles will reach the stop line of the intersection. This is in comparison with roadside sensors such as loop detectors that can only detect the presence or absence of vehicles and, at best estimate, the size of vehicle queues.

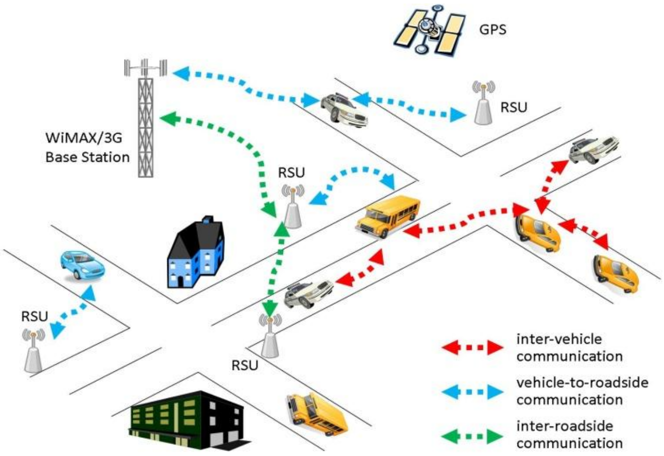

Figure 1 VANET

In VANET there are three types of communication exists.

First is, the inter-vehicle communication which is represented using red lines in Figure 1. Secondly, the vehicle-roadside communication represented using blue lines. Thirdly, inter-roadside communication represented using green lines.

II. RELATED WORK

SCOOT is a dynamic, on-line, real-time method of signal control that continuously measures traffic demand on all approaches to intersections in a network and optimizes the signal timings at each intersection to minimize delay and stops. Timing changes are small, to avoid major disruption to traffic flows, and frequent, to allow rapid response to changing traffic conditions.

a) *SCOOT Traffic Model*

The heart of SCOOT is a traffic model that predicts a short-term traffic demand. SCOOT uses this model to predict the effect of small changes to the current timing of signals. The SCOOT traffic model is based on data collected from presence detectors at the rate of once per second on each link to the network.

b) *Data Processing*

This data is processed and then updates the cyclic flow profiles - one for each link. The traffic flow model contains a representation of traffic demand at the stop line.

Results of implementing a SCOOT system include reduced travel time and driver delay, improvements in air quality, lower fuel consumption, and savings on planning time.

SCATS:

SCATS primarily manages the dynamic (on-line, real-time) timing of signal phases at traffic signals, meaning that it tries to find the best phasing (i.e. cycle times, phase splits and offsets) for the current traffic situation (for individual intersections as well as for the whole network). This is based on the automatic plan selection from a library in response to the data derived from loop detectors or other road traffic sensors.

The system uses sensors at each traffic signal to detect vehicle presence in each lane and pedestrians waiting to cross at the local site. The vehicle sensors are generally inductive loops installed within the road pavement. The pedestrian sensors are usually push buttons. Various other types of sensors can be used for vehicle presence detection, provided that a similar and consistent output is achieved. Information collected from the vehicle sensors allows SCATS to calculate and adapt the timing of traffic signals in the network.

Public Vehicle priority in SCATS (using data provided from PTIPS) caters for both buses and trams. SCATS has a facility to provide three levels of priority:

- **High** – In the high priority mode the hurry call facility is used. i.e. the phase needed by the tram is called immediately, skipping other phases if necessary
- **Medium** (*Flexible window*) – Phases can be shortened to allow the bus/tram phase to be brought in early. The bus/tram phase can occur at more than one place in the cycle.
- **Low** – takes its turn. Trams would normally be given high priority, the aim of which is to get the tram through without it stopping. Buses would normally expect to receive a medium level of priority.

The architecture of the system is at two basic levels, LOCAL and MASTER. The LOCAL is the control cabinet at the roadside, which provides the normal signal control as well as processing of traffic information deduced from the vehicle detectors. The MASTER is a remote computer which provides area based traffic control, i.e area traffic control (ATC) or urban traffic control (UTC). Detailed traffic signal and hardware diagnostics are passed from the LOCAL to the MASTER, with the ability to notify staff when a traffic signal has a fault.

RHODES:

The RHODES (Real-Time Hierarchical Optimized Distributed Effective System) traffic control system can play a major role in the realization of future Advanced Traffic Management Systems to meet the promises of intelligent transportation systems. RHODES takes as input sensor-based traffic data and outputs traffic signal timings to optimally control traffic flow.

The RHODES architecture for surface streets is depicted in Figure 1(from Head et al, 1992). At the highest level of RHODES is a “dynamic network loading" model that captures the slow - varying characteristics of traffic. These characteristics pertain to the network geometry (available routes including road closures, construction, etc.) and the typical route selection of travelers. Based on the slow -varying characteristics of the network traffic loads, estimates of the load on each particular link, in terms of vehicles per hour, can be calculated. The load estimates then allow RHODES to allocate "green time" for each different demand pattern and each phase (North - South through movement, North - South left turn, East - West left turn, and so on). These decisions are made at the middle level of the hierarchy, referred to as “network flow control”. Traffic flow characteristics at this level are measured in terms of platoons of vehicles and their speeds. Given the approximate green times, the "intersection control” at the third level selects the appropriate phase change epochs based on observed and predicted arrivals of individual vehicles at each intersection.

III. PROBLEM FORMULATION

The main problem addressed in this paper is formulated as follows: The traffic signal control is not dynamic currently; hence there is a situation for vehicles to experience high waiting time. The traffic signal timing is also static because the vehicle density is not considered. Hence the proposed system has to overcome this by moving onto the dynamic manner.

IV. PROPOSED METHOD

In this paper, we present an algorithm, which we call the oldest arrival first (OAF) algorithm, that makes use of the per-vehicle real time position and speed data to do vehicular traffic scheduling at an isolated traffic intersection with the objective of minimizing delays at the intersection. This simple algorithm leads to a near optimal (delay minimizing) schedule that we analyze by reducing the traffic scheduling problem to a job scheduling problem, with conflicts, on processors. The scheduling algorithm captures the conflicts among opposing vehicular traffic with a conflict graph, and the objective of the algorithm is to minimize the latency values of the jobs. If the condition that all jobs require equal processing time is enforced, we can show that the OAF algorithm becomes the oldest job first (OJF) algorithm in the job scheduling domain with conflicts between jobs and the objective of minimizing job latency values. We present a 2-competitive (with respect to job latencies) online algorithm that does non clairvoyant scheduling with conflicts of the jobs on the processors and then prove a stronger result that the best possible non clairvoyant scheduling with conflicts algorithm is 2-competitive.We leverage a VANET to implement the OJF algorithm. An important requirement for the OJF algorithm is that all jobs require equal processing time. We give an algorithm that uses the VANET to divide up the approaching vehicular traffic into platoons that can be treated as jobs in the job scheduling with conflicts. The traffic signal controller can then use the conflict-free schedule from the OJF algorithm to schedule platoons of vehicles in a safe conflict-free manner. This two-phase approach, where we first use the platooning algorithm to divide up the traffic into platoons and then treat each platoon as an equal-sized job and then apply the OJF algorithm on the jobs to generate a conflict-free schedule, leads to what we call the OAF algorithm.

```
Algorithm 1: OJF Scheduling Algorithm

[1] Let $a_i^r$, $a_j^{r'}$,$a_k^l$, $a_m^{l'}$ be the earliest arrival times on each of
    the vertices of G' ;
[2] While r, r', l, l' have jobs waiting, do
    Let $a_t^s$ be the earliest arrival time among $a_i^r$, $a_j^{r'}$,$a_k^l$, $a_m^{l'}$ ;
[3] For each vertex s' on side S in G', do
    Schedule the job with the earliest arrival $a_t^{s'}$;
```

Let *r* and *r'* be the vertices on the right side, and let *l* and

L' be the vertices on the left side of the bipartite graph. Let *L*

be the list of jobs that would arrive at the vertices in some time interval. Since we have no prior knowledge of the composition of *L*, the OJF algorithm aforementioned in Algorithm 1 makes decisions on the fly to reduce the maximum latency and is hence an *online algorithm*. For example, there exists an algorithm *A** that, given *L*, generates the optimal schedule (a schedule that minimizes maximum latency). *A** is the optimal *offline algorithm*. Let us compare the performance of OJF and *A** when it comes to minimizing the maximum latency. We claim that the OJF scheduling algorithm is 2-competitive, i.e., for any *L*, OJF produces a schedule where the maximum latency experienced by any job is at most twice the maximum latency experienced by any job in a schedule produced by $A*$. Thus, the OJF algorithm is 2-competitive. Furthermore, it turns out that there cannot exist a better than 2- competitive algorithm for job scheduling under the assumption of no future knowledge. To prove that OJF is 2-competitive, we need the following lemma.

Lemma 2.1: Let the *weight* of a vertex be the number of jobs waiting on it. The weight of an arc in *G_* is the sum of the weights of its two vertices. For example, *T* is the maximum latency in the schedule for *L* returned by $A*$. Then, OJF always maintains the following for all time *t*.

1) If *A**has an arc of weight *w* at some time unit *t*, then the optimal schedule has at least $w - T$ jobs on the same arc at time *t*.
2) If *A**has a vertex of weight *w* at some time unit *t*, then the optimal schedule has at least $w - T$ jobs on the same vertex at time *t*.

Proof: See the Appendix.

Theorem 2.2: OJF is 2-competitive.

Proof: We will prove that, for any *L*, if the schedule generated by *A**for *L* has maximum latency *T*, then OJF will generate a schedule that has latency at most $2T$. As long as the two conditions specified in the lemma are maintained, there can never be an arc of weight $2T + 2$ or more as algorithm OJF runs, since otherwise (by the lemma) there would be an arc of weight at least $T + 2$ and then the schedule produced by *A** would have a latency of at least $T + 1$ on some job. Therefore, OJF never has more than $2T + 1$ jobs on an arc, and when job j arrives on vertex *l*, there are never more than $2T$ other jobs on any arc going into to *l*. Let *X* be the number of jobs already on l when the job *j* arrives, i.e., $0 \leq X \leq 2T$. There are at most $2T - X$ jobs on any vertex on the right side. Once the left side has been chosen *x* times by OJF, *j* will be the oldest job on vertex *l*; therefore, it will be scheduled the next time the left side is chosen by OJF. If we can prove that the right side is not chosen more than $2T - X$ times before *j*, then we know that *j* incur latency at most $2T$ before it is scheduled. After the right side has been chosen $2T - X$ times, if *j* has not yet been chosen, then the left side has the oldest job in the system. This gives us our result. The given discussion shows that, if we can do the reduction from vehicular traffic scheduling to job scheduling correctly, we can employ the OJF algorithm to generate schedules that will then be applied to schedule vehicular traffic at intersections while maintaining the 2-competitive performance bounds.

The dataflow diagram, (Figure 2) details about the vehicular positioning, location, speed computation and then conflict graph generation. In that, the platoon division takes place. After the platoon division OJF algorithm is applied to the platoons in respective directions. The OJF algorithm is used to schedule the jobs (in the sense, platoons). All jobs are considered to be equal sized.

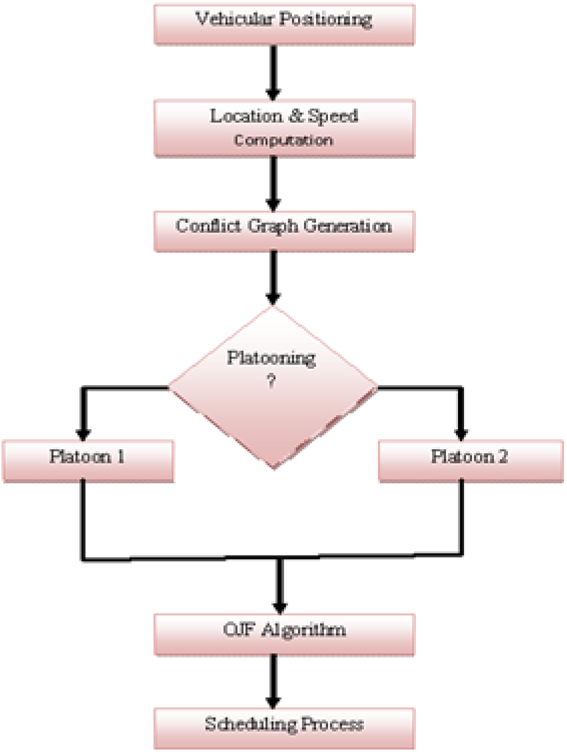

Figure 2 Data flow diagram

The architectural diagram, (Figure 3) focuses from the vehicular node deployment, speed and location calculation, conflict graph formulation, vehicular partitioning further divided into OJF calculation and scheduling, thereby balanced movement is obtained.

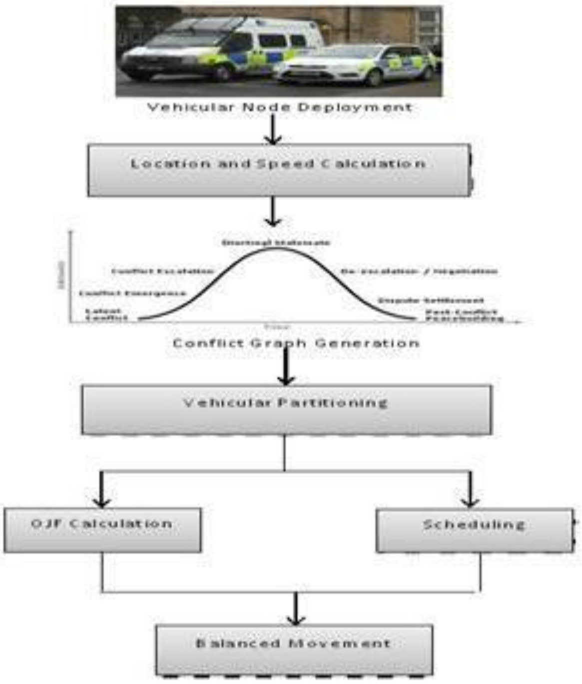

Figure 3 Architectural diagram

V. CONCLUSION

A new way to reduce the delay experienced by the vehicles in the traffic signal posts in a dynamic way by determining the vehicle density of the platoons in respective directions and minimizing the conflicts by conflict graph formulation can be made. This is achieved by the OJF algorithm mainly used for scheduling the platoons on the basis of first arrival of the vehicle in the platoon. By eliminating the buffer we can significantly increase the efficiency of adaptive traffic signal monitoring system.

References

1. C. N. Chuah, D. Ghosal, A. Chen, B. Khorashadi, and M. Zhang, “Smoothing vehicular traffic flow using vehicular_based ad hoc Networking amp; computing grid (VGrid),” in Proc. IEEE ITSC, Sep.2006, pp. 349–354.
2. K. LaCurts, S. Madden, H. Balakrishnan, S. Toledo, A. Thiagarajan, L.Ravindranath, and J.Eriksson, “Vtrack: Accurate, energy-aware road traffic delay estimation using mobile phones,” in Proc. 7th ACM Conf. Embedded Netw. SenSys, New York, NY, USA, 2009, pp. 85–98. Conf
3. D. Ghosal, C. N. Chuah, B. Liu, B. Khorashadi, andM. Zhang, “Assessing the VANET’s local information storage capability under different traffic mobility,” in Proc. INFOCOM, 2010, pp. 1–5.
4. D. Jiang and L. Delgrossi, “Ieee 802.11p: Towards an international standard for wireless access in vehicular environments,” in Proc. IEEE VTC Spring, May 2008, pp. 2036–2040.
5. B. Hull, R. Newton, S. Madden, J. Eriksson, L. Girod, and H. Balakrishnan, “The pothole patrol: Using a mobile sensor network for road surface monitoring,” in Proc. 6th Int. Conf. MobiSys, New York, NY, USA, 2008, pp. 29–39.
6. B. Khorashadi, F. Liu, D. Ghosal, M. Zhang, and C. N. Chuah, “Distributed automated incident detection with VGRID,” IEEE Wireless Commun., vol. 18, no. 1, pp. 64–73, Feb. 2011.
7. C. Priemer and B. Friedrich, “A decentralized adaptive traffic signal control using v2I communication data,” in Proc. 12th Int. IEEE ITSC, Oct. 2009, pp. 1–6.
8. K. L.Mirchandani, D. Head, and P. B. Sheppard, “Hierarchical framework for real-time traffic control,” Transp. Res. Rec., Traffic Operations, vol. 16, no. 1360, pp. 1420–1433, Dec. 2008.