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# A Vehicular Opportunistically Assisted Parking Scheme using Inter Vehicular Ad-hoc Network

Drashti S Baldev[1], Madhuri J Patel[2]

[1]*Asst.Prof. AITS, Rajkot, Gujarat, India,*
drashti.baldev@gmail.com

[2]*Asst.Prof. AITS, Rajkot, Gujarat, India,*
patel.madhuri1991@gmail.com

**Abstract. An advanced growth in Intelligent Transportation System (ITS) has made Vehicular Ad-hoc Network (VANET) an area of exploration in academic and industrial levels. In Intelligent Transportation System each vehicle acts as a sender, receiver and forwarding router which broadcast safety and non-safety information across the network. The three major classes of applications are classified in VANET are safety oriented, convenience oriented and infotainment oriented. Main focus in this literature is based on assistance oriented applications like providing information about vacant parking spaces to the drivers who are cruising for it around their destination.**

**Keywords:** Web Parking Assistance Schemes, Road side units, Sensor networks, Vehicular Networks, V2V Communications, V2I Communications, Vehicular ad-hoc network.

## I. INTRODUCTION

Recently VANET is has become very popular in foreign domains. According Donald Soup the traffic on roads is not because of travellers on the way but is because of commuters that have already arrived and cruising for parking lots. Therefore it is researched 30% of traffic congestion on roads are due to commuters searching for place to park. Hence if drivers are provided with efficient and effective information then parking search costs, congestion and pollution would reduce to some extent. Due to current advancement in VANETs devices such as OBUs and RSUs, inconveniency faced by the commuters to find parking areas has been reduced. Various parameters needs to be taken care while designing such a system like commuter will always choose a parking space nearer to the destination spot, the walking distance between parking spot and destination should be minimum, probability of parking space to be found empty when the commuter reaches the instructed parking lot.

## II. RESEARCH ON EXISTING PARKING SPACES

Many proposals and protocols have been researched to share information about available parking space to the interested commuters. Based on certain features such state of art can be classified. These include its area of interest such as parking lots, street line parking, parking underground garages, parking composed of parking meters etc, and type of communication models used like vehicle to vehicle, vehicle to infrastructure, infrastructure to infrastructure or above all client server relationships etc, mode of information dissemination like pull based and push based methods, requirement of Supporting Side Units such as any road side infrastructure or monitoring sensors and whether the approach is able to tackle completion and reservation issues or not.

Available parking spaces can be considered as the shared resource competed between many interested drivers rather than just an event. Events like providing emergency, congestion, and traffic signal related awareness to vehicles which is basically not pre decided and are based on the alerting situations while parking related information is known before hand and it encircles the drivers' preferences.

Events are classified as static events or non-static events, directional events or non-directional events and attractive events or non-attractive (repulsive) events. Finding

available parking space is a static, non-directional and attractive based event where resources are stationary parking spots and information needs to be disseminated in any direction towards all areas of interest and always interested drivers would like to meet (attract) such events.

Some works rely on a push model. With such an approach, each vehicle receives information (e.g., about an emergency braking, a traffic congestion, an available parking space, etc.) from its neighbours and has to decide whether that information is relevant enough to be transmitted to the driver or not. Other works rely on pull model where a query is actually communicated to other vehicles in the vehicular network. Vehicles receiving query may compute partial results based on information stored in the cache and send back to the originator and originator using query processing techniques can calculate final output.

## III. PROPOSED SYSTEM

The main objective of the proposed system is to provide parking information to the interested vehicles with using minimum communication infrastructure costs and effective data dissemination of occupancy of parking lots. The proposed system is defined for parking lots assuming fixed number of parking spaces. The proposed system goes with pull based approach where interested vehicle has to query for the parking space. Each parking lot has head defined which maintains the occupancy status of the parking lot it has been parked. The interested vehicle tries to communicate with all the heads of the parking lot to discover free parking spaces. Based on the relevancy the vehicle chooses one of the parking lots and responds to respective head. The head maintains the table of occupancy which keeps tracks of filled and empty spaces. The vehicle leaving the parking lot informs the head so that head can accordingly compute the parking status within the occupancy table. Here using V2V communication architecture the information regarding vacant parking space is distributed.

### 3.1 Objectives behind Proposed System

- The main objective is to provide useful information about occupancy status of parking spaces so that the driver can decide whether to enter parking lot or not in order to avoid unnecessary cruising in non-empty parking lots.
- Avoiding cruising saves driver from fuel consumption, non-productive time wastage and pollutions.
- The system needs to work well without any infrastructure like RSUs, Sensors etc i.e. information is disseminated only through V2V communications.
- The system needs to handles reservation perspectives where when vehicle requests for parking space and if doesn't turn up then the parking lot should be declared as empty changing the reserved space to free space after waiting for desired period of time.
- The system needs to handle competition perspective where no two vehicles should be informed about same parking space leading conflicts between vehicles.
- The system since uses the concept of head node, it should work flawlessly when the head leaves the parking lot.

## IV. WORKING OF PROPOSED SYSTEM

The proposed system uses" AODV, Ad Hoc On Demand Distance Vector Routing Protocol" for communication between vehicles. AODV is reactive routing protocol which uses AODV Route Discovery and AODV Route maintenance using RREQ, RREP and RRER messages.

### 4.1 How AODV gets compliance with proposed system?

- Using this protocol source establishes path only when it is required for it to transmit data.
- AODV allows mobile nodes to obtain routes quickly for new destinations, and does not require nodes to maintain routes to destinations that are not in active communication.
- Route Requests (RREQs), Route Replies (RREPs), and Route Errors (RERRs) are the message types defined by AODV which claims to be required to simulate parking scenarios where interested vehicle requests and the head responds.
- During request sending the RREQs are broadcasted to find valid path to destination node which is head in case of proposed system and with the help of route caching the reply in terms of RREP is unicasted to originator (interested vehicle).

- The initial broadcasting is also required since the requestor vehicle is ignorant about head information.
- In order to avoid competition the calculated information of the occupancy status of parking lots is unicasted to requested vehicle.

**4.2 Proposed Flowchart and Algorithm**

*CASE 1: When Vehicle wants parking.*

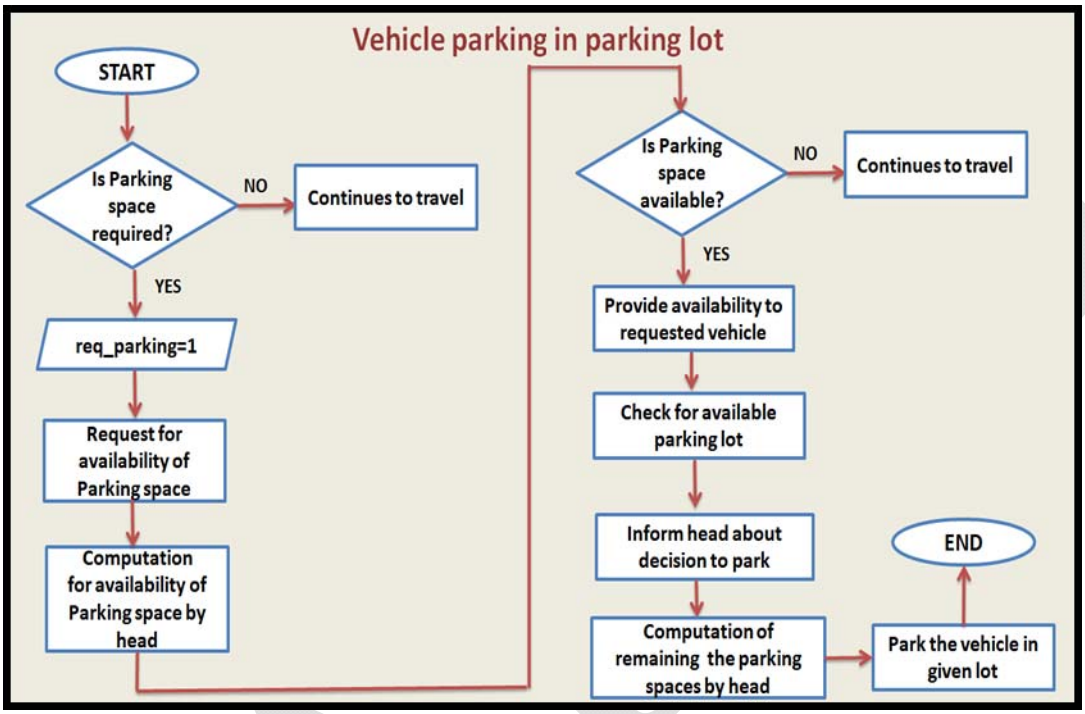



Figure 1 Vehicle parking in the parking lot

*CASE 2: When Vehicle wants leave the parking lot*

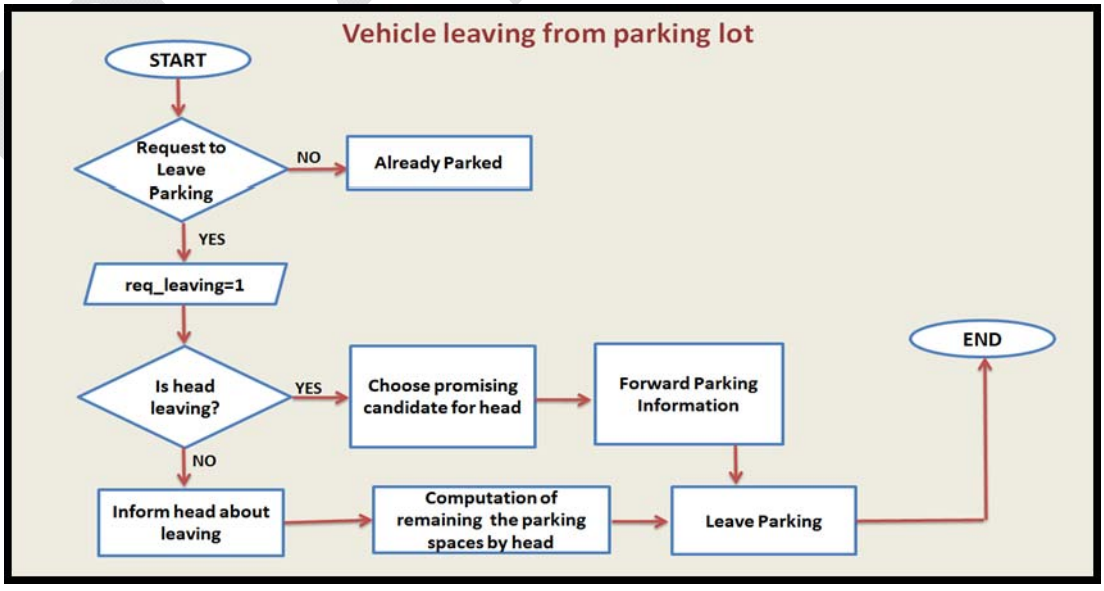



Figure 2 Vehicle leaving from the parking lot

**4.3 Advantages of proposed over current Non Assisted Parking system.**

- The main advantage of the proposed system is the increase utilization factor of parking spaces which means if parking space is empty no vehicle in diffusion range should be roaming without any knowledge.
- No vehicle will cruise around the huge parking lots if there is no vacant space in the parking lot.
- Also this system provides reservation for parking space for some time limits.
- The occupancy status table is maintained and handled dynamically by the vehicles parked within the lot instead of using fixed communication infrastructure which increases installation and maintenance costs.
- The proposed system decreases the competition since the vacant space information is retained reserved for the requested vehicle for some time slot and is not passed multiple vehicles at same time.

## V. SIMULATION TOOLS

Three simulators are used to simulate all the scenarios

- MOVE
- SUMO – 0.12.3
- NS 2.35

The MOVE generates following xml file and configurations which can be directly simulated in SUMO.

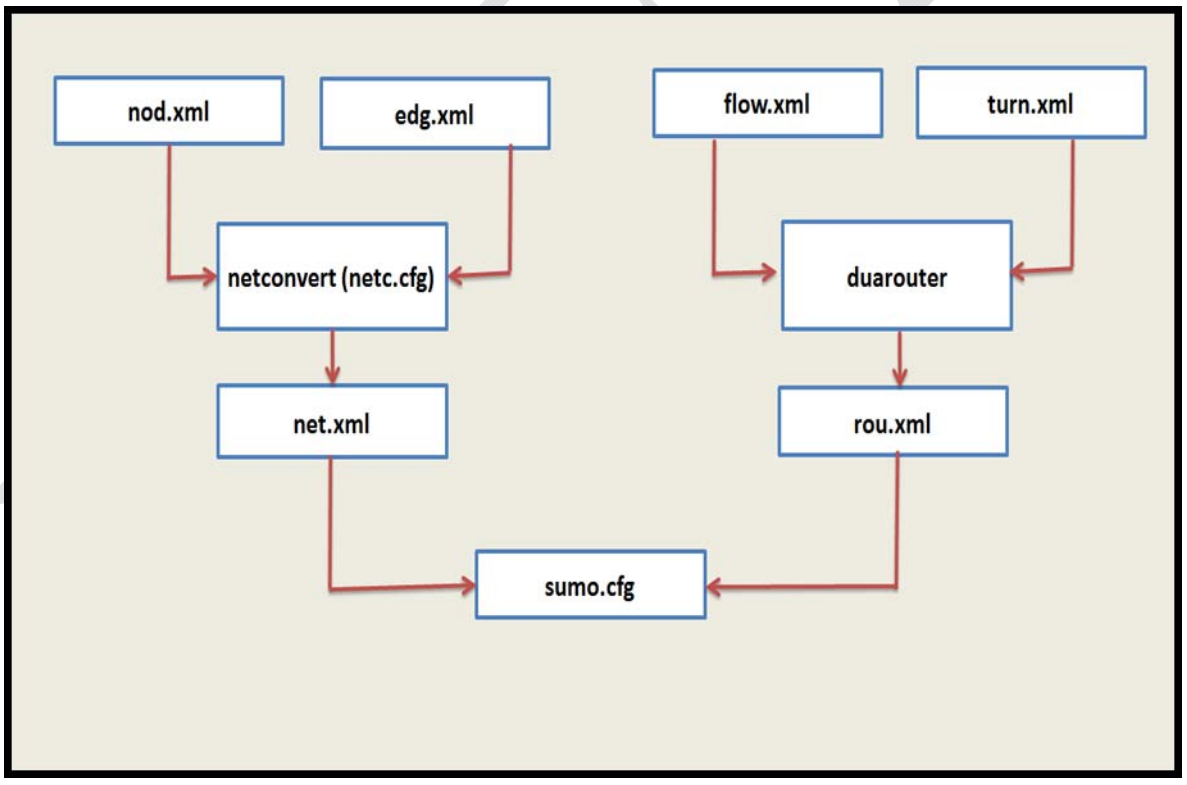



Figure 3 Move Simulation flow

NS2.35 flow configuration is shown as follows

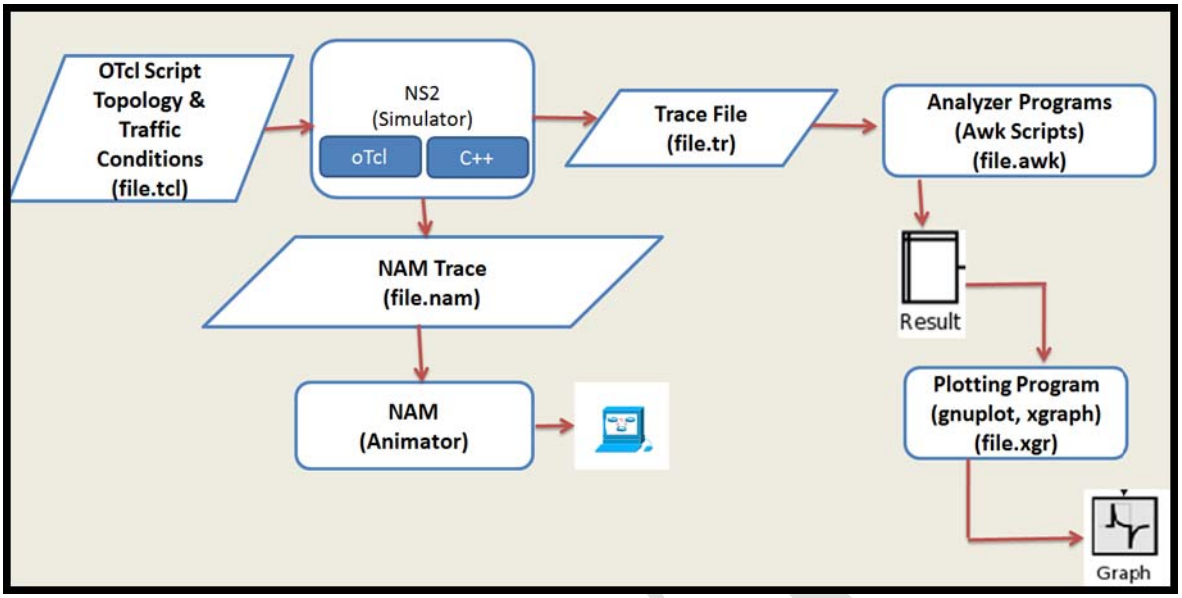
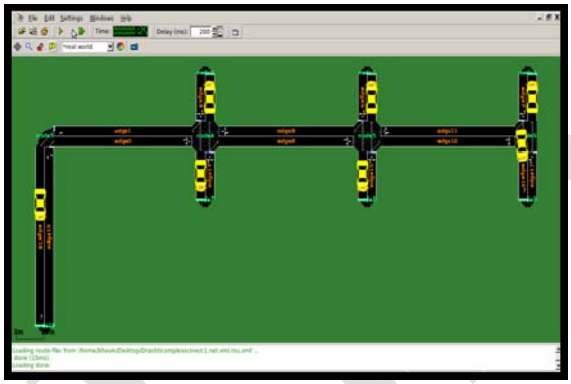


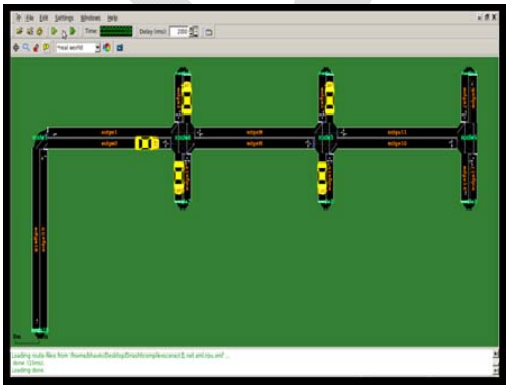

Figure 4 NS2.35 architecture

## VI. IMPLEMENTATION

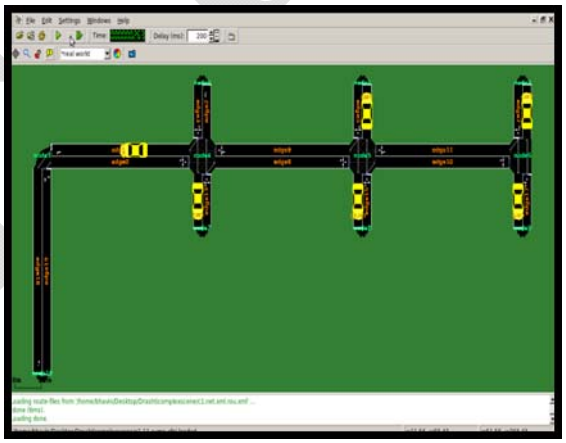
Various parking scenarios are implemented using SUMO and MOVE simulators as follows



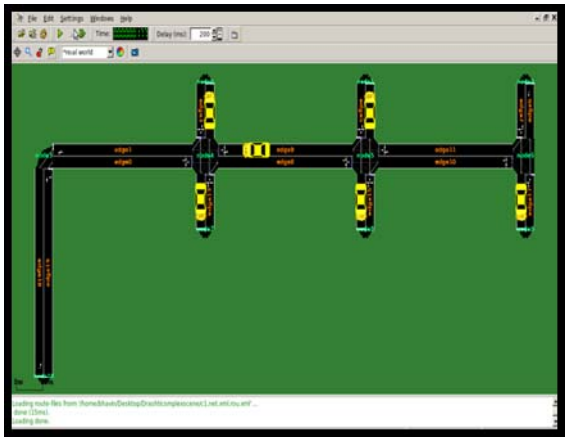
a) Interested vehicle parking in slot



b) when parking lot is full



c) when parked vehicle leaves the parking lot



d) when head leaves the parking lot

NS2.35 Simulation Setup

| Simulation Setup | |
|---|---|
| **Channel Type** | Channel/WirelessChannel |
| **Network Interface Type** | Phy/WirelessPhy |
| **Interface Queue Type** | Queue/DropTail/PriQueue |
| **Routing Protocol** | AODV |
| **Radio Propagation Model** | Propagation/TwoRayGround |
| **MAC Type** | Mac/802_11 |
| **Node** | 15 |
| **Traffic Type** | TCP |
| **No of lanes** | 2 |
| **X coordinate of topology** | 232 |
| **Y coordinate of topology** | 132 |
| **Simulation time** | 499 |

Following shows the Network Animator which reflects the scenario of parking and messages exchanged between head and the interested vehicles

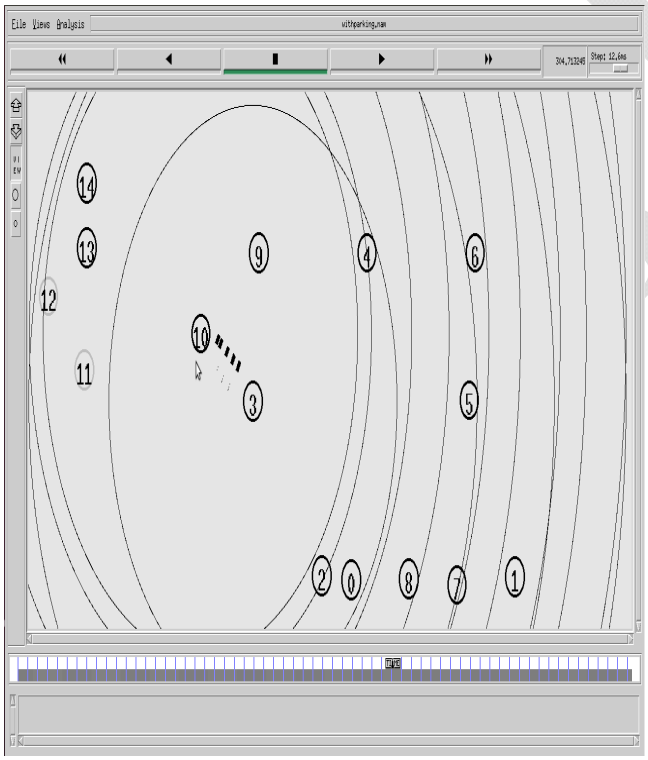


Figure 5 NAM

```
hey!!!Welcome to parking lot
I am car I want parking space.......req_park:1 and req_leav:0
Now 0 have received from 6 for request as req_parking = 1
 Parking space available for u in lot 6...
 Send reply to 0 from 6

Hurray!! I am parking at 6

hey!!!Welcome to parking lot
I am car I want parking space.......req_park:1 and req_leav:0
Now 0 have received from 7 for request as req_parking = 1
 Send reply to 0 from 7

Ok!! No parking available

I am car I want parking space.......req_park:1 and req_leav:0
Now 0 have received from 8 for request as req_parking = 1
 Send reply to 0 from 8

Ok!! No parking available

I am car I am leaving...req_park:0 and req_leav:1
 head leaves
Now 3 have received from 0 for request as req_leaving = 1
 Send reply to 3 from 0
I am car I want parking space.......req_park:1 and req_leav:0
Now 3 have received from 9 for request as req_parking = 1
 Parking space available for u in lot 1...
```

Figure 6 Messages

## VII. SIMULATION RESULTS

Here the analysis is based on results of the parking based scenario defined.

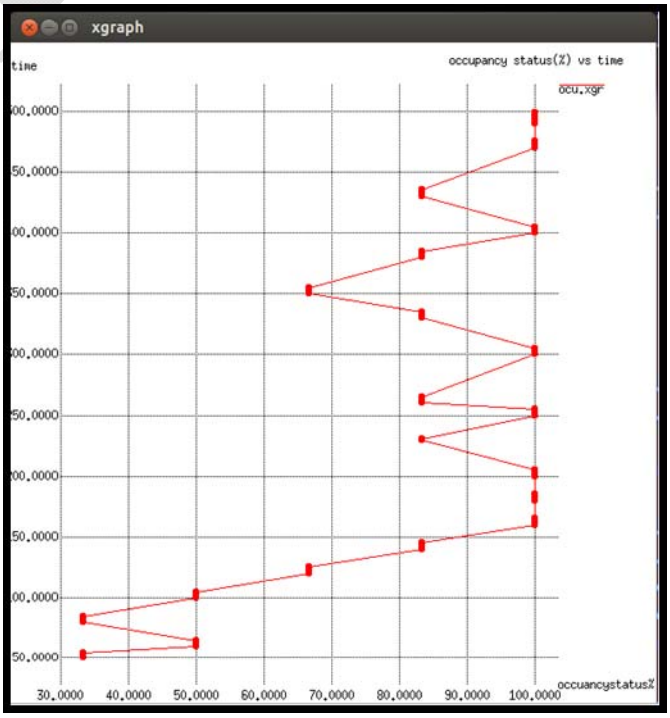



Figure 7 Simulation Time vs % of useful information delivered

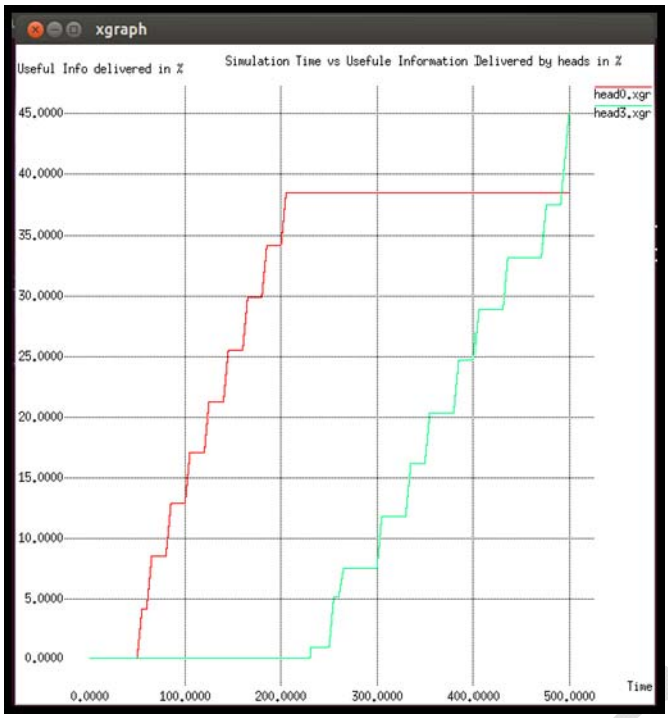



Figure 8 Occupancy Status vs Time

Figure 7 shows at each point during simulation amount of useful information delivered by heads which keeps on increasing as time elapses. This also depicts when one head leaves and passes the parking information to other

Figure 8 shows the utilization of parking area in percentage during simulation time. It shows number of vehicles parked at each point of time where 100% signifies that parking lot is full.

## VIII. CONCLUSION

The proposed system presented is used to disseminate and allocate available parking spaces to drivers. The proposed system provides benefits in terms of communication infrastructure costs and maintenance. There is no drastic performance change in Modified AODV when parking facility is added. Hence the system tries to reserve the parking space along with handling competition among the vehicles using inter vehicular opportunistic communications.

## IX. FUTURE WORK

In future this proposed work will be extended in terms of creating clusters of parking spots belonging to particular areas and then making communication possible among them so that the interested vehicle can also get information that if here the parking is not available then probably where it could find available then so that it could decide to travel towards it and not unnecessarily visit full parking spots.

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