POLITECNICO DI TORINO

III Facoltà di INGEGNERIA

Master of Science in Communication Engineering

Summary of the Thesis

Content Downloading in Vehicular Ad-hoc Networks

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➢ Background

The main aim of this thesis is to propose a scheme to download the content in Vehicular Ad-hoc NETwork(VANET) for convenience applications and comfort applications. VANETs will come into reality in the near future because of the widely deployment of Access Points(AP) and the new 802.11p standard. Besides safety critical applications, there is a growing demand for convenience applications and comfort applications. The previous include traffic management application, traffic coordination application, parking availability, etc. The main focus of comfort applications is to make travel more pleasant by providing audio and video streaming, web-browsing, email, etc. Both these applications do not require timely and reliable delivery of the contents, however they require a higher bandwidth.

Nodes in a VANET have both advantages and disadvantages compared to the nodes in generic Ad-hoc Networks. On one hand, VANET nodes do not have any energy and computational power limit. They know their positions thanks to the GPS receiver and their mobility is highly predictable. On the other hand, high velocity of vehicles results in frequent change of topology. Moreover the communication between AP and vehicle is fleeting due to the limited coverage range of AP and additional time to connect an AP. The communication is also intermittent because ubiquitous deployment of APs is not feasible.

In this thesis, we design a scheme, which utilizes GPS information and solves the problems presented above by using cooperative downloading and Vehicle to Vehicle(V2V) information sharing, to implement the applications in a VANET scenario.

➢ The Proposed Scheme

Some assumptions are made in order to develop the scheme. First of all, a group of vehicles interested in the same content is formed before entering the coverage range of AP. A vehicle header is selected for the whole group. It is the nearest vehicle to the AP. Secondly, all vehicles work in overhear mode. Thirdly, all vehicles know the group membership ID, the position and the velocity of other group members. Additionally, the ACK message in application layer is eliminated since the node can use the ACK message in MAC layer. The new header is selected such that the number of header handovers is the smallest. The selection of the new header depends both on its distance from the AP and its velocity.

The scheme works basically at application layer; it is composed of cooperative downloading phase and V2V information sharing phase.

- Cooperative Downloading Phase:

The basic idea of cooperative downloading is that the AP sends sequentially only one copy of the content to the group. More specifically, the header sends the REQUEST message as soon as it enters the coverage range for requesting the content from the AP. After receiving the REQUEST message, the AP sends the TRAFFIC message with a portion of the content to this vehicle header. At the same time, other vehicles, which are also inside the coverage range, can overhear the TRAFFIC message. The AP sends next TRAFFIC message if it receives ACK at the MAC layer. When the AP does not receive ACK for the TRAFFIC message at the MAC layer after maximum retry times, it directly sends the next TRAFFIC message to the new header vehicle without any handshake.

- V2V Information Sharing Phase:

The basic idea of V2V information sharing phase is that the vehicle obtains the missing packets from the other vehicles. The COVERAGE STATE of the vehicle, which means that the vehicle is still near the coverage range of an AP, is introduced in order not to interfere other vehicles' downloading phase. If the vehicle has not received any TRAFFIC message after traffic_timeout, it goes to COVERAGE STATE. Or if it overhears any TRAFFIC message, it enters into COVEARGE STATE. After having not received or overheard any packet after adver_timeout in COVERAGE STATE, it finally starts the V2V information sharing phase.

In V2V sharing phase, the vehicles advertise the received packets by sending broadcast ADVER message. The ADVER message is sent within one-hop. After receiving ADVER message, other vehicles can send back the CTS message about the packets they need. The ADVER sender then decides the forwarder to which the TRANSFER message is sent to. The TRANSFER message contains the payload data. The forwarder is the vehicle which wants the packet and is the farthest vehicle from the source so that the information can be distributed as quick as possible. When either all the vehicles get the contents or the group meets the second AP, the V2V information sharing phase ends.

➢ Implementation & Simulation Results

The scheme is implemented on the Network Simulator 2(NS2). Two application classes are added: *VCDServer* and *VCDClient*. The *GroupManager* class is used to simulate the group management protocol. Moreover, some modifications at lower layers are made to support the overhearing of unicast message and cross layer ACK notifications. Besides those, the AODV routing agent is changed in order to support the correct operation of AP.

Finally, the performance of the scheme is evaluated. An example is shown in Figure-1, where the group is composed of two vehicles and one AP. The two vehicles travel along the square route with 975 meters long on each side. They enter and leave at the bottom-left corner with the coordinate (25,25). The AP is located at the bottom-right corner with the coordinate (975,25). In this scenario, where the file size is unlimited, the number of received packets per each vehicle is 16.70% higher and the group throughput increases by 54.1%.

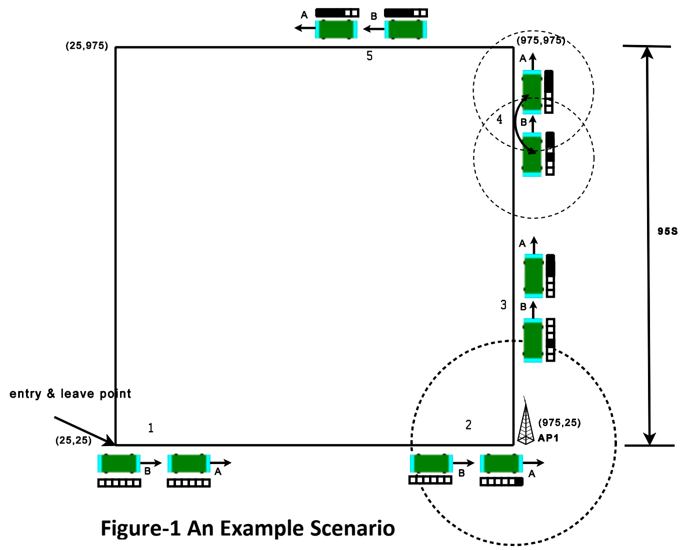

Figure-1 An Example Scenario

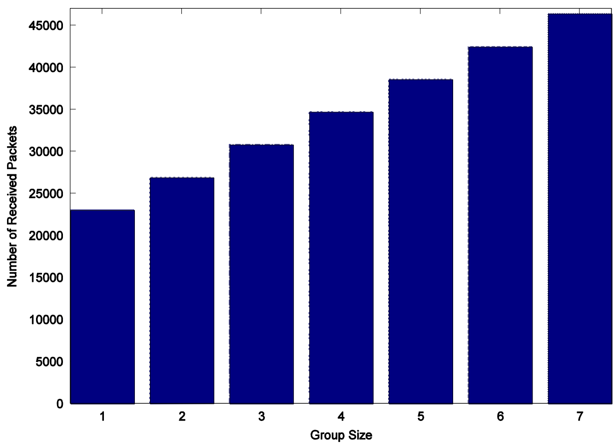

Figure-2 No. of Received Packets Per Vehicle vs Group Size

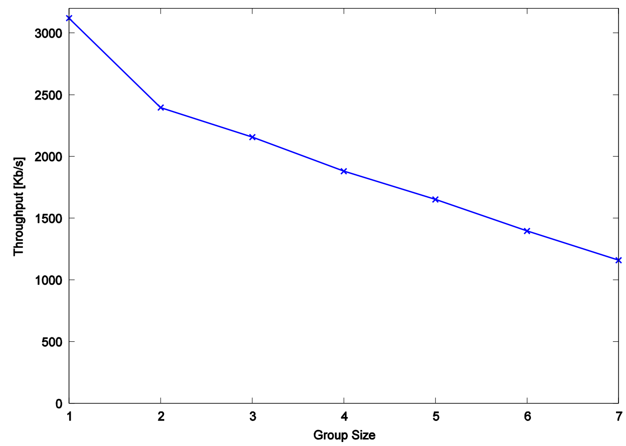

Figure-3 Throughput Per Vehicle vs Group Size

The tunable parameters of the simulation scenario include group size, file size, timeout value and radio range of the node. When we consider file size as unlimited, in Figure-2 the number of received packets per each vehicle increases linearly as vehicles in the group increases. As can be seen in Figure-3, the throughput per vehicle decreases as the group size increases. The reason is that more time is spent in setting up the V2V information sharing phase and more transmission collisions occur. So when the file size is limited, increasing the group size does not help.

Other simulation results are presented also. Firstly, the size of packet status field with respect to different group size is acceptable and does not change a lot. Secondly, higher sharing timeout can result in more number of received packets per vehicle but longer content distribution duration time. Thirdly, the number of received packets and throughput per vehicle increases as the radio range of the nodes becomes larger. Finally, in multiple APs' case, the packet receipt status is different for each vehicle because there may not be enough time in between two APs to share the contents from the first AP.