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Seamless and Efficient WiFi Access from Vehicles

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ABSTRACT: There has been a huge demand for internet access from vehicles. Every person who travels needs some mode to spend their time while travelling. Since everybody owns a smart phone these days being connected to the internet is inevitable. Majority of the people are active on social networking sites, and used a lot especially when travelling. An employee of a company is always on the move but needs to be connected to the company network at all times. While travelling since we either use cellular network like GSM or a dongle, these technologies are effective but the issue is since large number of people use it, it has a lot of overhead. Because of this overhead the speed of the internet reduces greatly. Therefore the company employee needs an alternative technology where the speed of the internet is more or less stable. The technology proposed in this paper is WiFi access from moving vehicles. When the client sends a message to the server it acts as group unicast where all the Access Points (APs) have same MAC and IP addresses. While, a message destined to client is sent to a group of APs by using multicast mode. Thus, WiFi Access from Vehicles provides high throughput and low packet loss.

KEYWORDS: Networks, Wifi, Access point

I. INTRODUCTION

Growing access to internet demands VoIP calls on the move, but we often see there are call drops when we move from one region to other region thus reducing the quality of access from the internet.

Currently cellular networks like GPRS provide a widely spread Internet connection, but they tend to get expensive. Along with that cellular networks have been proven to be insufficient for the increasing amount of data from Internet-enabled mobile devices. Because of the increasing number of subscribers, cellular networks are overloaded, and the users are experiencing service quality degradation.

WiFi which is based on IEEE 802.11, is a technology that provide wireless connectivity Compared with cellular networks, WiFi has many advantages: lower cost and higher peak throughput. Thus, WiFi is considered as a suitable solution for cellular traffic offloading.

The reasons for using WiFi to reduce cellular traffic are elaborated as follows:

- The channel condition in vehicular environment is harsh because of interference and noise, which results in high packet loss rate
- Because the client is moving at a vehicular speed, it is extremely difficult for it to be always associated with the most appropriate AP.
- Every AP has a limited coverage therefore the client suffers from frequent connection disruptions caused by handoffs and re-associations.

WiFi FROM MOVING VEHICLES provides consistent and efficient Internet access from vehicles. In this, a group of APs are used to communicate with a client called as AP diversity and the transmission succeeds if any AP in the group successfully delivers the packet to the client it is called as opportunistic transmission. These concepts of AP diversity and opportunistic transmission are used to overcome the high packet loss; this is achieved by setting every AP with the same MAC and IP addresses. Because of this configuration, the client gets an illusion that only one AP exists, and he will always be associated with this (virtual) AP. For uplink communications when the client transmits a packet

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to the virtual AP, but in reality multiple APs within its transmission range are able to receive it. The transmission is successful if at least one AP receives the packet correctly. Each AP that receives the packet returns an acknowledgement (ACK), therefore this model operates in a group unicast mode this increases the efficiency and reliability of the channel utilization. To avoid possible collisions of ACKs from different APs, an additional ACK detection function is developed to enhance the conventional ACK decoding.

For downlink communications, a packet destined for a client is delivered in two stages.

First stage: The packet is send to a group of APs through multicast

Second stage: The client then sends periodical requests to APs to fetch its packet stored in the AP group.

The advantages of SWIMMING are given below:

1) Because of AP diversity and opportunistic transmission, link reliability is enhanced, and packet loss is reduced.

2) The ACK detection function is designed to eliminate the effects of multiple acknowledgments. This ensures the efficiency of the channel utilization.

3) By setting all APs with the same configuration handoff is eliminated, and consistent roaming within the coverage of the entire network is achieved.

4) Two-stage packet delivery in downlink communications increases the probability of successful transmissions.

Because of these advantages, this model outperforms other schemes remarkably.

II. RELATED WORK

Wi-Fi Performance and Efficiency over TCP

IT presents the performance and efficiency of Wireless Fidelity (Wi-Fi) network over Transmission Control Protocol (TCP). The performance of this protocol plays a major role in deciding the deliverable Quality of Service (QOS) to network user. It presents performance and efficiency of the various component used for Wi-Fi facility by its integration with existing technology. This work has been done within the framework of B- Node theory. Wi-Fi network has been tested on Transmission Control Protocol (TCP) using an end-to-end bandwidth measurement tool.

It has been done in three phases:

i) The various Wi-Fi network segment performances has been measured over TCP in a live environment

ii) Calculation and Measurement of individual component performance using B-Node theory.

iii) Identification of coupling factor by comparison and analysis of results obtained by theoretical and practical measurement. It has been found that coupling factor and end network node configuration makes a significant role in deciding the deliverable QoS to the user.

In addition to the reliable network users also have a strong demand for increased mobility, flexibility and availability of its resources without losing its connectivity. Integration of Wi-Fi with strong and reliable optical fiber backbone is answer to the demand of academic community. This integration comes up with many challenges of performance, compatibility and security. This theory provides us a very simple and efficient method for measurement of performance of individual component of a system. The thumb rule of this theory is that, the capacity and limitation imposed by each link is measured and accordingly the value of efficiency of that particular component is measured. In this theory each node is treated as individual B- node (Bandwidth node). Product of all these B-node gives the performance of overall network link. B- node theory helped us to identify the weakest link in the chain and justify the principle that "the strength of chain is limited by its weakest link" and accordingly improvements in the network system could be made by removing the bottleneck identified, which is a high level bandwidth-centric abstraction used to decouple.

It presents a performance and efficiency testing of Wi-Fi implemented in the University The objectives of this study covered under three phases are as given below:

• To find the overall efficiency of Wi-Fi facility available in University Institute of Information Technology in live network segment of CWOFN over TCP.

• Component wise performance of Wi-Fi equipments used over TCP using B-Node theory.

• To identify the performance bottleneck and coupling factor, if any

Thus this paper helps us give an idea about the upper hand that WiFi technology has over traditional TCP.

Next Generation Vehicle Network (NGVN): Internet Access Utilizing Dynamic Discovery Protocols

In the near future, vehicles are expected to become a part of the Internet, either as a terminal in a mobile network, as a network node, or as a moving sensor (providing environmental information, cars status, streaming video, etc.) or a combination of the three. This is partly due to the steadily growing interest of vehicles' passengers in location-based information. Drivers and passengers that would want to receive information about traffic jams or accidents in their vicinity will likely be interested in accessing Internet services from within the vehicular network. Access can be gained by using roadside installed Internet Gateways (IGs), which are able to communicate with the vehicles. However, several difficulties must be addressed in such a scenario. Examples are the communication efficiency, mobility support, the discovery of Internet Gateways, and the handover of connections from one gateway to the next. In this paper, we are focusing on the aspect of accessing the Internet from within the vehicle network using a service discovery protocol. We therefore developed a Dynamic Discovery Service (DDS) protocol to discover Internet Gateways which is suitable for the characteristics of future vehicular ad hoc networks. Besides the benefit of efficient service discovery, our protocol is able to choose the most suitable Internet Gateway among others.into route discovery process. RREQ message will be forwarded when the nodes have sufficient amount of energy to transmit the message otherwise message will be dropped. This condition will be checked with threshold value which is dynamically changing. It allows a node with over used battery to refuse to route the traffic in order to prolong the network life. In [6] Authors had modified the route table of AODV adding power factor field. Only active nodes can take part in rout selection and remaining nodes can be idle. The lifetime of a node is calculated and transmitted along with Hello packets. In [7] authors considered the individual battery power of the node and number of hops, as the large number of hops will help in reducing the range of the transmission power. Route discovery has been done in the same way as being done in on-demand routing algorithms. After packet has been reached to the destination, destination will wait for time δt and collects all the packets. After time δt it calls the optimization function to select the path and send RREP. Optimization function uses the individual node's battery energy; if node is having low energy level then optimization function will not use that node.

III. PROPOSED SYSTEM

A) AP diversity

The association scheme in WiFi is inflexible, i.e., a client is associated with only a certain AP at any time. The consequence of this is that, if the associated AP of the client receives a packet with errors, the transmission fails even if a neighbouring AP receives the packet successfully. To reduce transmission redundancy and avoid ACK collisions, the most appropriate AP is selected to forward the packets to the switch, and return ACKs to the client.

In this model, the AP diversity is used to avoid performance degradation caused by possible collision of ACKs from different APs. The transmission succeeds if even one of the AP receives the packet correctly, which also increases the efficiency.

In this model, a client is not associated with a certain AP, and no handoff is triggered when the client roams within coverage of the entire network. Therefore, it is the most appropriate for the WiFi-based communications in vehicular environments.

For downlink communications, a packet destined for a client is delivered in two stages.

First stage: The packet is send to a group of APs through multicast

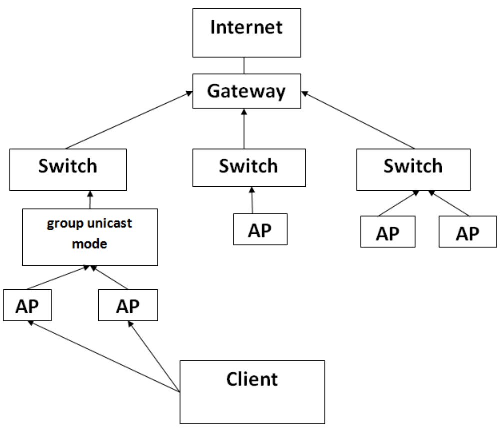

Fig1. An example scenario

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B. THE ARCHITECTURE OF SWIMMING

We assume that a road is completely covered by open WiFi access points (APs), and coverage of each AP may overlap with others. Each AP is has two interfaces- one is for client access based on WiFi, while the other uses wired or wireless medium. Switches are connected to the Internet through a gateway. When APs have established routing paths to the gateway, the network is organized into a tree topology with the gateway as the root and APs as leaves.

Since packet loss is severe in vehicular environments, AP diversity and opportunistic transmission are designed to enhance transmission reliability. When the client wants to join the network, it is associated with a virtual AP, and requests an IP address through DHCP. The DHCP server running at each AP uses the same hash function to compute a unique IP address for the client based on the its MAC address. The client in reality is associated with multiple APs at a given time but it is made to believe that he is associated with only one AP called as the virtual AP.A packet sent to the client is received by all the APs that lying in the transmission range of the client, so if the AP currently associated with the client fails to receive the packet any other AP in the transmission range of the client receives the packet. This leads to a successful transmission.

For instance, both AP1 and AP2 in Fig. 1 are located within the transmission range of Client1. Assume the success probabilities that these two APs receive the packets of Client1 are P1 and P2, respectively. When Client1 sends a packet to the AP, the probability that the transmission succeeds is

$$P=1-(1-P1)(1-P2)$$
$$=P1+P2-P1P2 \qquad (1)$$

The advantage of configuring the MAC address of the APs in the transmission range of the client is that MAC-layer handoff is eliminated. Therefore connection disruptions because of handoffs and re-associations are avoided. Even in the condition of failure of an AP the network will not be severely affected.

If client broadcasts its packets there are multiple APs receiving the client's packets. but other than the virtual AP no other AP send the acknowledgement frame (ACK) because of this the client cannot know if the transmission was successful or not. Therefore to maximize the delivery ratio, the client has to transmit packets at the lowest bit-rate, which s inefficient bandwidth utilization. As APs are configured into the unicast mode, they send ACKs when they receive a packet correctly. Because of the concept rate control, the transmission rate adapts to channel conditions better. Hence wireless resources are utilized efficiently, and the performance is improved.

If multiple APs receive a packet, each of them will transmit an ACK after a period of short interval. These multiple copies of ACKs may collide at the client.. Same client receiving multiple ACKs from multiple APs causes redundancy. Therefore a new scheme is required to manage multiple collisions. A strategy of dropping duplicate packets is needed to reduce redundancy.

C. UPLINK COMMUNICATION

1) ACK Detection Scheme

The format of the acknowledgement (ACK) frame specified in IEEE 802.11 standard is revealed in Fig. 2

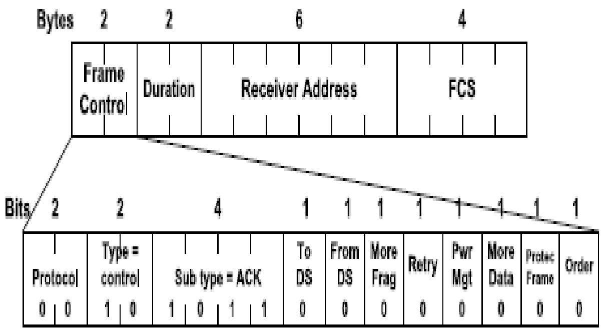

Fig2. Format of ACK frame specified in IEEE 802.11 standard

For a certain data packet of a client, the 14-byte ACKs generated by different APs are exactly the same.

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To avoid retransmissions caused by ACK collisions, an additional ACK detection function is proposed. Once a node has received a packet correctly, it responds with an ACK after a short interval. The transmission medium after this short interval is reserved for a period of ACK transmission. Because of this even if the simultaneously transmitted ACKs collide at the client, none of the other signals exist during that period when ACK is transmitted. Therefore, we can detect ACK even if collision happens.

2) Transmission Redundancy

Because of AP diversity, a packet can be received by multiple APs. If all copies of the same packet are forwarded to the switch, extra overhead is introduced. A metric of transmission redundancy ratio
(TRR) is defined to measure the overhead:

$$TRR= R/ E \quad \text{eq.(2)}$$

where R is the redundant transmissions, and E is the effective transmission times

D. DOWNLINK COMMUNICATION

When packets from the Internet need to be delivered to a client, AP diversity and opportunistic transmission are required to improve transmission reliability. That is, there are still a group of APs being employed to serve the client. To reduce transmission overhead, the packets are sent to this AP group using multicast. Therefore for downlink communications a multicast group is established for each client.

Downlink commutation can be executed in 2 stages
1) First stage: Packets destined for a given client are delivered to a group of APs through multicast. This multicast group is set to dynamically to follow the moving client.
2) Second stage: The client keeps sending downlink packet requests (DPRs) to fetch its packets that are stored in the buffer of the AP group.
The benefits of DPR are that it helps APs to locate the moving client, even if the client has not sent an uplink packet. Also, if an AP receives a DPR from a client and transmits a packet to the client immediately, there is a high probability that the packet can be received by the client. This two-stage strategy significantly reduces unnecessary transmissions when channel condition is poor, and dramatically improves the downlink transmission efficiency.

1) Multicast Group Management

When an AP receives a client's packet, the AP starts the multicast group of the client automatically. On receiving the message, each AP joins the multicast group, and then informs its parent node. The parent node also sends a notification to its parent until a multicast tree rooted at the gateway has been established.

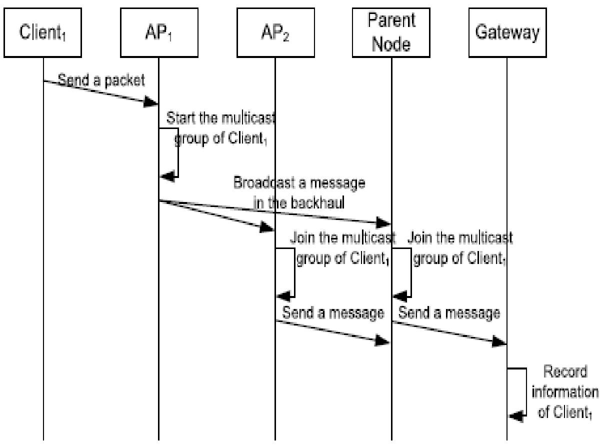

Fig3.Multicast group establishment

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2) Downlink Packet Delivery

The gateway stores the sequence numbers of each client to keep track of the number of downlink packets. The sequence number is initialized to 0. As soon as the gateway receives the packet from the internet it maps it to find the destination IP address. As given in figure 3 the gateway encapsulates the packet with a IP header with the destination IP address and adds the sequence number in the option field , and increases the sequence number by 1 for the next packet. The newly-encapsulated packet is transferred to all the APs.

Since the client does not know which the optimal AP is, the client requests its downlink packet from all the APs in sequence.

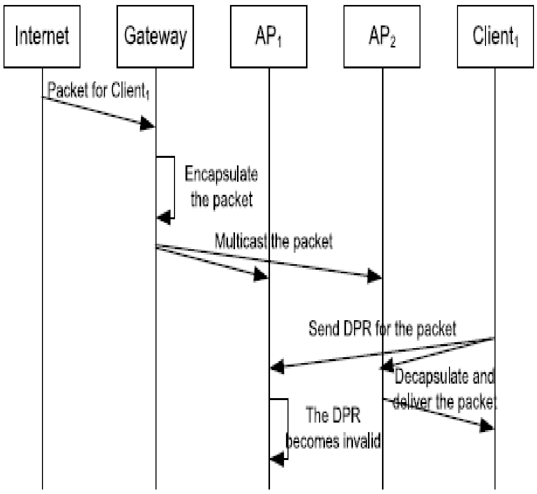

Fig4. Downlink communication

The client sends a downlink packet request, with a specified sequence number. Upon receiving DPR, the AP checks its buffer to determine whether it has the packet with the sequence number n. If such a packet exists in its buffer, the AP removes the IP header for multicast and delivers the actual IP packet to the client immediately. The probability that the packet can be received by the client is therefore high.

If a APs cannot transmit the packet, it continues to hold the packet. However, the DPR will become invalid for two reasons. First, possibly the packet has been sent to the client by another AP. Second, the channel condition may have changed so the delivery cannot be guaranteed.

If the client is not responded with its packet after sending DPR, it sends DPR repeatedly. If the client successfully receives its packet, it sends DPR+1.

IV. SIMULATION RESULTS

The simulation studies involves a small network topology with 13 nodes representing the moving vehicles as shown in Fig.1.1. The proposed system is implemented with NS2. It shows that node 4 and 5 are within the transmission range of AP 0, AP 1 and also AP 2, where AP's indicated in the green hexagon. Hence, it receives the services from all these AP's. The packets are being sent from client i.e. node 6 to all the APs in the transmission range of the client. As the vehicle is in range of both AP 0, AP 1 and AP 2 it is able to send the data to both of them. Therefore, even if the node moves, it will be able to send data to AP 1 as its ID is saved with it.

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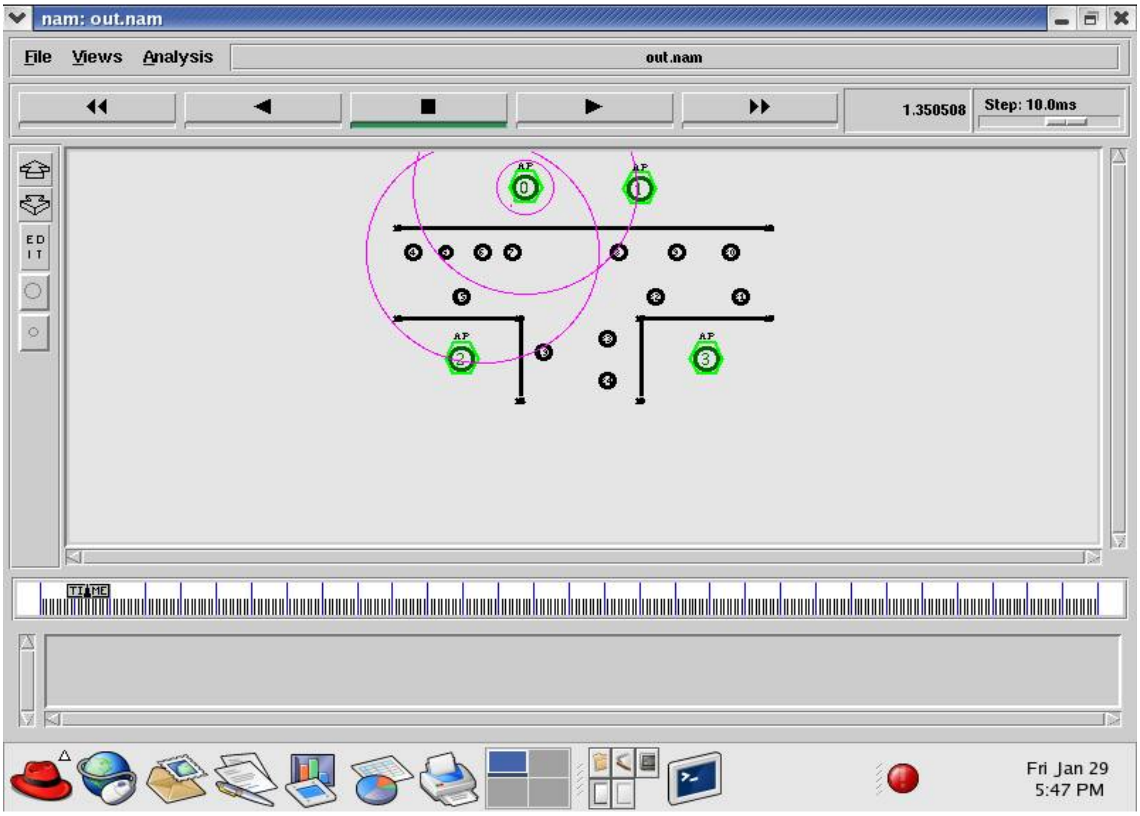

Fig. 1.1 Network Topology

The below graph in Fig 1.2, shows the difference between cellular and the proposed model. The packet loss in cellular network is shown by the red line, while the packet loss in proposed model, that is wifi from moving vehicles is shown by green line. This graph is indicating that the existing model has higher packet loss than that of the one proposed. Hence this model specifies that the drop rate in this model overcomes the existing one.

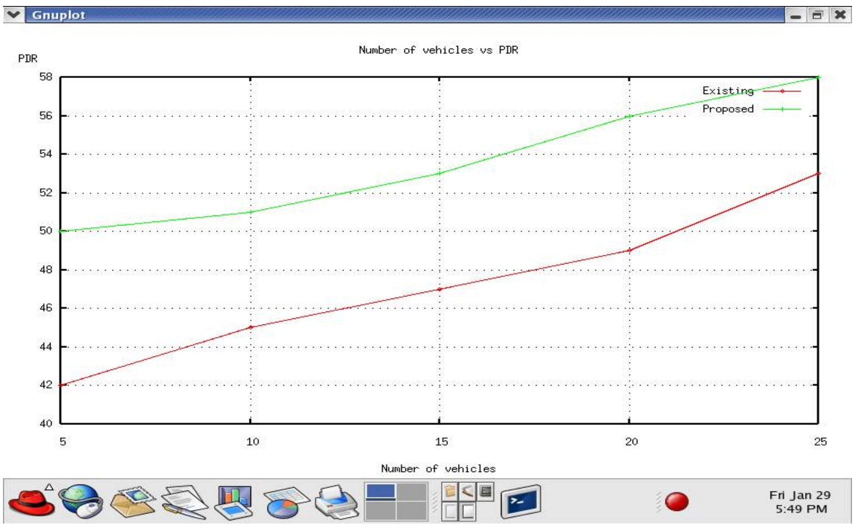

Fig 1.2 Cellular v/s Wifi from moving vehicles

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V. CONCLUSION

Therefore the model proposed in this paper is to support consistent and efficient WiFi- access from vehicles. It provides enhanced efficiency in both uplink and downlink communications. Hence it achieves greater channel utilization, high throughput and lowers the packet loss.

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