Access Point Diversity Using Seamless Internet Access for Moving Vehicles

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Abstract **- The cellular networks have been proven to be insufficient for the surging amount of data from Internet-enabled mobile devices. Due to the explosive growth of the subscriber number and the mobile data, cellular networks are suffering overload, and the users are experiencing service quality degradation. In this project implement seamless and efficient WIFI-based Internet access from moving vehicles. In our implementation, a group of aps are employed to communicate with a client (called "AP diversity"), and the transmission succeeds if any AP in the group accomplishes the delivery with the client (called "opportunistic transmission"). Such AP diversity and opportunistic transmission are exploited to overcome the high packet loss rate, which is achieved by configuring all the aps with the same MAC and IP addresses. With such a configuration, a client gets a graceful illusion that only one ("virtual") AP exists, and will always be associated with this "virtual" AP. Uplink communications, when the client transmits a packet to the virtual AP, actually multiple aps within its transmission range are able to receive it. seamless in the sense that any user can use it and maintain his workspace, including all existing network connections without manual configuration and with minimal network overhead. In downlink, a packet destined for a client is first pushed to a group of APs through multicast. This AP group is maintained dynamically to follow the moving client.**

Keywords **- ACK detection, Internet access, vehicle, WiFi.**

I. INTRODUCTION

Mobile Computing (MC) focuses on the key technical issues related to architectures, support services, algorithm/protocol design and analysis, mobile environments, mobile communication systems, applications, components, and more for mobile computing. Mobile Computing: A technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link. Mobile voice communication is widely established throughout the world and has had a very rapid increase in the number of subscribers to the various cellular networks over the last few years. An extension of this technology is the ability to send and receive data across these cellular networks. This is the principle of mobile computing. Mobile data communication has become a very important and rapidly evolving technology as it allows users to transmit data from remote locations to other remote or fixed locations. This proves to be the solution to the biggest problem of business people on the move - mobility.

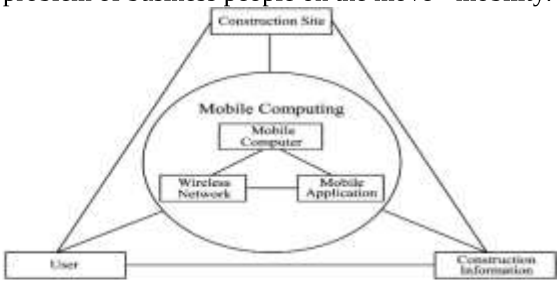

Fig. 1. Mobile Computing

Mobile Computing: A technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link. Mobile voice communication is widely established throughout the world and has had a very rapid increase in the number of subscribers to the various cellular networks over the last few years. An extension of this technology is the ability to send and receive data across these cellular networks. This is the principle of mobile computing. Mobile data communication has become a very important and rapidly evolving technology as it allows users to transmit data from remote locations to other remote or fixed locations. This proves to be the solution to the biggest problem of business people on the move - mobility.

Pervasive means 'existing in all parts of a place or thing'. Pervasive computing─ The next generation of computing which takes into account the environment in which information and communication technology is used everywhere, by everyone, and at all times. Assumes information and communication technology to be an integrated part of all facets of our environment, such as toys, computers, cars, homes, factories, and work-areas. Takes into account the use of the integrated processors, sensors, and actuators connected through high-speed networks and combined with new devices for viewing and display Mobile computing also called pervasive computing when a set of computing devices, systems, or networks have the characteristics of transparency, application-aware adaptation, and have an environment sensing ability.

II. LITERATURE SURVEY

Literature survey is that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. It is referred as reviewing and analyzing the work specified topic in research that precedes a research proposal and results section. Here we analysed various paper in order to bring some new ideas to overcome drawbacks present in the existing system.

The mobile access router infrastructure that exploits wireless diversity (e.g. channel diversity, network diversity, and technology diversity) to provide improved data performance for wireless data users. Our system design stems from the observation that rather than choosing a single wireless service provider (e.g. Sprint, AT&T, BT, Vodafone), a single technology (e.g. GPRS, UMTS, CDMA, 802.11), or a single wireless channel, users can obtain significant benefits by using the multiplicity of choices available. MAR is a wireless multi-homed device that can be placed in moving vehicles (e.g. car, bus, train) to enable high-speed data access. MAR dynamically instantiates new channels based on traffic demand, aggregates the bandwidth and dynamically shifts load from poor quality to better quality channels.

This paper investigates if WiFi access can be used to augment 3G capacity in mobile environments. We first conduct a detailed study of 3G and WiFi access from moving vehicles, in three different cities. We find that the average 3G and WiFi availability across the cities is 87% and 11%, respectively. WiFi throughput is lower than 3G throughput, and WiFi loss rates are higher. We then design a system, called Wiffler, to augments mobile 3G capacity. It uses two key ideas leveraging delay tolerance and fast switching to overcome the poor availability and performance of WiFi. For delay tolerant applications, Wiffler uses a simple model of the environment to predict WiFi connectivity. It uses these predictions to delays transfers to offload more data on WiFi, but only if delaying reduces 3G usage and the transfers can be completed within the application's tolerance threshold. For applications that are extremely sensitive to delay or loss (e.g.,VoIP), Wiffler quickly switches to 3G if WiFi is unable to successfully transmit the packet within a small time window. We implement and deploy Wiffler in our vehicular testbed. Our experiments show that Wiffler significantly reduces 3G usage. For a realistic workload, the reduction is 45% for a delay tolerance of 60 seconds. Wiffler (Combined both Wi-Fi & Cellular). Compared with cellular networks, WiFi has obvious advantages. However, it is still challenging to provide WiFi-based Internet access for users in moving vehicles. The reasons are elaborated as follows. Channel condition in a vehicular environment is usually harsh owing to severe multi-path fading, interference, and noise, which results in high packet loss rate. Since a client moves at a vehicular speed, it is extremely difficult for it to be always associated with the most appropriate AP. Due to the limited coverage of each single AP, a client suffers from frequent connection disruptions caused by handoffs and re-associations.

In this paper, we present OmniVoice, an 802.11 compliant solution that supports mobility for VoIP traffic without any client modifications. To effectively support such traffic, OmniVoice eliminates client handoff delays and manages interference from non-VoIP background traffic. It achieves this by using (a) a singlechannel WLAN design and (b) a lightweight central controller for scheduling non-interfering AP-to-client transmissions and dynamically associating clients. The controller minimizes interference with the help of an interference map that models potential exposed and hidden terminal conflicts in the WLAN, while allowing for the serialization of transmissions that would otherwise compete for medium access.

In DORA, we study random access in a drive thru scenario, where roadside access points (APs) are installed on a highway to provide temporary Internet access for vehicles. We consider Vehicle-to-Roadside (V2R) communications for a vehicle that aims to upload a file when it is within the APs' coverage ranges, where both the channel contention level and transmission data rate vary over time. The vehicle will pay a fixed amount each time it tries to access the APs, and will incur a penalty if it cannot finish the file uploading when leaving the APs. First we improved the optimization and created backbone for every network. Then we consider the problem of finding the optimal transmission policy with a single AP and random vehicular traffic arrivals. We create a finite-horizon sequential decision problem, solve it using Dynamic Programming (DP), and design a general, Dynamic Optimal Random Access (DORA) algorithm. We derive the conditions under which the optimal transmission policy has a threshold structure, and propose monotone DORA algorithm with a lower computational complexity for this special case. Next, we consider the problem of finding the optimal transmission policy with multiple APs and deterministic vehicular traffic arrivals thanks to perfect traffic estimation. We again obtain the optimal transmission policy using DP and propose a joint DORA algorithm.

Opportunistic connections to the Internet from open wireless access points are now commonly possible in urban areas. Vehicular networks can opportunistically connect to the Internet for several seconds via open access points. In this paper, we adapt the interactive process of web search and retrieval to vehicular networks with intermittent Internet access. Our system, called Thedu, has mobile nodes use an Internet proxy to collect search engine results and prefetch result pages. The mobile nodes download the pre-fetched web pages from the proxy. Our contribution is a novel set of techniques to make aggressive but selective prefetching practical, resulting in a significantly greater number of relevant web results returned to mobile users. In particular, we prioritize responses in the order of the usefulness of the response to the query, which allows the mobile node to download the most useful response first. To evaluate our scheme, we deployed Thedu on Diesel-Net, our vehicular testbed operating in a micro-urban area around Amherst, MA. Using a simulated workload, we find that users can expect four times as many useful responses to web search queries compared to not using Thedu's mechanisms.

III. PROPOSED SYSTEM

Support seamless and efficient Wi-Fi-based internet access from moving vehicles using AP diversity. WIFI is considered as a suitable solution for cellular traffic offloading. However, it is still challenging to provide WIFI-based Internet access for users in moving vehicles. The reasons are elaborated as follows. First, channel condition in a vehicular environment is usually harsh owing to severe multi-path fading, interference, and noise, which results in high packet loss rate. Second, since a client moves at a vehicular speed, it is extremely difficult for it to be always associated with the most appropriate AP. Third, due to the limited coverage of each single AP; a client suffers from frequent connection disruptions caused by handoffs and re-associations.

First, channel condition in a vehicular environment is usually harsh owing to severe multi-path fading, interference, and noise, which results in high packet loss rate. Second, since a client moves at a vehicular speed, it is extremely difficult for it to be always associated with the most appropriate AP. Third, due to the limited coverage of each single AP, a client suffers from frequent connection disruptions caused by handoffs and re-associations. Cellular networks (e.g., GPRS, 3 G, or LTE) provide ubiquitous Internet connection, but with relatively expensive cost. Unreliable links and unstable connections issues are unavoidable.

Insufficient for the surging amount of data from Internet-enabled mobile devices.

With the penetration of portable smart devices, the demand for Internet access from moving vehicles has grown sharply in recent years. An increasing number of commuters and passengers prefer accessing the Internet using their smart phones or tablet computers while traveling. At present, cellular networks (e.g., GPRS, 3 G, or LTE) provide ubiquitous Internet connection, but with relatively expensive cost. Proposed system to support seamless and efficient WiFi-based Internet access from moving vehicles. In proposed, a group of APs are employed to communicate with a client (called "AP diversity"), and the transmission succeeds if any AP in the group accomplishes the delivery with the client (called "opportunistic transmission"). In AP diversity a client gets a graceful illusion that only one ("virtual") AP exists, and will always be associated with this "virtual" AP.

Uplink communications, when the client transmits a packet to the virtual AP, actually multiple APs within its transmission range are able to receive it. The transmission is successful as long as at least one AP receives the packet correctly.

Since each AP that receives the packet returns an acknowledgement (ACK) frame, proposed system operates in a "group unicast" mode. Unlike broadcast or promiscuous mode, ACK-based rate control mechanisms can be seamlessly applied to this group unicast mode, which increases the efficiency and reliability of the channel utilization. In order 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. In the first stage, the packet is pushed to a group of APs through multicast rather than being pushed to the client directly through unicast. This AP multicast group is maintained dynamically to follow the moving client. In the second stage, the client then sends periodical requests to APs to fetch its packet buffered in the AP group. This twostage strategy maintains stable end-to-end downlink communications for the client in a moving vehicle. By exploiting the AP diversity and opportunistic transmission, the link reliability is enhanced, and packet loss is significantly reduced. An ACK detection function is designed to eliminate the adverse effect of multiple ACKs. This function ensures that ACK-based rate control mechanisms can be adopted in our proposed system to improve the efficiency of the channel utilization. By configuring all APs with the same setting, both layer-2 and layer-3 handoffs of the mobile client are eliminated, and seamless roaming within the coverage of the entire network is achieved. The two-stage packet delivery in downlink communications dramatically increases the probability of successful transmissions. AP diversity to overcome the issue of unreliable links and unstable connections.

IV. SYSTEM ARCHITECTURE AND DESIGN

Design is a meaningful engineering representation of something that is to be built. Software design is a process through which the requirements are translated into a representation of the software. Design is the place where quality is fostered in software engineering. Design is the perfect way to accurately translate a customer's requirements into a finished software product. Design creates a representation or model, provides detail about software data structure, architecture, interfaces and components that are necessary to implement a system. This chapter discusses the design part of the project. Here in this document the various UML diagrams that are used for the implementation of the project are discussed. The architecture involves the processing of data aggregation in the sensor environment. The sender wants to send the request query to intermediate nodes in order to collect the information from the sensor nodes.

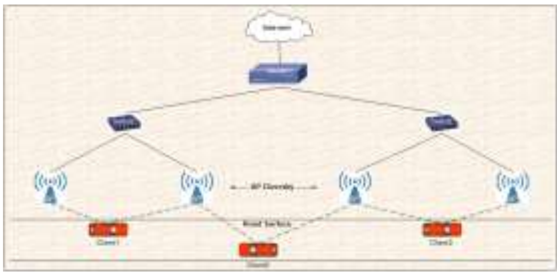

Fig.2 Architecture of seamless internet access for moving vehicles

A road is completely covered by open WiFi access points (APs), and coverage of each AP may overlap with others. Each AP is equipped with two interfaces; one is for client access based on WiFi, while the other uses wired or wireless medium to form a backhaul. Hence, the back- haul can be either a local area network (LAN) or a wireless mesh network. The backhaul connects to the Internet through a gateway. It is assumed that both bandwidth and reliability of backhaul links are higher than that of access links, and packet loss in backhaul is negligible. Moreover, only the traffic between clients and the Internet is taken into account in this paper. When APs have established routing paths to the gateway, the backhaul is organized into a tree topology with the gateway as the root and APs as leaves. The researchers conduct a large number of measurements in real vehicular environments, and the following experimental observations are revealed.

A Data Flow Diagram (DFD) takes an input – process-output view of a system. That is, data objects flow into the software is transformed by processing elements, and resultant data objects flow out of the software. A Data Flow Diagram (DFD) is a graphical representation of the "flow" of data through an information system, modelling its process aspects. DFDs can also be used for the visualization of data processing (structured design) for each building there will be an Emergency Response Team present for the safety of the employees.

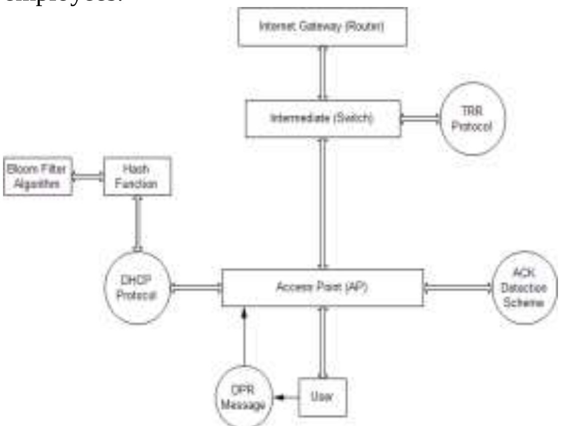

Fig. 3. Dataflow Diagram for continuous internet access for moving vehicles without delay

Initialise Virtual AP

Configuring all the APs with the same MAC and IP addresses with such a configuration, a client gets a graceful illusion that only one ("virtual") AP exists, and will always be associated with this "virtual" AP. When APs have established routing paths to the gateway, the backhaul is organized into a tree topology with the gateway as the root and APs as leaves. A group of APs are employed to communicate with a client (called "AP diversity"). The identical configuration of all the APs has advantage: both IP-layer and MAC-layer handoff are eliminated. Hence, connection disruptions caused by the handoffs and re-associations are avoided, and the network connection will not be disrupted even if an AP crashes. A potential requirement of AP diversity is that all APs operate on the same wireless channel.

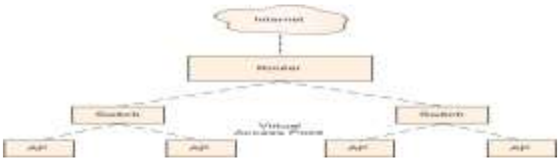

Fig. 4 Initialise Virtual AP

Client Joining

When the client intends to join the network, it is associated with this virtual AP, and requests an IP address through DHCP (Dynamic Host Configuration Protocol). 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. DHCP is a client/server protocol that automatically provides an Internet Protocol (IP) host with its IP address and other related configuration information such as the subnet mask and default gateway. The DHCP is a standardized network protocol used Internet Protocol (IP) networks for dynamically distributing network configuration parameters, such as IP address for interfaces and services. With DHCP, computers request IP addresses and networking parameters automatically from a DHCP server, reducing the need for a network administrator or a user to configure these settings manually.

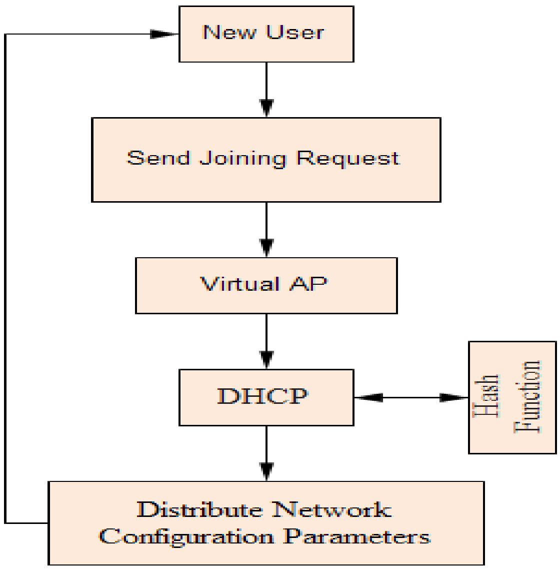

Fig. 5. Client Joining

Uplink Communication

The uplink communications, when the client transmits a packet to the virtual AP, actually multiple APs within its transmission range are able to receive it. These problems overcome following ways 1) ACK Detection Scheme and 2) Transmission Redundancy.

- ACK Detection Scheme

If multiple APs receive a packet, each of them will transmit an ACK after a period of short inter-frame space (SIFS). These multiple copies of ACKs may collide at the client. Hence, a new scheme is designed to handle such collisions. In the new scheme, the ACK decoding is enhanced with ACK detection. In this scheme the strength of one signal is considerably higher than the strength of the other one. Under the condition, the weak signal is dropped by the filter of the receiver, and only the strong signal is retained to be decoded.

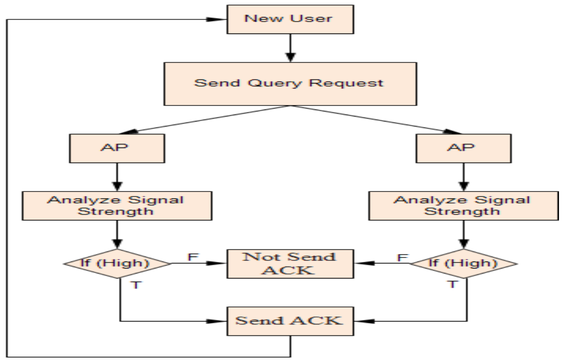

Fig. 6. Uplink Communication

Transmission Redundancy

A packet can be received by multiple Aps. If all copies of the same packet are forwarded to the gateway, extra overhead is introduced to the backhaul. In order to minimize TRR, a redundancy removal mechanism is used. If an intermediate node in the backhaul network receives a packet that has been forwarded, it simply drops the duplicated packet. To determine whether a packet has been delivered before, a few fields of the packet are checked to identify the packet. It can be identified by a 5-tuple of <source_IP, source_port, destination_IP, destination_port, transmission sequence_number>. In a LAN backhaul, the Aps are interconnected by cables, hubs and switches. When a node transmits a packet to its upper-layer node, other nodes in the same subnet can overhear the packet as well. Thus, these node are able to directly avoid redundant transmissions. In a WMN backhaul, one AP may not overhear the backhaul transmission of a packet from another AP. In this case, two Aps may forward the same packet to an upper-layer node. Such redundancy has to be eliminated at the upper-layer node.

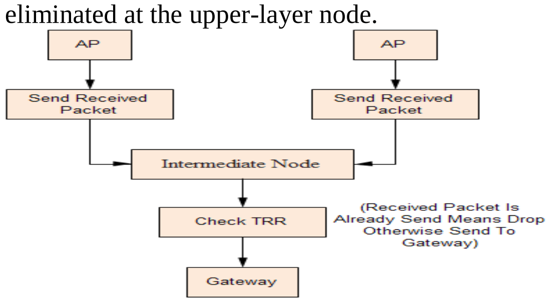

Fig. 7. Transmission Redundancy

Downlink Communication

The downlink communication is divided into two stages. In the first stage, packets destined for a client are delivered to a group of Aps through multicast. This AP multicast group is maintained dynamically to follow the moving client. In the second stage, the client periodically sends downlink packet requests (DPRs) to fetch its packets buffered in the AP group. The introduction of DPR brings two benefits. First, it helps Aps to locate the moving client, even if the client has no uplink packets to transmit. Second, it probes the channel quality. Due to the strong symmetric correlation of wireless links, if an AP receives a DPR from a client and transmits a packet to the client immediately, it is with 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.

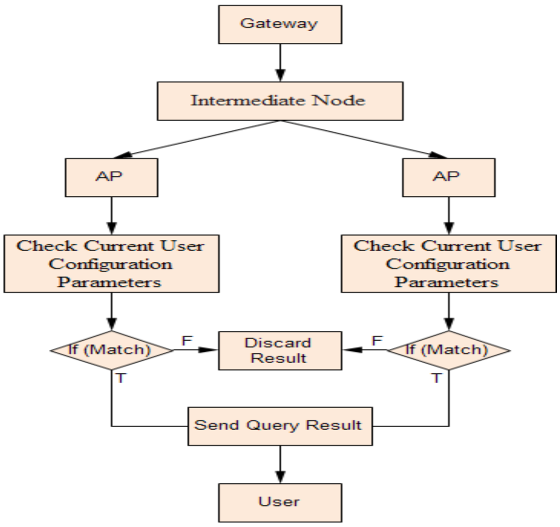

Fig. 8. Downlink Communication

The format of the acknowledgement (ACK) frame specified in IEEE 802.11 standard is revealed in a certain data packet of a client, the 14-byte ACKs generated by dif- ferent APs are exactly the same. When multiple identical ACKs are emitted by different APs almost simultaneously, whether or not these ACKs will collide at the client raises a question. Consider a scenario as shown in Fig. 3. The distance between the client and AP1 is denoted as S1, while the dis- tance between the client and AP2 is S2. Without loss of generality, it is assumed that S1 <S 2. Hence, when both AP1 and AP2 reply ACKs to the client, the two ACKs par- tially overlaps as sketched in Fig. 4. The duration from the arrival of the first ACK to the arrival of the last ACK, referred to as arrival time difference, is T1,T2, where T1 and T2 are the signal propagation time from the client to AP1 and AP2, respectively.
The ACK detection scheme is entirely implemented at the client. Our implementation is based on a wireless network interface card with Atheros AR5414 chipset and MadWiFi. The duration of ACK reception is measured by a 32-bit counter register RFCNT, which counts the time at the 40 MHz (for 802.11a mode) or 44 MHz (for 802.11g mode) built-in quartz resolution. The counter of RFCNT accumulates the time in clock units during which the card receives signals. To record the receiving time of a single ACK, a few interrupts are exploited to reset the counter at a proper time.

ACK detection, as the foundation of SWIMMING, has never been proposed or implemented by previous studies. In order to verify the effectiveness of ACK detection, this scheme is implemented on a real testbed. The wireless network interface card used in the experi- ments is based on Atheros AR5414 chipset. The MadWiFi driver is modified to read the RFCNT register at every TXERR interrupt and to reset the register at every TXEOL interrupt. Three WiFi nodes are deployed in the experi- ments. One of them works as the client, while the other two serve as the APs. The configurations of the two APs are totally identical. All the nodes are configured into 802.11a mode, and operate on Channel 40 (5.20 GHz). In the experi- ments, the client transmits UDP packets to the APs, and the APs return ACKs. To prevent retransmissions when ACKs collide, the retransmission function of the client is modified such that retransmission is initiated by our driver codes instead of hardware. This driver level retransmission func- tion also ensures only one packet is pushed to the hardware queue at a time, which guarantees a TXEOL interrupt after a transmission.

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

TRR = R-E (or) R/E

where R is the redundant transmissions, and E is the effec- tive transmission times. For instance, if a packet is trans- ferred from an AP to the gateway through three hops, the value of E is 3. In order to minimize TRR, a redundancy removal mecha- nism is proposed as follows. If an intermediate node in the backhaul network receives a packet that has been forwarded, it simply drops the duplicated packet. To determine whether a packet has been delivered before, a few fields of the packet are checked to identify the packet. For a TCP packet, it can be identified by a 5-tuple of <source_IP, source_port, destination_IP, destination_port, TCP_sequence_number>. For a UDP packet, TCP_sequence_- numberinthe5-tupleisreplaced by checksum. In a LAN backhaul, the APs are interconnected by cables, hubs and switches. When a node transmits a packet to its upper-layer node, other nodes in the same subnet can over- hear the packet as well. Thus, these node are able to directly avoid redundant transmissions.

When packets from the Internet need to be delivered to a client, AP diversity and opportunistic transmission are also leveraged to improve transmission reliability. In other words, there are still a group of APs being employed to serve the client. Inorder to reduce transmission overhead, the packets are sent to this AP group using multicast. a client with the IP address of 10.A.B.C, its correspond- ing multicast group is assigned a class D private multicast IP address of 239.A.B.C. Once an AP receives a client's packet, the AP starts the multicast group of the client automatically. As the client is moving, geographically neighboring nodes of the AP are likely to communicate with the client.

V. RESULTS

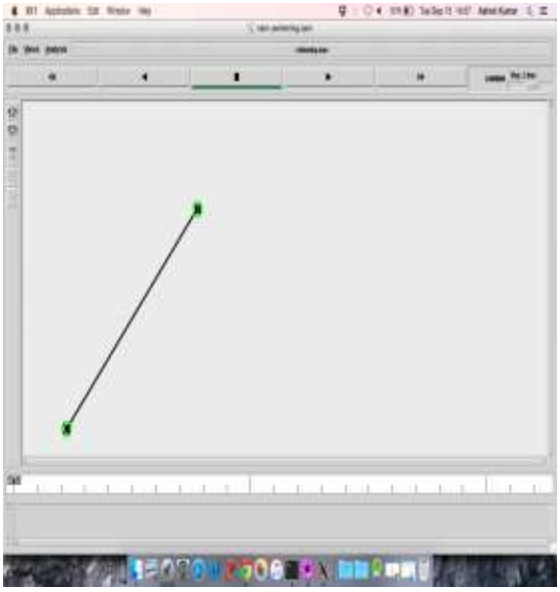

Fig. 9. Node Initialization

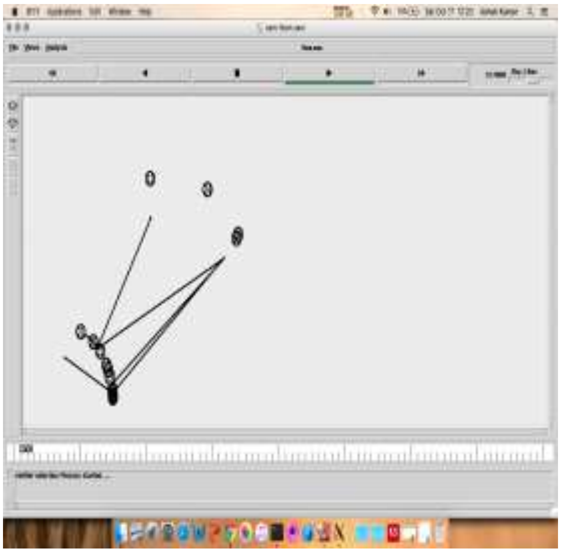

Fig. 10. Mutlicast Group Node

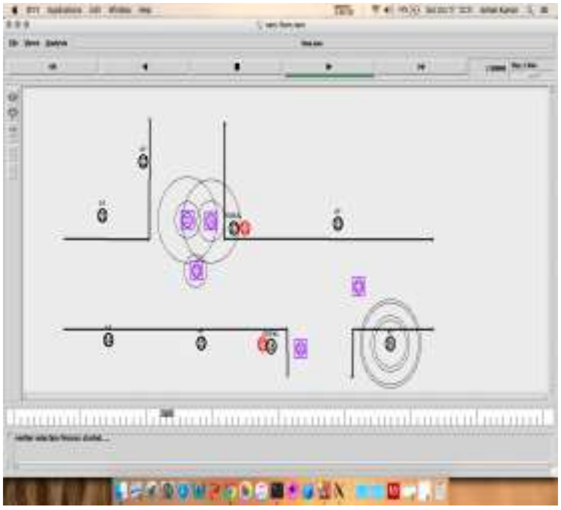

Fig. 11. Access Point Coverage Area

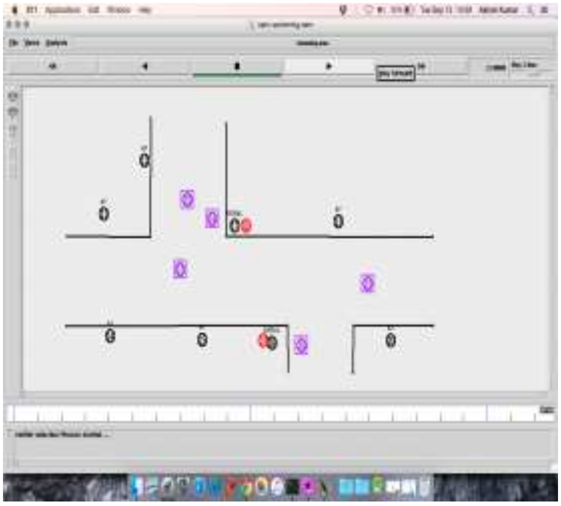

Fig. 12. Seamless internet access

VI. CONCLUSION

Support seamless and efficient Wi-Fi based Internet access for moving vehicles. It consists of innovative protocols in both uplink and downlink. Seamless roaming of clients was gracefully achieved, while channel utilization efficiency was dramatically improved. Experimental results from both real test bed and simulations revealed feasibility and effectiveness of SWIMMING. With the above innovative design, SWIMMING achieves seamless roaming with reliable link, high throughput, and low packet loss. Test bed implementation and experiments are conducted to validate the effectiveness of the ACK detection function. Extensive simulations are carried out to evaluate the performance of SWIMMING. Experimental results show that SWIMMING outperforms existing schemes remarkably. Next Generation WIFI hotspots are deployed widely and densely in many cities and the trend continues. Compared with cellular networks, WIFI has obvious advantages: lower cost and higher peak throughput. Thus, WIFI is considered as a suitable solution for cellular traffic offloading. However, it is still challenging to provide WIFI -based Internet access for users in moving vehicles. The above problems solve our proposed SWIMMING concept. To support seamless and efficient WIFI-based Internet access for moving vehicles. It consists of innovative protocols in both uplink and downlink. Seamless roaming of clients was gracefully achieved, while channel utilization efficiency was dramatically improved. Will prove swimming is high performance of compared to existing system.

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