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Experimental Based Performance Analysis of IEEE 802.11/g Hybrid Network

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Abstract

The performance of IEEE 802.11/g hybrid network consisting of wired nodes, a mobile access point and mobile wireless nodes where the mobile access point is moving from one point to another to make the mobile wireless nodes or mobile hosts communicate is analysed. Taking into consideration the strong drive towards the wireless internet access through the mobile terminals, the impact on the performance of the network due to the mobile access point is analysed and examined. The result of the simulation based upon the experiment demonstrates the performance factors like throughput, packet delivery ratio and average delay over the conventional hybrid network. The whole simulation is done and analysed by using network simulator NS-2.35. It concludes on the performed throughput, packet delivery ratio and average delay.

Keywords: IEEE 802.11/G, Hybrid Network, Access Point, Mobile Hosts Network Simulator, NS2.35, Throughput, Packet-Delivery-Ratio, Average Delay

1. Introduction

In recent time the wireless Local Area Network are being successfully and conveniently used as the last-mile technology in this inescapable computing environments. They provide enough bandwidth for office application with relatively limited mobility. Even if the wireless LANs don't replace the wired networks but they can be very much helpful in extending the wired networks where they are impractical and overly expensive to use cabling. In classic wired-cum –wireless network laptop computers, peripherals and storage devices act as the mobile hosts and can roam in wireless networks. The wired infrastructure can be an IEEE 802 Ethernet LAN or some other IP based networks. The wired and wireless network is connected via access point. This access point generally provides the interface between wired and wireless network. In a wired-cum-wireless data connection, the IEEE 802.11/g wireless link from the base station BS to the mobile hosts MH is frequently getting disconnected due to excessive mobility or power crises. This type of disconnections typically last longer than a Retransmission Timeout (RTO) at TCP, while potentially being shorter than the lifetime of a TCP connection. A serious problem caused by this temporal disconnection is of serial timeouts at the TCP sender wherein multiple consecutive retransmissions of the same packet are attempted for the disconnected destination. Since the RTO interval is doubled with each unsuccessful retransmission (until it reaches 64s) [1], several consecutive failures can lead to inactivity lasting several minutes. This increases idle time at sender TCP even when the link is re-established because of the mobile access point. The packet flow also reduces because of the drastic reduction in congestion window (cwnd) [2], which introduces additional delay for raising cwnd up to a reasonable value so as to utilize network capacity. Thus serial timeouts can be more harmful to overall throughput, compared to losses due to bit errors [3]. Hence this kind of timeouts should be avoided. The mobile hosts can only access the infrastructure through the access point as shown in the figure-1

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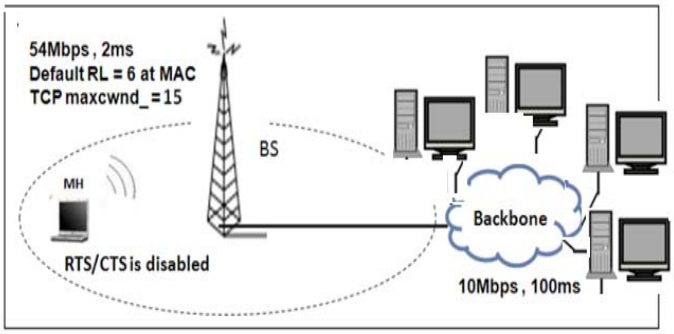
Figure 1: Wired-Cum-Wireless Network



The whole analysis is done by making the access point wireless and adding mobility to it. Because in normal hybrid networks the access point is kept fixed, but our network is tested by keeping the access point mobile. The performance issues over a network suffering from frequent link failures are studied through simulations under ns-2.35 [5]. The performance factor of the network is being analysed by increasing the number of wireless nodes. The basic goal is to analyse the throughput of the hybrid network and to find the amounts of the packets received by the network. We address the end-to-end optimization of the hybrid network. In this scenario each session in the network runs across both wired and wireless links. The both wired and wireless links have fixed link capacity depending upon the IEEE 802.11/g standard [4]. Network topology of multiple LANs connected through wired nodes. Therefore, a mixed scenario consisting of a wireless and a wired domain. The whole scenario is generated by using the network simulator tool and analysed. The basic performance problem of hybrid network has been analysed and proposed. It has been found that the basic performance problem of this hybrid network arises due to the link break-up due to the mobile hosts and mobile access points.

Rest of the paper discusses about the related work in section-2, problem definition in section-3, simulation analysis in section-4, graphical analysis in section-5 and the paper is concluded with a conclusion in section-6

2. Related Work

A lot of research to alleviate the performance problem of the hybrid network, related to the wireless mobile environment is happening and as a result several versions have been emerged. A huge amount of research work is going on to improve the performance of the hybrid network by modifying the transport layer protocols like TCP and MAC layer protocol. As per the literature review it has been found that

1. In the year 2009 the authors [6] proposed an end to end fair rate optimization where they considered CSMA/CA based wireless LANs connected to wire network. They jointly optimized the problems both at transport layer and link layer and a new algorithm was developed to solve the problem of cross-layer optimization.
2. In the year 2006, the authors [7] used PDIP algorithm (Primal-Dual-Interior-Point) to analyse and solve the rate control problem in the conventional hybrid network. They applied the PDIP algorithm at transport layer. Again they compared the above algorithm with the DB (dual-based algorithm) and found a better rate in the conventional hybrid network
3. In the year 2006 authors [8] proposed a flow control reservation scheme RSVP by using widely accepted resource reservation protocol and designed another protocol RSVP-WRSV for hybrid network with better quality of services and easily implemented the cross-layer interaction at the access point .and flow reservation is controlled at mac layer.
4. In the year 2002 the authors [9] proposed a new protocol for IEEE 802.11 that is ARME (Assured Rate MAC Extension), a Mac protocol to provide better throughput. This protocol was applied at Mac layer to provide better throughput.
5. In the year 2001 authors [10] evaluated four basic schemes like point coordination function on IEEE 802.11 LANs, Enhanced distributed coordination function ,Distributed fair scheduling and black-burst protocol and analyzed various performance parameters. They concluded that for conventional Wireless LANs black-burst protocol is a better one and provides better quality of services.
6. In the year 2001, authors [11] proposed and end-to-end admission control mechanism for IP telephony called PCP-DV. This procedure was completely dependent upon two basic features, first one is it is completely independent of the function of the internal router and second one is that the triggering mechanism for the connection admission is based upon the delay variation. Numerically it was

proved that 99th delay percentiles not greater than few ms per router are guaranteed even in overload conditions.

And these mechanisms also provided the solutions at the link layer by hiding the deficiencies of the wireless channel. But in all the above cases the access points of the hybrid network is kept fixed. In our network scenario the access point is completely wireless and a certain amount of mobility of (setdest -v 1 -n 50 -p 0 -M 20 -t 900 -x 1500 -y 1500)that will generate a 1500*1500 topology with 5 to 50 mobile nodes randomly distributed labelled by a XY(Z) coordinates and connected to 4 wired nodes. Then the performance of the hybrid network is analyzed depending upon the mobile hosts and mobile access point without modifying the transport layer protocol like TCP.

2.1. Wireless Access Points

Wireless network technology has a much smaller effective data throughput than the wired equivalent currently deployed, and this situation is likely to be the case for some time. While the technology has advanced greatly, real-world deployment of some of the advances is still some time away.

The wireless network should not be considered a like-for-like replacement for the conventional University wired network. It is intended to facilitate short-duration connection to the network from convenient locations without being inhibited by cabling and the need to find a physical network point.

According to the computer networking the wireless access point is a device that allows the wireless device to get connected with the wired network using Wi-Fi or related standards. The access point usually connects to a router (via a wired network) or it is a part of router itself. Modern access points are designed to support a standard for sending and receiving data by using radio frequencies. The standards and frequencies used are normally defined by IEEE. And most access points use IEEE 802.11/g standards .

2.2. Basic Approach of Hybrid Network

The basic area to focus in the hybrid network is the link layer (LL) which is running on the top of the physical layer and is more adequate to link characteristics than the other higher level protocols. Again we can say that it is much faster and can have the immediate knowledge of the dropped frames alleviate the inefficiencies of the wireless medium at the link layer provides the transport layer protocol with a dependable communication channel.

3. Problem Definition

Generally in the hybrid network if the access point is kept wireless and mobile for example any mobile device that is acting as mobile wirelss access point through which we can access the hotspot, it has been seen that there is a huge probability of link failure leading to the drop of packets and creating more congested links.

A total number of five hybrid networks has been designed using ns2.35.For each and every scenario different trace files has been obtained. By using the trace files the parameters like throughput, delay, packet delivery ratio, packets received and lost are analyzed.

4. Simulation Results and Analysis

In the above section the performance of the hybrid network is analyzed where the authors initially have kept one link as wireless link. Below given code mentions the amount of mobility added to the access point .

```
set val(chan) Channel/Wireless Channel ;# channel type
set val(prop) Propagation/TwoRayGround ;# radio-propagation model
set val(netif) Phy/WirelessPhy;# network interface type
set val(mac) Mac/802_11 ;# MAC type
set val(ifq) Queue/DropTail/PriQueue ;# interface queue type
set val(ll) LL ;# link layer type
set val(ant) Antenna/OmniAntenna ;# antenna model
set val(ifqlen) 50 ;# max packet in ifq
set val(nn) 50 ;# number of mobilenodes
set val(rp) AODV ;# routing protocol
set val(x) 1500 ;# X dimension of topography
set val(y) 1500
# nodes: 5, pause: 0.00, max speed: 20.00, max x: 1500.00, max y: 1500.00
#
$ns at 10.0 "$node_(0) setdest 590.0 350.0 1000.0"
$ns at 35.0 "$node_(5) setdest 460.0 360.0 1000.0"
$ns at 50.0 "$node_(6) setdest 590.0 350.0 1000.0"
$ns at 60.0 "$node_(7) setdest 100.0 360.0 1000.0"
```

#$ns_ at 80.0 “$node_(8) setdest 100.0 360.0 1000.0”

The code above describes the mobility for wireless access point (node_(0)) and nodes number 1,2,3,4 are wired nodes, that is kept same for all the network scenarios and number of mobile hosts are increased. The scenarios are given in table 1.

Figure 2:

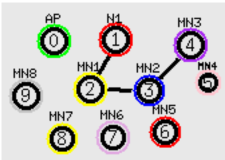
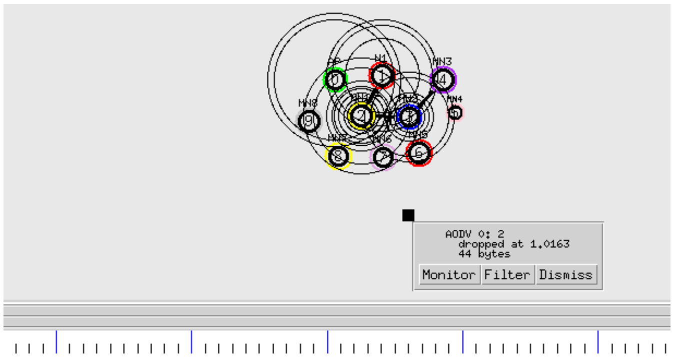


Figure 3:



The back bone of the hybrid network is represented by the wired portion with 10 mbps of data rate and 100 ms of delay as in figure-1. And the wireless mobile hosts are given bandwidth of 54Mbps and 2 ms of delay. The RTS/CTS mechanism for the wireless network is disabled, the default routing load of the wireless network at the MAC layer is kept 6 as in the figure-1 and the size of maximum congestion window is kept 15. The whole performance of this hybrid network is analyzed based upon the simulation based experiments. The extensive simulation of the controlled wireless network is analyzed using the network simulator ns-2.35. However the basic aim is to analyze the performance factors of the hybrid network like throughput, packet delivery ratio, and delay by keeping the access point mobile and increasing the number of mobile hosts. The typical simulation scenario considers IEEE 802.11/g hybrid network which consists of 4 wired nodes connected to a wireless access points with certain mobility (as per the code) and in each and every scenario the number of wireless nodes or the mobile hosts is increased. In every case the simulation time interval is kept for 10.0 minutes which is kept long enough so that the performance of the networks can be easily exploited. Here how the performance of the hybrid networks are analyzed based upon the table-1

Table 1:

Scenario	*Mobile Access Point*	*Wired Nodes*	*Mobile Hosts*
1	1	4	5
2	1	4	10
3	1	4	20
4	1	4	30
5	1	4	40
6	1	4	50

5. Graphical Analysis

Graph 1: Throughput v/s Number of Nodes

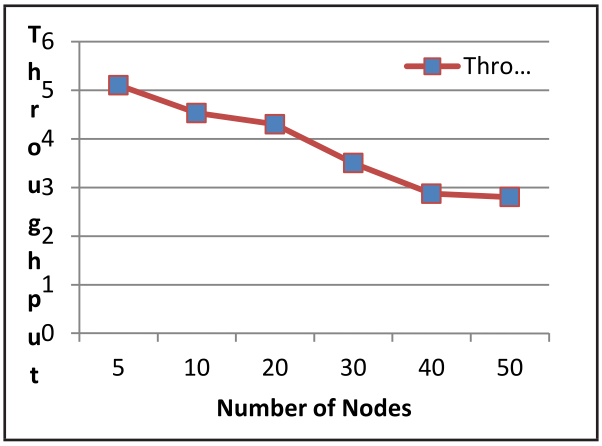


Table 2: Throughput of Variant Mobile Host’s v/s Fixed Wired Nodes

Scenario	*Mobile Access Point*	*Wired Nodes*	*Mobile Hosts*	*Throughput (bps)*
1	1	4	5	5.1
2	1	4	10	4.53
3	1	4	20	4.3
4	1	4	30	3.5
5	1	4	40	2.87
6	1	4	50	2.80

Throughput: Throughput refers to how much data can be transferred from one location to another in a given amount of time. Depending upon the fixed time period for each scenario that is about 10.0 minutes the throughput is calculated as mentioned in the above table. Throughput of a network can be measured using various tools available on different platforms. Here the values of the throughput are analyzed by using tracegraph202. By analyzing the throughput we found that it is continuously fluctuating by increasing the number of the mobile hosts. This fluctuation is due to the mobile access points and continuous link failures at the link layer which leads to the degradation of the throughput.

Graph 2: Average Delay v/s Number of Nodes

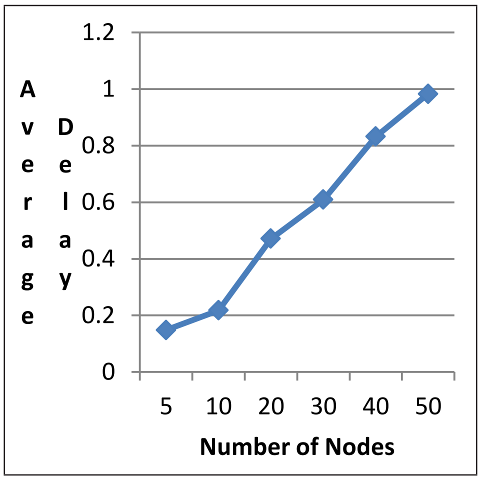


Table 3: Average Delay of Variant Mobile Hosts v/s Fixed Wired Nodes

Scenario	Mobile Access Point	Wired Nodes	Mobile Hosts	Average Delay (ms)
1	1	4	5	0.148
2	1	4	10	0.218
3	1	4	20	0.471
4	1	4	30	0.609
5	1	4	40	0.832
6	1	4	50	0.983

Average Delay: The average delay can be defined as the amount of time it takes to travel data packets from one node to another or from one endpoint to another in a network. In this case the average delay is analyzed for all the scenarios depending upon the number of increasing mobile hosts. It has been observed that the average delay of the network is increasing to a certain amount when the number of mobile hosts is increased. By increasing the number of nodes to 50 the average delay increases to a certain extent because of the congestion.

Graph 3: Packet Delivery Ratio v/s Number of Nodes

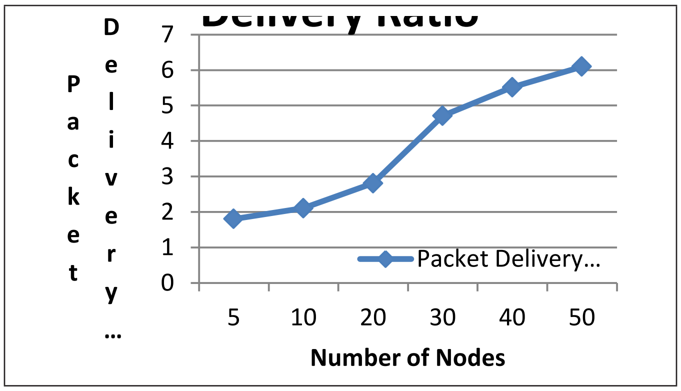


Table 4: Packet Delivery Ratio of Variant Mobile Hosts v/s Fixed Wired Nodes

Scenario	Mobile Access Point	Wired Nodes	Mobile Hosts	Packet Delivery Ratio
1	1	4	5	1.805
2	1	4	10	2.105
3	1	4	20	2.809
4	1	4	30	4.714
5	1	4	40	5.516
6	1	4	50	6.097

Packet Delivery Ratio: The packet delivery ratio can be defined as the ratio between the data packets that are sent by the source and the data packets that are received by the sink. In the above table-4 the packet delivery ratio has been analysed and it has been found that the packet delivery ratio is increasing continuously as the number of mobile hosts increases. This is because the total number of packets received by the network decreases thoroughly due to increasing of number of mobile hosts.

The simulations were repeated by increasing the number of nodes and then the graphs were drawn. From the above scenario it has been it has been concluded that the very important performance parameters like throughput, delay and packet delivery ratio decreases consistently as the number of the wireless nodes or the mobile hosts are increased. This degradation of the network is due to consistent link failure and heavy congestion.

Graph 4: Packets Received v/s Number of Nodes

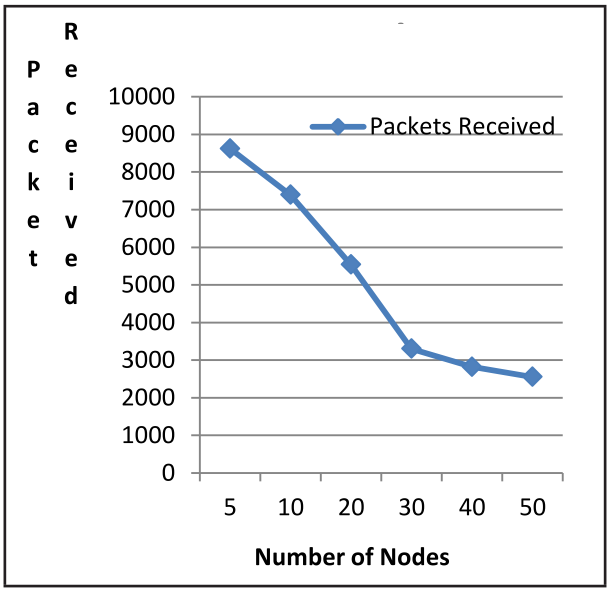


Table 5: Packet Received of Variant Mobile Hosts v/s Fixed Wired Nodes

Scenario	Mobile Access Point	Wired Nodes	Mobile Hosts	packets received
1	1	4	5	8621
2	1	4	10	7392
3	1	4	20	5540
4	1	4	30	3301
5	1	4	40	2821
6	1	4	50	2552

Graph 5: Packets Lost v/s Number of Nodes

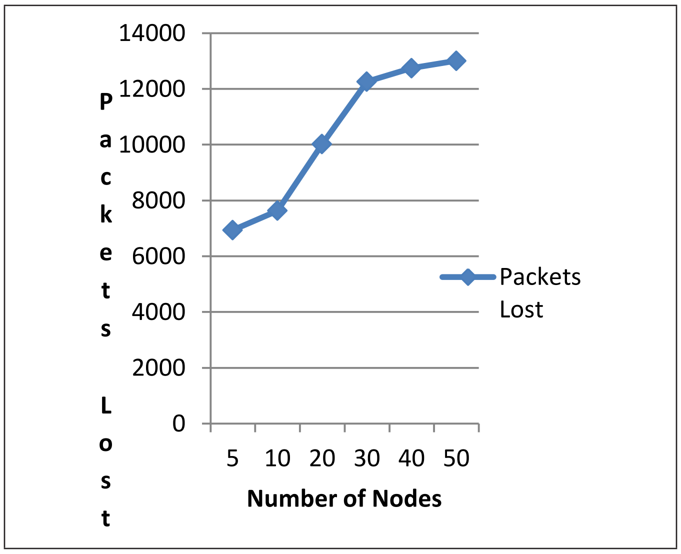


Table 6: Packet Lost at Each Variant Mobile Hosts v/s Fixed Wired Nodes

Scenario	Mobile Access Point	Wired Nodes	Mobile Hosts	packet loss
1	1	4	5	6941
2	1	4	10	7630
3	1	4	20	10022
4	1	4	30	12261
5	1	4	40	12741
6	1	4	50	13010

Packets Received: As we know that the packet the unit of the binary data capable of being routed through a computer network. The hybrid network scenario designed here seems that the amount of packets received goes on decreasing as the number of the mobile hosts decreases. Therefore we can conclude that as the number of the mobile hosts puts a great deal of effect in decreasing the number of packets received where the Total packets sent=15562

Packets Loss: Packet loss is defined as the loss that occurs when one or more packets of data travelling across a network scenario is unable to reach the destination due to communication error or interference. The table-6 shows that the network scenario designed bears huge packet losses due to high interference and the increasing distance between the access point and the mobile hosts.

6. Conclusion

In view of the increasing demand of a wide range of services over Internet, it has become essential to learn about the major network scenarios like hybrid networks with abilities, which can combat the issues of the wireless networks with mobility. We observed that frequent link failures due to mobility lead to performance degradation resulting from the unnecessary serial timeouts coupled with congestion control. We have kept a mobile access point, 4 wired nodes acting as the backbone of the network. All the wireless nodes or the mobile hosts are accessing the network through the wired backbone and the access point. Due to consistent link failure and congestion the performance of the network degrades consistently.

A lot of researchers are still working in this scenario to control the congestion and to avoid the link failure. This factor can only be done if we can modify the Transport layer protocol like TCP without focusing on the link layer.

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