

# Delay and Delay Variation for Multimedia Traffic in WLAN 802.11: a Case Study of Network Simulator

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**Abstract**—IEEE 802.11 WLAN has become a necessity nowadays in wireless communication and is widely used in intracampus scenarios. The common traffic transmitted in WLANs are multimedia applications such as VoIP, video streaming etc. To manage this traffic efficiently, access point used in WLAN implement one of the scheduling mechanisms such as FIFO, PQ, FQ etc. that handle how packets of related traffic are buffered while waiting to be transmitted. In the present work, network analysis for scheduling mechanisms used at the link with AP is presented with respect to delay and delay variation in packet transmission. The work is intended to give helpful insight as how to use ns-simulation for network analysis. It demonstrates about ns2.35, WLAN infrastructure mode scenario, control and data packet transmission between nodes (wired and wireless), results and post execution analysis.

**Keywords**— WLAN, delay, PDV, scheduling, VoIP, video; ns2.35, simulator

## I. INTRODUCTION

A wireless network is a large set of network packets, to carry information from one host to logically connect another user. At any given moment, transmission of a packet is being processed by a network device, like AP, switch or router. Each device in the WLAN executes one of the scheduling algorithms (FIFO, PQ etc.) that manages packets in queues, waiting for transmission [1, 2] (Fig. 1).

The performance of any network is analyzed by total number of packets transmitted per unit time (throughput), propagation delay (latency), delay variation and packet loss [3]. Among these, delay and delay variation in packets become utmost important in multimedia applications such as VoIP, video conferencing and online gaming. The main cause of delay in received packets is due to one of the scheduling mechanism running over each network device in the network other than propagation time of packet; whereas delay variation is the time difference between two received packets.

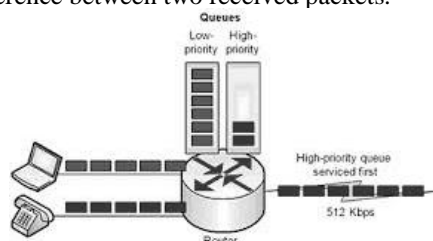


Fig. 1 Scheduling of Packets

Ns2.35 is a helpful simulation tool to analyze these network parameters without actually implementing the real network. The work demonstrates performance study between different packet handling techniques with respect to delay and delay variation in different applications. For today's high speed applications, users are asking for better performance and quality deliverables and developers always work towards maintaining tradeoff between technology, cost and user satisfaction but it is still in need to make multimedia applications (VoIP, video streaming) and business applications (Video Conferencing) run over others.

## II. NETWORK SIMULATOR

Any system is modeled and simulated to study system's performance, operations, making it free from errors and further improvements. In a broad sense, simulation is a tool to evaluate any system, existing or proposed under different configurations of interest. Network Simulator is such a powerful and open source tool which can be used in performance evaluations of various networks – wired or wireless. It is a discrete level simulator originally developed at LBL, University of California under the VINT Project [4, 5].

Ns2.35 can be employed in most UNIX systems and windows systems. In this work ns2.35 is installed in CentOS5.0. Ns2.35 is written in C++ and use OTcl as configuration and interfacing language. OTcl is used to define simulation setup whereas C++ is used to implement behavior of any network component. Ns-2.35 follows hierarchy in compiled C++ and interpreted OTcl with one to one correspondence in core execution. Any networking scenario in ns-2.35 can be developed with different topologies, node configuration, links, queues and desired traffic generators etc. using Tcl scripts. It includes a vast library of network components, links – wired, wireless, satellites; layer components – application layer: FTP, HTTP, CBR; transport layer: UDP, TCP; network layer: Adhoc routing (AODV, DSDV); MAC layer: Ethernet, 802.11 etc. [4, 5]. Output is stored as trace files and nam files. For statistical analysis, compatibility with perl and awk scripts make ns2.35 more useful tool as these files can be used for further calculations

and visual representations as animations in NAM or graph illustration.

### III. PACKET HANDLING TECHNIQUES

Queuing algorithms take effect when congestion is experienced. If the link is not congested, then there is no need to queue packets. In the absence of congestion, all packets are delivered directly to the interface [6]. Network devices handle an overflow of arriving traffic by queuing techniques, and then determine some method of prioritizing it onto an output link. The basic or some of the standard queuing mechanism in ns2.35 can include:

#### A. DropTail

The default form of queuing on nearly all interfaces is DropTail (FIFO). This form of queuing requires no configuration, and simply processes and forwards packets in the order that they arrive. If the queue becomes saturated, new packets will be dropped (tail drop) [4, 7]. This form of queuing may be insufficient for real-time applications, especially during times of congestion. FIFO will never discriminate or give preference to higher-priority packets. Thus, multimedia applications such as VoIP, video can be starved out during periods of congestion.

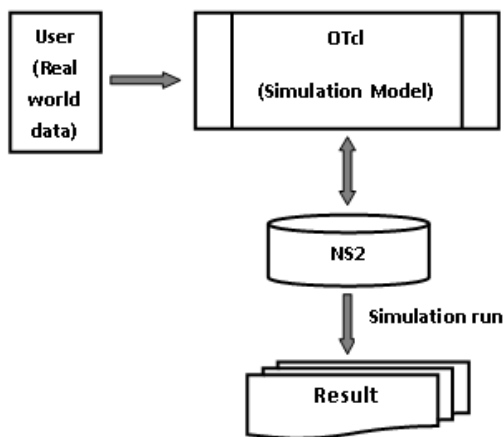


Fig. 2. Ns2.35 Simulation Framework

#### B. Priority Queue

Priority queuing [3] mechanism provides a smooth transition of important traffic (packets) through the network, using management at all intermediate points. PQ works by giving priority to the most important traffic. Priority queuing can be flexible regarding the allocation of different traffic parameters such as: the network protocols input interfaces, the size of packets, source/destination addresses etc. During the data transmission the algorithm first handles the high-priority queues and then the low-priority queues.

#### C. Fair Queue

Fair Queuing (FQ) is used to service non priority queues with priority queue in fair manner in terms of bandwidth. This prevents overuse of resource by any one source.

#### D. Stochastic Fair Queue

It dynamically creates queues based on traffic flows [4]. Traffic flows are identified with values generated from the packet header fields: Source/Destination IP address, port, Type of Service value (IP Precedence or DSCP). Traffics of the same flow are placed in the same flow queue. If the

priority of all packets is the same, bandwidth is divided equally among all queues. But it has limitations -- it cannot provide specific bandwidth guarantees to a particular traffic flow and is only supported on slower links (2.048 Mbps or less).

### IV. NETWORK DESIGN AND CONFIGURATION

The present work presents simulation studies of WLAN in Network Simulator (NS2.35). In a WLAN, infrastructure mode, scenario is considered with servers, AP and hosts as illustrated in Fig. 3.

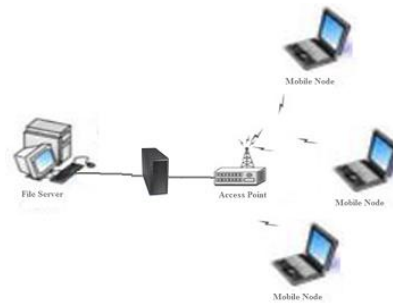


Fig. 3. Network Scenario

AP is connected with servers in structured mode whereas nodes are wirelessly connected and movable within a building, though mobility is not considered in the analysis. Data traffic travels from servers to nodes through AP at download and data from nodes to servers at the time of upload. In the present work, performance of scheduling techniques applied at link between AP and network device in download state is studied.

The different simulation parameters are as per the Table. 1. Traffic load – FTP, VoIP and Video are considered in the simulation experiments. Congestion is experienced at AP. Traffic is generated through agents and applications in ns2.35; VoIP is generated through UDP-CBR and video traffic with UDP-pareto distribution.

TABLE I. SIMULATION PARAMETERS

Parameters	Values
WLAN Mode	Infrastructure
Channel	Wireless-phy
Radio Propagation Model	Two Ray Ground
Frequency	2.472 GHz
Band	ISM
PHY Modulation	DSSS
Simulation Time	5 Sec
Traffic	UDP, TCP
Application	FTP, VoIP, Video
RTS/CTS	On
Routing	DSDV
Mobility of Nodes	Off

### V. RESULTS AND DISCUSSION

The results shown in Fig. 4 are the nam output (animation) in which data is communicated between servers and hosts in download state. Due to congestion at link with AP, some packets may drop depends on factors like scheduling

technique, bandwidth, queue length etc. as shown in fig. 4. Nam output shows traffic transmission in different colors in wired mode but does not support colors for different traffic in wireless connections [4, 5].

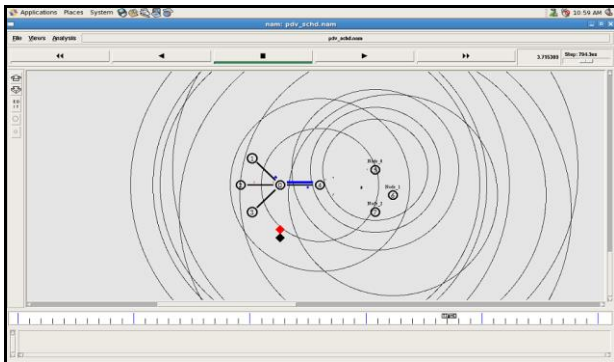


Fig. 4. Simulation Run of WLAN 802.11- infrastructure mode

A. Delay

Xgraph utility in ns2.35 shows the simulation results for FIFO, PQ, FQ and WFQ in Fig.5, Fig. 6 and Fig. 7 for packet end to end delay.



Fig. 5. Packet Delay for different traffic load in FIFO

Packet delay is calculated as the time experienced by the packet when it leaves the source node and reaches at the destination node. The variations in delays like transmission delay, queuing delay etc. experienced by the packets will be covered in end to end delay itself. Post execution analysis is done with the help of trace file output and awk scripting.



Fig. 6. Packet Delay for different traffic load in WFQ



Fig. 7. Packet Delay for FQ

As shown in the figures, in FIFO, delay is approximately equal for all - VoIP, Video and FTP. Average delay is calculated as -

$$E [delay] = \frac{\sum \text{all delay samples}}{\text{no. of samples}} \tag{1}$$

Table 2. Average End to End Delay (sec.)

Scheduling Technique	VoIP	Video	FTP
FIFO	0.435983	0.349828	0.506047
PQ	0.435983	0.349828	0.506047
FQ	0.089218	0.097249	0.529165
WFQ	0.303564	0.119757	0.374317

B. DelayVariation

Packet delay variation is the time difference between the packets arrival times at destination. It can be constant or variable depends on behavior of network. If end to end delay of ith packet is  $\delta_i$  and jth packet is  $\delta_j$  ( $i < j$ ), then pdv can be calculated as -

$$pdv = \frac{\delta_j - \delta_i}{j - i} \tag{2}$$

As shown in the figures (Fig. 8, Fig. 9 and Fig. 10), PDV for VoIP is minimum in all the applied scheduling techniques, whereas for video traffic it is maximum.

Table 3. Packet Delay Variation (PDV) (sec.)

Scheduling Technique	VoIP	Video	FTP
FIFO	0.032134	0.098045	0.052881
PQ	0.032134	0.098045	0.052881
FQ	0.021523	0.065360	0.058100
WFQ	0.025092	0.070588	0.050753

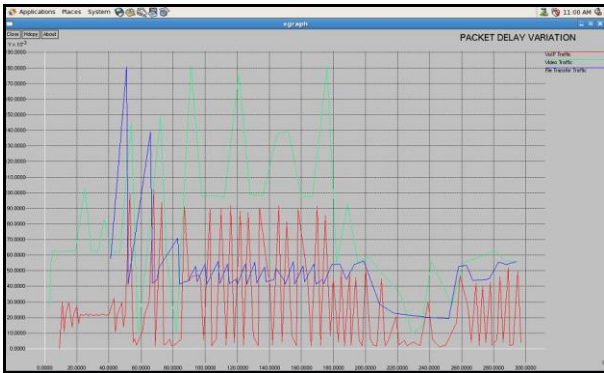


Fig. 8. Packet Delay Variation for different traffic load in FIFO



Fig. 9. PDV for different traffic in WFQ

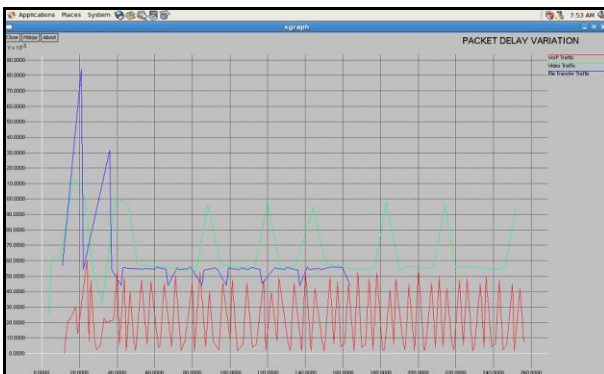


Fig. 10. PDV for different traffic in FQ

## VI. CONCLUSION

This case study of ns2.35 simulator is intended to give an exposure of the simulator for the network analysis. It describes about ns2.35 with wireless scenario generation, component configuration, output visualization, post execution analysis and scripting for results accumulation.

The simulation results show that network performance depends on scheduling techniques used at different points of network. Time dependent parameters end to end delay and delay variation vary according to applied scheduling technique for different traffic – VoIP, FTP and Video. For FTP, delay and pdv is somewhat similar in all the cases, which should be; whereas results verify that for VoIP and video traffic advanced scheduling techniques should be used for better network performance.

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