Comparing Wireless N (IEEE 802.11n) and Wireless G (IEEE 802.11g) Standards in terms of Performance and Reliability

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***Abstract*—After the emergence of IEEE 802.11, Wi-Fi has made a big impact on the wireless network environment. With decent data rate available lately at low cost, implementation of wireless networks are growing all over the place. To deliver bandwidth of around 54 Mbps, 802.11g was released. This paper seeks to compare wireless N (802.11n) and wireless G (802.11g) standards in terms of performance and reliability. Since security cannot be overemphasized when dealing with Wireless LAN, this paper also looks at the security implementation of these standards. It is worth nothing that the effectiveness of a wireless network depends on the structure of the building, interference with other networks and security implemented. This paper could be useful for those who want increase in bandwidth with strong security encryption activated. It is tuned to small and medium scale enterprises and also home users.**

***Index Terms*—IEEE 802.11g/b, Wireless N, Wireless G, Wireless LAN, Wireless Communication**

I. INTRODUCTION

The primary goal of any wireless deployment today is to provide reliable signal coverage and security but also a decent level for performance for small networks as well as large enterprise WLAN (Wireless Local Area Network). The 802.11 standard has become very popular as a means to augment traditional wired LANs (Local Area Network) within organizations. Wireless LAN's (WLAN's) popularity is undeniable because of their flexibility and cost effectiveness compared to wired networks and also their increased productivity. By looking at these new standard capabilities it may be possible to advice people to migrate their existing routers from wireless G to wireless N. But of course the security has always been a big issue when it comes to deployment of WLAN. Security should be a priority for anyone who uses or administers networks. The difficulties in keeping a wired network secure are amplified with a wireless network. The demand for wireless LAN hardware has experienced phenomenal growth, evolving quickly from novelty into necessity. This compelled the industry to come up with a phenomenal standard that could offer up to 600Mbps connectivity speed (802.11n). [1][2]

Many businesses today are deploying WLANs because of the benefits and its flexibility.

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802.11n completely redefines Wi-Fi speed, ushering in a whole new level of network performance. This standard, 802.11n, promises far greater bandwidth, better range, and reliable than its predecessor 802.11g. Indeed 802.11n has vast advantage in terms of network configurations. WLAN clients may migrate from 802.11g standard to 802.11n because wireless N standard offers better throughput and increased coverage than wireless G standard. As emerging Network Applications take hold in the enterprise, a growing number of consumers will come to view 802.11n standard not just as an enhancement to their existing network, but especially as a necessity. Pervasive 802.11n deployment will also accelerate the growth of the enterprise Voice over WLAN market to profit applications such as VOIP or video streaming. 802.11n standard is a good opportunity to increase productivity and mobility. However, the pervasive nature of wireless communications forces a network designer to re-evaluate some of the underlying principles of traditional network architectures. Indeed security is still a big issue when it comes to implementing a wireless LAN. To access wireless, a hacker only has to be in the proximity of the wireless network range, often without even having to enter the building of the potential victim. [3][4]

II. BACKGROUND

Demand for more bandwidth access and wireless LAN equipment has experienced a phenomenal growth in recent times. The growing deployment of protocols from the Wi-Fi alliance is helping consumers take advantage of new electronic application such as VOIP telephony or video streaming. Officially known as 802.11n and often referred to as "Wireless N," this standard from the Wi-Fi (Wireless Fidelity) alliance paves the way for blazing fast high definition video and data. It is a new standard that promises both higher data rates and increased performance. This N wireless standard has also the ability to have up to four simultaneous streams of high-definition video, voice and data. It also promises easy backward compatibility which means new devices will work smoothly with older product. [5]

Unlike wireless G (802.11g), the Wireless N (802.11n) standard promises more bandwidth and high throughput to help consumers and businesses benefit from the Voice over IP (VoIP) technology. It is evidently known that huge amount of moneys can be saved on long distance calls trough VoIP as against traditional telephony, which is why individuals and corporate businesses are leered into using wireless N today and also migrating from existing wireless G to wireless N. The 802.11n standard is a successor to the 802.11g Wi-Fi protocol and therefore offers an improvement such as speeds of up to 54 Mbps. 802.11n supports much faster wireless connections over longer distances. The most important addition is the multiple-input multiple-output (MIMO) capability, alternatively called. MIMO allows for multiple antennas to resolve more information more quickly and improves the reliability, range and performance of connection that is almost close to Ethernet quality. This means users can get at least six (6) times the speed of Wireless G with Wireless N and high definition video can be transmitted across multiple rooms in large house with just a single access point. MIMO also increases the performance of 802.11g present on a network. Chips like WCN 1320 that do this are available in Wireless N routers and set-top boxes. Another helpful feature is the inclusion of an intrusion detector on the Buffalo wireless-N-infinity; which constantly looks for unwanted attempts at accessing the network and once found, alerts you to those attempts. [3][6][7][8]

Orthogonal frequency-division multiplexing OFDM implementation is a major change to the physical layer of 802.11n to improve performance. By adapting the way it is set-up, the data rate can be increased from 54 Mbps for 802.11a/g to 65 Mbps. Antenna technology associated with 802.11n have been significantly improved by the introduction of beam forming and diversity. Beam forming focuses the radio signals directly along the path for the receiving antenna to improve the range and overall performance whiles diversity uses the multiple antennas available and combines the best subset from a larger number of antennas to obtain the optimum signal conditions. 802.11n comes with an optical mode chips that runs using a double sized channel bandwidth. 802.11g used 20MHz bandwidth whilst 802.11n has an option of using 40 MHz. The backward compatibility of Wireless N is removed when all the devices operating on the network are 802.11n standard, thereby removing overheads that are not required and consequently maintaining maximum efficiency. This feature is reinstalled when earlier devices such as 802.11b and 802.11g are joined to the network. Wireless N offers a considerable advantage when operated on a network with older standards. [4][9][10][11]

802.11n standard could be configured to operate in three modes; Legacy mode, Mixed mode and Greenfield mode. The Legacy mode allows a Wireless N router to work in a network of entirely legacy clients, i.e. 802.11a/b/g without any 802.11n clients as part of the network. The Mixed mode is used for networks with an 802.11n router and a mixed environment of 802.11n clients as well as legacy 802.11a/b/g clients. Greenfield mode is used for networks with only 802.1n clients connecting 802.11n routers. The highest performance is achieved with the Greenfield mode. Network performance is reduced slightly with the other modes due to compatibility issues that let 802.11n work with a protective mode. Wireless N increases data rate from 15-20 Mbps to 100-200 Mbps which means several users can now join the network. The MIMO technology creates a uniform coverage which has always been an issue and extends the perimeter range from 20 meters to around 80 meters. In an open field where there is no interference, wireless N equipment could give a throughput of between 14 Mbit/sec to 16 Mbit/sec as against 1Mbit/sec for wireless G equipment. Wireless N users experience a significant improvement in range. Intel reports that 802.11n equipment typically delivers more than twice the range of 802.11g equipment, at any throughput speed. Users of wireless N standard benefit from an increased coverage with much higher throughput, meaning they would be able to use a single Wi-Fi router in their entire organizations or homes. Not only but also users stand to enjoy high bandwidth applications such as video streaming or VoIP on their networks. The problem of dead spots will also be reduced and multiple users can do many things over the network. [8][9][12]

Air Magnet wireless LAN analyzer can be used to monitor wireless N LAN for increased reliability. The software identifies and classifies most 802.11n capable devices in a network and differentiates between standards-compliant and pre-standard 802.11n devices. It supports monitoring for 20 MHz and 40 MHz channels and also detects and classifies higher data rates used by the 802.11n devices. Wireless N routers from SMC come with a unique 4 or 8 digit pin required for each device to get connected on the network. A fixed PIN label is placed on the device which is used to confirm the connection of intended devices. For increased security, it also uses Wi-Fi Protected Setup (WPS) to encrypt data and authenticate each device on the network.

III. METHOD

Two simulations were performed with both 802.11g (MicraDigital) and 802.11n (SMC) routers and two (2) laptops, One (1) desktop separately and an access point to form both wireless N and G LAN to assess the wider and better coverage, large bandwidth, speed i.e. throughput etc that users can benefit from Wireless N. In this simulation, it was taken into consideration the principal difference between 802.11g and 802.11n, i.e. MIMO and the option of 40 MHz channel instead of 20 MHz.

Files were sent from one point to another to measure the speed and calculate the result in Megabits per second (Mbps). The Wireless N LAN simulation revealed an increased coverage area, better download and upload speeds i.e. higher throughput over the Wireless G LAN and also provided both channels. The figure below reveals the maximum link speed of the router as 150 Mbps on uplink and 300 Mbps on downlink.

The objective of this experiment was to evaluate the wireless N router’s performance and reliability in a mixed mode where wireless N and G devices can be connected together and the Greenfield mode. It is also to verify whether the 802.11n AP has high performance and more reliable compared to 802.11g in the Greenfield mode. The experiment was performed using 2.4 GHz frequency spectrum which is compatible to both standards (802.11n and 802.11g). Three location distances of 10, 30 and 200 feet were selected. In each location, files were sent from one point to another with the client devices, each time measuring the speed and the throughput.

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IV. RESULT ANALYSIS

The following table is the result of the experiment performed in Mixed mode. The values in the table are averages in Mbps from the three clients' devices at each location but on two occasions 100 Mbps were recorded during the experiment. As can be seen from the table 2, the experimental results showed that the wireless G can provide link speed until a certain distance compared to wireless N. The wireless N can go above the 100 Mbps of link speed which is very remarkable because it means that users may replace all the Ethernet cables that could reach a maximum of 100 Mbps. As with 11g, 11 n connection speed drops as the distance to the access point increases. The test in the Greenfield mode (result not shown) revealed results well above the ones obtained in the mixed mode. It was again noticed twice that the connection speed reached 240 Mbps (downlink) and 76 Mbps (uplink) when close to the 802.11n AP. CONCLUSION. In conclusion, it was conspicuous from the experiment that, 802.11n could change the way people access the internetwork in their daily life by enjoying an improved throughput and wider coverage.

In addition, it can also be said that to measure the ideal performance of 802.11n standard routers, an environment without interfering signal is much appreciated. The ability to change the signal between the 802.11n Access Point (AP) and the clients' devices could also lead to repeatable increased throughput. It was also ascertained that, the connection speed with 802.11n is increased over a certain distance. It was established also that 802.11n routers can provide connection until 200 feet, which means several office within a specified distance can share the same connection if it well implemented.

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Table 1: Comparing Wireless G and Wireless N

	Wireless G (802.11g)	**Wireless N (802.11n)**
Maximum data rate	54 Mbps	600Mbps
Radio frequency (RF)	2.4 GHz	2.4 GHz or 5 GHz
Number of spatial streams	1	1, 2, 3, or 4
Channel width	20 MHz	20 MHz or 40 MHz

Table 2: Average speed performance comparison between wireless G and N in Mbps.

802.11 n (SMC)	***Location 1 (10 feet)***	***Location 2 (30 feet)***	***Location3 (200 feet)***
Downlink speed	108.45	45.21	35.78
Uplink speed	14.7	3.8	0.41
802.11 g (MicraDigital)	Location 1 (10 feet)	location 2 (30 feet)	
Downlink speed	5.45	2.14	0
Uplink speed	0.24	0.004	0

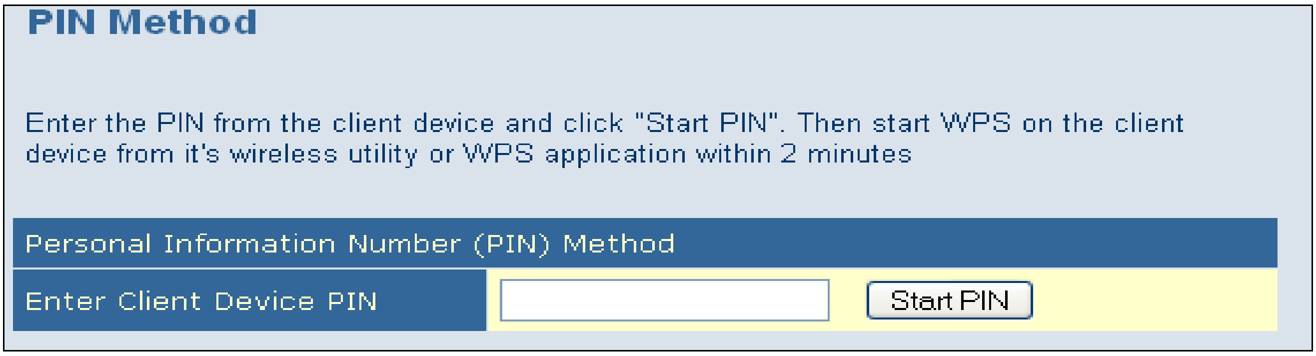

Figure 1: SMC 802.11n Router PIN method Interface for WPS

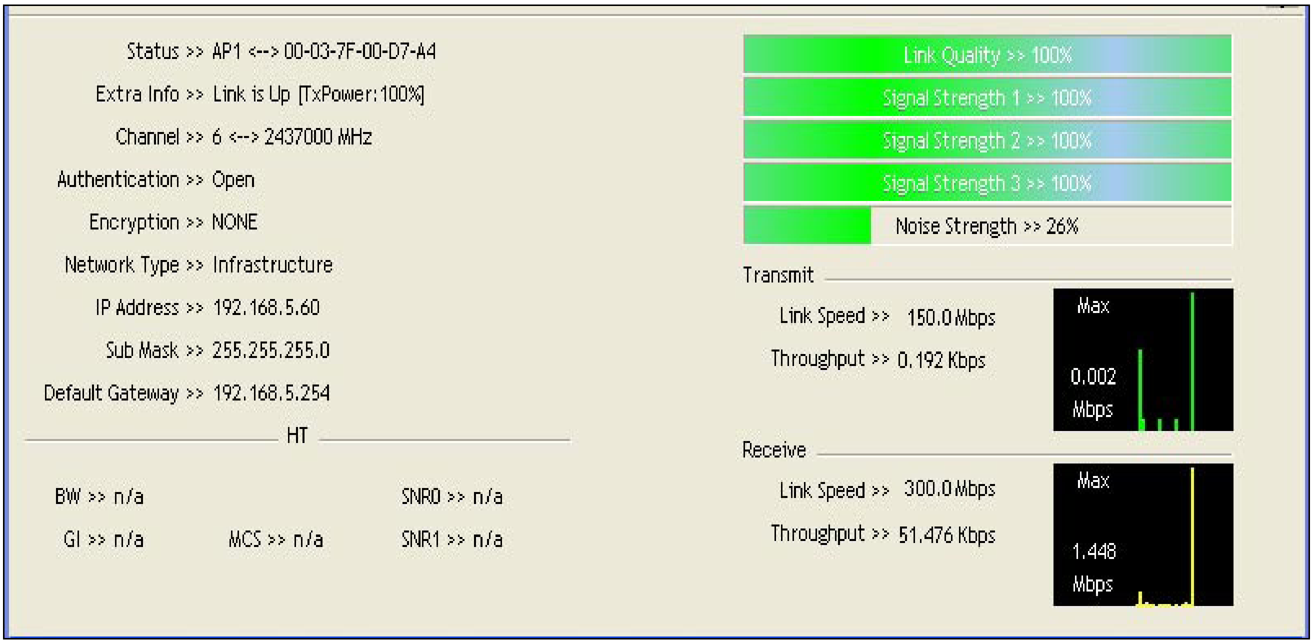

Figure 2: SMC interface showing maximum link speed

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