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IMPACT OF NEXT GENERATION WIRELESS LAN ON LEGACY DEVICES

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Abstract
The next generation wireless LAN Technology which offers new challenges and opportunities called 802.11n is a set of IEEE standard specification. It promises for designing and delivering data on wireless networking that is four to six times faster than earlier 802.11a/g (legacy WLAN devices) networks and improve transmission range. It has been proven that the 802.11n technology having wide bandwidth channel that satisfy next generation application and maintaining backward compatibility with previous generations of hardware by making two comparison. The first comparison has been made between different Legacy Devices on 802.11n to show throughputs of these devices. The second comparison has been made between the rate and range to evaluate the effect of higher rate on both sides of the link. The next-generation WLAN would also need to provide native support for wireless voice and video, with high levels of accessibility, availability, and security to reduce service-impacting incidents.

***Keywords**: MIMO, Access Points, Channel Bonding, Aggregation, MAC.*

1 Introduction

The 802.11n standard uses new technology over existing technologies (802.11 a/g) to give more range and speed of Wi-Fi. This new technology called as multiple input, multiple output (MIMO). MIMO is the heart of 802.11n because it uses several antennas to move multiple data streams from one place to another. Instead of sending and receiving a single data stream, MIMO can also simultaneously transmit three streams of data and receive two. This way more data had transmitted in the same period of time. The second technology is Channel Bonding incorporated 802.11n, which can use two separate non-overlapping channels at the same time to transmit data. This technique increases the amount of data which can be transmitted and last technology in 802.11n called payload optimization or packet aggregation which uses more data can be stuffed into each transmitted packet. These techniques can increase range and the distance over the data which can be transmitted. 802.11n uses a number of new technologies and concepts to derive Ethernet-like performance for mobile users. The primary advances used to improve the performance and higher-throughput mobility.

1.1 Basic Operations

The basic operation of 802.11n either operated in 2.4GHz or 5GHz unlicensed spectrum bands. It has been designed to be compatible with earlier 802.11 networks. This means that 802.11 networks (such as 802.11a/b/g) clients associate with the new 802.11n Access Points (APs) which send and receive packets. The 802.11n network configured with the support of legacy clients and newer 802.11n clients so that connectivity remains built in between older and newer one.

This concept is more clear with the example, the 802.11n running in mixed mode that means 802.11a/b/g and n clients all served by 802.11n Access Points(APs) and sharing single band. According to the recent measurements the throughput decreases and improvement for 802.11n clients by 30% (according to the survey record). The reason is that in mixed-mode operation, clients

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must decode the 802.11a/b/g preambles tagged onto the 802.11n preamble in order to talk to the 11n Access points (AP). The use of the 802.11a/b/g preamble has significant overhead and slows down the overall network. In addition to the mixed mode deployments can't leverage the 40MHz option available in pure 802.11n networks, because legacy clients weren't designed to operate across 40MHz-wide channels. This situation reduces available capacity.

2 Placement of Access Points

The access point which is also called APs is easy to places but it's depending on you that how many APs that are placed and install. This way it providing minimum throughput and throughout covered the area or building. It also uses multi-path. In a multi-path that you can send the multiple radio signals which is called as spatial stream. This signal sent from its own antenna using its own transmitter. There is some space between each of these antennas; each signal follows a slightly different path to the receiver. This is called spatial diversity.

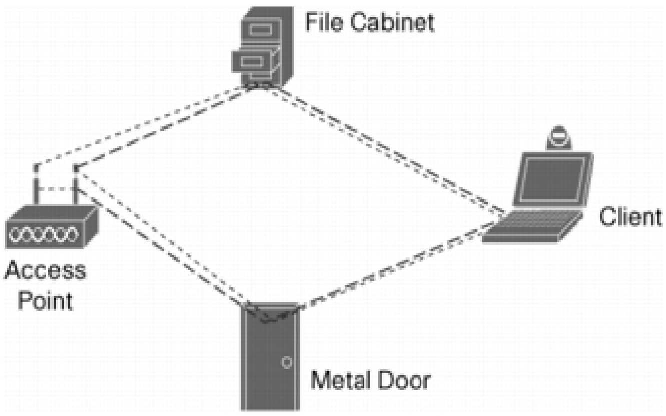

Figure 1. Multipath

The multipath shown in figure 1 prefer shortest path. In the multipath a signal travels over different paths to a single receiver and the time in which the signal arrives; receiver received the signal the length of the path traveled. The signal that is called as radio signals which travel from shortest path is followed by copies or echoes of the signal. There is slightly delayed by each of the longer paths that the copies traveled. The placement of 11n APs performance is more as compared to 11a/g APs because it has different bands and also its performance factor means that newer APs are easily replace older one. The new client devices appear over the next quarters and 802.11n compatible with existing 802.11a, b, and g access points and will operate on existing devices do today. The Placement of APs migrate the infrastructure portion of a network to support 802.11n on these new client devices is straightforward. The newer technology also concentrates on the security option and to manage the RF Sources. Therefore, the placement of 802.11n APs replace legacy 802.11 a/g APs.

3 MIMO

The MIMO stands for multiple input, multiple output (MIMO). It is a new technology used for several antennas to move multiple data streams from one place to another place. Instead of sending and receiving a single stream of data, it can simultaneously transmit three streams of data and receive two. This allows more data to be transmitted in the same period of time. MIMO WiFi as a technology which will double range and increase actual data throughput by six times. This approach can also increase the range and the distance over which data can be transmitted. It also provides that how 802.11n achieve 600 Mbps speed. This Technology also uses channel bonding, which can use two separate non overlapping channels at the same time to transmit data. In this way, it also increases the amount of data that can be transmitted. A last technology in 802.11n is called payload optimization or packet aggregation, which means more data, can be stuffed into each transmitted packet.

3.1 Channel Bonding

The MIMO Technology uses Channel Bonding which increases the capacity of a network and also increases the operating bandwidth. However, Legacy wireless devices are limited to transmitting over one of several 20-MHz channels. 802.11n (Next Wireless LAN) networks employ a technique called channel bonding to combine two adjacent 20-MHz channels into a single 40-MHz channel. The technique more than doubles the channel bandwidth. Channel bonding is most effective in the 5-GHz frequency given the far greater number of available channels. The 2.4-GHz frequency has only 3 non-overlapping 20-MHz channels. Therefore, bonding two 20-MHz channels uses two thirds of the total frequency capacity. The IEEE Standard has defined rules on when a device can operate in 40MHz channels in the 2.4GHz space for optimal performance.

3.2 Packet Aggregation*:*

In Legacy wireless transmission, the amount of channel access overhead required to transmit each packet is fixed, instead of the size of the packet itself. As the data rates increase, the time required to transmit each packet shrinks, but the overhead cost remains the same, potentially becoming much greater than the packet itself at the high speeds delivered with 802.11n.

802.11n technologies increase efficiency by aggregating multiple packets of application data into a single transmission frame. In this way, 802.11n networks can send multiple data packets with the fixed overhead cost of just a single frame. Packet aggregation is more beneficial for certain types of applications such as file transfers due to the ability to aggregate packet content. In some real-time applications (such as voice) do not benefit specifically from packet aggregation because its packets would be interspersed at regular intervals and combining packets into a larger payload would introduce unnecessary latency. Voice and other multimedia applications still benefit from other effects of MIMO. The maximum size of packet is 4KB to 64 KB.

Radio Preamble	Radio Header	Mac Header	Data	FCS

Figure 2. Packet Aggregation

4 802.11n Enhancements

The changes should be done in 802.11n including its Radio and MAC Enhancement that were problems occur in the legacy devices. In the enhancement of 802.11n the change should be done in Radio so that increase throughput, higher data rate and decrease overhead. Whereas in an Enhancement over MAC to increase the data rate. The following explanation should be done in both the cases.

4.1 Radio Enhancement

The MIMO Technology used in 802.11n makes a additional number of changes to the radio to increase throughput of the Wireless local area network. The other changes which include in 11n are increased the size of the channel, increase in modulation rates, overhead reduction etc.

The 802.11n uses 20 and 40 MHz channels to transmit higher data rate and reduce interference. In this way, the problem which is occurred in legacy devices are covered b the 802.11n Technology (Next generation wireless LAN). The 802.11n using the Radio channels (i.e. 20 and 40MHz) is also called as Channel bonding. This channel bonding incorporates the latest wireless LAN which can use two separate non overlapping channels at same time to transmit the data. This

ISSN 1512-1232

technique increases the amount of data that can be transmitted one to another end. The 802.11n having higher data rates when they are moving from 20 MHz to 40 MHz.

4.2 802.11n Modulation

The 802.11 uses direct sequence radio to transmit the data from one place to another in the form of bits (set of bits) which is also called as Symbol. The symbols are use in wireless networking. These symbols are set by 1 microsecond time to transmit the data. The 802.11b extended in the direct sequence radio that send more bits in to the symbol. Whereas legacy devices such as 802.11aand g uses OFDM (orthogonal division multiplexing) which divide larger channels into smaller one therefore easy to send the information and take 4 millisecond. 802.11n uses same method (OFDM) and takes the same time to transmit the data but it send more data rate s compared to legacy devices because 802.11a/g uses 48 to 52 Mbps at 20 MHz channels but 11n transmit 65Mbps over 20 MHz channel. Therefore 802.11n having higher data rate over legacy devices. The other side it transmit large data i.e. 135,207,405 and 540 Mbps at 40 MHz channel which is not get in legacy devices.

4.2.1 Guard Interval

The guard interval is a part of OFDM.

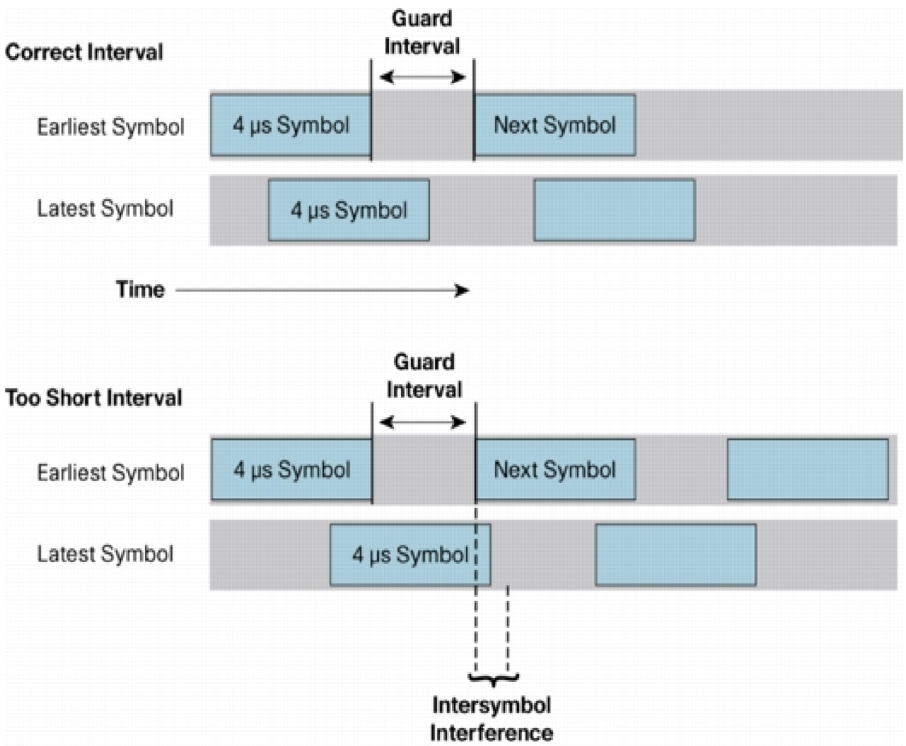

Figure 3. Guard Interval

The guard interval is used to minimize inter symbol interference. Guard interval means the interval in between the last symbol and new symbol. When the last symbol is go to the receiver and sender send the newer symbol then gap or interval in between the newer and older one is the guard interval. The guard interval is shown in the figure 3.

In legacy devices the interval time is 800 Nanosecond but in a newer technology it reduces the time interval and uses 400 Nanosecond. It also reduces symbol time up to 4 microseconds to 3.6 microseconds. This way it increases the data rate because of reduction of time interval and therefore lower overhead is their which is not in the legacy devices therefore 11n having impact over 11a/g.

ISSN 1512-1232

5 MAC Enhancement

The Mac uses Frame Aggregation for improving MAC layer, which combines multiple packets and transmits them together as one packet over the network. Therefore, it reduces the overhead that is associated with sending each individual packet out one at a time.

Typically, in a standards mode network, the transmitter sends a packet, then waits for an acknowledgment, sends another packet, waits for another acknowledgment, and so on. In 802.11n (i.e. Next WLAN), there is something called a Block ACK Frame. Instead of sending and receiving one ACK (acknowledgement code) after each packet, 802.11 devices will be able to send a whole stream of packets and at the end request a single ACK Frame that indicates only those packets that need to be retransmitted.

The next improvement to the 802.11n MAC is Reduced Interframe Spacing (RIFS). This is a change from the current standard, where Short Interframe Spacing (SIFS) is used. RIFS greatly minimizes the space between packets that are being sent out over the air, thereby decreasing unusable dead time.

This way MAC enhances the performance of 802.11n

5.1 Security

The security is the main issue for any technology. The 802.11n uses the standard 802.11i for authentication and encryption. Authentications means when to users are communicate with each other on wireless networks are authenticated or not. Whereas encryption means that the data which is travel in between sender and receiver must not read by anyone (means unauthorized user).Therefore, it uses wireless equivalent privacy (WEP) method for further security mostly for encryption. The 802.11n uses channel bonding approach to transmit data cross 40 MHz channel i.e. twice to other technology. Further more wireless intrusion detection/prevention system (WIPS) scan frequencies for malicious pattern as do in 20 MHz channels. The latest WIPS also detect rogue (or unauthorized user).

At last, 802.11n that uses a mechanism to acknowledge a block of packets instead of using individual packets identified by beginning and ending sequence identifier to improve efficiency.

5.2 Other Security Parameters

The Next generation WLAN which provides uncompromised protection and data privacy over distributed Networks. It uses four tiers security Architecture which offers various securities on different LAN:

• **802.11n Integrity assurance***:* With endpoint integrity assurance, WLAN prevents misconfigured or infected devices from accessing the network by checking for the latest security patches and service packs, personal firewall and routing policy, anti-virus and anti-spyware software.

• **802.11n authentication and encryption:** 802.11n provides Strong authentication, authorization, accounting, coupled with advance wireless protected access (also called WPA2) encryption prevents misuse and eavesdroppers and sniffers, isolating traffic between private users and groups, and ensuring data privacy.

• 802.11n Application-based firewall policy: 802.11n provides per user, per station, per group policy for QoS scheduling and security filtering that is application aware. Policy is enforced at the point in the network that is closest to the end station, preserving network bandwidth and improving performance throughout.

• **Intrusion protection.** The AirDefense solution defends against rogue devices, denial-of-service attacks, Evil Twins that spoof legitimate hotspots, misconfigured machines, and many other threats. An integrated Intrusion prevention system (IPS) reduces configuration efforts in comparison with deploying a separate IPS overlay, and simplifies administration.

ISSN 1512-1232

6 Interoperability

The Interoperability means that a system which works with other system without any special effort. Then it means when we compare the 802.11n with other legacy devices whether it supports it and existing 802.11a/b/g networks work with 11n devices.

There are two elements in 802.11n that have been built into the standard to provide backward compatibility. They are PHY Layer Protection and MAC Layer Protection.

6.1 PHY Layer Protection

In the legacy devices, the signal field contains information from a transmitting packet that indicates the length of the packet and at what data rate it is being sent. All other stations that hear this information can then correctly calculate the distance which the send packet out over the air. It means that the information send to the stations and how long to stay off the air.

With the new 802.11n high-throughput mode, a legacy packet is sent out at a legacy data rate in the signal field, and then a high-throughput packet is sent using some of the new data rates that the 11n standard defines. The high-throughput mode still uses the same legacy data rates, but the length of the packet is increased. So, even though they're using a new 11n data rate, legacy stations still understand how long to stay off the air.

6.2 MAC Protection

MAC Protection is used to send multiple packets in sequence. This is also doing in the same way in 11b and 11g. The Next generation WLAN 802.11 standard states that the presence of an 11b station within range of an 11g access point forces the access point to invoke a Request to Send/Clear to Send (RTS/CTS) or CTS-to-self protection mechanism. This protected mode prevents simultaneous transmission by devices using legacy 802.11 standards, which would result in collisions and retransmissions.

7 Comparison

There are some comparisons between 802.11n and legacy devices (e.g.802.11 a/b/g) are:

7.1 Throughput Comparison

As the Shown in Figure 4, data rates went from 11Mbps with 802.11b to 54Mbps with 802.11a and g and will go to hundreds of Mbps with 802.11n. The 300Mbps listed here is based on a 2x3 transmit/receive using 40MHz band with 400 ns. Guard Interval.

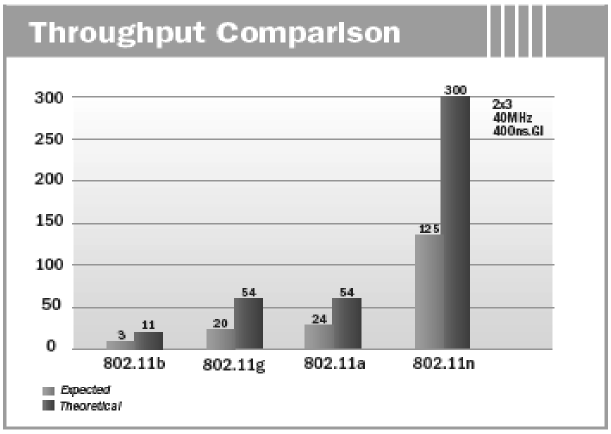

Figure 4. Data rate comparison of 802.11a/b/g & 802.11n

7.2 Rate and Range Comparison

This figure 5 illustrates rate and range, which are critical in all wireless networks. Generally speaking, one must choose between higher data rates, or longer range at lower data rates. The higher data rates will require you to have an 11n client on both sides of the link.

ISSN 1512-1232

In order to achieve these higher data rates, MIMO-enabled, or 11n-enabled access points must be used together with 11n-enabled clients. Since cell sizes can only be as large as their legacy clients allow, all of the stations in that cell must be upgraded to support MIMO or 11n.

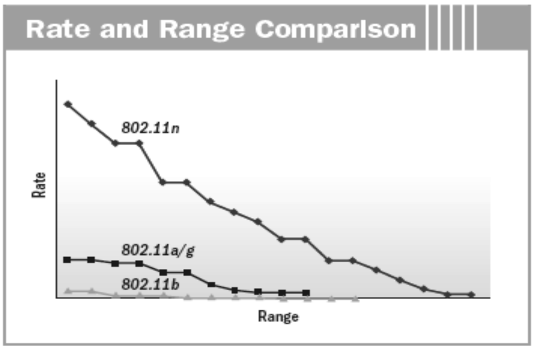

Figure 5. Rate and Range comparison of 802.11a/b/g & 802.11n

Conclusions

The next generation wireless technology solves many problems which are occurred in the legacy devices. It improves the throughput problems; increase the capacity of WLAN and opening the way for more applications such as wireless voice over IP and also for video conferencing. The newer technology will support all major platforms including home, offices and public environment. The 802.11n technology having wide bandwidth channel that satisfy next generation application and maintaining backward compatibility with previous generations of hardware.

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