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Performance Analysis of IEEE 802.11 ac WLANS on Throughput and TXOP Sharing for MU MIMO WLANS

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Abstract:-- **Ever increasing proliferation of the multimedia application on wireless, LAN'S demands high-throughput transmission support from these networks which in turn necessitates efficient resource approaches. The latest standard of IEEE 802.11ac leverages several physical layer techniques including downlink (DL) multiuser transmission to provide throughput application of the multimedia applications.. In this work, we analyze the TXOP sharing mechanism, by focusing on the MAC modification and enhancements introduced in the 802.11ac amendment, to achieve efficient DL-MU-MIMO transmission. The performance of the proposed TXOP sharing mechanism is simulated using the NS3.**

Keywords:— **Wireless Local Area Network LAN's (WLAN'S) , Downlink (DL), Medium Access control (MAC), Downlink Multi User Multiple Input Multiple Output (DL-MU-MIMO), Transmission opportunity period (TXOP).**

I. INTRODUCTION

Wireless local Area Network(WLAN) standard are released by IEEE (Institute of Electrical and Electronics Engineers) in 1997. In the 802.x standards there are various other popular standards also there like Ethernet IEEE 802.3 [2] , token ring IEEE 802.5. Various specification for medium access control (MAC) and physical layer (PHY) were defined in IEEE 802.11 wireless LAN. Totally three different PHY technology are outlined. namely, Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS) and Infrared (IR), with the maximum data transmission rate of up to 2 Mbps. The DSSS and FHSS Physical layers operated in the license free 2.4 GHz ISM (Industrial, Scientific and Medical) band.

In IEEEs 802.11 BSS (Basic Service Set) and IBSS (Independent Basic Service Set) are the two different architectures. The basic building block of an 802.11 network is the basic service set (BSS), which is simply a group of stations that communicate with each other. Communications take place within a somewhat fuzzy area, called the basic service area, defined by the propagation characteristics of the wireless medium. When a station is in the basic service area, it can communicate with the other members of the BSS. In an Independent Basic Service Set, STAs can communicate directly to each other, providing that they are within each other's transmission range. This form of architecture is facilitated to form a wireless ad-hoc network in absence of any network infrastructure

In this paper, we focus on MAC layer issues only, and propose a technique called TXOP sharing to extend the existing Transmit Opportunity (TXOP) of WLAN standard to support multiple downlink traffic streams to multiple receiver STAs simultaneously.

II. IEEE 802.11 AC FEATURES

In 2007, the IEEE [10] started a new task group, called Very High Throughput (VHT), with a goal to provide significantly higher throughput. In early 2014, 802.11ac was approved by the IEEE, and it is an evolution of the previous 802.11n standard. As such, 802.11ac is backwards compatible with 802.11a, -b, -g and -n. Inorder to use the new features, both the AP and the client need to support 802.11ac, otherwise one of the above legacy modes will be used. A key change in 802.11ac is the provision of greater bandwidth, which is required by the increasing use of demanding applications such as video streaming, database searches, and filetransfers. The 802.11ac standard provides speeds up to 2.6 Gbps [3].

As mentioned previously, to increase throughput, wider channels can be used. 802.11n [1] introduced the ability to send data over a wider 40 Mhz channel instead of over the traditional 20 Mhz channel. 802.11ac goes further and adds the option to use 80 Mhz and 160 Mhz channels as well. Due to the difficulty of finding contiguous 160 MHz spectrum in some areas, 802.11ac introduces two forms of 160 MHz channels: a single 160 MHz block and an "80+80 MHz" channel which combines two 80 MHz channels with the same capability. It only operates in the 5 GHz frequency band. 802.11ac has the option to use a new modulation, 256-QAM, which uses 16 constellation points instead of the 8 that are used in 802.11n. Figure 2.5 shows the different modulations.

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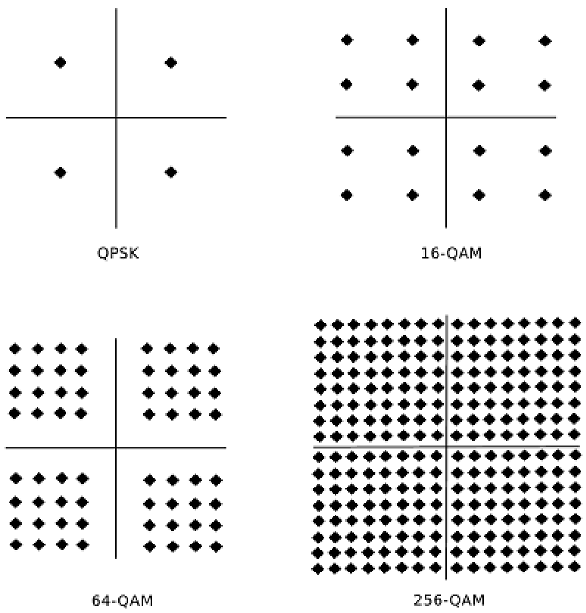

Figure 1: Modulation

III. TRANSMISSION OPPORTUNITY (TXOP) AND THEIR ISSUES FOR DL-MU-MIMO

IEEE 802.11e introduces Transmission Opportunity (TXOP), defined as the time Period during which a QSTA has the right to transmit the data in the given TXOP limit. In other words, in 802.11e when a station gets access to the medium, it is said to be granted the TXOP. Generally TXOP is in msec, which has starting time (min duration) and end time (max duration), called TXOP limit. When a QSTA gets the TXOP, it can then start transmitting frames such that the transmission duration of frame does not exceed the TXOP limit. TXOP Limit is specified by the QAP.

As described above, TXOP is the time duration an EDCAF may transmit after winning access to the medium. TXOP is characterized by a maximum duration, and minimum duration called TXOP Limit. As an EDCAF gets the TXOP, it can then start transmitting frames such that the transmission duration does not exceed the TXOP Limit. The transmission duration covers the whole frame exchange sequence, including the intermediate SIFS periods and ACKs, and the RTS and CTS frames if RTS/CTS mechanism is used.

Why the current TXOP is not DL MU-MIMO capable?

We believe the major hurdle for enabling DL MU-MIMO transmission at the MAC layer in the current 802.11standard resides at the operating rules of Transmit Opportunity (TXOP) – the current operation is per-AC (or single-user) based. To elaborate, these rules include

- An EDCA TXOP obtained by a STA can only be used to transmit frames belonging to the AC used to contend for the TXOP.
- During an EDCA TXOP won by an EDCAF, a STA may initiate multiple frame exchange sequences to transmit management/data frames, but only within the same AC.
- Internal contention among frames belonging to different ACs allows only one AC to win the internal competition for the TXOP.

Clearly, these existing rules would not allow multiple frames belonging to different ACs to be transmitted simultaneously; Hence limit the usefulness of the DL MU-MIMO technology.

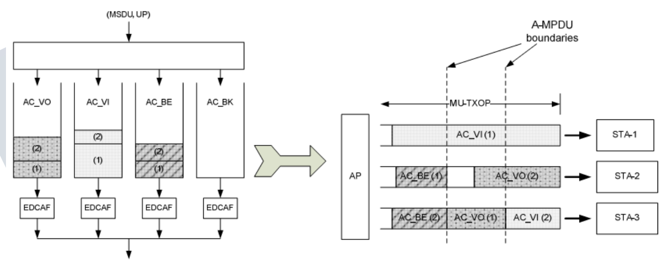

Figure 2 : Illustration of Access Category and TXOP Sharing

IV. TXOP SHARING ALGORITHM FOR MUMIMO IEEE802.11AC WLANS:

1. In the IEEE 802.11e/n standard, there are two modes in an EDCA TXOP ,the initiation of the TXOP and the multiple frame transmission within a TXOP.

2. when the EDCA rules permit access to the medium, the initiation of the TXOP was happen and when an EDCAF retains the right to access the medium, the multiple frame transmission occurs

3. In our approach, the initiation mode is kept the same as in the current specification while the multiple frame transmission mode was enhanced to allow multiple, simultaneous frame exchange sequences.

4. Our basic idea is that, the AP's each EDCAF competes for TXOP using its own EDCA parameter as it done in the IEEE 802.11 e/n.

5. Once an EDCAF gets a TXOP, it becomes the owner of that TXOP and its corresponding AC becomes Primary AC. Other ACs naturally become Secondary ACs.

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6. The Primary AC can then decide whether to share the TXOP with Secondary ACs for simultaneous transmissions.

7. If it does, the said TXOP becomes a multi-user TXOP (MU-TXOP)

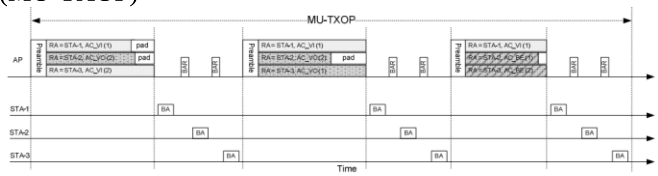


Figure 3: Illustration of Multiple frame transmission using in shred TXOP

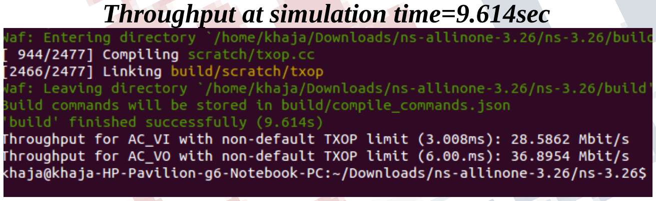
V NS3:

Ns3 [1] is a discrete-event network simulator, which means that the state of the simulation model can only change at discrete points in time, referred to as events. Events ate inserted into a queue, each with a specific time. Between the events in the nothing is changed. The execution of a event often leads to new scheduled events.

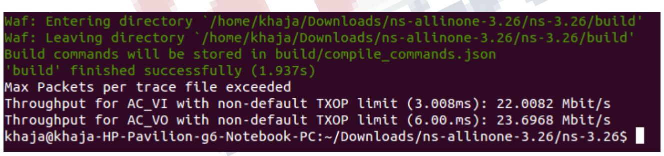
Ns3 project is started in 2006 and is open source. It is free software under GNU GPLv2[12] license. One advantage of ns3 is that it is written in C++ so that there is no need to debug two languages same time, as in the case with its predecessor, Ns2 which is written in C++ and an object orientation of tool compiled language (TCL)

V. SIMULATION AND OUTPUT:

Throughput at simulation time=9.614sec

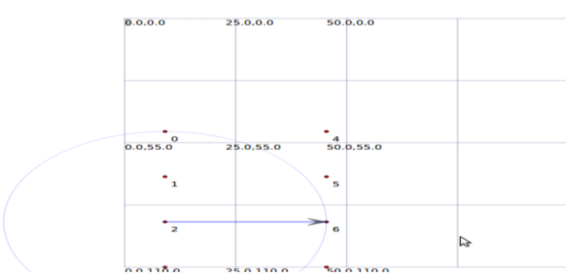


```
Waf: Entering directory `/home/khaja/Downloads/ns-allinone-3.26/ns-3.26/build
[ 944/2477] Compiling scratch/txop.cc
[2466/2477] Linking build/scratch/txop
Waf: Leaving directory `/home/khaja/Downloads/ns-allinone-3.26/ns-3.26/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (9.614s)
Throughput for AC_VI with non-default TXOP limit (3.008ms): 28.5862 Mbit/s
Throughput for AC_VO with non-default TXOP limit (6.00.ms): 36.8954 Mbit/s
khaja@khaja-HP-Pavilion-g6-Notebook-PC:~/Downloads/ns-allinone-3.26/ns-3.26$
```



```
Waf: Entering directory `/home/khaja/Downloads/ns-allinone-3.26/ns-3.26/build'
Waf: Leaving directory `/home/khaja/Downloads/ns-allinone-3.26/ns-3.26/build'
Build commands will be stored in build/compile_commands.json
'build' finished successfully (1.937s)
Max Packets per trace file exceeded
Throughput for AC_VI with non-default TXOP limit (3.008ms): 22.0082 Mbit/s
Throughput for AC_VO with non-default TXOP limit (6.00.ms): 23.6968 Mbit/s
khaja@khaja-HP-Pavilion-g6-Notebook-PC:~/Downloads/ns-allinone-3.26/ns-3.26$
```

Net-Anim:



VI. CONCLUSION

Develop the network model of NS3 for IEEE 802.11 n TXOP, and also measure the throughput for various access categories. Partially develop the NS3 network model for IEEE 802.11ac TXOP sharing and measure the throughput. And the current results shows that existing model will give the better simulation results.

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