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THE EFFECT OF MAC SUBLAYER PERFORMANCE IN WIRELESS AD-HOC NETWORKS

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Abstract: Many studies investigated to improve the MAC layer protocol performance in different standards, that these standards are generalized to other standards through changes. However, beam formation based on sharp loss way problems in 60GHz; it is one of the important features of IEEE802.11ad &IEEE802.15.3c. In this study, a beam formation protocol has presented first, for researching of antenna weight vectors, which has a low launch time and complexity. Since it assigned space in the super frame of MAC layer, its launch time has a high importance. Resource reservation in ad-hoc networks is a very challenging task due to the instability of radio channels, node mobility and lack of coordination between mobile nodes. Proposed reservation MAC protocols like CATA, FPRP, R-CSMA and SRMA/PA have limitations and are suitable only for particular situations. This paper proposed a comparative analysis of the most representative reservation MAC protocols. The major issues unresolved by reservation MAC protocols have been identified.
Keywords: MAC protocol, sub layer, ad-hoc network, launch time, standards

1. INTRODUCTION

Wireless networks have a wide range of applications such as complex structures like wireless cellular networks, which it has used for mobiles. Wireless personal networks include the different simple models of wireless headphones. (Rasid and Woodward, 2005; Sarkar et al., 2016; Wu and Fong, 2004). In the other hand, all equipment using infrared waves such as keyboards, mousses and some mobiles are also in this category. Data transfer speed, telecommunication networks capacity and place of network access network and in general, users request for improving system quality (QoS) are one of the main concerns in telecommunication network operators. These works have more energy consume increase in networks and then it can have environmental degradation factors. Therefore, wireless telecommunication network operators based on resolving of user needs have considered decreasing power consumption in cellular network. (Shi, 2016)

Quality of service is possible only if supported by the underlying medium access technology. In other words, the network-level QoS mechanisms cannot work in MANETs, unless the MAC ensures orderly access to the shared wireless medium, playing a crucial role in the efficient and fair sharing of the scarce wireless bandwidth. The nature of the wireless channel requires that different layers, in particular the network-layer and MAC sub-layer, interact constantly in order to provide an overall QoS. However, most of the network-layer QoS work is tailored to the distributed coordination function (DCF) of IEEE 802.11a/b as the underlying MAC. In the legacy IEEE 802.11, an ad hoc network is named Independent Basic Service Set (IBSS). An IBSS is based on the DCF that utilizes a random access method of carrier sense multiple accesses with collision avoidance (CSMA-CA). Since the latter is mainly meant for best-effort traffic, the present DCF-based MANET cannot support QoS at MAC-level, and subsequently overall end-to-end QoS guarantees. The time required to resolve collisions is a function of the network load. (Al-Turjman, 2018; Charfi et al., 2013; Ahn et al., 2000)

Given that millimeter band is a best technology, which plays important role in wireless communications, so, we meet with the problems such as intense channel inertia, the vulnerability to obstacles for millimeter wave communication, reduce spreading interference, and even a complete revision of the design principles in millimeter wave communications.

In (Qiao et al., 2015), a comprehensive analysis has been done on fifth generation millimeter band connection until 2015 and two standards IEEE802.15.3c and IEEE802.11ad introduced to MAC protocols of millimeter band connection based on comparative view, the dividing of unblocking performed activities in MAC layer and physical activity for millimeter band and transmitter/receiver structure along with used biopharming.

In this paper, millimeter band connection MMWC considers as a wireless technology of the future generation connections. MMWC refereed to connections with load frequency in millimeter band and 100GHz frequency of MMW. MMWC has many commercial uses and because of its broad frequency; it has more capabilities related to fewer than 6GHz connections. Therefore, beam formation algorithm proposed for wireless personal network in millimeter band waves.

2. METHODS AND SIMULATIONS

In MAC layer, the number of data must divide from upper layers to data service factors of MAC layer on data transformation. Protocol of automatic repeating request used for resending mechanism towards to increasing transmission assurance on wireless channel with error. Three resending performances in IEEE802.15.3 include no-ACK, Imm-ACK and Dly-ACK. Standard frame combination senders plan loads a MSDU under the sub load. Then, one sub header constructed for each frame, which include essential information for help to receiver to main data recovery. In sub header MAC, sender and

receiver notify to each other the available buffer size for preventing of buffer overflow. This information are important for sender and adjustment to bellow frame number and its length. Multi sub-frames arranged to one single frame for collecting standard frame performance (Al-Kaseem et al., 2017; Kiran et al., 2016).

A good error control mechanism provides a certain level of reliability in terms of communication robustness and dependability for higher network layers. In accordance with IEEE, 802.15.3 standard defines three types of acknowledgment mechanisms for CTAs and CAPs: No-ACK, Imm-ACK and Dly-ACK. (Karunatilaka, 2015)

The IEEE standard 802.15.3 MAC layer is based on a centralized, connection-oriented topology, which divides a large network into several smaller ones, termed as "Piconets". As shown in Figure 1, a Piconet consists of a Piconet Network Controller (PNC) and DEVs (Devices). The DEV, a sensor node, is made to be low power and low cost. In a given Piconet one DEV is required to perform the role of PNC (Piconet Coordinator), which provides the basic timing for the Piconet as well as other Piconet management functions, such as power management, Quality of Service (QoS) scheduling, and security. Using the formation of neighboring Piconets users can increase the range of network span. The WPAN starter Piconet is called a "parent Piconet" and child/neighbor Piconets are called "dependent Piconets". These Piconets differ in the way they associate themselves to the parent Piconet. (Chandra et al., 2014)

We consider a MMWC system with linear array of half-wave uniform distance by Ns and Nct parameters over system 1 and system2. The channel criteria for MMWC caused reaction based on MPCs and LOS. Distraction and scattering effects is negligible due to low wavelength MMWC. Therefore, MPCs in MMWC has directional property. In these channels, NLOS have low powers related to LOS elements. (Xia, 2007)

For resolving problem, assume that we have just one LOS element. According to this property, H channel matrix can write as bellow:

$$\mathrm{H} = \sqrt{\mathrm{N_d N_s}}\,\mathrm{g}(\mathrm{N_d}, \Omega_\mathrm{d})\ \lambda \mathrm{h}(\mathrm{N_s}, \Omega_\mathrm{s})^{\mathrm{H}} \tag{1}$$

$(.)^{H}$ is conjugate transpose operation; λ is a coefficient of LOS element channel. $\Omega_\mathrm{s} = \cos(\varphi_\mathrm{s})$ and $\Omega_\mathrm{d} = \cos(\varphi_\mathrm{d})$ which is φ_s and $\boldsymbol{\varphi_\mathrm{d}}$ indicators of LOS directions related to system 1 and 2 in it. (N_s,Ω_s) and $(\mathrm{N_d}, \Omega_\mathrm{d})$ are steering vector functions. (Xiao, 2016)

When system1 transfer normal training system X to system 2, a received signal in system 2 can be expressed as follows:

$$\mathrm{y} = \sqrt{\mathrm{N_d N_s}}\,\mathrm{w_d^H H w_s x} + \mathrm{w_d^H n} \tag{2}$$

Which is n white normal Gaussian noise vector. $\boldsymbol{\gamma}$-received SNR is divided as follows based on signal:

$$\mathrm{y} = \frac{\sqrt{\mathrm{N_d N_s}}\,\mathrm{w_d^H H w_s^2}}{\mathrm{w_d^H w_d}} = \sqrt{\mathrm{N_d N_s}}\,\mathrm{w_d^H H w_s^2} \tag{3}$$

Furthermore, we used of simultaneous links, which is applicable in 85GHz millimeter wave internal networks. A wireless personal network includes various wireless tools and a controller, which schedule device-to-device connections among wireless systems.

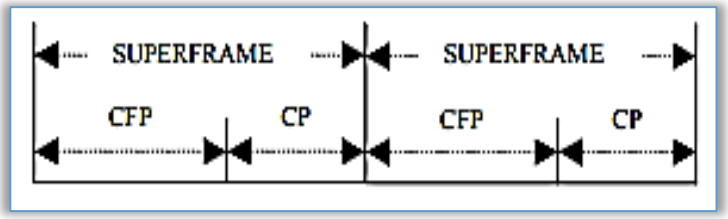


Figure 1. Timing diagram for IEEE 802.11 MAC layer

All the systems have directional antenna that is optimal for supporting of simultaneous transmissions. Simultaneous link transmission select a special beam for all wireless systems towards access the best performance.

MAC protocols can be classified based on the mode of operation into random access, guaranteed access, and hybrid access protocol. Guaranteed and hybrid access schemes normally require central nodes. Most of the works on QoS-enabled MAC have been based on guaranteed and hybrid access schemes, hence targeting infrastructure-based networks such as WLANs. Time Division Multiple Access (TDMA) frame based MAC protocol that allocates stations to different time-slots. In this scheme, the number of slots in each frame is dependent on the number of nodes in the network, and hence each slot belongs to a single node only. The higher the number of nodes in the network, the larger the frame size would be. This leads to unbounded delay for time-sensitive applications. Similar approach is followed in reservation CSMA-CA. In this scheme, CP and CFP alternate, and the CFP is based on TDMA.

Today, beamforming with exact phase change can provided in training data and high loads. So, we prefer bandwidth connection based on codebook to phase change without arrangement to each antenna. Codebook is a matrix that each columns of it shows phase change for each antenna element and it forms a special beam pattern. Each M antenna with N weight vector codebook of IEEE 802.15.3c shows as a bellow matrix:

$$\mathrm{W} = \left|\mathrm{w_{(m,u)}}\right| = \left|\mathrm{j}\frac{\mathrm{m} \times \mathrm{mod}(\mathrm{u} + \frac{\mathrm{N}}{2})}{\mathrm{N}/4}\right| \tag{4}$$

N is total of beam patterns. If N or M is greater than 4, the codebook can cause reducing beam efficiency in some directions. To achieving antenna uniform effect in different directions, must use designed codebook based on DFT.

All systems can predict beamforming, support three beam pattern such as Quasi-omni, sector and beam. All of these patterns created by codebooks. Beam pattern has highest resolution among codebooks. For reducing arrangement time in beamforming, beamforming process divided in three categories: device-to-device linking, searching in allover the section, and optional beam tracking level (Niu et al., 2018).

Designing codebook is based on researching algorithm. For consuming in searching time, researcg process divided in two levels: coarse search and fine search. Using of binary search in coarse search is based on hierarchy and organized binary tree. Coarse codebook must be layered.

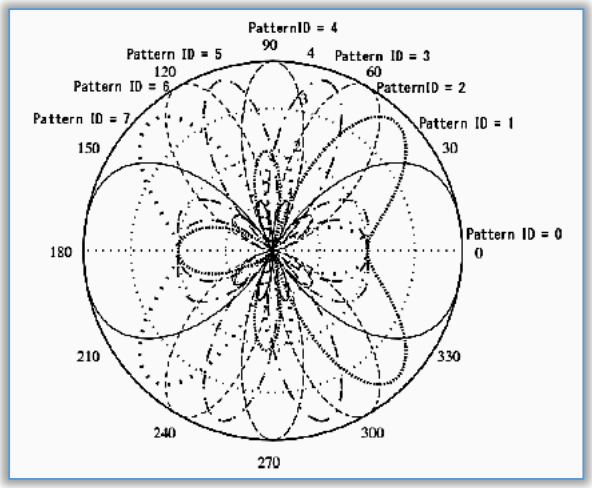


Figure 2. The sample of codebook with 4 antennas

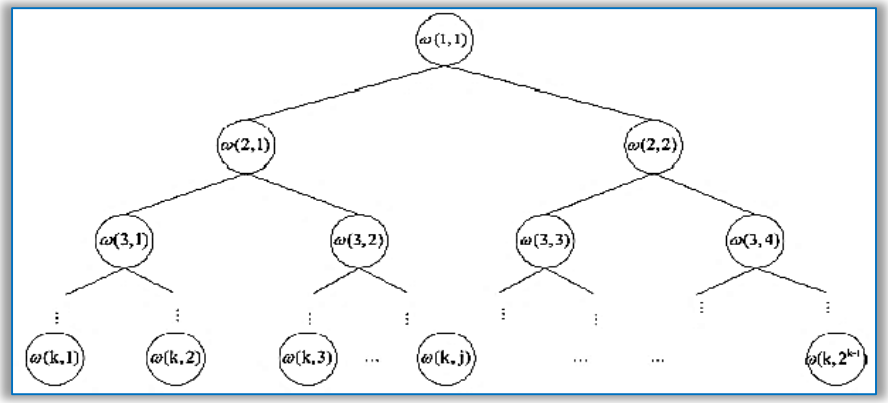


Figure 3. Structure of designed binary tree of coarse codebook

The angle resolution of coarse codebook can limited to N/2. It means that research AWV may have almost 1/N error. To achieve this purpose, resolution of AWV in Fine codebook cannot be greater than 2.

$$c(i) = g\left(N, -1 + \frac{2}{\alpha N} i\right), i = 1, \ldots., \alpha N \quad (5)$$

As can be seen, AWV Fine codebook N has higher resolution. The size of Fine codebook is (a-1) N.

We consider one system with simultaneous multilink connections. Figure2 shows beamforming model with the aim of achieving the best beam transmission pattern of $\mathbf{WDEV}_L^T$ and receive beam of $\mathbf{WDEV}_L^R$ in sender connection $\mathbf{WDEV}_L^T$ and receiver$\mathbf{WDEV}_L^R$. DACs and ADCs consume higher power in base band due to performance on several sample of gigahertz in second.

Beamforming has done on RF radio frequency band include only one RF singular chain for reducing energy consume. RF signal transfer using of received weight vector and combination changed in RF domain, then combined signal used for base band process. (He and Xiao, 2015)

In BP superconducting, PNC develop programmed information to wireless systems and shows that links in each time active for all activated links of beamforming. Each link begins with permitting to sender for sending training by each beam pattern to receiver. Sinr parameters can trace parallel link in corresponding receiver used of each any sender of beam transmission pattern. Then, sinr parameters identified and sent to the receiver. Training in $\mathbf{WDEV}_1^R$include period time. Each time include Nr attempts. Training continuous creates in IEEE802.15.3b with 128bit and 32 repeat. (Xiao, 2016)

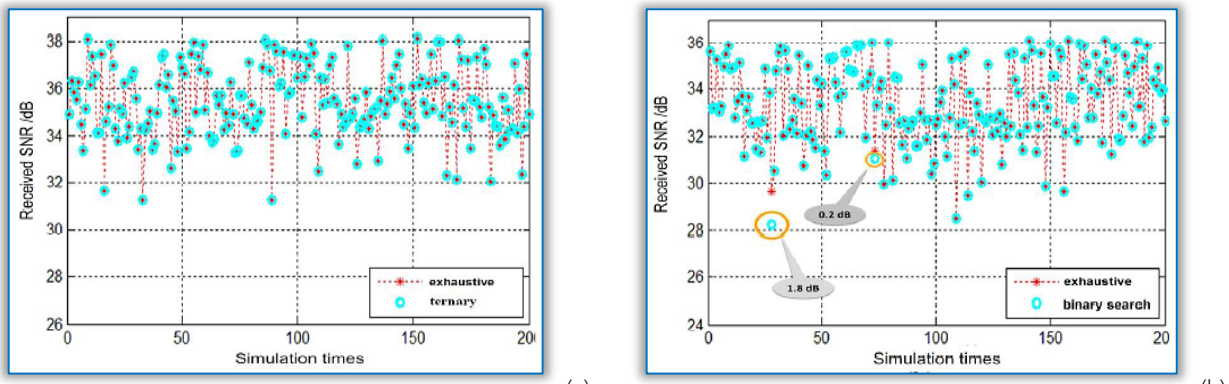
Simultaneous beamforming problem formulated by considering corresponding interference formula as an approximation problem of maximizing signals transmission speed. For reducing beamforming complexity and launch time, beamforming decomposed to multi beamforming and proposed a repeated research pattern. A beamforming based on codebook in MAC layer introduced by distribution method for determining beam set. Therefore, some beamforming method based on codebook in MAC layer presented for wireless personal networks in millimeter band wave.

3. RESULTS AND DISCUSSION

In this article, first of all beamforming, algorithm simulation or beam switching presented and then, weight vector antenna based on codebook investigated for wireless personal networks. We will simulate one of the important problems of increasing throughput network that is simultaneous links in MAC layer.

One of the important problems in wireless personal networks is having a high-speed beamforming protocol, little complexity and low time launching. Low time launching is important problem in implementing protocol on super frame MAC layer. (Ikeda, 2006)

The amount of received SNR calculates with proposed method. Proposed algorithm after 20step reaches to the threshold. Complexity of ternary search is better than binary search and they are better than IEEE.802.15.3c. In fair comparison between proposed method and exhaustive considered similar high level of SNR. The proposed algorithm gets 8 steps faster than exhaustive to the threshold. In comprising of received SNR for ternary research with exhaustive, we can see that it has accurate compliance.



(a) (b)

Figure 4. (a) Comprising of ternary research with exhaustive (b) comprising of binary research with exhaustive

Complexity of ternary research is better than binary and these methods are better than IIEEE802.15.3.c. Therefore, complexity of ternary search is better than Li Bin method. Piconet time launching based on super frame is assigned to beamforming between two spatial systems in CTA. Beam antenna related to the number of used antennas in sender. Each ID pattern is according to weight vector column, which will use for identifying the best-used beam in beamforming protocol. In the levels and performance of MAC layer among PNC and systems identified the best receiver and sender direction and used in all of receives and sends. This ID pattern achieved by antenna weight vectors based on codebook.

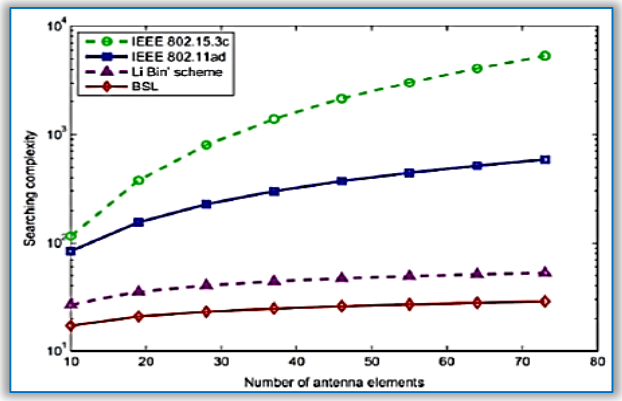


Figure 5. Comprising of ternary complexity with Li Bin and IEEE802, 11.ad and IEEE802.15.3c methods

If PER increased, the amount of launching time can increase to 701.585 microseconds. In the PER=0, stop time is 385.932 microseconds. In the SAS case, launching time with comprehensive search algorithm is 15.79ms.

For simultaneous transmissions protocol on MAC layer, we meet with correspond interference of simultaneous links. Therefore, the best receive and send beam for each link can be choose by considering interference effect on simultaneous links in network. Although increasing the number of network simultaneous links will subject to far away links, choosing best beam technique has not notable effect. Nevertheless, we can choose shorter links to reducing interference effect on other links.

4. CONCLUSION

In this research, we investigated MAC layer protocol performance for wireless personal networks. Therefore, all methods obtained based on CSMA\CA, beamforming protocol in MAC layer, time launching MAC layer with unblocking environments, multi-directional beam layer, ASTMA algorithm etc. This beamforming protocol has a space for super frame MAC layer. Therefore, reducing this time caused improving MAC layer performance. A beamforming protocol in MAC layer presented by capability of simultaneous transmission links on wireless personal networks. The average of throughput networks for proposed protocol rather than all transmit protocol has high stability and low fluctuates and more amount. Then a new method added to this protocol based on link length for transmission prioritizing.

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